KARUAH PIT CONSOLIDATION PROJECT – KARUAH EAST QUARRY (MP09_0175 MOD11)

Air Quality Impact Assessment

Final | Revision 1

16 February 2026

Project: 24075

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Acronyms and definitions

Abbreviation	Definition
AQIA	Air Quality Impact Assessment
BoM	Bureau of Meteorology
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPHI	NSW Department of Planning, Housing and Infrastructure, also referred to as NSW Planning
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence 12133
HQPL	Hunter Quarries Pty Ltd
HVAS	High volume air sampler
KEQ	Karuah East Quarry
KHRQ	Karuah Hard Rock Quarry
NEPM	National Environment Protection Measure
NEPC	National Environment Protection Council of Australia
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
$PM_{2.5}$	Particulate matter with equivalent aerodynamic diameters less than 2.5 microns
PM_{10}	Particulate matter with equivalent aerodynamic diameters less than 10 microns
POEO Act	Protection of the Environment Operations (POEO) Act 1997
SO_2	Sulphur dioxide
SSD	State Significant Development
TEOM	Tapered Element Oscillating Microbalance
TSP	Total suspended particulate matter

Executive Summary

Karuah East Quarry Pty Limited (KEQPL) owns and operates the Karuah East Quarry (KEQ), and together with Hunter Quarries Pty Ltd (HQPL) who owns and operates the Karuah Hard Rock Quarry (KHRQ), forms the Karuah Quarry Complex located approximately 5 kilometres (km) northeast of Karuah at Blue Rock Close / Andersite Road, Karuah. The KHRQ and KEQ sites produce a high quality andesite resource which is supplied to construction, infrastructure, and other development projects across Greater Newcastle, the Hunter Valley and Mid-North Coast regions.

HQPL and KEQPL are proposing to modify the State Significant Development (SSD) approvals for the Karuah Hard Rock Quarry (DA 265-10-2004) and the Karuah East Quarry (Project Approval MP09_0175) under the provisions of Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The applications are being referred to as the Karuah Pit Consolidation Project and will consist of two concurrent modification applications to the SSD approval for each quarry, that will be known as KHRQ MOD 2 and KEQ MOD 11.

HQPL has recently acquired Lot 11 DP 1024564 (Lot 11), enabling HQPL and KEQPL to control all landholdings within the Karuah Quarry Complex. This acquisition now allows the HQPL and KEQPL to readily extract previously sterilised resource from the remnant dividing highwall between the KEQ and KHRQ extraction pits forming a Consolidated Extraction Area (CEA). The purpose of the modification is to primarily enable the extraction of the previously sterilised andesite resource from the remnant dividing highwall as well as within other cleared areas from the KEQ site in a coordinated approach with the adjoining KHRQ.

Airen Consulting (Airen) has been engaged by KEQPL to prepare the Air Quality Impact Assessment (AQIA) for the Karuah Pit Consolidation Project, with this report considering the KEQ MOD 11 component of the overall project, which should be read in conjunction with the concurrent KHRQ MOD 2 AQIA.

The assessment has been undertaken in accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2022). The adopted methodology considers the existing operations, the modification design parameters, site-specific meteorological data and site-specific ambient quality monitoring data to determine the potential impacts to air quality with reference to the EPA's air quality impact assessment criteria.

The assessment involved identifying the key air quality issues, characterising the existing environment, quantifying emissions to air and modelling the potential impact of the KEQ on local air quality. The key air quality issues were identified as operational dust, post-blast fume and diesel exhaust. These issues were the focus of the assessment.

A detailed review of the existing environment was carried out including an analysis of historically measured concentrations of key quality indicators from regional and site-specific monitoring stations. The review showed that air quality in many parts of NSW, including the Hunter Region, is heavily influenced by climatic conditions such as drought. Data from site-specific monitoring showed that concentrations of key air quality indicators near the KEQ are within acceptable (EPA) levels and that the KEQ has not caused exceedances of EPA criteria at sensitive locations.

The key outcomes of the modelling and subsequent assessment were as follows:

- The proposed modification will not cause adverse impacts with respect to dust concentrations or deposition levels, based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.
- Post blast fume emissions are not expected to result in any adverse air quality impacts (as NO_2), based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.
- Emissions from diesel exhausts associated with off-road vehicles and equipment are not expected to result in any adverse air quality impacts, based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.

Based on this assessment, it has been concluded that the KEQ is unlikely to cause any adverse air quality impacts at sensitive locations, and it is considered that the proposed modification can be supported. A conservative approach was adopted for the modelling which (primarily) assumed that maximum daily production would occur every day of the year. The modelling results at all sensitive receptors are sufficiently below the respective air quality assessment criteria which demonstrate that any uncertainties in the modelling would not change the outcomes of the assessment.

KEQPL has committed to reviewing and revising the established Air Quality Management Plan, as appropriate, to meet conditions for air quality. An application will also be made to vary EPL 20611.

1 Introduction

1.1 Background

Karuah East Quarry Pty Limited (KEQPL) owns and operates the Karuah East Quarry (KEQ), and together with Hunter Quarries Pty Ltd (HQPL) who owns and operates the Karuah Hard Rock Quarry (KHRQ), forms the Karuah Quarry Complex located approximately 5 kilometres (km) northeast of Karuah at Blue Rock Close / Andersite Road, Karuah (**Figure 1**).

The KHRQ and KEQ produce a high quality andesite resource which is supplied to construction, infrastructure, and other development projects across Greater Newcastle, the Hunter Valley and Mid-North Coast regions.

HQPL and KEQPL are proposing to modify the State Significant Development (SSD) approvals for the Karuah Hard Rock Quarry (DA 265-10-2004) and the Karuah East Quarry (Project Approval MP09_0175) under the provisions of Section 4.55(2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The applications are being referred to as the Karuah Pit Consolidation Project and will consist of two concurrent modification applications to each quarries SSD approval, that will be known as KHRQ MOD 2 and KEQ MOD 11.

HQPL has recently acquired Lot 11 DP 1024564 (Lot 11), enabling HQPL and KEQPL to control all landholdings within the Karuah Quarry Complex. This acquisition now allows the HQPL and KEQPL to readily extract previously sterilised resource from the remnant dividing highwall between the KEQ and KHRQ extraction pits forming a Consolidated Extraction Area (CEA).

The purpose of the modification is to primarily enable the extraction of the previously sterilised andesite resource from the remnant dividing highwall as well as within other cleared areas from the KEQ site in a coordinated approach with the adjoining KHRQ.

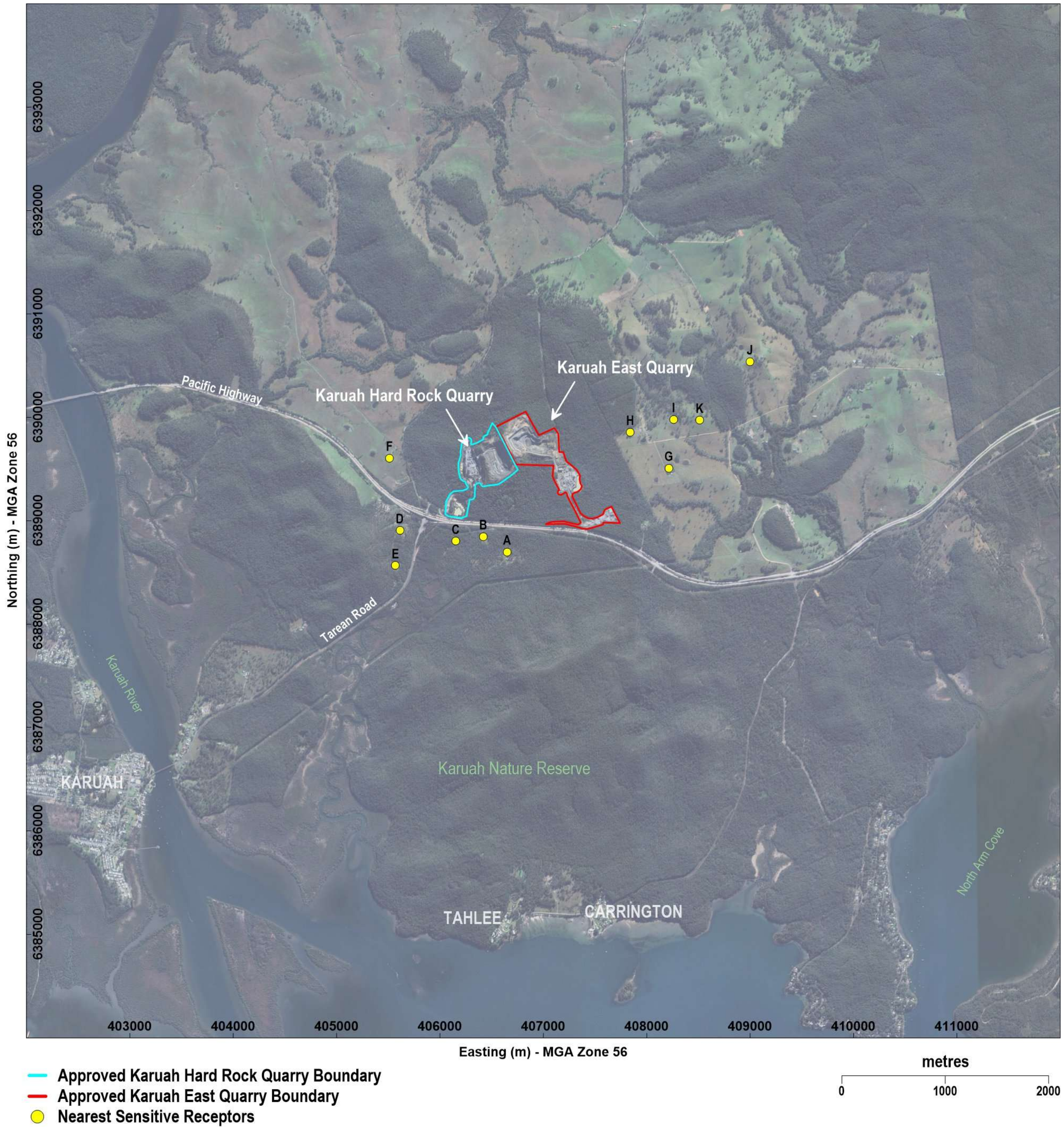


Figure 1 Location of Karuah East Quarry

1.2 Quarry Description

The operation of KEQ and KHRQ contribute towards satisfying significant and ongoing market demand associated with various State Significant Infrastructure (SSI) projects in the Newcastle, Hunter Valley and Mid-North Coast regions. These projects are critical to deliver improved connectivity of the Mid North Coast to Newcastle, the Hunter Valley and Sydney and include the Newcastle Inner-city Bypass (SSI-6888), Pacific Highway widening at Hexham Straight, Singleton Bypass, and the M1 Pacific Motorway extension to Raymond Terrace (SSI-7319).

KEQPL supplies high quality quarry products to a large and rapidly emerging customer base that includes Transport for NSW, a number of local Councils, the Port of Newcastle, Ausgrid, Newcastle Airport, Tier 1 infrastructure providers as well as the general construction, development and infrastructure industries within greater Newcastle, Hunter Valley and the Mid North Coast Regions. KEQPL also supplies and supports downstream businesses, including the Tea Gardens Hunter Readymix Concrete Plant, which in turn contributes to the local construction industry.

Project Approval (PA) MP09_0175 was granted for the KEQ on 17 June 2014 under the provisions of Section 75J of the EP&A Act 1979. The KEQ is well established and operational. The KEQ is operated by KEQPL, a company affiliated with Hunter Quarries Pty Ltd (HQPL), who also operate the KHRQ.

Key features of the PA MP09_0175 are summarised as follows:

- Quarrying operation is permitted on the site until 31 December 2034;
- Establishment and use of quarry plant and associated infrastructure;
- The extraction (excluding overburden), processing, stockpiling and transport of quarry products is limited to 1.5 million tonnes (Mt) in any calendar year;
- Roadworks to secure access to the site including upgrade and extension of Blue Rock Close, realignment of the Andersite Road and Blue Rock Close intersection and adjust road markings at Branch Lane and Andersite Road intersection;
- A total permitted disturbance area of 40.18ha;
- Establishment of a land based biodiversity offset on Part Lot 13 DP 1024564, Lot 14 DP 1024564, Lot 5 DP 838128 and part Lot 201 DP 1042537 / part Lot 21 DP 1042341 (location to be determined);
- Conditions apply to manage / mitigate potential impacts associated with a range of environmental conditions including noise; blasting; air quality; soil and water; transport; biodiversity; heritage; emergency and hazards management and waste; and
- Progressive rehabilitation of the subject site.

Approved operating hours for the quarry activities are as follows:

- 7.00am to 9.00pm, Monday to Friday.
- 7.00am to 10.00pm, Monday to Friday, on 50 calendar days per year.
- 7.00am to 6.00pm, Saturday.
- No drilling 6.00pm to 10.00pm Monday to Friday or 1.00pm to 6.00pm Saturday.
- No quarrying operations on Sundays or Public Holidays.

Approved operating hours for product loading and dispatch are as follows:

- 5.00am to 9.00pm, Monday to Friday.
- 5.00am to 10.00pm, Monday to Friday, on 50 calendar days per year.
- 6.00am to 6.00pm, Saturday.
- No product loading and dispatch on Sundays or Public Holidays.

Key features of the KEQ are illustrated on **Figure 2.** These include an extraction area, processing and stockpiling areas. Extracted rock is processed by fixed crushing and screening equipment, with finished quarry products transferred to discrete stockpiles. A north south internal haulage road links the stockpiling area to the processing and extraction areas. Access to and from the quarry is via Blue Rock Close, Andersite Road, The Branch Lane, and Pacific Highway. The haulage route to the Pacific Highway does not require heavy vehicles to pass any sensitive receptors (e.g. a property with a dwelling).

Figure 2 Site layout

1.3 Project Description

The proposal seeks to enable the extraction of previously sterilised andesite resource from the remnant dividing highwall and all disturbed areas at the KEQ (MOD 11 to MP 09_0175) and KHRQ (MOD 2 to DA 265-10-2004) in a coordinated approach. The proposal does not seek to increase the approved annual throughputs at either quarry (1.5 Mtpa at KEQ and 500,000 tpa at KHRQ). There will be no intensification of annual quarry operations.

For completeness, full details of the proposal relevant to each modification application are provided below. It is noted that this AQIA has been prepared specifically to support the MOD 11 application to the KEQ, with a separate, concurrent report prepared for the MOD 2 application to the KHRQ.

Development plans are provided within **Appendix A**, which include the proposed KEQ site plan and the proposed KHRQ site plan.

Karuah East Quarry MP09_0175 (MOD 11)

The proposed Modification to the KEQ (MOD 11) project approval consists of the following key components:

- Concurrently modify both the KEQ and KHRQ consents to extract the known resource contained within already disturbed areas of Lot 12, Lot 13 and Lot 11 including the dividing highwall, within the currently approved excavation depths of RL45 at KEQ and RL65 at KHRQ.
- Formalise a total life of quarry extraction at KEQ of 28.33Mt (a nominal reduction from the 29 million tonnes anticipated in the original KEQ Project Approval documentation).
- Minor extension and overlap of extraction boundary of both KEQ (into Lot 11) and KHRQ (into Lot 12) extraction areas to holistically encompass the highwall structure, inclusive of appropriate safety offsets.
- Extension of the KEQ extraction area to the west (highwall removal) and to the east.
- Material sourced from the overlapping area of the CEA will be transported by internal haul road to either the KEQ or KHRQ for processing, stockpiling, sale and transport to market within currently approved throughput rates.
- A minor extension of 4,690m^2 to the KEQ disturbance area. This area is located at the north-eastern boundary of the approved KEQ and is highly degraded and comprised entirely of exotic grasses and disturbed vegetation that has been historically cleared and managed to support a now redundant powerline corridor (infrastructure has been previously removed). This area is proposed to form a minor extension of the approved disturbance area and is incorporated into the consolidated extraction area. With the inclusion of this area, the total site disturbance area of KEQ will increase nominally from 40.18 Ha to approximately 40.65 Ha.
- Changes to approved blasting activity as follows:
  - Reduction in blasting frequency to limit the number of blasts to a maximum of two (2) blasts per week in total between KEQ and KHRQ.
  - Approved blasting hours at KEQ are proposed to be extended by one (1) hour to occur between the hours of 9am and 5pm (Monday to Friday) to provide improved flexibility during blasting of the dividing highwall and align with proposed arrangements at KHRQ.
- Revised final landform resulting in a free-draining landscape of the current extraction area, reduced geotechnical risks over the long-term and a landform with greater consistency with the existing surrounding environment.
- Reviewing and modernising the established Air Quality Management Plan and monitoring program.

No change is necessary to the Project Approval as it relates to annual extraction, processing and transport rates (capped at 1.5 Mtpa).

Karuah Hard Rock Quarry DA265-10-2004 (MOD 2)

The separately proposed Modification to the KHRQ (MOD 2) development consent consists of the following key components:

- Concurrently modify both the KHRQ and KEQ consents to extract the known resource contained within already disturbed areas of Lot 12, Lot 13 and Lot 11 including the dividing highwall, within the currently approved excavation depths of RL65 at KHRQ and RL45 at KEQ.
- Minor extension and overlap of extraction boundary of both KHRQ (into Lot 12) and KEQ (into Lot 11) extraction areas to holistically encompass the highwall structure, inclusive of appropriate safety offsets.

- Material sourced from the overlapping area of the combined extraction area (CEA) will be transported by internal haul road to either the KHRQ or KEQ for processing, stockpiling, sale and transport to market within currently approved throughput rates.
- An extension of the life of quarrying operations from 3 June 2027 to 31 December 2034 to align with the approved operational timeframe of the KEQ.
- Increase in approved total resource volume from 11.20 Mt to 13.20 Mt (18% increase).
- Extended operating hours to match the approved hours of operation of the KEQ (refer to section 1.2 above).
- Changes to approved blasting activities as follows:
  - Change in blasting frequency from one (1) blast per week at KHRQ to a combined two (2) blasts per week in total between KHRQ and KEQ. This will result in a cumulative reduction of blasting activities between KHRQ (one blast per week currently approved) and KEQ (2 blasts per week currently approved) from a total of three (3) blasts per week to two (2) blasts per week.
  - Approved blasting hours are proposed to be extended by 2 hours to occur between 9am and 5pm (Monday to Friday) to provide improved flexibility during blasting of the dividing highwall and align with proposed arrangements at KEQ.
- Revised final landform resulting in a free-draining landscape of the current extraction area, resulting in reduced geotechnical risks over the long-term and a landform with greater consistency with the existing surrounding environment.
- Reviewing and modernising the established air quality monitoring program.
- Environmental safeguards incorporated into Management Plans that are in place for the KHRQ operation will be reviewed and updated (where required) to accommodate the proposal.

No change is necessary to the Development Consent as it relates to annual extraction, processing and transport rates (capped at 500,000 tpa).

Extraction Staging

The following coordinated extraction sequence between the KEQ and the KHRQ will be generally undertaken to complete the Karuah Pit Consolidation Project (inclusive of remnant highwall removal):

- Stage 1: Extract the current top benches of the remnant highwall (RL135 m) down to RL90 m (currently lowest KEQ bench at the time of writing (February 2026)), forming a single extraction level/area on Lot 12. This approach is needed to safely remove peak of the dividing highwall and make the extraction area level with the current KEQ extraction area.
- Stage 2: Extract Lot 12 from RL90 m (currently lowest KEQ bench at the time of writing (February 2026)), down to RL65 m in line with KHRQ pit floor and KEQ boot-bin levels, forming a single extraction level/area over the entire Consolidated Extraction Area.
- Stage 3: Extract final benches at KEQ (Lots 12 & 13) from RL65 m down to RL45 m. The KHRQ pit floor is to remain at RL65 m.

Other Proposed Quarry Operations – Karuah South Quarry

The proposed Karuah South Quarry (KSQ) (State Significant Development (SSD) SSD-8795) application at Lot 11 DP 1024564 is located to the west of KEQ and the south of the existing KHRQ extraction area. The KSQ proposal seeks to extract the remaining resource south (of KHRQ) and west (of KEQ) of the existing quarry's limit of extraction. The quarry is proposed to be a conventional drill and blast operation with rock collected and processed onsite. Processed product is proposed to be stockpiled onsite with a loader used to load trucks for transport off-site when required. The proposed hours of operation are 5:00 am to 6:00 pm Monday to Friday and 5:00 am to 1:00 pm Saturday with only product loading and transport activity to occur between 5:00 am and 7:00 am. The proposed annual production limit is 600,000 tonnes.

Following acquisition of Lot 11 DP 1024564, KEQPL (and affiliated companies) is also the proponent for the proposed KSQ. In relation to the consideration of cumulative impacts, the following is noted:

- If approved, KSQ will not commence operations until after operations at KHRQ have ceased;
- The applicant is currently reviewing the business case for the proposed KSQ; and
- Any future revision or amendment to the proposed KSQ project will be supported by an updated AQIA that accounts for the proposed Karuah Pit Consolidation Project

This assessment has included consideration of potential cumulative air quality impacts with the proposed KSQ.

1.4 Environmental Assessment Requirements

This AQIA has been prepared in accordance with the Assessment Requirements issued by the NSW Department of Planning, Housing & Infrastructure (NSW Planning) issued on 1 October 2025, that requires the Modification Application to consider air quality impacts.

1.5 Report Structure

The report is structured as follows:

- **Section 1** provides a background and description of the KEQ and KHRQ.
- **Section 2** identifies the key air quality issues to be addressed.
- **Section 3** outlines the key legislative and policy assessment requirements for air quality.
- **Section 4** discusses key features of the existing environment including surrounding land uses, sensitive receptors, and local meteorological and air quality conditions.
- **Section 5** provides an overview of the methods used to assess the potential for air quality impacts.
- **Section 6** provides an assessment of the potential air quality impacts.
- **Section 7** outlines the measures to mitigate or otherwise effectively manage potential impacts.
- **Section 8** provides the conclusions of the assessment.

2 Key Issues

Air quality issues can arise when emissions from an industry or activity lead to a deterioration in the ambient air quality. Potential air quality issues have been identified from a review of the KEQ and associated activities. This identification process has considered the types of emissions to air and proximity of these emission sources to sensitive receptors.

Emissions to air from the KEQ could occur from a variety of activities including material handling, material transport, processing, and wind erosion from exposed areas. These emissions will primarily occur during the operational phase, as limited construction works will be required. The main emission to air from quarry activities is dust, also referred to as particulate matter.

Key classifications of particulate matter include:

- Total suspended particulates (TSP).
- Particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}).
- Particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$).
- Deposited dust.

Plant and equipment engine exhausts also have the potential to generate emissions that include carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter, and to a lesser extent sulphur dioxide (SO_2). Post-blast fume has the potential to generate nitric oxide (NO) emissions which, in turn, can oxidise to the more harmful nitrogen dioxide (NO_2).

The key issues which were identified for the KEQ for consideration in this assessment included:

- Quarry dust i.e. particulate matter in the form of TSP, PM_{10}, $PM_{2.5}$ and deposited dust from extraction, processing and material transport to the site boundary.
- Post-blast fume (NO_2).
- Diesel exhaust (PM_{10}, $PM_{2.5}$ and NO_2).

3 Air Quality Criteria

Air quality is typically quantified by the concentrations of substances in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of one or more substances known to cause health, nuisance and/or environmental effects, exceeds a certain level. With regard to human health and nuisance effects, the substances most relevant to the KEQ have been identified, from **Section 2**, as particulate matter and NO_2.

3.1 Project Approval MP09_0175

Air quality impact assessment criteria for particulate matter are prescribed in PA MP09_0175. The EPA has also developed impact assessment criteria for a range of air quality indicators. The relevant criteria are discussed below.

Schedule 3, Condition 13 of PA MP09_0175 requires KEQPL to "ensure that all reasonable and feasible avoidance and mitigation measures are employed so that particulate matter emissions generated by the development do not exceed the criteria listed in Tables 7 to 9 at any residence on privately owned land". **Table 1** shows the air quality criteria from PA MP09_0175. It should be noted that air quality criteria from the PA 09_0175 (**Table 1**) are not used for the purposes of project assessment but are included for the purpose of benchmarking KEQPL's performance with respect to air emissions.

Table 1 Air quality criteria from PA MP09_0175

Air quality indicator	Averaging time	[d] Air quality criteria from PA MP09_0175
Particulate matter (PM_{10})	24-hour	[a] 50 µg/m³
	Annual	[a] 30 µg/m³
Particulate matter (TSP)	Annual	[a] 90 µg/m³
Deposited dust [c]	Annual (maximum increase)	[b] 2 g/m²/month
	Annual (maximum total)	[a] 4 g/m²/month

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).
[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).
[c] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air – Determination of Particulate Matter – Deposited Matter – Gravimetric Method.
[d] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, sea fog, fire incidents, illegal activities or any other activity agreed by the Planning Secretary in consultation with EPA.

3.2 Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

The EPA has developed assessment criteria for a range of air quality indicators including particulate matter and NO_2. These criteria are outlined in the "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA, 2022), hereafter referred to as the Approved Methods. Most of the EPA criteria referred to in this report have been drawn from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPMs) (NEPC, 1998 and updates). **Table 2** shows the relevant EPA air quality assessment criteria. These criteria apply to existing and potentially sensitive receptors, where a sensitive receptor is defined as including "a location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area".

Table 2 EPA air quality assessment criteria

Air quality indicator	Averaging time	Criterion
Particulate matter (PM_{10})	24-hour	50 µg/m³
	Annual	25 µg/m³
Particulate matter ($PM_{2.5}$)	24-hour	25 µg/m³
	Annual	8 µg/m³
Particulate matter (TSP)	Annual	90 µg/m³
Deposited dust	Annual (maximum increase)	2 g/m²/month
	Annual (maximum total)	4 g/m²/month
Nitrogen dioxide (NO_2)	1-hour	164 µg/m³
	Annual	31 µg/m³

The EPA air quality assessment criteria relate to the total concentration of pollutants in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess the potential impacts. In situations where background levels are elevated the proponent must "demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical" (EPA, 2022). **Section 4** provides further discussion on background levels.

The KEQ has been assessed in terms of its ability to comply with the relevant air quality criteria set by the EPA as part of the Approved Methods.

4 Existing Environment

This section provides a description of the environmental characteristics in the area, including a review of recent and historical meteorological and ambient air quality conditions.

4.1 Local Setting

KEQ is located on the northern side of the Pacific Highway approximately 5 km north-west of the township of Karuah, NSW. There are a several existing rural dwellings to the west, south and east of the KEQ, with the closest dwelling located approximately 800 m from the site's eastern boundary (**Figure 1**).

KEQ is located in a coastal environment consisting of gently undulating terrain and at an elevation of between around 50 and 100 m above mean sea level. **Figure 3** shows a three-dimensional representation of the local terrain. This topographical environment has the potential to influence local wind conditions, discussed in **Section 4.2**.

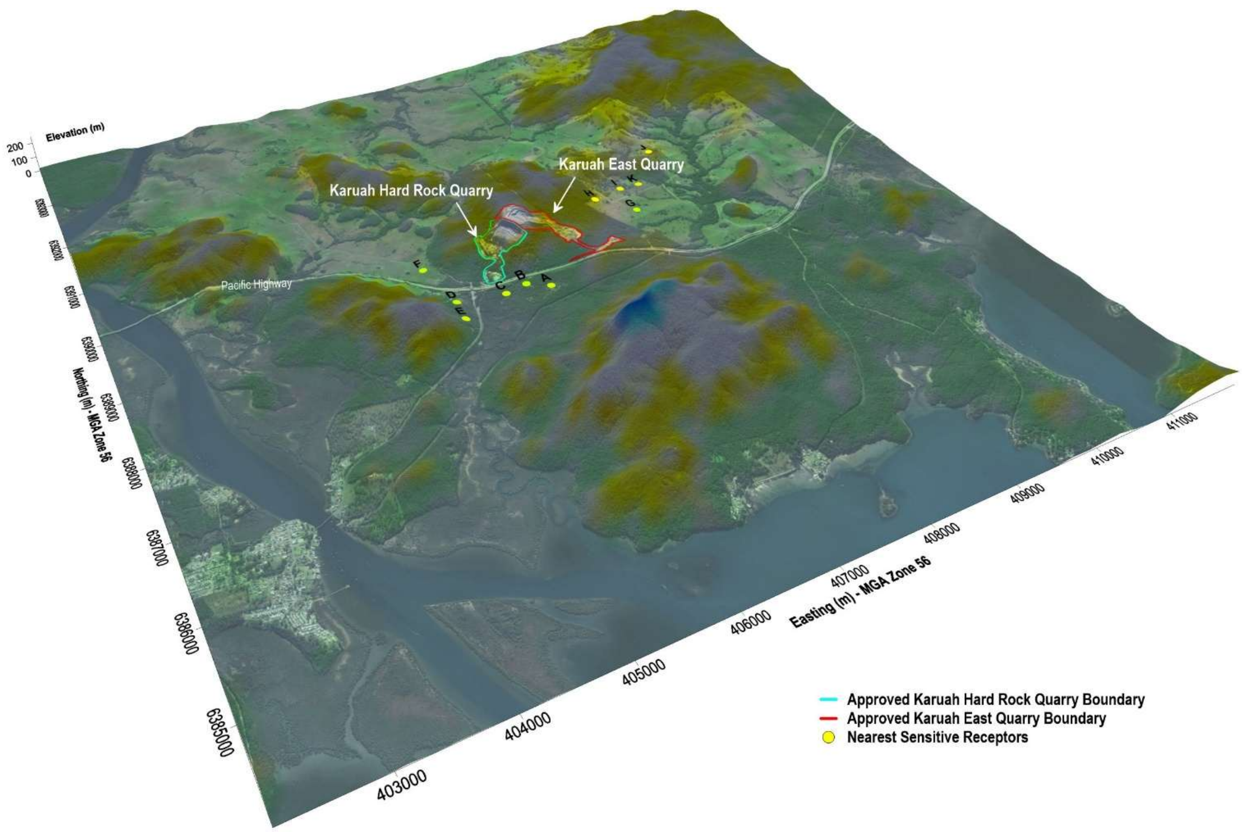


Figure 3 Three-dimensional representation of the local terrain

4.2 Meteorology

Meteorological conditions are important for determining the transport of emissions, and the potential influences on air quality. In addition, meteorological data are often used with concurrent air quality data to determine potential contributions from sources of interest. This section provides an analysis of the meteorological conditions around the site and identifies the datasets that are representative of the long term, local conditions.

The EPA prescribes the minimum requirements for meteorological data that are to be used for air quality assessments. These requirements are outlined in the Approved Methods and include minimum data capture rates, siting and operation, and data preparation. Meteorological stations that are used for the purposes of air quality assessments can be classified (EPA, 2022) as either "site specific" or "site representative". Data from site-specific meteorological stations are preferred however site representative data are also acceptable where site-specific meteorological data are not available provided that the data adequately describe the expected meteorological conditions at the site of interest. Air quality assessments that involve modelling are usually carried out using at least one year of site-specific or site-representative meteorological data that is over 90% complete.

On behalf of KEQPL, HQPL operates a meteorological station near the entrance of the KHRQ. **Figure 4** shows the location. The monitoring is carried out to understand the local meteorological conditions, assist with operational decisions, and to inform air quality and other environmental studies. The EPA does not define specific criteria (such as distances) for determining “site-specific” or “site-representative” meteorological stations. However, the meteorological station was installed in accordance with the applicable Australian Standard (AS 3580.14) and specifically collect data to assist with site operations. This station can be considered as “site-specific” for the purposes of this air quality assessment and will have collected data that can be classified as specific to the prevailing conditions at KEQ and KHRQ.

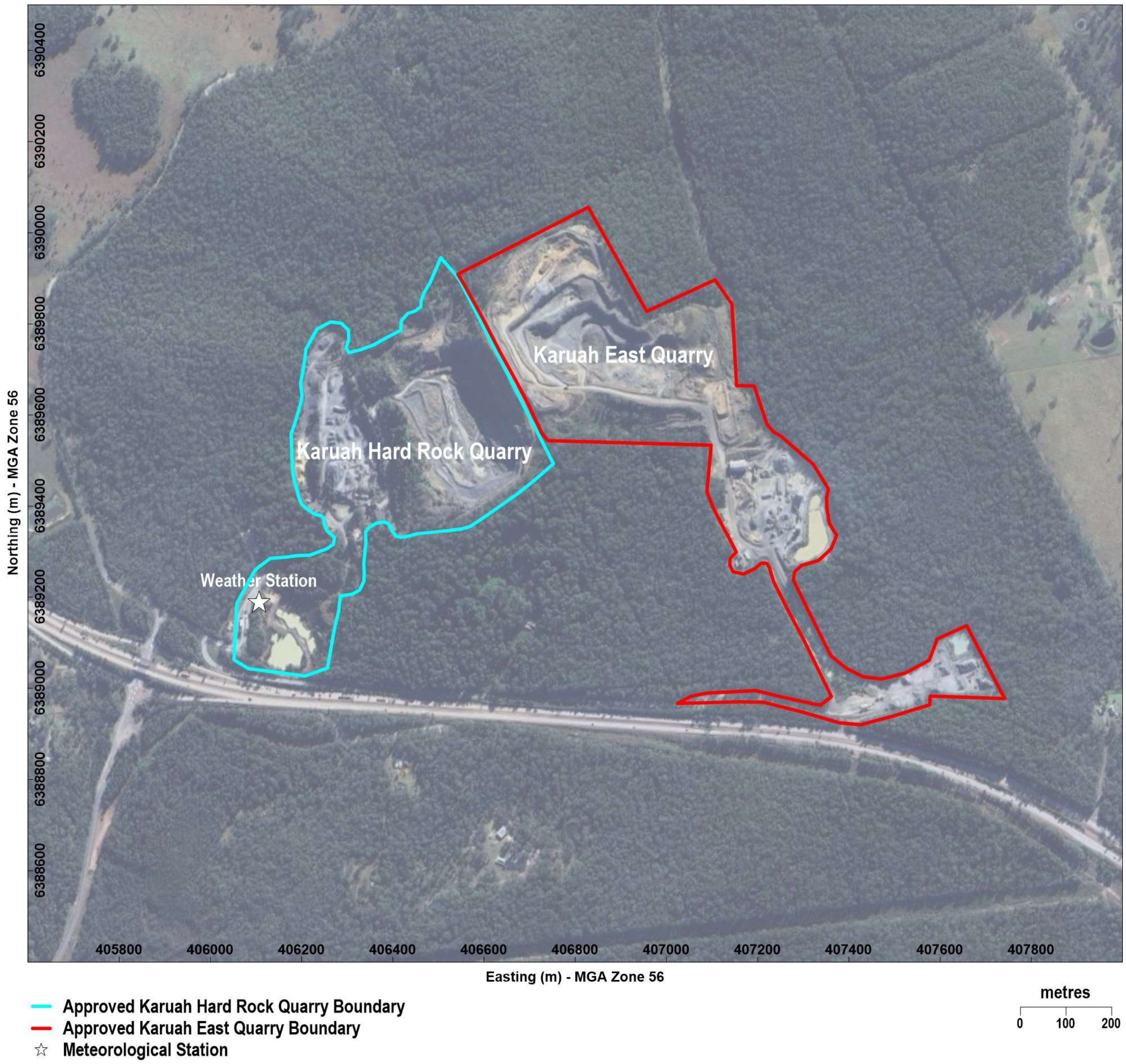


Figure 4 Location of meteorological station

Table 3 provides annual statistics from the data collected at the site weather station. These statistics do not highlight any unusual or extraordinary years in terms of wind speed statistics.

Table 3 Statistics from data collected at the site weather station between 2020 and 2024

Statistic	2020	2021	2022	2023	2024
Percentage complete (%)	100	100	100	100	100
Mean wind speed (m/s)	1.4	1.3	1.3	1.3	1.3
Percentage of calms (<= 0.5 m/s) (%)	29	29	28	29	30

Figure 5 shows the hourly wind speed data from data collected from the site weather station between 2020 and 2024. These data show that maximum hourly wind speeds have reached around 7 metres per second (m/s) with the strongest winds generally occurring in summer. There were no periods that might be considered as unusual or extraordinary.

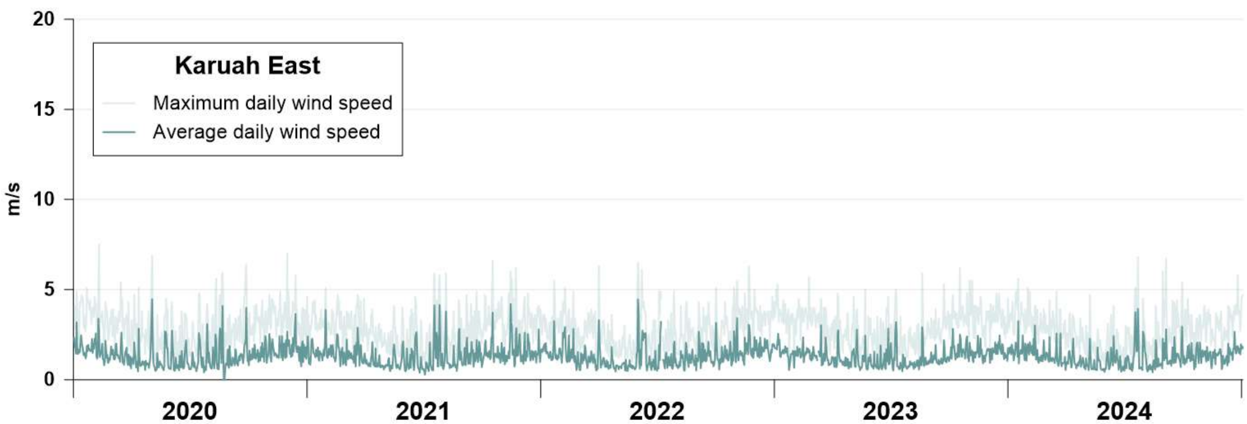


Figure 5 Wind speed data collected between 2020 and 2024

Wind-roses have also been prepared from the available data (**Figure 6**). The wind-roses show the frequency of wind speeds and wind directions based on hourly records. The circular format of the wind rose shows the direction from which the wind blew and the length of each "spoke" around the circle shows how often the wind blew from that direction. The different colours of each spoke provide details on the speed of the wind from each direction.

Figure 6 shows that the winds at the site are predominantly from the southeast or west. This pattern of winds is evident in all years of data with some variation from year to year. Data from 2024 have been selected for modelling to inform the air quality impacts of the KEQ. The selected data are site-specific and are over 90% complete for a one-year period, meeting the EPA's requirement for "Level 2" impact assessments (EPA, 2022). **Section 4.2** also indicates that air quality conditions in 2024 were not adversely influenced by bushfire activity or extreme conditions. Methods for incorporating the 2024 data into the modelling are discussed in detail in **Section 5**. Annual and seasonal wind-roses are provided in **Appendix B**.

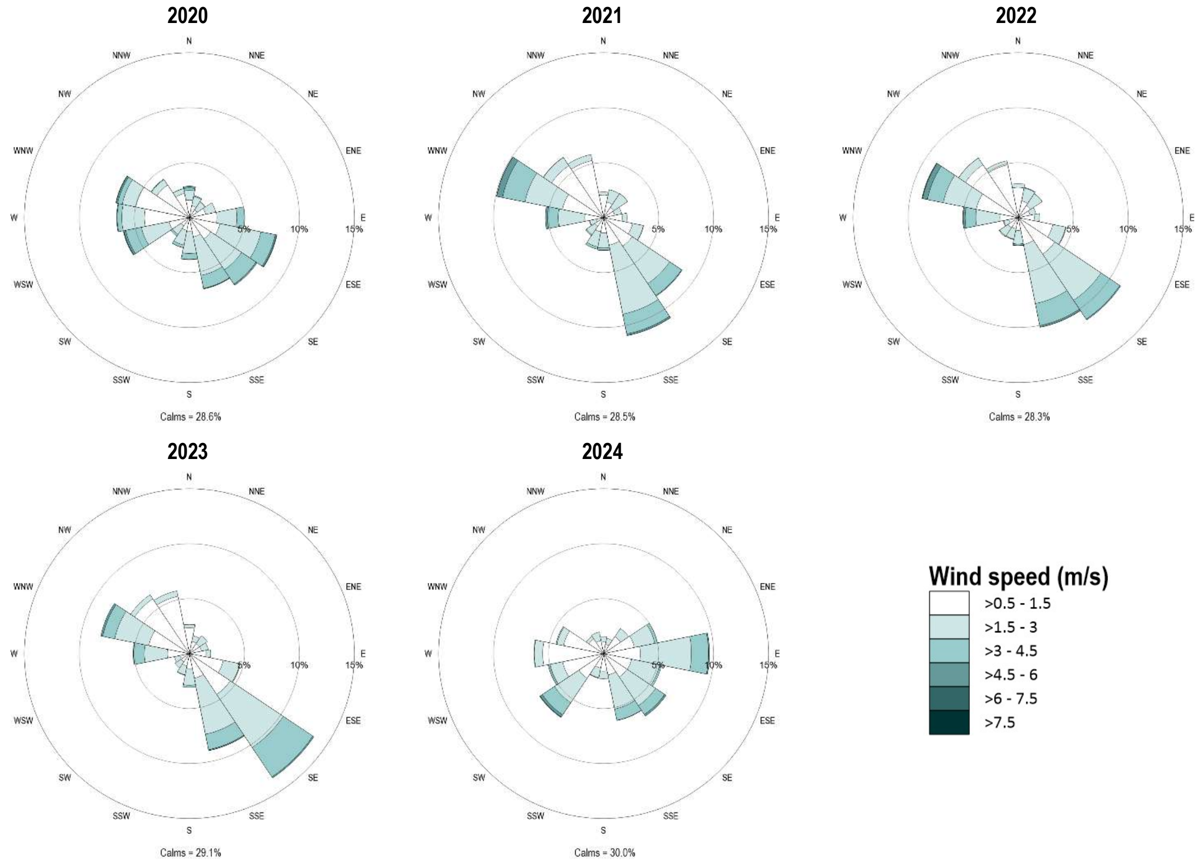


Figure 6 Wind-roses from data collected at the site meteorological station

4.3 Air Quality

The NSW Department of Planning, Housing and Infrastructure (NSW Planning) monitors air quality at various locations across NSW including in the Lower Hunter. The network includes over 90 air quality monitoring stations. Over 50 stations use compliance methods to monitor air quality in areas of the State's highest populations, near industrial activities, and at locations with special interest or research purposes. Over 35 stations, supported by rural communities, use indicative instrumentation methods to monitor particles across the NSW rural air quality monitoring network.

This section examines the historical air quality conditions of the region and establishes the appropriate background levels to be considered for assessment of the KEQ. It should be noted that air quality monitoring data represent the contributions from all sources that have at some stage been upwind of each monitor. In the case of particulate matter (as PM_{10}) for example, a measurement may contain contributions from many sources such as from construction works, wood fires, bushfires and 'burning off', agricultural activities, industry, vehicles, roads, wind-blown dust from nearby and remote areas, fragments of pollens, moulds, and so on.

KEQPL operates a local air quality monitoring network primarily to assist with evaluating performance against the air quality criteria in the approvals for KEQ and KHRQ. **Figure 7** shows the location of the air quality monitors. The monitors are used to collect information of PM_{10} and deposited dust levels. The data from these monitors are discussed below, as well as data from regional locations.

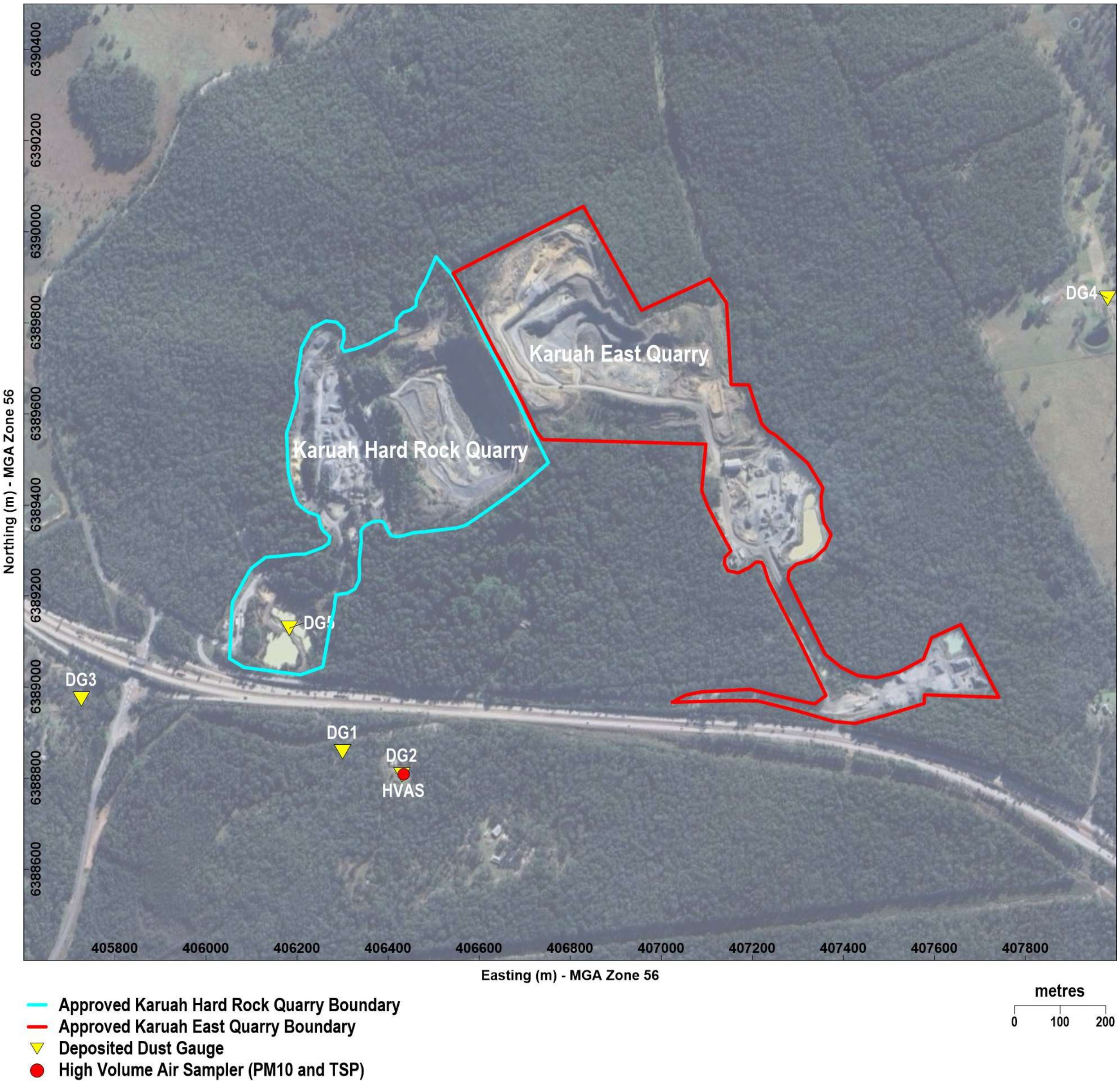


Figure 7 Location of air quality monitors

4.3.1 Extraordinary Events

Air quality in many parts of NSW, including the Hunter Region, was adversely influenced by drought conditions between 2017 to 2019 and lower than average rainfall. A deterioration in air quality conditions over these years was not unique to the Hunter Region and extraordinary events, beyond normal conditions, have been identified as part of annual reviews of monitoring data.

In its “Annual Air Quality Statement 2018”, NSW Planning concluded that particle levels increased across NSW due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH, 2019). NSW Planning subsequently concluded, from their “Annual Air Quality Statement 2019”, that air quality in NSW was greatly affected by the continuing intense drought conditions and unprecedented extensive bushfires during 2019. In addition, the continued “intense drought has led to an increase in widespread dust events throughout the year” (DPE, 2020).

The influence of drought conditions on air quality is evident in NSW Planning’s monitoring data. **Figure 8** shows the rolling annual average PM_{10} concentrations from data collected at various rural and urban air quality monitoring sites since 2011. These data clearly show an increase in PM_{10} concentrations at all rural and urban locations from 2017 onwards, reflecting the onset of drought conditions, and increased bushfire activity in 2019. The rolling annual average PM_{10} concentrations decreased rapidly from 2020 to 2022 as rainfall increased.

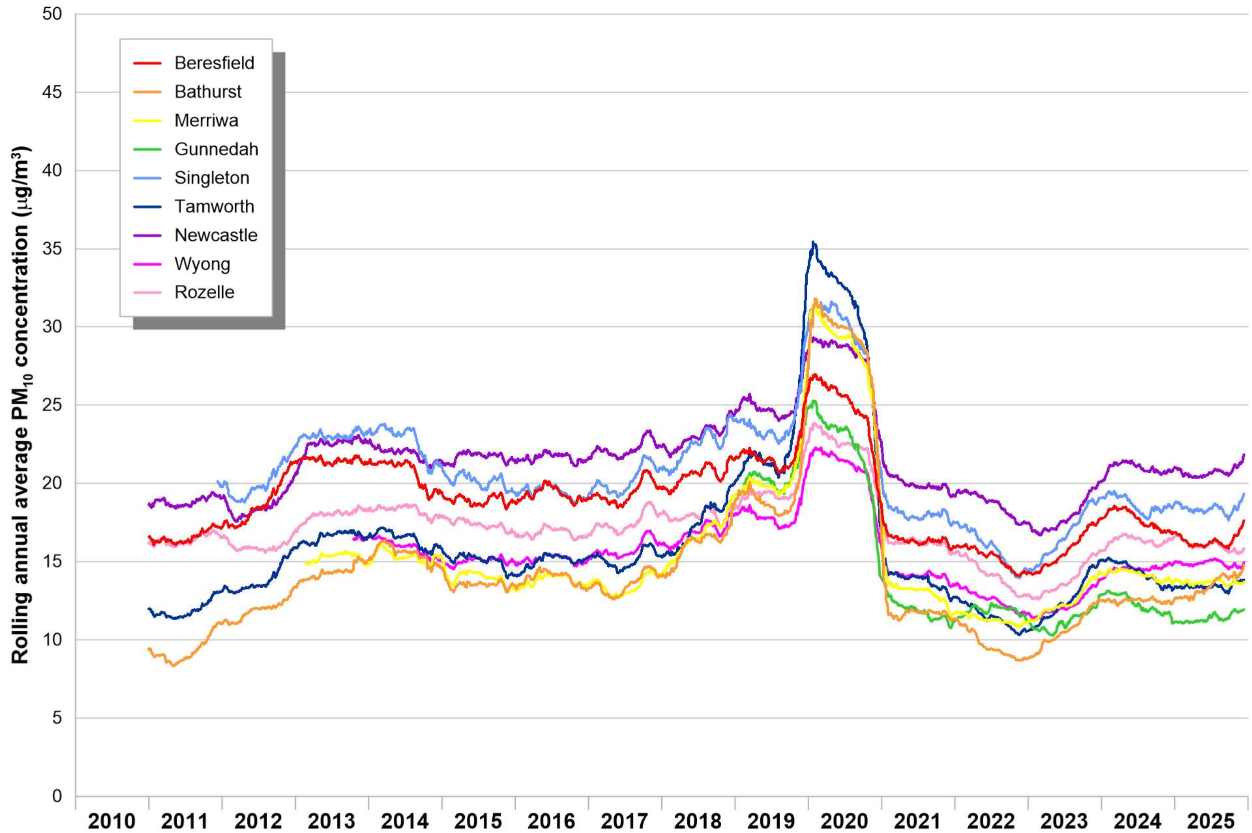


Figure 8 Rolling annual average PM_{10} concentrations at various NSW air quality monitoring sites

The use of years with elevated air quality levels, largely driven by extraordinary events or extreme climatic conditions (or both) are avoided in modelling studies primarily because they do not address the definition of representative. In addition, extraordinary events cannot be reliably simulated in air dispersion models as it is not possible to identify all possible factors that led to these events, for example, the factors that influence the time, location, and intensity of bushfires. This context has been considered in the analysis below.

4.3.2 Particulate Matter (as PM_{10})

Air quality criteria for PM_{10} are set to protect against adverse health impacts. KEQPL monitors PM_{10} by High Volume Air Sampler (HVAS) on a nearby property south of the Pacific Highway (see **Figure 7** for the location). **Table 4** provides a summary of the PM_{10} data collected between 2020 to 2024.

The PM_{10} concentrations at the HVAS exceeded 50 µg/m³ on one day (16 June 2023). Winds on this day were from the west which indicates that activities at KEQ or KHRQ were not the cause of the exceedance, based on the quarry locations relative to the monitor. There were no other days with measured concentrations above 50 µg/m³. Annual average PM_{10} concentrations have been well below the EPA's 25 µg/m³ criterion.

Table 4 Summary of measured PM_{10} concentrations near KEQ and KHRQ

Statistic	2020	2021	2022	2023	2024	EPA criterion
Maximum 24-hour average (µg/m³)	32	24	21	51	21	50
Number of days above 50 µg/m³ (days)	0	0	0	1	0	-
Annual average (µg/m³)	12	11	10	14	10	25

4.3.3 Particulate Matter (as $PM_{2.5}$)

Air quality criteria for $PM_{2.5}$ are set to protect against adverse health impacts. KEQPL does not monitor $PM_{2.5}$ so concentrations have been estimated from the measured PM_{10} concentrations on the assumption that 50% of the PM_{10} would be $PM_{2.5}$. **Table 5** shows the estimated $PM_{2.5}$ concentrations. In general, concentrations of $PM_{2.5}$ near KEQ and KHRQ are likely to be well below the EPA assessment criteria.

Table 5 Summary of estimated $PM_{2.5}$ concentrations near KEQ and KHRQ

Statistic	2020	2021	2022	2023	2024	EPA criterion
Maximum 24-hour average (µg/m^3)	16.0	12.0	10.5	25.5	10.5	25
Annual average (µg/m^3)	6.2	5.3	4.8	7.0	4.8	8

4.3.4 Particulate Matter (as TSP)

KEQPL monitors TSP by HVAS on a nearby property south of the Pacific Highway (**Figure 7**). **Table 6** shows the measured annual average TSP concentrations from data collected between 2020 and 2024. Annual average TSP concentrations have been well below the EPA's 90 µg/m^3 assessment criterion,

Table 6 Summary of measured TSP concentrations near KEQ and KHRQ

Statistic	2020	2021	2022	2023	2024	EPA criterion
Annual average (µg/m^3)	23	18	17	25	20	90

4.3.5 Deposited Dust

Air quality criteria for deposited dust are set to protect against nuisance amenity impacts. Deposited dust is monitored at five locations near the KEQ and KHRQ (see **Figure 7**). **Table 7** shows the annual average deposited dust levels. These data show that deposited dust levels have not exceeded the annual 4 g/m^2/month criterion in the past five years.

Table 7 Summary of measured deposited dust near KEQ and KHRQ

Statistic	2019	2020	2021	2022	2023	EPA criterion
Annual averages (g/m^2/month)						
DDG1	1.0	1.0	0.6	0.8	1.0	4
DDG2	0.8	0.5	0.8	1.2	0.8	4
DDG3	0.7	0.5	0.5	1.0	0.9	4
DDG4	0.9	0.5	0.5	0.8	1.5	4
DDG5*	1.5	0.7	0.7	1.1	0.9	4

* DDG5 was discontinued from monitoring following the acquisition of Lot 11 from August 2025 in accordance with the KEQ Air Quality Management Plan and KEQ EPL 20611.

4.3.6 Nitrogen Dioxide (NO_2)

Table 8 provides a summary of the measured NO_2 concentrations from Beresfield, the closest monitoring station to KEQ which measures this parameter. These data show that maximum NO_2 concentrations have not exceeded the EPA's 1-hour average criterion of 164 µg/m^3. Annual averages have not exceeded the EPA's annual average criterion of 31 µg/m^3.

Table 8 Summary of measured NO_2 concentrations at Beresfield

Statistic	2020	2021	2022	2023	2024	EPA criterion
Maximum 1-hour average (µg/m^3)	72	70	60	78	66	164
Annual average (µg/m^3)	14	14	12	16	14	31

4.4 Background Levels

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to modelled site contributions for the assessment of potential cumulative impacts. **Table 9** shows the assumed background levels that would apply to sensitive receptors near the KEQ. These levels have been added to the modelled quarry contributions to determine the potential cumulative impacts.

Table 9 Assumed background levels that apply at sensitive receptors

Air quality indicator	Averaging time	Assumed background level	Notes
Particulate matter (PM_{10})	24-hour	Variable by day (Figure 9)	Derived from site measurements in 2024. Maximum = 21 µg/m³
	Annual	9.7 µg/m³ (Figure 9)	Derived from site measurements in 2024. Average = 9.7 µg/m³
Particulate matter ($PM_{2.5}$)	24-hour	Variable by day (Figure 9)	Estimated from PM_{10} measurements in 2024. Maximum = 10.5 µg/m³
	Annual	4.8 µg/m³ (Figure 9)	Estimated from PM_{10} measurements in 2024. Average = 4.8 µg/m³
Particulate matter (TSP)	Annual	20 µg/m³	Annual average TSP from site in 2024
Deposited dust	Annual	1.0 g/m²/month	Average deposited dust from all monitoring sites in 2024
Nitrogen dioxide (NO_2)	1-hour	66 µg/m³	Maximum 1-hour average NO_2 from Beresfield in 2024
	Annual	14 µg/m³	Annual average NO_2 from Beresfield in 2024

For PM_{10} and $PM_{2.5}$, daily variable background concentration datasets were derived from the site monitoring data. **Figure 9** shows a graphical representation of the assumed background PM_{10} and $PM_{2.5}$ concentrations that were used in this assessment and added to the model results. The six-day HVAS records were linearly interpolated to daily records.

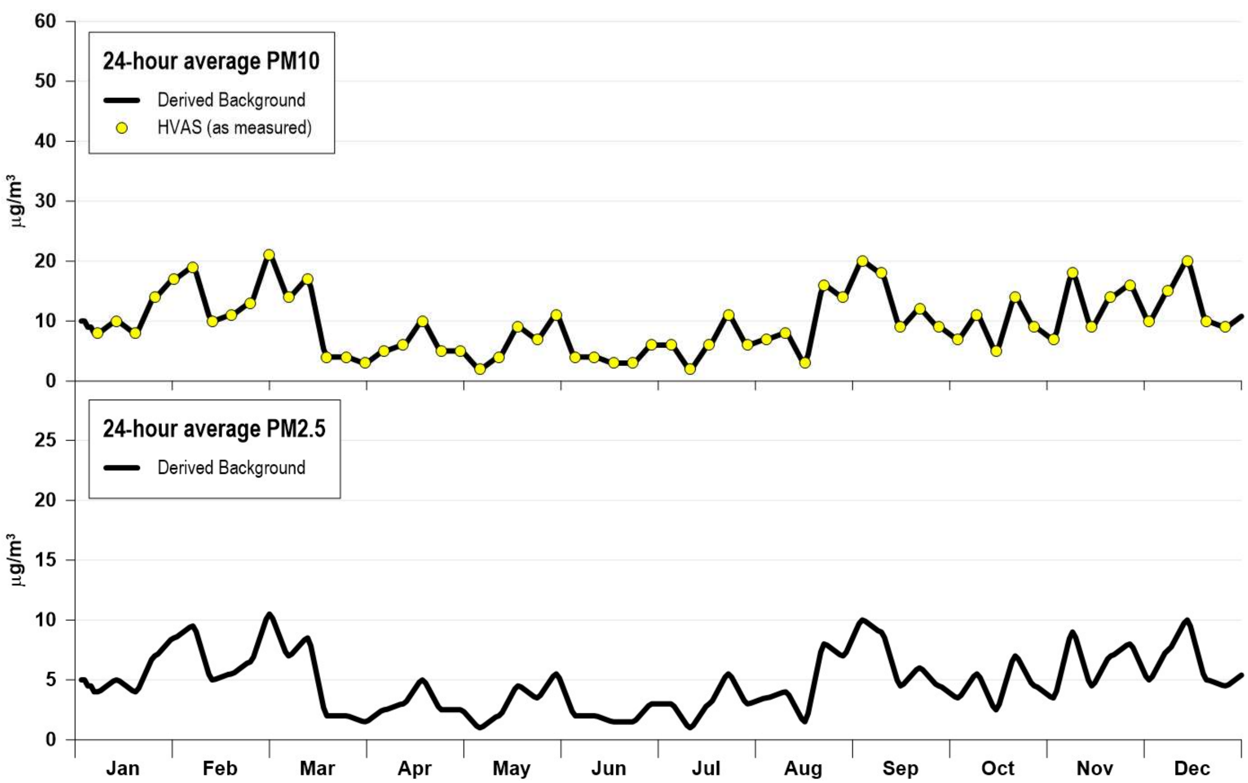


Figure 9 Assumed background PM_{10} and $PM_{2.5}$ concentrations

5 Assessment Methodology

This assessment has followed the procedures outlined in the Approved Methods (EPA, 2022). The Approved Methods include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of expected impacts. Specific methodologies for each of the identified key issues (from **Section 2**) are described below.

5.1 Operational Dust

Operational dust has been quantified by modelling. The choice of model has considered the expected transport distances for the emissions, as well as the potential for temporally and spatially varying flow fields due to influences of the locally complex terrain, non-uniform land use, and potential for stagnation conditions characterised by calm or very low wind speeds with variable wind directions. The CALPUFF model was selected for this purpose. This model is listed in the Approved Methods and has been used to predict ground-level particulate matter concentrations and deposition levels due to the KEQ and other sources. Concentrations and deposition levels have been simulated for every hour of the representative year and results at local communities and sensitive receptors have then been compared to the relevant air quality assessment criteria.

Figure 10 shows an overview of the model inputs and outputs. **Appendix C** provides details of all model settings.

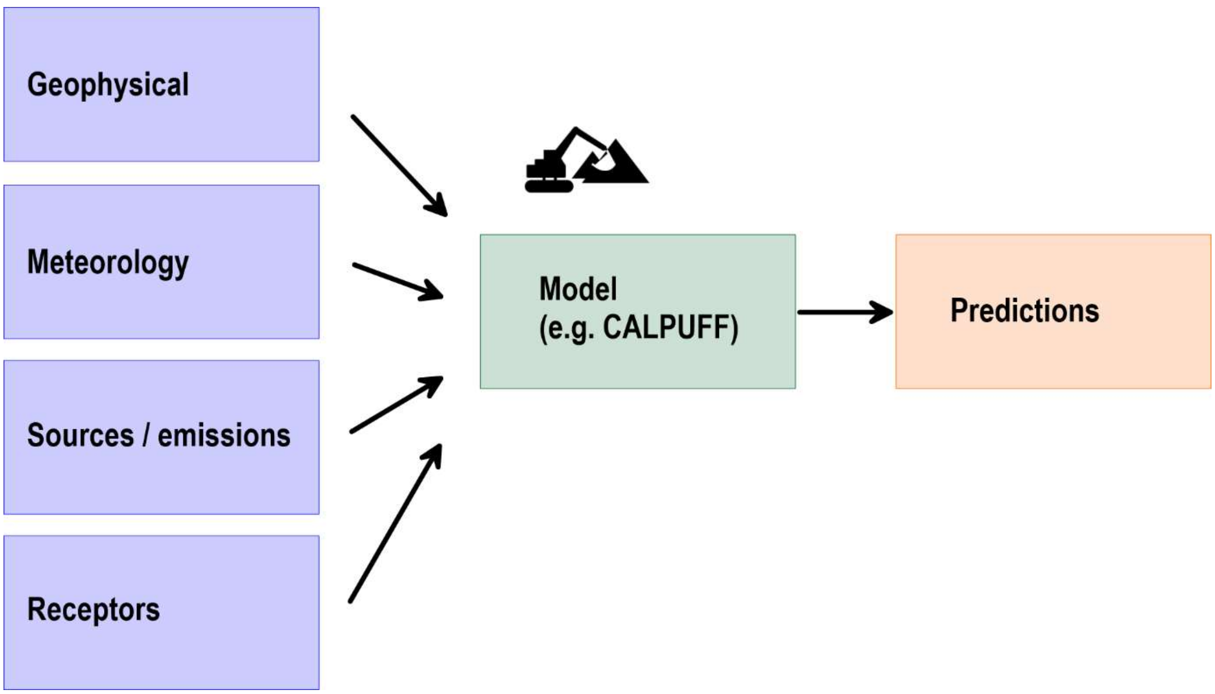


Figure 10 Overview of model inputs and outputs

Dust (particulate matter) is the most significant emission to air from the KEQ and estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated for the proposed operations using the material handling schedule, equipment listing, and site layout plans combined with emission factors from:

- "Emission Estimation Technique Manual for Mining" (NPI, 2012); and
- AP 42 (US EPA 1985 and updates).

Table 10 summarises the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions, respectively, due to the KEQ, as well as the assumed emission controls for the assessment. It was assumed that the KEQ will extract, process, stockpile and transport up to 6,250 tonnes per day (tpd) for every day of the year, for the worst-case progressive extraction sequence. This is a conservative approach that will over-estimate the maximum annual production and potential air quality impacts. Full details on the emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations are provided in **Appendix C**.

Table 10 Estimated annual dust emissions from operational activities

Activity	Annual emissions (kg/y)						Assumed emission controls for the assessment
	Approved Operation			Modified Operation			
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$	
Excavators working	1,435	679	72	1,435	679	72	Nil.
Drilling rock	748	393	37	2,780	1,460	139	Water sprays, 70% control.
Blasting rock	300	156	15	1,116	578	56	Nil.
Loading rock to trucks	1,435	679	72	1,435	679	72	Nil.
Hauling rock to hopper	62,734	11,949	2,987	62,734	11,949	2,987	Water truck, 75% control.
Unloading to hopper	1,435	679	72	1,435	679	72	Nil.
Primary crushing	7,597	2,977	380	7,597	2,977	380	Enclosure, 70% control.
Screen 1	34,219	11,406	1,711	34,219	11,406	1,711	Water sprays, 50% control.
Secondary crushing	7,597	2,977	380	7,597	2,977	380	Enclosure, 70% control.
Screen 2	34,219	11,406	1,711	34,219	11,406	1,711	Water sprays, 50% control.
Tertiary crushing	7,597	2,977	380	7,597	2,977	380	Enclosure, 70% control.
Loading product stockpiles	718	339	36	718	339	36	Water sprays, 50% control.
Wind erosion from exposed areas	10,074	5,037	756	11,388	5,694	854	Nil.
Wind erosion from product stockpiles	1,402	701	105	1,402	701	105	Water sprays, 50% control.
Loading product to trucks	1,435	679	72	1,435	679	72	Nil
Hauling product off-site	85,547	16,295	4,074	85,547	16,295	4,074	Water truck, 75% control.
Total	**258,492**	**69,329**	**12,858**	**262,653**	**71,476**	**13,099**	**-**

The KEQ operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. Emissions from the dust generating activities were assigned to one or more of source location (refer to **Appendix C** for details of the allocations).

Dust emissions for all modelled construction-related sources have been considered to fit in one of three categories, as follows:

- Wind insensitive sources, where emissions are relatively insensitive to wind speed (for example, dozers).
- Wind sensitive sources, where emissions vary with the hourly wind speed, raised to the power of 1.3, a generic relationship published by the US EPA (1987). This relationship has been applied to sources such as loading and unloading of material to/from trucks and results in increased emissions with increased wind speed.
- Wind sensitive sources, where emissions also vary with the hourly wind speed, but raised to the power of 3, a generic relationship published by Skidmore (1998). This relationship has been applied to sources including wind erosion from stockpiles or emplacement areas, and results in increased emissions with increased wind speed.

Emissions from each volume source were developed on an hourly time step, taking into account the level of activity at that location and, in some cases, the hourly wind speed. This approach ensured that light winds corresponded with lower dust generation and higher winds, with higher dust generation. Activities and associated emissions were modelled at their approved or proposed operating hours, except for wind erosion which was assumed to occur 24 hours per day. In practice, blasting will likely occur between the hours of 12 pm to 3 pm however flexibility is required to conduct the blast slightly earlier or later than this three-hour window.

Finally, the model results at identified sensitive receptors were then compared with the EPA air quality assessment criteria, previously discussed in **Section 3**. Contour plots have also been created to show the spatial distribution of model results. **Section 6.1** provides the assessment of operational dust.

5.2 Post Blast Fume

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are produced from the modelling discussed in **Section 5.1**. Post-blast fume has also been quantified by modelling.

Post-blast fume can be produced in non-ideal explosive conditions of the ammonium nitrate/fuel oil (ANFO) and is visible as an orange / brown plume. The fumes comprise of NO_x including nitric oxide (NO) and NO_2. In general, at the point of emission, NO will comprise the greatest proportion of the total NO_x emission. Typically, this is 90% by volume of the NOx. The remaining 10% will comprise mostly NO_2. Ultimately however, much of the NO emitted into the atmosphere is oxidised to NO_2. The rate at which this oxidisation takes place depends on prevailing atmospheric conditions including temperature, humidity, and the presence of other substances in the atmosphere such as ozone. It can vary from a few minutes to many hours. The rate of conversion is important because from the point of emission to the point of maximum ground-level concentration there will be an interval of time during which some oxidation will take place. If the dispersion is sufficient to have diluted the plume to the point where the concentration is very low, then the level of oxidation is unimportant. However, if the oxidation is rapid and the dispersion is slow then high concentrations of NO_2 can occur.

The NO_x monitoring data from Beresfield (NSW Planning data from 2024) show that the percentage of NO_2 in the NO_x is inversely proportional to the total NO_x concentration, and when NO_x concentrations increase, the percentage of NO_2 in the NO_x generally decreases to 20% or less. This is demonstrated by **Figure 11** which shows that, for higher NO_x concentrations, the NO_2 to NO_x ratio reduces to less than 20%.

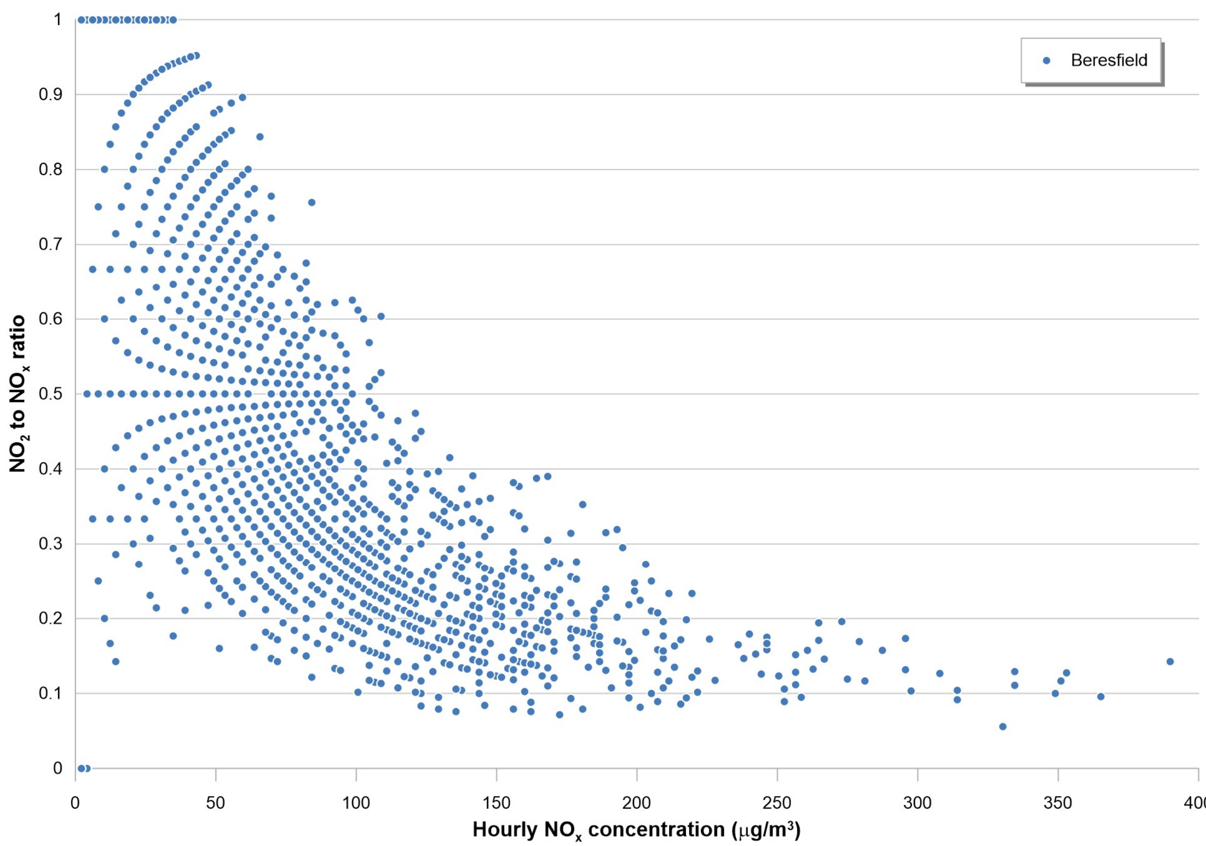


Figure 11 Measured NO_2 to NO_x ratios from hourly average data collected at Beresfield in 2024

The methodology for the operational post-blast fume modelling is outlined below:

- Blast modelled as a single volume source in a location indicative of the centre of the quarry.
- Release height of 10 m, effective plume height of 20 m, initial horizontal spread (sigma y) of 10 m and initial vertical spread (sigma z) of 5 m.
- Emissions assumed to occur every hour between 9 am and 5 pm, and on any day of the week. These are conservative assumptions noting that KEQ is approved to undertake two (2) blasts per week (Mon – Fri) (and MOD 11 to KEQ and MOD 2 to KHRQ seek to establish a cumulative total of 2 blasts per week (Monday-Friday)).
- NO_x emissions based on data presented in the Queensland Guidance Note for the management of oxides in open cut blasting (DEEDI, 2011). It was conservatively assumed that the initial NO_2 concentration in the plume would be 17 ppm (34.9 mg/m³) based on the Rating 3 Fume Category in the Queensland Guidance Note.

- The initial NO_2 concentration in the plume was converted to a total NO_x emission rate based on a detailed measurement program of NO_x in blast plumes in the Hunter Valley made by Attalla et al. (2008) which found that the NO:NO_2 ratio was typically 27:1, giving a NO_x:NO_2 ratio of approximately 18.6 g NO_x/g NO_2.
- Calculated emission of 57.8 g/s of NO_x per blast and an emission release time of 5 minutes.
- 20% of the NO_x is NO_2 at the points of maximum 1-hour average concentrations and at sensitive receptors.

Model results for post-blast fume have been compared to the applicable EPA air quality criterion for NO_2; that is 164 µg/m^3 as a 1-hour average and taking background levels into account. **Section 6.2** provides the assessment of operational post blast fume.

5.3 Diesel Exhaust

The most significant emissions from diesel exhausts are products of combustion including CO, NO_x, PM_{10} and $PM_{2.5}$. It is the NO_x, or more specifically NO_2, and PM_{10} (including $PM_{2.5}$) which have been assessed. NSW Planning monitoring data have shown that CO concentrations have not exceeded relevant air quality criteria at rural or urban monitoring stations in NSW, indicating that this substance represents a much lower air quality risk.

The modelling for operational dust (**Section 5.1**) has considered emission factors that represent the contribution from both wheel-generated particulates and the exhaust particulates. These emission factors, including with control factors, are based on measured emissions which included diesel particulates in the form of both PM_{10} and $PM_{2.5}$.

Table 11 provides the explicit estimates of PM_{10} and $PM_{2.5}$ emissions due only to diesel plant and equipment exhausts. Emission factors for "Industrial off-road vehicles and equipment" from the EPA's 2008 Air Emissions Inventory (EPA, 2012) were used for the calculations and it has been assumed that there will be no reduction to emissions in the future; a conservative approach. These factors relate to diesel exhaust and evaporative emissions.

Table 11 Estimated PM_{10} and $PM_{2.5}$ emissions from diesel engines

Parameter	Value
Maximum fuel usage from both KEQ and KHRQ based past five years of records (Source: KEQPL) (kL/y)	3,970
PM_{10} calculations	
Diesel exhaust emission factor (kg/kL)	2.84
Diesel exhaust emission (all equipment) (kg/y)	11,274
$PM_{2.5}$ calculations	
Diesel exhaust emission factor (kg/kL)	2.75
Diesel exhaust emission (all equipment) (kg/y)	10,917

Emissions of NO_x from diesel exhausts have been estimated using fuel consumption data and an emission factor from the EPA's Air Emissions Inventory for 2008 (EPA, 2012). **Table 12** shows the calculations. Again, it has been assumed that there will be no reduction to emissions in the future, a conservative approach.

Table 12 Estimated NO_x emissions from diesel engines

Parameter	Value
Maximum fuel usage from both KEQ and KHRQ based past five years of records (Source: KEQPL) (kL/y)	3,970
NO_x calculations	
Diesel exhaust emission factor (kg/kL)	40.77
Diesel exhaust emission (all equipment) (kg/y)	161,847

The NO_x emission estimates from **Table 12** have been explicitly modelled to provide an indication of the off-site NO_2 concentrations due to diesel exhaust emissions. **Section 6.3** provides the assessment of operational diesel exhaust.

6 Air Quality Assessment

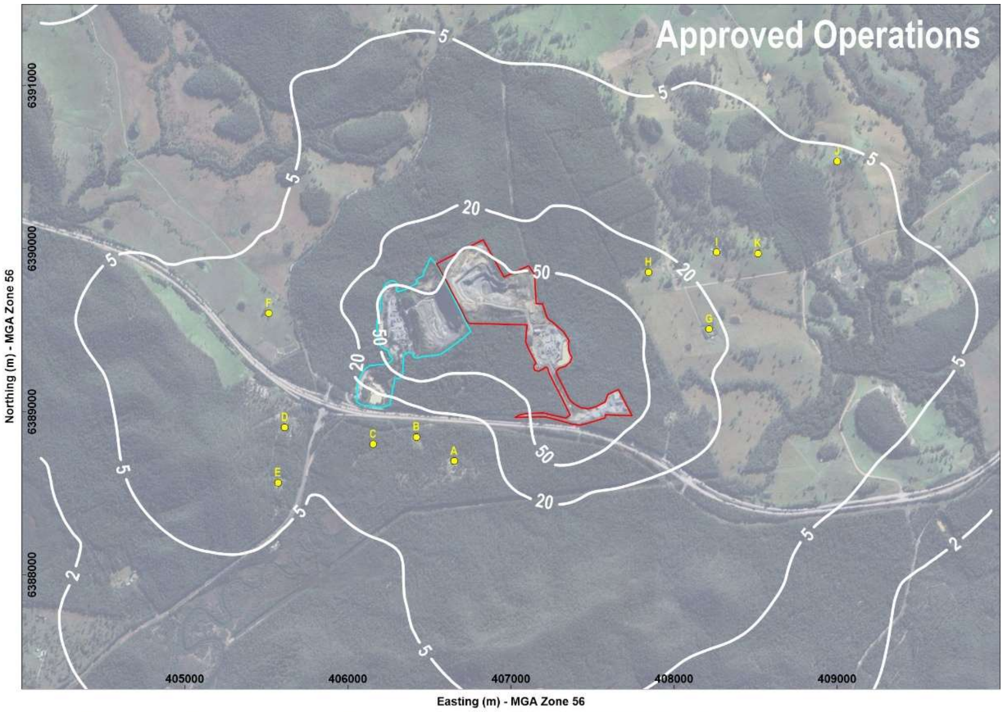
6.1 Operational Dust

This section provides an assessment of the KEQ in terms of operational dust, based on the methodology described in **Section 5.1**. Model results have been assessed for each of the key particulate matter classifications. **Appendix E** provides tabulated results.

6.1.1 Particulate Matter (as PM_{10})

Figure 12 shows the modelled maximum 24-hour average PM_{10} concentrations due to KEQ (and KHRQ) for each scenario. These results show that the maximum potential contributions of KEQ and KHRQ to the nearest sensitive receptors would be in the order of 20 to 50 µg/m^3, in both the approved and proposed modified operational scenarios. The results do not show the pattern of concentrations on any one day. Rather they show the maximum daily concentrations that have been predicted at all locations over the course of a year. The EPA does not prescribe an incremental criterion for 24-hour average PM_{10}, so it is necessary to also consider the contributions from other sources of PM_{10}.

Figure 13 shows the modelled maximum 24-hour average PM_{10} concentrations due to KEQ (and KHRQ) as well as contributions from other sources, represented by background levels as detailed in **Section 4.4**. These results can be compared to the EPA's assessment criterion for 24-hour average PM_{10} (that is, 50 µg/m^3). The results show compliance with the EPA assessment criterion (i.e. 50 µg/m^3) at all sensitive receptors.



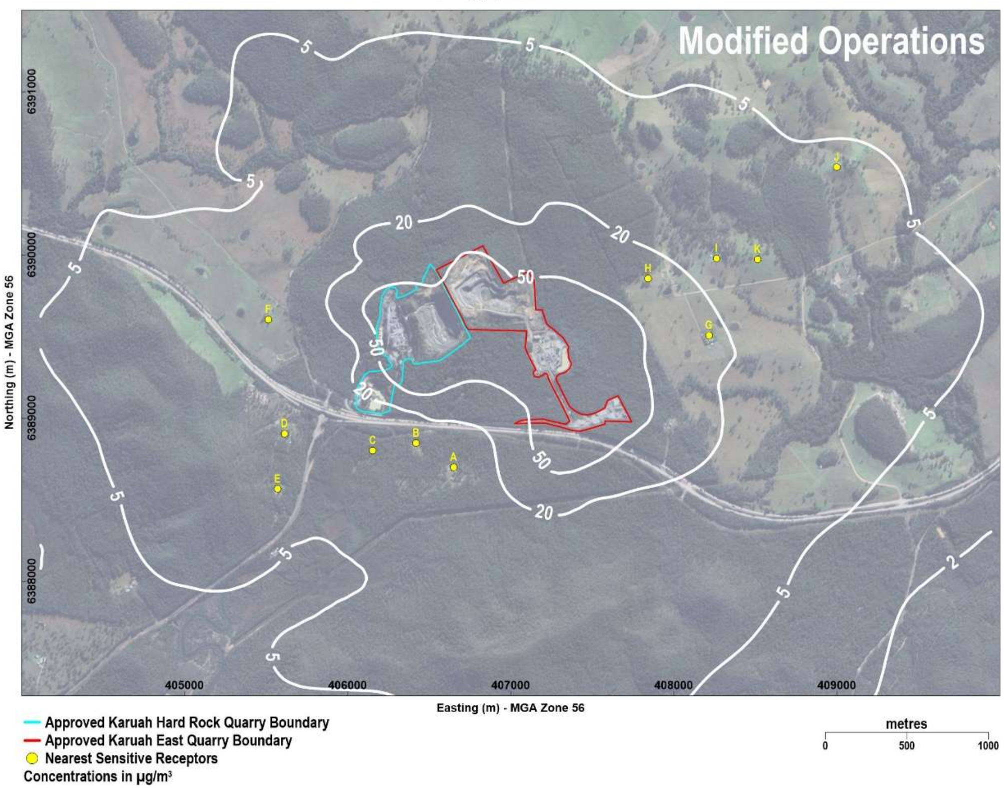


Figure 12 Modelled maximum 24-hour average PM_{10} concentrations due to KEQ and KHRQ

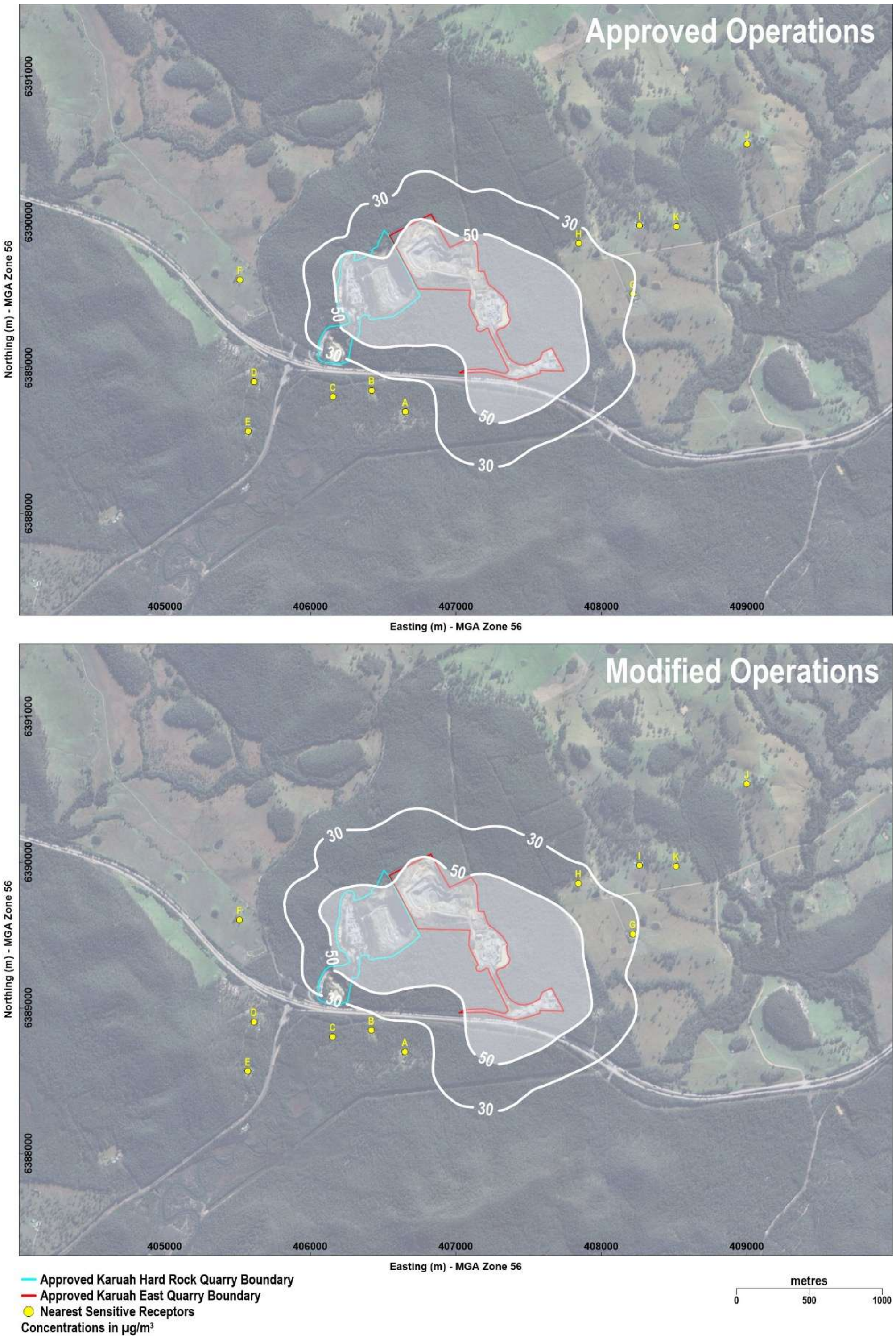


Figure 13 Modelled maximum 24-hour average PM_{10} concentrations due to KEQ and KHRQ and other sources

Figure 14 shows the modelled annual average PM_{10} concentrations due to KEQ (and KHRQ), and **Figure 15** shows the results including contributions from other sources. These results have been assessed against the EPA's annual average PM_{10} criterion (25 µg/m³). The results (**Figure 15**) show compliance with the EPA's assessment criterion (25 µg/m³) at all sensitive receptors.

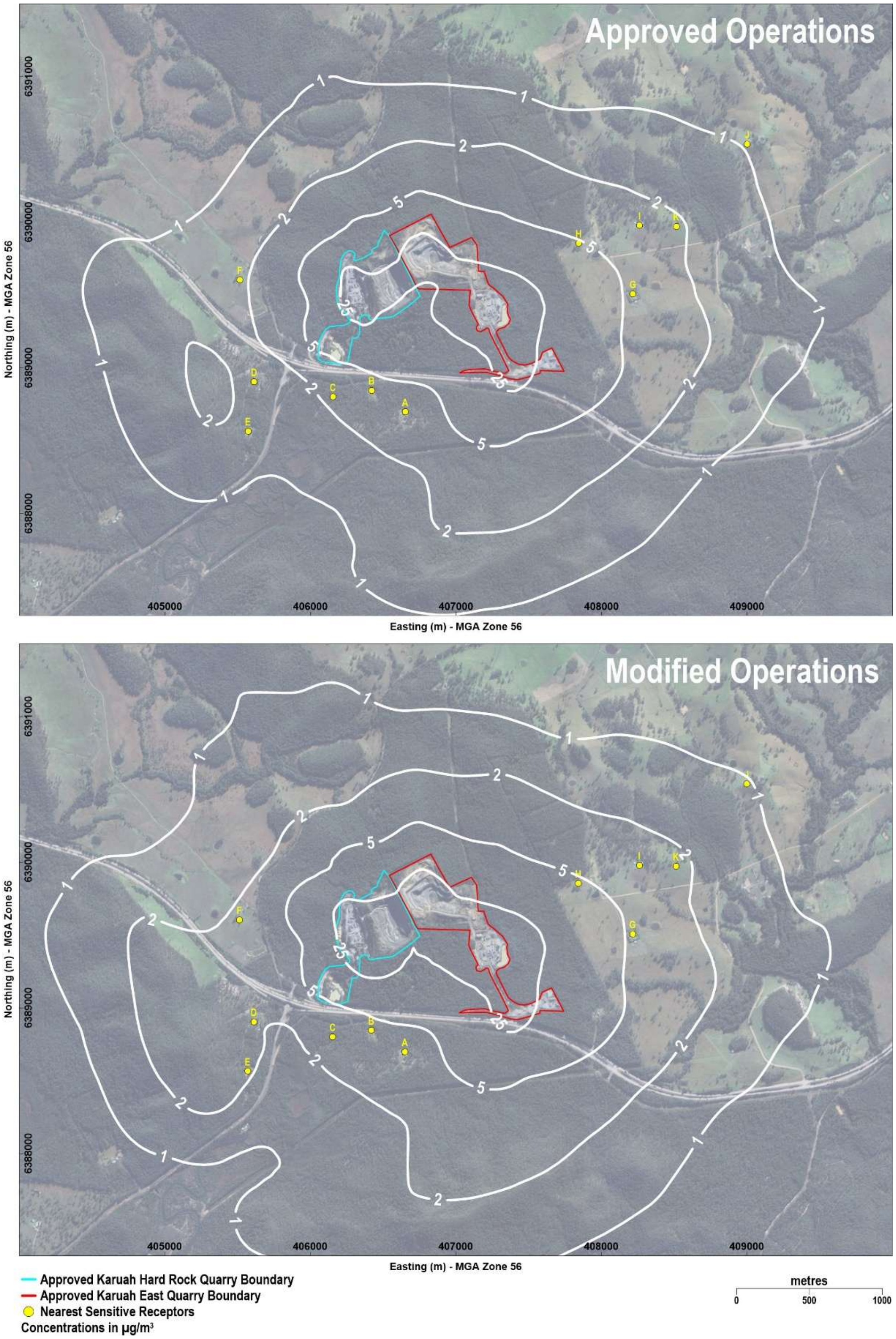


Figure 14 Modelled annual average PM_{10} concentrations due to KEQ and KHRQ

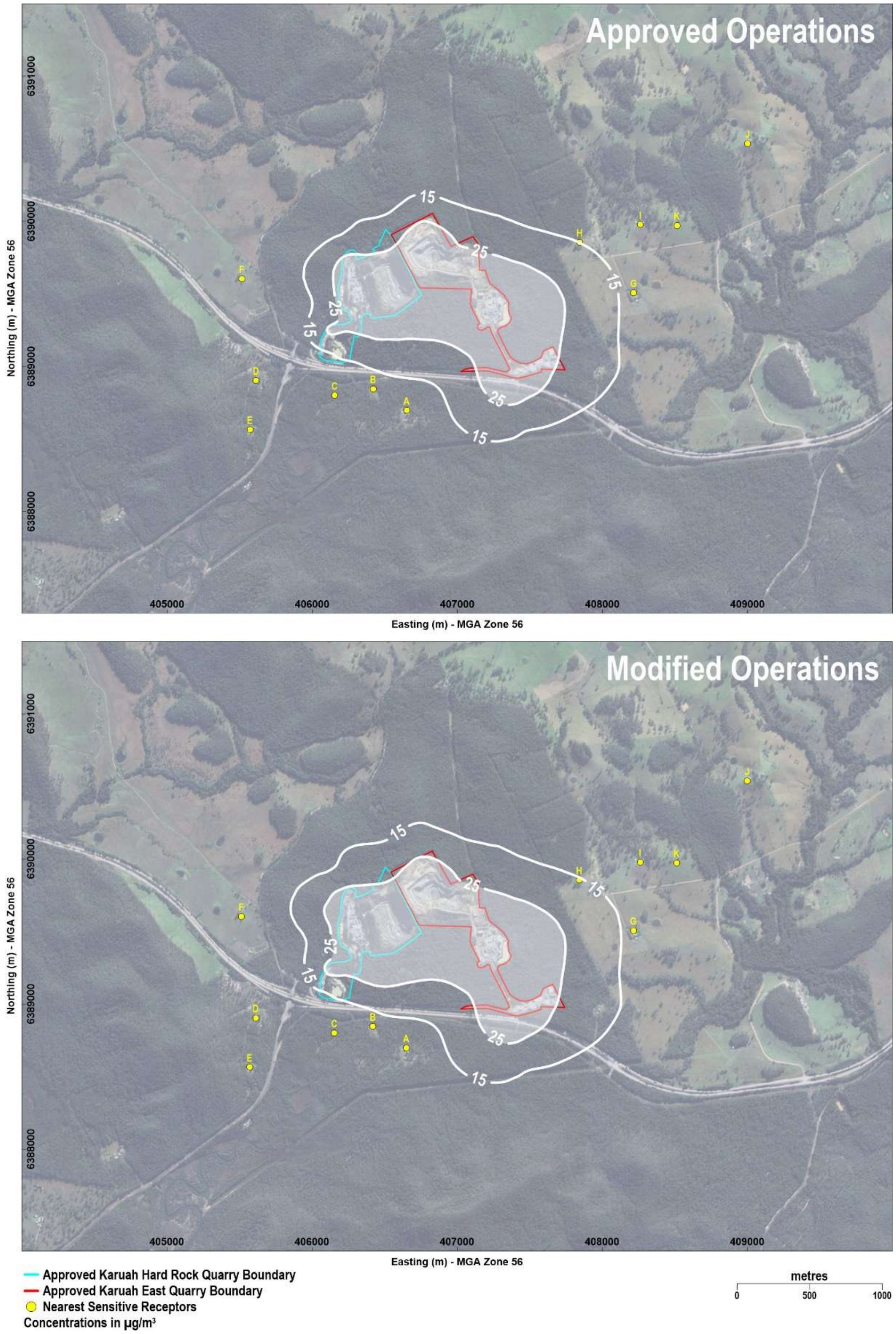


Figure 15 Modelled annual average PM_{10} concentrations due to KEQ and KHRQ

6.1.2 Particulate Matter (as $PM_{2.5}$)

Figure 16 shows the modelled maximum 24-hour average $PM_{2.5}$ concentrations due to KEQ and KHRQ. These results show that the maximum potential contributions of KEQ and KHRQ would be in the order of 5 µg/m^3 at sensitive receptors. **Figure 17** shows the modelled maximum 24-hour average $PM_{2.5}$ concentrations due to KEQ and KHRQ including contributions from other sources. The results show that KEQ and KHRQ would not cause an exceedance of the EPA's assessment criterion (25 µg/m^3) at sensitive receptors.

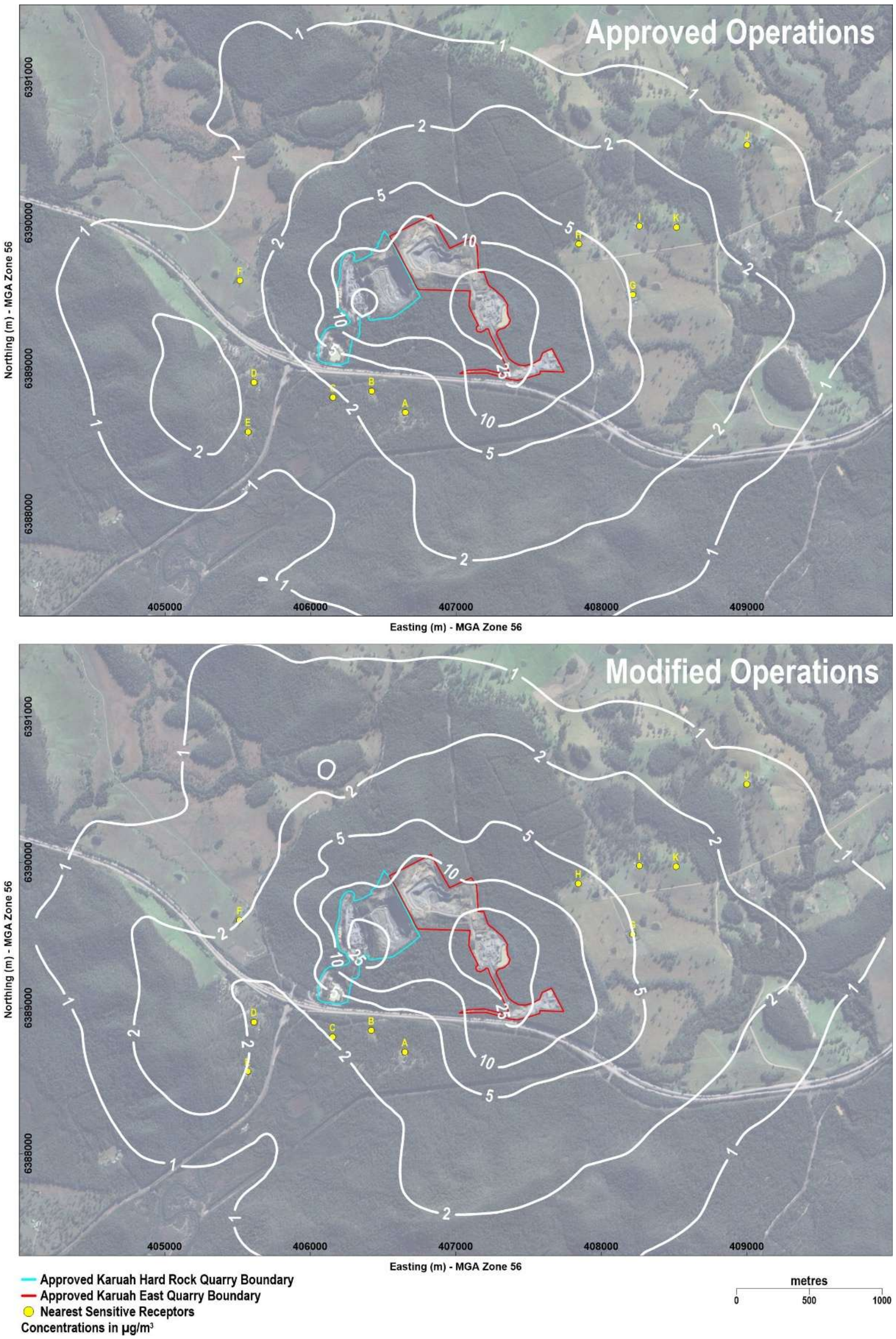


Figure 16 Modelled maximum 24-hour average $PM_{2.5}$ concentrations due to KEQ and KHRQ

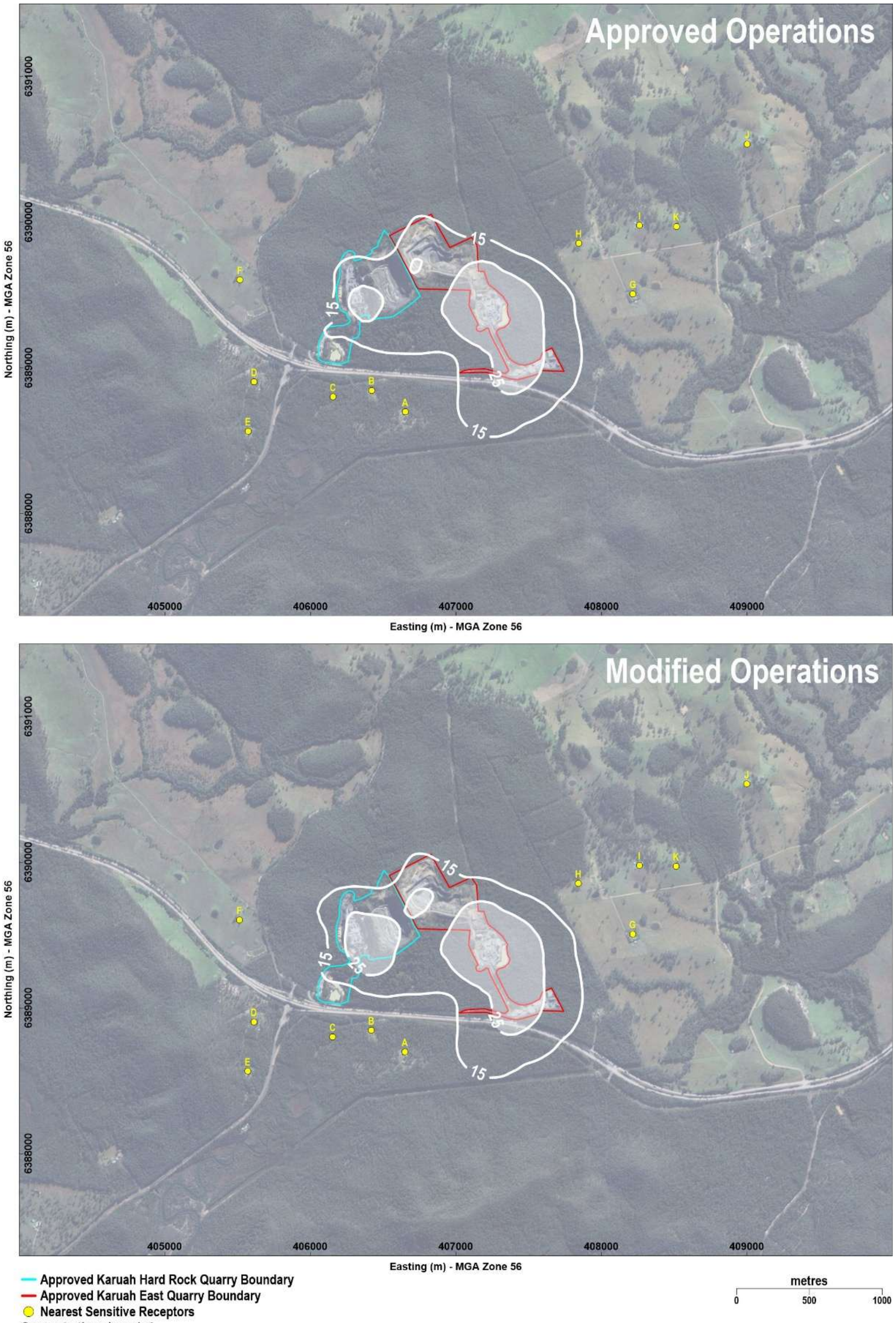


Figure 17 Modelled maximum 24-hour average $PM_{2.5}$ concentrations due to KEQ and KHRQ and other sources

Figure 18 shows the modelled annual average $PM_{2.5}$ concentrations due to KEQ and KHRQ, and **Figure 19** shows the results including contributions from other sources. These results have been assessed against the EPA's annual average $PM_{2.5}$ criterion (8 µg/m³). The results (**Figure 19**) show compliance with the EPA's assessment criterion (8 µg/m³) at all sensitive receptors.

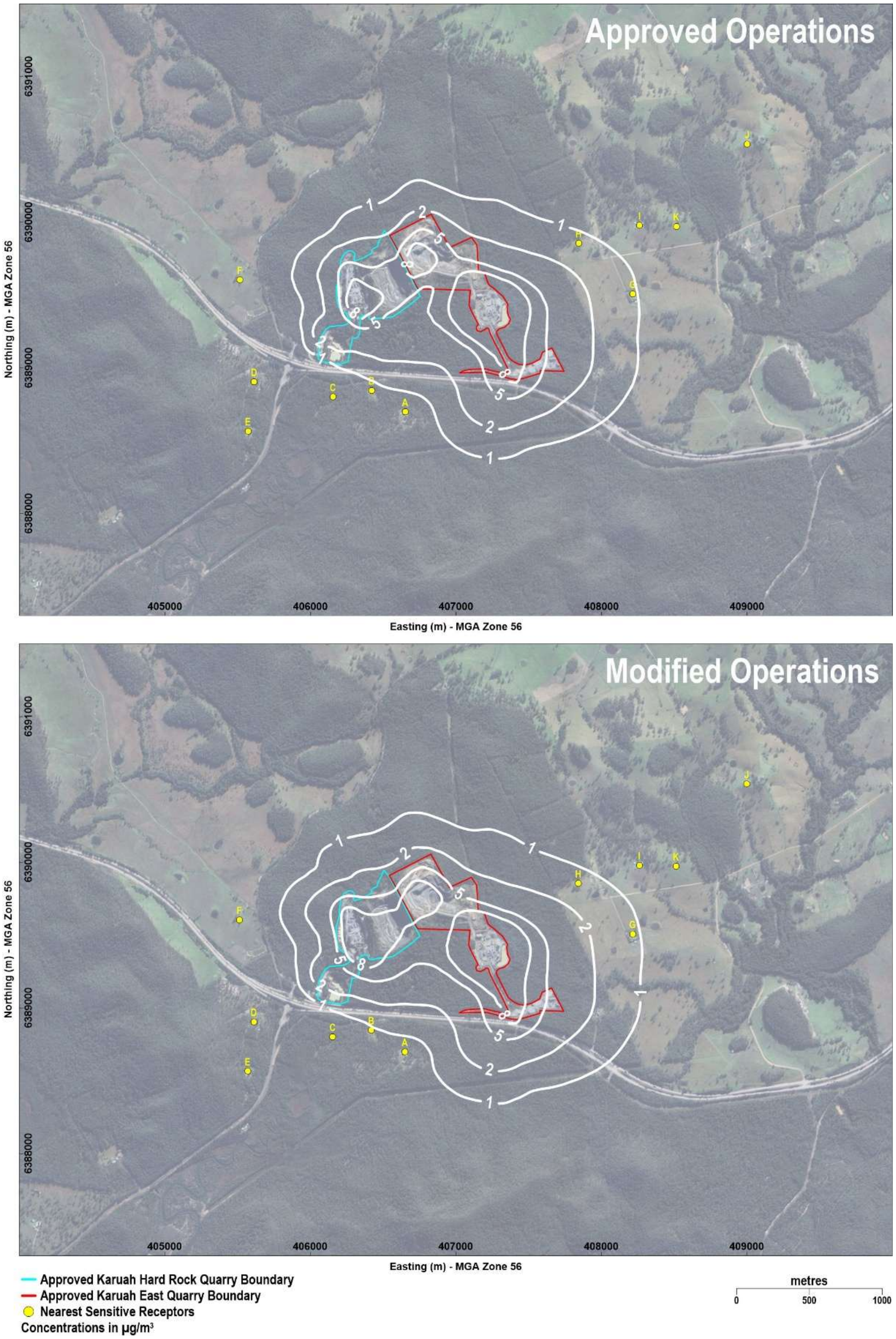


Figure 18 Modelled annual average $PM_{2.5}$ concentrations due to KEQ and KHRQ

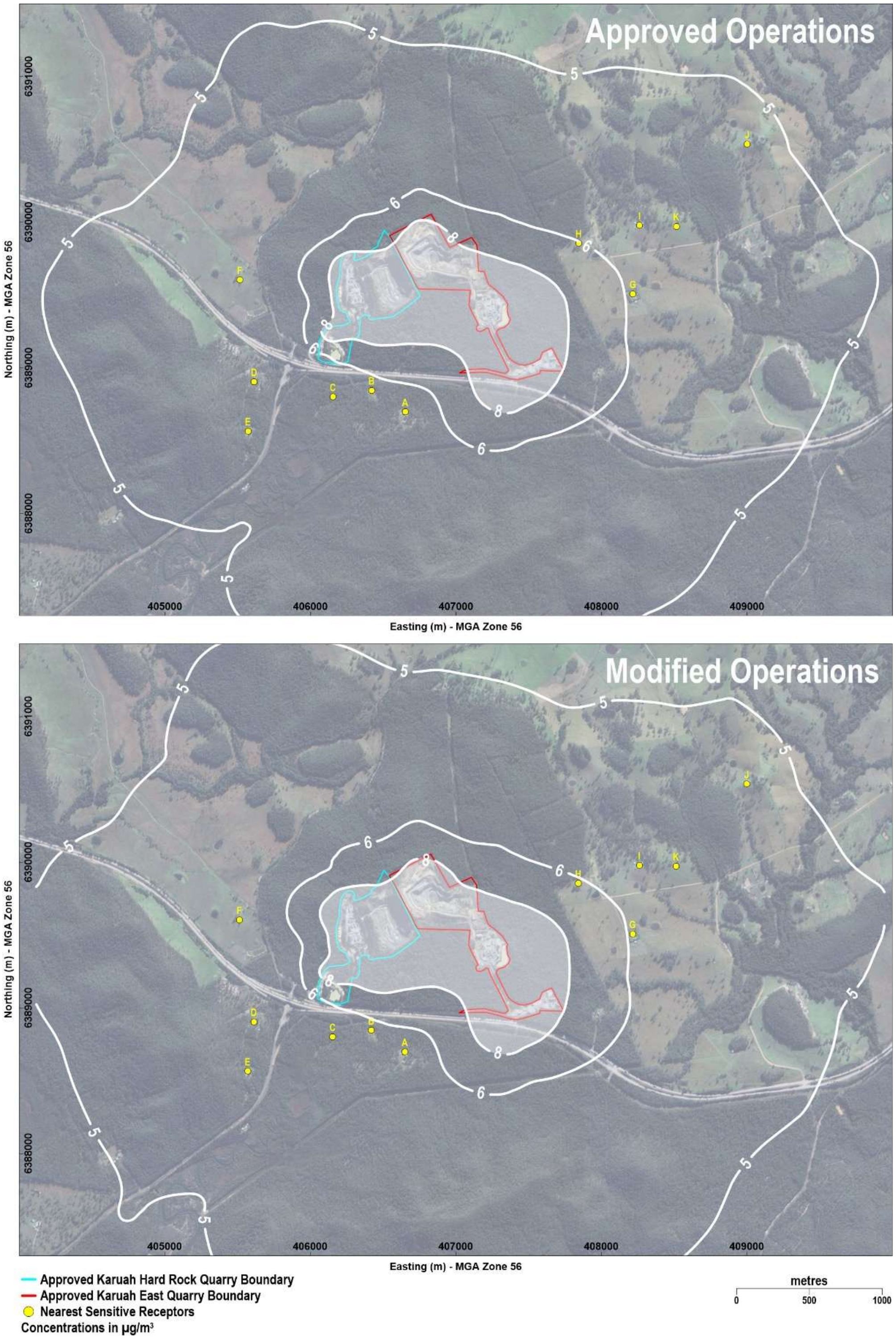


Figure 19 Modelled annual average $PM_{2.5}$ concentrations due to KEQ and KHRQ and other sources

6.1.3 Particulate Matter (as TSP)

Figure 20 shows the modelled annual average TSP concentrations due to KEQ and KHRQ, and **Figure 21** shows the results including contributions from other sources. **Figure 21** shows compliance with the EPA's assessment criterion (90 µg/m³) at all sensitive receptors.

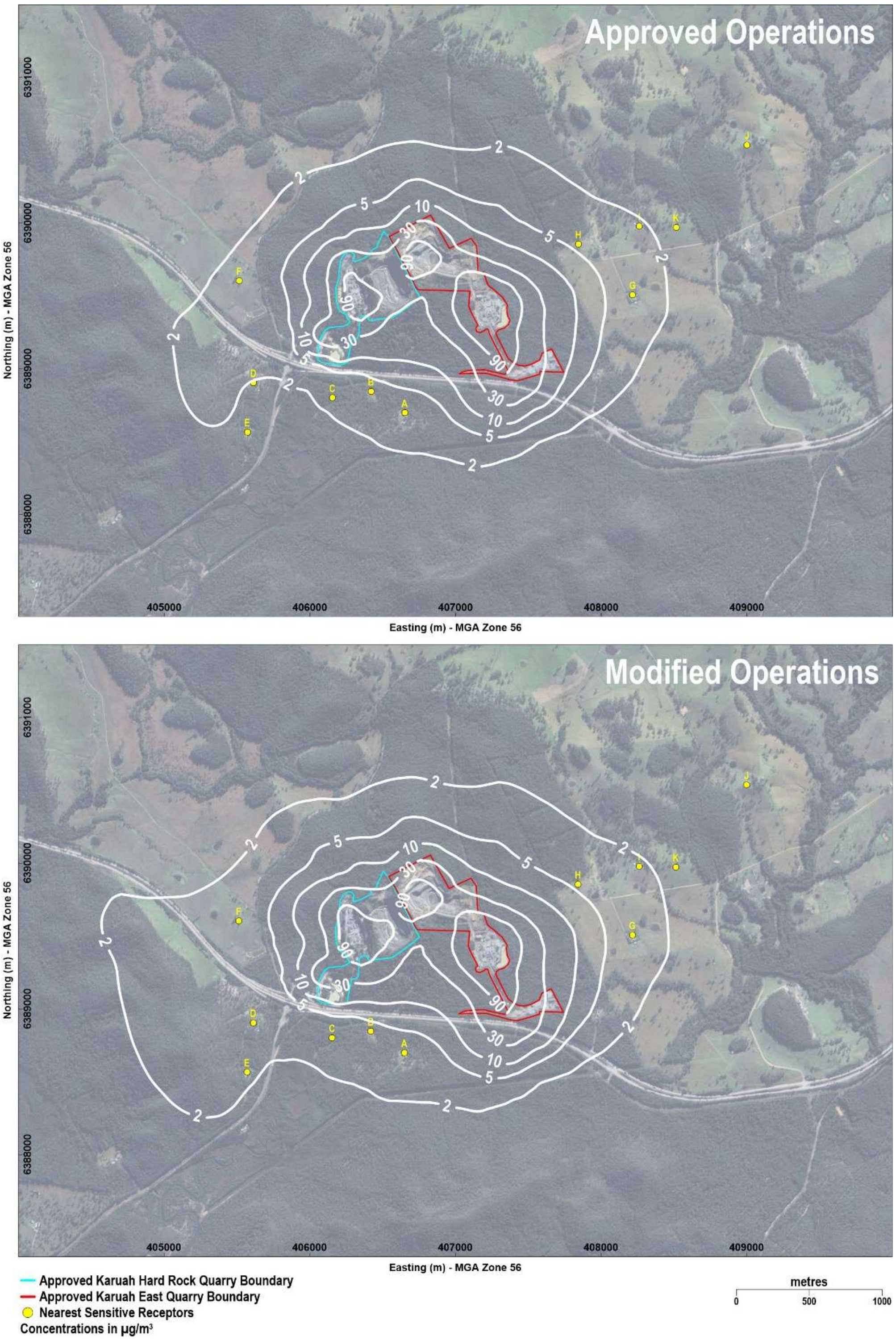


Figure 20 Modelled annual average TSP concentrations due to KEQ and KHRQ

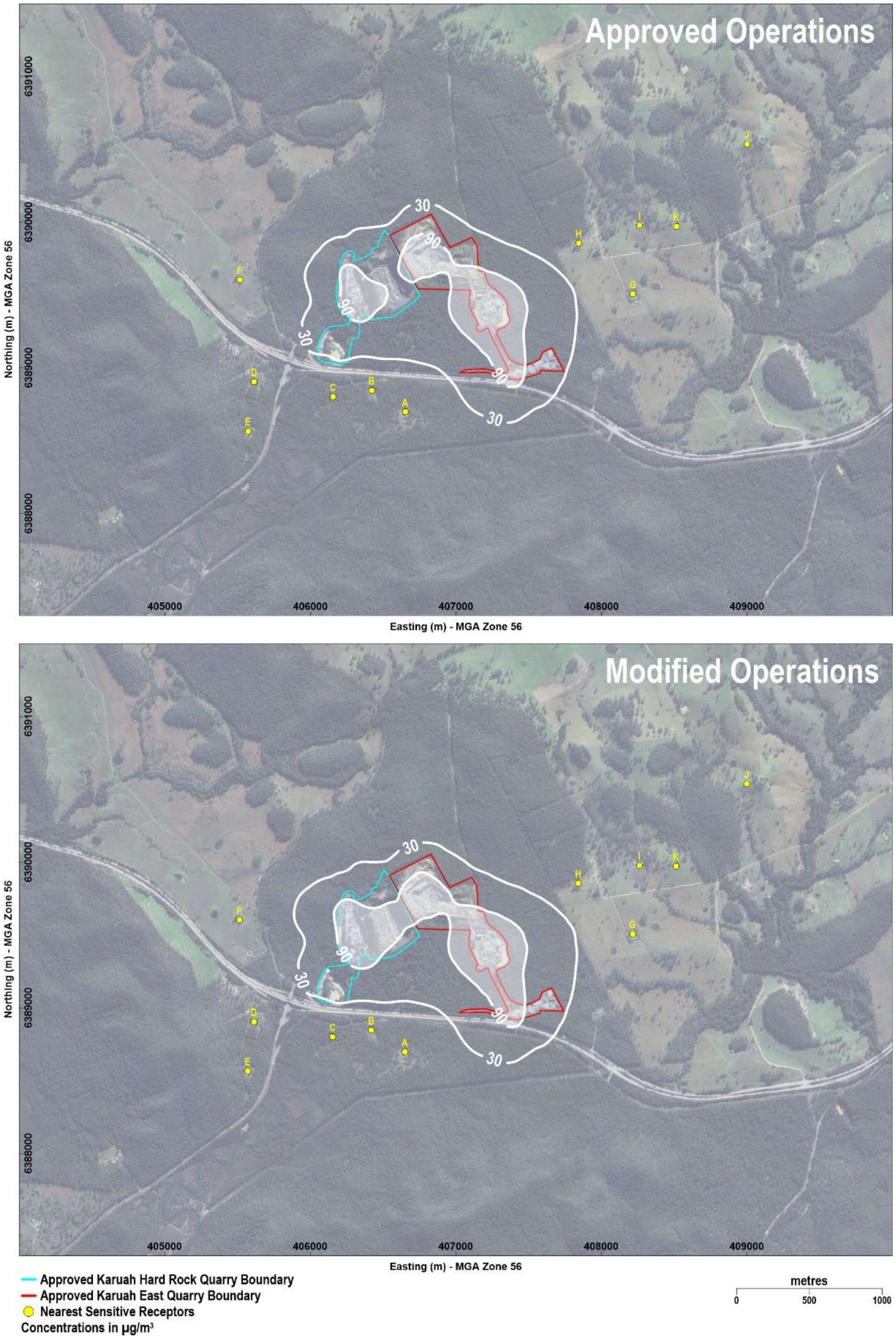


Figure 21 Modelled annual average TSP concentrations due to KEQ and KHRQ and other sources

6.1.4 Deposited Dust

Figure 22 shows the modelled annual average deposited dust levels due to KEQ and KHRQ, and **Figure 23** shows the results including contributions from other sources. These results have been assessed against the EPA's annual average deposited dust criteria of 2 g/m²/month (incremental) and 4 g/m²/month (total). The results show compliance with the EPA criteria at all sensitive receptors.

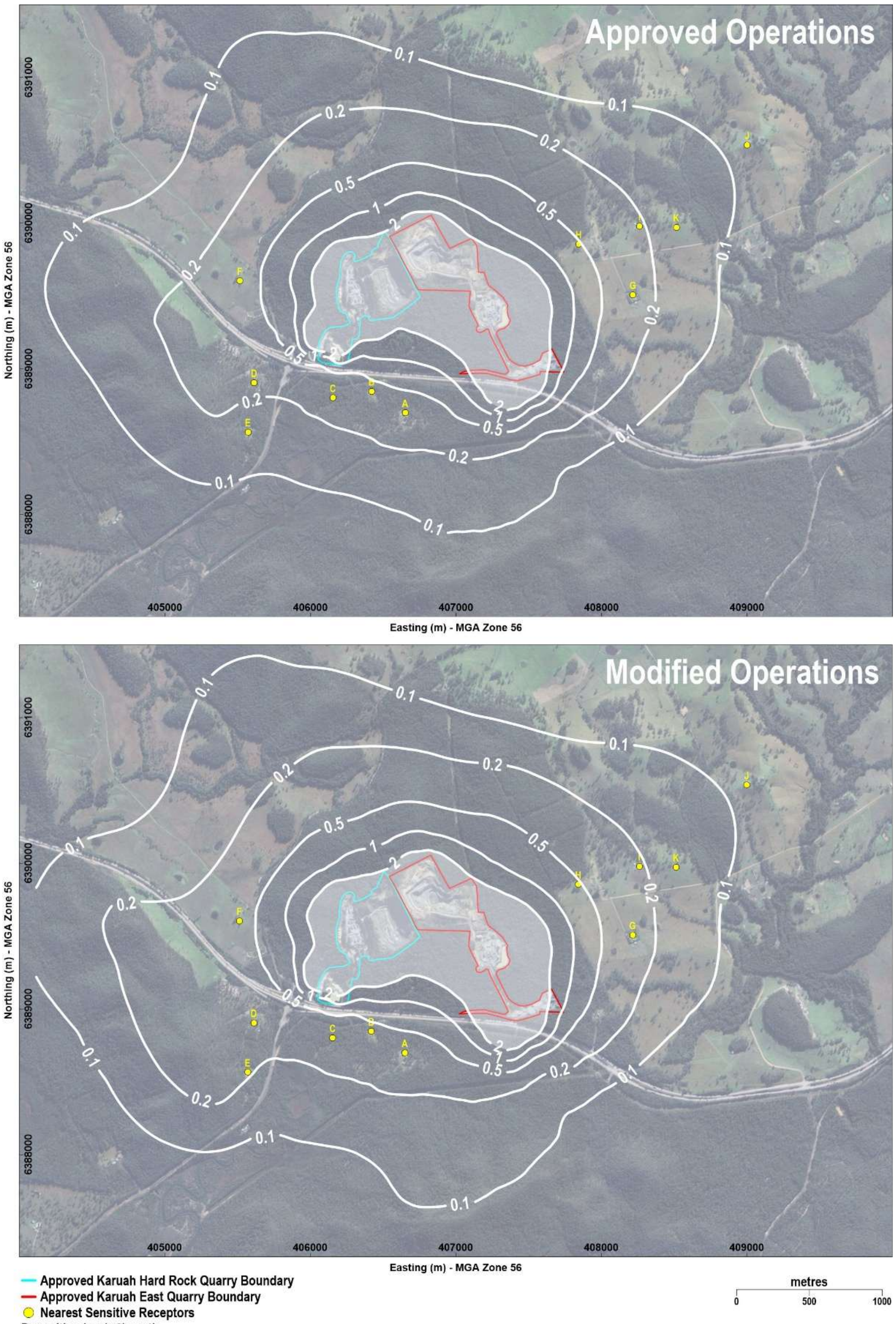


Figure 22 Modelled annual average deposited dust levels due to KEQ and KHRQ

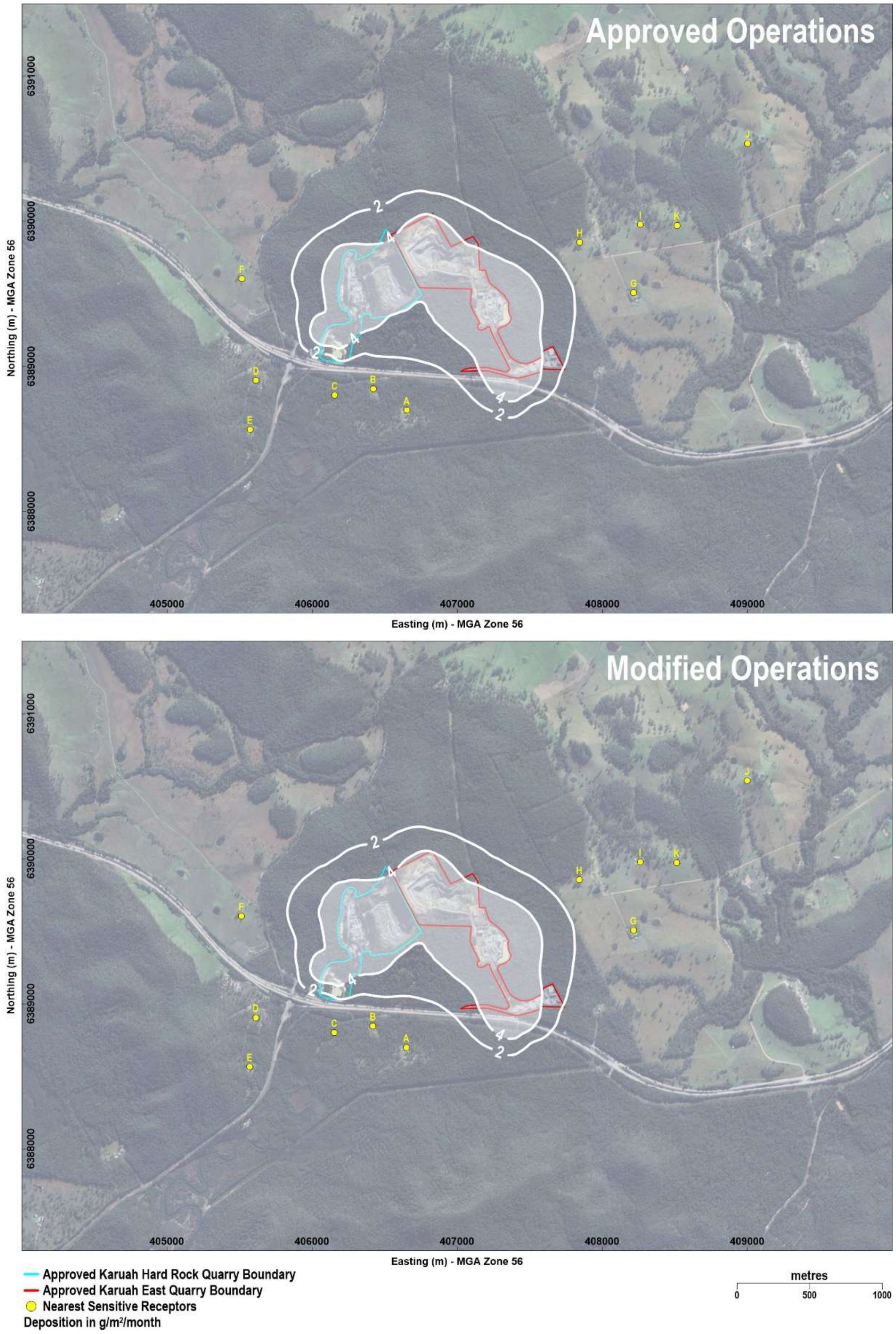


Figure 23 Modelled annual average deposited dust levels due to KEQ and KHRQ and other sources

6.2 Post Blast Fume

Figure 24 shows the modelled maximum 1-hour average NO_2 concentrations due to post-blast fume, based on the methodology outlined in **Section 5.2**. These results include the assumed maximum background levels of 66 µg/m³ (from **Table 9**). The 164 µg/m³ contour represents the EPA's assessment criterion. These results show that, under worst-case meteorological conditions with a rated 3 fume, blasting every day between 9 am and 5 pm and maximum background concentrations, the maximum 1-hour average NO_2 concentrations will not exceed the EPA's criterion at any off-site sensitive receptor. Results are presented from blasting in both KEQ and KHRQ however blasting will not occur simultaneously in both quarries (it is noted that the proposal seeks to establish two cumulative blasts per week (Mon-Fri) at KEQ and KHRQ).

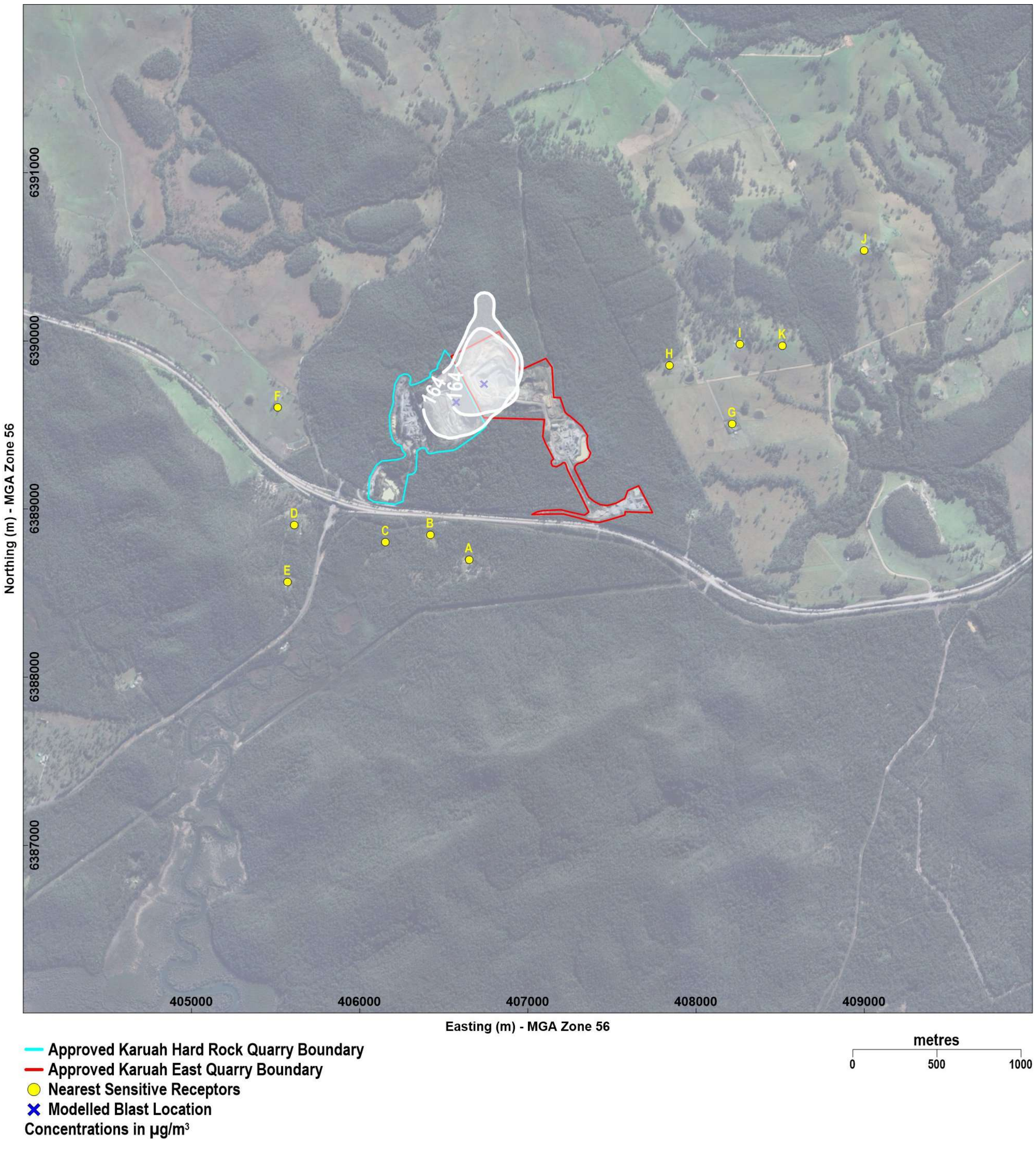


Figure 24 Modelled 1-hour average NO_2 concentrations due to blasting (including background levels)

6.3 Diesel Exhaust

Figure 25 shows the modelled maximum 1-hour average NO_2 concentrations due to diesel exhaust emissions, based on the methodology outlined in **Section 5.3**. The results assume that 20% of the NO_x is NO_2 at the locations of maximum ground-level concentrations and include maximum background concentrations of 66 µg/m^3. Compliance with the EPA's 164 µg/m^3 criterion is expected at all sensitive receptors.

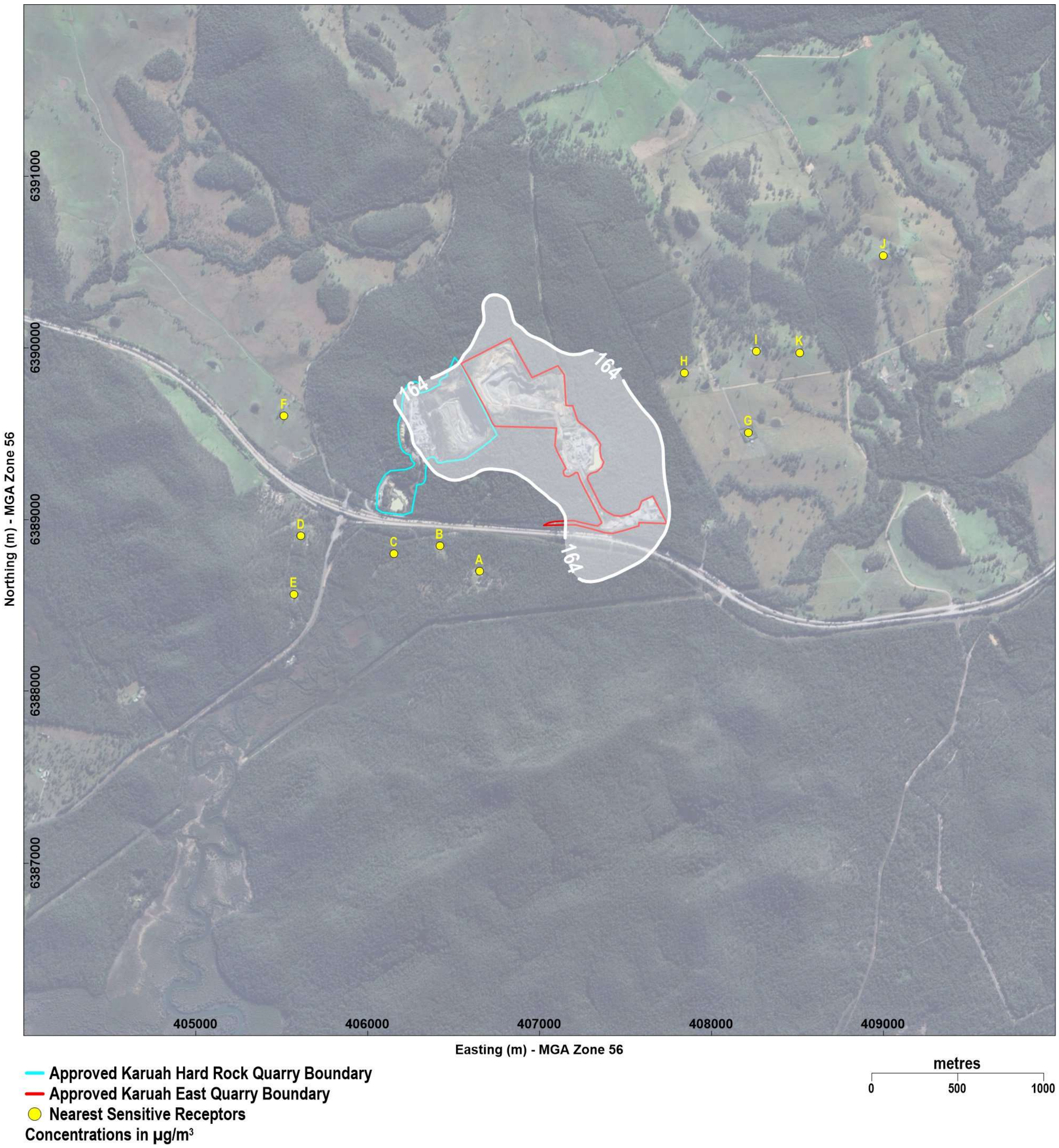


Figure 25 Modelled maximum 1-hour average NO_2 concentrations due to diesel exhausts (including background levels)

Figure 26 shows the modelled annual average NO_2 concentrations due to diesel exhaust emissions. These results assume that 100% of the NO_x is NO_2 and include background concentrations. Compliance with the EPA's 31 µg/m³ criterion is expected at all sensitive receptors.

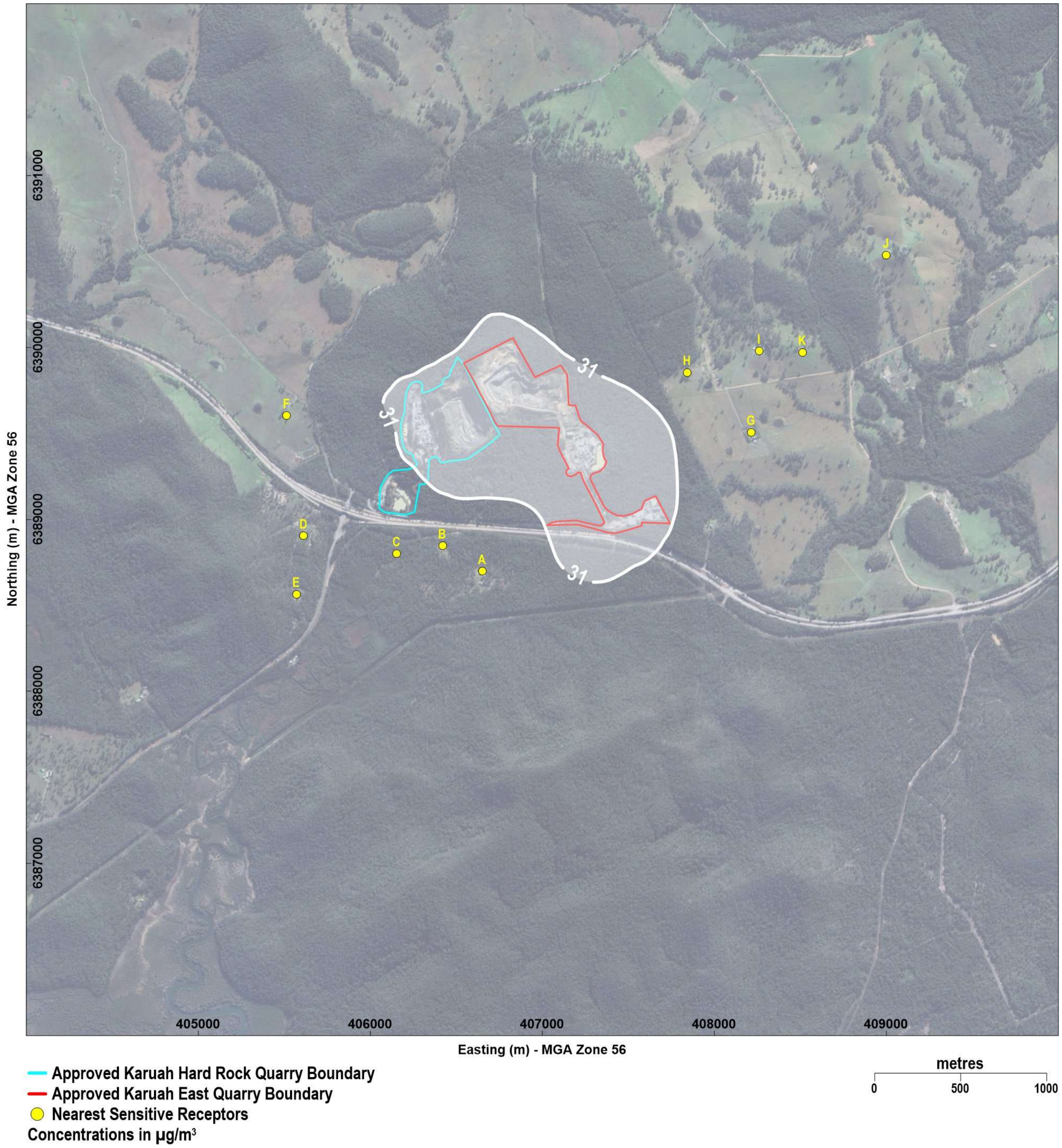


Figure 26 Modelled annual average NO_2 concentrations due to diesel exhausts (including background levels)

7 Monitoring and Management

The modelling showed that off-site dust concentrations, dust deposition levels and NO_2 concentrations would be below the relevant EPA assessment criteria and established criteria within MP09_0175 (Schedule 3 Condition 13). Therefore, an appropriate air quality management strategy would include continuation of the current mitigation measures including:

- Minimising disturbance of land to only what is required by quarry activities.
- Minimising distance travelled by hauling rock the shortest distance possible.
- Adopting controls for unsealed haul road dust emissions.
- Use of water sprays when drilling if / as required.
- Use of water sprays on stockpile areas if / as required.
- Undertake regular road sweeping to clean roadways around the entrance to the quarry.
- Visual monitoring to identify excessive dust generation.

These measures are incorporated into the KEQ Air Quality Management Plan (current version KEQ, version 5A, March 2025).

As noted in **Section 4**, the current monitoring consists of one HVAS (measuring TSP and PM_{10}), four deposited dust gauges and one meteorological station. This monitoring addresses the parameters and conditions from PA MP09_0175, however contemporary approvals have the included the following updates:

- Inclusion of assessment criteria for $PM_{2.5}$.
- Incremental criteria for 24-hour average PM_{10} and $PM_{2.5}$ (previously total impact).

The monitoring will need to be updated to reflect potential changes to PA MP09_0175 such as those listed above. It is anticipated that a revised monitoring program to meet contemporary approvals would consist of:

- One site specific meteorological station, at the current location.
- Provision of an additional HVAS monitor for $PM_{2.5}$, at the current location, for compliance purposes.
- Two real-time air quality monitors capable of measuring PM_{10} and $PM_{2.5}$ and positioned on opposite sides of the combined KEQ / KHRQ site so as to allow for the calculation of development contributions to air quality, for management purposes.

KEQPL has committed to reviewing and revising the KEQ Air Quality Management Plan, as appropriate, to meet conditions for air quality.

8 Conclusions

This report provides an assessment of the potential air quality effects of MOD 11 at KEQ. It has been undertaken in accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2022). The adopted methodology considers the existing operations, the modification design parameters, site-specific meteorological data and site-specific ambient quality monitoring data to determine the potential impacts to air quality with reference to the EPA's air quality impact assessment criteria.

The assessment involved identifying the key air quality issues, characterising the existing environment, quantifying emissions to air and modelling the potential impact of the KEQ on local air quality. The key air quality issues were identified as operational dust, post-blast fume and diesel exhaust. These issues were the focus of the assessment.

A detailed review of the existing environment was carried out including an analysis of historically measured concentrations of key quality indicators from regional and site-specific monitoring stations. The review showed that air quality in many parts of NSW, including the Hunter Region, is heavily influenced by climatic conditions such as drought. Data from site-specific monitoring showed that concentrations of key air quality indicators near the KEQ are within acceptable (EPA) levels and that the KEQ has not caused exceedances of EPA criteria at sensitive locations.

The key outcomes of the modelling and subsequent assessment were as follows:

- The proposed modification will not cause adverse impacts with respect to dust concentrations or deposition levels, based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.
- Post blast fume emissions are not expected to result in any adverse air quality impacts (as NO_2), based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.
- Emissions from diesel exhausts associated with off-road vehicles and equipment are not expected to result in any adverse air quality impacts, based on modelling which showed compliance with air quality assessment criteria at all sensitive receptors.

Based on this assessment, it has been concluded that the KEQ is unlikely to cause any adverse air quality impacts at sensitive locations, and it is considered that the proposed modification can be supported. A conservative approach was adopted for the modelling which (primarily) assumed that maximum daily production would occur every day of the year. The modelling results at all sensitive receptors are sufficiently below the respective air quality assessment criteria which demonstrate that any uncertainties in the modelling would not change the outcomes of the assessment.

HQPL has committed to reviewing and revising the KEQ Air Quality Management Plan, as appropriate, to meet conditions for air quality.

9 References

Attalla M I, Day S J, Lange T, Lilley W and Morgan S (2008) "NO_x emissions from blasting operations in open-cut coal mining" published in Atmospheric Environment, 42, (2008), 7874-7883. CSIRO Energy Technology, PO Box 330, Newcastle, NSW 2300.

DEEDI (2011) "Management of oxides of nitrogen in open cut blasting". Queensland Guidance Note QGN 20 v3. Department of Employment, Economic Development and Innovation.

DPE (2020) "Annual Air Quality Statement 2019". Available from https://www.environment.nsw.gov.au/

EPA (2012) "Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year, Off-Road Mobile Emissions". Technical Report No. 6. Prepared by the Environment Protection Authority. EPA 2012/0050. August 2012.

EPA (2022) "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW". August 2022. Published by the Environment Protection Authority.

KEQPL (2025) "Karuah East Quarry Air Quality Management Plan". Karuah East Quarry Pty Limited, March 2025.

NEPC (1998 and updates) "Ambient Air – National Environment Protection Measure for Ambient Air Quality", National Environment Protection Council, Canberra.

NPI (2012) "Emission Estimation Technique Manual for Mining". Version 3.1, January 2012. National Pollutant Inventory.

NSW Department of Planning, Housing & Infrastructure, Project Approval MP09-0175.

New South Wales Government (2018) "Voluntary Land Acquisition and Mitigation Policy For State Significant Mining, Petroleum and Extractive Industry Developments".

OEH (2019) "Annual Air Quality Statement 2018". Available from https://www.dpie.nsw.gov.au/air-quality.

Skidmore, E.L. (1998) "Wind Erosion Processes". USDA-ARS Wind Erosion Research Unit, Kansas State University. Wind Erosion in Africa and West Asia: Problems and Control Strategies. Proceedings of the expert group meeting 22-25 April 1997, Cairo, Egypt.

TRC (2011) "Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW'". Prepared for the Office of Environment and Heritage by TRC, March 2011.

US EPA (1985 and updates) "Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Now a web-based document.

US EPA (1987) Update of fugitive dust emission factors in AP-42 Section 11.2, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, July 1987.

Appendix A. Development plans

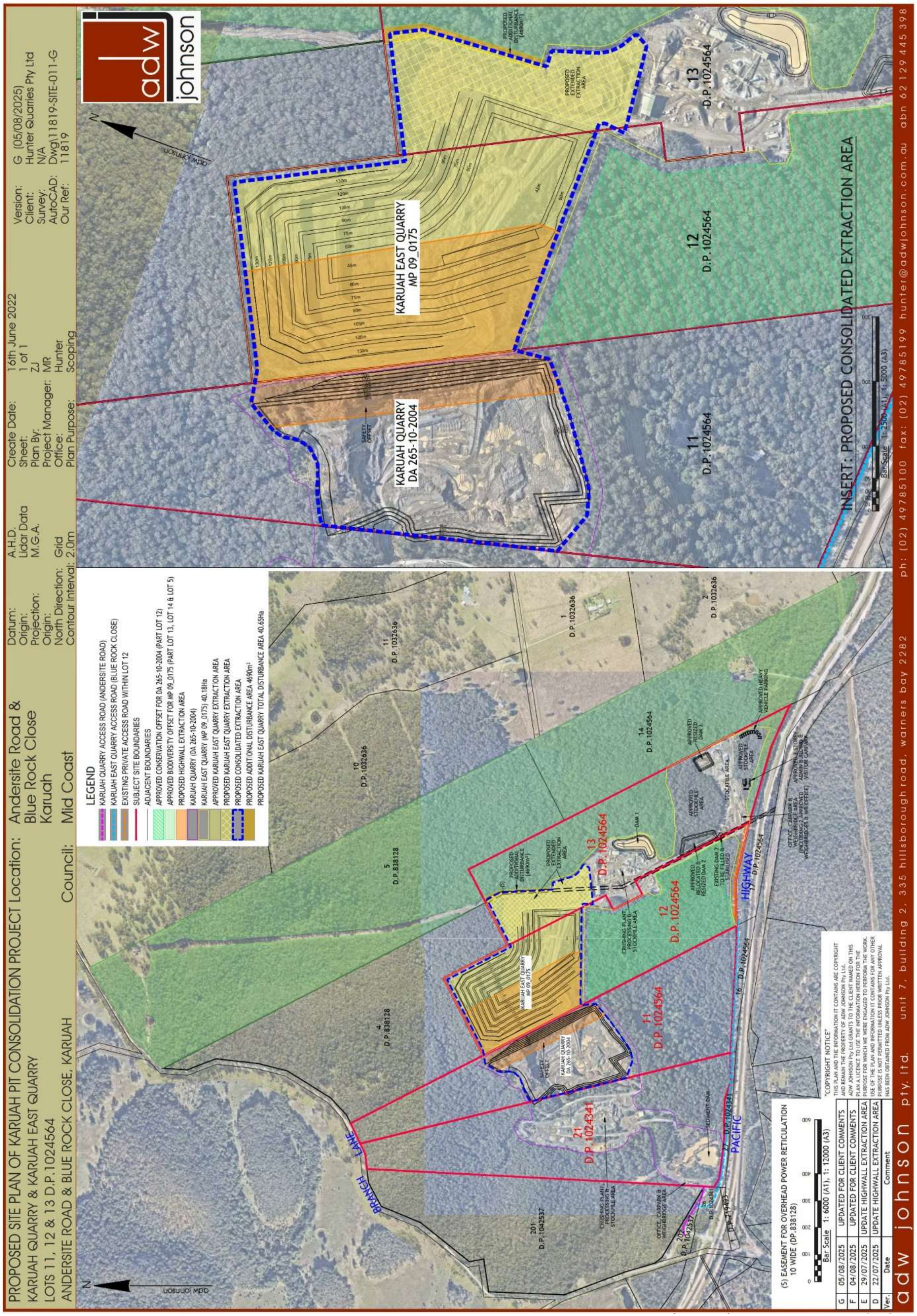


Figure A1 Consolidated development plan

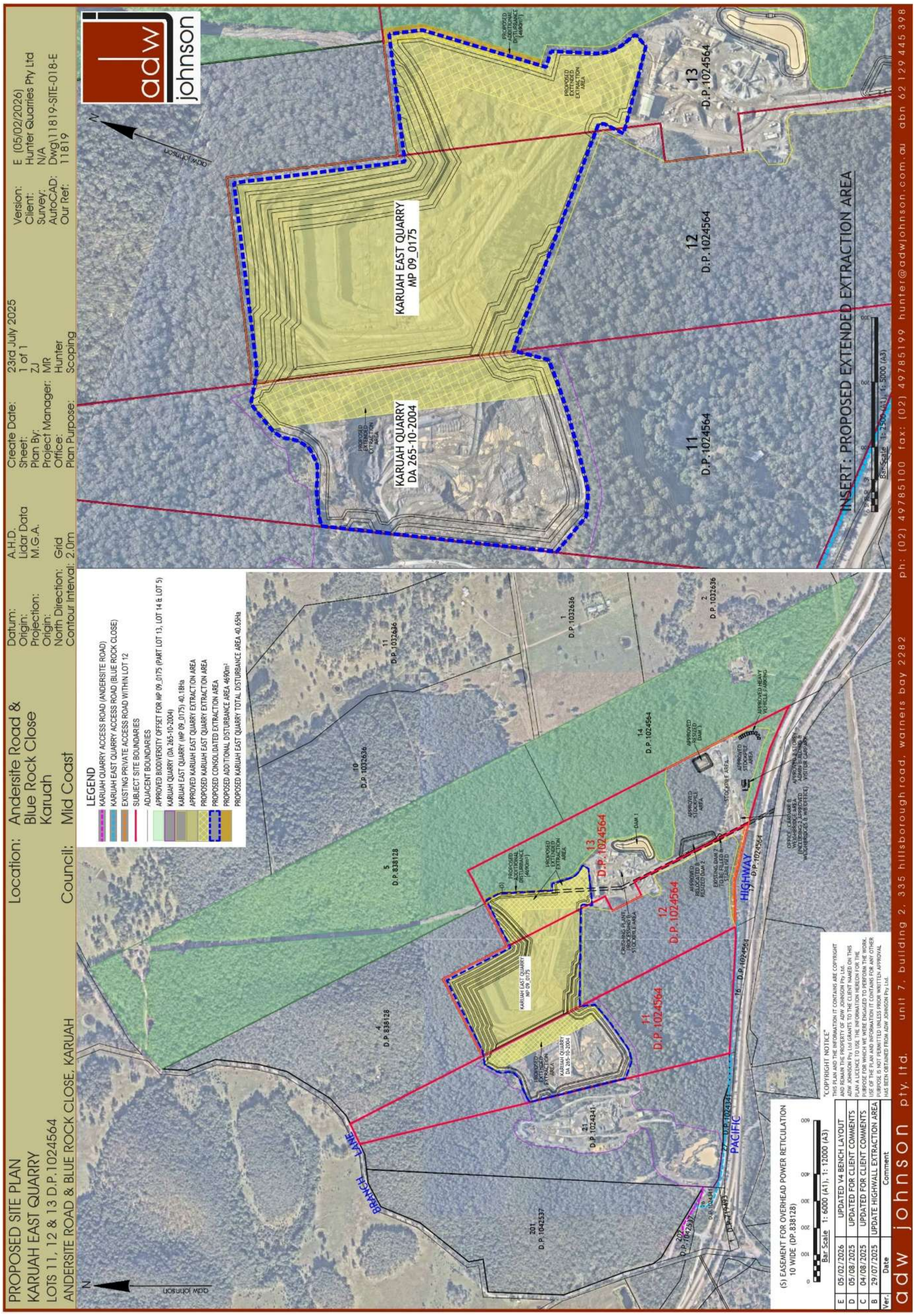


Figure A2 Development plan for Karuah East Quarry

Appendix B. Annual and seasonal wind-roses

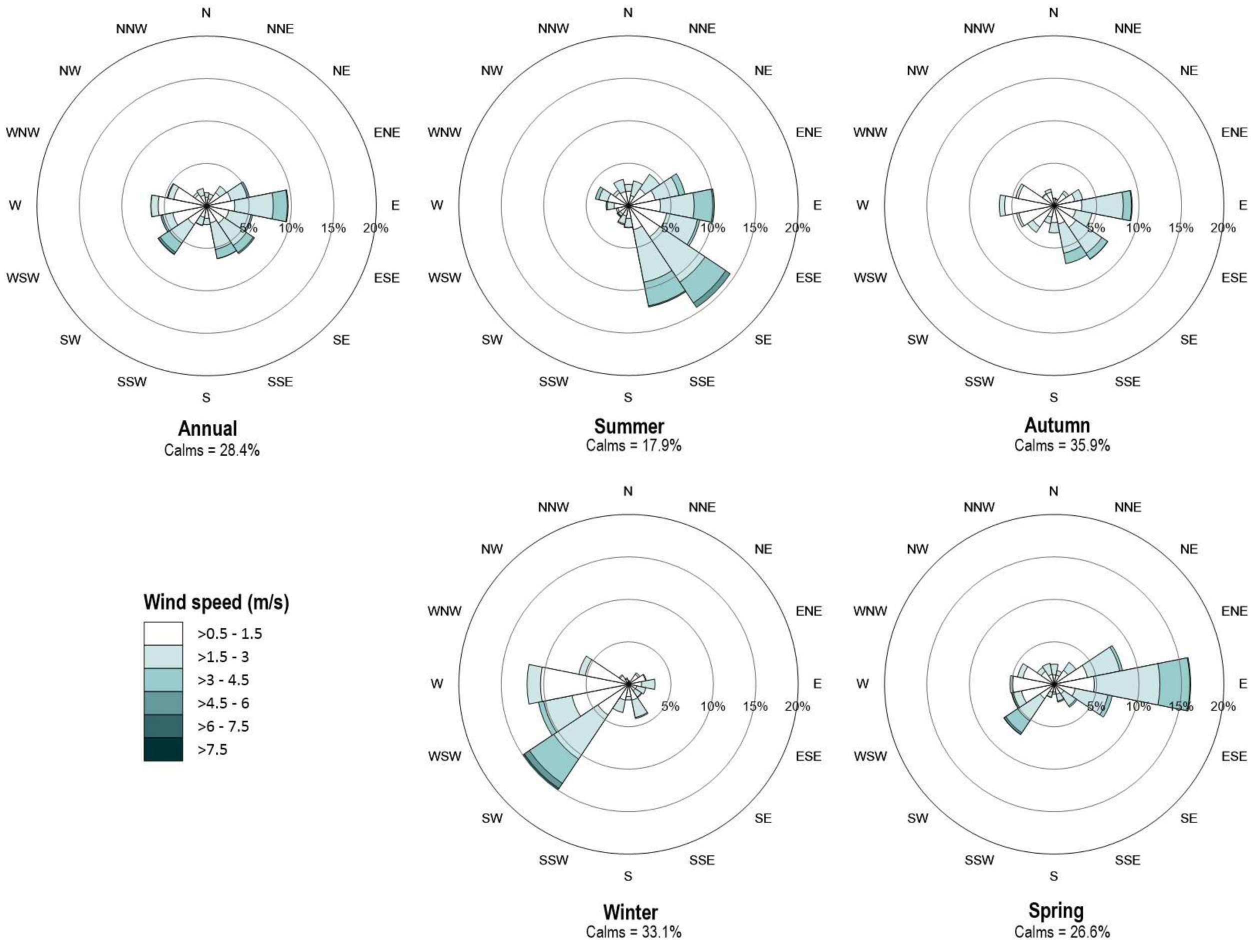


Figure B1 Annual and seasonal wind-roses from site data collected in 2024

Appendix C. Model settings

Geophysical

Figure C1 shows the model grid, land-use and terrain information, as used by CALMET.

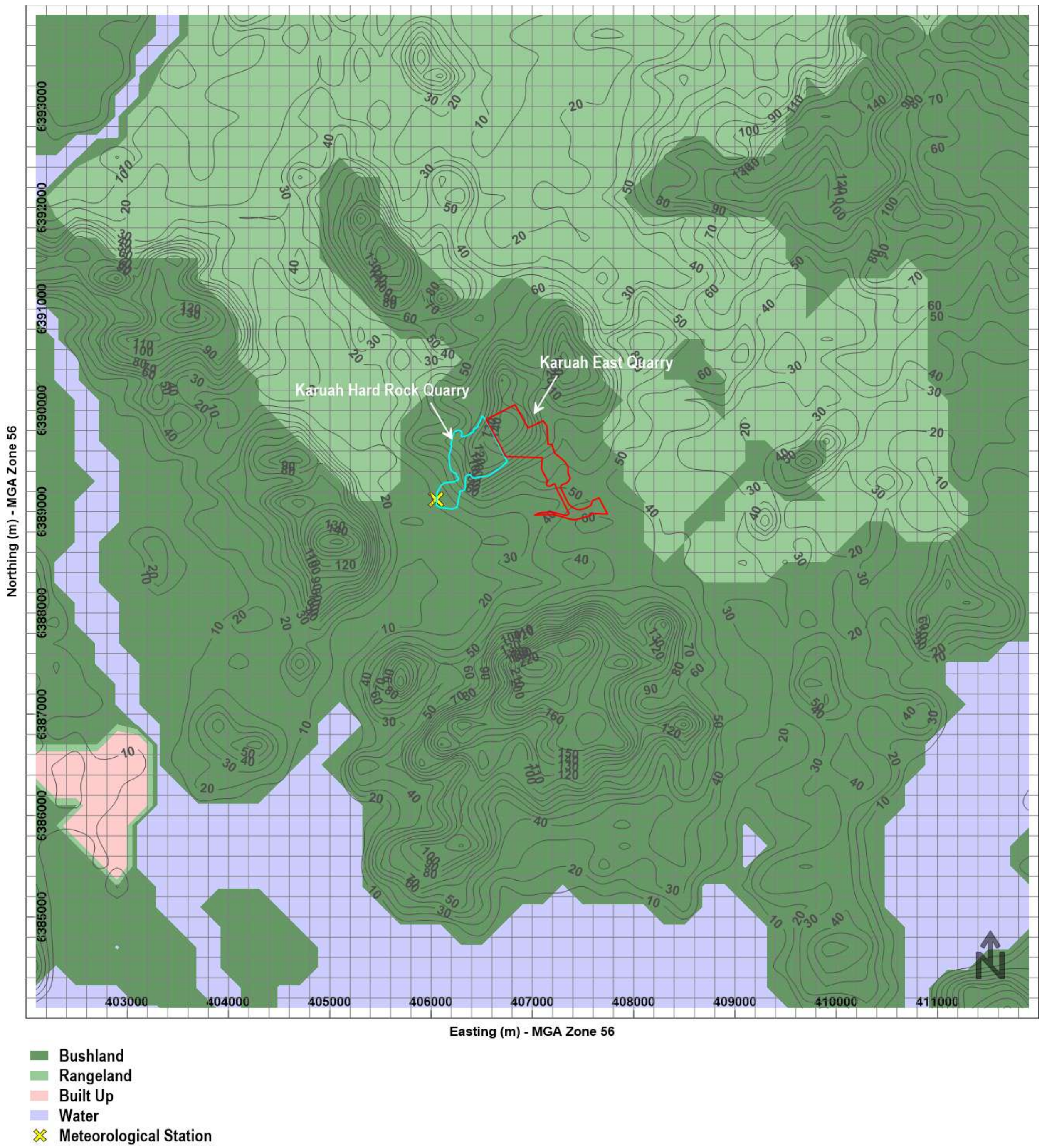


Figure C1 Model domain, grid, land use and terrain information

Meteorology

The CALPUFF model, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The necessary surface and upper air data for CALMET were generated by the CSIRO's prognostic model, TAPM. CALMET was used to produce a year-long, three-dimensional output of meteorological conditions for input to the CALPUFF air dispersion model. The meteorological modelling followed the guidance of TRC (2011) and adopted the "no-observations" mode.

Table C1 Model settings and inputs for TAPM

Parameter	Value(s)
Model version	4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grids point	35 x 35 x 25
Year(s) of analysis	2024
Centre of analysis	32°38' S, 152°00' E
Terrain data source	30 m Shuttle Research Topography Mission (SRTM)
Land use data source	Default
Meteorological data assimilation	None

Table C2 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	30 m SRTM
Land use data source(s)	Digitised from aerial imagery
Meteorological grid domain	10 km x 10 km
Meteorological grid resolution	0.2 km
Meteorological grid dimensions	50 x 50 x 9 grid points
Meteorological grid origin	402000 mE, 6384000 mN. MGA Zone 56
Surface meteorological stations	Site: wind speed, wind direction (TAPM for temperature, relative humidity, ceiling height, cloud cover and pressure)
Upper air meteorological stations	Upper air data file for the location of the site meteorological station, derived by TAPM. Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8784 hours (1 Jan 2024 to 31 Dec 2024)
R1, R2	0.5, 1
RMAX1, RMAX2	5, 20
TERRAD	5

Figure C2 shows a snapshot of winds at 10 metres above ground-level as simulated by the CALMET model under stable conditions. This plot shows the effect of the topography on local winds, for this particular hour, and highlights the non-uniform wind patterns in the area, further supporting the use of a non-steady-state model such as CALPUFF.

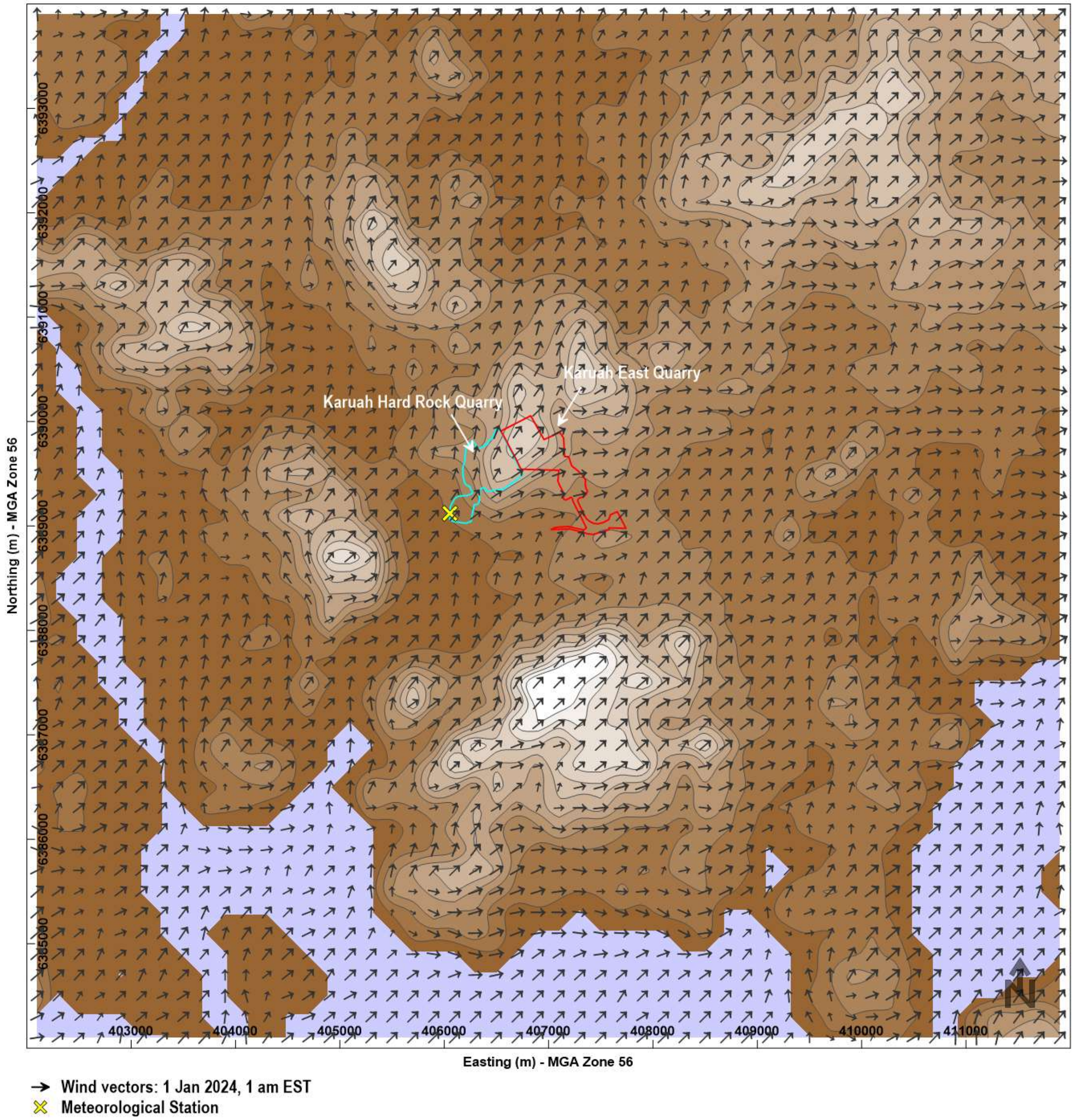


Figure C2 Example of CALMET simulated ground-level wind flows

Figure C3 shows annual and seasonal wind-roses from meteorological modelling for the KEQ site as described above. These wind-roses exhibit patterns that are similar to those measured at the site (**Appendix B**). The annual average wind speed from these modelled data was 1.2 m/s which is also similar to the statistics from the site data (see **Table 3**).

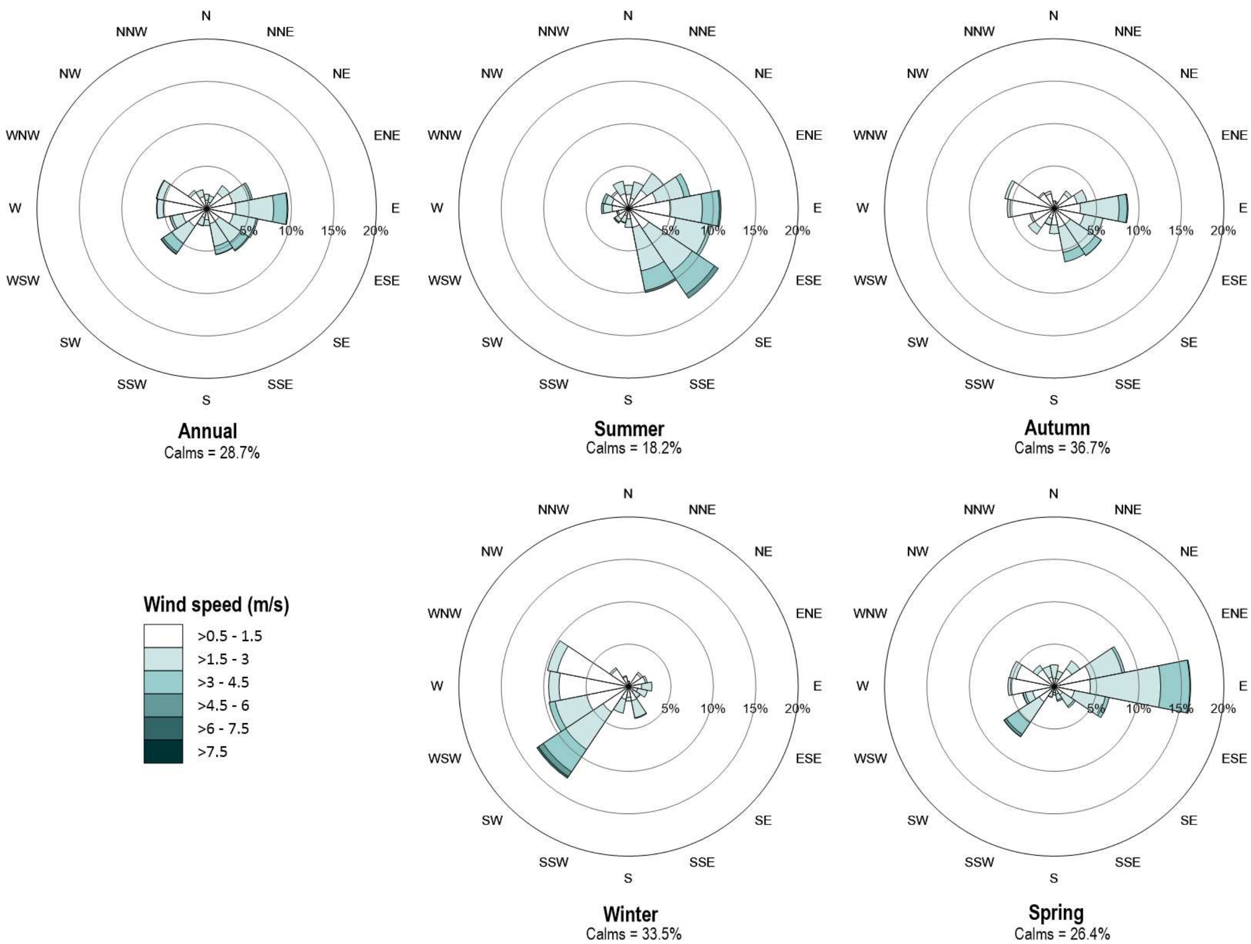


Figure C3 Annual and seasonal wind-roses from modelled data for the KEQ site in 2024

Figure C4 shows a range of meteorological parameters from modelled data for the KEQ site in 2024. This includes hourly temperature, wind speed, wind direction and mixing height records, as well as histograms of stability classes and wind speeds. The modelled temperature data show a seasonal pattern with warmer temperatures in summer and cooler temperatures in winter, as expected. Modelled maximum wind speeds are in the order of 7 m/s and modelled maximum mixing heights are in the order of 2,000 m. These data do not exhibit any unusual or extreme patterns and have been considered acceptable for use in the dispersion modelling.

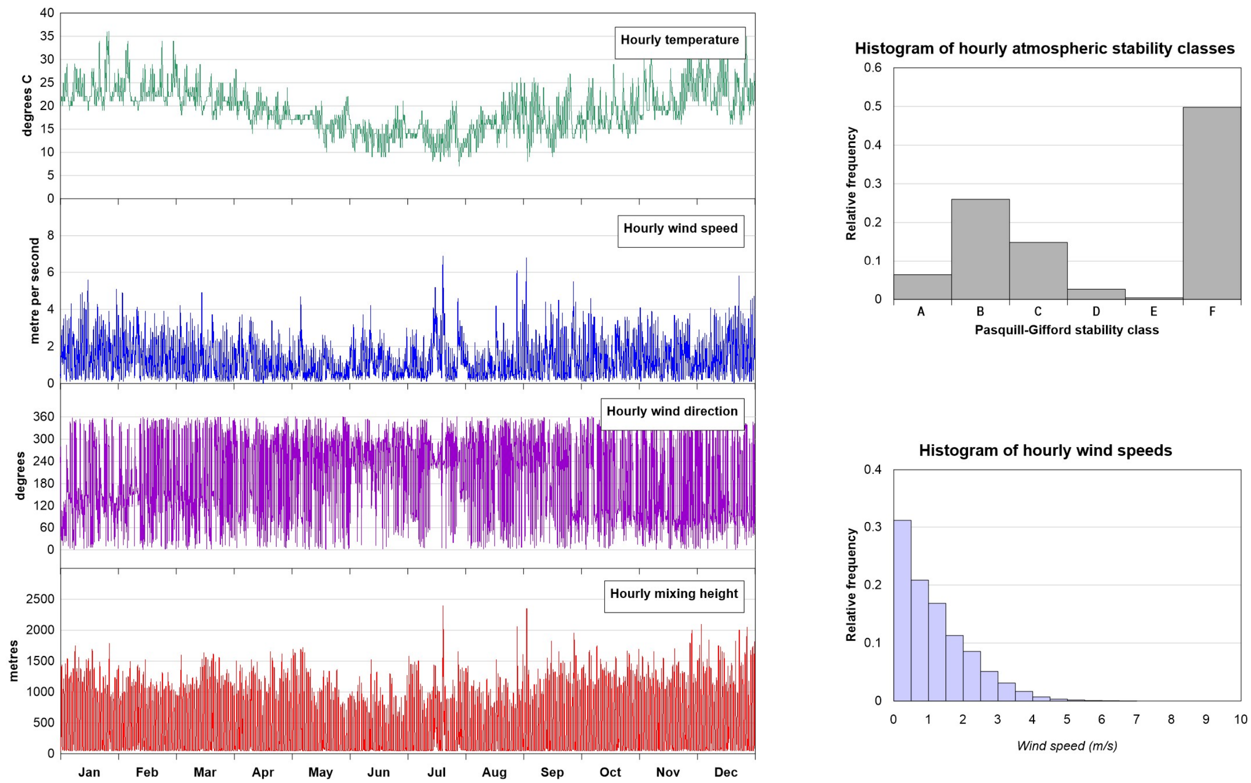


Figure C4 Meteorological parameters from modelled data for the KEQ site in 2024

Table C3 shows the model settings and input for the dispersion model, CALPUFF.

Table C3 Model settings and inputs for CALPUFF

Parameter	Value(s)
Model version	6.42
Computational grid domain	50 x 50
Chemical transformation	None
Dry deposition	Yes
Wind speed profile	ISC rural
Puff element	Puff
Dispersion option	Turbulence from micrometeorology
Time step	3600 seconds (1 hour)
Terrain adjustment	Partial plume path
Number of volume sources	See below. Height = 5 m, SY = 20 m, SZ = 10 m.
Number of discrete receptors	521. See below.

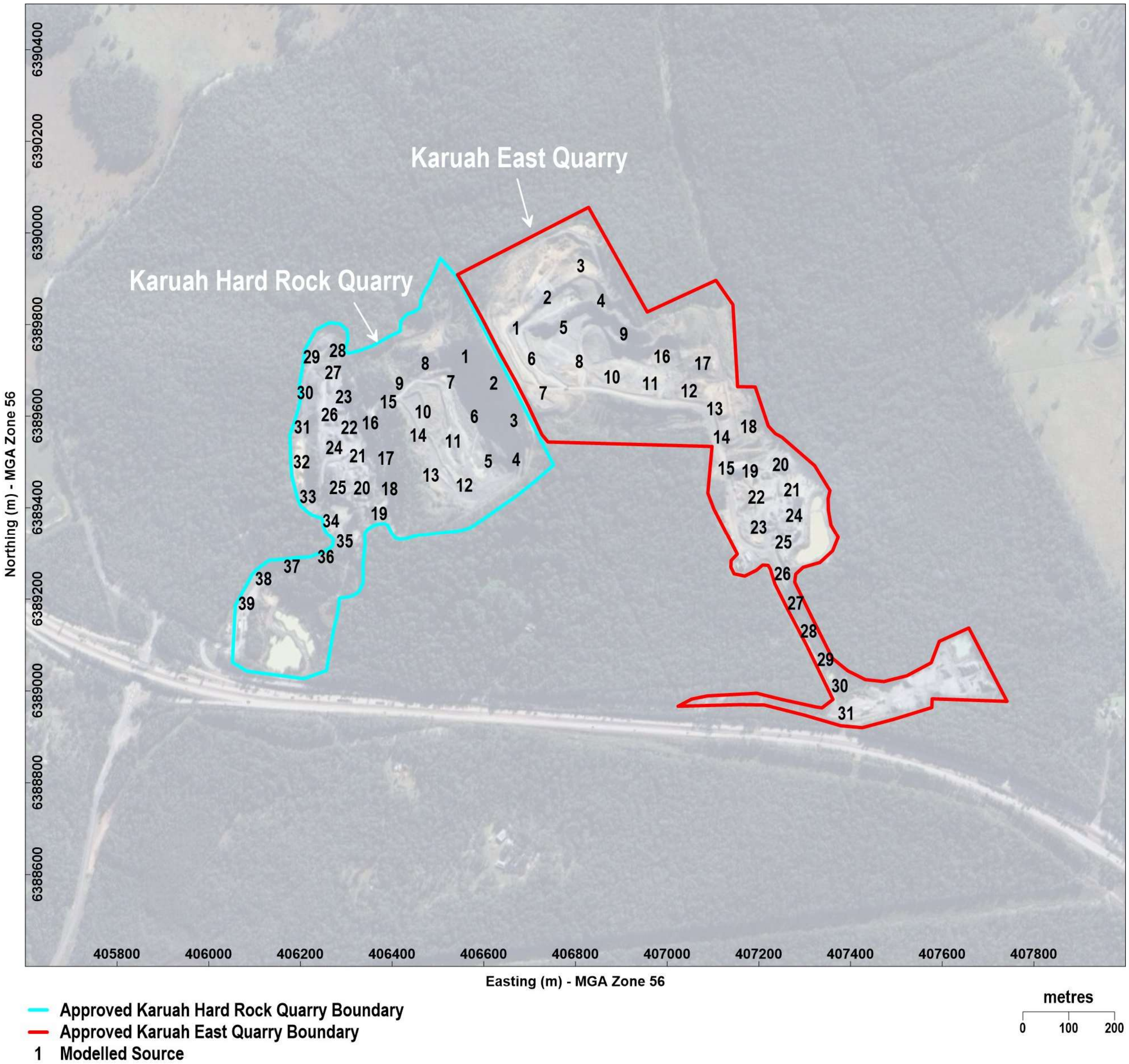


Figure C5 Modelled source locations

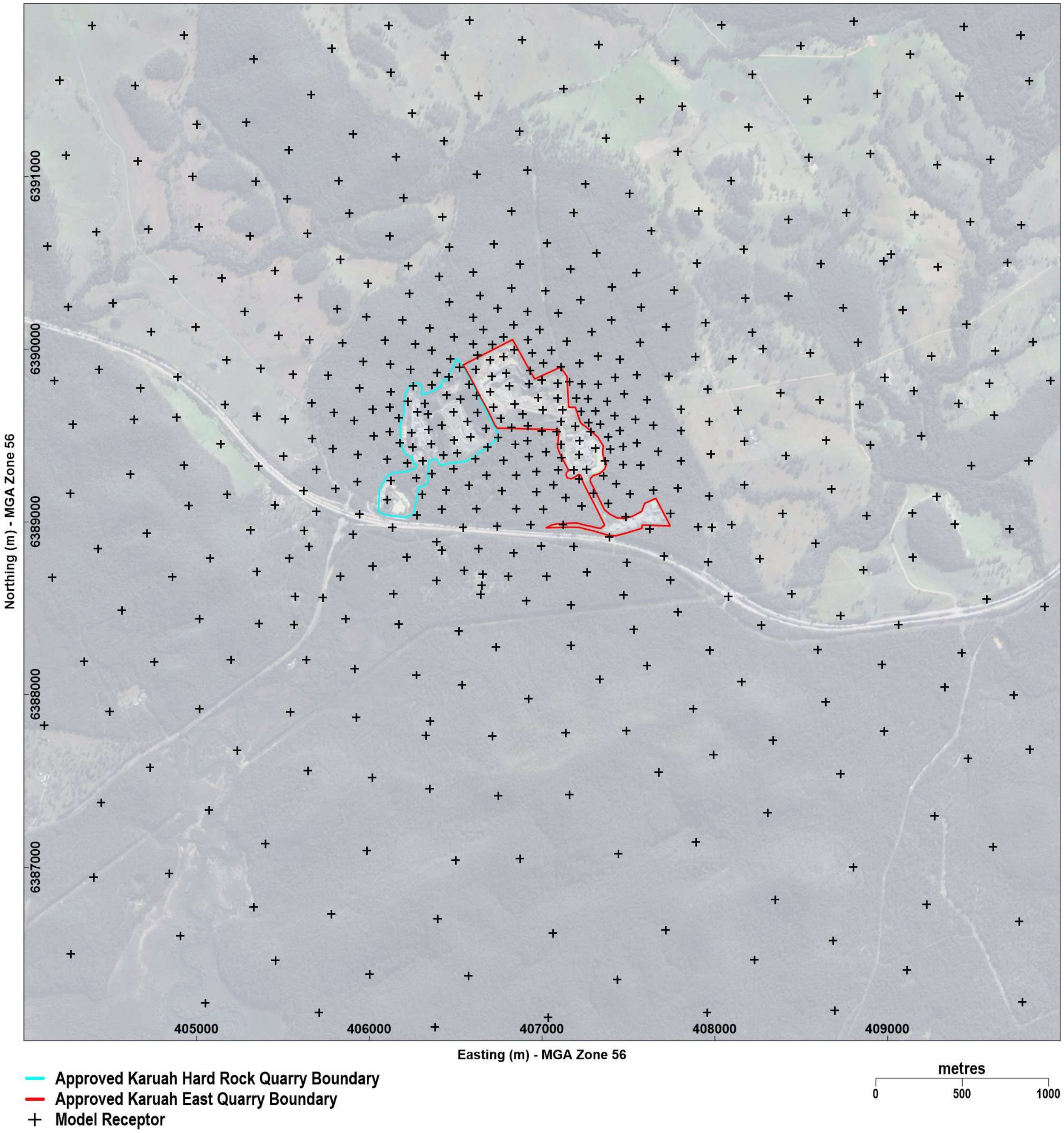


Figure C6 Model receptor locations

Appendix D. Emission calculations

Table D1 details the emission factors for the calculations.

Table D1 Emission factors

Activity	Emission factors	Units	Source
Drilling	$E_{TSP} = 0.59$ $E_{PM10} = 0.52 \times E_{TSP}$ $E_{PM2.5} = 0.03 \times E_{TSP}$	kg/hole	US EPA / NPI
Blasting	$E_{TSP} = 0.00022 \times A^{1.5}$ $E_{PM10} = 0.52 \times E_{TSP}$ $E_{PM2.5} = 0.03 \times E_{TSP}$	kg/blast	US EPA / NPI
Dozers working	$E_{TSP} = 2.6 \times (S^{1.2}/M^{1.3})$ $E_{PM10} = 0.3375 \times (S^{1.5}/M^{1.4})$ $E_{PM2.5} = 0.105 \times E_{TSP}$	kg/hour	US EPA / NPI
Excavators loading	$E_{TSP} = 0.74 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$ $E_{PM10} = 0.35 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$ $E_{PM2.5} = 0.053 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	kg/t	US EPA / NPI
Loading / unloading rock	$E_{TSP} = 0.74 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$ $E_{PM10} = 0.35 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$ $E_{PM2.5} = 0.053 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	kg/t	US EPA / NPI
Crushing	$E_{TSP} = 0.01$ $E_{PM10} = 0.004$ $E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA
Screening	$E_{TSP} = 0.03$ $E_{PM10} = 0.01$ $E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA
Hauling on unsealed roads	$E_{TSP} = 4$ $E_{PM10} = 0.3 \times E_{TSP}$ $E_{PM2.5} = 0.03 \times E_{TSP}$	kg/VKT	SPCC
Wind erosion from exposed areas	$E_{TSP} = 0.1$ $E_{PM10} = 0.5 \times E_{TSP}$ $E_{PM2.5} = 0.075 \times E_{TSP}$	kg/ha/h	US EPA

A = blast area (m^2)
U = wind speed (m/s)
M = moisture content (%). A default value of 2% has been used.
S = silt content (%). A default value of 10% has been used.

Emission calculations

Karuah East Quarry (Approved)	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables						
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	kg/VKT	t/truck	km/trip	Silt (%)
Drilling overburden	0	0	0	0	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting overburden	0	0	0	0	0	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Dozer working	0	0	0	0	0	h/y	16.7	kg/h	4.07	kg/h	1.757	kg/h	-	-	2	-	-	-	10
Excavators working	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Drilling rock	748	393	37	70	4228	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting rock	300	156	15	0	28	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Loading rock to trucks	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling rock to hopper	62734	11949	2987	75	2281250	t/y	0.11000	kg/t	0.02095	kg/t	0.005	kg/t	-	-	-	4.0	40	1.1	-
Unloading to hopper	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Primary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 1	34219	11406	1711	50	2281250	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Secondary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 2	34219	11406	1711	50	2281250	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Tertiary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Loading product stockpiles	718	339	36	50	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Wind erosion from exposed areas	10074	5037	756	0	11.5	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Wind erosion from product stockpiles	1402	701	105	50	3.2	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Loading product to trucks	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling product off-site	85547	16295	4074	75	2281250	t/y	0.15000	kg/t	0.02857	kg/t	0.007	kg/t	-	-	-	4.0	32	1.2	-
	258492	69329	12858																

Karuah East Quarry (Proposed)	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables						
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	kg/VKT	t/truck	km/trip	Silt (%)
Drilling overburden	0	0	0	0	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting overburden	0	0	0	0	0	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Dozer working	0	0	0	0	0	h/y	16.7	kg/h	4.07	kg/h	1.757	kg/h	-	-	2	-	-	-	10
Excavators working	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Drilling rock	2780	1460	139	70	15704	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting rock	1116	578	56	0	104	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Loading rock to trucks	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling rock to hopper	62734	11949	2987	75	2281250	t/y	0.11000	kg/t	0.02095	kg/t	0.005	kg/t	-	-	-	4.0	40	1.1	-
Unloading to hopper	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Primary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 1	34219	11406	1711	50	2281250	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Secondary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 2	34219	11406	1711	50	2281250	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Tertiary crushing	7597	2977	380	70	2281250	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Loading product stockpiles	718	339	36	50	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Wind erosion from exposed areas	11388	5694	854	0	13.0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Wind erosion from product stockpiles	1402	701	105	50	3.2	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Loading product to trucks	1435	679	72	0	2281250	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling product off-site	85547	16295	4074	75	2281250	t/y	0.15000	kg/t	0.02857	kg/t	0.007	kg/t	-	-	-	4.0	32	1.2	-
	262653	71476	13099																

Karuah Hard Rock Quarry (Approved)	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables						
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	kg/VKT	t/truck	km/trip	Silt (%)
Drilling overburden	0	0	0	0	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting overburden	0	0	0	0	0	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Dozer working	0	0	0	0	0	h/y	16.7	kg/h	4.07	kg/h	1.757	kg/h	-	-	2	-	-	-	10
Excavators working	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Drilling rock	216	113	11	70	1220	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting rock	107	56	5	0	10	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Loading rock to trucks	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling rock to hopper	20075	3824	956	75	803000	t/y	0.10000	kg/t	0.01905	kg/t	0.005	kg/t	-	-	-	4.0	40	1	-
Unloading to hopper	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Primary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 1	12045	4015	602	50	803000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Secondary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 2	12045	4015	602	50	803000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Tertiary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Loading product stockpiles	253	119	13	50	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Wind erosion from exposed areas	6482	3241	486	0	7.4	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Wind erosion from product stockpiles	1226	613	92	50	2.8	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Loading product to trucks	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling product off-site	50188	9560	2390	75	803000	t/y	0.25000	kg/t	0.04762	kg/t	0.012	kg/t	-	-	-	4.0	32	2	-
	112680	29656	5659																

Karuah Hard Rock Quarry (Proposed)	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables						
Activity	TSP	PM10	PM2.5	Control (%)	Intensity	Units	Factor	Units	Factor	Units	Factor	Units	Area (m2)	(ws/2.2)^1.3	Moisture (%)	kg/VKT	t/truck	km/trip	Silt (%)
Drilling overburden	0	0	0	0	0	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting overburden	0	0	0	0	0	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Dozer working	0	0	0	0	0	h/y	16.7	kg/h	4.07	kg/h	1.757	kg/h	-	-	2	-	-	-	10
Excavators working	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Drilling rock	2246	1180	112	70	12688	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-	-
Blasting rock	1116	578	56	0	104	blasts/y	10.7	kg/blast	5.6	kg/blast	0.537	kg/blast	1335	-	-	-	-	-	-
Loading rock to trucks	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling rock to hopper	20075	3824	956	75	803000	t/y	0.10000	kg/t	0.01905	kg/t	0.005	kg/t	-	-	-	4.0	40	1	-
Unloading to hopper	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Primary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 1	12045	4015	602	50	803000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Secondary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Screen 2	12045	4015	602	50	803000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-	-
Tertiary crushing	2674	1048	134	70	803000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-	-
Loading product stockpiles	253	119	13	50	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Wind erosion from exposed areas	7008	3504	526	0	8.0	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Wind erosion from product stockpiles	1226	613	92	50	2.8	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-	-
Loading product to trucks	505	239	25	0	803000	t/y	0.00063	kg/t	0.0003	kg/t	0.000	kg/t	-	0.53	2	-	-	-	-
Hauling product off-site	50188	9560	2390	75	803000	t/y	0.25000	kg/t	0.04762	kg/t	0.012	kg/t	-	-	-	4.0	32	2	-
	116244	31508	5851																

Source allocation

```
  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0
```

```
 ACTIVITY NAME : Blasting overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Dozer working
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Excavators working
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1435 kg/y TSP  679 kg/y PM10  72 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2780 kg/y TSP  1460 kg/y PM10  139 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1116 kg/y TSP  578 kg/y PM10  56 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1435 kg/y TSP  679 kg/y PM10  72 kg/y PM2.5
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Hauling rock to hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 62734 kg/y TSP  11949 kg/y PM10  2987 kg/y PM2.5
 FROM SOURCES  : 15
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Unloading to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1435 kg/y TSP  679 kg/y PM10  72 kg/y PM2.5
 FROM SOURCES  : 1
15
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7597 kg/y TSP  2977 kg/y PM10  380 kg/y PM2.5
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Screen 1
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 34219 kg/y TSP  11406 kg/y PM10  1711 kg/y PM2.5
 FROM SOURCES  : 1
19
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7597 kg/y TSP  2977 kg/y PM10  380 kg/y PM2.5
 FROM SOURCES  : 1
20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
```

```
 ACTIVITY NAME : Screen 2
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 34219 kg/y TSP  11406 kg/y PM10  1711 kg/y PM2.5
 FROM SOURCES  : 1
20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7597 kg/y TSP  2977 kg/y PM10  380 kg/y PM2.5
 FROM SOURCES  : 1
21
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 718 kg/y TSP  339 kg/y PM10  36 kg/y PM2.5
 FROM SOURCES  : 5
22 23 24 25 26
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 11388 kg/y TSP  5694 kg/y PM10  854 kg/y PM2.5
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1402 kg/y TSP  701 kg/y PM10  105 kg/y PM2.5
 FROM SOURCES  : 7
19 20 21 22 23 24 25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1435 kg/y TSP  679 kg/y PM10  72 kg/y PM2.5
 FROM SOURCES  : 5
22 23 24 25 26
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0

 ACTIVITY NAME : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 85547 kg/y TSP  16295 kg/y PM10  4074 kg/y PM2.5
 FROM SOURCES  : 10
22 23 24 25 26 27 28 29 30 31
 HOURS OF DAY  :
0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0
```

Appendix E. Tabulated results

Table E1 Tabulated particulate matter results from the modelling

Property ID	Description	Due to KEQ quarry	Due to KHRQ	Due to KEQ, KHRQ and other sources (i.e. cumulative)	Criterion
Predicted maximum 24-hour average PM_{10} concentrations (µg/m^3)					
A	Sensitive receptor	9	3	26	50
B	Sensitive receptor	9	4	26	50
C	Sensitive receptor	6	4	24	50
D	Sensitive receptor	6	4	24	50
E	Sensitive receptor	6	4	24	50
F	Sensitive receptor	5	5	24	50
G	Sensitive receptor	21	3	31	50
H	Sensitive receptor	26	5	33	50
I	Sensitive receptor	14	3	26	50
J	Sensitive receptor	5	2	23	50
K	Sensitive receptor	12	2	26	50
Predicted annual average PM_{10} concentrations (µg/m^3)					
A	Sensitive receptor	2.5	0.8	12.9	25
B	Sensitive receptor	2.6	1.2	13.4	25
C	Sensitive receptor	1.7	0.9	12.3	25
D	Sensitive receptor	1.2	1.0	11.9	25
E	Sensitive receptor	1.3	0.9	11.9	25
F	Sensitive receptor	1.1	1.2	11.9	25
G	Sensitive receptor	4.1	0.4	14.2	25
H	Sensitive receptor	4.9	0.7	15.2	25
I	Sensitive receptor	2.4	0.4	12.4	25
J	Sensitive receptor	0.8	0.2	10.7	25
K	Sensitive receptor	2.0	0.3	11.9	25
Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m^3)					
A	Sensitive receptor	2.2	0.8	11.5	25
B	Sensitive receptor	1.9	1.1	11.5	25
C	Sensitive receptor	1.3	1.0	11.0	25
D	Sensitive receptor	1.2	0.9	10.9	25
E	Sensitive receptor	1.2	0.9	10.8	25
F	Sensitive receptor	1.0	1.0	10.8	25
G	Sensitive receptor	4.4	0.7	11.7	25
H	Sensitive receptor	5.6	1.0	12.4	25
I	Sensitive receptor	3.1	0.6	11.2	25
J	Sensitive receptor	1.2	0.4	10.6	25
K	Sensitive receptor	2.5	0.5	10.9	25
Predicted annual average $PM_{2.5}$ concentrations (µg/m^3)					
A	Sensitive receptor	0.6	0.2	5.6	8
B	Sensitive receptor	0.6	0.3	5.8	8

Property ID	Description	Due to KEQ quarry	Due to KHRQ	Due to KEQ, KHRQ and other sources (i.e. cumulative)	Criterion
C	Sensitive receptor	0.4	0.2	5.5	8
D	Sensitive receptor	0.3	0.2	5.4	8
E	Sensitive receptor	0.3	0.2	5.3	8
F	Sensitive receptor	0.3	0.3	5.3	8
G	Sensitive receptor	1.0	0.1	5.9	8
H	Sensitive receptor	1.1	0.2	6.1	8
I	Sensitive receptor	0.6	0.1	5.5	8
J	Sensitive receptor	0.2	0.1	5.1	8
K	Sensitive receptor	0.5	0.1	5.4	8
Predicted annual average TSP concentrations (µg/m^3)					
A	Sensitive receptor	2.7	0.7	23.4	90
B	Sensitive receptor	2.8	1.3	24.1	90
C	Sensitive receptor	1.8	1.1	22.9	90
D	Sensitive receptor	1.1	1.8	22.9	90
E	Sensitive receptor	1.1	1.4	22.5	90
F	Sensitive receptor	1.1	2.1	23.2	90
G	Sensitive receptor	3.0	0.2	23.3	90
H	Sensitive receptor	4.0	0.4	24.4	90
I	Sensitive receptor	1.9	0.2	22.2	90
J	Sensitive receptor	0.7	0.1	20.8	90
K	Sensitive receptor	1.5	0.2	21.7	90
Predicted annual average deposited dust (g/m^2/month)					
A	Sensitive receptor	0.3	0.1	1.3	4
B	Sensitive receptor	0.3	0.1	1.4	4
C	Sensitive receptor	0.2	0.1	1.3	4
D	Sensitive receptor	0.1	0.2	1.3	4
E	Sensitive receptor	0.1	0.1	1.2	4
F	Sensitive receptor	0.1	0.2	1.4	4
G	Sensitive receptor	0.3	0.0	1.3	4
H	Sensitive receptor	0.5	0.1	1.5	4
I	Sensitive receptor	0.2	0.0	1.2	4
J	Sensitive receptor	0.1	0.0	1.1	4
K	Sensitive receptor	0.1	0.0	1.2	4

Appendix F. Tabulated results with Karuah South Quarry

Table F1 Tabulated particulate matter results from the modelling (with KSQ)

Property ID	Description	Due to KEQ quarry	Due to KHRQ	Due to KSQ	Due to KEQ, KHRQ, KSQ and other sources (i.e. cumulative)	Criterion
Predicted maximum 24-hour average PM_{10} concentrations (µg/m³)						
A	Sensitive receptor	9	3	5	28	50
B	Sensitive receptor	9	4	6	29	50
C	Sensitive receptor	6	4	4	26	50
D	Sensitive receptor	6	4	2	26	50
E	Sensitive receptor	6	4	3	25	50
F	Sensitive receptor	5	5	2	25	50
G	Sensitive receptor	21	3	2	33	50
H	Sensitive receptor	26	5	2	34	50
I	Sensitive receptor	14	3	2	26	50
J	Sensitive receptor	5	2	1	23	50
K	Sensitive receptor	12	2	2	26	50
Predicted annual average PM_{10} concentrations (µg/m³)						
A	Sensitive receptor	2.5	0.8	0.8	13.7	25
B	Sensitive receptor	2.6	1.2	1.2	14.6	25
C	Sensitive receptor	1.7	0.9	0.6	12.9	25
D	Sensitive receptor	1.2	1.0	0.4	12.3	25
E	Sensitive receptor	1.3	0.9	0.3	12.2	25
F	Sensitive receptor	1.1	1.2	0.3	12.2	25
G	Sensitive receptor	4.1	0.4	0.3	14.5	25
H	Sensitive receptor	4.9	0.7	0.3	15.6	25
I	Sensitive receptor	2.4	0.4	0.2	12.6	25
J	Sensitive receptor	0.8	0.2	0.1	10.8	25
K	Sensitive receptor	2.0	0.3	0.2	12.1	25
Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)						
A	Sensitive receptor	2.2	0.8	1.0	11.9	25
B	Sensitive receptor	1.9	1.1	1.1	11.7	25
C	Sensitive receptor	1.3	1.0	0.6	11.1	25
D	Sensitive receptor	1.2	0.9	0.5	11.0	25
E	Sensitive receptor	1.2	0.9	0.6	10.9	25
F	Sensitive receptor	1.0	1.0	0.3	11.0	25
G	Sensitive receptor	4.4	0.7	0.5	11.8	25
H	Sensitive receptor	5.6	1.0	0.5	12.7	25
I	Sensitive receptor	3.1	0.6	0.3	11.3	25
J	Sensitive receptor	1.2	0.4	0.2	10.7	25
K	Sensitive receptor	2.5	0.5	0.3	11.0	25
Predicted annual average $PM_{2.5}$ concentrations (µg/m³)						
A	Sensitive receptor	0.6	0.2	0.2	5.8	8

Property ID	Description	Due to KEQ quarry	Due to KHRQ	Due to KSQ	Due to KEQ, KHRQ, KSQ and other sources (i.e. cumulative)	Criterion
B	Sensitive receptor	0.6	0.3	0.2	6.0	8
C	Sensitive receptor	0.4	0.2	0.1	5.6	8
D	Sensitive receptor	0.3	0.2	0.1	5.4	8
E	Sensitive receptor	0.3	0.2	0.1	5.4	8
F	Sensitive receptor	0.3	0.3	0.1	5.4	8
G	Sensitive receptor	1.0	0.1	0.1	6.0	8
H	Sensitive receptor	1.1	0.2	0.1	6.2	8
I	Sensitive receptor	0.6	0.1	0.0	5.5	8
J	Sensitive receptor	0.2	0.1	0.0	5.1	8
K	Sensitive receptor	0.5	0.1	0.0	5.4	8
Predicted annual average TSP concentrations (µg/m^3)						
A	Sensitive receptor	2.7	0.7	0.9	24.3	90
B	Sensitive receptor	2.8	1.3	1.6	25.8	90
C	Sensitive receptor	1.8	1.1	0.8	23.6	90
D	Sensitive receptor	1.1	1.8	0.4	23.3	90
E	Sensitive receptor	1.1	1.4	0.3	22.8	90
F	Sensitive receptor	1.1	2.1	0.4	23.6	90
G	Sensitive receptor	3.0	0.2	0.2	23.5	90
H	Sensitive receptor	4.0	0.4	0.4	24.8	90
I	Sensitive receptor	1.9	0.2	0.2	22.4	90
J	Sensitive receptor	0.7	0.1	0.1	20.9	90
K	Sensitive receptor	1.5	0.2	0.2	21.9	90
Predicted annual average deposited dust (g/m^2/month)						
A	Sensitive receptor	0.3	0.1	0.1	1.4	4
B	Sensitive receptor	0.3	0.1	0.2	1.6	4
C	Sensitive receptor	0.2	0.1	0.1	1.4	4
D	Sensitive receptor	0.1	0.2	0.1	1.4	4
E	Sensitive receptor	0.1	0.1	0.0	1.3	4
F	Sensitive receptor	0.1	0.2	0.1	1.4	4
G	Sensitive receptor	0.3	0.0	0.0	1.3	4
H	Sensitive receptor	0.5	0.1	0.1	1.6	4
I	Sensitive receptor	0.2	0.0	0.0	1.2	4
J	Sensitive receptor	0.1	0.0	0.0	1.1	4
K	Sensitive receptor	0.1	0.0	0.0	1.2	4