APPENDIX E

Air Quality Impact Assessment

Martins Creek Quarry Extension Project

Buttai Gravel Pty Ltd

Air Quality Impact Assessment

Final | Revision 1

17 November 2020

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JACOBS

Martins Creek Quarry Extension Project

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D3R0	9/09/2020	Draft report, revised project	SL	Umwelt	PH
D4R0	2/10/2020	Draft report	SL	Umwelt	PH
Final	17/11/2020	Final report	SL	Umwelt	PH

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Executive Summary

This report provides an assessment of the air quality impacts of the Martins Creek Quarry Extension Project. The air quality impact assessment has been carried out in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016). The 2016 version of the EPA's "Approved Methods" introduces revised, more stringent criteria for particulate matter concentrations, compared to the criteria used to assess the Project in the original Environmental Impact Statement (EIS).

The potential air quality issues for the Revised Project were identified as:

- Dust (that is, airborne and deposited particulate matter) from the general quarrying activities;
- Fume from blasting;
- Emissions from machinery exhausts, that is, diesel exhaust emissions; and
- Crystalline silica due to the crushing of rock.

A detailed review of the existing environment was carried out to understand any current air quality related issues. The following conclusions were made in relation to the existing environment:

- The most common winds in the area are from the northwest, east and south, with typically light winds and a high proportion of calm conditions.
- Up until 2018, PM_{10} concentrations had complied with EPA criteria, based on data collected near Station Street. However, particle levels (as PM_{10} and $PM_{2.5}$) increased significantly across NSW in 2018 and 2019 due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning. These events adversely influenced air quality with multiple days observed when PM_{10} and $PM_{2.5}$ concentrations exceeded EPA criteria.
- TSP concentrations comply with EPA criteria, if estimated from PM_{10} measurements using relationships measured in other rural areas.
- Deposited dust levels comply with EPA criteria, based on data collected in the Martins Creek area.
- NO_2 concentrations at Singleton (the closest monitoring site that measures NO_2) comply with EPA criteria. Compliance would also be expected in the Martins Creek area.

Air dispersion modelling was carried out to predict the potential air quality impacts of the Revised Project. The modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts during operations. The focus of the assessment was on the potential change in air quality, noting that the quarry likely contributed to historically measured air quality.

The main conclusions of the assessment were as follows:

- Very little change in contribution from the quarry is expected beyond the site boundary, for all particulate matter classifications (PM_{10}, $PM_{2.5}$, TSP and dust deposition). Given that the existing air quality monitoring data has demonstrated compliance with EPA criteria it follows that compliance with EPA criteria can continue subject to the implementation of the same management and mitigation measures.
- Emissions from blasting and associated fume are not expected to result in any adverse air quality impacts, based on model predictions which show compliance with EPA criteria.
- Emissions from truck diesel exhausts travelling on public roads are not expected to result in any adverse air quality impacts based on modelling which showed that maximum kerbside concentrations would not exceed EPA criteria.
- Monitoring and modelling suggest that the quarry has not caused, and is not expected to cause, adverse air quality impacts with respect to crystalline silica.

It has therefore been concluded that the Revised Project can proceed without causing adverse air quality impacts at private sensitive receptors. This conclusion has been informed by monitoring data which show that historical activities at the quarry have not caused adverse off-site air quality impacts, predicted compliance with

relevant criteria by modelling, and proposed continuation of current air quality mitigation and management measures.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to quantify the potential air quality impacts of the Martins Creek Quarry Extension project in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

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1. Introduction

Martins Creek Quarry is an existing hard rock quarry located on Station Street, Martins Creek, in the Dungog Shire Council Local Government Area (LGA), see **Figure 1**. Buttai Gravel Pty Ltd (Buttai Gravel, a subsidiary of Daracon) took over the operation of the quarry from the State Rail Authority in December 2012 and is seeking approval to increase the extraction rate to up to a maximum of 1.1 million tonnes per annum (Mtpa) over a period of 25 years (the Revised Project).

An application to increase the extraction rate to 1.5 Mtpa over a period of 30 years was previously the subject of an Environmental Impact Statement (EIS) (Monteath & Powys [2016]) (the Original Project). The EIS was placed on public exhibition in late 2016. In the submissions phase, the Environment Protection Authority (EPA) requested more information on the potential air quality impacts of the Original Project. As noted above, the Original Project has subsequently been scaled back to a maximum extraction rate of 1.1 Mtpa in accordance with an Amended Development Application (ADA) (refer to **Section 2**). This Air Quality Impact Assessment (AQIA) has been prepared by Jacobs Group (Australia) Pty Ltd (Jacobs) on behalf of Umwelt (Australia) Pty Limited (Umwelt) to support the Amended Development Application and Response to Submissions (ADA & RtS), prepared by Umwelt. Its purpose is to quantify and assess the potential air quality impacts of the Revised Project and to address the air quality related submissions on the EIS.

The AQIA has been carried out in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016). The 2016 version of the EPA's "Approved Methods" introduces revised, more stringent criteria for particulate matter concentrations, compared to the criteria in previous version of the Approved Methods which were referenced in the 2016 EIS.

The main objectives of this assessment were to:

- Identify potential air quality issues;
- Quantify existing and potential air quality impacts; and
- Identify suitable air quality management and monitoring measures, as appropriate, to minimise impacts.

This assessment has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs), issued on 4 August 2016, as well as relevant governmental assessment requirements, guidelines and policies. This assessment also considers the matters raised by government agencies following the exhibition of the 2016 EIS. **Table 1** lists the matters raised in the SEARs relevant to this assessment and where they are addressed in this report. **Section 4** of this report provides further detail on other relevant government requirements, guidelines and policies.

Table 1 Relevant matters raised in SEARs

Requirement	Section where addressed
Air Quality – including a quantitative assessment of potential: - construction and operational impacts, with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}; - dust generation from blasting and processing, as well as diesel emissions and dust generated from the transportation of quarry products; - reasonable and feasible mitigation measures to minimise dust and diesel emissions; and - monitoring and management measures, in particular, real-time air quality monitoring.	**Section 3** (identified issues) **Section 8.1** (PM_{10}) and **Section 8.2** ($PM_{2.5}$) including from blasting, processing and transportation **Section 8.6** (diesel emissions) **Section 9** (management and monitoring).

Table 2 lists the matters raised by the EPA in their review of the EIS and where these have been addressed in the current assessment.

Table 2 Items raised by the EPA in the Environmental Assessment Review

Information required by the EPA	Section addressed / comments
Clear identification of all potential sources of emissions to the air associated with the proposal and clearly articulated estimation for those sources deemed significant with justification for any sources excluded from emission calculation.	**Section 6**
Details on the calculations used to estimate emissions from the identified significant sources	**Section 6** and **Appendix A**
At least one year of meteorology data that has been shown to be suitably representative of weather conditions at the site based on comparison to at least five years of meteorological data. The chosen data must reflect the range of conditions occurring at the site, conditions leading to greatest impacts, and conservatively represent the frequency of poor dispersion conditions.	**Section 5.2** and **7.2**. The data used are "site-specific", therefore only one year of data is required. Five years of site-specific data have been evaluated to identify a representative year for modelling.
The AQIA needs to demonstrate that the chosen meteorology model performed acceptably by comparing model output to corresponding observations that have not been used in the modelling. Comparison should use at least one set of observations as close to the proposal as possible.	**Section 7.2**. Site-specific data have been used in the meteorological model and it has been confirmed that the data used by the dispersion model accurately reflects the measurement data. There are no other data sources inside the model domain that can be used to perform the requested analysis.
Land-use description with a resolution commensurate to that of the modelling scale.	**Section 7.2** and in particular **Figure 9**
Clear description of the approach to generating land-use description, including correspondence between any categories independently derived and those used in the model.	**Section 7.2** and in particular **Figure 9**
Meteorological modelling using terrain data with a resolution commensurate to that of the modelling scale.	**Section 7.2**
Clarification regarding the source of the meteorology used to initialise the meteorology module (CALMET) of the dispersion model (CALPUFF).	**Section 7**
Assessment of cumulative impacts against 24-hour criteria must use 24-hour data for background and follow the guidance set out in Section 5.1.1 of the Approved Methods.	**Section 8**. A "Level 1" assessment has been carried out using assumed maximum background levels and predicted Project increment. It was not possible to perform a "Level 2" assessment as hourly average background monitoring data were not available.
Include the impact assessment criteria for TSP in [the AQIA].	**Section 4**
Amend / vary the incorrect background concentration used in [the AQIA] and amend interpretation of results.	The approach to background levels has been amended, relative to the EIS information. **Section 5.5** provides details on the assumed background levels.

The current assessment was based on the use of an air dispersion model to predict concentrations of substances emitted to air due to the Revised Project. Model predictions have been compared with relevant air quality criteria in order to assess the effect that the Revised Project may have on the existing air quality environment.

In summary, the report provides information on the following:

- A description of the Revised Project (**Section 2**);
- Potential air quality issues (**Section 3**);
- Relevant air quality criteria (**Section 4**);
- Existing meteorological and air quality conditions (**Section 5**);

- Emissions to air from previous operations and proposed quarry activities (**Section 6**);
- Methods used to predict air quality impacts (**Section 7**);
- Expected air quality impacts, as determined by a comparison of model results with air quality assessment criteria (**Section 8**); and
- Management measures to be implemented, and recommended monitoring of potential impacts (**Section 9**).

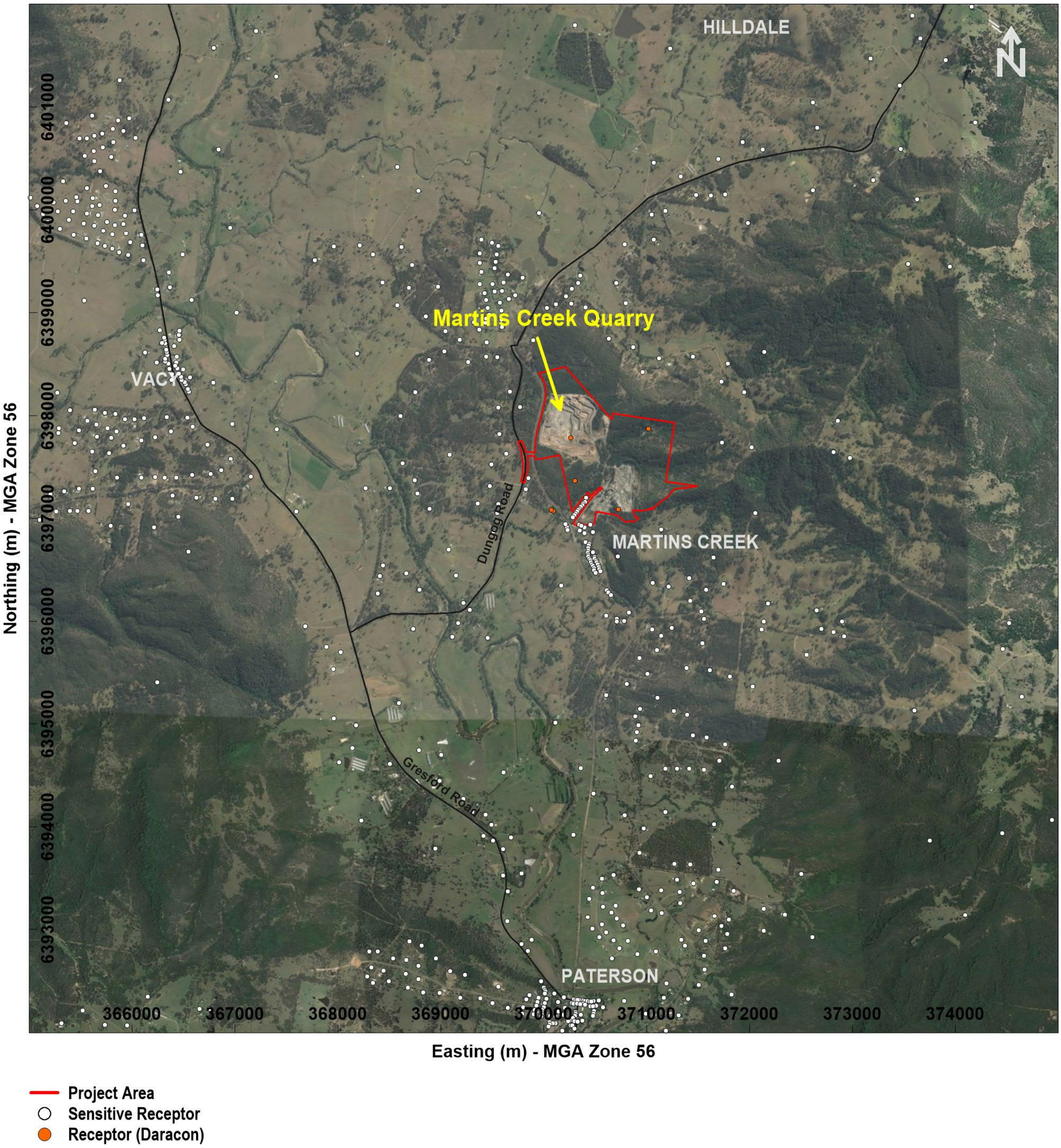


Figure 1 Location of Martins Creek Quarry

2. Revised Project Description

Full details of the Revised Project are outlined in the ADA & RtS. The most relevant aspects of the Revised Project in relation to potential air quality impacts include:

- Construction and use of a new access road and bridge crossing from Dungog Road, over the North Coast rail line, to allow for all heavy vehicle movements via a new site access;
- Expanding the existing quarry to extract and process up to 1.1 Mtpa of hard rock material over 25 years;
- Transportation of up to 500,000 tpa of quarry product via public roads;
- Transportation of up to 600,000 tpa of quarry product by rail; and
- Operating between the hours of 7.00 am and 6.00 pm Monday to Saturday, except for road haulage (Monday to Friday) and rail haulage (24/7);
- Use of blasting between 11.00 am and 3.00 pm on Monday to Friday, with no blasting on Saturday, Sunday or public holiday; and
- Progressive rehabilitation of the site.

Table 3 provides a comparison of the Project between the EIS and the Revised Project.

Table 3 Key changes between the EIS and Revised Project

Component	Environmental Impact Statement (2016)	Revised Project (2020)
Quarry operation approval term	30 years	25 years
Quarry extent	Proposed additional disturbance of 28.2 ha	Proposed additional disturbance of 17 ha (including a new access road) – a reduction of 13.5 ha
Extraction limit	1.5 Mtpa	1.1 Mtpa
Road transport limit	Up to 1.45 Mtpa by road	Maximum 500,000 tpa by road
Rail transport limit	Up to 50,000 tpa by rail	Up to 600,000 tpa by rail
Truck limits per day	Maximum 215 laden trucks per day	Maximum 140 laden trucks per day
Truck limits per hour	Maximum 40 laden trucks per hour	Maximum 20 laden trucks per hour
In pit quarry operations	6.00 am to 6.00 pm Monday to Saturday	7.00 am to 6.00 pm Monday to Saturday No in-pit mobile crushing in the West Pit
Evening / night crushing and processing activities	6.00 am to 10.00 pm	No operations during evening period (6.00 pm to 10.00 pm) No operations during night period (10.00 pm to 7.00 am) No crushing or processing prior to 7.00 am Monday to Saturday
Sales loading and stockpiling for road transport	5.30am to 7.00pm Monday to Saturday	No loading of product trucks prior to 7.00am Monday to Friday No quarry trucks through Paterson prior to 6.45am Monday to Friday No road haulage of quarry product on Saturday

Component	Environmental Impact Statement (2016)	Revised Project (2020)
Loading and overnight parking	Loading and parking of trucks on site overnight	Provision for up to 10 unladen Daracon trucks (not contractors) to return to the quarry between 6.00 pm and 7.00 pm Monday to Friday to park in the quarry overnight and be loaded during this time in readiness for departure from 7.00 am the following morning. (Note: in the case of trucks loaded on Friday evening, departure will be no earlier than 7.00 am Monday morning).
Train loading and rail transport	24 hours / 7 days per week	No change
General Maintenance and Environmental Management Controls	No specified	24 hours / 7 days per week as required, including vehicles/trucks moving in and out of the site for maintenance purposes, as required

Figure 2 shows the maximum extent of the proposed disturbance area as well as the location of the nearest sensitive receptors, some of which are located along Station Street. Receptor numbers Q1, Q3 and Q4 have been allocated to on-site locations within the Project Area boundary. They have been included as part of the modelling process and are not sensitive receptors. Receptor number Q2 is within the Project Area boundary and is a quarry-owned residence. Receiver numbers R27 and R29 are also quarry-owned residences.

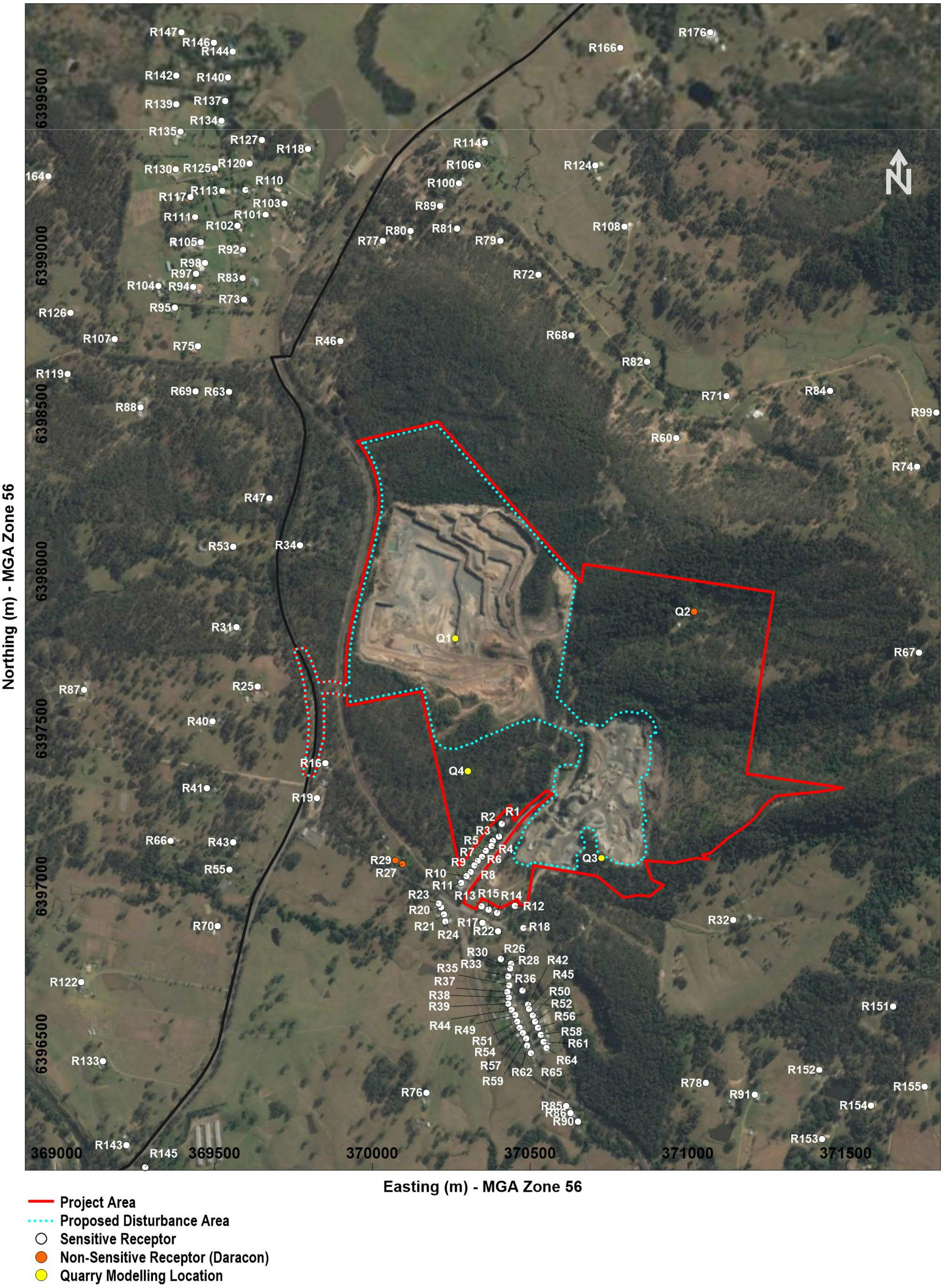


Figure 2 Proposed Extraction Area and Nearest Sensitive Receptors

3. Air Quality 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 Revised Project and its 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 will occur from a variety of activities including material handling, material transport, processing, wind erosion, and blasting. These emissions would mainly comprise of particulate matter in the form of total suspended particulates (TSP), particulate matter with equivalent aerodynamic diameter of 10 microns or less (PM_{10}) and particulate matter with equivalent aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$). There would also be relatively minor emissions from machinery exhausts such as carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter.

Air quality issues were also identified through consultation with local stakeholders as part of a Collaborative Assessment Forum (CAF) on Air Quality and Blasting hosted by Buttai Gravel in March 2019. The results of the AQIA were summarised and provided to local stakeholders prior to the CAF which was attended by Buttai Gravel, Umwelt and Jacobs.

As a result of the review of the Revised Project activities and consultation, the potential air quality issues associated with the existing and proposed quarry activities have been identified as:

- Dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from the general quarrying activities;
- Fume (that is, NO_x emissions) from blasting;
- Emissions of substances from machinery exhausts, that is, diesel exhaust emissions such as NO_x, PM_{10} and $PM_{2.5}$; and
- Crystalline silica due to the crushing of rock.

The issues above are the focus of this assessment.

4. Air Quality Criteria

Typically, air quality is quantified by the concentrations of air pollutants in the ambient air. Air pollution occurs when the concentration (or some other measure of intensity) of substances known to cause health, nuisance and/or environmental effects, exceeds a certain level. With regard to human health and nuisance effects, the air pollutants most relevant to the Revised Project are particulate matter emissions from blasting, excavation works and material handling, transport and processing activities (see **Section 3**).

There are various classifications of particulate matter and the EPA has developed assessment criteria for:

- TSP, to protect against nuisance amenity impacts;
- PM_{10}, to protect against health impacts;
- $PM_{2.5}$, to protect against health impacts; and
- Deposited dust, to protect against nuisance amenity impacts.

Table 4 shows the criteria that have been adopted for this assessment including those for particulate matter as well as nitrogen dioxide and crystalline silica. Air quality impacts from a development are determined by the level of compliance with these criteria and all criteria apply to existing and potential sensitive receptors such as residences, schools and hospitals.

The EPA criteria are published in the “Approved Methods for the Modelling and Assessment of Air Pollutants in NSW” (EPA 2016) and most of these criteria have been derived from national standards for air quality set by the National Environmental Protection Council of Australia (NEPC) as part of the National Environment Protection Measures (NEPM). To measure compliance with ambient air quality criteria, the Department of Planning, Industry and Environment (DPIE) has established a network of monitoring stations across the State and up-to-date records are published on the DPIE website. There are no impact assessment criteria for respirable crystalline silica in NSW so the criterion from the Victorian EPA (VEPA) has been adopted. The State of California Department of Industrial Relations (DIR) also refers to an “action level respirable crystalline silica” (included in **Table 4**) above which employers must “assess employee exposure”.

Table 4 Air quality assessment criteria

Substance	Averaging time	Criterion	Reference
Particulate matter (PM_{10})	24-hour	50 $\mu g/m^3$	EPA (2016)
	Annual	25 $\mu g/m^3$	EPA (2016)
Particulate matter ($PM_{2.5}$)	24-hour	25 $\mu g/m^3$	EPA (2016)
	Annual	8 $\mu g/m^3$	EPA (2016)
Particulate matter (TSP)	Annual	90 $\mu g/m^3$	EPA (2016)
Deposited dust	Annual (maximum increase)	2 g/m^2/month	EPA (2016)
	Annual (maximum total)	4 g/m^2/month	EPA (2016)
Nitrogen dioxide (NO_2)	1-hour	246 $\mu g/m^3$	EPA (2016)
	Annual	62 $\mu g/m^3$	EPA (2016)
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3 $\mu g/m^3$	VEPA (2007)
	8-hour time weighted average	25 $\mu g/m^3$	State of California DIR

It should be noted that the assessment to support the Project as described in the EIS (Monteath & Powys [2016]) was based on an earlier version of the “Approved Methods” (see DEC 2005). The 2016 version introduced a revised, more stringent criterion for PM_{10} as well as new criteria for 24-hour and annual average $PM_{2.5}$. The Revised Project has now been assessed against the current, more stringent, EPA assessment criteria even though applications submitted prior to 20 January 2017 need only be assessed against earlier version of the “Approved Methods” (DEC 2005).

The air quality assessment criteria relate to the total concentration of air pollutant in the air (that is, cumulative) and not just the contribution from project-specific sources. Therefore, background air quality needs to be established to assess the potential impacts of the Revised Project against these criteria. Further discussion of background levels in the locality of the quarry is provided in **Section 5**.

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 2016).

In December 2015 the Australian Government announced a National Clean Air Agreement (Agreement). This Agreement aims to reduce air pollution and improve air quality via the following main actions.

- The introduction of emission standards for new non-road spark ignition engines and equipment.
- Measures to reduce air pollution from wood heaters.
- Strengthened ambient air quality reporting standards for particle pollution.

The strengthening of ambient air quality reporting standards for particle pollution is relevant to the Revised Project. On 25 February 2016, an amendment to the NEPM entered into force and introduced the new national air quality standards for PM_{10} and $PM_{2.5}$, as noted above. The EPA subsequently revised their PM_{10} and $PM_{2.5}$ assessment criteria as part of an update to the "Approved Methods for the Modelling and Assessment of Air Pollutants NSW" (EPA 2016). These revised criteria are reflected in **Table 4**.

The NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP) (2018) includes the NSW Government's policy for voluntary mitigation and land acquisition to address dust (particulate matter) impacts from State significant mining, petroleum and extractive industry developments. VLAMP (2018) brings the air quality criteria in line with the NEPM standards and EPA criteria.

From this Policy, voluntary mitigation rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 5** at any residence or workplace.

Table 5 VLAMP mitigation criteria for particulate matter

Substance	Averaging time	Mitigation criterion	Impact type
Particulate matter ($PM_{2.5}$)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM_{10})	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

** Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).*
*** Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.*

Voluntary acquisition rights may apply where, even with best practice management, the development contributes to exceedances of the criteria in **Table 6** at any residence or workplace on privately owned land, or on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.

Table 6 VLAMP acquisition criteria for particulate matter

Substance	Averaging time	Acquisition criterion	Impact type
Particulate matter ($PM_{2.5}$)	Annual	8 µg/m^3*	Human health
	24-hour	25 µg/m^3**	Human health
Particulate matter (PM_{10})	Annual	25 µg/m^3*	Human health
	24-hour	50 µg/m^3**	Human health
Particulate matter (TSP)	Annual	90 µg/m^3*	Amenity
Deposited dust	Annual	2 g/m^2/month**	Amenity
	Annual	4 g/m^2/month*	Amenity

** Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources).*
*** Incremental impact (i.e. increase in concentrations due to the development alone), with up to 5 allowable exceedances of the criteria over the life of the development.*

The particulate matter levels for comparison with the criteria in **Table 5** and **Table 6** must be calculated in accordance with the EPA's "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (EPA 2016).

5. Existing Environment

This section provides a description of the existing environmental characteristics in the locality of the quarry, including a review of the local meteorological and ambient air quality conditions.

5.1 Local Setting

Martins Creek Quarry is located on Station Street, Martins Creek, approximately 20 km north of Maitland and 7 km north of Paterson in the Dungog Shire Council LGA. The site is set at an elevation of approximately 60 m above sea level and is situated on the eastern side of valley that follows the general north to south alignment of the Paterson River and Gresford Road. The site is bounded by the North Coast Rail line the west, Vogeles Road to the south, and densely vegetated land to the north and east. Martins Creek is a small village locality and the area around the quarry is largely rural residential with many private properties. Other key local industries and activities include chicken broiler / layer farms to the south and west. **Figure 3** shows a pseudo three-dimensional representation of the local terrain.

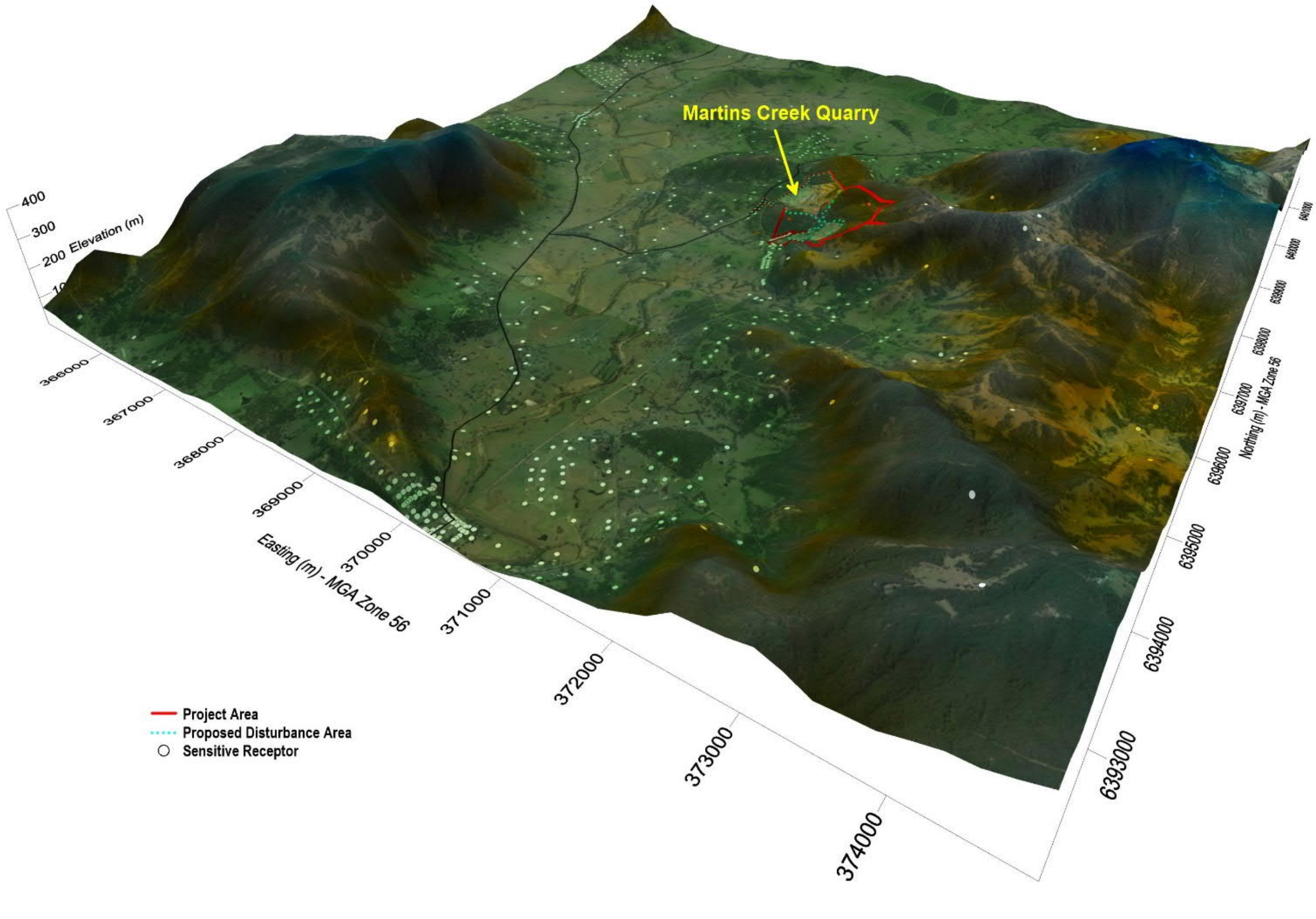


Figure 3 Pseudo three-dimensional representation of the local terrain

This review also considers data collected from existing meteorological and air quality monitoring sites, the locations of which are shown in **Figure 4**. One of the objectives for reviewing these data was to develop an understanding of any existing air quality issues as well as the meteorological conditions which typically influence the local air quality conditions.

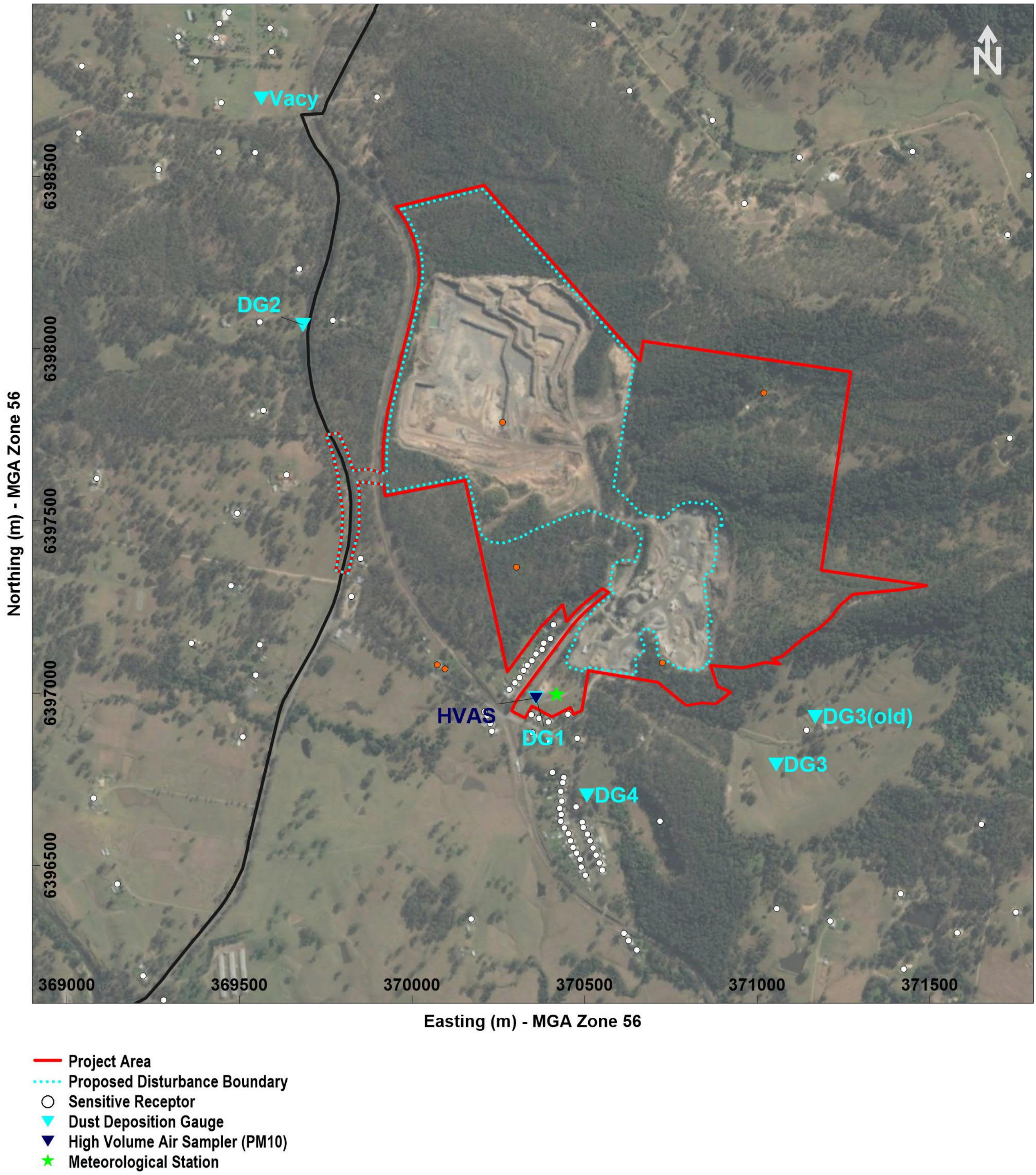


Figure 4 Location of air quality and meteorological monitoring sites

5.2 Meteorological Conditions

Meteorological conditions are important for determining the direction and rate at which emissions from a source will disperse. The key meteorological requirements of air dispersion models are, typically, hourly records of wind speed, wind direction, temperature, and atmospheric stability. For air quality assessments, a minimum one year of hourly data is usually required, which means that almost all possible meteorological conditions, including seasonal variations, are considered in the model simulations.

Buttai Gravel has been operating a meteorological station near Martins Creek Quarry since late 2012. The meteorological station is located on an open parcel of land, off Station Street, approximately 300 metres (m) to the southwest of the processing plant (see **Figure 4** for the location). The proximity of this station to the area and activities of interest means that this station can be regarded as "site-specific", based on the descriptions from the Approved Methods.

Five recent years of meteorological data were available for this assessment, 2015 to 2019 inclusive, and all available data have been analysed in order to confirm suitability for the dispersion modelling. Hourly records of temperature, wind speed and wind direction were obtained, among other parameters. A range of statistics from the 2015 to 2019 datasets have been examined to assist with identifying a suitable meteorological year for the dispersion modelling. **Table 7** shows the statistics.

Table 7 Annual statistics from meteorological data collected at Martins Creek Quarry meteorological station

Statistic	2015	2016	2017	2018	2019
Percent complete (%)	95	90	67	100	100
Mean wind speed (m/s)	0.9	1.2	1.5	1.4	1.4
99th percentile wind speed (m/s)	3.0	4.1	5.7	5.3	5.4
Percentage of calms (%)	38	30	24	30	35
Percentage of winds >6 m/s (%)	0.1	0.1	0.5	0.5	0.4

Over these five years, the mean wind speed was in the order of 1.3 m/s, and the percentage of calms ranged between 24 and 38 per cent. The EPA requires that, for "Level 2" assessments based on site-specific information, the meteorological data should be derived from a site-specific source and at least 90% complete. All years except 2017 meet the EPA's requirements for data capture.

Figure 5 shows the annual wind patterns for each year from 2015 to 2019, based on data collected at Martins Creek Quarry. Winds are generally quite light; most likely an outcome of the influence of the undulating local terrain and surrounding bushland. The most common winds are from the west-northwest and south although winds can occur from most directions. This pattern is evident in most of the years presented, to various extents, indicating that the data from any of the recent five years could be considered as representative for modelling purposes.

The 2015 calendar year has been selected as the meteorological modelling year, based on the data capture rate (i.e. greater than 90% complete). The 2015 meteorological year contains representative meteorological conditions to other years considered. In addition, the higher frequency of calm conditions typically leads to higher predictions of ground-level concentrations as these conditions are often associated with poor dispersion whereby any dust emissions disperse more slowly and allow higher concentrations to exist for extended periods of time. Simulations in strong winds are also desirable because emissions can be higher, although the meteorological data from the past five years show that strong winds are not very common for this area. The 2015 calendar year also has an advantage from a calibration perspective in that the measured air quality was not adversely impacted by bushfires and dust storms which was the case for the 2018 and 2019 years.

Appendix A shows the annual and seasonal wind patterns for data collected at the Martins Creek Quarry meteorological station in 2015. These wind-roses show that the most common winds in the area are from the northwest, east and south. Methods used for incorporating the 2015 data into the meteorological modelling (CALMET) and air dispersion modelling (CALPUFF) are discussed in detail in **Section 7**.

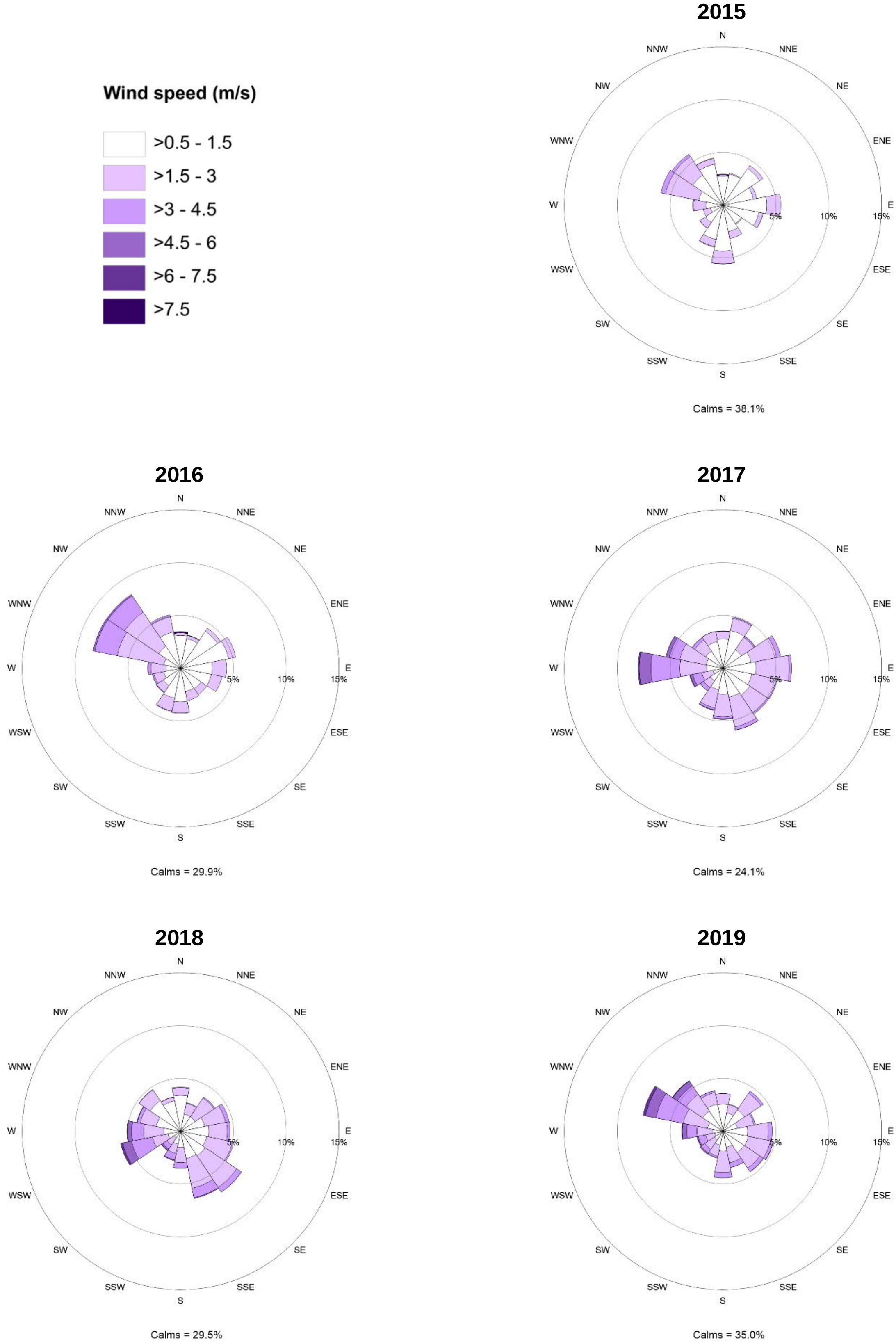


Figure 5 Annual wind-roses for data collected at Martins Creek Quarry from 2015 to 2019

5.3 Air Quality Conditions

The EPA air quality criteria refer to levels of substances which generally include the contribution from the project of interest as well as the contribution from existing sources. To fully assess impacts against all the relevant air quality criteria (see **Section 4**) it is necessary to have information or estimates of the existing air quality conditions. This section provides a description of the existing air quality.

Air quality in the vicinity of the Martins Creek Quarry is monitored by Buttai Gravel. This monitoring includes the measurement of:

- Particulate matter (as PM_{10}); and
- Dust deposition.

As is often the case for existing quarry operations (and indeed large mining operations, particularly for $PM_{2.5}$), concentrations of TSP and $PM_{2.5}$ have not been measured in the vicinity of the quarry and so these parameters have been estimated from the available data or other sources.

It should be noted that the measurement data represent the contributions from all sources that have at some stage been upwind of each monitor. In the case of particulate matter (such as PM_{10}) for example, the background concentration may contain emissions from many sources such as from quarry activities, construction works, bushfires and 'burning off', industry, vehicles, roads, the main rail line, wind-blown dust from nearby and remote areas, fragments of pollens, moulds and other factors.

Concentrations of $PM_{2.5}$ and NO_2 have not been measured in the area, however, the DPIE measures these substances at other locations as part of its Upper Hunter Air Quality Monitoring Network. **Sections 5.3.1** to **5.3.5** describe the existing air quality conditions, based on a review of monitoring results for the substances listed above, as well as for NO_2.

5.3.1 Particulate Matter (as PM_{10})

PM_{10} concentrations are measured by a high volume air sampler located next to the meteorological station (see **Figure 4**). **Figure 6** shows the measured 24-hour average PM_{10} concentrations for data collected every six days between January 2013 and June 2020 (inclusive). The EPA's air quality assessment criteria for PM_{10} (50 µg/m^3) has also been shown on this graph.

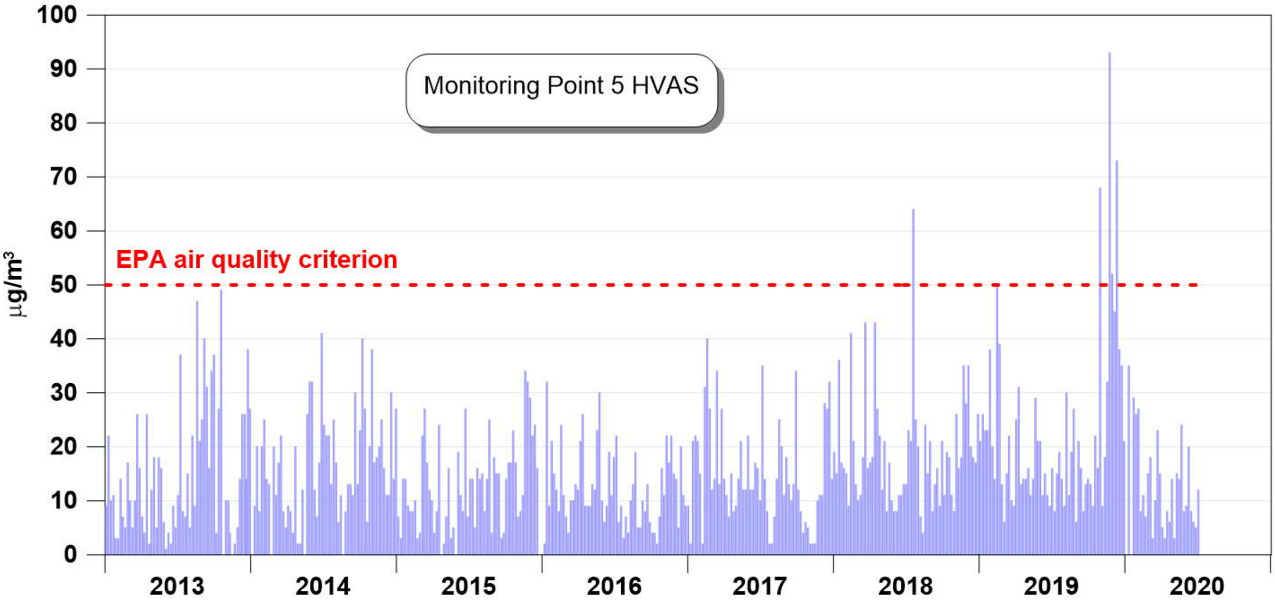


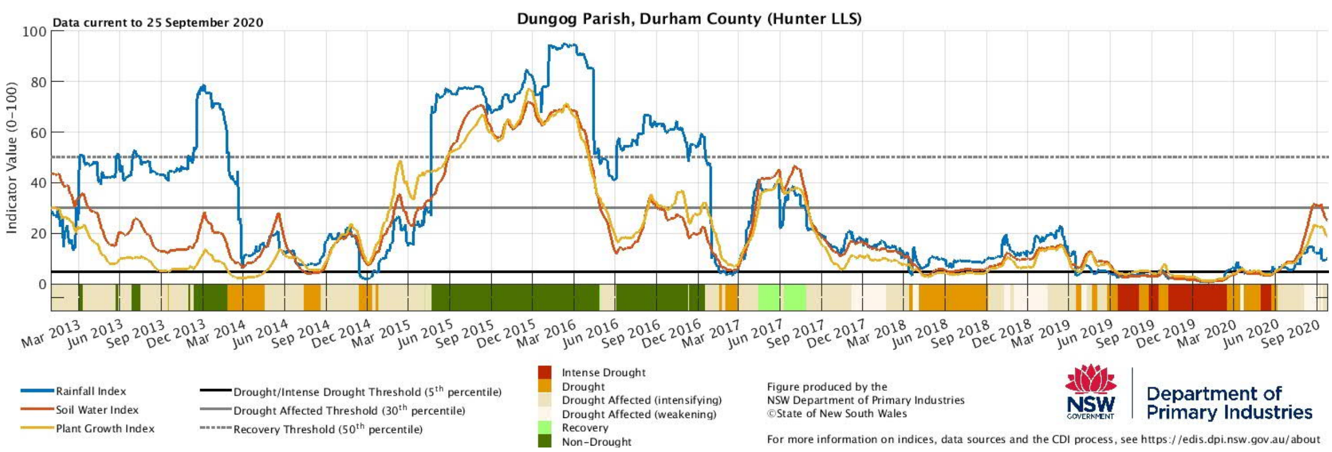
Figure 6 Measured 24-hour average PM_{10} concentrations near Martins Creek Quarry

The data from **Figure 6** show that, prior to 2019, there was one day in the six year period (18 July 2018) when PM_{10} concentrations exceeded 50 µg/m^3. Data collected by the DPIE showed that there was a regional dust storm event influencing air quality across many parts of NSW on 18 July 2018. On this day, PM_{10} concentrations also exceeded 50 µg/m^3 at Newcastle (52 µg/m^3), Singleton (59 µg/m^3) and Muswellbrook (57 µg/m^3). There had not been any other exceedances of 50 µg/m^3 in the 2013 to 2018 period. This absence of any other recorded exceedances of the 24-hour average PM_{10} criteria suggests that the activities at the existing quarry had not caused adverse off-site air quality impacts with respect to PM_{10} despite air quality conditions in the Dungog region being influenced by the drought conditions in 2017 and 2018 and lower than average rainfall.

During 2019, there were multiple instances when the 24-hour average PM_{10} concentrations exceeded 50 µg/m^3. Specifically, there were four measurement days in 2019 when the 24-hour average PM_{10} concentration exceeded 50 µg/m^3. In their "Annual Air Quality Statement 2019", the DPIE concluded 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" (DPIE, 2020). All four reported exceedances of the 24-hour average PM_{10} criteria in 2019 aligned with a period of unprecedented bushfires in Australia, predominantly across southeast Australia. The bushfires adversely affected air quality across many parts of NSW including the Dungog region and these events are reflected in the data presented in **Figure 6**.

Data for the first six months of 2020 show that PM_{10} concentrations had not exceed 50 µg/m^3. This outcome has been influenced by an increase in rainfall from January 2020 onwards.

Figure 7 shows the drought indictor that is published by the Department of Primary Industries. The "Intense Drought" period between June 2019 and March 2020 coincided with increased particulate matter concentrations across NSW, including those measured near Martins Creek Quarry as shown in **Figure 6**.



Source: Department of Primary Industries

Figure 7 Combined drought indicator for the Dungog Parish

Table 8 summarises the measured PM_{10} concentration data for 24-hour and annual average periods, for comparison with the respective EPA criteria. The effect of bushfires in late 2019 is reflected in these data. It should also be noted that the quarry was placed into limited operations on 24 September 2019. The quarry would not have been a significant contributor to local air quality after this date.

Annual average PM_{10} concentrations have been recorded as being well below the 25 µg/m^3 criterion. This criterion was applicable from 2017 onwards.

Table 8 Summary of measured PM_{10} concentrations near Martins Creek Quarry

Year	Martins Creek high volume air sampler	Criterion
Maximum 24-hour average in µg/m³		
2013	49	50
2014	41	
2015	34	
2016	32	
2017	40	
2018	64 (regional event on 18 July)	
2019	93 (bushfires around 22 Nov)	
2020*	35*	
Number of days above 24-hour average criteria		
2013	0	-
2014	0	
2015	0	
2016	0	
2017	0	
2018	1 (regional event on 18 July)	
2019	4 (bushfires from Oct to Dec))	
2020*	0*	
Annual average in µg/m³		
2013	15	30
2014	17	
2015	13	
2016	12	
2017	15	25
2018	19	
2019	23	
2020*	13*	

** Data available to June 2020*

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

No known monitoring of $PM_{2.5}$ is conducted in the vicinity of Martins Creek Quarry. The closest air quality monitoring stations which record concentrations of $PM_{2.5}$ with publicly available data are located at Singleton (40 km to the west) and Beresfield (30 km to the south). These stations are operated by the DPIE and use Beta Attenuation Monitors (BAM) for the measurement of $PM_{2.5}$.

Both the Singleton and Beresfield monitoring sites are located close to regional population centres and neither site would measure $PM_{2.5}$ concentrations that are representative of levels in the Martins Creek area. This is because Martins Creek is well removed from regional population centres and industries, with the exception of the quarry. Consequently the ambient $PM_{2.5}$ concentrations in the Martins Creek area would be expected to be lower than those measured at Singleton and Beresfield.

Nevertheless, $PM_{2.5}$ concentration data from Singleton have been reviewed and presented in this assessment. Data from the Singleton site were chosen over those from Beresfield as Singleton is situated in a rural residential area that has closer environmental characteristics to those of Martins Creek.

Figure 8 shows the measured 24-hour average $PM_{2.5}$ concentrations from the Singleton monitoring site for data collected between January 2013 and June 2020. Some weak seasonal variation is evident, with the higher concentrations tending to occur in winter. The EPA's current air quality assessment criteria for $PM_{2.5}$ (25 µg/m^3) has also been shown, but it should be noted that this criterion came into effect from 20 January 2017 onwards. $PM_{2.5}$ concentrations have been below the EPA criterion for the majority of the time but, as for PM_{10}, there were several days in late 2019 when $PM_{2.5}$ concentrations exceeded the EPA's impact assessment criterion (in this case 25 µg/m^3) with these exceedances occurring as a result of the bushfires.

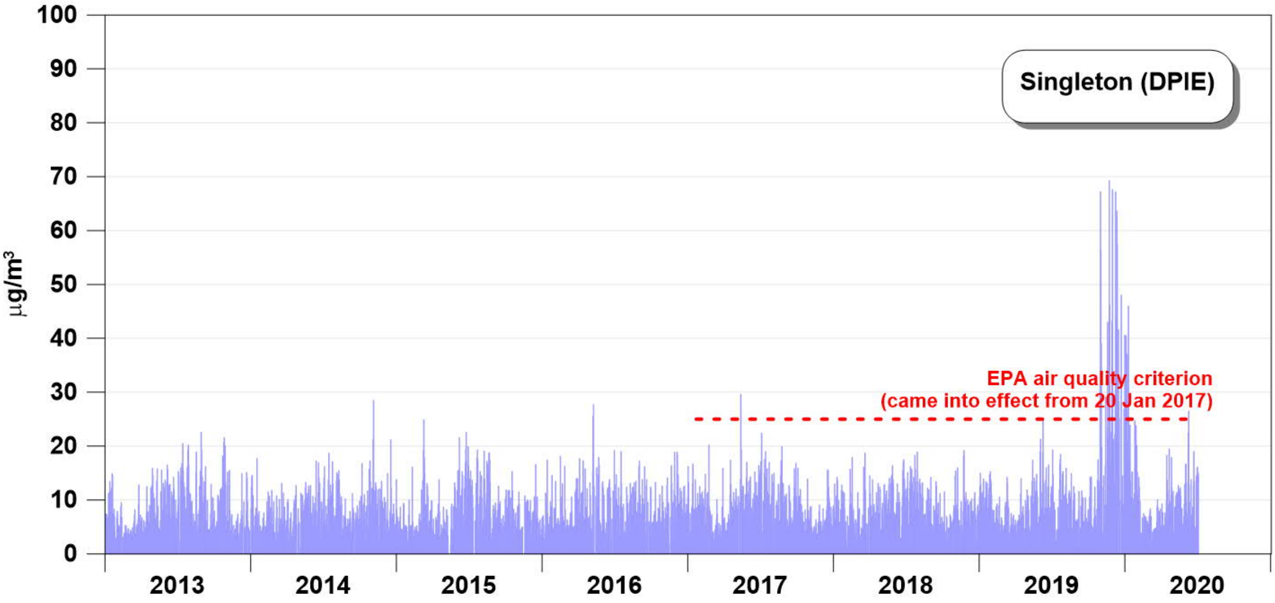


Figure 8 Measured 24-hour average $PM_{2.5}$ concentrations at Singleton

Table 9 summarises the measured $PM_{2.5}$ results for data collected between January 2013 and June 2020 at Singleton. The inclusion of these data in this report is not intended to suggest that these levels are representative of air quality in the vicinity of Martins Creek. Rather, the data are presented to show the types of statistics that are of interest for this assessment, and potentially those that represent the likely upper limit of levels in the Martins Creek area.

Table 9 Summary of measured $PM_{2.5}$ concentrations at Singleton

Year	Singleton (DPIE)	Criterion
Maximum 24-hour average in µg/m^3		
2013	23	-
2014	29	
2015	25	
2016	28	
2017	30	25
2018	19	
2019	69	
2020*	46*	

Year	Singleton (DPIE)	Criterion
Number of days above 24-hour average criteria		
2013	0	-
2014	1	
2015	0	
2016	2	
2017	1	
2018	0	
2019	22	
2020*	5*	
Annual average in µg/m^3		
2013	7.9	-
2014	7.8	
2015	7.6	
2016	7.9	
2017	8.2	8
2018	8.1	
2019	10.9	
2020*	9.7*	

** Data available to June 2020*

It can be seen from **Table 9** that there was one day in 2017 when the measured 24-hour average $PM_{2.5}$ concentration at Singleton exceeded 25 µg/m^3, and 22 days in 2019. Prior to 2017 the level of 25 µg/m^3 was referred to as an advisory reporting goal and not an EPA air quality impact assessment criterion. Data from the first six months of 2020 showed the measured 24-hour average $PM_{2.5}$ concentration at Singleton has exceeded 25 µg/m^3 on five days; four of these days were in early January 2020 and were influenced by bushfire smoke. Annual averages were close to 8 µg/m^3, exceeding this level in 2017, 2018 and 2019 respectively.

The Upper Hunter Fine Particle Characterisation Study (OEH, 2013) investigated the factors which contributed to elevated $PM_{2.5}$ concentrations in the Hunter Valley. This study identified a clear seasonal trend with higher $PM_{2.5}$ concentrations occurring in the cooler months, and predominantly due to wood smoke from domestic heating. Specifically, in Singleton, wood smoke accounted for an average of approximately 14% of the total $PM_{2.5}$, peaking at around 38% in winter.

Further analysis of the data from the collocated PM_{10} and $PM_{2.5}$ monitors at Singleton revealed that the average $PM_{2.5}$ to PM_{10} ratio in the representative meteorological year (2015) was 0.42 (i.e. 42%). This ratio was used to estimate $PM_{2.5}$ concentrations from the PM_{10} data in the Martins Creek area.

5.3.3 Particulate Matter (as TSP)

No known monitoring of TSP is conducted in the vicinity of Martins Creek Quarry. The NSW Minerals Council estimated that, for rural environments in NSW, the average PM_{10} concentrations are typically 40 per cent of the TSP concentrations (Minerals Council 2000). More recent studies (see for example Jacobs 2018) have examined PM_{10} and TSP data and also shown that average PM_{10} concentrations are close to 40 per cent of the TSP concentrations in rural environments of NSW.

5.3.4 Deposited Dust

Table 10 shows the annual average deposited dust levels for each gauge from data collected between January 2013 and June 2020. **Figure 4** shows the location of the monitoring sites. The results in **Table 10** can be compared with the EPA's 4 g/m^2/month criterion.

There has been historical contamination issues at DG3. Specifically, DG3 had been located on private property adjacent to an un-vegetated farm dam that required regular maintenance with earthmoving machinery. These regular earthmoving activities adversely affected the measurements at DG3 and resulted in annual average dust deposition levels above 4 g/m^2/month in 2013, 2014 and 2017. DG3 was subsequently relocated in September 2017 to its current position and, from **Table 10**, the 2018 annual average deposition result was below 4 g/m^2/month. All 2018 and 2019 data were below the 4 g/m^2/month criterion indicating good air quality with respect to deposited dust levels.

At the Air and Blasting CAF in March 2019 (refer to **Section 3**), community participants noted the absence of air quality monitoring to the north-west of the quarry. In response, Buttai Gravel voluntarily committed to expand the air quality monitoring network for the quarry to include a dust deposition gauge at a location in View Street, Vacy. This dust deposition gauge was installed on 9 May 2019 and data are published on the Martins Creek Quarry website.

Table 10 Summary of measured deposited dust levels near Martins Creek Quarry

Year	DG1	DG2	DG3	DG4	Vacy**	Criterion
Annual average expressed as g/m^2/month						
2013	1.3	1.2	10.4***	1.1	-	4
2014	1.4	0.8	11.7***	0.7	-	
2015	1.1	0.9	2.4***	0.9	-	
2016	0.9	1.5	1.9***	0.9	-	
2017	1.6	1.2	4.8***	1.7	-	
2018	2.1	2.3	2.0	1.0	-	
2019	2.2	3.3	2.5	1.3	2.1	
2020*	1.9*	2.3*	2.9*	1.2*	1.2*	

* Data available to June 2020

** Vacy gauge installed on 9 May 2019

*** Data from old location for DG3, see **Figure 4**

5.3.5 Nitrogen Dioxide (NO_2)

Table 11 provides a summary of the measured NO_2 concentrations from Singleton. These data show that the maximum NO_2 concentrations have been well below the EPA's 1-hour average criterion of 246 µg/m^3. Annual averages have also been well below the EPA's annual average criterion of 62 µg/m^3. Concentrations in the Martins Creek area will be lower than those in Singleton since there are fewer sources of NO_x and therefore NO_2.

Table 11 Summary of measured NO_2 concentrations at Singleton

Year	Singleton (DPIE)	Criterion
Maximum 1-hour average in µg/m^3		
2013	84	246
2014	74	
2015	66	
2016	66	
2017	74	
2018	72	
2019	76	
2020*	68*	
Annual average in µg/m^3		
2013	18	62
2014	16	
2015	16	
2016	16	
2017	17	
2018	16	
2019	14	
2020*	12*	

** Data available to June 2020*

5.4 Summary of the Existing Environment

The following conclusions have been made from the review of local meteorological and ambient air quality monitoring data:

- The most common winds in the area are from the northwest, east and south, with typically light winds (around 1 m/s) and a high proportion of calm conditions (measured between 24 and 38%).
- Up until 2018, PM_{10} concentrations (as 24-hour and annual averages) had complied with EPA criteria, based on data collected near Station Street. However, particle levels (as PM_{10} and $PM_{2.5}$) increased across NSW from 2017 to 2019 due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019). These events adversely influenced air quality with multiple days observed when PM_{10} and $PM_{2.5}$ concentrations exceeded EPA criteria. Similar outcomes were determined for $PM_{2.5}$, based on PM_{10} and $PM_{2.5}$ relationships measured in the Hunter Valley.
- TSP concentrations comply with EPA criteria, if estimated from PM_{10} measurements using relationships measured in the Hunter Valley (NSW Minerals Council 2000; Jacobs 2018).
- Deposited dust levels comply with EPA criteria, based on data collected in the Martins Creek area.
- NO_2 concentrations at Singleton (the closest monitoring site that measures NO_2) comply with EPA criteria. Compliance would also be expected in the Martins Creek area.

The monitoring data suggest that the activities at the existing quarry are not causing adverse off-site air quality impacts. In addition, the review highlighted that drought and bushfires had adversely influenced air quality between 2017 and 2019 but particularly in late 2019. The 2019 calendar year was an extraordinary year with regards to background air quality and cannot be considered as representative. The quarry was placed into limited operations on 24 September 2019 and would not have been a significant contributor to local air quality after this date.

5.5 Assumed Background Levels

One of the objectives for reviewing the air quality monitoring data was to determine appropriate background levels to be added to model predictions for the assessment of potential cumulative impacts, that is, Revised Project contribution plus other sources. The establishment of background levels also needs to consider that the existing quarry may have contributed to the historically measured levels.

For this assessment the background levels that are assumed to apply at the nearest sensitive receptors, for the purposes of assessing the Revised Project, have been derived primarily from the measurement data collected at the Station Street monitor in 2015; the identified representative year. It is noted that, in 2015, the existing quarry was likely to have contributed to the monitored levels. This contribution was estimated by modelling and the potential change in air quality as a result of the Revised Project has been predicted and assessed.

The estimated background levels that apply at sensitive receptors including the basis for assumptions are shown below in **Table 12**. As noted above, the monitored levels at Station Street represent conservatively high estimates of background levels at the nearest sensitive receptors and this has been addressed in the assessment by modelling the potential change in air quality as a result of the Revised Project. **Section 8** provides additional information on the potential change.

Table 12 Assumed non-modelled background levels that apply at sensitive receptors

Substance	Averaging time	Assumed background level that applies at sensitive receptors	Notes
Particulate matter (PM_{10})	24-hour	34 µg/m^3	Maximum 24-hour average PM_{10} as measured by the Station Street monitor in the modelled meteorological year (2015)
	Annual	13 µg/m^3	Annual average PM_{10} as measured by the Station Street monitor in the modelled meteorological year (2015)
Particulate matter ($PM_{2.5}$)	24-hour	14 µg/m^3	Estimated maximum 24-hour average $PM_{2.5}$ based on 42% $PM_{2.5}$ to PM_{10}.
	Annual	5.5 µg/m^3	Estimated annual average $PM_{2.5}$ based on 42% $PM_{2.5}$ to PM_{10}.
Particulate matter (TSP)	Annual	33 µg/m^3	Estimated from the assumed background level for annual average PM_{10}, and based on 40% PM_{10} to TSP.
Deposited dust	Annual	2.4 g/m^2/month	Highest deposited dust level from all gauges in 2015.
Nitrogen dioxide (NO_2)	1-hour	66 µg/m^3	Maximum 1-hour average from Singleton in 2015.
	Annual	16 µg/m^3	Annual average from Singleton in 2015.

6. Emissions to Air

The most significant emission to air from the Revised Project will be dust (particulate matter) due to material handling, material transport, processing, wind erosion, and blasting. Estimates of these emissions are required by the dispersion model. Total dust emissions have been estimated by analysing the material handling schedule, equipment listing and quarry plans and identifying the location and intensity of dust generating activities. Operations have been combined with emissions factors developed both locally and by the US EPA.

The emission factors used for this assessment have been drawn largely from the following sources:

- *Emission Estimation Technique Manual for Mining* (NPI, 2012); and
- Compilation of Air Pollutant Emissions Factors (AP-42) (US EPA, 1985 and updates).

Dust emission inventories have been developed for each of the modelled scenarios, namely:

- "Previous Operations". This scenario was developed in order to estimate the contribution of the quarry to local air quality in 2015. The estimated contribution of Previous Operations was removed from the assumed background levels (see **Section 5.4**) and the potential contribution of the Revised Project was added. Production was assumed to be in the order of 900 ktpa, based on Daracon records.
- Year 2, Year 10 and Year 20, representing proposed future operations, and assuming maximum production at 1.1. Mtpa. These scenarios cover a range of machinery locations and quarry extents, therefore addressing the potential worst case operating scenarios.

Table 13, **Table 14** and **Table 15** show the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions (in kg/y) due to the Revised Project respectively. **Appendix A** provides details of the dust emission calculations, including assumptions, emission controls and allocation of emissions to modelled locations.

Table 13 Estimated TSP emissions due to the Revised Project

Activity	Estimated annual emissions (kg/y)			
	Previous Operations	Year 2	Year 10	Year 20
Drilling rock	673	673	673	673
Blasting rock	174	209	209	209
Loading rock to mobile crusher	415	0	0	495
Crushing (mobile)	4,620	0	0	5,500
Loading rock to trucks	415	495	495	495
Hauling rock to plant	33,883	29,333	40,333	44,000
Primary crushing	924	1,100	1,100	0
Secondary crushing	2,772	3,300	3,300	16,500
Tertiary crushing	13,861	9,900	9,900	16,500
Screening	8,317	9,900	9,900	16,500
Mobile pugmill (blending)	13,861	16,500	16,500	16,500
Loading product stockpiles	208	247	247	247
Wind erosion from exposed areas	21,023	25,920	29,463	36,189
Wind erosion from product stockpiles	6,132	6,132	6,132	6,132
Loading product to trucks	415	225	225	225
Hauling product off-site (paved)	14,231	9,800	9,800	9,800
Loading product to trains	14	270	270	270
Total	**121,939**	**114,004**	**128,546**	**170,234**

Table 14 Estimated PM_{10} emissions due to the Revised Project

Activity	Estimated annual emissions (kg/y)			
	Previous Operations	Year 2	Year 10	Year 20
Drilling rock	354	354	354	354
Blasting rock	90	108	108	108
Loading rock to mobile crusher	197	0	0	234
Crushing (mobile)	1,848	0	0	2,200
Loading rock to trucks	197	234	234	234
Hauling rock to plant	10,013	8,668	11,919	13,002
Primary crushing	370	440	440	0
Secondary crushing	1,109	1,320	1,320	6,600
Tertiary crushing	4,620	3,300	3,300	5,500
Screening	2,772	3,300	3,300	5,500
Mobile pugmill (blending)	4,620	5,500	5,500	5,500
Loading product stockpiles	98	117	117	117
Wind erosion from exposed areas	10,511	12,960	14,732	18,094
Wind erosion from product stockpiles	3,066	3,066	3,066	3,066
Loading product to trucks	197	106	106	106
Hauling product off-site (paved)	2,711	1,867	1,867	1,867
Loading product to trains	7	128	128	128
Total	**42,779**	**41,467**	**46,490**	**62,610**

Table 15 Estimated $PM_{2.5}$ emissions due to the Revised Project

Activity	Estimated annual emissions (kg/y)			
	Previous Operations	Year 2	Year 10	Year 20
Drilling rock	34	34	34	34
Blasting rock	9	10	10	10
Loading rock to mobile crusher	21	0	0	25
Crushing (mobile)	231	0	0	275
Loading rock to trucks	21	25	25	25
Hauling rock to plant	1,694	1,467	2,017	2,200
Primary crushing	46	55	55	0
Secondary crushing	139	165	165	825
Tertiary crushing	693	495	495	825
Screening	416	495	495	825
Mobile pugmill (blending)	693	825	825	825
Loading product stockpiles	10	12	12	12
Wind erosion from exposed areas	1,577	1,944	2,210	2,714
Wind erosion from product stockpiles	460	460	460	460
Loading product to trucks	21	11	11	11
Hauling product off-site (paved)	678	467	467	467
Loading product to trains	1	13	13	13
Total	**6,742**	**6,478**	**7,294**	**9,546**

It should be noted that the main intent of the inventories is to capture the most significant emission sources that may affect off-site air quality. Not every source will be captured, however, the contribution of emissions from sources not identified will be captured in the assumed background levels and these data have been considered for predicted Project contributions. The emission estimates will also include particulate emissions associated with fuel combustion (predominately diesel) by on-site machinery.

Based on management commitments made by Buttai Gravel, the following emission controls have been assumed to be applicable to the Revised Project:

- Watering of unsealed access roads (leading to a 75% control on emissions);
- Water sprays for drilling activities (leading to a 70% control on emissions);
- Enclosure and water sprays on the primary and secondary plant (leading to a 90% control on emissions);
- Enclosure of the tertiary crusher and hopper (leading to a 70% control on emissions);
- Enclosure of the screening plant (leading to a 70% control on emissions); and
- Water sprays on product stockpiles (leading to a 50% control on emissions).

The controls listed above have been directly considered in the emission calculations. Buttai Gravel has also made other management commitments, such as restricting vehicle speeds and automated water sprays on fixed crushing plant and underbelt stockpiles, however the control efficiencies for some of these measures are not listed/identified by the NPI (2012). This means that the estimated emissions for the assessment will be conservatively high.

7. Approach to Assessment

7.1 Overview

This assessment has followed the EPA's "Approved Methods of the Modelling and Assessment of Air Pollutants in New South Wales" (EPA, 2016), which specifies how assessments based on the use of air dispersion models should be undertaken. The "Approved Methods" include guidelines for the preparation of meteorological data, reporting requirements and air quality assessment criteria to assess the significance of dispersion model predictions.

The CALPUFF computer-based air dispersion model has been used to predict ground-level concentrations and deposition levels due to the identified emission sources, and the model predictions have been compared with relevant air quality criteria. 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, through the CALMET meteorological pre-processor, simulates complex meteorological patterns that exist in a particular region. The effects of local topography and changes in land surface characteristics are accounted for by this model. The model comprises meteorological modelling as well as dispersion modelling, both of which are described below.

7.2 Meteorological Modelling

The air dispersion model used for this assessment, CALPUFF, requires information on the meteorological conditions in the modelled region. This information is typically generated by the meteorological pre-processor, CALMET, using surface observation data from local weather stations and upper air data from radio-sondes or numerical models, such as the CSIRO's prognostic model known as TAPM (The Air Pollution Model). CALMET also requires information on the local land-use and terrain. The result of a CALMET simulation is a year-long, three-dimensional output of meteorological conditions that can be used as input to the CALPUFF air dispersion model.

There are no known meteorological stations in the Martins Creek area that collect suitable upper air data for CALMET. The closest station with suitable data is operated by the Bureau of Meteorology at Williamtown, approximately 30 km to the southeast. The necessary upper air data were therefore generated by TAPM, using influence from the surface observations at the Martins Creek Quarry meteorological station. CALMET was then set up with one surface observations station (Martins Creek Quarry) and one upper air station (based on TAPM output for the Martins Creek Quarry). The meteorological modelling followed the guidance of TRC (2011) and adopted the "observations" mode.

Key model settings for TAPM are shown below in **Table 16**.

Table 16 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	2015
Centre of analysis	Martins Creek Quarry (32°33' S, 151°37' E)
Terrain data source	Shuttle Research Topography Mission (SRTM), 30 m resolution
Land use data source	Default
Meteorological data assimilation	Martins Creek Quarry meteorological station. Radius of influence = 10 km. Number of vertical levels for assimilation = 4

Table 17 lists the model settings and input data for CALMET.

Table 17 Model settings and inputs for CALMET

Parameter	Value(s)
Model version	6.334
Terrain data source(s)	SRTM and Project Digital Elevation Model (DEM)
Land-use data source(s)	Digitized 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
Meteorological grid origin	365000 mE, 6392000 mN. MGA Zone 56
Surface meteorological stations	Martins Creek Quarry meteorological station (Observations of wind speed and wind direction. TAPM for ceiling height, cloud cover, temperature, relative humidity and air pressure)
Upper air meteorological stations	Upper air data file for the location of Martins Creek Quarry meteorological station derived by TAPM. Biased towards surface observations (-1, -0.8, -0.6, -0.4, -0.2, 0, 0, 0, 0)
Simulation length	8760 hours (1 Jan 2015 to 31 Dec 2015)
R1, R2	0.5, 1
RMAX1, RMAX2	5, 20
TERRAD	5

Terrain information was extracted from the NASA Shuttle Research Topography Mission database which has global coverage at approximately 30 metre resolution. Land use data were extracted from aerial imagery. **Figure 9** shows the model grid, land-use and terrain information, as used by CALMET.

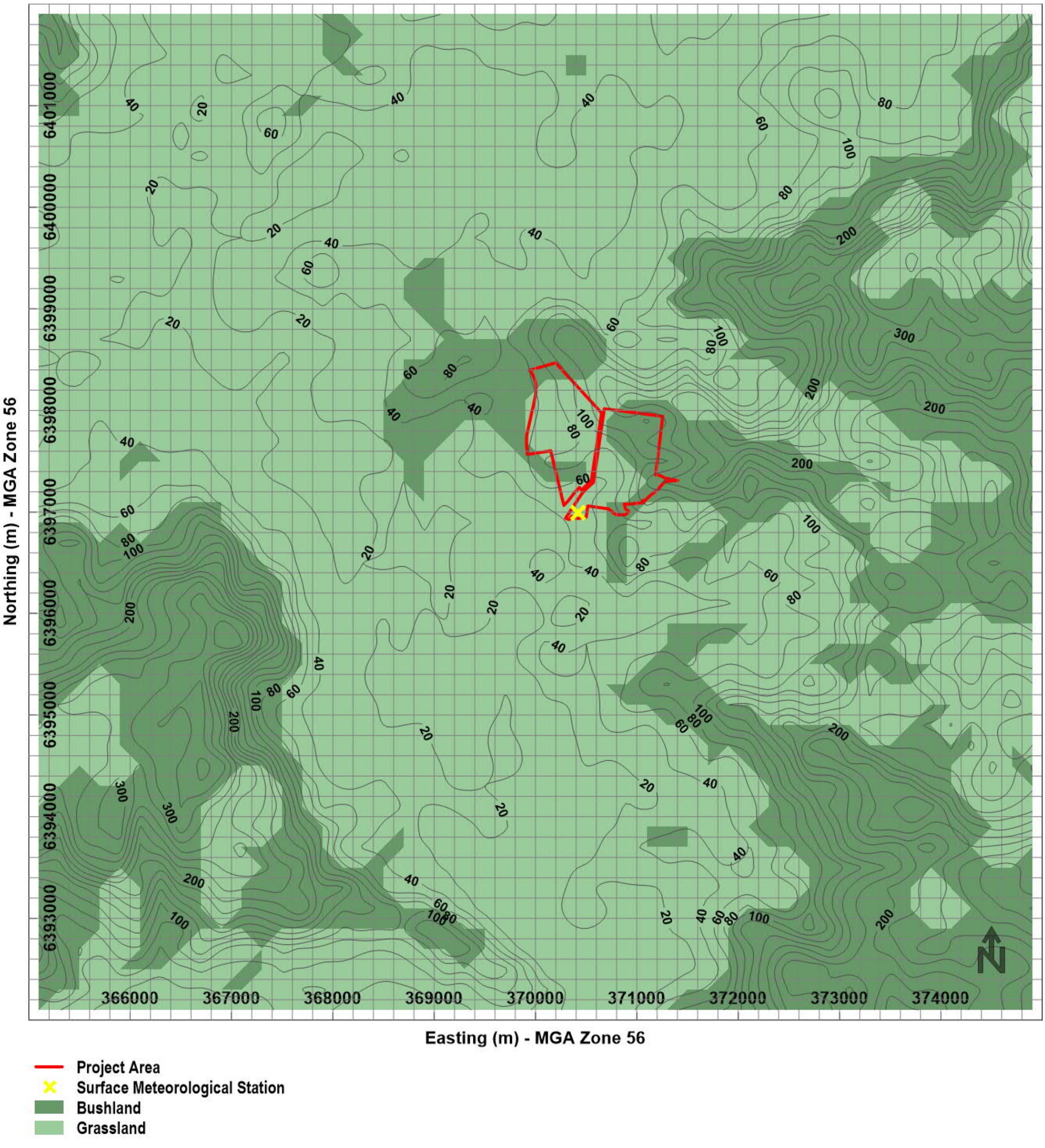


Figure 9 Model grid, land-use and terrain information

Figure 10 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, which further supports the use of a non-steady-state model such as CALPUFF.

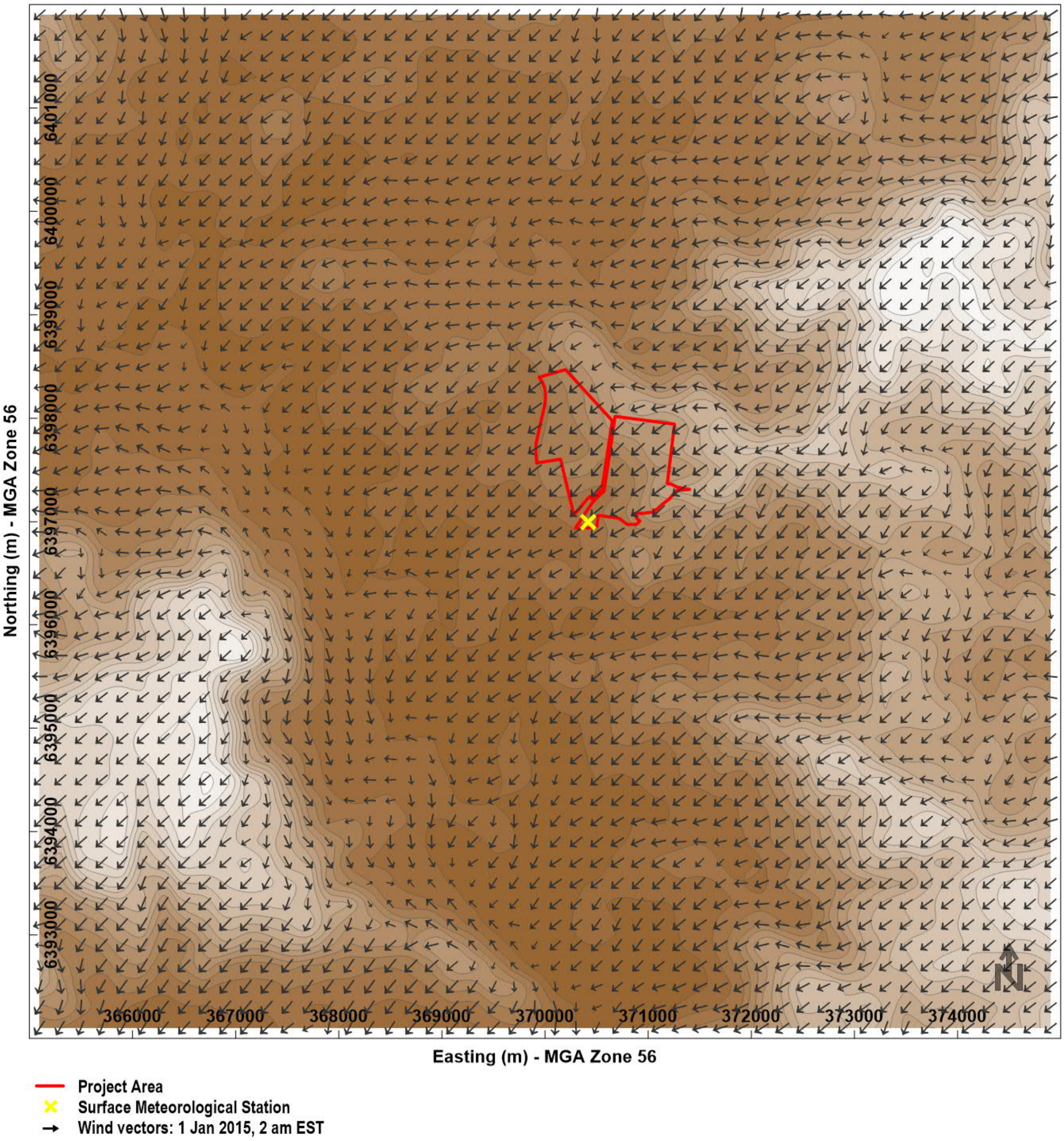


Figure 10 Example of CALMET simulated ground-level wind flows

7.3 Dispersion Modelling

Ground-level concentration and deposition levels due to the identified emission sources have been predicted using the air dispersion model known as CALPUFF (Version 6.42). CALPUFF is a Lagrangian dispersion model that simulates the dispersion of pollutants within a turbulent atmosphere by representing emissions as a series of puffs emitted sequentially. Provided the rate at which the puffs are emitted is sufficiently rapid, the puffs overlap and the serial release is representative of a continuous release.

The CALPUFF model differs from traditional Gaussian plume models (such as AUSPLUME and ISCST3) in that it can model spatially varying wind and turbulence fields that are important in complex terrain, long-range transport and near calm conditions. CALPUFF has the ability to model the effect of emissions entrained into the thermal internal boundary layer that forms over land, both through fumigation and plume trapping. CALPUFF is an air dispersion model which has been approved by the NSW EPA for these types of assessments (EPA 2016).

The modelling was performed using the emission estimates from **Section 6** and using the meteorological information provided by the CALMET model, described in **Section 7.2**. Predictions were made at 1,169 discrete receptors including the nearest sensitive receptors to the quarry over a 10 km by 10 km region to allow for contouring of results. The locations of the model receptors are shown in **Appendix C**.

Quarry operations were represented by a series of volume sources located according to the location of activities for each modelled scenario. **Figure 11** shows the location of the modelled sources where the emissions from the dust generating activities listed in **Table 13** to **Table 15** were assigned to one or more of these source locations (refer to **Appendix A** for details of the allocations).

Dust emissions for all modelled quarry-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 rock 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, exposed areas or active pits, 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.

All site activities have been modelled for the hours of day proposed under the Revised Project, for every day of the year. In reality the quarry will not operate for every day of the year so the model predictions will likely over-estimate the quarry contribution to local air quality.

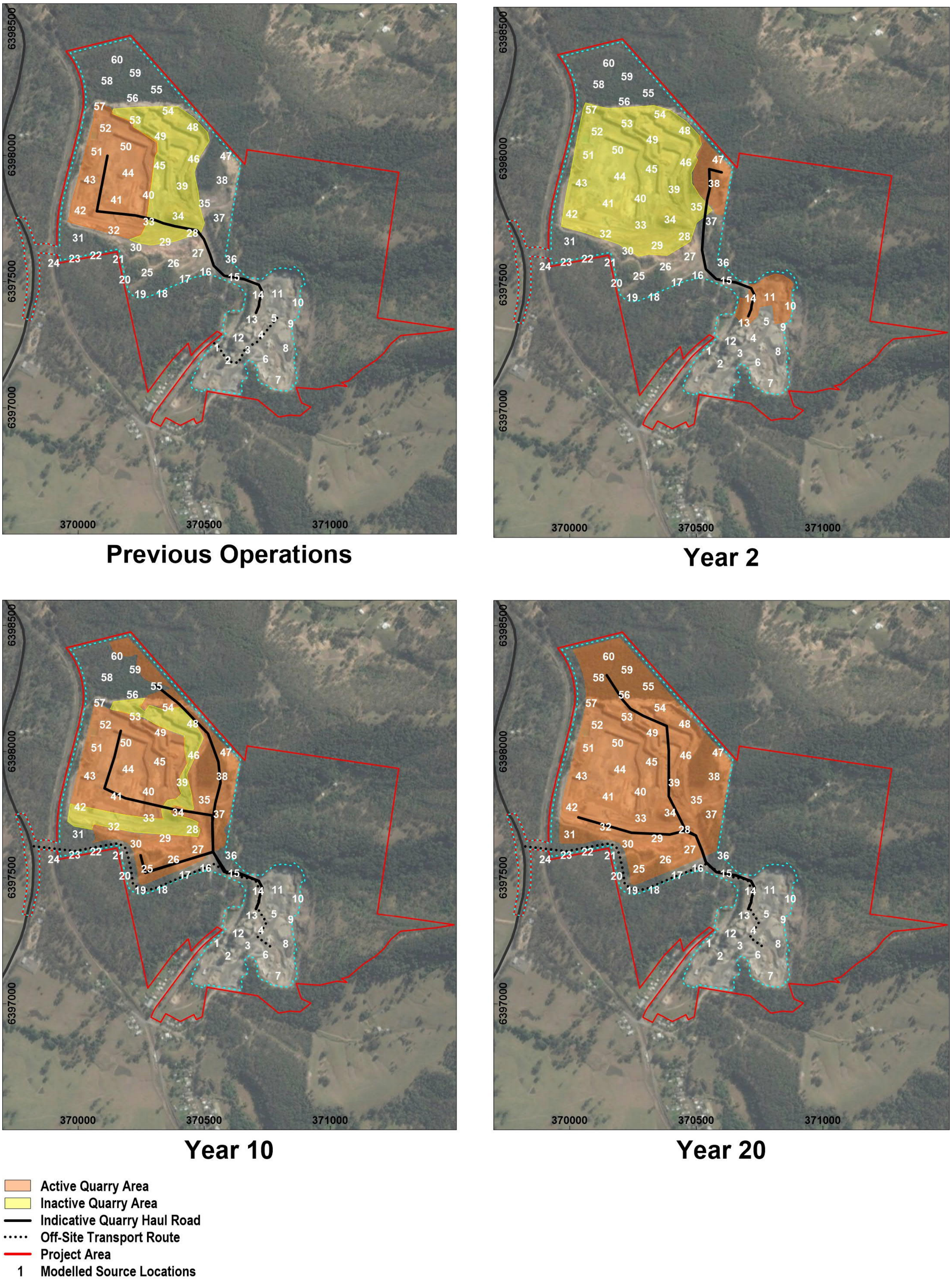


Figure 11 Location of modelled sources

Pit retention (that is, retention of dust particles within the open pits) and the effects of rainfall have not been included in the model simulations. This is a conservative approach as inclusion of these parameters would result in lower predicted dust impacts.

Key model settings and inputs for CALPUFF are provided in **Table 18**.

Table 18 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 Appendix A. Height = 5m, SY = 20 m, SZ = 10 m
Number of discrete receptors	543. See Appendix C.

Finally, the model predictions at identified sensitive receptors were then compared with the EPA air quality criteria, previously discussed in **Section 4**. Contour plots have also been created to show the spatial distribution of model predictions.

8. Assessment of Impacts

This section provides an assessment of the key air quality issues associated with the Revised Project, primarily based on model predictions and comparisons to air quality criteria.

The main objective of the modelling was to predict the potential change in air quality as a result of the Revised Project, that is, the incremental change from previous operations to proposed operations. In doing so, the contribution of the quarry to the historical air quality has been taken into account. Recognising that the Martins Creek Quarry previously operated and that the Revised Project represents the continuation of quarrying activities, albeit with an increase in the extraction rate and quarry footprint, the incremental change due to the Revised Project has been added to background levels. That is, the “Cumulative” concentration or deposition has been determined from the “Project” minus “Previous Operations” plus “Background”. This approach represents a “Level 1” assessment according to the “Approved Methods” (EPA 2016) whereby assumed maximum background levels have been combined with the predicted Project increment.

The tabulated results in this section of the report have been prepared for 16 locations representing the nearest sensitive receptors at various compass points around the quarry. **Appendix D** provides results for all identified sensitive receptors.

8.1 Particulate Matter (as PM_{10})

Table 19 presents the predicted PM_{10} concentrations at 16 of the nearest private sensitive receptors. The results from **Table 19** shows that the incremental change in the contribution from the Revised Project would not cause exceedances of the EPA criteria. The cumulative PM_{10} concentrations are predicted to remain below both the 24-hour and annual average criteria. In some cases the predicted contributions of the previous operations were higher than the background level (for example, annual average PM_{10} at R1). This outcome suggests that the model has a tendency for over-prediction.

Table 19 Predicted PM_{10} concentrations at the nearest private sensitive receptors

ID	Due to quarry				Background	Cumulative			Criteria
	Previous Operations	Project Year 2	Project Year 10	Project Year 20		Project Year 2	Project Year 10	Project Year 20	
Predicted maximum 24-hour average PM_{10} concentrations ($\mu g/m^3$)									
R1	39	33	30	50	34	28	25	45	50
R5	22	19	18	28	34	31	30	40	50
R10	14	12	11	18	34	32	31	38	50
R12	22	19	17	29	34	31	30	41	50
R16	9	7	7	11	34	32	32	36	50
R25	9	5	6	9	34	30	31	34	50
R31	7	6	8	10	34	33	34	36	50
R32	14	14	13	19	34	35	34	39	50
R34	12	12	12	15	34	34	34	37	50
R46	5	4	5	7	34	33	34	36	50
R48	23	19	19	26	34	30	29	37	50
R60	3	4	3	5	34	35	34	36	50
R63	6	3	5	7	34	31	33	35	50
R67	2	2	2	4	34	34	34	35	50
R68	4	4	4	5	34	34	34	36	50
R74	2	2	2	3	34	34	34	35	50
Predicted annual average PM_{10} concentrations ($\mu g/m^3$)									
R1	14.5	12.6	12.2	19.1	13	11	11	18	25

ID	Due to quarry				Background	Cumulative			Criteria
	Previous Operations	Project Year 2	Project Year 10	Project Year 20		Project Year 2	Project Year 10	Project Year 20	
R5	8.5	7.3	7.2	11.1	13	12	12	16	25
R10	5.3	4.5	4.5	6.9	13	12	12	15	25
R12	7.4	6.2	6.1	9.4	13	12	12	15	25
R16	3.5	2.5	3.0	4.3	13	12	12	14	25
R25	2.8	1.5	2.1	3.0	13	12	12	13	25
R31	2.0	1.0	1.5	2.1	13	12	12	13	25
R32	2.3	2.2	2.1	2.9	13	13	13	14	25
R34	2.6	1.0	1.8	2.5	13	11	12	13	25
R46	0.9	0.6	0.9	1.3	13	13	13	13	25
R48	4.4	3.9	3.8	5.1	13	13	12	14	25
R60	0.6	0.6	0.7	0.9	13	13	13	13	25
R63	0.8	0.5	0.8	1.1	13	13	13	13	25
R67	0.3	0.3	0.3	0.5	13	13	13	13	25
R68	0.6	0.6	0.7	0.9	13	13	13	13	25
R74	0.2	0.2	0.2	0.3	13	13	13	13	25

Figure 12 shows the predicted maximum 24-hour average PM_{10} concentrations due to previous operations and the Revised Project (Years 2, 10 and 20) scenarios. **Figure 13** shows the predicted annual average PM_{10} concentrations. Background concentrations are not included in these plots. These figures have been prepared to show the likely change to PM_{10} concentrations as a result of the Revised Project. It can be seen from these figures that very little change in contribution from the quarry (relative to previous operations) is expected beyond the site boundary.

Given that the existing air quality monitoring data (PM_{10}) has demonstrated compliance with EPA criteria it follows that compliance with EPA criteria can continue with the Revised Project subject to the implementation of the same or improved management and mitigation measures.

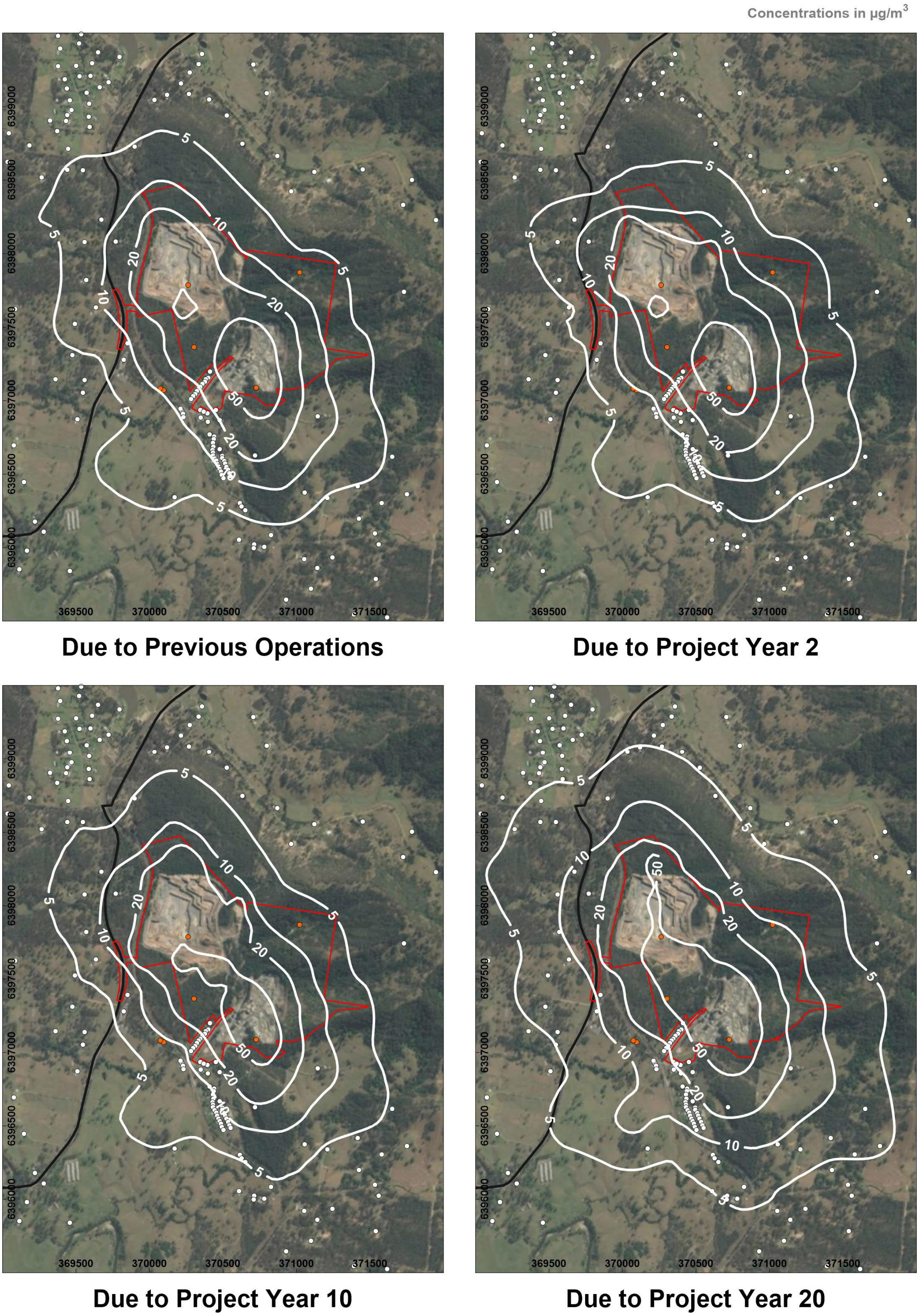


Figure 12 Predicted maximum 24-hour average PM_{10} concentrations due to Martins Creek Quarry

Figure 13 Predicted annual average PM_{10} concentrations due to Martins Creek Quarry

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

Table 19 presents the predicted $PM_{2.5}$ concentrations at 16 of the nearest private sensitive receptors. These results show that the incremental change in the contribution from the Revised Project would not cause exceedances of the EPA criteria. The cumulative $PM_{2.5}$ concentrations are predicted to remain below both the 24-hour and annual average criteria.

Table 20 Predicted $PM_{2.5}$ concentrations at the nearest private sensitive receptors

ID	Due to quarry				Background	Cumulative			Criteria
	Previous Operations	Project Year 2	Project Year 10	Project Year 20		Project Year 2	Project Year 10	Project Year 20	
Predicted maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)									
R1	7.0	5.7	5.3	8.1	14	13	12	15	25
R5	4.1	3.4	3.3	4.7	14	13	13	15	25
R10	2.7	2.2	2.1	3.2	14	14	13	14	25
R12	3.9	3.3	3.0	4.7	14	13	13	15	25
R16	1.8	1.3	1.4	2.0	14	14	14	14	25
R25	1.7	0.9	1.1	1.7	14	13	13	14	25
R31	1.4	1.2	1.5	1.9	14	14	14	14	25
R32	2.3	2.4	2.2	3.0	14	14	14	15	25
R34	2.2	2.2	2.3	2.8	14	14	14	15	25
R46	1.0	0.6	1.0	1.4	14	14	14	14	25
R48	4.4	3.5	3.3	4.6	14	13	13	14	25
R60	0.6	0.7	0.7	0.9	14	14	14	14	25
R63	1.1	0.6	1.0	1.3	14	14	14	14	25
R67	0.5	0.5	0.5	0.7	14	14	14	14	25
R68	0.7	0.7	0.7	1.0	14	14	14	14	25
R74	0.5	0.5	0.5	0.7	14	14	14	14	25
Predicted annual average $PM_{2.5}$ concentrations (µg/m³)									
R1	2.5	2.1	2.0	3.1	5.5	5.1	5.0	6.1	8
R5	1.5	1.2	1.2	1.9	5.5	5.2	5.2	5.9	8
R10	1.0	0.8	0.8	1.2	5.5	5.3	5.3	5.7	8
R12	1.3	1.1	1.0	1.6	5.5	5.2	5.2	5.8	8
R16	0.6	0.4	0.5	0.8	5.5	5.3	5.4	5.6	8
R25	0.5	0.3	0.4	0.5	5.5	5.3	5.4	5.5	8
R31	0.4	0.2	0.3	0.4	5.5	5.3	5.4	5.5	8
R32	0.4	0.4	0.4	0.5	5.5	5.5	5.5	5.6	8
R34	0.5	0.2	0.3	0.4	5.5	5.2	5.4	5.5	8
R46	0.2	0.1	0.2	0.2	5.5	5.4	5.5	5.6	8
R48	0.8	0.7	0.7	0.9	5.5	5.4	5.4	5.6	8
R60	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.6	8
R63	0.2	0.1	0.1	0.2	5.5	5.4	5.5	5.5	8
R67	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R68	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.6	8
R74	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8

Figure 14 shows the predicted maximum 24-hour average $PM_{2.5}$ concentrations due to the previous operations and Revised Project (Years 2, 10 and 20) scenarios. **Figure 15** shows the predicted annual average $PM_{2.5}$ concentrations. Background concentrations are not included in these plots. These figures have been prepared

to show the likely change to $PM_{2.5}$ concentrations as a result of the Revised Project. Very little change in contribution from the quarry is expected beyond the site boundary.

As for PM_{10}, the model predictions for $PM_{2.5}$ indicate that the Revised Project will comply with EPA criteria, subject to the implementation of the same or improved management and mitigation measures.

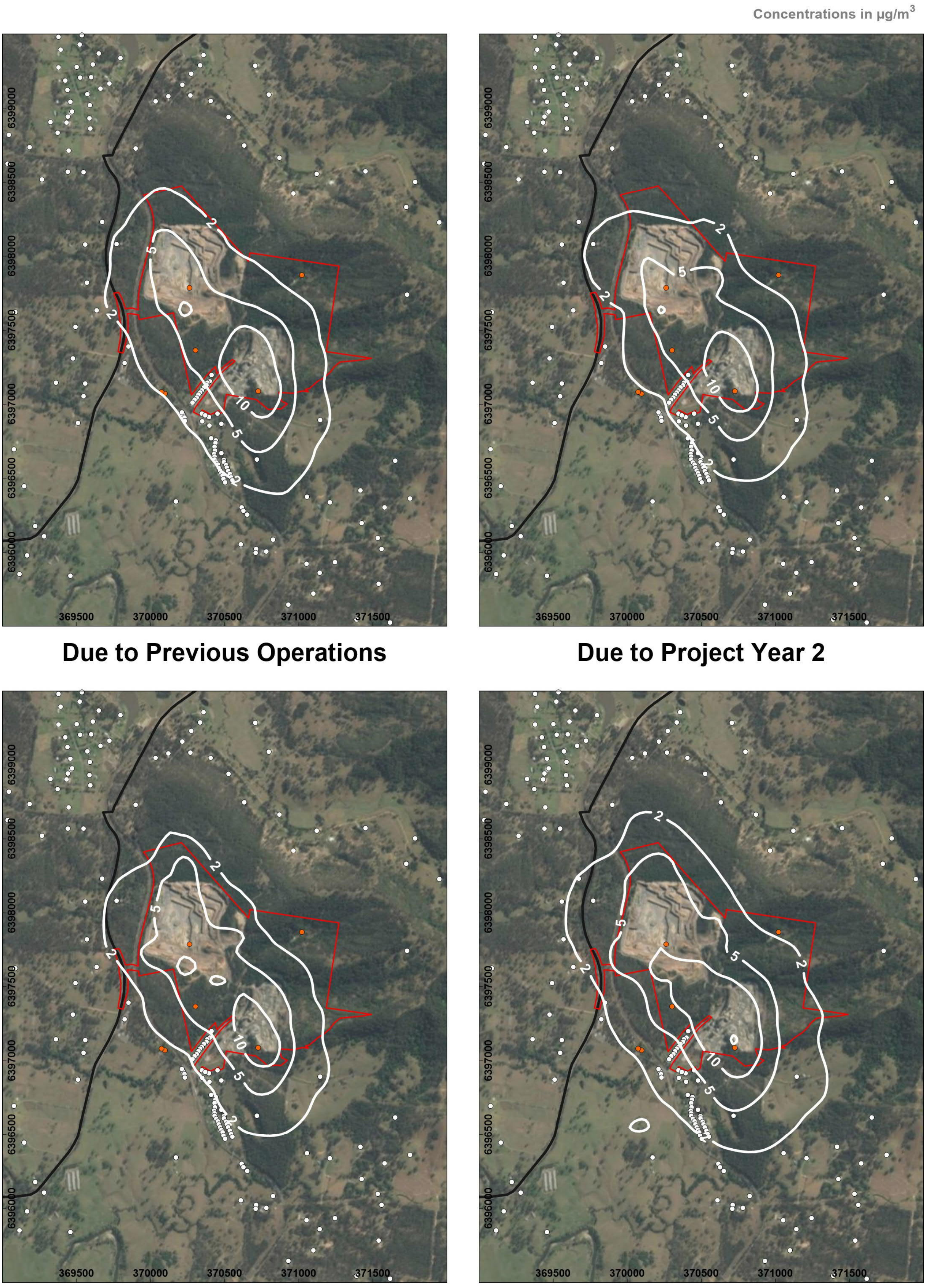


Figure 14 Predicted maximum 24-hour average $PM_{2.5}$ concentrations due to Martins Creek Quarry

Figure 15 Predicted annual average $PM_{2.5}$ concentrations due to Martins Creek Quarry

8.3 Particulate Matter (as TSP)

Table 21 presents the predicted TSP concentrations at 16 of the nearest private sensitive receptors. Compliance with the EPA's assessment criterion for annual average TSP (90 µg/m^3) is predicted at all locations.

Table 21 Predicted TSP concentrations at the nearest private sensitive receptors

ID	Due to quarry				Background	Cumulative			Criteria
	Previous Operations	Project Year 2	Project Year 10	Project Year 20		Project Year 2	Project Year 10	Project Year 20	
Predicted annual average TSP concentrations (µg/m^3)									
R1	21	18	17	25	33	30	29	38	90
R5	10	9	9	13	33	32	31	35	90
R10	6	5	5	7	33	32	32	34	90
R12	9	7	7	10	33	32	31	34	90
R16	3	2	3	4	33	32	33	34	90
R25	2	1	2	3	33	32	33	33	90
R31	2	1	1	2	33	32	33	33	90
R32	3	3	3	4	33	33	33	34	90
R34	3	1	2	3	33	31	32	33	90
R46	1	1	1	1	33	33	33	33	90
R48	5	4	4	5	33	33	33	34	90
R60	1	1	1	1	33	33	33	33	90
R63	1	0	1	1	33	33	33	33	90
R67	0	0	0	1	33	33	33	33	90
R68	1	1	1	1	33	33	33	33	90
R74	0	0	0	0	33	33	33	33	90

Figure 16 shows the predicted annual average TSP concentrations (excluding background concentrations) due to the quarry. Very little change in contribution from the quarry is expected beyond the site boundary.

Figure 16 Predicted annual average TSP concentrations due to Martins Creek Quarry

8.4 Deposited Dust

Table 22 presents the predicted dust deposition at 16 of the nearest private sensitive receptors. Compliance with the EPA's assessment criterion for annual average dust deposition (4 g/m²/month) is predicted at all locations.

Table 22 Predicted dust deposition at the nearest private sensitive receptors

ID	Due to quarry				Background	Cumulative			Criteria
	Previous Operations	Project Year 2	Project Year 10	Project Year 20		Project Year 2	Project Year 10	Project Year 20	
Predicted annual average dust deposition (g/m²/month)									
R1	1.8	1.5	1.5	2.3	2.4	2.2	2.2	2.9	4
R5	1.0	0.8	0.9	1.3	2.4	2.3	2.3	2.7	4
R10	0.6	0.5	0.6	0.8	2.4	2.3	2.4	2.6	4
R12	0.7	0.6	0.7	0.9	2.4	2.3	2.3	2.6	4
R16	0.3	0.2	0.3	0.4	2.4	2.3	2.4	2.5	4
R25	0.2	0.1	0.2	0.3	2.4	2.3	2.4	2.5	4
R31	0.2	0.1	0.2	0.2	2.4	2.3	2.4	2.4	4
R32	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4
R34	0.4	0.1	0.3	0.4	2.4	2.2	2.3	2.4	4
R46	0.1	0.1	0.1	0.2	2.4	2.4	2.4	2.5	4
R48	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4
R60	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.5	4
R63	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R67	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R68	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.5	4
R74	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4

Figure 17 shows the predicted annual average dust deposition (excluding background concentrations) due to Martins Creek Quarry. Very little change in contribution from the quarry is expected beyond the site boundary. The modelling does however indicate a potential for the annual average dust deposition due to the Revised Project to exceed the 2 g/m²/month criterion at R1 (on Station Street). This result, 2.3 g/m²/month, can be compared to the predicted previous operations contribution of 1.8 g/m²/month to infer that the increase due to the Revised Project will be in the order of 0.5 g/m²/month; an increase that is below the EPA's 2 g/m²/month criterion for a "maximum increase". Historical monitoring near Martins Creek Quarry has shown that dust deposition levels on Station Street have not exceeded 4 g/m²/month in the past seven years and that the maximum annual average was 2.2 g/m²/month (see **Section 5.3.4**).

Nevertheless, it will be important to continue monitoring in the Station Street area (DG1) to confirm that the impacts of the Revised Project are within those predicted by the modelling, and that there is continued implementation of dust management and mitigation measures.

Figure 17 Predicted annual average dust deposition due to Martins Creek Quarry

8.5 Post-Blast Fume (NO_2)

Blasting activities have the potential to result in fume and particulate matter emissions. Particulate matter emissions from blasting are included in the dispersion modelling results presented in **Sections 8.1** to **8.4**. 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.

Post-blast fumes comprise of oxides of nitrogen (NO_x) including nitric oxide (NO) and nitrogen dioxide (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 NO_x. The remaining 10% will comprise mostly NO_2. It is the NO_2 which has been linked to adverse health effects.

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.

In NO_x monitoring data near significant emission sources (for example, power stations and motorways) the percentage of NO_2 in the NO_x is (as a rule) inversely proportional to the total NO_x concentration, and when NO_x concentrations are high, the percentage of NO_2 in the NO_x is typically of the order of 20%. This is demonstrated by **Figure 18** which shows that, for high NO_x concentrations, the NO_2 to NO_x ratio reduces to less than 20%.

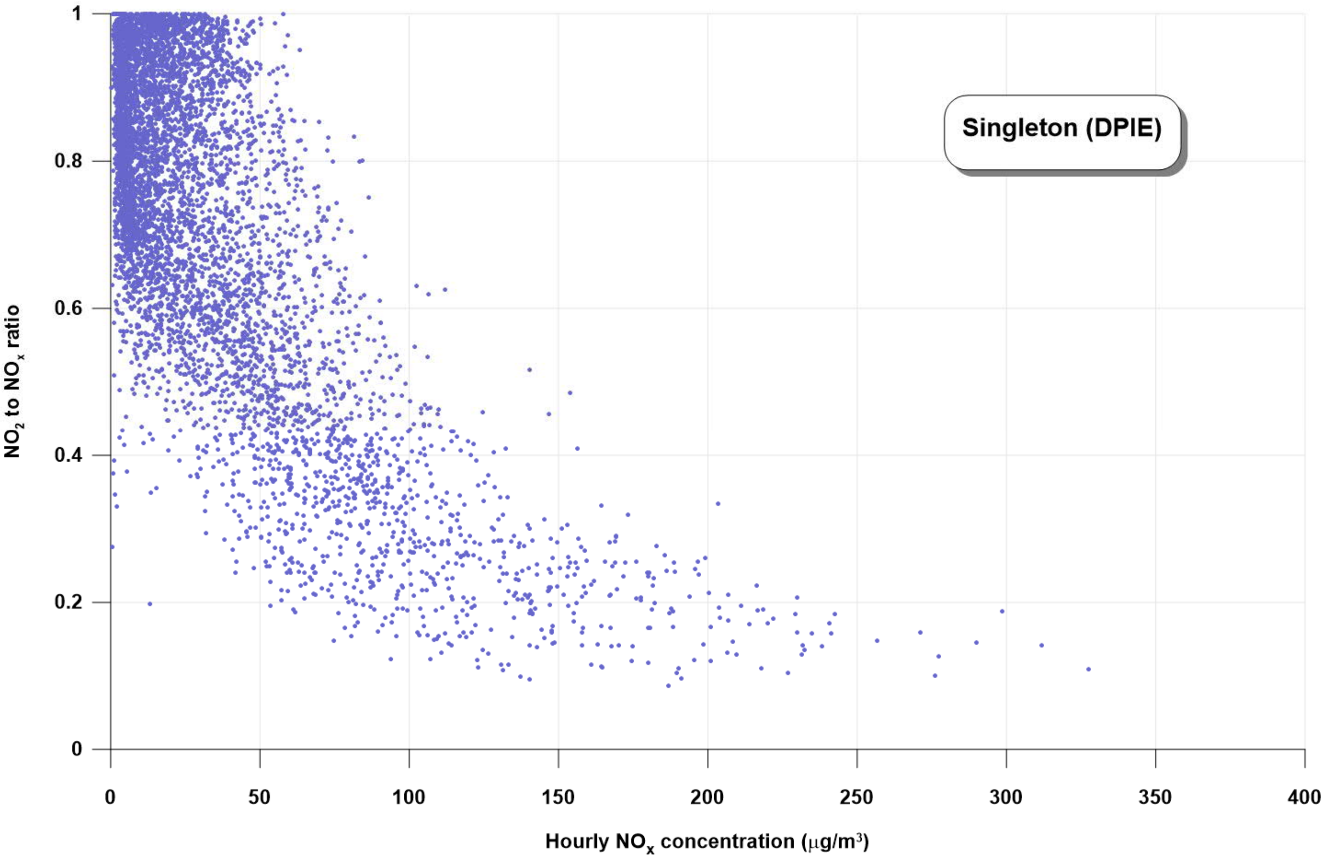


Figure 18 Measured NO_2 to NO_x ratios from hourly average data collected at Singleton by the DPIE (2014 data)

For assessment of post-blast fume the applicable EPA air quality criterion for NO_2 is 246 µg/m^3 as a 1-hour average.

The CALPUFF dispersion model has been used to quantify potential NO_2 concentrations due to blasting. The methodology was as follows:

- Blast modelled as a single volume source in the centre of the current active pit. It is acknowledged that moving the blast location, for example further to the northwest, would lead to a corresponding shift in the contours, potentially changing the predicted extent of impacts. However, it will be seen below that impacts are predicted to be well within criteria so an alternative assumption on the blast location would not change outcomes.
- Release height of 10 m, effective plume height of 20 m, initial horizontal spread (sigma y) of 25 m and initial vertical spread (sigma z) of 10 m. These are conservative estimates based on the data presented by Attalla *et al*. (2008). No plume rise due to buoyancy was modelled, which is again a conservative assumption.
- Emissions assumed to occur between the hours of 11 am and 3 pm.
- Blasting emissions modelled for every day of the year.
- 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/m^3) based on the Rating 3 Fume Category in the Queensland Guidance Note. There have been no reported instances of Rating 3 blasts at Martins Creek.
- 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.
- Emission release time of 5 minutes.
- Calculated emission of 43 g/s of NO_x per blast.
- 20% of the NO_x is NO_2 at the points of maximum 1-hour average concentrations and at sensitive receptors.

Figure 19 shows the predicted maximum 1-hour average NO_2 concentrations due to post-blast fume, based on the methodology outlined above. These results show that, under worst-case meteorological conditions with a rated 3 fume, and blasting every day between 11 am and 3 pm, the predicted maximum 1-hour average NO_2 concentrations at the nearest sensitive receptors are less than 20 µg/m^3. With the addition of maximum background levels (66 µg/m^3 in 2015 from **Table 11**) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion.

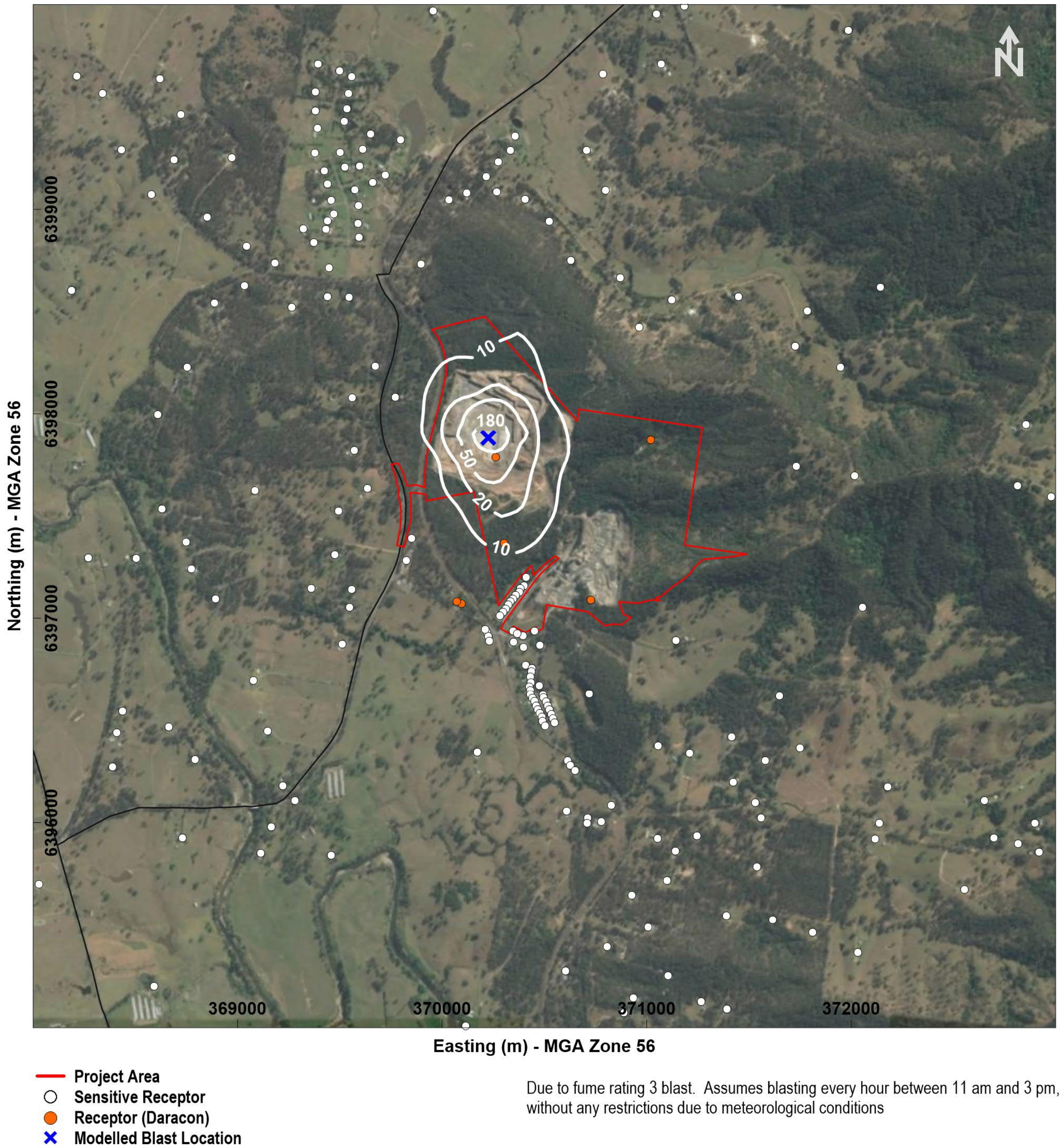


Figure 19 Predicted maximum 1-hour average NO_2 concentrations due to blasting

8.6 Diesel Exhaust Emissions

Emissions from diesel exhausts associated with off-road vehicles and equipment at quarry and mine sites are often deemed a lower air quality impact risk than dust emissions from the material handling activities. This is because of the relatively few emission sources involved, for example when compared to a busy motorway, and the large distances between the sources and sensitive receptors. Nevertheless, a review of the potential impacts has been carried out.

The most significant emissions from diesel exhausts are products of combustion including carbon monoxide (CO), oxides of nitrogen (NO_x) and particulate matter (PM_{10} and including $PM_{2.5}$). It is the NO_x, or more specifically NO_2, and PM_{10} (including $PM_{2.5}$) which have been reviewed in this section. DPIE 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.

8.6.1 Particulate Matter (as PM_{10} and $PM_{2.5}$)

The emission factors, presented in **Section 6** and **Appendix A**, 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 include diesel particulates in the form of both PM_{10} and $PM_{2.5}$. The emission factors are also likely to include more diesel exhaust particulate than from a modern truck as the factors were developed on the basis of emissions from trucks measured in the 1980s (that is, older trucks). Todoroski Air Sciences has also reported (TAS 2016) that several studies, reported to the EPA, confirmed that a control factor of 85% can be maintained, representing all components of the truck haulage emission.

Based on the information collated above, the potential impacts of diesel exhaust emissions (as PM_{10} and $PM_{2.5}$) are represented in the preceding results, in **Sections 8.1** to **8.4**.

8.6.2 Nitrogen Dioxide (NO_2)

Emissions of NO_x from diesel exhausts have been estimated using fuel consumption data, based on information provided by the proponent, and an emission factor from the EPA's Air Emissions Inventory for 2008 (EPA 2012). **Table 23** shows the calculations.

Table 23 Estimated NO_X emissions from diesel exhausts

Parameter	Value
Estimated fuel used (L) (source: Buttai Gravel maximum of 2013/14 and 2014/15 NPI reported data)	670,615
NO_x calculations	
Diesel exhaust emission factor (kg/kL)	40.77
Diesel exhaust emissions - all equipment (kg/y)	27,341

The NO_x emission estimate from **Table 23** has been modelled using the same source locations as Year 20 (a potential worst case year in terms of area) to provide an indication of the off-site NO_2 concentrations due to diesel exhaust emissions. The predicted maximum 1-hour average NO_2 concentrations are shown in **Figure 20**, which assumes that 20% of the NO_x is NO_2 at the locations of maximum ground-level concentrations.

At the nearest sensitive receptors, the predicted maximum 1-hour average NO_2 concentrations are in the order of 20 µg/m^3. With the addition of maximum background levels (66 µg/m^3 in 2015 from **Table 11**) the results demonstrate compliance with the EPA's 246 µg/m^3 criterion.

Figure 21 shows the predicted annual average NO_2 concentrations and assume that 100% of the NO_x is NO_2. At nearest sensitive receptors the predicted average NO_2 concentrations are in the order of 10 µg/m^3 or less. With the addition of background levels (16 µg/m^3 in 2015 from **Table 11**) the results show compliance with the EPA's 62 µg/m^3 criterion.

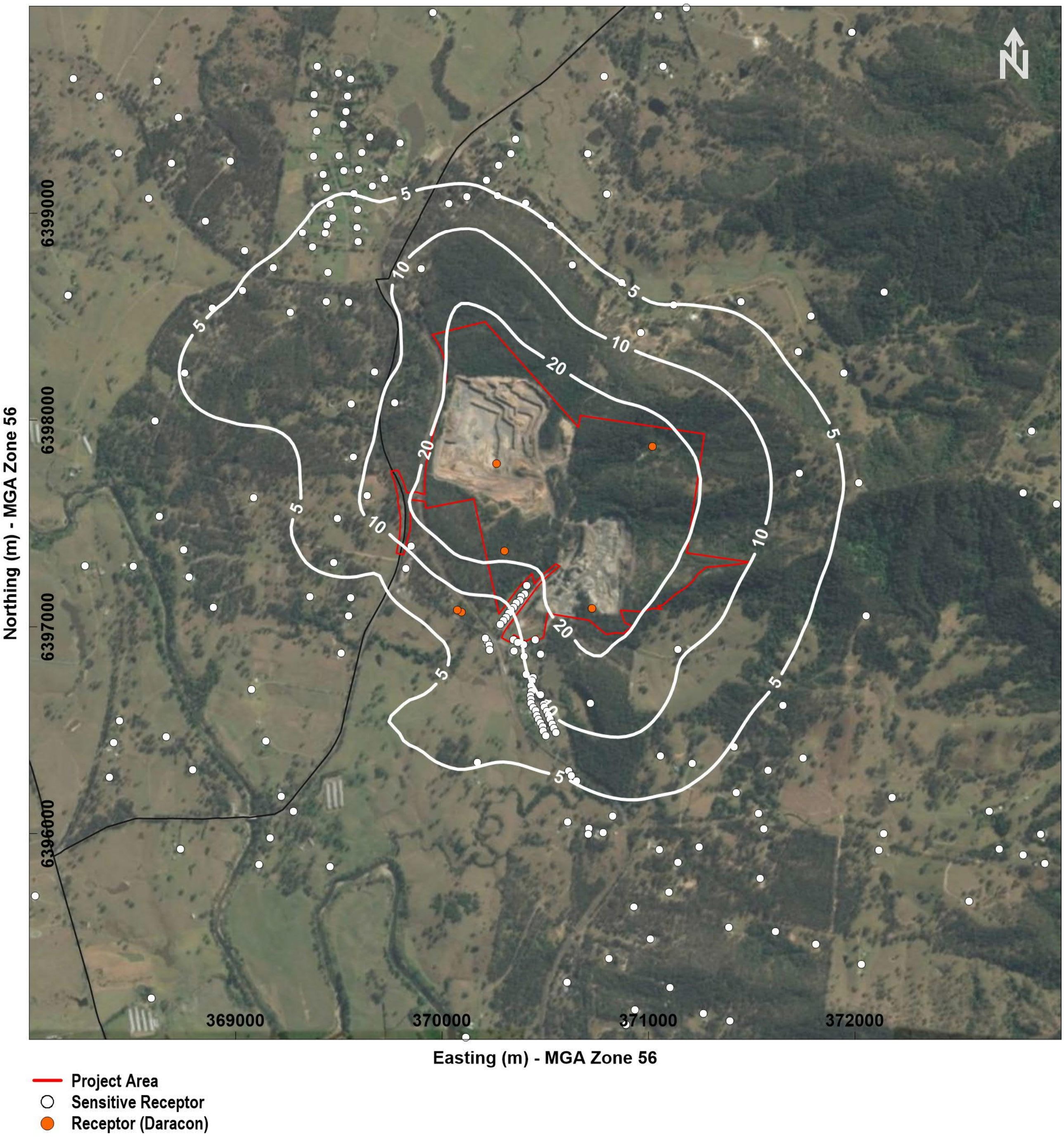


Figure 20 Predicted maximum 1-hour average NO_2 concentrations due to diesel exhausts

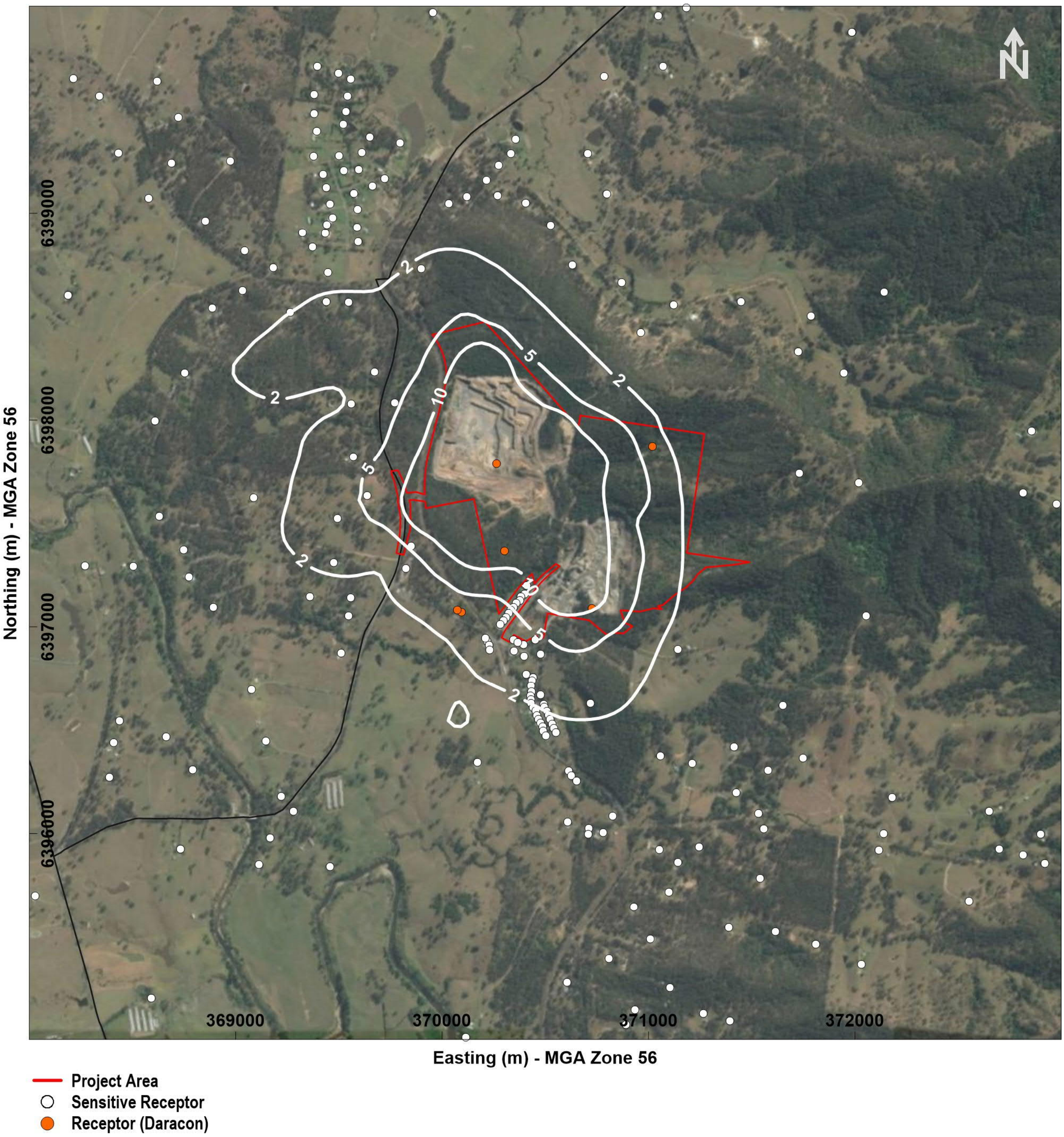


Figure 21 Predicted annual average NO_2 concentrations due to diesel exhausts

8.7 Road Transport

The transport of quarry product off-site and to final destinations on public roads has the potential to cause air quality impacts. These impacts may arise from diesel exhaust emissions and from wheel-generated dust. The wheel-generated dust may only present an issue if the build-up of dirt on paved roads leading out of the quarry is not appropriate managed. Diesel exhaust emissions have been quantitatively assessed as discussed below.

The potential for air quality impacts due to diesel exhaust emissions has been examined by using the Roads and Maritime Services air quality screening tool known as TRAQ. TRAQ ("Tool for Roadside Air Quality") adopts emission factors from the EPA's Motor Vehicle Emissions Inventory (MVEI) and uses the CALINE air dispersion model to predict the maximum near roadside air pollutant concentrations based on traffic volume, traffic mix, traffic speed, road type, road grade, and other factors. Results from TRAQ are compared to the EPA assessment criteria in order to determine the potential for impacts.

TRAQ has been configured for the prediction of diesel exhaust emission impacts as follows:

- Two lane road with lane widths of 3.5 m.
- 25 laden and 25 unladen trucks per hour. This is a conservatively high estimate as the proposed maximum number of truck movements for the Revised Project is 20 laden and 20 unladen trucks per hour.
- "Residential" road type for emission factors.
- Peak-hour speed of 25 km/h (worst-case for residential road type, noting that the Daracon Driver Code of Conduct for selected areas is 40 km/h).
- Zero per cent grade.
- "Rigid diesel truck" for all vehicles. (A conservative approach given that most will be truck and dog).
- Emission factors for 2021.
- "Rural" land-use and air quality environment.
- Worst-case season emission rates and including cold start factors.
- Worst-case meteorological conditions.

Table 24 shows the maximum concentrations at kerbside of key air quality indicators, as predicted by TRAQ. Based on the comparisons with the EPA criteria these results indicate that diesel exhausts emissions from trucks travelling on public roads will not lead to any adverse air quality impacts.

Table 24 Predicted maximum concentrations at kerbside due to diesel exhaust emissions

Substance	Averaging time	Due to diesel exhaust emissions	Background level	Cumulative	Criterion
Carbon monoxide (CO) (mg/m^3)	1-hour	<0.1	0.7*	0.7	30
	8-hour	<0.1	0.7*	0.7	10
Nitrogen dioxide (NO_2) (µg/m^3)	1-hour	3.7	66.0	69.7	246
	Annual	0.7	16.0	16.7	62
Particulate matter (PM_{10}) (µg/m^3)	24-hour	2.3	34.0	36.3	50
	Annual	0.9	13.0	13.9	25

* TRAQ defaults for "rural" environment

8.8 Crystalline Silica

Silica (SiO_2) occurs in abundance in nature and comprises minerals composed of silicon and oxygen. It exists in crystalline and amorphous forms which relate to the structural arrangement of the oxygen and silicon atoms. Only the crystalline forms are known to be fibrogenic (that is, dust which causes an increase of scar tissue after deposition in the gas exchange region of the lung) and only the respirable particles, being those which are capable of reaching the gas exchange region of the lungs, are considered in determining health effects of crystalline silica.

Dust from quarrying activities such as crushing may contain silica and this section provides an assessment of potential impacts. These potential impacts have been informed by ambient monitoring carried out by Buttai Gravel at the Martins Creek Quarry and from the model predictions presented in **Section 8.2**.

Buttai Gravel conducted ambient monitoring of respirable crystalline silica at the Martins Creek Quarry on 14 June 2019. This monitoring involved the installation of a monitor located on the site boundary and positioned downwind of the quarry activities on a day representative of normal operations. The monitor was fitted with a PVC filter to allow for analysis of crystalline silica. The sampling and analysis was conducted in accordance with the following methods:

- Inhalable Dust – AS 3640-2009: Workplace atmospheres - Method for sampling and gravimetric determination of inhalable dust; Gravimetric analysis of samples was performed by GCG Health Safety & Hygiene, Townsville, Queensland, NATA Site Number 20653, NATA accreditation number 16791.
- Respirable Dust – AS 2985-2009: Workplace atmospheres - Method for sampling and gravimetric determination of respirable dust; Gravimetric analysis of samples was performed by GCG Health Safety & Hygiene, Townsville, Queensland, NATA Site Number 20653, NATA accreditation number 16791.
- Analysis for Crystalline Silica was conducted by MPL Laboratories (NATA Accreditation 2901) by direct on filter Infra-Red Spectrometry following ashing and redeposition.

Results from the sampling were used to estimate a maximum annual average respirable crystalline silica concentration at the site boundary for comparison with the relevant assessment criteria (from **Table 4**).

Table 25 shows the measured respirable crystalline silica concentration on 14 June 2019 as well as the estimated maximum annual average at the site boundary. The measured respirable crystalline silica concentration (4.2 µg/m^3) is below the 8-hour time weighted average “action level” noted by the State of California DIR (25 µg/m^3).

The estimated maximum annual average respirable crystalline silica concentration was determined by assuming that the measured concentration of 4.2 µg/m^3 would persist for 11 ½ hours each day (consistent with the quarry operating hours) for every day of the year. This assumption will overstate the annual average concentration since the quarry does not, and is not proposed to, operate every day of the year. It can be seen from **Table 25** that the estimated maximum annual average respirable crystalline silica concentration at the site boundary is 2 µg/m^3, a result which is below the 3 µg/m^3 criterion noted by the Victorian EPA. Concentrations further from the site boundary, including at sensitive receptors, will be lower than 2 µg/m^3.

Table 25 Estimated annual average crystalline silica concentration at the site boundary

Substance	Measured result at site boundary on 14 June 2019	Estimated annual average at site boundary, based on operating times and assuming quarry operations every day of the year	Criterion
Respirable crystalline silica	4.2 µg/m^3	2.0 µg/m^3	3 µg/m^3

In addition to the respirable crystalline silica monitoring, **Figure 15** shows that the predicted annual average $PM_{2.5}$ concentrations due to the quarry (for both previous operations and Revised Project scenarios) will be less than 3 µg/m^3 at all private sensitive receptors. Respirable crystalline silica concentrations will be lower than the $PM_{2.5}$ concentrations since it is a subset of $PM_{2.5}$. Both of these outcomes (i.e. monitoring and modelling) suggest that the quarry has not caused, and is not expected to cause, adverse air quality impacts with respect to crystalline silica.

8.9 Construction

Dust emissions from construction works have the potential to cause nuisance impacts if not properly managed. In practice, it is not possible to realistically quantify impacts using dispersion modelling. To do so would require knowledge of weather conditions for the period in which work will be taking place in each location on the site.

Air quality impacts during construction would largely result from dust generated during the upgrading of infrastructure including intersections, rail siding, new access road, and bridge over the railway line. The total amount of dust generated would depend on the quantities of material handled, silt and moisture content of the soil, the types of operations being carried out, exposed areas, frequency of water spraying and speed of machinery. The detailed approach to construction will depend on decisions that will be made by the proponent in conjunction with the contractor(s) and changes to the construction methods and sequences that are expected to take place during the construction phase.

Material handling quantities in the construction phase are currently not known but are anticipated to be much lower than the material handling quantities in the operations phase. Consequently, the air quality impacts during construction will be lower than during operations. However, as for the operations phase, it is important that exposed areas be stabilised as quickly as possible and that appropriate dust suppression methods be used to keep dust impacts to a minimum. Dust management will require the use of water carts, the defining of trafficked areas, the imposition of site vehicle speed limits and constraints on work under extreme unfavourable weather conditions, such as dry wind conditions. Monitoring would also continue to be carried out during the construction phase to assess compliance with EPA criteria.

9. Management and Monitoring

Based on the operational details provided by Buttai Gravel, **Table 26** outlines the existing dust management measures that are in place at the quarry and the assumed emission control factors that were applied for the modelling. These measures will continue to be adopted as part of the Revised Project.

Table 26 Emission management measures

Activity	Emission management measures	Assumed emission control (%) (NPI 2012, Donnelly et el 2011)
Drilling rock	Water sprays Minimising activities when excessive visible dust is generated	70
Hauling on unsealed roads	Watering of unsealed haul routes / roads Restricting vehicle speeds Clearly marked haul routes	75
Primary and secondary crushing	Enclosure Water sprays	90
Screening	Enclosure	70
Loading product stockpiles	Water sprays	70
Wind erosion from product stockpiles	Water sprays	50

Buttai Gravel is proposing to have a water cart available at all times however it is not possible to know precisely when watering will be required. In many situations watering will not be required to achieve a desired dust mitigation; for example, in the periods after the water cart has run the circuits, when there is low evaporation, in high moisture conditions, when it is raining, or when there are lower truck volumes. The modelling has therefore assumed that roads will be maintained in a state to target at least 75% control at all times. According to the NPI (2012) an emission control of 75% is achieved with a water application rate of greater than 2 litres/m^2/h.

The modelling showed that the incremental change in dust concentrations and deposited dust levels due to the Revised Project would be relatively minor and that levels would not exceed relevant EPA assessment criteria at the nearest private sensitive receptors. Therefore no additional dust emission mitigation would be warranted. Nevertheless, due to efforts to minimise noise impacts, a number of the fixed plant have been enclosed. These measures will also reduce dust emissions from these sources. Further, Buttai Gravel has and will continue to be committed to the practice of limiting dust-generating activities at the quarry during periods of dry and windy weather.

As noted in **Section 5.3** the current monitoring consists of five dust deposition gauges, one high volume air sampler and one meteorological station. As the modelling showed that the change in ambient air quality at the nearest private sensitive receptors would not lead to exceedances of criteria, no additional monitoring is proposed.

10. Conclusions

This report has assessed the potential air quality impacts of the Martins Creek Quarry Extension Project. The potential air quality issues for the Revised Project were identified as:

- Dust (that is, particulate matter in the form of TSP, deposited dust, PM_{10} or $PM_{2.5}$) from the general quarrying activities;
- Fume (that is, NO_x emissions) from blasting;
- Emissions of substances from machinery exhausts, that is, diesel exhaust emissions such as NO_x, PM_{10} and $PM_{2.5}$; and
- Crystalline silica due to the crushing of rock.

A detailed review of the existing environment was carried out to understand any current air quality related issues. The following conclusions were made in relation to the existing environment:

- The most common winds in the area are from the northwest, east and south, with typically light winds and a high proportion of calm conditions.
- Up until 2018 (specifically 18 July 2018), measured PM_{10} concentrations at the quarry had complied with EPA criteria, based on data collected near Station Street. However, particle levels (as PM_{10} and $PM_{2.5}$) increased significantly across NSW in 2018 and 2019 due to dust from the widespread, intense drought and smoke from bushfires and hazard reduction burning (OEH 2019). These events adversely influenced air quality with multiple days observed when PM_{10} and $PM_{2.5}$ concentrations exceeded EPA criteria at multiple monitoring stations in the region. The five measured exceedances of the 24-hour average PM_{10} criterion in 2018 and 2019 corresponded with elevated regional PM_{10} levels that were associated with dust storms or bushfires. These exceedances were not caused by activities at the quarry.
- TSP concentrations comply with EPA criteria, if estimated from PM_{10} measurements using relationships measured in other rural areas.
- Deposited dust levels comply with EPA criteria, based on data collected in the Martins Creek area.
- NO_2 concentrations at Singleton (the closest monitoring site that measures NO_2) comply with EPA criteria. Compliance would also be expected in the Martins Creek area.

The computer-based dispersion model known as CALPUFF was used to predict the potential air quality impacts of the Revised Project. The modelling accounted for meteorological conditions, land use and terrain information and used dust emission estimates to predict the off-site air quality impacts. The focus of the assessment was on the potential change in air quality, noting that the quarry likely contributed to historically measured air quality.

The main conclusions of the assessment were as follows:

- Very little change in contribution from the quarry is expected beyond the site boundary, for all particulate matter classifications (PM_{10}, $PM_{2.5}$, TSP and dust deposition). Given that the existing air quality monitoring data has demonstrated compliance with EPA criteria it follows that compliance with EPA criteria can continue subject to the implementation of the same management and mitigation measures.
- Emissions from blasting and associated fume are not expected to result in any adverse air quality impacts, based on model predictions which show compliance with EPA criteria.
- Emissions from truck diesel exhausts travelling on public roads are not expected to result in any adverse air quality impacts based on modelling which showed that maximum kerbside concentrations would not exceed EPA criteria.
- Monitoring and modelling suggest that the quarry has not caused, and is not expected to cause, adverse air quality impacts with respect to crystalline silica.

It has therefore been concluded that the Revised Project can proceed without causing adverse air quality impacts at private sensitive receptors. This conclusion has been informed by monitoring data which show that historical activities at the quarry have not caused adverse off-site air quality impacts, predicted compliance with relevant criteria by modelling, and proposed continuation of current air quality mitigation and management measures.

11. References

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Appendix A. Annual and Seasonal Wind Roses

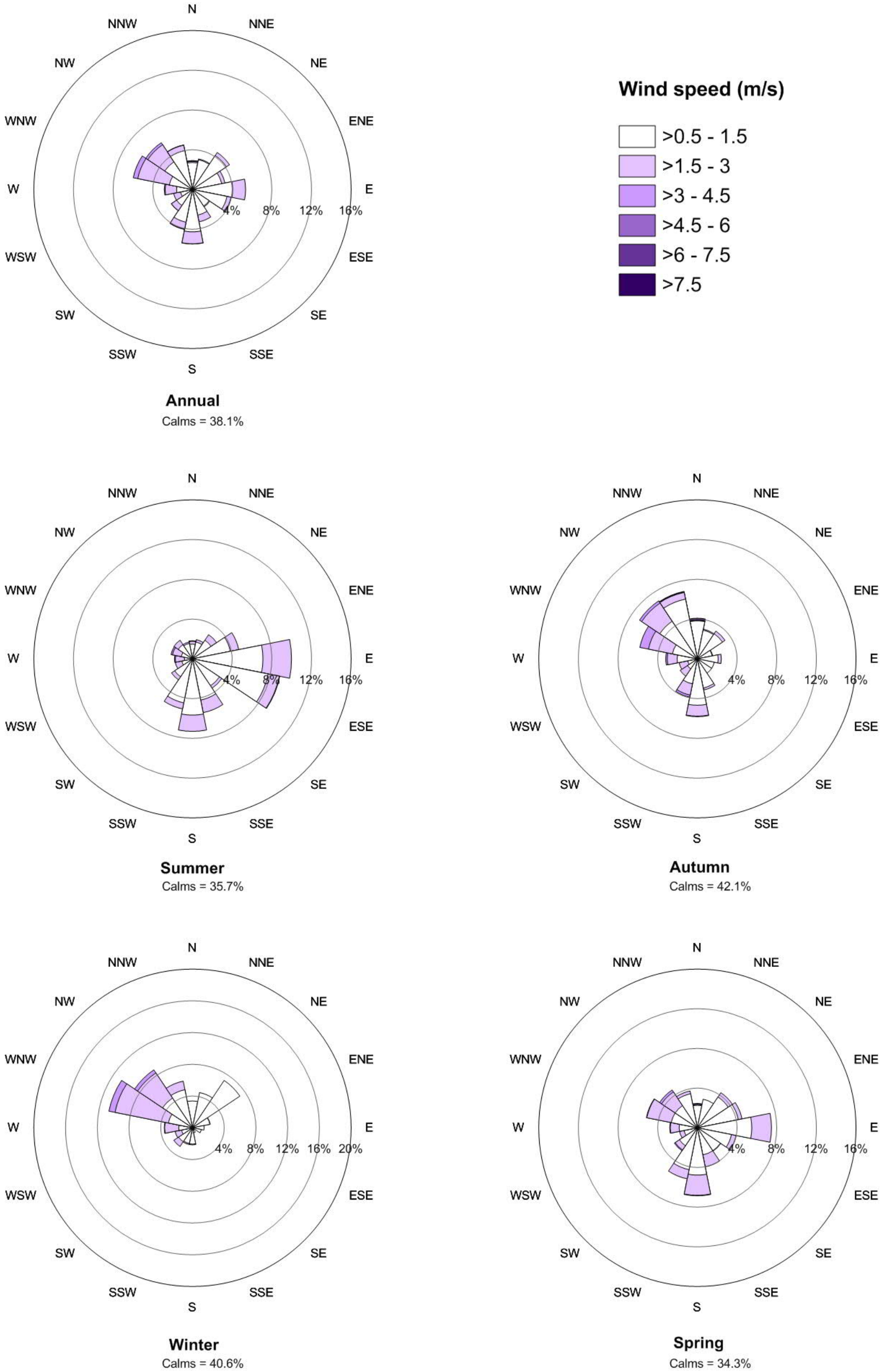

Figure A1 Annual and seasonal wind-roses for data collected at Martins Creek Quarry in 2015

Appendix B. Emissions Calculations

Emission factors

Activity	Emission factor			Units	Source
	TSP	PM_{10}	$PM_{2.5}$		
Drilling	$E_{TSP} = 0.59$	$E_{PM10} = 0.52 \times E_{TSP}$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/hole	US EPA / NPI
Blasting	$E_{TSP} = 0.00022 \times A^{1.5}$	$E_{PM10} = 0.52 \times E_{TSP}$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/blast	US EPA / NPI
Loading rock to trucks	$E_{TSP} = 0.74 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM10} = 0.35 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA / NPI
Hauling rock to plant	$E_{TSP} = 4$	$E_{PM10} = 0.3 \times E_{TSP}$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/VKT	SPCC
Primary crushing	$E_{TSP} = 0.01$	$E_{PM10} = 0.004$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA
Secondary crushing	$E_{TSP} = 0.03$	$E_{PM10} = 0.012$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA
Tertiary crushing	$E_{TSP} = 0.03$	$E_{PM10} = 0.01$	$E_{PM2.5} = 0.05 \times E_{TSP}$	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
Mobile pugmill (blending)	$E_{TSP} = 0.03$	$E_{PM10} = 0.01$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA
Loading product stockpiles	$E_{TSP} = 0.74 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM10} = 0.35 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA / NPI
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
Wind erosion from product stockpiles	$E_{TSP} = 0.1$	$E_{PM10} = 0.5 \times E_{TSP}$	$E_{PM2.5} = 0.075 \times E_{TSP}$	kg/ha/h	US EPA
Loading product to trucks	$E_{TSP} = 0.74 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM10} = 0.35 \times 0.0016 \times ((U/2.2)^{1.3}/(M/2)^{1.4})$	$E_{PM2.5} = 0.05 \times E_{TSP}$	kg/t	US EPA / NPI

A = blast area (m^2)
U = wind speed (m/s)
M = moisture content (%)

Emission estimates, controls factors, and input variables

Emission calculations

Martins Creek Quarry (Previous Operations)

	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
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	19.7	kg/blast	10.2	kg/blast	0.984	kg/blast	2000	-	-	-	-	-
Excavators loading overburden to trucks	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling overburden to dumps	0	0	0	75	0	t/y	0.04000	kg/t	0.01182	kg/t	0.002	kg/t	-	-	-	4.0	60	0.6
Unloading overburden to dumps	0	0	0	0	0	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-
Drilling rock	673	354	34	70	3802	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-
Blasting rock	174	90	9	0	25	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-
Loading rock to mobile crusher	415	197	21	0	924074	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Crushing (mobile)	4620	1848	231	50	924074	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Loading rock to trucks	415	197	21	0	924074	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling rock to plant	33883	10013	1694	75	924074	t/y	0.14667	kg/t	0.04334	kg/t	0.007	kg/t	-	-	-	4.0	60	2.2
Primary crushing	924	370	46	90	924074	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Secondary crushing	2772	1109	139	90	924074	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-
Tertiary crushing	13861	4620	693	50	924074	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Screening	8317	2772	416	70	924074	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Mobile pugmill (blending)	13861	4620	693	50	924074	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Loading product stockpiles	208	98	10	50	924074	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Wind erosion from exposed areas	21023	10511	1577	0	24	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Wind erosion from product stockpiles	6132	3066	460	50	14	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Loading product to trucks	415	197	21	0	924074	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling product off-site (paved)	14231	2711	678	75	924074	t/y	0.06160	kg/t	0.01173	kg/t	0.003	kg/t	-	-	-	0.8	30	2.2
Loading product to trains	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
	121925	42772	6741															

Emission calculations

Martins Creek Quarry Year 2

	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
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	19.7	kg/blast	10.2	kg/blast	0.984	kg/blast	2000	-	-	-	-	-
Excavators loading overburden to trucks	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling overburden to dumps	0	0	0	75	0	t/y	0.04000	kg/t	0.01182	kg/t	0.002	kg/t	-	-	-	4.0	60	0.6
Unloading overburden to dumps	0	0	0	0	0	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-
Drilling rock	673	354	34	70	3802	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-
Blasting rock	209	108	10	0	30	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-
Loading rock to mobile crusher	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Crushing (mobile)	0	0	0	50	0	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Loading rock to trucks	495	234	25	0	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling rock to plant	29333	8668	1467	75	1100000	t/y	0.10667	kg/t	0.03152	kg/t	0.005	kg/t	-	-	-	4.0	60	1.6
Primary crushing	1100	440	55	90	1100000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Secondary crushing	3300	1320	165	90	1100000	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-
Tertiary crushing	9900	3300	495	70	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Screening	9900	3300	495	70	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Mobile pugmill (blending)	16500	5500	825	50	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Loading product stockpiles	247	117	12	50	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Wind erosion from exposed areas	25920	12960	1944	0	30	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Wind erosion from product stockpiles	6132	3066	460	50	14	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Loading product to trucks	225	106	11	0	500000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling product off-site (paved)	7700	1467	367	75	500000	t/y	0.06160	kg/t	0.01173	kg/t	0.003	kg/t	-	-	-	0.8	30	2.2
Loading product to trains	270	128	13	0	600000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
	111904	41067	6378															

Emission calculations	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables					
Martins Creek Quarry Year 10																		
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
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	19.7	kg/blast	10.2	kg/blast	0.984	kg/blast	2000	-	-	-	-	-
Excavators loading overburden to trucks	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling overburden to dumps	0	0	0	75	0	t/y	0.04000	kg/t	0.01182	kg/t	0.002	kg/t	-	-	-	4.0	60	0.6
Unloading overburden to dumps	0	0	0	0	0	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-
Drilling rock	673	354	34	70	3802	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-
Blasting rock	209	108	10	0	30	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-
Loading rock to mobile crusher	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Crushing (mobile)	0	0	0	50	0	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Loading rock to trucks	495	234	25	0	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling rock to plant	40333	11919	2017	75	1100000	t/y	0.14667	kg/t	0.04334	kg/t	0.007	kg/t	-	-	-	4.0	60	2.2
Primary crushing	1100	440	55	90	1100000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Secondary crushing	3300	1320	165	90	1100000	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-
Tertiary crushing	9900	3300	495	70	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Screening	9900	3300	495	70	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Mobile pugmill (blending)	16500	5500	825	50	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Loading product stockpiles	247	117	12	50	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Wind erosion from exposed areas	29463	14732	2210	0	34	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Wind erosion from product stockpiles	6132	3066	460	50	14	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Loading product to trucks	225	106	11	0	500000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling product off-site (paved)	9800	1867	467	75	500000	t/y	0.07840	kg/t	0.01493	kg/t	0.004	kg/t	-	-	-	0.8	30	2.8
Loading product to trains	270	128	13	0	600000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
	128546	46490	7294															

Emission calculations	Annual emissions (kg/y)						TSP		PM10		PM2.5		Variables					
Martins Creek Quarry Year 20																		
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
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	19.7	kg/blast	10.2	kg/blast	0.984	kg/blast	2000	-	-	-	-	-
Excavators loading overburden to trucks	0	0	0	0	0	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling overburden to dumps	0	0	0	75	0	t/y	0.04000	kg/t	0.01182	kg/t	0.002	kg/t	-	-	-	4.0	60	0.6
Unloading overburden to dumps	0	0	0	0	0	t/y	0.01200	kg/t	0.0043	kg/t	0.001	kg/t	-	-	-	-	-	-
Drilling rock	673	354	34	70	3802	holes/y	0.59	kg/hole	0.31	kg/hole	0.030	kg/hole	-	-	-	-	-	-
Blasting rock	209	108	10	0	30	blasts/y	7.0	kg/blast	3.6	kg/blast	0.348	kg/blast	1000	-	-	-	-	-
Loading rock to mobile crusher	495	234	25	0	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Crushing (mobile)	5500	2200	275	50	1100000	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Loading rock to trucks	495	234	25	0	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling rock to plant	44000	13002	2200	75	1100000	t/y	0.16000	kg/t	0.04728	kg/t	0.008	kg/t	-	-	-	4.0	60	2.4
Primary crushing	0	0	0	90	0	t/y	0.01	kg/t	0.004	kg/t	0.001	kg/t	-	-	-	-	-	-
Secondary crushing	16500	6600	825	50	1100000	t/y	0.03	kg/t	0.012	kg/t	0.002	kg/t	-	-	-	-	-	-
Tertiary crushing	16500	5500	825	50	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Screening	16500	5500	825	50	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Mobile pugmill (blending)	16500	5500	825	50	1100000	t/y	0.03	kg/t	0.01	kg/t	0.002	kg/t	-	-	-	-	-	-
Loading product stockpiles	247	117	12	50	1100000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Wind erosion from exposed areas	36189	18094	2714	0	41	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Wind erosion from product stockpiles	6132	3066	460	50	14	ha	876.0	kg/ha/y	438.0	kg/ha/y	65.7	kg/ha/y	-	-	-	-	-	-
Loading product to trucks	225	106	11	0	500000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
Hauling product off-site (paved)	9800	1867	467	75	500000	t/y	0.07840	kg/t	0.01493	kg/t	0.004	kg/t	-	-	-	0.8	30	2.8
Loading product to trains	270	128	13	0	600000	t/y	0.00045	kg/t	0.00021	kg/t	0.000	kg/t	-	0.38	2	-	-	-
	170234	62610	9546															

Source allocations (Previous Operations)

```
  -----ACTIVITY SUMMARY-----
ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 673 kg/y TSP  354 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 11
32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 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 : 174 kg/y TSP  90 kg/y PM10  9 kg/y PM2.5
 FROM SOURCES  : 11
32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 415 kg/y TSP  197 kg/y PM10  21 kg/y PM2.5
 FROM SOURCES  : 11
```

```
32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 4620 kg/y TSP  1848 kg/y PM10  231 kg/y PM2.5
 FROM SOURCES  : 11
32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 415 kg/y TSP  197 kg/y PM10  21 kg/y PM2.5
 FROM SOURCES  : 11
32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 33883 kg/y TSP  10013 kg/y PM10  1694 kg/y PM2.5
 FROM SOURCES  : 18
12 13 14 15 16 27 28 32 33 40 41 42 43 44 50 51 52 57
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 924 kg/y TSP  370 kg/y PM10  46 kg/y PM2.5
 FROM SOURCES  : 1
12
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2772 kg/y TSP  1109 kg/y PM10  139 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 13861 kg/y TSP  4620 kg/y PM10  693 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8317 kg/y TSP  2772 kg/y PM10  416 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 13861 kg/y TSP  4620 kg/y PM10  693 kg/y PM2.5
 FROM SOURCES  : 1
7
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 208 kg/y TSP  98 kg/y PM10  10 kg/y PM2.5
 FROM SOURCES  : 8
5 6 7 8 9 10 11 12
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 21023 kg/y TSP  10511 kg/y PM10  1577 kg/y PM2.5
 FROM SOURCES  : 22
28 29 30 32 33 34 39 40 41 42 43 44 45 46 48 49 50 51 52 53 54 57
 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 : 6132 kg/y TSP  3066 kg/y PM10  460 kg/y PM2.5
```

```
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : 415 kg/y TSP  197 kg/y PM10  21 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling product off-site (paved)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 14231 kg/y TSP  2711 kg/y PM10  678 kg/y PM2.5
 FROM SOURCES  : 14
1 2 3 4 5 6 7 8 9 10 11 12 13 14
 HOURS OF DAY  :
0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading product to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 14 kg/y TSP  7 kg/y PM10  1 kg/y PM2.5
 FROM SOURCES  : 3
3 4 5
 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
```

Source allocations (Year 2)

```
  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 673 kg/y TSP  354 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 9
10 11 14 35 37 38 39 46 47
 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 : 209 kg/y TSP  108 kg/y PM10  10 kg/y PM2.5
 FROM SOURCES  : 9
10 11 14 35 37 38 39 46 47
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 9
10 11 14 35 37 38 39 46 47
 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 : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 9
10 11 14 35 37 38 39 46 47
 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 : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 495 kg/y TSP  234 kg/y PM10  25 kg/y PM2.5
 FROM SOURCES  : 9
10 11 14 35 37 38 39 46 47
 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 : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 29333 kg/y TSP  8668 kg/y PM10  1467 kg/y PM2.5
 FROM SOURCES  : 16
9 10 11 12 13 14 15 16 27 28 35 37 38 39 46 47
 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 : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1100 kg/y TSP  440 kg/y PM10  55 kg/y PM2.5
 FROM SOURCES  : 1
12
```

```
 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 : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3300 kg/y TSP  1320 kg/y PM10  165 kg/y PM2.5
 FROM SOURCES  : 1
4
 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 : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9900 kg/y TSP  3300 kg/y PM10  495 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9900 kg/y TSP  3300 kg/y PM10  495 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  5500 kg/y PM10  825 kg/y PM2.5
 FROM SOURCES  : 1
7
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 247 kg/y TSP  117 kg/y PM10  12 kg/y PM2.5
 FROM SOURCES  : 8
5 6 7 8 9 10 11 12
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 25920 kg/y TSP  12960 kg/y PM10  1944 kg/y PM2.5
 FROM SOURCES  : 29
10 11 14 28 29 30 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 57
 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 : 6132 kg/y TSP  3066 kg/y PM10  460 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : 225 kg/y TSP  106 kg/y PM10  11 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 7700 kg/y TSP  1467 kg/y PM10  367 kg/y PM2.5
 FROM SOURCES  : 14
1 2 3 4 5 6 7 8 9 10 11 12 13 14
 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 : Loading product to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 270 kg/y TSP  128 kg/y PM10  13 kg/y PM2.5
 FROM SOURCES  : 3
3 4 5
 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
```

Source allocations (Year 10)

```
  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 673 kg/y TSP  354 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 25
25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 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 : 209 kg/y TSP  108 kg/y PM10  10 kg/y PM2.5
 FROM SOURCES  : 25
25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 25
25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 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 : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 25
25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 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 : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 495 kg/y TSP  234 kg/y PM10  25 kg/y PM2.5
 FROM SOURCES  : 25
25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 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 : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 40333 kg/y TSP  11919 kg/y PM10  2017 kg/y PM2.5
 FROM SOURCES  : 30
12 13 14 15 16 25 26 27 29 30 32 34 35 37 38 40 41 43 44 45 47 49 50 51 52 53 54 55 59 60
 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 : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1100 kg/y TSP  440 kg/y PM10  55 kg/y PM2.5
 FROM SOURCES  : 1
12
 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 : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3300 kg/y TSP  1320 kg/y PM10  165 kg/y PM2.5
 FROM SOURCES  : 1
4
 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 : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9900 kg/y TSP  3300 kg/y PM10  495 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9900 kg/y TSP  3300 kg/y PM10  495 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  5500 kg/y PM10  825 kg/y PM2.5
```

```
 FROM SOURCES  : 1
7
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 247 kg/y TSP  117 kg/y PM10  12 kg/y PM2.5
 FROM SOURCES  : 8
5 6 7 8 9 10 11 12
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 29463 kg/y TSP  14732 kg/y PM10  2210 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 59 60
 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 : 6132 kg/y TSP  3066 kg/y PM10  460 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : 225 kg/y TSP  106 kg/y PM10  11 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9800 kg/y TSP  1867 kg/y PM10  467 kg/y PM2.5
 FROM SOURCES  : 19
4 5 6 7 8 9 10 11 13 15 16 17 18 19 20 21 22 23 24
 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 : Loading product to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 270 kg/y TSP  128 kg/y PM10  13 kg/y PM2.5
 FROM SOURCES  : 3
3 4 5
 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
```

Source allocations (Year 20)

```
  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Drilling rock
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 673 kg/y TSP  354 kg/y PM10  34 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
 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 : 209 kg/y TSP  108 kg/y PM10  10 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Loading rock to mobile crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 495 kg/y TSP  234 kg/y PM10  25 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
 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 : Crushing (mobile)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5500 kg/y TSP  2200 kg/y PM10  275 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
```

```
 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 : Loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 495 kg/y TSP  234 kg/y PM10  25 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
 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 : Hauling rock to plant
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 44000 kg/y TSP  13002 kg/y PM10  2200 kg/y PM2.5
 FROM SOURCES  : 40
12 13 14 15 16 25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59
60
 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 : Primary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y TSP  0 kg/y PM10  0 kg/y PM2.5
 FROM SOURCES  : 1
12
 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 : Secondary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  6600 kg/y PM10  825 kg/y PM2.5
 FROM SOURCES  : 1
4
 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 : Tertiary crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  5500 kg/y PM10  825 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  5500 kg/y PM10  825 kg/y PM2.5
 FROM SOURCES  : 1
4
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Mobile pugmill (blending)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16500 kg/y TSP  5500 kg/y PM10  825 kg/y PM2.5
 FROM SOURCES  : 1
7
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Loading product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 247 kg/y TSP  117 kg/y PM10  12 kg/y PM2.5
 FROM SOURCES  : 8
5 6 7 8 9 10 11 12
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 36189 kg/y TSP  18094 kg/y PM10  2714 kg/y PM2.5
 FROM SOURCES  : 35
25 26 27 28 29 30 31 32 33 34 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
 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 : 6132 kg/y TSP  3066 kg/y PM10  460 kg/y PM2.5
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : 225 kg/y TSP  106 kg/y PM10  11 kg/y PM2.5
```

```
 FROM SOURCES  : 8
4 5 6 7 8 9 10 11
 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 : Hauling product off-site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9800 kg/y TSP  1867 kg/y PM10  467 kg/y PM2.5
 FROM SOURCES  : 19
4 5 6 7 8 9 10 11 13 15 16 17 18 19 20 21 22 23 24
 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 : Loading product to trains
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 270 kg/y TSP  128 kg/y PM10  13 kg/y PM2.5
 FROM SOURCES  : 3
3 4 5
 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
```

Appendix C. Model Receptors

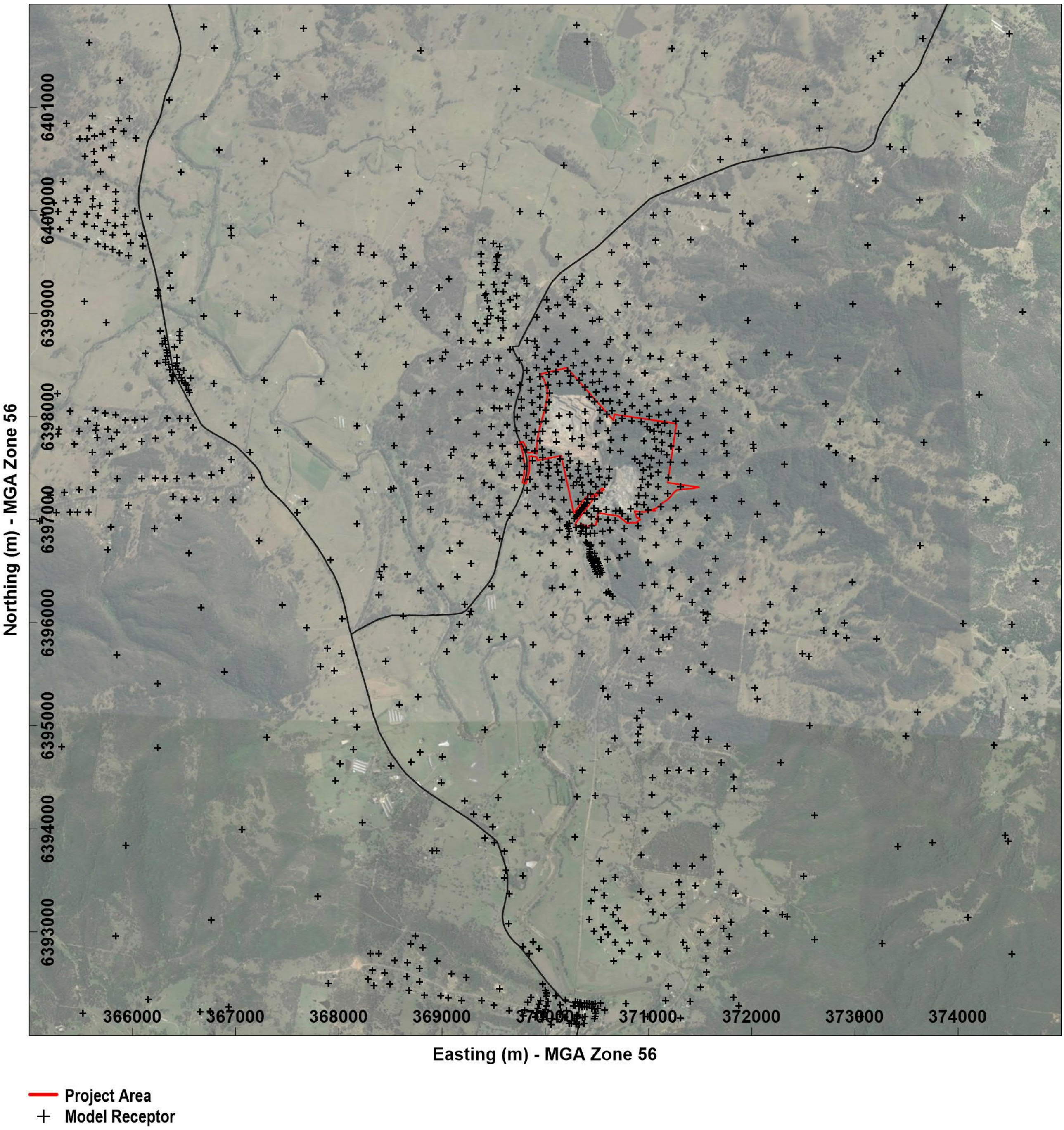

Figure C1 Location of model receptors

Appendix D. Tabulated Model Results for all Receptors

Model predictions at quarry and property locations

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
Maximum 24-hour average PM_{10} (µg/m^3)									
Q1	46	36	41	55	34	24	29	43	50
Q2	7	8	7	10	34	35	34	37	50
Q3	102	95	91	135	34	27	23	67	50
Q4	34	34	40	56	34	34	40	56	50
R1	39	33	30	50	34	28	25	45	50
R2	32	27	25	41	34	29	27	43	50
R3	29	24	23	37	34	30	28	42	50
R4	25	22	21	32	34	30	29	41	50
R5	22	19	18	28	34	31	30	40	50
R6	19	16	16	25	34	31	31	39	50
R7	18	15	15	23	34	31	31	39	50
R8	16	14	13	21	34	32	31	39	50
R9	15	13	12	20	34	32	31	39	50
R10	14	12	11	18	34	32	31	38	50
R11	14	11	11	18	34	32	31	38	50
R12	22	19	17	29	34	31	30	41	50
R13	16	13	13	21	34	32	31	39	50
R14	17	15	14	23	34	32	31	40	50
R15	16	14	13	22	34	32	31	39	50
R16	9	7	7	11	34	32	32	36	50
R17	14	12	11	18	34	32	31	39	50
R18	19	16	15	24	34	31	30	39	50
R19	7	6	6	9	34	33	32	36	50
R20	11	9	9	14	34	32	32	37	50
R21	11	9	9	14	34	32	32	37	50
R22	15	13	12	20	34	32	31	39	50
R23	11	9	9	14	34	32	32	37	50
R24	11	9	9	14	34	32	32	37	50
R25	9	5	6	9	34	30	31	34	50
R26	13	11	10	16	34	32	32	38	50
R27	11	9	9	14	34	32	32	37	50
R28	13	11	10	17	34	31	31	37	50
R29	10	9	8	13	34	33	32	37	50
R30	13	10	10	16	34	31	31	37	50
R31	7	6	8	10	34	33	34	36	50
R32	14	14	13	19	34	35	34	39	50
R33	12	9	9	15	34	31	31	37	50
R34	12	12	12	15	34	34	34	37	50
R35	12	9	9	14	34	31	31	37	50
R36	13	10	10	16	34	31	31	37	50
R37	11	9	9	14	34	31	32	37	50
R38	11	8	9	13	34	31	32	37	50
R39	10	8	8	13	34	32	32	36	50
R40	8	5	5	8	34	31	32	34	50
R41	5	4	4	6	34	33	33	35	50
R42	12	10	10	15	34	32	31	37	50
R43	4	4	4	5	34	34	34	35	50

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R44	10	8	8	13	34	32	32	36	50
R45	12	10	10	15	34	32	32	37	50
R46	5	4	5	7	34	33	34	36	50
R47	8	8	8	11	34	34	35	37	50
R48	23	19	19	26	34	30	29	37	50
R49	10	8	8	13	34	32	32	36	50
R50	12	10	9	14	34	32	32	37	50
R51	10	8	8	12	34	32	32	36	50
R52	12	10	10	14	34	32	32	37	50
R53	7	7	8	9	34	34	35	36	50
R54	10	8	8	12	34	32	32	36	50
R55	4	3	3	5	34	34	34	35	50
R56	11	9	9	14	34	32	32	37	50
R57	10	8	8	12	34	32	32	36	50
R58	11	9	9	14	34	32	32	37	50
R59	10	8	8	12	34	32	32	36	50
R60	3	4	3	5	34	35	34	36	50
R61	11	9	9	13	34	32	32	36	50
R62	9	7	7	11	34	32	32	36	50
R63	6	3	5	7	34	31	33	35	50
R64	10	9	8	13	34	32	32	36	50
R65	9	7	7	11	34	32	32	36	50
R66	3	3	3	5	34	34	34	35	50
R67	2	2	2	4	34	34	34	35	50
R68	4	4	4	5	34	34	34	36	50
R69	5	3	5	7	34	32	33	35	50
R70	3	3	3	4	34	34	34	35	50
R71	2	3	2	3	34	34	34	35	50
R72	3	3	3	5	34	34	34	36	50
R73	4	2	3	5	34	33	34	35	50
R74	2	2	2	3	34	34	34	35	50
R75	4	2	4	6	34	32	34	35	50
R76	6	4	4	7	34	33	33	35	50
R77	4	3	4	5	34	33	34	36	50
R78	7	6	6	9	34	33	33	36	50
R79	3	3	3	5	34	33	34	35	50
R80	4	3	4	5	34	33	34	35	50
R81	3	2	3	5	34	33	34	35	50
R82	3	3	3	4	34	35	34	35	50
R83	3	2	3	4	34	33	34	35	50
R84	2	2	2	3	34	34	34	35	50
R85	6	5	5	7	34	33	33	35	50
R86	6	5	5	7	34	33	33	35	50
R87	3	2	3	4	34	33	34	35	50
R88	4	3	4	5	34	33	34	35	50
R89	3	2	3	4	34	33	34	35	50
R90	5	5	5	7	34	33	34	35	50
R91	5	5	5	7	34	34	34	36	50
R92	3	2	3	4	34	33	34	35	50
R93	2	2	2	3	34	34	34	35	50

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R94	3	2	3	4	34	33	34	35	50
R95	3	2	3	4	34	33	34	35	50
R96	2	2	2	2	34	34	34	35	50
R97	3	2	3	4	34	33	34	35	50
R98	3	2	3	4	34	33	34	35	50
R99	2	2	2	3	34	34	34	35	50
R100	3	2	3	4	34	34	34	35	50
R101	3	2	3	3	34	33	34	35	50
R102	3	2	2	4	34	33	34	35	50
R103	3	2	3	4	34	34	34	35	50
R104	3	2	2	4	34	33	34	35	50
R105	3	2	3	4	34	33	34	35	50
R106	2	2	2	4	34	34	34	35	50
R107	3	2	3	4	34	33	34	35	50
R108	2	3	3	4	34	34	35	35	50
R109	4	4	5	6	34	34	35	36	50
R110	3	2	2	3	34	33	34	35	50
R111	2	2	2	3	34	33	34	35	50
R112	4	4	4	5	34	34	34	35	50
R113	2	2	2	3	34	33	34	35	50
R114	2	2	2	3	34	34	34	35	50
R115	3	3	3	4	34	34	34	35	50
R116	4	4	4	5	34	34	34	35	50
R117	2	2	2	3	34	33	34	35	50
R118	2	2	2	3	34	34	34	35	50
R119	3	2	2	3	34	33	34	35	50
R120	2	2	2	3	34	34	34	35	50
R121	4	4	4	5	34	34	35	36	50
R122	2	2	2	3	34	34	34	35	50
R123	4	4	4	5	34	34	34	35	50
R124	2	2	3	3	34	34	35	35	50
R125	2	2	2	3	34	33	34	35	50
R126	2	2	2	3	34	33	34	35	50
R127	2	2	2	3	34	34	34	35	50
R128	2	2	2	3	34	34	34	35	50
R129	2	2	2	3	34	34	34	35	50
R130	2	1	2	3	34	33	34	35	50
R131	2	2	2	3	34	34	34	35	50
R132	3	3	3	4	34	34	34	35	50
R133	2	2	3	3	34	34	34	35	50
R134	2	2	2	3	34	34	34	35	50
R135	2	1	2	3	34	34	34	35	50
R136	2	2	2	3	34	34	34	35	50
R137	2	2	2	3	34	34	34	35	50
R138	2	2	2	3	34	34	34	35	50
R139	2	1	2	3	34	34	34	35	50
R140	2	2	2	2	34	34	34	35	50
R141	2	2	2	3	34	34	34	35	50
R142	2	1	2	2	34	34	34	35	50
R143	3	2	2	3	34	33	34	34	50

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R144	2	2	2	2	34	34	34	35	50
R145	3	2	2	4	34	33	33	34	50
R146	2	2	2	2	34	34	34	34	50
R147	2	1	2	2	34	34	34	34	50
R148	2	2	2	3	34	34	34	35	50
R149	2	2	2	3	34	34	34	35	50
Annual average PM_{10} ($\mu g/m^3$)									
Q1	15.6	5.3	9.6	13.2	13	3	7	11	25
Q2	1.3	1.4	1.3	1.9	13	13	13	14	25
Q3	40.9	40.7	39.9	49.1	13	13	12	21	25
Q4	11.0	9.5	10.4	14.7	13	12	12	17	25
R1	14.5	12.6	12.2	19.1	13	11	11	18	25
R2	12.2	10.6	10.3	16.1	13	11	11	17	25
R3	11.0	9.5	9.3	14.5	13	12	11	16	25
R4	9.8	8.5	8.3	12.9	13	12	11	16	25
R5	8.5	7.3	7.2	11.1	13	12	12	16	25
R6	7.4	6.3	6.3	9.7	13	12	12	15	25
R7	6.8	5.8	5.8	8.9	13	12	12	15	25
R8	6.3	5.4	5.3	8.2	13	12	12	15	25
R9	5.7	4.9	4.9	7.5	13	12	12	15	25
R10	5.3	4.5	4.5	6.9	13	12	12	15	25
R11	5.1	4.3	4.3	6.6	13	12	12	15	25
R12	7.4	6.2	6.1	9.4	13	12	12	15	25
R13	5.6	4.7	4.6	7.1	13	12	12	15	25
R14	6.0	5.0	5.0	7.6	13	12	12	15	25
R15	5.8	4.9	4.8	7.4	13	12	12	15	25
R16	3.5	2.5	3.0	4.3	13	12	12	14	25
R17	4.8	4.0	4.0	6.1	13	12	12	14	25
R18	6.2	5.1	5.0	7.7	13	12	12	15	25
R19	2.8	2.2	2.4	3.6	13	12	13	14	25
R20	4.0	3.4	3.4	5.1	13	12	12	14	25
R21	3.9	3.3	3.3	5.0	13	12	12	14	25
R22	5.0	4.2	4.1	6.3	13	12	12	14	25
R23	4.0	3.4	3.4	5.2	13	12	12	14	25
R24	3.8	3.2	3.2	4.8	13	12	12	14	25
R25	2.8	1.5	2.1	3.0	13	12	12	13	25
R26	4.1	3.4	3.4	5.1	13	12	12	14	25
R27	4.1	3.5	3.6	5.4	13	12	12	14	25
R28	4.1	3.4	3.4	5.1	13	12	12	14	25
R29	4.0	3.4	3.5	5.3	13	12	12	14	25
R30	4.0	3.3	3.3	4.9	13	12	12	14	25
R31	2.0	1.0	1.5	2.1	13	12	12	13	25
R32	2.3	2.2	2.1	2.9	13	13	13	14	25
R33	3.6	3.0	2.9	4.5	13	12	12	14	25
R34	2.6	1.0	1.8	2.5	13	11	12	13	25
R35	3.4	2.8	2.8	4.2	13	12	12	14	25
R36	3.5	2.8	2.8	4.2	13	12	12	14	25
R37	3.2	2.7	2.6	4.0	13	12	12	14	25
R38	3.1	2.5	2.5	3.8	13	12	12	14	25
R39	2.9	2.3	2.3	3.5	13	12	12	14	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R40	2.4	1.5	1.9	2.8	13	12	13	13	25
R41	1.7	1.3	1.5	2.2	13	13	13	13	25
R42	3.1	2.5	2.5	3.7	13	12	12	14	25
R43	1.5	1.2	1.3	1.9	13	13	13	13	25
R44	2.8	2.3	2.3	3.5	13	12	12	14	25
R45	3.0	2.4	2.4	3.6	13	12	12	14	25
R46	0.9	0.6	0.9	1.3	13	13	13	13	25
R47	1.4	0.7	1.1	1.6	13	12	13	13	25
R48	4.4	3.9	3.8	5.1	13	13	12	14	25
R49	2.7	2.2	2.2	3.3	13	12	12	14	25
R50	2.8	2.3	2.3	3.4	13	12	12	14	25
R51	2.6	2.1	2.1	3.2	13	13	13	14	25
R52	2.8	2.3	2.3	3.4	13	13	12	14	25
R53	1.3	0.7	1.0	1.4	13	12	13	13	25
R54	2.5	2.0	2.0	3.0	13	13	13	14	25
R55	1.3	1.1	1.2	1.8	13	13	13	13	25
R56	2.6	2.1	2.1	3.2	13	13	13	14	25
R57	2.4	1.9	1.9	2.9	13	13	13	14	25
R58	2.5	2.0	2.0	3.0	13	13	13	14	25
R59	2.3	1.8	1.8	2.7	13	13	13	13	25
R60	0.6	0.6	0.7	0.9	13	13	13	13	25
R61	2.3	1.9	1.9	2.8	13	13	13	13	25
R62	2.1	1.7	1.7	2.5	13	13	13	13	25
R63	0.8	0.5	0.8	1.1	13	13	13	13	25
R64	2.1	1.8	1.8	2.6	13	13	13	13	25
R65	1.9	1.5	1.6	2.3	13	13	13	13	25
R66	1.2	1.0	1.1	1.6	13	13	13	13	25
R67	0.3	0.3	0.3	0.5	13	13	13	13	25
R68	0.6	0.6	0.7	0.9	13	13	13	13	25
R69	0.8	0.5	0.7	1.0	13	13	13	13	25
R70	1.2	1.0	1.1	1.6	13	13	13	13	25
R71	0.4	0.4	0.4	0.6	13	13	13	13	25
R72	0.5	0.4	0.6	0.8	13	13	13	13	25
R73	0.6	0.4	0.6	0.8	13	13	13	13	25
R74	0.2	0.2	0.2	0.3	13	13	13	13	25
R75	0.6	0.4	0.6	0.8	13	13	13	13	25
R76	1.5	1.3	1.3	1.9	13	13	13	13	25
R77	0.6	0.4	0.6	0.8	13	13	13	13	25
R78	1.2	1.0	1.0	1.5	13	13	13	13	25
R79	0.5	0.4	0.5	0.7	13	13	13	13	25
R80	0.5	0.4	0.6	0.8	13	13	13	13	25
R81	0.5	0.4	0.5	0.7	13	13	13	13	25
R82	0.5	0.5	0.5	0.8	13	13	13	13	25
R83	0.5	0.4	0.5	0.7	13	13	13	13	25
R84	0.3	0.3	0.3	0.4	13	13	13	13	25
R85	1.1	0.9	0.9	1.3	13	13	13	13	25
R86	1.0	0.8	0.8	1.2	13	13	13	13	25
R87	0.9	0.6	0.8	1.1	13	13	13	13	25
R88	0.7	0.5	0.7	0.9	13	13	13	13	25
R89	0.5	0.4	0.5	0.7	13	13	13	13	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R90	0.9	0.8	0.8	1.1	13	13	13	13	25
R91	0.8	0.7	0.7	1.0	13	13	13	13	25
R92	0.5	0.4	0.5	0.7	13	13	13	13	25
R93	0.2	0.2	0.2	0.3	13	13	13	13	25
R94	0.5	0.3	0.5	0.7	13	13	13	13	25
R95	0.5	0.4	0.5	0.7	13	13	13	13	25
R96	0.2	0.2	0.2	0.3	13	13	13	13	25
R97	0.5	0.3	0.5	0.6	13	13	13	13	25
R98	0.5	0.3	0.5	0.6	13	13	13	13	25
R99	0.2	0.2	0.2	0.3	13	13	13	13	25
R100	0.4	0.3	0.4	0.6	13	13	13	13	25
R101	0.4	0.3	0.4	0.6	13	13	13	13	25
R102	0.4	0.3	0.4	0.6	13	13	13	13	25
R103	0.4	0.3	0.4	0.6	13	13	13	13	25
R104	0.4	0.3	0.4	0.6	13	13	13	13	25
R105	0.4	0.3	0.4	0.6	13	13	13	13	25
R106	0.4	0.3	0.4	0.6	13	13	13	13	25
R107	0.5	0.3	0.5	0.6	13	13	13	13	25
R108	0.3	0.3	0.4	0.5	13	13	13	13	25
R109	0.6	0.5	0.5	0.8	13	13	13	13	25
R110	0.4	0.3	0.4	0.6	13	13	13	13	25
R111	0.4	0.3	0.4	0.5	13	13	13	13	25
R112	0.6	0.5	0.5	0.8	13	13	13	13	25
R113	0.4	0.3	0.4	0.5	13	13	13	13	25
R114	0.3	0.3	0.4	0.5	13	13	13	13	25
R115	1.0	0.8	0.9	1.3	13	13	13	13	25
R116	0.6	0.5	0.5	0.8	13	13	13	13	25
R117	0.4	0.3	0.4	0.5	13	13	13	13	25
R118	0.4	0.3	0.4	0.5	13	13	13	13	25
R119	0.5	0.4	0.5	0.6	13	13	13	13	25
R120	0.4	0.3	0.4	0.5	13	13	13	13	25
R121	0.6	0.5	0.5	0.7	13	13	13	13	25
R122	0.8	0.7	0.7	1.0	13	13	13	13	25
R123	0.6	0.5	0.5	0.8	13	13	13	13	25
R124	0.3	0.3	0.3	0.5	13	13	13	13	25
R125	0.3	0.3	0.3	0.5	13	13	13	13	25
R126	0.4	0.3	0.4	0.5	13	13	13	13	25
R127	0.4	0.3	0.4	0.5	13	13	13	13	25
R128	0.7	0.6	0.7	1.0	13	13	13	13	25
R129	0.7	0.6	0.7	0.9	13	13	13	13	25
R130	0.3	0.2	0.3	0.4	13	13	13	13	25
R131	0.4	0.3	0.4	0.6	13	13	13	13	25
R132	0.6	0.4	0.6	0.8	13	13	13	13	25
R133	0.7	0.6	0.6	0.9	13	13	13	13	25
R134	0.3	0.2	0.3	0.4	13	13	13	13	25
R135	0.3	0.2	0.3	0.4	13	13	13	13	25
R136	0.6	0.5	0.5	0.8	13	13	13	13	25
R137	0.3	0.2	0.3	0.4	13	13	13	13	25
R138	0.6	0.4	0.5	0.7	13	13	13	13	25
R139	0.3	0.2	0.3	0.4	13	13	13	13	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R140	0.3	0.2	0.3	0.4	13	13	13	13	25
R141	0.6	0.5	0.6	0.8	13	13	13	13	25
R142	0.3	0.2	0.3	0.4	13	13	13	13	25
R143	0.7	0.6	0.6	0.9	13	13	13	13	25
R144	0.3	0.2	0.3	0.4	13	13	13	13	25
R145	0.8	0.7	0.7	1.0	13	13	13	13	25
R146	0.3	0.2	0.3	0.4	13	13	13	13	25
R147	0.2	0.2	0.2	0.3	13	13	13	13	25
R148	0.5	0.5	0.5	0.7	13	13	13	13	25
R149	0.6	0.5	0.5	0.8	13	13	13	13	25
Maximum 24-hour average $PM_{2.5}$ ($\mu g/m^3$)									
Q1	7.4	5.9	6.7	8.9	14	12	13	15	25
Q2	1.4	1.5	1.4	1.9	14	14	14	14	25
Q3	17.5	15.6	14.9	21.5	14	12	11	18	25
Q4	6.1	6.0	6.9	9.5	14	14	15	17	25
R1	7.0	5.7	5.3	8.1	14	13	12	15	25
R2	5.9	4.8	4.5	6.7	14	13	13	15	25
R3	5.4	4.3	4.1	6.1	14	13	13	15	25
R4	4.8	3.9	3.7	5.4	14	13	13	15	25
R5	4.1	3.4	3.3	4.7	14	13	13	15	25
R6	3.6	3.0	2.9	4.2	14	13	13	15	25
R7	3.4	2.7	2.7	3.9	14	13	13	15	25
R8	3.1	2.5	2.5	3.7	14	13	13	15	25
R9	2.9	2.3	2.3	3.4	14	13	13	15	25
R10	2.7	2.2	2.1	3.2	14	13	13	14	25
R11	2.6	2.1	2.0	3.1	14	13	13	14	25
R12	3.9	3.3	3.0	4.7	14	13	13	15	25
R13	3.0	2.5	2.3	3.6	14	13	13	15	25
R14	3.2	2.7	2.5	3.9	14	13	13	15	25
R15	3.1	2.6	2.4	3.7	14	13	13	15	25
R16	1.8	1.3	1.4	2.0	14	14	14	14	25
R17	2.6	2.2	2.0	3.1	14	14	13	15	25
R18	3.6	2.8	2.6	4.1	14	13	13	15	25
R19	1.5	1.1	1.1	1.7	14	14	14	14	25
R20	2.1	1.7	1.7	2.5	14	14	14	14	25
R21	2.1	1.7	1.7	2.5	14	14	14	14	25
R22	2.8	2.3	2.1	3.3	14	14	13	15	25
R23	2.1	1.7	1.7	2.5	14	14	14	14	25
R24	2.1	1.7	1.6	2.5	14	14	14	14	25
R25	1.7	0.9	1.1	1.7	14	13	13	14	25
R26	2.4	1.9	1.8	2.8	14	14	13	14	25
R27	2.1	1.7	1.6	2.4	14	14	14	14	25
R28	2.6	1.9	1.9	3.0	14	13	13	14	25
R29	2.0	1.6	1.5	2.3	14	14	14	14	25
R30	2.5	1.9	1.9	2.9	14	13	13	14	25
R31	1.4	1.2	1.5	1.9	14	14	14	14	25
R32	2.3	2.4	2.2	3.0	14	14	14	15	25
R33	2.3	1.7	1.7	2.7	14	13	13	14	25
R34	2.2	2.2	2.3	2.8	14	14	14	15	25
R35	2.3	1.7	1.7	2.6	14	13	13	14	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R36	2.5	1.9	1.9	2.8	14	13	13	14	25
R37	2.2	1.6	1.6	2.5	14	13	13	14	25
R38	2.2	1.6	1.6	2.4	14	13	13	14	25
R39	2.0	1.5	1.5	2.3	14	13	13	14	25
R40	1.4	0.9	1.0	1.4	14	13	14	14	25
R41	0.9	0.7	0.8	1.1	14	14	14	14	25
R42	2.4	1.8	1.8	2.7	14	13	13	14	25
R43	0.8	0.7	0.7	1.0	14	14	14	14	25
R44	2.1	1.5	1.5	2.3	14	13	13	14	25
R45	2.3	1.7	1.7	2.6	14	13	13	14	25
R46	1.0	0.6	1.0	1.4	14	14	14	14	25
R47	1.5	1.5	1.6	2.1	14	14	14	15	25
R48	4.4	3.5	3.3	4.6	14	13	13	14	25
R49	2.0	1.5	1.5	2.3	14	13	13	14	25
R50	2.3	1.7	1.7	2.5	14	13	13	14	25
R51	2.0	1.4	1.5	2.2	14	13	13	14	25
R52	2.3	1.7	1.7	2.5	14	13	13	14	25
R53	1.4	1.4	1.5	1.8	14	14	14	14	25
R54	1.9	1.4	1.4	2.2	14	13	13	14	25
R55	0.7	0.6	0.6	0.9	14	14	14	14	25
R56	2.2	1.6	1.6	2.5	14	13	13	14	25
R57	1.9	1.4	1.4	2.1	14	13	13	14	25
R58	2.2	1.6	1.6	2.4	14	13	13	14	25
R59	1.9	1.3	1.4	2.1	14	13	13	14	25
R60	0.6	0.7	0.7	0.9	14	14	14	14	25
R61	2.1	1.5	1.5	2.3	14	13	13	14	25
R62	1.8	1.3	1.3	1.9	14	14	14	14	25
R63	1.1	0.6	1.0	1.3	14	14	14	14	25
R64	2.0	1.4	1.4	2.1	14	13	13	14	25
R65	1.7	1.2	1.2	1.8	14	14	14	14	25
R66	0.7	0.6	0.6	0.9	14	14	14	14	25
R67	0.5	0.5	0.5	0.7	14	14	14	14	25
R68	0.7	0.7	0.7	1.0	14	14	14	14	25
R69	1.0	0.6	0.9	1.2	14	14	14	14	25
R70	0.6	0.6	0.5	0.8	14	14	14	14	25
R71	0.5	0.5	0.5	0.7	14	14	14	14	25
R72	0.6	0.5	0.6	0.9	14	14	14	14	25
R73	0.7	0.4	0.7	0.9	14	14	14	14	25
R74	0.5	0.5	0.5	0.7	14	14	14	14	25
R75	0.9	0.5	0.8	1.1	14	14	14	14	25
R76	1.1	0.8	0.9	1.2	14	14	14	14	25
R77	0.7	0.5	0.7	1.0	14	14	14	14	25
R78	1.3	1.1	1.1	1.6	14	14	14	14	25
R79	0.6	0.5	0.6	0.9	14	14	14	14	25
R80	0.7	0.5	0.7	0.9	14	14	14	14	25
R81	0.7	0.5	0.7	0.9	14	14	14	14	25
R82	0.5	0.6	0.5	0.7	14	14	14	14	25
R83	0.6	0.4	0.6	0.8	14	14	14	14	25
R84	0.5	0.5	0.5	0.7	14	14	14	14	25
R85	1.1	1.0	1.1	1.4	14	14	14	14	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R86	1.0	1.0	1.1	1.4	14	14	14	14	25
R87	0.6	0.4	0.5	0.7	14	14	14	14	25
R88	0.8	0.6	0.8	1.0	14	14	14	14	25
R89	0.6	0.4	0.6	0.8	14	14	14	14	25
R90	1.0	1.0	1.1	1.4	14	14	14	14	25
R91	0.9	0.9	0.8	1.2	14	14	14	14	25
R92	0.6	0.4	0.5	0.7	14	14	14	14	25
R93	0.4	0.4	0.4	0.6	14	14	14	14	25
R94	0.6	0.4	0.6	0.8	14	14	14	14	25
R95	0.7	0.4	0.6	0.8	14	14	14	14	25
R96	0.4	0.4	0.4	0.5	14	14	14	14	25
R97	0.6	0.4	0.6	0.8	14	14	14	14	25
R98	0.6	0.4	0.6	0.8	14	14	14	14	25
R99	0.5	0.5	0.4	0.6	14	14	14	14	25
R100	0.5	0.4	0.5	0.7	14	14	14	14	25
R101	0.5	0.4	0.5	0.7	14	14	14	14	25
R102	0.5	0.4	0.5	0.7	14	14	14	14	25
R103	0.5	0.4	0.5	0.7	14	14	14	14	25
R104	0.6	0.3	0.5	0.7	14	14	14	14	25
R105	0.6	0.4	0.5	0.7	14	14	14	14	25
R106	0.5	0.4	0.5	0.6	14	14	14	14	25
R107	0.6	0.4	0.6	0.8	14	14	14	14	25
R108	0.4	0.5	0.5	0.6	14	14	14	14	25
R109	0.9	1.0	1.1	1.3	14	14	14	14	25
R110	0.5	0.3	0.5	0.6	14	14	14	14	25
R111	0.5	0.3	0.5	0.6	14	14	14	14	25
R112	0.8	0.8	0.9	1.1	14	14	14	14	25
R113	0.5	0.3	0.4	0.6	14	14	14	14	25
R114	0.4	0.3	0.4	0.6	14	14	14	14	25
R115	0.6	0.5	0.5	0.7	14	14	14	14	25
R116	0.8	0.9	1.0	1.2	14	14	14	14	25
R117	0.4	0.3	0.4	0.6	14	14	14	14	25
R118	0.4	0.3	0.4	0.6	14	14	14	14	25
R119	0.5	0.4	0.5	0.6	14	14	14	14	25
R120	0.4	0.3	0.4	0.6	14	14	14	14	25
R121	0.8	0.9	1.0	1.2	14	14	14	14	25
R122	0.4	0.4	0.4	0.6	14	14	14	14	25
R123	0.8	0.8	0.9	1.2	14	14	14	14	25
R124	0.4	0.4	0.5	0.6	14	14	14	14	25
R125	0.4	0.3	0.4	0.5	14	14	14	14	25
R126	0.5	0.3	0.4	0.6	14	14	14	14	25
R127	0.4	0.3	0.4	0.5	14	14	14	14	25
R128	0.5	0.4	0.4	0.6	14	14	14	14	25
R129	0.5	0.4	0.4	0.6	14	14	14	14	25
R130	0.4	0.3	0.4	0.5	14	14	14	14	25
R131	0.5	0.5	0.5	0.6	14	14	14	14	25
R132	0.6	0.5	0.6	0.7	14	14	14	14	25
R133	0.5	0.4	0.4	0.5	14	14	14	14	25
R134	0.4	0.3	0.4	0.5	14	14	14	14	25
R135	0.4	0.3	0.4	0.5	14	14	14	14	25

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R136	0.4	0.3	0.4	0.5	14	14	14	14	25
R137	0.3	0.3	0.3	0.5	14	14	14	14	25
R138	0.5	0.4	0.5	0.6	14	14	14	14	25
R139	0.4	0.3	0.3	0.5	14	14	14	14	25
R140	0.3	0.3	0.3	0.4	14	14	14	14	25
R141	0.4	0.3	0.4	0.5	14	14	14	14	25
R142	0.3	0.2	0.3	0.4	14	14	14	14	25
R143	0.5	0.4	0.4	0.6	14	14	14	14	25
R144	0.3	0.3	0.3	0.4	14	14	14	14	25
R145	0.6	0.4	0.5	0.7	14	14	14	14	25
R146	0.3	0.3	0.3	0.4	14	14	14	14	25
R147	0.3	0.2	0.3	0.4	14	14	14	14	25
R148	0.4	0.4	0.4	0.5	14	14	14	14	25
R149	0.4	0.4	0.4	0.5	14	14	14	14	25
Annual average $PM_{2.5}$ (µg/m^3)									
Q1	2.5	0.9	1.6	2.2	5.5	3.9	4.6	5.2	8
Q2	0.2	0.2	0.2	0.3	5.5	5.5	5.5	5.6	8
Q3	6.7	6.4	6.3	7.7	5.5	5.3	5.1	6.5	8
Q4	1.9	1.6	1.8	2.5	5.5	5.2	5.4	6.1	8
R1	2.5	2.1	2.0	3.1	5.5	5.1	5.0	6.1	8
R2	2.2	1.8	1.7	2.7	5.5	5.1	5.1	6.0	8
R3	1.9	1.6	1.6	2.4	5.5	5.2	5.1	6.0	8
R4	1.7	1.4	1.4	2.1	5.5	5.2	5.2	5.9	8
R5	1.5	1.2	1.2	1.9	5.5	5.2	5.2	5.9	8
R6	1.3	1.1	1.1	1.6	5.5	5.3	5.3	5.8	8
R7	1.2	1.0	1.0	1.5	5.5	5.3	5.3	5.8	8
R8	1.1	0.9	0.9	1.4	5.5	5.3	5.3	5.8	8
R9	1.0	0.9	0.8	1.3	5.5	5.3	5.3	5.7	8
R10	1.0	0.8	0.8	1.2	5.5	5.3	5.3	5.7	8
R11	0.9	0.8	0.8	1.1	5.5	5.3	5.3	5.7	8
R12	1.3	1.1	1.0	1.6	5.5	5.2	5.2	5.8	8
R13	1.0	0.8	0.8	1.2	5.5	5.3	5.3	5.7	8
R14	1.1	0.9	0.9	1.3	5.5	5.3	5.3	5.7	8
R15	1.0	0.8	0.8	1.3	5.5	5.3	5.3	5.7	8
R16	0.6	0.4	0.5	0.8	5.5	5.3	5.4	5.6	8
R17	0.9	0.7	0.7	1.0	5.5	5.3	5.3	5.7	8
R18	1.1	0.9	0.9	1.3	5.5	5.3	5.3	5.7	8
R19	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R20	0.7	0.6	0.6	0.9	5.5	5.4	5.4	5.7	8
R21	0.7	0.6	0.6	0.9	5.5	5.4	5.4	5.7	8
R22	0.9	0.7	0.7	1.1	5.5	5.3	5.3	5.7	8
R23	0.7	0.6	0.6	0.9	5.5	5.4	5.4	5.7	8
R24	0.7	0.6	0.6	0.8	5.5	5.4	5.4	5.6	8
R25	0.5	0.3	0.4	0.5	5.5	5.3	5.4	5.5	8
R26	0.8	0.6	0.6	0.9	5.5	5.3	5.3	5.6	8
R27	0.7	0.6	0.6	0.9	5.5	5.4	5.4	5.7	8
R28	0.8	0.6	0.6	0.9	5.5	5.3	5.3	5.6	8
R29	0.7	0.6	0.6	0.9	5.5	5.4	5.4	5.7	8
R30	0.7	0.6	0.6	0.9	5.5	5.3	5.3	5.6	8
R31	0.4	0.2	0.3	0.4	5.5	5.3	5.4	5.5	8

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R32	0.4	0.4	0.4	0.5	5.5	5.5	5.5	5.6	8
R33	0.7	0.5	0.5	0.8	5.5	5.4	5.4	5.6	8
R34	0.5	0.2	0.3	0.4	5.5	5.2	5.4	5.5	8
R35	0.6	0.5	0.5	0.7	5.5	5.4	5.4	5.6	8
R36	0.6	0.5	0.5	0.7	5.5	5.4	5.4	5.6	8
R37	0.6	0.5	0.5	0.7	5.5	5.4	5.4	5.6	8
R38	0.6	0.5	0.5	0.7	5.5	5.4	5.4	5.6	8
R39	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R40	0.4	0.3	0.4	0.5	5.5	5.3	5.4	5.6	8
R41	0.3	0.2	0.3	0.4	5.5	5.4	5.5	5.6	8
R42	0.6	0.4	0.4	0.7	5.5	5.4	5.4	5.6	8
R43	0.3	0.2	0.2	0.3	5.5	5.4	5.5	5.6	8
R44	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R45	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R46	0.2	0.1	0.2	0.2	5.5	5.4	5.5	5.6	8
R47	0.3	0.1	0.2	0.3	5.5	5.4	5.4	5.5	8
R48	0.8	0.7	0.7	0.9	5.5	5.4	5.4	5.6	8
R49	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R50	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R51	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R52	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R53	0.2	0.1	0.2	0.3	5.5	5.4	5.5	5.5	8
R54	0.5	0.4	0.4	0.5	5.5	5.4	5.4	5.6	8
R55	0.3	0.2	0.2	0.3	5.5	5.5	5.5	5.6	8
R56	0.5	0.4	0.4	0.6	5.5	5.4	5.4	5.6	8
R57	0.4	0.3	0.3	0.5	5.5	5.4	5.4	5.6	8
R58	0.5	0.4	0.4	0.5	5.5	5.4	5.4	5.6	8
R59	0.4	0.3	0.3	0.5	5.5	5.4	5.4	5.6	8
R60	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.6	8
R61	0.4	0.3	0.3	0.5	5.5	5.4	5.4	5.6	8
R62	0.4	0.3	0.3	0.5	5.5	5.4	5.4	5.6	8
R63	0.2	0.1	0.1	0.2	5.5	5.4	5.5	5.5	8
R64	0.4	0.3	0.3	0.5	5.5	5.4	5.4	5.6	8
R65	0.4	0.3	0.3	0.4	5.5	5.4	5.4	5.6	8
R66	0.2	0.2	0.2	0.3	5.5	5.5	5.5	5.6	8
R67	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R68	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.6	8
R69	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R70	0.2	0.2	0.2	0.3	5.5	5.5	5.5	5.6	8
R71	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R72	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R73	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R74	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8
R75	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R76	0.3	0.2	0.2	0.4	5.5	5.4	5.4	5.6	8
R77	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R78	0.2	0.2	0.2	0.3	5.5	5.5	5.5	5.5	8
R79	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R80	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R81	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R82	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R83	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R84	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R85	0.2	0.2	0.2	0.2	5.5	5.5	5.5	5.5	8
R86	0.2	0.2	0.2	0.2	5.5	5.5	5.5	5.5	8
R87	0.2	0.1	0.2	0.2	5.5	5.5	5.5	5.5	8
R88	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R89	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R90	0.2	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R91	0.2	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R92	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R93	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8
R94	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R95	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R96	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8
R97	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R98	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R99	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8
R100	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R101	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R102	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R103	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R104	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R105	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R106	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R107	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R108	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R109	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R110	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R111	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R112	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R113	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R114	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R115	0.2	0.2	0.2	0.2	5.5	5.5	5.5	5.6	8
R116	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R117	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R118	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R119	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R120	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R121	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R122	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R123	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R124	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R125	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R126	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R127	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R128	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R129	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R130	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R131	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R132	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R133	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R134	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R135	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R136	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R137	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R138	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R139	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R140	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R141	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R142	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R143	0.1	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R144	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R145	0.2	0.1	0.1	0.2	5.5	5.5	5.5	5.5	8
R146	0.1	0.0	0.1	0.1	5.5	5.5	5.5	5.5	8
R147	0.0	0.0	0.0	0.1	5.5	5.5	5.5	5.5	8
R148	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
R149	0.1	0.1	0.1	0.1	5.5	5.5	5.5	5.5	8
Annual average TSP (µg/m^3)									
Q1	33	8	19	26	33	8	19	26	90
Q2	2	2	2	2	33	33	33	34	90
Q3	91	91	89	105	33	34	31	47	90
Q4	14	12	14	19	33	31	34	38	90
R1	21	18	17	25	33	30	29	38	90
R2	17	14	13	20	33	30	30	37	90
R3	14	12	12	18	33	31	30	36	90
R4	13	11	10	15	33	31	31	36	90
R5	10	9	9	13	33	32	31	35	90
R6	9	8	7	11	33	32	32	35	90
R7	8	7	7	10	33	32	32	35	90
R8	7	6	6	9	33	32	32	35	90
R9	6	5	5	8	33	32	32	34	90
R10	6	5	5	7	33	32	32	34	90
R11	5	5	5	7	33	32	32	34	90
R12	9	7	7	10	33	32	31	34	90
R13	6	5	5	7	33	32	32	34	90
R14	6	5	5	8	33	32	32	34	90
R15	6	5	5	7	33	32	32	34	90
R16	3	2	3	4	33	32	33	34	90
R17	5	4	4	6	33	32	32	34	90
R18	7	6	5	8	33	32	32	34	90
R19	2	2	2	3	33	33	33	34	90
R20	4	3	3	5	33	33	32	34	90
R21	4	3	3	5	33	33	32	34	90
R22	5	4	4	6	33	32	32	34	90
R23	4	3	3	5	33	33	33	34	90
R24	4	3	3	4	33	33	33	34	90
R25	2	1	2	3	33	32	33	33	90
R26	4	3	3	5	33	32	32	34	90
R27	4	3	3	5	33	33	33	34	90

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R28	4	3	3	5	33	32	32	34	90
R29	4	3	3	5	33	33	33	34	90
R30	4	3	3	4	33	32	32	34	90
R31	2	1	1	2	33	32	33	33	90
R32	3	3	3	4	33	33	33	34	90
R33	3	3	3	4	33	32	32	34	90
R34	3	1	2	3	33	31	32	33	90
R35	3	3	3	4	33	32	32	34	90
R36	3	3	3	4	33	32	32	34	90
R37	3	2	2	3	33	33	33	33	90
R38	3	2	2	3	33	33	33	33	90
R39	2	2	2	3	33	33	33	33	90
R40	2	1	2	2	33	32	33	33	90
R41	1	1	1	2	33	33	33	33	90
R42	3	2	2	3	33	33	33	33	90
R43	1	1	1	1	33	33	33	33	90
R44	2	2	2	3	33	33	33	33	90
R45	3	2	2	3	33	33	33	33	90
R46	1	1	1	1	33	33	33	33	90
R47	1	1	1	2	33	32	33	33	90
R48	5	4	4	5	33	33	33	34	90
R49	2	2	2	3	33	33	33	33	90
R50	2	2	2	3	33	33	33	33	90
R51	2	2	2	3	33	33	33	33	90
R52	2	2	2	3	33	33	33	33	90
R53	1	1	1	1	33	32	33	33	90
R54	2	2	2	2	33	33	33	33	90
R55	1	1	1	1	33	33	33	33	90
R56	2	2	2	3	33	33	33	33	90
R57	2	2	2	2	33	33	33	33	90
R58	2	2	2	2	33	33	33	33	90
R59	2	2	2	2	33	33	33	33	90
R60	1	1	1	1	33	33	33	33	90
R61	2	2	2	2	33	33	33	33	90
R62	2	1	1	2	33	33	33	33	90
R63	1	0	1	1	33	33	33	33	90
R64	2	2	2	2	33	33	33	33	90
R65	2	1	1	2	33	33	33	33	90
R66	1	1	1	1	33	33	33	33	90
R67	0	0	0	1	33	33	33	33	90
R68	1	1	1	1	33	33	33	33	90
R69	1	0	1	1	33	33	33	33	90
R70	1	1	1	1	33	33	33	33	90
R71	0	0	0	1	33	33	33	33	90
R72	1	0	1	1	33	33	33	33	90
R73	0	0	0	1	33	33	33	33	90
R74	0	0	0	0	33	33	33	33	90
R75	0	0	0	1	33	33	33	33	90
R76	1	1	1	1	33	33	33	33	90
R77	1	0	1	1	33	33	33	33	90

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R78	1	1	1	1	33	33	33	33	90
R79	0	0	1	1	33	33	33	33	90
R80	1	0	1	1	33	33	33	33	90
R81	0	0	1	1	33	33	33	33	90
R82	1	1	1	1	33	33	33	33	90
R83	0	0	0	1	33	33	33	33	90
R84	0	0	0	0	33	33	33	33	90
R85	1	1	1	1	33	33	33	33	90
R86	1	1	1	1	33	33	33	33	90
R87	1	0	1	1	33	33	33	33	90
R88	0	0	1	1	33	33	33	33	90
R89	0	0	0	1	33	33	33	33	90
R90	1	1	1	1	33	33	33	33	90
R91	1	1	1	1	33	33	33	33	90
R92	0	0	0	1	33	33	33	33	90
R93	0	0	0	0	33	33	33	33	90
R94	0	0	0	1	33	33	33	33	90
R95	0	0	0	1	33	33	33	33	90
R96	0	0	0	0	33	33	33	33	90
R97	0	0	0	0	33	33	33	33	90
R98	0	0	0	0	33	33	33	33	90
R99	0	0	0	0	33	33	33	33	90
R100	0	0	0	1	33	33	33	33	90
R101	0	0	0	1	33	33	33	33	90
R102	0	0	0	0	33	33	33	33	90
R103	0	0	0	1	33	33	33	33	90
R104	0	0	0	0	33	33	33	33	90
R105	0	0	0	0	33	33	33	33	90
R106	0	0	0	1	33	33	33	33	90
R107	0	0	0	0	33	33	33	33	90
R108	0	0	0	1	33	33	33	33	90
R109	1	0	0	1	33	33	33	33	90
R110	0	0	0	0	33	33	33	33	90
R111	0	0	0	0	33	33	33	33	90
R112	0	0	0	1	33	33	33	33	90
R113	0	0	0	0	33	33	33	33	90
R114	0	0	0	0	33	33	33	33	90
R115	1	1	1	1	33	33	33	33	90
R116	0	0	0	1	33	33	33	33	90
R117	0	0	0	0	33	33	33	33	90
R118	0	0	0	0	33	33	33	33	90
R119	0	0	0	0	33	33	33	33	90
R120	0	0	0	0	33	33	33	33	90
R121	0	0	0	1	33	33	33	33	90
R122	1	1	1	1	33	33	33	33	90
R123	0	0	0	1	33	33	33	33	90
R124	0	0	0	0	33	33	33	33	90
R125	0	0	0	0	33	33	33	33	90
R126	0	0	0	0	33	33	33	33	90
R127	0	0	0	0	33	33	33	33	90

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R128	0	0	1	1	33	33	33	33	90
R129	0	0	0	1	33	33	33	33	90
R130	0	0	0	0	33	33	33	33	90
R131	0	0	0	0	33	33	33	33	90
R132	0	0	0	1	33	33	33	33	90
R133	0	0	0	1	33	33	33	33	90
R134	0	0	0	0	33	33	33	33	90
R135	0	0	0	0	33	33	33	33	90
R136	0	0	0	1	33	33	33	33	90
R137	0	0	0	0	33	33	33	33	90
R138	0	0	0	1	33	33	33	33	90
R139	0	0	0	0	33	33	33	33	90
R140	0	0	0	0	33	33	33	33	90
R141	0	0	0	1	33	33	33	33	90
R142	0	0	0	0	33	33	33	33	90
R143	0	0	0	1	33	33	33	33	90
R144	0	0	0	0	33	33	33	33	90
R145	0	0	0	1	33	33	33	33	90
R146	0	0	0	0	33	33	33	33	90
R147	0	0	0	0	33	33	33	33	90
R148	0	0	0	0	33	33	33	33	90
R149	0	0	0	1	33	33	33	33	90
Annual average dust deposition (g/m^2/month)									
Q1	3.4	1.2	2.3	3.0	2.4	0.2	1.3	2.1	4
Q2	0.2	0.3	0.3	0.4	2.4	2.4	2.4	2.5	4
Q3	7.8	8.0	7.8	9.0	2.4	2.6	2.4	3.6	4
Q4	1.3	1.1	1.7	2.2	2.4	2.2	2.8	3.3	4
R1	1.8	1.5	1.5	2.3	2.4	2.2	2.2	2.9	4
R2	1.4	1.3	1.3	1.9	2.4	2.2	2.2	2.8	4
R3	1.3	1.1	1.1	1.6	2.4	2.2	2.3	2.8	4
R4	1.1	1.0	1.0	1.5	2.4	2.3	2.3	2.7	4
R5	1.0	0.8	0.9	1.3	2.4	2.3	2.3	2.7	4
R6	0.8	0.7	0.8	1.1	2.4	2.3	2.3	2.7	4
R7	0.8	0.7	0.7	1.0	2.4	2.3	2.4	2.7	4
R8	0.7	0.6	0.7	0.9	2.4	2.3	2.4	2.6	4
R9	0.6	0.6	0.6	0.8	2.4	2.3	2.4	2.6	4
R10	0.6	0.5	0.6	0.8	2.4	2.3	2.4	2.6	4
R11	0.5	0.5	0.5	0.7	2.4	2.3	2.4	2.6	4
R12	0.7	0.6	0.7	0.9	2.4	2.3	2.3	2.6	4
R13	0.5	0.5	0.5	0.7	2.4	2.3	2.4	2.6	4
R14	0.6	0.5	0.5	0.7	2.4	2.3	2.4	2.6	4
R15	0.6	0.5	0.5	0.7	2.4	2.3	2.4	2.6	4
R16	0.3	0.2	0.3	0.4	2.4	2.3	2.4	2.5	4
R17	0.5	0.4	0.4	0.6	2.4	2.3	2.4	2.5	4
R18	0.6	0.5	0.5	0.7	2.4	2.3	2.3	2.5	4
R19	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R20	0.4	0.3	0.4	0.5	2.4	2.4	2.4	2.5	4
R21	0.4	0.3	0.4	0.5	2.4	2.4	2.4	2.5	4
R22	0.5	0.4	0.4	0.6	2.4	2.3	2.4	2.5	4
R23	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R24	0.4	0.3	0.3	0.5	2.4	2.4	2.4	2.5	4
R25	0.2	0.1	0.2	0.3	2.4	2.3	2.4	2.5	4
R26	0.4	0.3	0.3	0.5	2.4	2.4	2.4	2.5	4
R27	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4
R28	0.4	0.3	0.3	0.5	2.4	2.4	2.4	2.5	4
R29	0.4	0.3	0.4	0.5	2.4	2.4	2.4	2.5	4
R30	0.4	0.3	0.3	0.5	2.4	2.4	2.4	2.5	4
R31	0.2	0.1	0.2	0.2	2.4	2.3	2.4	2.4	4
R32	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4
R33	0.3	0.3	0.3	0.4	2.4	2.4	2.4	2.5	4
R34	0.4	0.1	0.3	0.4	2.4	2.2	2.3	2.4	4
R35	0.3	0.3	0.3	0.4	2.4	2.4	2.4	2.5	4
R36	0.3	0.3	0.3	0.4	2.4	2.4	2.4	2.5	4
R37	0.3	0.3	0.3	0.4	2.4	2.4	2.4	2.5	4
R38	0.3	0.2	0.3	0.3	2.4	2.4	2.4	2.5	4
R39	0.3	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R40	0.2	0.1	0.2	0.2	2.4	2.3	2.4	2.4	4
R41	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R42	0.3	0.3	0.3	0.3	2.4	2.4	2.4	2.5	4
R43	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R44	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R45	0.3	0.2	0.3	0.3	2.4	2.4	2.4	2.5	4
R46	0.1	0.1	0.1	0.2	2.4	2.4	2.4	2.5	4
R47	0.2	0.1	0.2	0.2	2.4	2.3	2.4	2.5	4
R48	0.4	0.4	0.4	0.5	2.4	2.4	2.4	2.5	4
R49	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R50	0.3	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R51	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R52	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R53	0.2	0.1	0.1	0.2	2.4	2.3	2.4	2.4	4
R54	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R55	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R56	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R57	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R58	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R59	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R60	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.5	4
R61	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R62	0.2	0.2	0.2	0.2	2.4	2.4	2.4	2.5	4
R63	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R64	0.2	0.2	0.2	0.3	2.4	2.4	2.4	2.5	4
R65	0.2	0.2	0.2	0.2	2.4	2.4	2.4	2.4	4
R66	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R67	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R68	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.5	4
R69	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R70	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R71	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R72	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R73	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R74	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R75	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R76	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R77	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R78	0.1	0.1	0.1	0.2	2.4	2.4	2.4	2.4	4
R79	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R80	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R81	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R82	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R83	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R84	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R85	0.1	0.1	0.1	0.2	2.4	2.4	2.4	2.4	4
R86	0.1	0.1	0.1	0.2	2.4	2.4	2.4	2.4	4
R87	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R88	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R89	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R90	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R91	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R92	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R93	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R94	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R95	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R96	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R97	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R98	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R99	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R100	0.0	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R101	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R102	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R103	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R104	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R105	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R106	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R107	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R108	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R109	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R110	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R111	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R112	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R113	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R114	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R115	0.1	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R116	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R117	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R118	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R119	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R120	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R121	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4
R122	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R123	0.1	0.1	0.1	0.1	2.4	2.4	2.4	2.4	4

ID	Due to quarry in isolation				Back-ground	Cumulative			Criterion
	Previous operation	Y2	Y10	Y20		Y2	Y10	Y20	
R124	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R125	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R126	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R127	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R128	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R129	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R130	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R131	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R132	0.0	0.0	0.1	0.1	2.4	2.4	2.4	2.4	4
R133	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R134	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R135	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R136	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R137	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R138	0.0	0.0	0.0	0.1	2.4	2.4	2.4	2.4	4
R139	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R140	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R141	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R142	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R143	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R144	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R145	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R146	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R147	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R148	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4
R149	0.0	0.0	0.0	0.0	2.4	2.4	2.4	2.4	4