APPENDIX 5

Air Quality Assessment

AIR QUALITY IMPACT ASSESSMENT: PROPOSED LYNWOOD QUARRY, MARULAN

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Prepared for
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EXECUTIVE SUMMARY

The following reports presents an assessment of the air quality impacts associated with the operation of the proposed Lynwood quarry at Marulan. The report forms part of an Environmental Impact Statement prepared by Umwelt (Australia) Pty Limited.

Dispersion modelling has been used to quantitatively assess the air quality impacts likely to arise from the operation of the quarry. The report deals with the following topics:

- The existing environment with respect to the meteorology and existing air quality
- Air quality assessment criteria based on existing air quality and acceptable concentration and deposition levels
- Dust emissions from the proposed quarry operations
- The use of a computer-based dispersion model to predict ground-level dust concentration and deposition levels in the local area due to emissions from the operations for representative periods in the life of the project.

Impacts have been assessed by comparing the predicted dust concentration and deposition levels due to the proposed operations with relevant air quality criteria.

With proper controls the model indicates that the ambient assessment criteria will not be exceeded due to the quarry activities and therefore the study concludes that the air quality impacts will be within acceptable limits at surrounding private residences.

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1. INTRODUCTION

Readymix Holdings Pty Limited is proposing to establish a hard rock quarry near Marulan in the Southern Tablelands region of NSW (refer to **Figure 1**). This report has been prepared by Holmes Air Sciences for Umwelt (Australia) Pty Limited. Umwelt in turn is acting on behalf of Readymix to prepare an Environmental Impact Statement (EIS) for the project. The purpose of this report is to quantitatively assess the air quality impacts of the project, referred to as the proposed Lynwood Quarry.

The assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the quarry. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality goals.

The assessment is based on a conventional approach following the procedures outlined in the NSW Environment Protection Authority's (EPA, now known as Department of Environment and Conservation (DEC) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (**NSW EPA, 2001**).

In summary, the report provides information on the following:

- A description of the proposed quarrying activities including extraction, processing and transportation operations
- Air quality goals that need to be met to protect air quality
- Meteorological and climatic conditions in the area
- A discussion of the existing air quality conditions in the area
- The methods used to estimate dust emissions and the way in which dust emissions from the proposal would disperse and fallout
- The expected dispersion and dust fallout patterns due to emissions from the quarry and a comparison between the predicted dust concentration and fallout levels and the relevant air quality criteria
- Control methods which can be used to reduce dust emissions and associated impacts.

2. PROJECT DESCRIPTION

The proposed hard rock quarry is located primarily on a property known as "Lynwood". **Figure 1** shows the location of the Project Site with the town of Marulan approximately one kilometre to the east of the nearest works and the Hume Highway to the south. Landuse surrounding the site is agricultural to the north, west and south, with rural residential land adjoining the property boundary to the northeast and the township of Marulan to the east. The terrain of the project area is shown in **Figure 2**.

The proposed quarry will have a production rate of up to 5 million tones per annum (Mtpa) with an expected life of in excess of 90 years. At this stage an approval of 30 years is being sought. Products from the proposed quarry will include high quality concrete and asphalt aggregates, structural rock for building products, road base, manufactured sand and rail ballast.

Figure 3 shows the proposed 30 year extents of the quarry including overburden, product stockpiles and site facilities. Extraction of hard rock from the quarry pit will generally occur in a south to north direction.

The quarrying activities will include vegetation and topsoil removal. This will be done using a dozer, loader and haul trucks. Overburden will be removed by front-end loader and dump trucks (nominally 100 t) will transport both topsoil and overburden to emplacement areas. Dozers will be used for shaping stockpiles and assisting with ripping material. It is estimated that approximately 1/3 of the overburden will need to be drilled and blasted equating to approximately one blast per week. Overburden removal and emplacement, and drilling and blasting activities will be limited to hours between 7 am and 6 pm.

In the quarry pit an excavator (nominally 45 t) will be used to break oversize rock and for general quarry development work (7 am to 6 pm only). Front-end loaders will load the excavated rock to dump trucks (nominally 100 t) for transportation to the main hopper. These activities are proposed for the hours between 7 am and 10 pm.

From the primary crusher hopper, rock will pass through the processing plant where it will be crushed and screened into various product sizes. For assessment purposes, the crushing and screening activities are assumed to operate for 24 hours per day. Following processing the product is then distributed to the on-site stockpiles by conveyor before being either loaded to train or to road truck for transportation off-site.

It has been determined from material calculations that there would be excess quantities of manufactured sand and scalps. These excess products will be transported from the processing area by dump trucks (nominally 50 t) and stockpiled in emplacement areas on the southern side of the railway. These stockpiling activities will be limited to daylight hours.

It is proposed to progress the extraction operations from generally south to north as shown by **Figure 4**. The main sources of dust associated with the operation of the quarry would be as follows:

- Drilling and blasting of rock within the active extraction areas
- Vehicles travelling on unpaved surfaces
- Crushing and screening of rock within the processing plant
- Loading and unloading of material to crushers, stockpiles, trains and trucks
- Wind erosion from stockpiles and unpaved exposed areas.

Dust control measures, such as the watering of haul roads and fitting of dust collection devices on the crushing and screening plant, will be used as part of the project. These measures are discussed further in **Section 6**.

Table 1 summarises the estimated quantities of material excavated from the quarry. The years shown in the table have been used as stages for the dispersion modelling.

Table 1 : Summary of estimated annual material quantities

Modelled year	Overburden and topsoil (Mtpa)*	Hard rock[1] (Mtpa)
Year 2	1.4	3
Year 5	0.7	5
Year 10	0.8	5
Year 15	1.1	5
Year 20	0.3	5
Year 25	0	5
Year 30	0	5

** Estimated maximum annual overburden and topsoil removal of modelled year or lead up years.*

3. AIR QUALITY GOALS

Table 2 and **Table 3** summarise the air quality assessment criteria that are relevant to this project. The air quality goals relate to the total dust burden in the air and not just the dust from the project. In other words, some consideration of background levels needs to be made when using these goals to assess impacts. The estimation of appropriate background levels will be discussed further in **Section 4.3**.

Table 2 : Air quality assessment criteria for particulate matter concentrations

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	National Health & Medical Research Council
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	DEC
	30 $\mu g/m^3$	Annual mean	DEC long-term reporting goal
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council

The quarrying operations will also result in the emission of crystalline silca. At this time there are no ambient air quality assessment criteria that are relevant to these emissions. The assessment of this potential impact is discussed in **Section 8.4.**

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3** shows the maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against nuisance impacts (**NSW EPA, 2001**).

[1] The production of 5 Mtpa of product will require the recovery of approximately 5.6 Mtpa of primary feed and the production of 3 Mtpa will require 3.4 Mtpa of primary feed.

Table 3 : NSW DEC criteria for dust fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m^2/month	4 g/m^2/month

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[2] and mixing height[3]. Two sources of meteorological data have been used for the study and these data are discussed below.

Holmes Air Sciences installed a weather station on the Lynwood site in June 2004. The location of the meteorological monitoring station and other monitoring sites are shown in **Figure 5**. These data include 10-minute records of temperature, wind speed, wind direction and sigma-theta and have been processed into a form suitable for use in the ISCST3 dispersion model. At the time of writing, one full year of data had not been collected with the meteorological data file containing 5468 hours of data (62% of one year). A requirement of DEC is that the meteorological data used for dispersion modelling should contain at least 90% of one year.

Meteorological data has also been collected by Holmes Air Sciences on behalf of Mittagong Mushrooms at the property known as “Wangi” on the Hume Highway near Marulan. This site is approximately 8 km to the southwest of Lynwood site and these data have also been processed into a form suitable for use in the ISCST3 dispersion model. In 2000 there was 100% data recovery from this site.

Data are continuing to be collected from the Lynwood site.

The Lynwood and “Wangi” data have been prepared into meteorological data files suitable for use in dispersion modelling. Comparisons of the wind patterns from the Lynwood and “Wangi” sites are presented as windroses in **Figures 6** and **7** respectively. It can be seen from **Figure 6** that the winds measured at the Lynwood site are very defined and predominantly from either the east or west. Westerly winds are also common at the “Wangi” site (**Figure 7**) however the pattern is less pronounced with a more even spread of winds across all wind sectors. The annual percentage of calms (that is, winds less than or equal to 0.5 m/s) recorded from each site was very similar at around 8%. Again, it should be noted that only 62% of one years worth of data has been collected from the Lynwood site at the time of this report.

[2] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[3] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

The annual average wind speed from the Lynwood and “Wangi” sites was 3.6 and 3.0 m/s respectively.

To use the wind data to assess dispersion it is necessary to also have available data on atmospheric stability. For the Lynwood and “Wangi” datasets, a stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). **Table 4** shows the frequency of occurrence of the stability categories expected in the area from the two meteorological datasets.

To use the wind data to assess dispersion it is necessary to also have available data on atmospheric stability. For the Lynwood and Wangi datasets, a stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). **Table 4** shows the frequency of occurrence of the stability categories expected in the area from the two meteorological datasets.

It can be seen from **Table 4** that there are similarities between the calculated occurrence of each of the stability classes for both sites. The most common stability class was determined to be D class which would suggest that the dispersion conditions would be such that dust emissions would disperse rapidly for a significant proportion of the time.

Table 4 : Frequency of occurrence of stability in the project area

Stability Class	Lynwood (18-Jun-04 to 1-Feb-05)	“Wangi” (2000)
A	5.6	9.7
B	3.0	9.9
C	7.6	11.3
D	55.4	38.9
E	18.2	15.6
F	10.1	14.6
Total	**100**	**100**

Given that the Lynwood data represent less than 90% of one year, the “Wangi” data have been chosen for use in the dispersion modelling. From analysis of the windroses the use of the “Wangi” data in the dispersion modelling would be expected to represent a worst-case assessment for residences to the south of the project area, but not necessarily for sites to the east. Dispersion modelling using the Lynwood data may however result in slightly higher predicted impacts to the east of the project area than from using the “Wangi” data. This is critical given the location of nearest residences to the east and therefore differences that may arise from the use of the Lynwood data are discussed in **Section 8.3**. Joint wind speed, wind direction and stability class frequency tables for the Lynwood and “Wangi” data are provided in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology also collects climatic information in the local area. A range of climatic information collected from Goulburn (Progress Street) are presented in **Table 5** (**Bureau of Meteorology, 2004**).

Temperature data shows that January is typically the warmest month with a mean daily maximum of 27.5 ^{o}C. July is the coldest month with a mean daily minimum of 1.3 ^{o}C.

Rainfall data collected from Goulburn shows that November is the wettest month with a mean rainfall of 66 mm over 12 rain days. Annually the area experiences, on average, 650 mm of rain per year.

Table 5 : Climate information for the local area

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature - deg C	27.5	26.5	24	20.1	16	12.4	11.5	13.1	16.2	19.3	22.2	25.8	19.5
Mean no. of days where Max Temp >= 30.0 deg C	10.2	7.4	3.3	0.2	0	0	0	0	0	0.3	2	6.9	30.4
Highest daily Max Temp - deg C	40.1	39.2	36.9	32.6	25	20	18.6	24	28.2	32.7	40.1	38.4	40.1
Mean daily minimum temperature - deg C	13.4	13.6	11.1	7.8	4.8	2.4	1.3	2	4.6	6.7	9.1	11.6	7.3
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0.1	0.9	4.4	8.7	12	10	3.4	1.1	0.1	0	40.7
Lowest daily Min Temp - deg C	4.2	3.3	-0.6	-4.4	-5.5	-7.4	-8.5	-6.8	-6	-2	-0.5	0.9	-8.5
Mean 9am air temp - deg C	18.4	17.5	15.8	12.8	9	5.9	5	6.6	10.5	13.8	15	17.7	12.4
Mean 9am relative humidity - %	73	79	80	81	86	88	86	81	75	70	72	68	78
Mean 3pm air temp - deg C	26	25.1	22.6	18.8	14.7	11.2	10.4	12	15	18	21	24.3	18.3
Mean 3pm relative humidity - %	45	50	52	54	62	67	65	59	56	54	51	45	55
Mean monthly rainfall – mm	60.7	59.1	55.6	51.1	47.8	45.7	44.6	57.7	50.2	56.6	66	54.4	649.5
Mean no. of raindays	10	9.2	9	9.2	10.6	11.2	12.2	11.9	10.8	11.4	11.5	9.2	126
Highest monthly rainfall – mm	181.1	167	180.8	208.2	124.6	185.2	97.2	215	97.8	148.4	116.6	131.4	
Lowest monthly rainfall – mm	3	2.5	2.4	0.2	2.6	9.4	4	5.2	4.4	5	4.6	0.9	
Highest recorded daily rainfall – mm	63	73.4	93.4	92	61.2	114	40.4	99.2	33.6	51.6	58.6	56.6	114
Mean no. of clear days	7.6	6.1	7.1	7.1	6.2	5.1	6.5	8.5	7.6	7	6.3	8	83.3
Mean no. of cloudy days	10.9	11.8	11.7	11.1	13.3	13.7	12.1	10.9	9.6	10.8	11.5	10.8	138.3
Mean daily evaporation – mm	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8	5	6.2	3.5

Climate averages for Station: 070263 GOULBURN (PROGRESS ST). Commenced: 1971; Last record: 2004; Latitude (deg S): -34.7208; Longitude (deg E): 149.7420; State: NSW

Source : Bureau of Meteorology (2004)

4.3 Existing air quality

Air quality standards and goals refer to pollutant levels which include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals (refer to **Section 3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the project is likely to contribute to these levels.

A monitoring program has been established in the area as part of the project which includes the measurement of dust deposition and dust concentration (as PM_{10}). **Figure 5** shows the location of the monitoring sites. The monitoring commenced in June 2004.

The project area is predominantly grassland although some areas are well vegetated with tall trees. Sources of particulate matter in the area would include traffic on unsealed roads, local building and construction activities, animal grazing activities and to a lesser extent traffic from the Hume Highway. The Johniefelds quarry to the north, is too far away to significantly affect air quality at Marulan, and the effects of these emissions, to the extent that they occur, would of course be captured by the existing monitoring program.

4.3.1 Dust Deposition

Dust deposition is monitored using dust deposition gauges at eight locations around the Lynwood site (refer to **Figure 5** for the locations). Dust deposition gauges use a funnel and bottle to measure the rate at which dust settles onto the surface over periods approximating one month.

Data collected from the eight gauges are summarised in **Table 6**. Eight months of data are available for this study. These measurements include the effects of all background sources relevant to that location.

Table 6 : Dust deposition data for Lynwood Quarry

Month	Insoluble solids (g/m^2/month)							
	DD1	DD2	DD3	DD4	DD5	DD6	DD7	DD8
Jun-04	1.2	0.9	1.3	1.1	0.9	1.4	0.5	1.0
Jul-04	1.4	5.9	0.6	0.6	0.8	2	1	0.5
Aug-04	1.1	2.8	1	0.9	0.9	5.1	450*	2.4
Sep-04	0.5	3.2	1	0.7	0.9	8.1	0.5	0.8
Oct-04	0.7	0.9	0.8	0.8	0.8	0.6	0.6	0.7
Nov-04	0.4	0.5	0.4	0.6	0.5	2.7	0.6	0.3
Dec-04	1.7	1.3	1.1	1.7	1.3	2.6	1.1	0.9
Jan-05	6.1	5.9	3	5.2	3.6	4.5	3.6	3.4
Annual	**1.6**	**2.7**	**1.2**	**1.5**	**1.2**	**3.4**	**1.1**	**1.3**

** Funnel found to have been tampered with. Value discarded from annual average calculation.*

The data in **Table 6** shows that no location has reported an average level above the DEC 4 g/m^2/month dust fallout criteria. Gauges DD2 and DD6 experience noticeably higher deposition levels compared with the other sites, although it is highly unlikely that any of the gauges will recorded a deposition level above the DEC's annual assessment criterion of 4 g/m^2/month once a full year of data has been collected. The reasons for the relatively elevated readings at DD2 and DD6 is likely to be the proximity of the unsealed road, which runs reasonably close to these sites.

4.3.2 Dust Concentration

Measurements of PM_{10} concentrations commenced in the area in June 2004. A second high volume air sampler measuring PM_{10} was installed in December 2004. These air samplers record a 24 hour sample, every six days.

Data collected from the high volume air samplers installed for this project are shown below in **Table 7**. The highest 24-hour average PM_{10} concentration since monitoring began was from HVAS 1 with 61.4 $\mu g/m^3$ on 17 June 2004. This is above the 50 $\mu g/m^3$ DEC 24 hour maximum goal suggesting that there are existing sources of dust in the area which contribute to elevated concentrations. As meteorological monitoring began on 18 June 2004 it is difficult to determine the reason for the elevated level however strong westerly winds persisted for a few days after 18 June 2004 so it was possible that wind blown dust from exposed land caused elevated dust concentrations.

Table 7 : Dust concentration data for Lynwood Quarry

Date sampled	Measured PM_{10} 24 hour concentration ($\mu g/m^3$)	
	HVAS 1	HVAS 2
11-Jun-04	3.8	
17-Jun-04	61.4	
23-Jun-04	14	
11-Jul-04	4.9	
17-Jul-04	24.1	
23-Jul-04	6.4	
29-Jul-04	3.4	
4-Aug-04	0.93	
10-Aug-04	4.2	
16-Aug-04	8.7	
26-Aug-04	17.3	
1-Sep-04	30.4	
7-Sep-04	8.2	
13-Sep-04	3.3	
19-Sep-04	7.3	
25-Sep-04	10	
1-Oct-04	1.1	
7-Oct-04	10.7	
13-Oct-04	35.8	
19-Oct-04	5.3	
25-Oct-04	4.7	
31-Oct-04	*	
6-Nov-04	1.2	
10-Nov-04	27.4	
17-Nov-04	17.3	
23-Nov-04	9.6	
29-Nov-04	15.4	
5-Dec-04	12.8	
11-Dec-04	17.5	10.5
17-Dec-04	21.2	*
23-Dec-04	12.3	14.3
29-Dec-04	8.9	4.4
4-Jan-05	23.1	19.2
10-Jan-05	10.2	10.8
16-Jan-05	11.8	11.6
22-Jan-05	20.7	17.1
28-Jan-05	17.4	15.2
3-Feb-05	13.7	6.7
9-Feb-05	24.9	23
15-Feb-05	24.7	20.9
21-Feb-05	6.8	7.6
27-Feb-05	8.4	8.3
Average	**13.9**	**13.0**

** Sampler did not run due to power failure or electrical fault.*

For the purposes of establishing the existing air quality, a value of 13 $\mu g/m^3$ has been taken to be the annual average PM_{10} background level to apply over the entire study area. The average PM_{10} concentration is likely to change slightly as more data becomes available. Assuming that PM_{10} constitutes 40% of the TSP, an annual average background TSP level would be 33 $\mu g/m^3$.

From the monitoring data available it has been assumed that the following background concentrations apply at the nearest residences.

- Annual average TSP of 33 $\mu g/m^3$
- Annual average PM_{10} of 13 $\mu g/m^3$
- Annual average dust deposition of 1.7 g/m^2/month

In addition, the DEC guidelines require an assessment against 24-hour PM_{10} concentrations. This assessment adopts the approach that the predicted 24-hour average PM_{10} concentration from the development should be less than 50 $\mu g/m^3$ at the nearest residences.

5. ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at quarries. Total dust emissions due to the quarry have been estimated by analysing the activities taking place at the quarry during selected stages of operation.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. There were significant revisions to the US EPA emission factors for quarry operations in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The assessment has considered seven selected stages. The operations which apply in each case have been combined with emission factors developed, both within NSW and by the US EPA, to estimate the amount of dust produced by each activity. There have been significant revisions to the US EPA emission factors for quarry operations in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account in the dispersion modelling.

The assessment has considered seven selected years of the project operation. These cover impacts arising for a range of product and overburden quantities. The operational description for the project has been used to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions for each stage of assessment.

The most significant dust generating activities from the quarry operations have been identified and the dust emission estimates during the seven operational scenarios are presented below in **Table 8**. Details of the calculations of the dust emissions are presented in **Appendix B**.

Table 8 : Estimated dust emissions due to Lynwood Quarry operations

Activity	*TSP emission rate (kg/y)*						
	Year 2	*Year 5*	*Year 10*	*Year 15*	*Year 20*	*Year 25*	*Year 30*
Dozer stripping topsoil	13020	9380	5320	10920	6300	700	0
Loading topsoil to trucks	190	137	78	159	92	10	0
Hauling topsoil to stockpiles	2432	2062	1578	2760	1592	177	0
Dumping topsoil to stockpiles	190	137	78	159	92	10	0
Drilling rock and overburden	5015	9272	9272	9272	9272	9272	9272
Blasting rock and overburden	658	1623	1623	1623	1623	1623	1623
FEL loading overburden to trucks	3439	1644	1960	2871	756	0	0
Hauling overburden to emplacement area	44012	24751	39839	49708	13086	0	0
Dumping overburden to emplacement area	3439	1644	1960	2871	756	0	0
Dozer shaping overburden dump	17472	17472	17472	17472	17472	0	0
FEL loading rock to trucks	8067	13287	13287	13287	13287	13287	13287
Hauling rock to hopper	47600	78400	380800	168000	257600	257600	257600
Dumping rock to hopper	8067	13287	13287	13287	13287	13287	13287
Primary crushing and screening	5168	8512	8512	8512	8512	8512	8512
Secondary crushing and screening	103836	171024	171024	171024	171024	171024	171024
Tertiary crushing and screening	103836	171024	171024	171024	171024	171024	171024
Loading to product stockpiles	5712	9519	9519	9519	9519	9519	9519
Loading product to road trucks	792	792	792	792	792	792	792
Transport product off-site (sealed rd)	67200	67200	67200	67200	67200	67200	67200
Loading product to trains by conveyor	792	1848	1848	1848	1848	1848	1848
Wind erosion from exposed pit areas	112177	227935	436775	619206	643826	649196	649196
Wind erosion from product stockpiles	8355	8355	8355	8355	8355	8355	8355
Wind erosion from Rail OEA	24464	0	0	0	0	0	0
Wind erosion from Eastern OEA	0	21003	41768	0	0	0	0
Wind erosion from Western OEA	0	0	0	17901	23867	0	0
Wind erosion from Eastern EOEA	23867	17901	34608	0	0	0	0
Wind erosion from Western EOEA	0	0	0	6683	30312	49167	53463
Loading excess product to trucks from plant	611	930	930	930	930	930	930
Hauling excess product to emplacement area	9200	14000	14000	8400	8400	8400	8400
Dumping excess product to emplacement area	611	930	930	930	930	930	930
Dozer shaping excess product emplacement area	17472	17472	17472	17472	17472	17472	17472
Grading roads	21566	21566	21566	21566	21566	21566	21566
TOTAL DUST (kg)	**659263**	**933106**	**1492878**	**1423752**	**1520792**	**1481902**	**1485300**
Annual production (t)	**3000000**	**5000000**	**5000000**	**5000000**	**5000000**	**5000000**	**5000000**
Ratio Dust:Production (kg/t)	**0.22**	**0.19**	**0.30**	**0.28**	**0.30**	**0.30**	**0.30**

Of the years selected for the assessment Year 20 is estimated to generate the most dust

6. DUST CONTROL MEASURES

The controls that are available for quarry operations can be summarised in three broad categories:

1. Engineering controls
2. Operational controls which vary operations when adverse meteorological conditions occur
3. Planning controls (which increase the separation between dust emission sources on the plant and sensitive areas).

Engineering controls involve measures such as shielding and enclosing crushers and screens, conveyors, transfer points and the installation of spray systems on stockpiles etc. Planning controls include the maintenance of adequate buffer distances between dust sources and sensitive receptors. Generally these types of controls would be implemented before a project commences.

The following list presents a range of dust control measures which have been adopted for the project.

Engineering

- covering of conveyors
- enclosing of crushing and screening plant with dust extraction system fitted
- fitting of scraper for cleaning conveyor belts
- dust suppression sprays on the primary crusher which will be located below ground level in a box cut but will not be enclosed
- fitting drills with either water sprays or dry dust collection devices
- controlling stockpiles of fine material with water sprays etc.

Operational controls

- traffic confined to identified haul road routes
- removal and rehabilitation of unnecessary roads
- exposed areas kept to a minimum
- watering of haul roads
- cleaning of areas which could become sources of wind erosion dust due to build-up of settled fine material
- reviewing meteorological conditions prior to blasting to minimise the exposure of residences to dust emissions
- daily assessment of meteorological conditions to identify wind conditions that may be conducive to excessive dust generation – for example, very high winds

Planning controls

- Establishing adequate buffer zones

These measures will ensure that a high level of dust control is maintained at the quarry. Dust control measures that form part of the quarry operations and which have been taken into account in the modelling include enclosing the crushing, screening and transfer points, and using water sprays as required on haul roads and exposed areas.

7. APPROACH TO ASSESSMENT

In August 2001, DEC published new guidelines for the assessment of air pollution sources using dispersion models (**NSW EPA, 2001**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. The approach taken in this assessment follows as closely as possible the approaches suggested by the guidelines.

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model used was the US EPA Industrial Source Complex Model (Short-term Version 3) (ISCST3) model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). The modelling has been based on the use of three particle-size categories (0 to 2.5 μm - referred to as $PM_{2.5}$, 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest). Mass emission rates in each of these size ranges have been determined using the factors derived from the **SPCC (1986)** study and TSP emission rates calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work (see **Appendix B**).

The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 0.0468 of the TSP
- $PM_{2.5-10}$ (CM) is 0.3440 of TSP
- PM_{10-30} (Rest) is 0.6090 of TSP.

Modelling was done using three ISCST3 source groups corresponding to the three size categories defined above i.e. each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentration in the three plot-output files for each group were then combined according to the weightings above to determine the concentration of PM_{10} and TSP.

The ISC model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on mining or quarry operations where wind speed is an important factor in determining the rate at which dust is generated.

For the current study, the operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 8** shows the location of the modelled sources for each assessment stage. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISCST3 model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a quarry site would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted over an area 8 km by 8 km. Local terrain has been included in the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. It has been assumed that each activity will occur between the hours indicated in the operational description provided by Umwelt and included in **Section 2**. Most activities are proposed to occur during daylight hours however crushing, screening and loadout activities have been modelled for 24-hours per day. Dust emissions from wind erosion sources have been modelled for 24 hours per day in all modelling scenarios. Model predictions have been made at 115 discrete receptors located in the project area. The location of these receptors have been chosen to provide finer resolution closer to the quarry dust sources and nearby residences.

As an example the ISCST3 model input file is provided in **Appendix C**.

A calibration study was undertaken as part of the EIS for the Warkworth mine in the Hunter Valley (**Holmes Air Sciences, 2002**). The calibration was done by comparing the predicted maximum 24-hour average PM_{10} concentrations in the period 1 November 2000 to 31 October 2001 at the several mine operated monitors. The maximum measured PM_{10} concentration and TSP concentrations at four sites over the same period were then determined by inspection of the monitoring data records. The TSP concentrations have been converted to equivalent PM_{10} concentrations assuming that PM_{10} constitutes 40% of the TSP in this area. The results are shown below in **Table 9.**

Table 9 : Comparison of measured and predicted maximum 24-hour PM_{10} concentrations

Monitoring site	Maximum predicted 24-hour PM_{10}	Maximum measured or inferred 24-hour PM_{10}	Ratio of predicted to measured concentration
HV1	100	170 x 0.4 = 68	1.5
HV2	140	140 x 0.4 = 56	2.5
Bulga PM_{10}	160	44 (direct measurement)	3.6
Bulga TSP	160	102 x 0.4 = 41	3.9
Lot 543	95	138 x 0.4 = 55	1.7
Average			2.6

** Note, PM_{10} concentrations are only measured at the Bulga monitoring site, the other sites measure TSP only*

The average extent of over prediction was a factor of 2.6; that is unadjusted model predictions over predict 24-hour PM_{10} concentrations by 260%. This factor was used to adjust the model predictions for the Warkworth EIS downwards to obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for all scenarios that were assessed. This same factor has been used for the 24-hour PM_{10} predictions in the current assessment.

The model ISCST3 was used in this instance as it has been the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the DEC's model of first choice but it has had limited use in dust modelling applications. Dust impacts and model predictions using ISCST3 are presented as contour plots in **Figures 10** to **16**. Comparisons of model predictions (refer to **Holmes Air Sciences, 2003** for example) have shown that AUSPLUME predicts almost 50% lower than uncorrected ISCST3 predictions of maximum 24-hour average concentrations. Annual average predictions using AUSPLUME are slightly lower than ISCST3 predictions. This supports the use of a correction factor for the maximum 24-hour PM_{10} concentration predictions using ISCST3.

Other studies undertaken at other locations have derived different calibration factors, both larger and smaller, than the 2.6 factor applied in this study. Further studies to develop a more scientifically robust methodology for dealing with the overprediction of short-term concentratrions by the ISCST3 model are to be conducted as part of the approval conditions for the Mt Owen Mine. At this time these studies have not been commenced.

8. ASSESSMENT OF IMPACTS

8.1 Introduction

This section provides an interpretation of the predicted dust concentrations and deposition levels.

Dust concentrations and deposition rates due to the selected years of assessment have been presented as isopleth diagrams showing the following:

1. Predicted maximum 24-hour average PM_{10} concentration
2. Predicted annual average PM_{10} concentration
3. Predicted annual average TSP concentration, and
4. Predicted annual average dust deposition.

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location regardless of when it occurred. The maxima are used to show concentrations which can possibly be reached under the modelled conditions. It should be noted that the contour plots show predicted concentrations and deposition levels due only to Lynwood quarry dust sources. That is, the predictions do not include contribution from existing non-quarry sources.

Model predictions for each assessment scenario have also been presented in tabular form for the nearest residences and potential future residential locations that are not on Readymix owned land (**Table 10**). **Figure 9** shows the identification label given to each assessment location. Interpretation and analysis of the model predictions for each assessment scenario are provided below.

8.2 Assessment Criteria

The air quality criteria used for deciding which properties are likely to experience air quality impacts are those specified in the DEC's modelling guidelines (refer to **Table 2** and **Table 3**).

The criteria are:

- 50 $\mu g/m^3$ for 24-hour PM_{10} for the quarry considered alone
- 30 $\mu g/m^3$ for annual average PM_{10} due to the quarry and other sources
- 90 $\mu g/m^3$ for annual TSP concentrations due to the quarry and other sources
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the quarry considered alone, and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the quarry and other sources

8.3 Assessment of Impacts

Dispersion model predictions for the each stage of the quarry operations are presented in **Figures 10** to **16** and are summarised in **Table 10** for the nearest residences and potential future residential locations. The residences and potential future residential locations have been selected to represent the most potentially affected areas for various wind directions.

Table 10 : Model predictions at selected locations due to quarry operations

Location	Year 2	Year 5	Year 10	Year 15	Year 20	Year 25	Year 30
Predicted maximum 24-hour average PM_{10} concentrations ($\mu g/m^3$). Goal = 50 $\mu g/m^3$ (Model predictions with estimated background are shown in parentheses)							
R1	4.9	7.5	9.7	7.5	8.6	8.3	8.3
R2	5.9	10.0	16.4	12.3	14.0	13.8	13.8
R3	10.8	17.8	17.8	15.2	14.8	14.7	14.7
R4	10.1	16.1	16.7	17.0	17.0	16.8	16.8
R5	13.6	22.3	24.8	21.7	22.2	21.6	21.6
R6	9.4	15.5	14.5	14.6	14.0	13.8	13.8
R7	9.7	10.2	10.7	10.5	11.7	11.4	11.4
R8	9.4	14.1	13.9	13.8	13.7	13.4	13.4
Predicted annual average PM_{10} concentrations ($\mu g/m^3$). Goal = 30 $\mu g/m^3$ (Model predictions with estimated background are shown in parentheses)							
R1	0.4 (13.4)	0.7 (13.7)	1 (14)	0.8 (13.8)	0.9 (13.9)	0.9 (13.9)	0.9 (13.9)
R2	1.6 (14.6)	2.5 (15.5)	4 (17)	3.4 (16.4)	3.7 (16.7)	3.7 (16.7)	3.7 (16.7)
R3	2.8 (15.8)	4.9 (17.9)	6.5 (19.5)	4.9 (17.9)	5.4 (18.4)	5.5 (18.5)	5.5 (18.5)
R4	2.4 (15.4)	3.4 (16.4)	4.2 (17.2)	3.9 (16.9)	4.3 (17.3)	4.2 (17.2)	4.2 (17.2)
R5	3 (16)	4.9 (17.9)	8 (21)	6.5 (19.5)	7.3 (20.3)	7.1 (20.1)	7.1 (20.1)
R6	2.2 (15.2)	3.2 (16.2)	4 (17)	3.4 (16.4)	3.6 (16.6)	3.6 (16.6)	3.6 (16.6)
R7	2.4 (15.4)	2.9 (15.9)	3.4 (16.4)	3 (16)	3.3 (16.3)	3.3 (16.3)	3.3 (16.3)
R8	2.7 (15.7)	4.4 (17.4)	5.6 (18.6)	4.4 (17.4)	4.8 (17.8)	4.8 (17.8)	4.8 (17.8)
Predicted annual average TSP concentrations ($\mu g/m^3$). Goal = 90 $\mu g/m^3$ (Model predictions with estimated background are shown in parentheses)							
R1	0.5 (33.5)	0.7 (33.7)	1.2 (34.2)	1 (34)	1.1 (34.1)	1 (34)	1 (34)
R2	1.8 (34.8)	2.8 (35.8)	4.5 (37.5)	3.9 (36.9)	4.2 (37.2)	4.2 (37.2)	4.2 (37.2)
R3	3.3 (36.3)	6 (39)	8 (41)	5.8 (38.8)	6.3 (39.3)	6.4 (39.4)	6.4 (39.4)
R4	2.7 (35.7)	3.8 (36.8)	4.7 (37.7)	4.4 (37.4)	4.8 (37.8)	4.7 (37.7)	4.7 (37.7)
R5	3.3 (36.3)	5.5 (38.5)	9.1 (42.1)	7.5 (40.5)	8.4 (41.4)	8.2 (41.2)	8.2 (41.2)
R6	2.5 (35.5)	3.6 (36.6)	4.5 (37.5)	3.8 (36.8)	4.1 (37.1)	4 (37)	4.1 (37.1)
R7	2.8 (35.8)	3.3 (36.3)	4 (37)	3.5 (36.5)	3.9 (36.9)	3.8 (36.8)	3.8 (36.8)
R8	3.2 (36.2)	5.1 (38.1)	6.7 (39.7)	5.1 (38.1)	5.5 (38.5)	5.5 (38.5)	5.5 (38.5)
Annual average dust deposition (g/m^2/month). Goal : 2 for Project only, 4 with estimated background (Model predictions with estimated background are shown in parentheses)							
R1	0.02 (1.72)	0.03 (1.73)	0.05 (1.75)	0.05 (1.75)	0.06 (1.76)	0.05 (1.75)	0.05 (1.75)
R2	0.06 (1.76)	0.1 (1.8)	0.2 (1.9)	0.21 (1.91)	0.22 (1.92)	0.21 (1.91)	0.21 (1.91)
R3	0.21 (1.91)	0.46 (2.16)	0.71 (2.41)	0.48 (2.18)	0.5 (2.2)	0.5 (2.2)	0.5 (2.2)
R4	0.12 (1.82)	0.16 (1.86)	0.22 (1.92)	0.21 (1.91)	0.25 (1.95)	0.26 (1.96)	0.26 (1.96)
R5	0.12 (1.82)	0.22 (1.92)	0.52 (2.22)	0.54 (2.24)	0.57 (2.27)	0.55 (2.25)	0.55 (2.25)
R6	0.14 (1.84)	0.19 (1.89)	0.28 (1.98)	0.23 (1.93)	0.25 (1.95)	0.25 (1.95)	0.26 (1.96)
R7	0.15 (1.85)	0.17 (1.87)	0.22 (1.92)	0.2 (1.9)	0.22 (1.92)	0.23 (1.93)	0.23 (1.93)
R8	0.2 (1.9)	0.36 (2.06)	0.53 (2.23)	0.38 (2.08)	0.41 (2.11)	0.4 (2.1)	0.4 (2.1)

Comparing the model predictions with air quality goals the following conclusions can be made:

- Maximum 24-hour average PM_{10} concentrations due to the operations are below the 50 $\mu g/m^3$ goal at all selected residences.

- Annual average PM_{10} concentrations due to the operations are below the 30 $\mu g/m^3$ goal at all residences. If an annual average background PM_{10} of 13 $\mu g/m^3$ is added to the model predictions, concentrations at all residences are still below the 30 $\mu g/m^3$ goal.

- Annual average TSP concentrations due to the operations are below the 90 $\mu g/m^3$ goal at all residences. If an annual average background TSP of 33 $\mu g/m^3$ is added to the model predictions, concentrations at all residences are still below the 90 $\mu g/m^3$ goal.

- The predicted contribution of the quarry to dust deposition levels are below the 2 g/m^2/month criteria at all residences. Model predictions at the nearest residences are also below the 4 g/m^2/month goal when an existing background dust deposition level of 1.7 g/m^2/month is added. (Note, the monitoring data indicates that the existing deposition levels in the residential areas are lower than the average over all sites, which includes data from the rural gauges DD2 and DD6).

Model predictions have been presented as contour plots, shown in **Figures 10** to **16**. It can be seen from these figures that air quality impacts to the east of the site would generally be higher than those predicted to the west. The westerly winds that are common in the area would be driving this pattern.

The assessment includes cumulative effects since the background monitoring data includes the effects of all existing sources.

Table 11 shows the dispersion model predictions at selected locations using the Lynwood meteorological data. These results have been prepared to determine whether using the on site data (Lynwood) would affect the conclusions of the study. It can be seen from **Table 11** that predicted concentrations and deposition levels are generally lower using the Lynwood data than for the "Wangi" data. There are some locations, however, where the model predictions were slightly higher using the Lynwood data. The higher mean wind speed at the Lynwood site may explain lower predictions since dust emissions would disperse more rapidly under these conditions. Again, it should be noted that there was only 62% of one year of data from the Lynwood site. This initial investigation suggests that the use of the Lynwood data would not affect the conclusions of the study.

Table 11 : Model predictions using different meteorological data

Location	Year 2 using "Wangi" meteorological data	Year 2 using preliminary Lynwood meteorological data
Predicted maximum 24-hour average PM_{10} concentrations (µg/m^3)		
R1	4.9	3.1
R2	5.9	2.9
R3	10.8	5.9
R4	10.1	7.0
R5	13.6	16.4
R6	9.4	3.3
R7	9.7	5.3
R8	9.4	6.2
Predicted annual average PM_{10} concentrations (µg/m^3)		
R1	0.4 (13.4)	0.5 (13.5)
R2	1.6 (14.6)	0.3 (13.3)
R3	2.8 (15.8)	3.2 (16.2)
R4	2.4 (15.4)	1.9 (14.9)
R5	3 (16)	3.9 (16.9)
R6	2.2 (15.2)	1.5 (14.5)
R7	2.4 (15.4)	1.1 (14.1)
R8	2.7 (15.7)	2.5 (15.5)
Predicted annual average TSP concentrations (µg/m^3)		
R1	0.5 (33.5)	0.6 (33.6)
R2	1.8 (34.8)	0.4 (33.4)
R3	3.3 (36.3)	3.7 (36.7)
R4	2.7 (35.7)	2 (35)
R5	3.3 (36.3)	4.3 (37.3)
R6	2.5 (35.5)	1.6 (34.6)
R7	2.8 (35.8)	1.2 (34.2)
R8	3.2 (36.2)	2.8 (35.8)
Annual average dust deposition (g/m^2/month)		
R1	0.02 (1.72)	0.03 (1.73)
R2	0.06 (1.76)	0.01 (1.71)
R3	0.21 (1.91)	0.35 (2.05)
R4	0.12 (1.82)	0.04 (1.74)
R5	0.12 (1.82)	0.22 (1.92)
R6	0.14 (1.84)	0.06 (1.76)
R7	0.15 (1.85)	0.03 (1.73)
R8	0.2 (1.9)	0.21 (1.91)

8.4 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[4] and only the respirable particles (those which are capable of reaching the gas exchange region of the lungs) are considered in determining health effects of crystalline silica (PM_7).

[4] Fibrogenic dust is a dust which causes increase of fibrotic (scar) tissue after deposition in the gas exchange region of the lung.

Excessive exposure to respirable crystalline silica can cause the disease known as silicosis. This respiratory disease is characterised by scarring and hardening of the lung tissue and it reduces the ability of the lungs to extract oxygen from the air.

On 31 December 2004 The National Occupational Health and Safety Commission (NOHSC) declared an amendment to the exposure standards for crystalline silica. This amendment updated the national exposure standards for the three forms of crystalline silica - quartz, cristobalite and tridymite. The date of effect for the amendments was 1 January 2005. The revised national exposure standard for crystalline silica has changed the Time Weighted Average (TWA) for quartz, from 200 $\mu g/m^3$ to 100 $\mu g/m^3$. Further the revised exposure standard for all three forms of crystalline silica has been revised and should now be measured in accordance with the new methodology in Australian Standard Workplace Atmospheres – Method for sampling and gravimetric determination of respirable dust AS2985-2004.

The DEC lists crystalline silica in Table 3.3 of their Draft "Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales" which is currently under public review (closing date for comments 18 February 2005). The table specifies a 1-hour average concentration limit for the $PM_{2.5}$ component of crystalline silica from point sources of 0.18 $\mu g/m^3$. The Victorian EPA refer to "Respirable Crystalline Silica as a Class 3 indicator and specify an ambient air quality criterion of 0.33 $\mu g/m^3$, expressed as concentrations of $PM_{2.5}$ particles and averaged over 3-minutes. (From a dispersion point of view the NSW and Victorian criteria are equivalent once the adjustement is made for the two different averaging times.)

Although the criteria for point sources have been developed, the criteria for ambient levels due to emissions from fugitive sources such as mines, quarries, unsealed rural roads, agricultural activities and the like have not been developed. The Victorian EPA is currently developing an appropriate criterion for such sources. Thus to date, the relevant environmental standard to allow an assessment of the risks posed to the general public (as opposed to the people in occupational settings) through exposure to crystalline silica is still under development.

The ambient assessment criteria when developed is likely to be significantly lower than the occupational TWA for respirable quartz of 100 $\mu g/m^3$ and is likely to be expressed as a longer-term average to reflect that ambient standards as based on continuous exposure and further is likely to be expressed in term of $PM_{2.5}$ rather than respirable particles.

Professor David McKenzie works in the field of respiratory medicine and has assessed the health effects of quarrying including silicosis. He notes that the risk of silicosis among people living in areas surrounding activities such as quarrying would be very small provided the inhalable particles level at the source was acceptable in terms of occupational safety.

The proportion of crystalline silica within the dust that will be liberated by the quarry is not known however testing on the source rock shows that it has a crystalline silica content of between 35 and 40%. For estimation of crystalline silica impacts it has been assumed that 40% of the $PM_{2.5}$ emissions are crystalline silica and the model predictions have been assessed for the year of maximum dust generation (year 20).

Figure 17 shows the predicted annual average crystalline silica concentration ($PM_{2.5}$) due to the quarry activities in year 20. In the absence of formal ambient air quality criteria these results have provided for information purposes only. It can be seen from this figure that predicted annual average crystalline silica concentrations at the nearest receptors are below

0.5 $\mu g/m^3$. The equivalent[5] 8-hour exposure would be approximately 6 $\mu g/m^3$ for respirable particles. This is approximately 1/16th of the new NOHSC TWA occupational standard of 100 $\mu g/m^3$.

9. AIR QUALITY MONITORING PROGRAM

The existing air quality monitoring program includes two high volume air samplers and eight dust deposition gauges. **Section 4.3** provided the details on the location of these gauges and a summary of the data collected by these gauges.

The dispersion model predictions indicated that some increases to off-site dust concentration and dust deposition levels would be detectable due to operation of the quarry. It will be important to monitor the change in air quality that may arise from the operation of the quarry and it is recommended that the current air quality monitoring program continue once the quarry commences operation. The focus of the monitoring program should be on air quality at residential locations once quarrying commences so some gauges that are currently on site should be relocated to residential locations.

10. CONCLUSIONS

This report has assessed the air quality impacts associated with the operation of the proposed Lynwood Quarry near Marulan. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to emissions from the quarry. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for seven operational scenarios. The scenarios were selected to cover a range of quarry production, overburden extraction and pit location combinations.

Air quality monitoring data have been collected for the project which indicated that existing short-term dust concentrations were for the great majority of the time well below DEC's assessment criteria, but could be above air quality goals on occasions. The existing sources of dust in the area were difficult to determine, but distant sources would likely have contributed significant quantities of wind blown dust during the extended dry period which has coincided with the monitoring period

The conclusions of the assessment can be summarised as follows:

- Air quality goals are not predicted to be exceeded at nearby residences due to the proposed quarry operations

- Particulate matter concentrations arising from non-Project related sources, such as bushfires and regional dust storms, may continue to result in elevated short-term concentrations on occasions

- Compliance with occupational health and safety standards for crystalline silica on the site should ensure that there would be no adverse impacts in the general community who would experience much lower concentrations

[5] Based on dispersion theory, the concentration (C_t) over averaging time t is related to the concentration (C_{tref}) over a reference time t_{ref} by the following: $C_t = C_{tref}(t/t_{ref})^{0.2} = C_{tref} \times 4$. Futher we have assumed that respirable concentrations will be three times the $PM_{2.5}$ concentration. Thus 0.5 $\mu g/m^3$ would be equivalent to 0.5 x 4 x 3 = 6 times the predicted annual average $PM_{2.5}$ concentration.

Remodelling of the dispersion using the on-site meteorological data would be expected to change figures slightly, but should not result in different conclusions.

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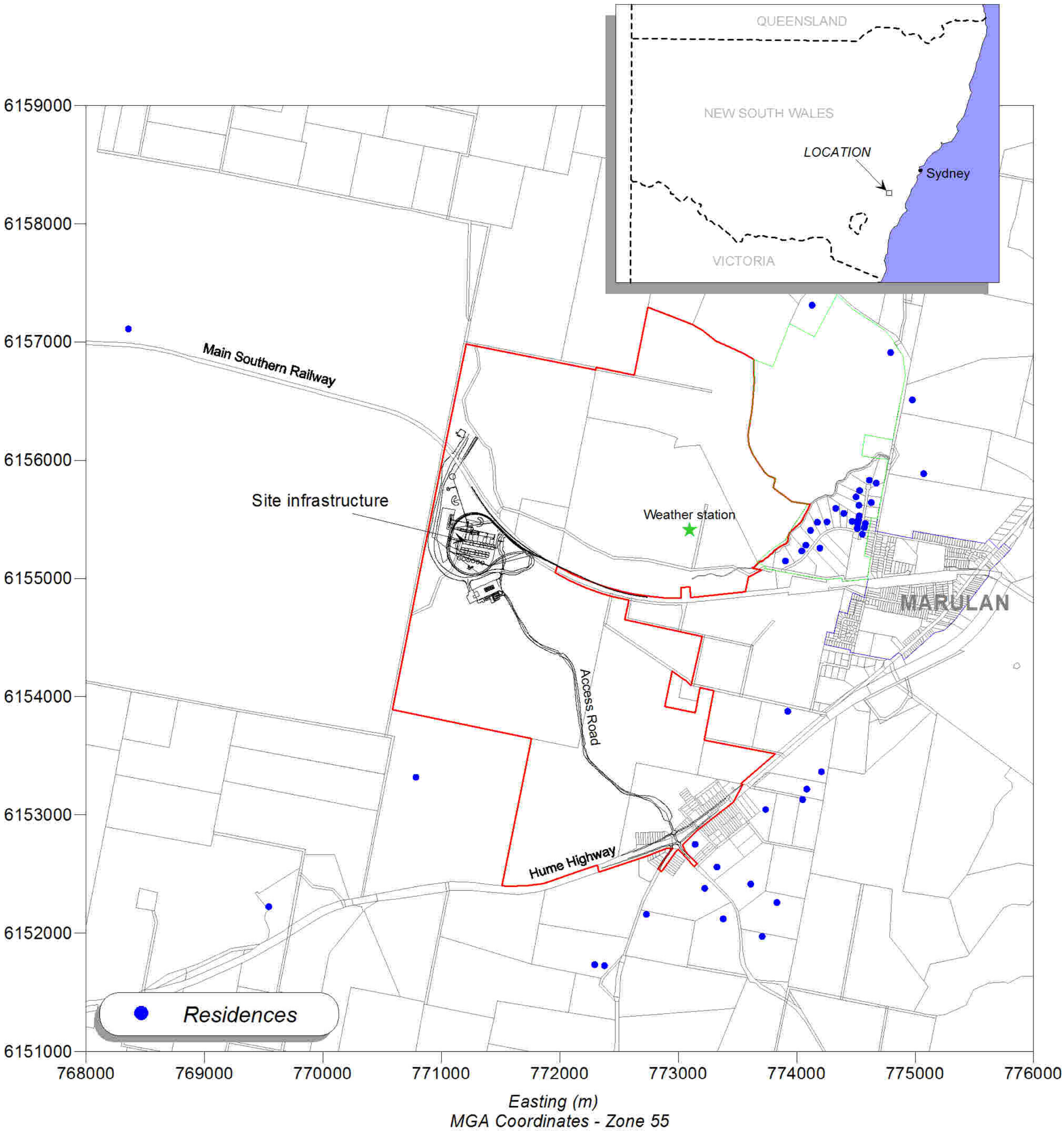
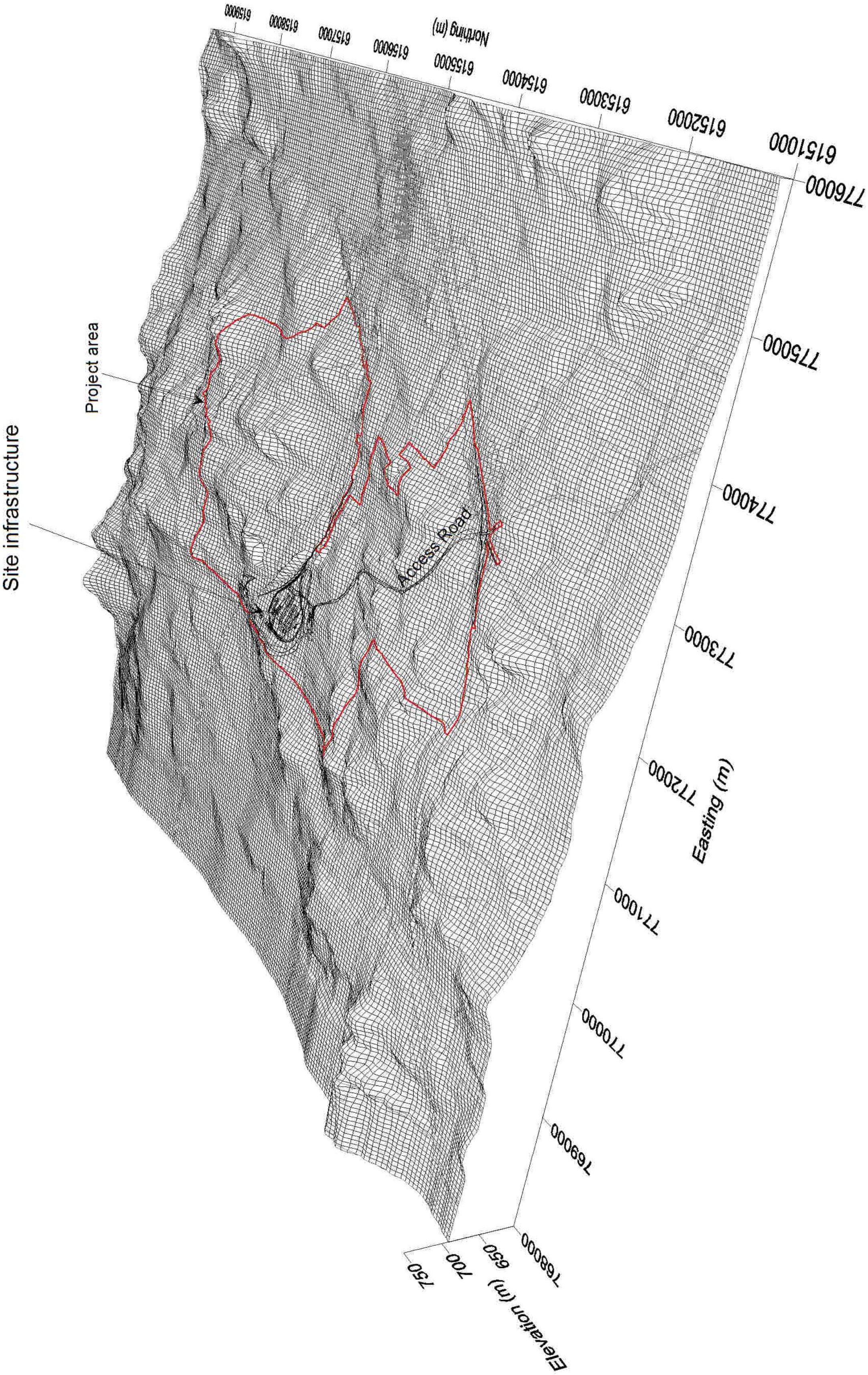
FIGURES



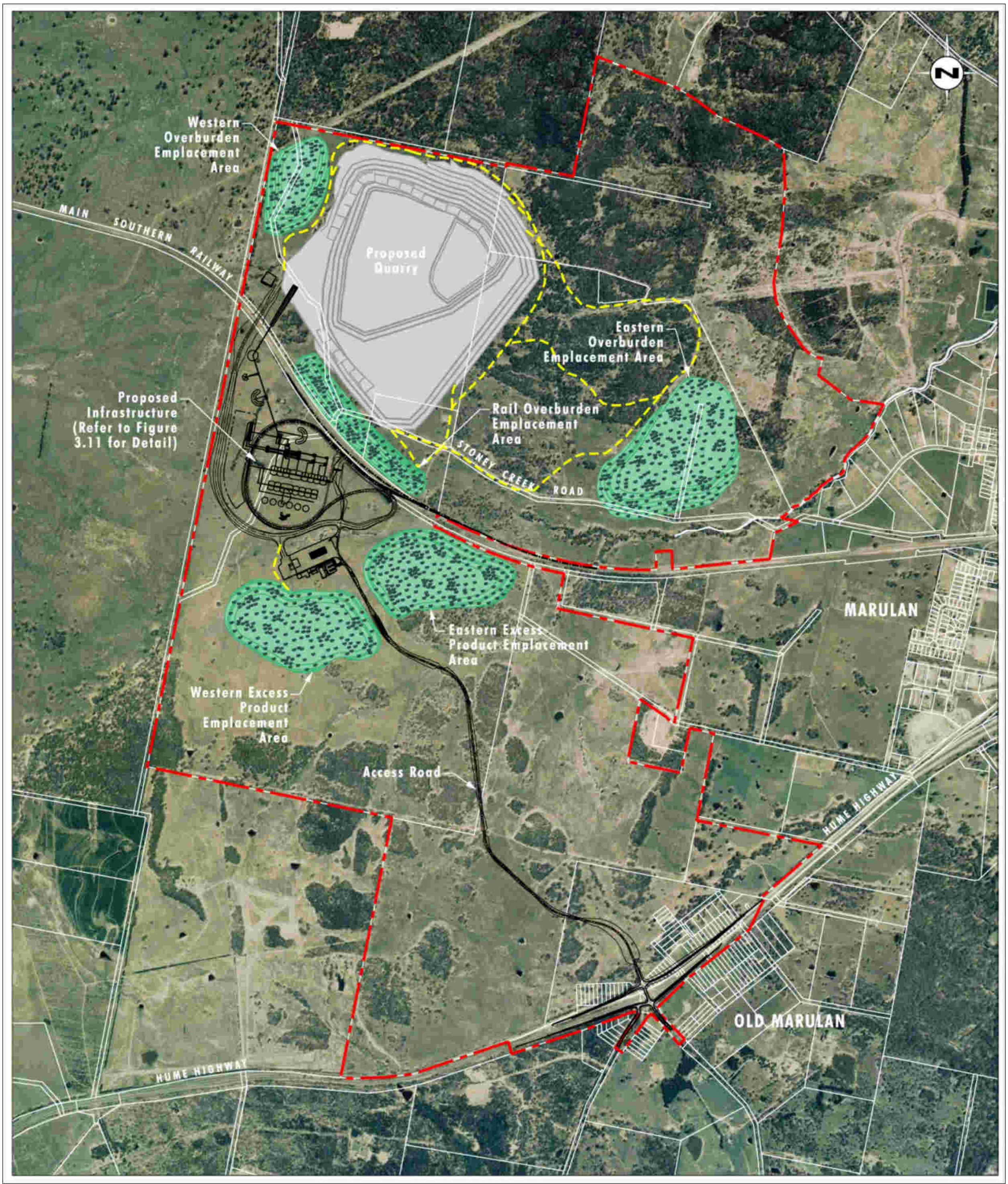
Location of proposed 'Lynwood' hard rock quarry

FIGURE 1



Pseudo 3-dimensional representation of the project area

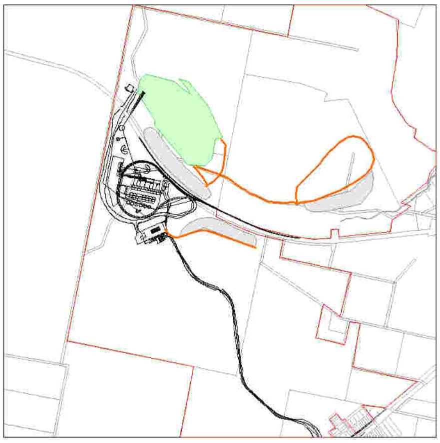
FIGURE 2



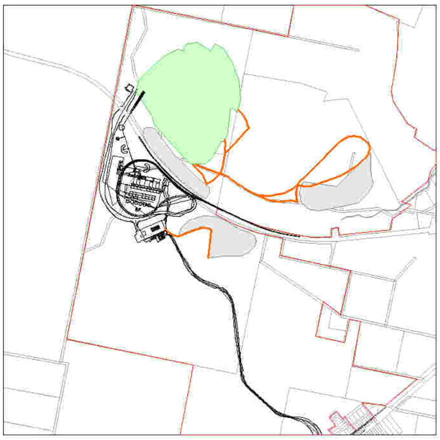
Quarry extents and site facilities

FIGURE 3

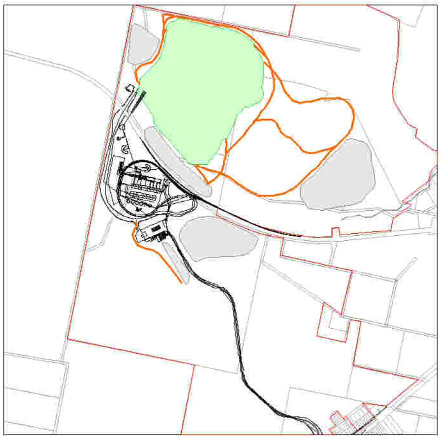
Year 2



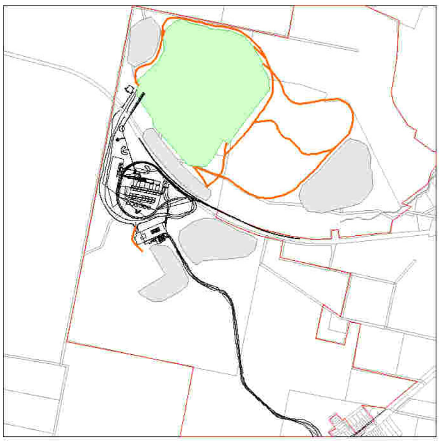
Year 5



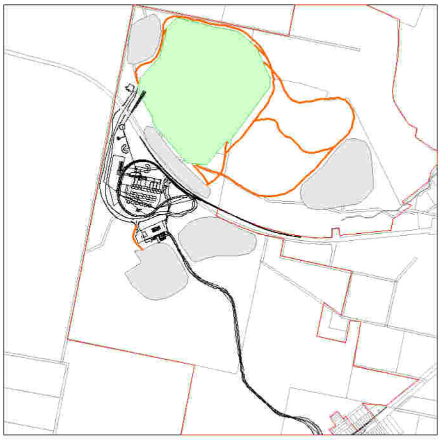
Year 10



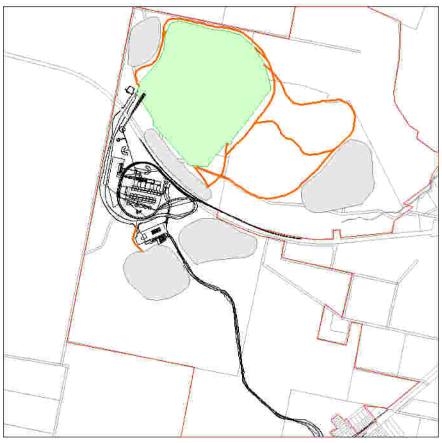
Year 15



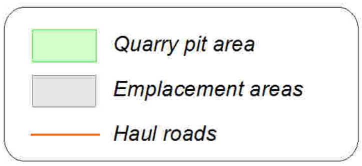
Year 20



Year 25

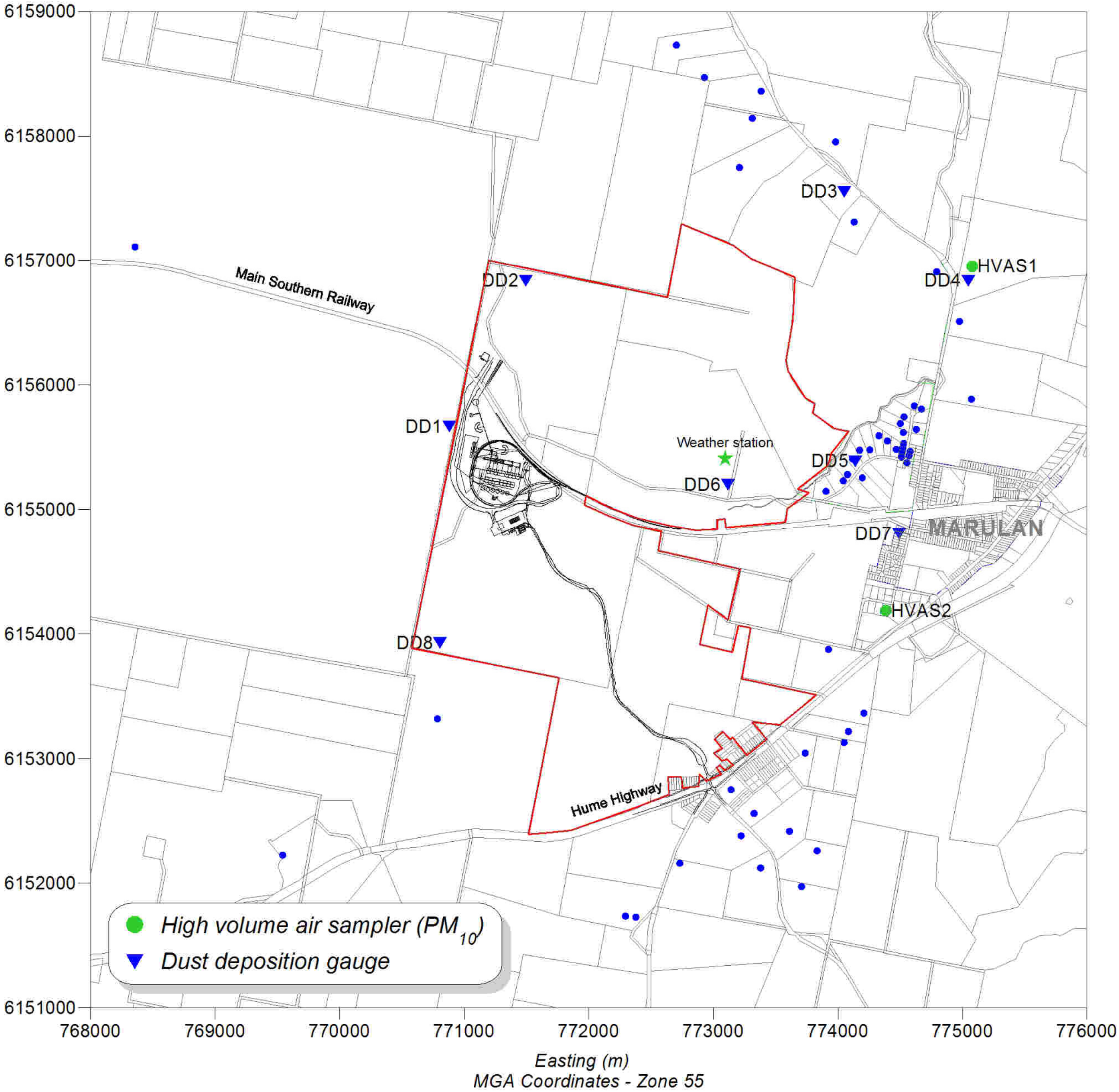


Year 30



Conceptual quarry development

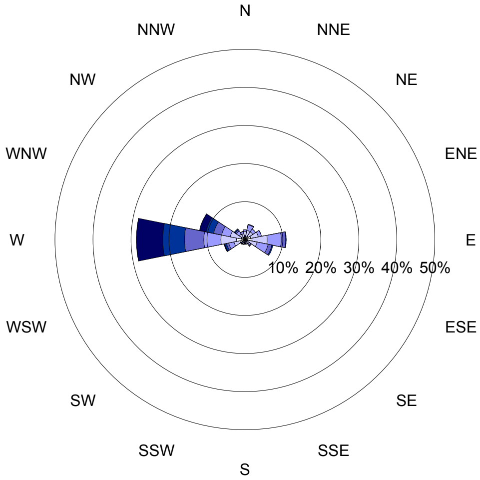
FIGURE 4



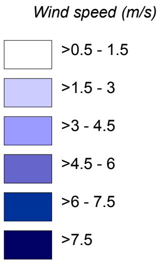
Monitoring for Lynwood quarry

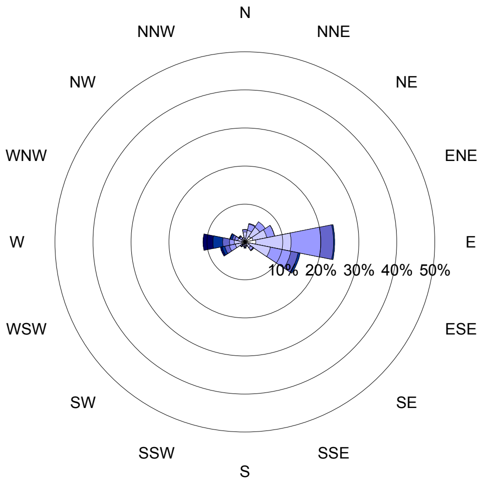
FIGURE 5

Annual and seasonal windroses for 'Lynwood' Marulan (18-Jun-05 to 1-Feb-05)

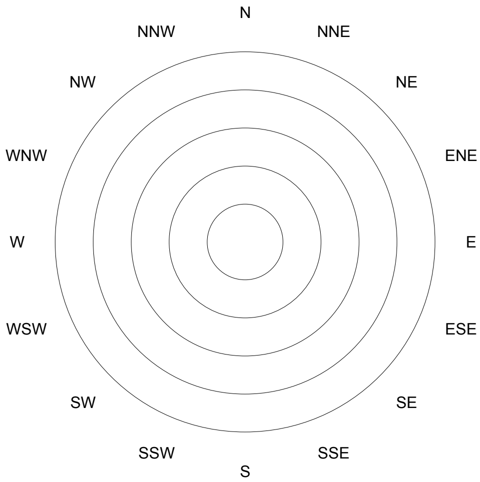


Annual
Calms = 7.8%

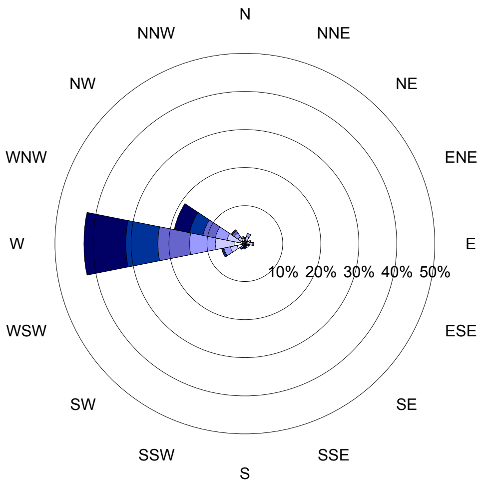




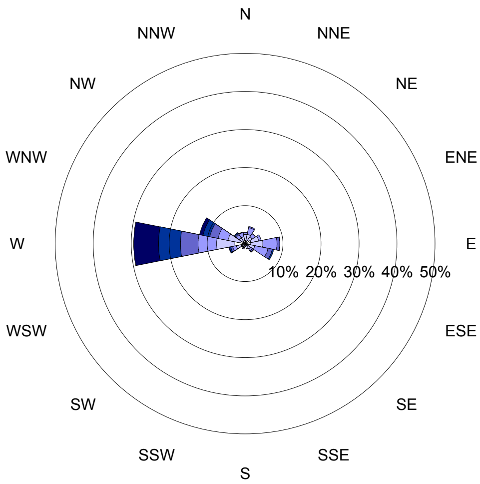
Summer
Calms = 5.5%



Autumn
Calms = 10.7%



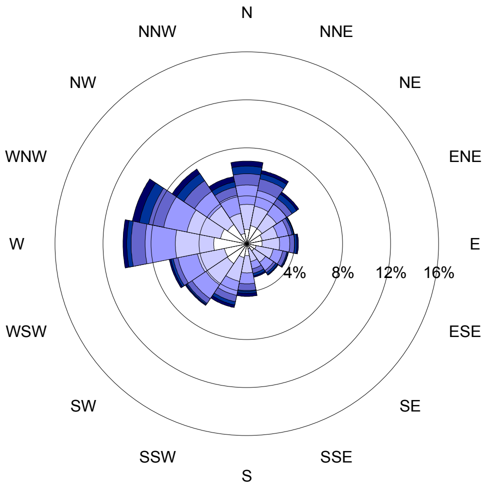
Winter
Calms = 9.2%



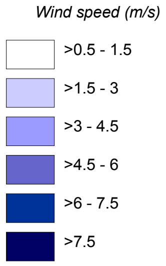
Spring
Calms = 8.1%

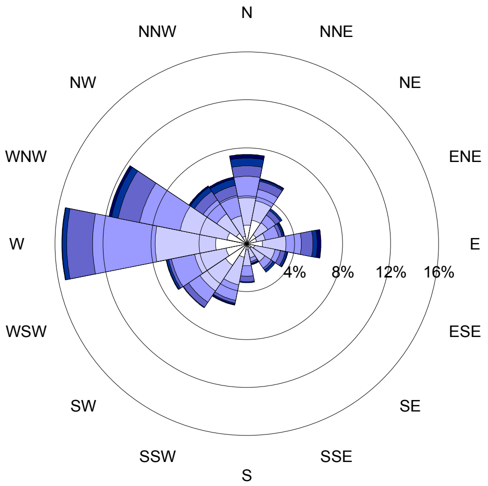
FIGURE 6

Annual and seasonal windroses for 'Wangi' Marulan (2000)

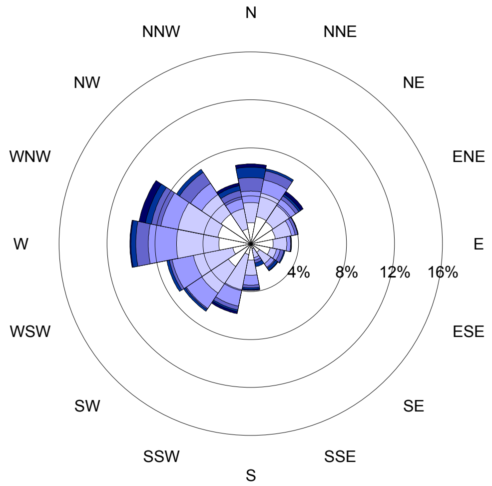


Annual
Calms = 8.0%

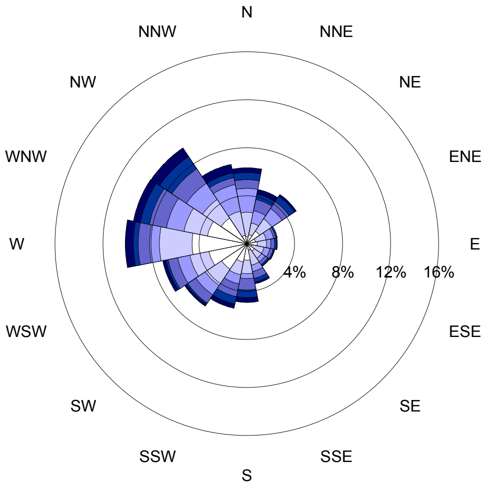




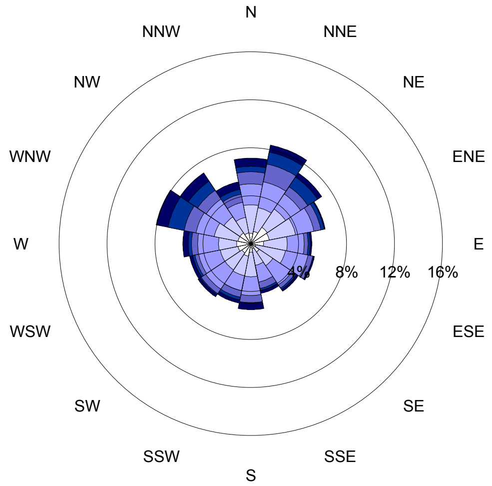
Summer
Calms = 5.6%



Autumn
Calms = 10.7%

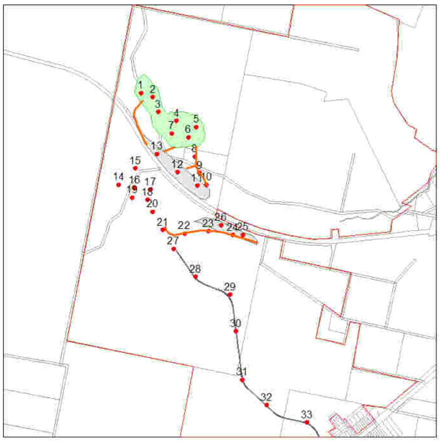


Winter
Calms = 11.1%

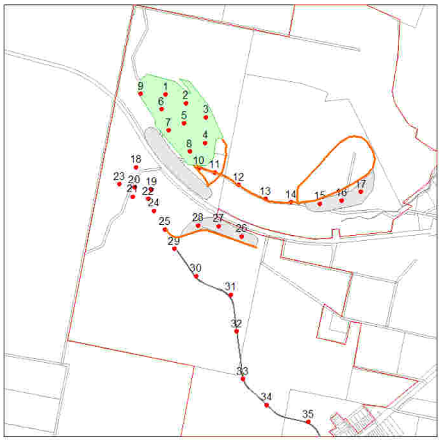


Spring
Calms = 4.4%

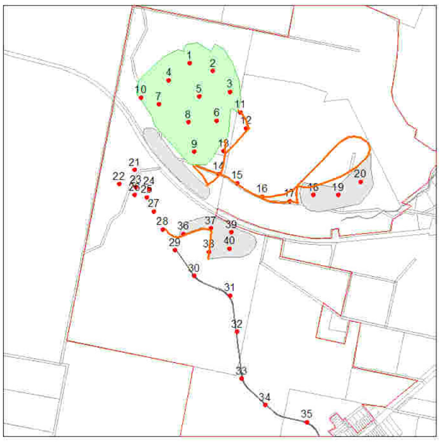
FIGURE 7



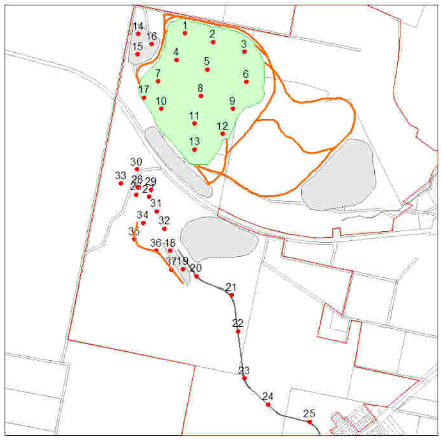
Year 2



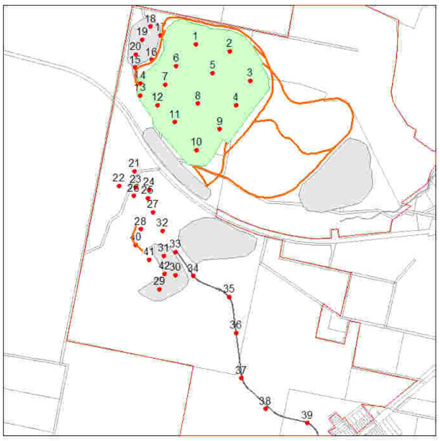
Year 5



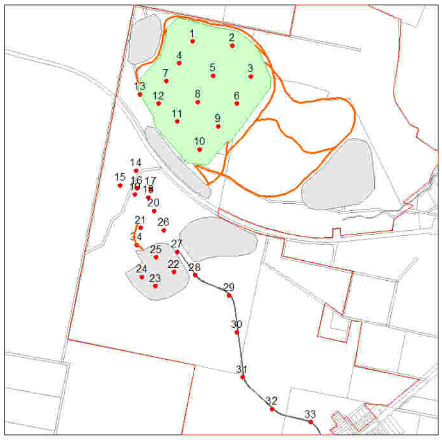
Year 10



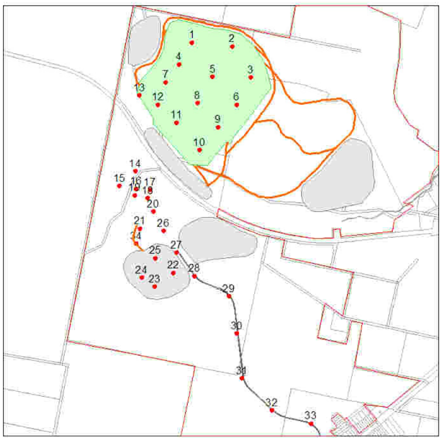
Year 15



Year 20



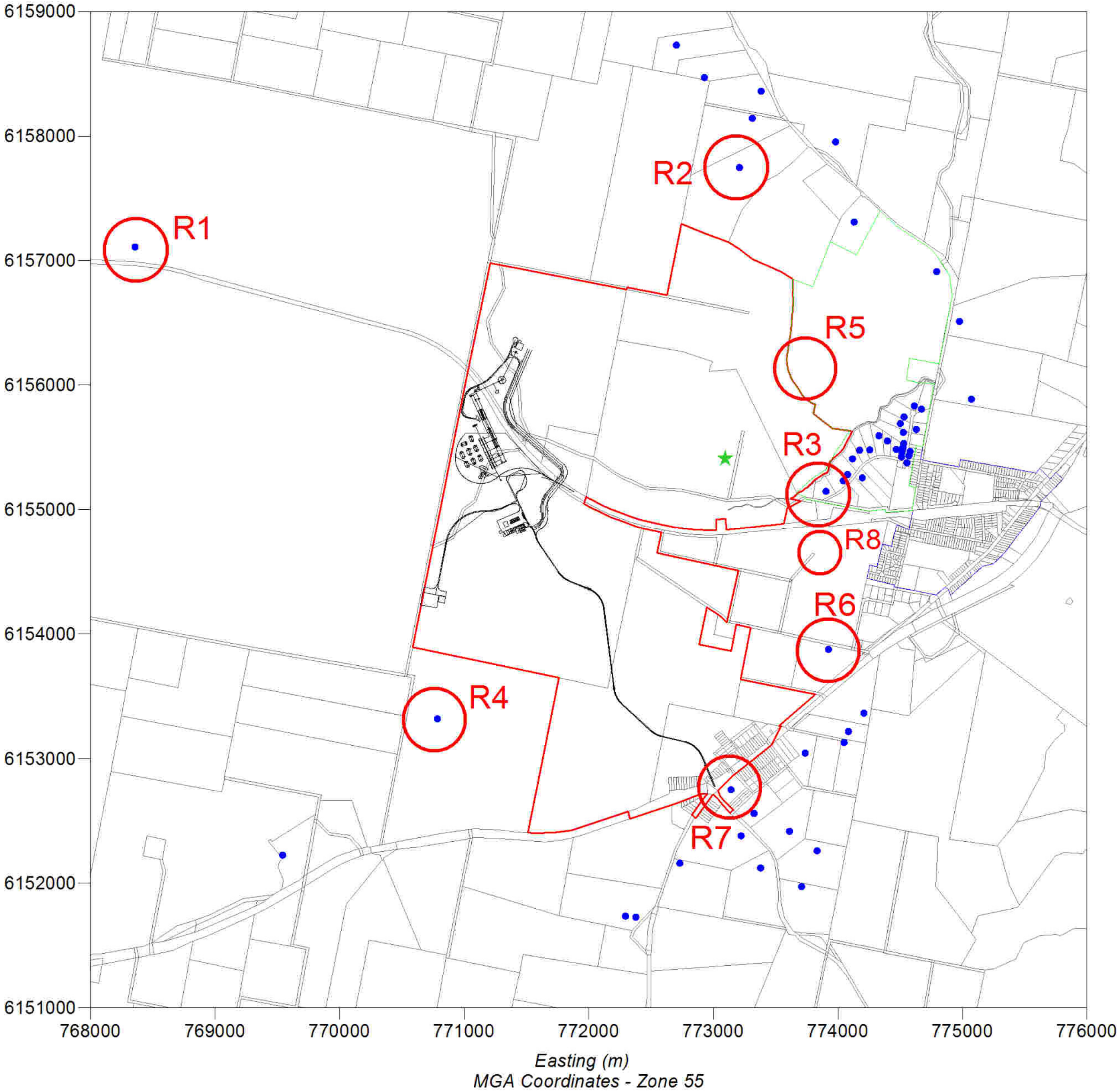
Year 25



Year 30

Modelled dust sources during stages of quarry

FIGURE 8

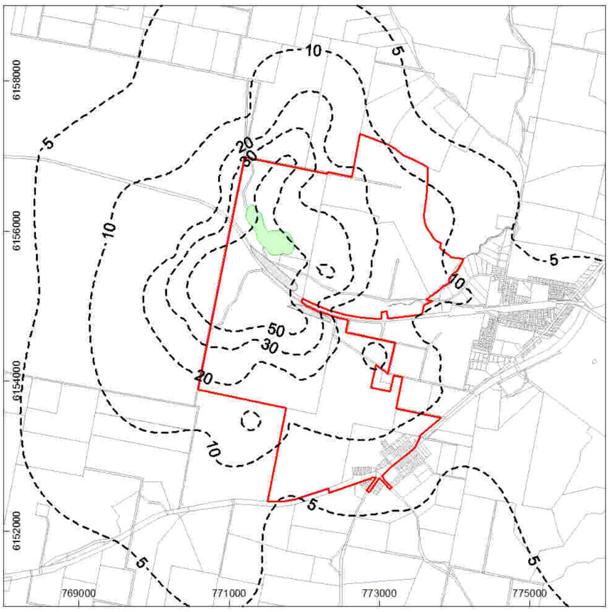


Note: "R5" and "R8" chosen to represent possible future residential locations

Residences selected for the purposes of the assessment

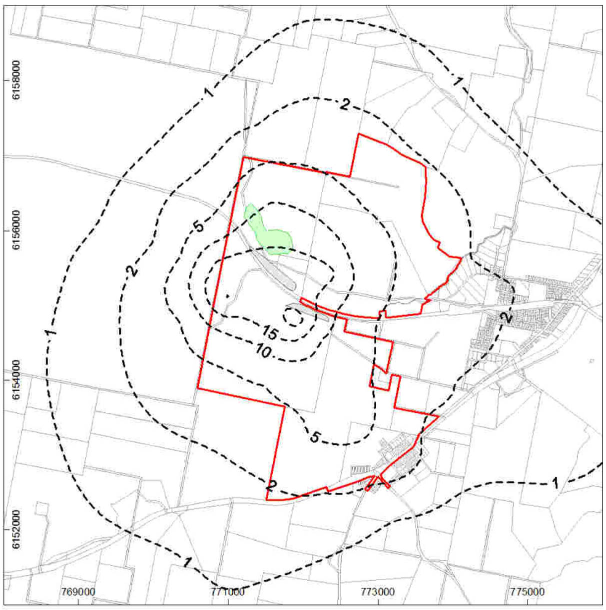
FIGURE 9

Relevant air quality goal: 50 µg/m^3



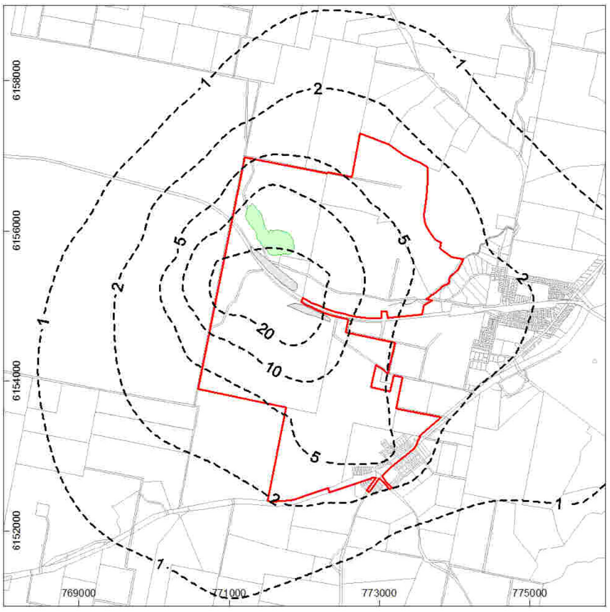
Maximum 24-hour average PM_{10} - µg/m^3

Relevant air quality goal: 30 µg/m^3



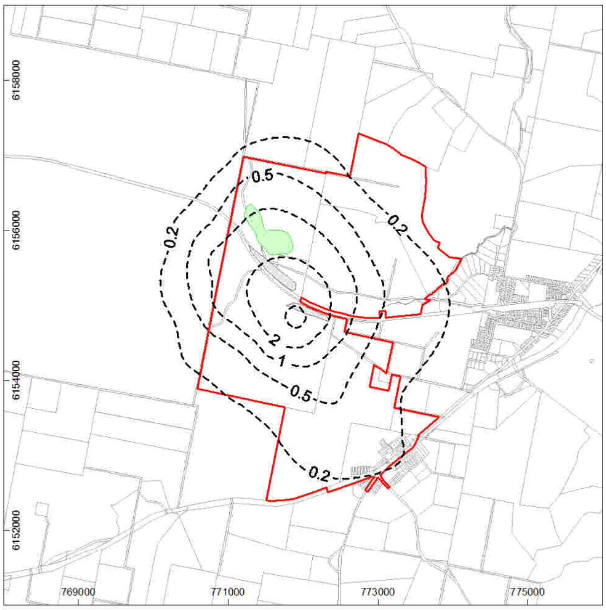
Annual average PM_{10} - µg/m^3

Relevant air quality goal: 90 µg/m^3



Annual average TSP - µg/m^3

Relevant air quality goal: 2 g/m^2/month

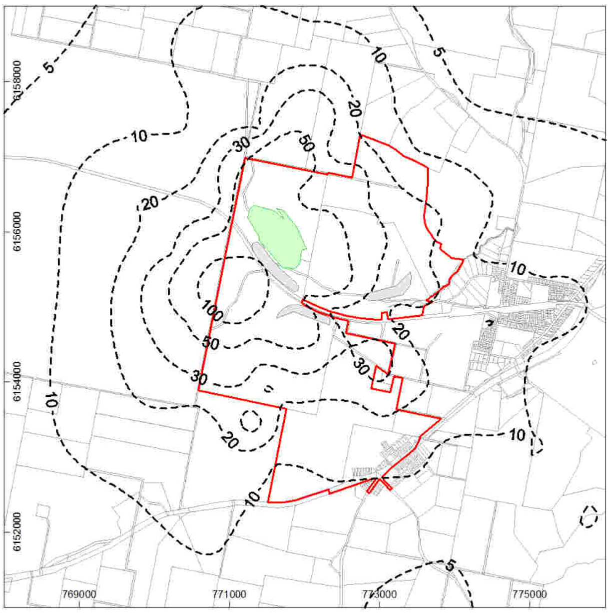


Annual average dust deposition - g/m^2/month

Dispersion model predictions for Year 2 quarry operations

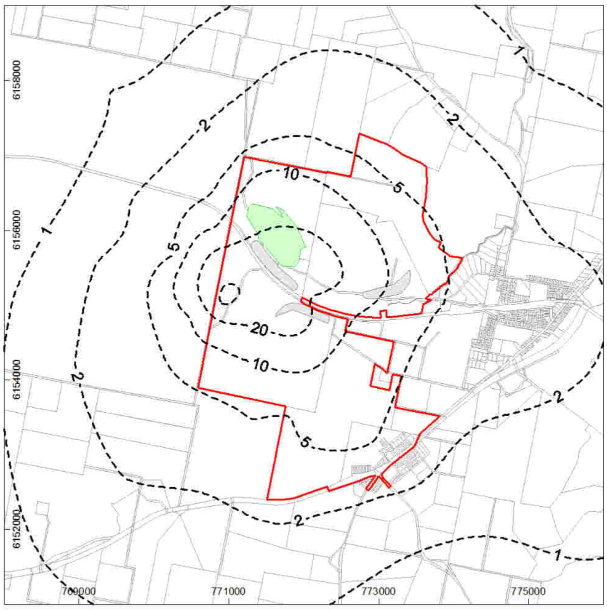
FIGURE 10

Relevant air quality goal: 50 µg/m³



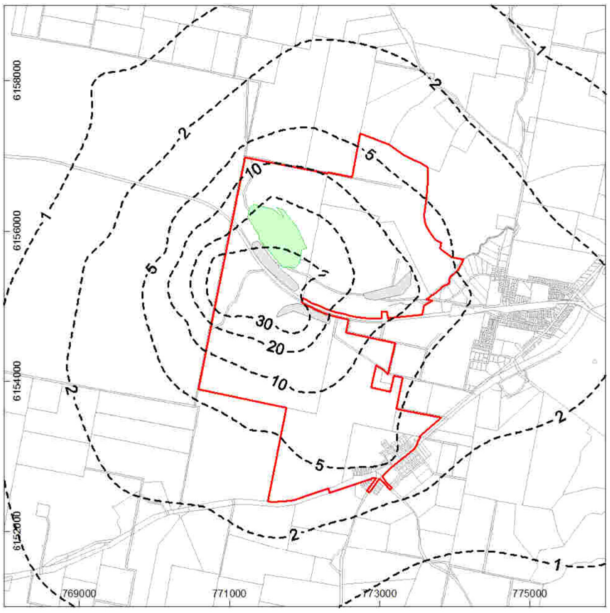
Maximum 24-hour average PM_{10} - µg/m³

Relevant air quality goal: 30 µg/m³



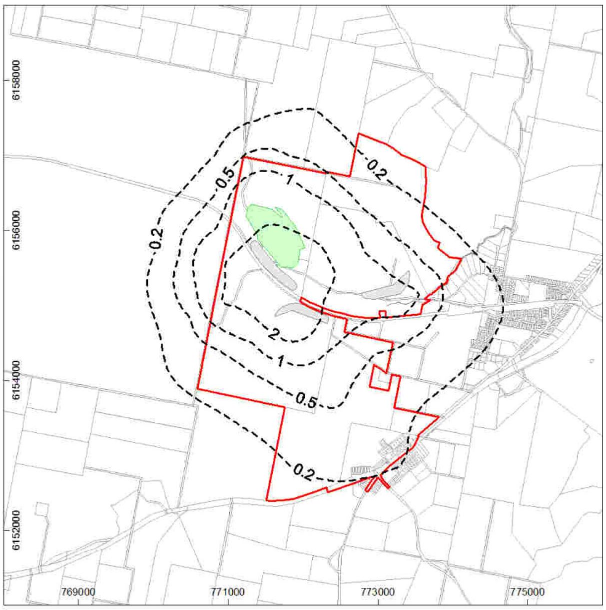
Annual average PM_{10} - µg/m³

Relevant air quality goal: 90 µg/m³



Annual average TSP - µg/m³

Relevant air quality goal: 2 g/m²/month

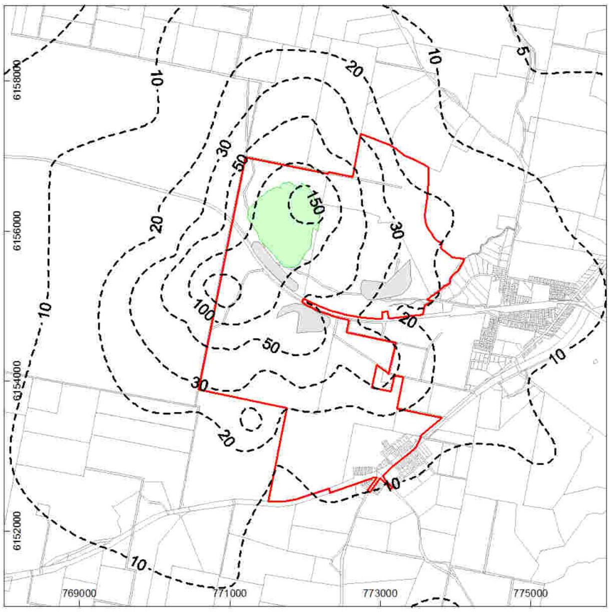


Annual average dust deposition - g/m²/month

Dispersion model predictions for Year 5 quarry operations

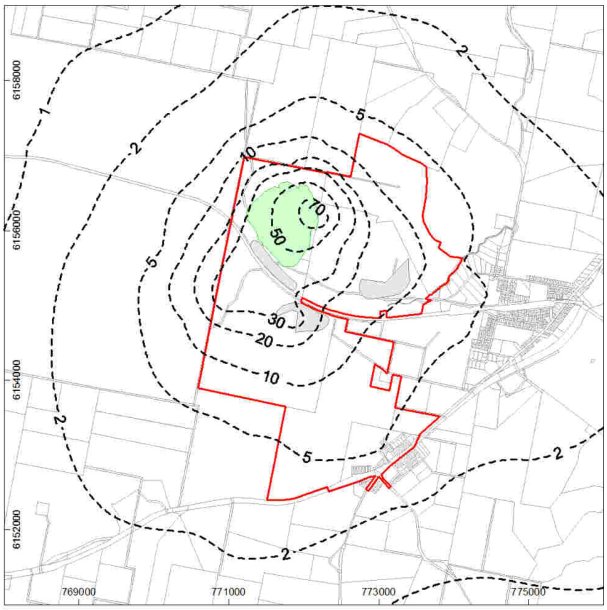
FIGURE 11

Relevant air quality goal: 50 µg/m³



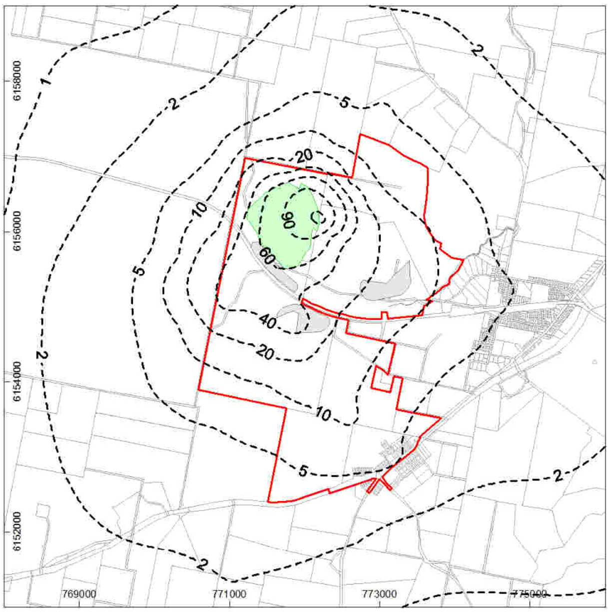
Maximum 24-hour average PM_{10} - µg/m³

Relevant air quality goal: 30 µg/m³



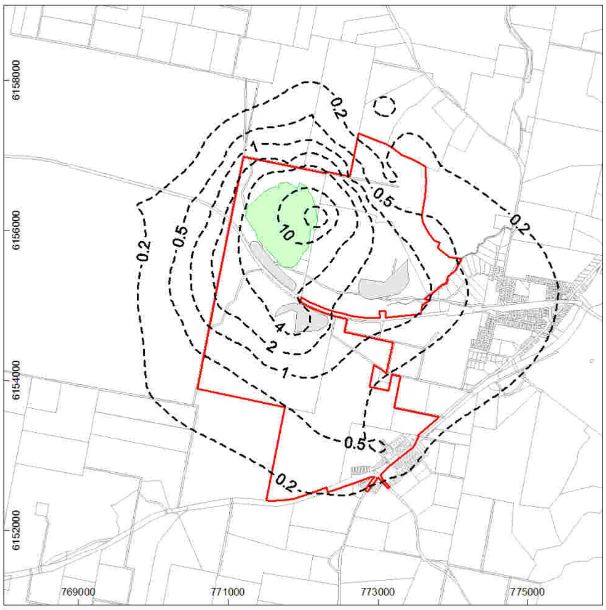
Annual average PM_{10} - µg/m³

Relevant air quality goal: 90 µg/m³



Annual average TSP - µg/m³

Relevant air quality goal: 2 g/m²/month

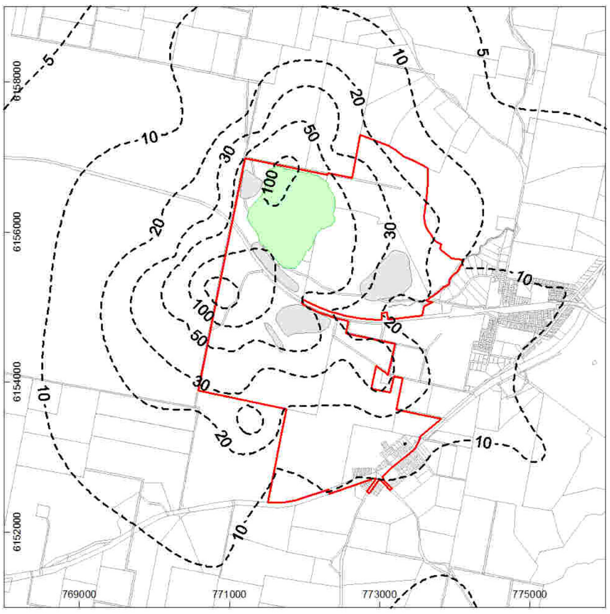


Annual average dust deposition - g/m²/month

Dispersion model predictions for Year 10 quarry operations

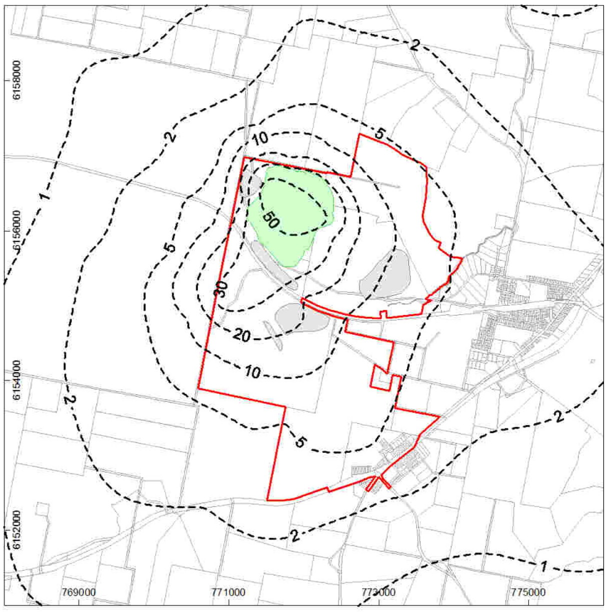
FIGURE 12

Relevant air quality goal: 50 µg/m³



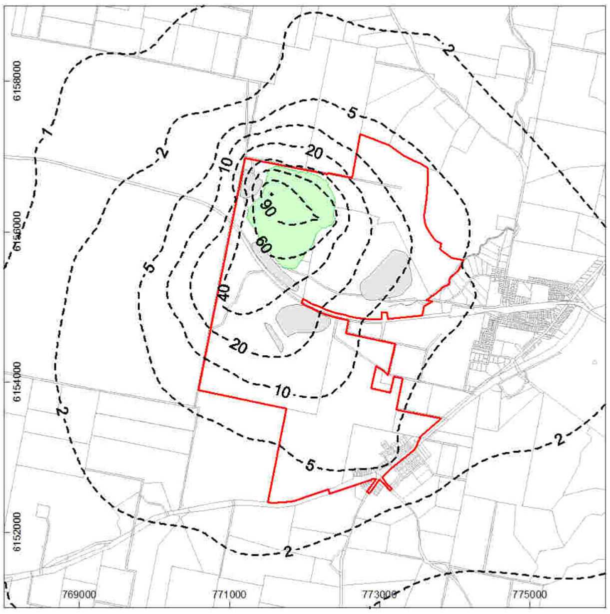
Maximum 24-hour average PM_{10} - µg/m³

Relevant air quality goal: 30 µg/m³



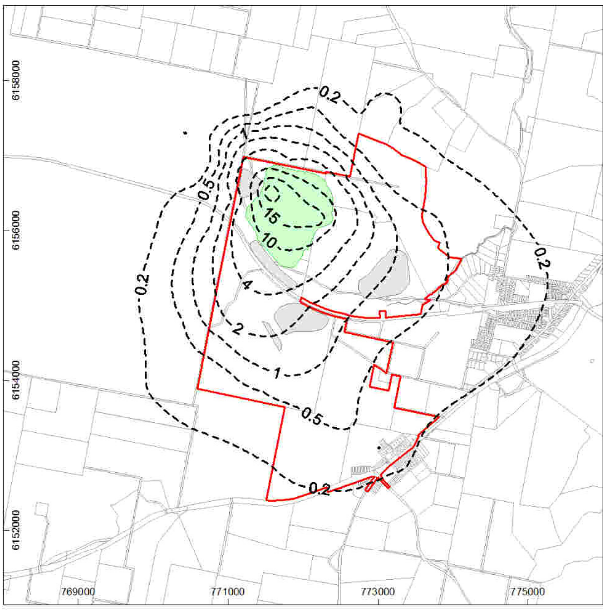
Annual average PM_{10} - µg/m³

Relevant air quality goal: 90 µg/m³



Annual average TSP - µg/m³

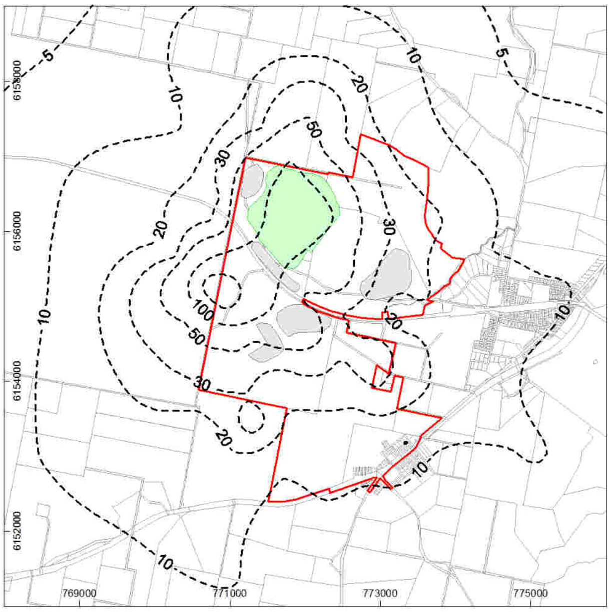
Relevant air quality goal: 2 g/m²/month



Annual average dust deposition - g/m²/month

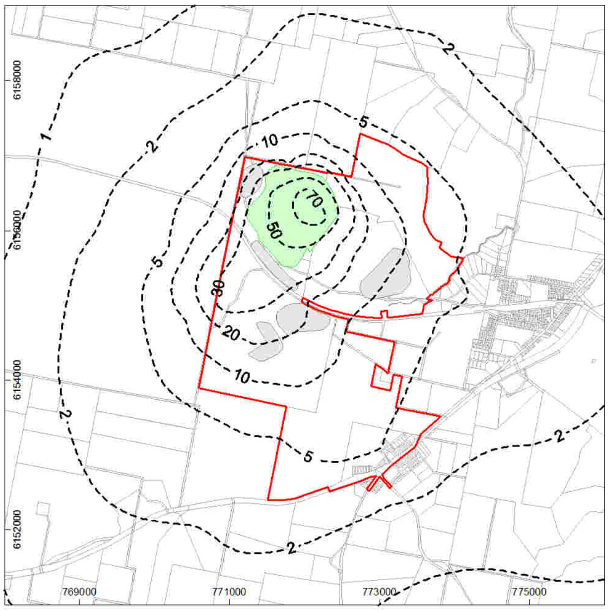
Dispersion model predictions for Year 15 quarry operations

Relevant air quality goal: 50 µg/m³



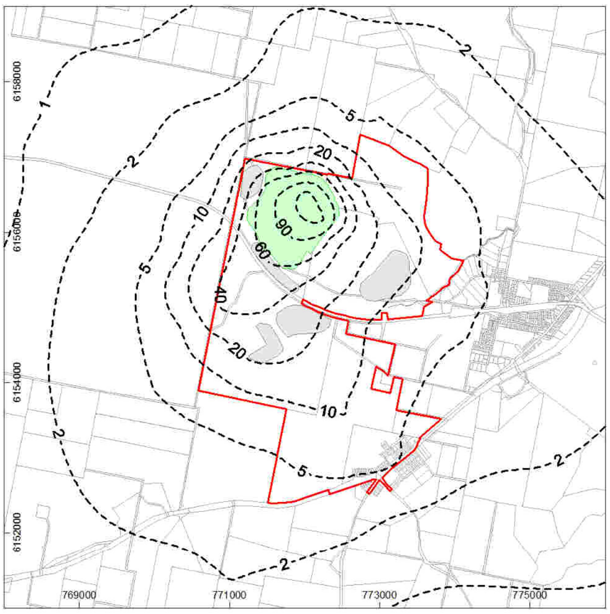
Maximum 24-hour average PM_{10} - µg/m³

Relevant air quality goal: 30 µg/m³



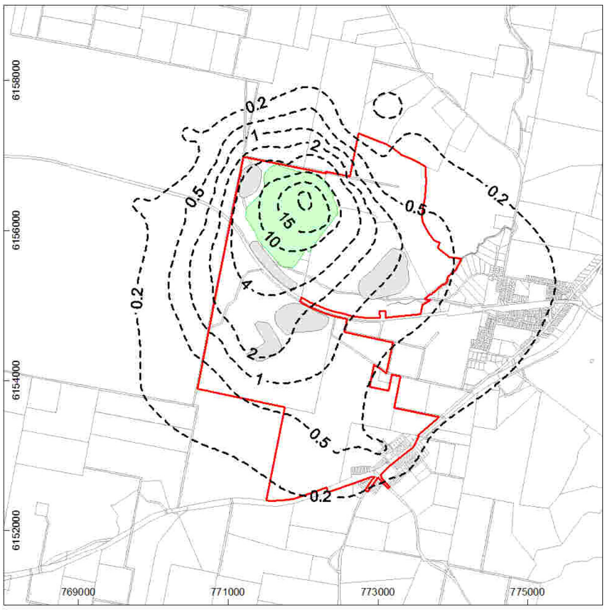
Annual average PM_{10} - µg/m³

Relevant air quality goal: 90 µg/m³



Annual average TSP - µg/m³

Relevant air quality goal: 2 g/m²/month

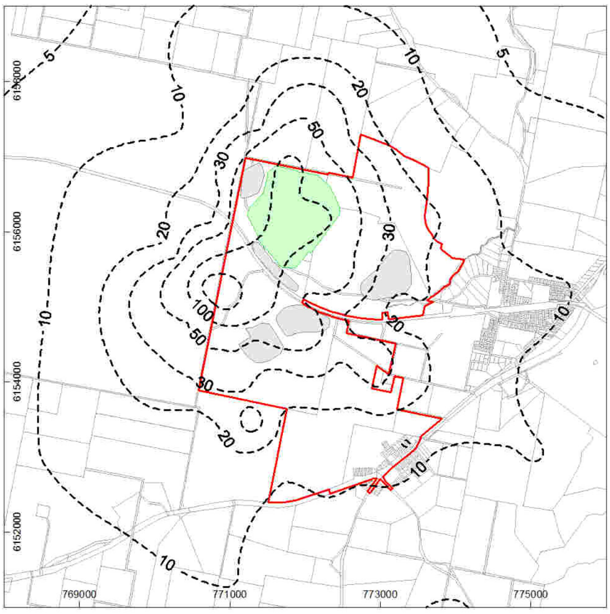


Annual average dust deposition - g/m²/month

Dispersion model predictions for Year 20 quarry operations

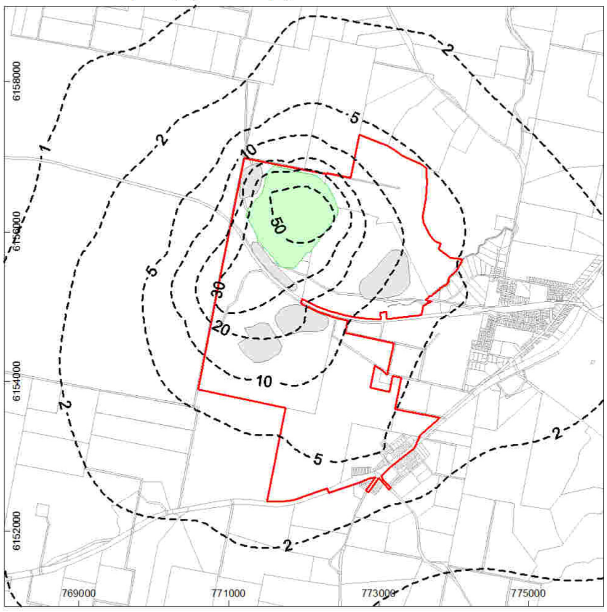
FIGURE 14

Relevant air quality goal: 50 µg/m^3



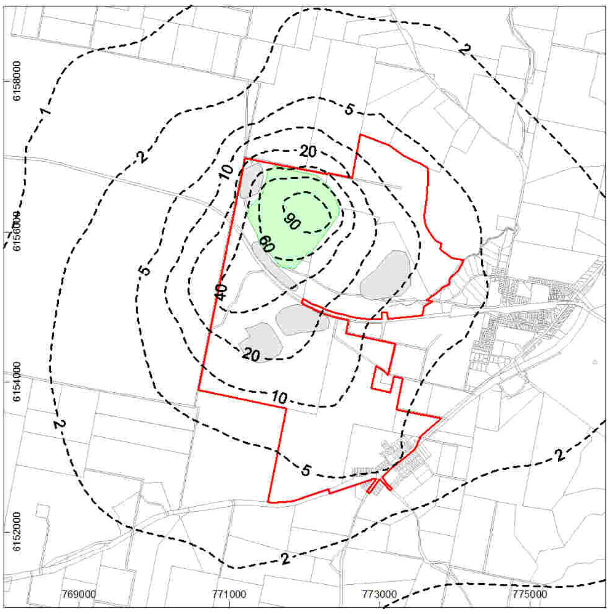
Maximum 24-hour average PM_{10} - µg/m^3

Relevant air quality goal: 30 µg/m^3



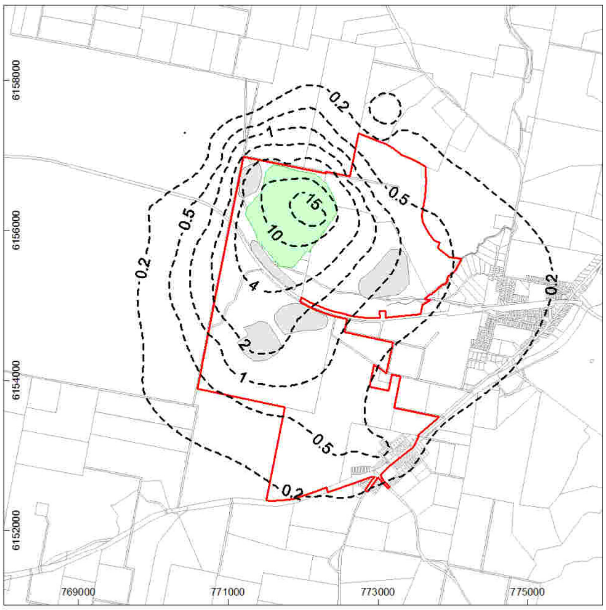
Annual average PM_{10} - µg/m^3

Relevant air quality goal: 90 µg/m^3



Annual average TSP - µg/m^3

Relevant air quality goal: 2 g/m^2/month

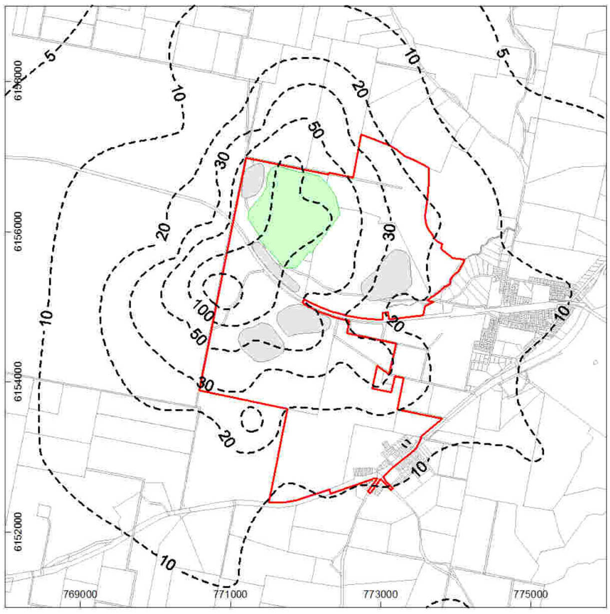


Annual average dust deposition - g/m^2/month

Dispersion model predictions for Year 25 quarry operations

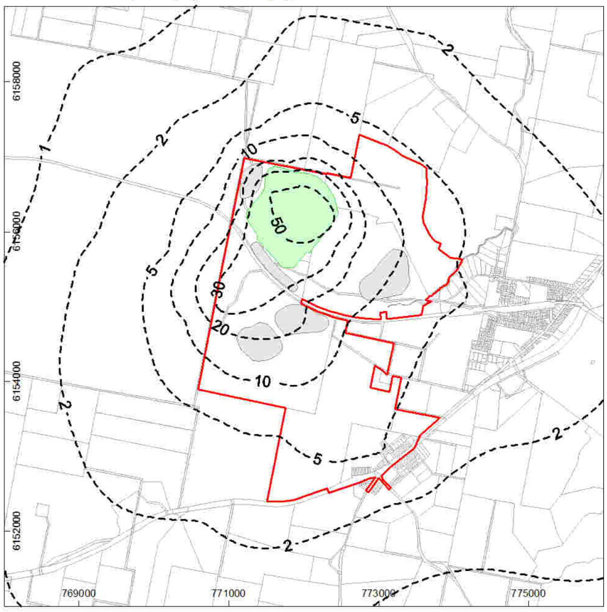
FIGURE 15

Relevant air quality goal: 50 µg/m³



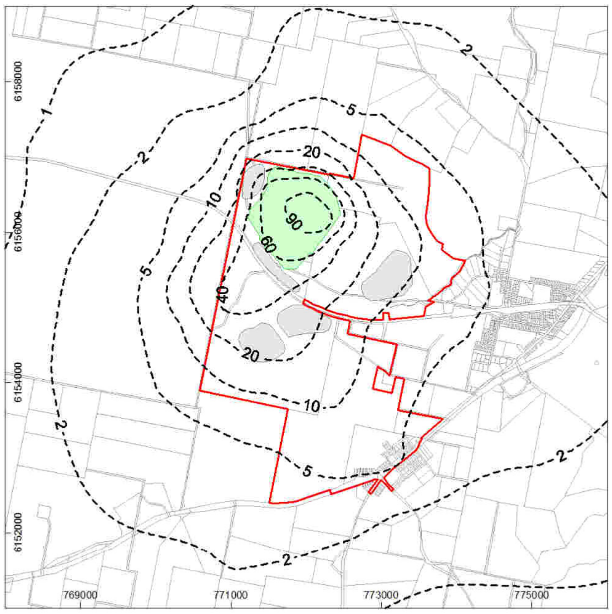
Maximum 24-hour average PM_{10} - µg/m³

Relevant air quality goal: 30 µg/m³



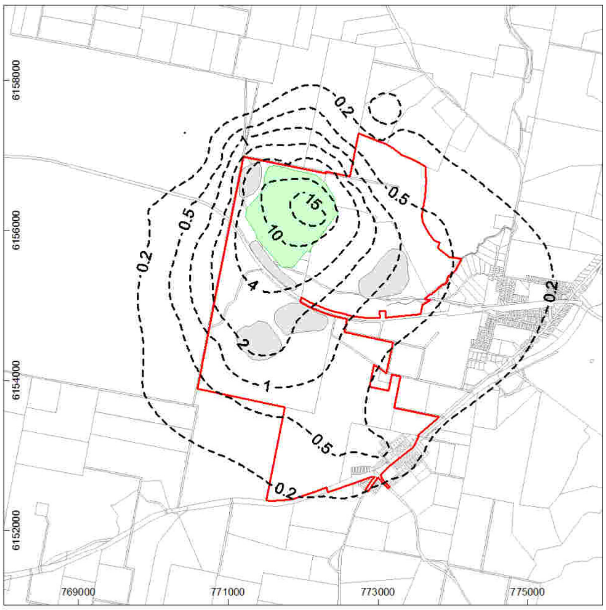
Annual average PM_{10} - µg/m³

Relevant air quality goal: 90 µg/m³



Annual average TSP - µg/m³

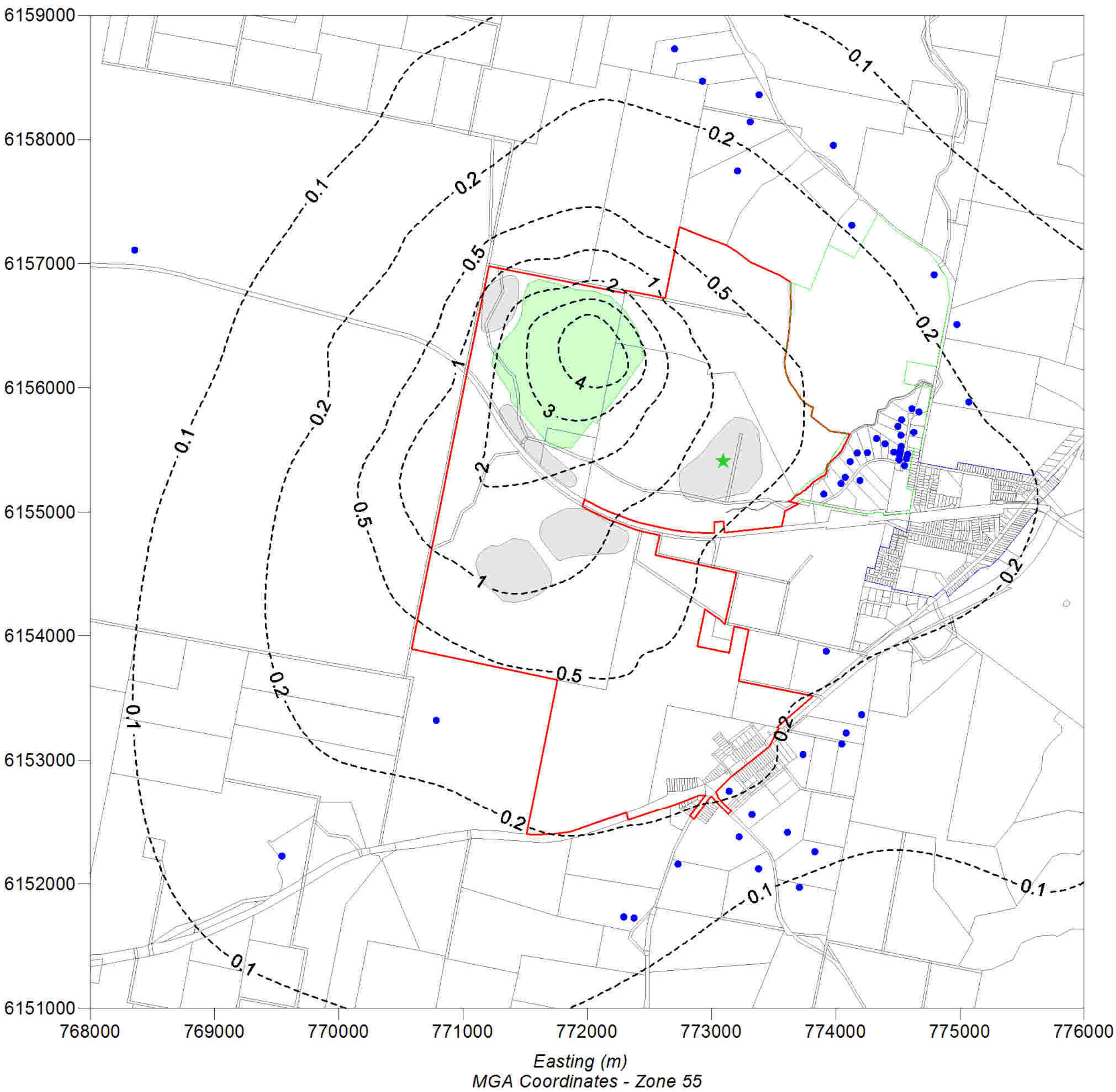
Relevant air quality goal: 2 g/m²/month



Annual average dust deposition - g/m²/month

Dispersion model predictions for Year 30 quarry operations

FIGURE 16



Predicted annual average silica concentration for Year 20 quarry operations (µg/m^3)

FIGURE 17

APPENDIX A
JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES

JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES:

Lynwood (18-Jun-04 to 1-Feb-05) data

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000366	0.002195	0.000366	0.000183	0.000000	0.000000	0.000000	0.000000	0.003110
NE	0.000915	0.002195	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.003293
ENE	0.001098	0.001829	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.003293
E	0.001464	0.003293	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.004940
ESE	0.001464	0.003110	0.000915	0.000000	0.000000	0.000000	0.000000	0.000000	0.005488
SE	0.000915	0.002744	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
SSE	0.000549	0.001464	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
S	0.000732	0.000915	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001647
SSW	0.001281	0.001281	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.002927
SW	0.000549	0.001281	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
WSW	0.001098	0.003659	0.000183	0.000183	0.000000	0.000000	0.000000	0.000000	0.005123
W	0.001098	0.004391	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.005671
WNW	0.000549	0.003293	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.004025
NW	0.000732	0.001281	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
NNW	0.000732	0.001098	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001829
N	0.000732	0.001647	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.002561
CALM									0.002378
TOTAL	0.014270	0.035675	0.003476	0.000366	0.000000	0.000000	0.000000	0.000000	0.056165

MEAN WIND SPEED (m/s) = 1.92
NUMBER OF OBSERVATIONS = 307

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000183	0.002744	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.003110
NE	0.000183	0.001647	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
ENE	0.000183	0.001647	0.000732	0.000000	0.000000	0.000000	0.000000	0.000000	0.002561
E	0.000366	0.000732	0.001281	0.000000	0.000000	0.000000	0.000000	0.000000	0.002378
ESE	0.000183	0.001098	0.000732	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
SE	0.000366	0.001098	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.001829
SSE	0.000183	0.000549	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000915
S	0.000000	0.000549	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000732
SSW	0.000000	0.000000	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000366
SW	0.000000	0.000732	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.001098
WSW	0.000366	0.001829	0.001647	0.000183	0.000000	0.000000	0.000000	0.000000	0.004025
W	0.000366	0.002378	0.001281	0.000183	0.000000	0.000000	0.000000	0.000000	0.004208
WNW	0.000000	0.000183	0.000183	0.000183	0.000000	0.000000	0.000000	0.000000	0.000549
NW	0.000366	0.000366	0.001098	0.000366	0.000000	0.000000	0.000000	0.000000	0.002195
NNW	0.000000	0.000183	0.000549	0.000000	0.000000	0.000000	0.000000	0.000000	0.000732
N	0.000000	0.001281	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001281
CALM									0.000183
TOTAL	0.002744	0.017014	0.009330	0.000915	0.000000	0.000000	0.000000	0.000000	0.030187

MEAN WIND SPEED (m/s) = 2.76
NUMBER OF OBSERVATIONS = 165

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000549	0.002927	0.004391	0.000549	0.000000	0.000000	0.000000	0.000000	0.008416
NE	0.000549	0.003293	0.003842	0.000183	0.000000	0.000000	0.000000	0.000000	0.007867
ENE	0.000183	0.001647	0.003110	0.000000	0.000000	0.000000	0.000000	0.000000	0.004940
E	0.000732	0.001647	0.005123	0.000549	0.000000	0.000000	0.000000	0.000000	0.008050
ESE	0.000183	0.001281	0.002744	0.000549	0.000000	0.000000	0.000000	0.000000	0.004757
SE	0.000366	0.000183	0.000732	0.000000	0.000000	0.000000	0.000000	0.000000	0.001281
SSE	0.000366	0.000732	0.000549	0.000000	0.000000	0.000000	0.000000	0.000000	0.001647
S	0.000366	0.000366	0.000366	0.000549	0.000000	0.000000	0.000000	0.000000	0.001647
SSW	0.000549	0.000549	0.000549	0.000000	0.000000	0.000000	0.000000	0.000000	0.001647
SW	0.000366	0.000732	0.000183	0.000732	0.000000	0.000000	0.000000	0.000000	0.002012
WSW	0.000000	0.002378	0.002927	0.001098	0.000000	0.000000	0.000000	0.000000	0.006403
W	0.000366	0.000915	0.002927	0.001281	0.000000	0.000000	0.000000	0.000000	0.005488
WNW	0.000366	0.000915	0.001829	0.003476	0.000000	0.000000	0.000000	0.000000	0.006586
NW	0.000000	0.001098	0.003476	0.001829	0.000000	0.000000	0.000000	0.000000	0.006403
NNW	0.000000	0.001281	0.001464	0.000366	0.000000	0.000000	0.000000	0.000000	0.003110
N	0.000366	0.002561	0.001098	0.000000	0.000000	0.000000	0.000000	0.000000	0.004025
CALM									0.002012
TOTAL	0.005306	0.022503	0.035309	0.011160	0.000000	0.000000	0.000000	0.000000	0.076290

MEAN WIND SPEED (m/s) = 3.26
NUMBER OF OBSERVATIONS = 417

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002012	0.007318	0.009513	0.001098	0.000000	0.000000	0.000000	0.000000	0.019941
NE	0.004757	0.006403	0.004574	0.000000	0.000000	0.000000	0.000000	0.000000	0.015734
ENE	0.008416	0.012623	0.004208	0.000183	0.000000	0.000000	0.000000	0.000000	0.025430
E	0.007318	0.024332	0.022869	0.010977	0.001098	0.000000	0.000000	0.000000	0.066593
ESE	0.002012	0.007135	0.015002	0.009147	0.002927	0.000000	0.000000	0.000000	0.036224
SE	0.001829	0.002195	0.002561	0.002012	0.000366	0.000183	0.000000	0.000000	0.009147
SSE	0.000915	0.003293	0.001829	0.000183	0.000000	0.000000	0.000000	0.000000	0.006220
S	0.000915	0.002378	0.002012	0.000732	0.001464	0.000000	0.000000	0.000000	0.007501
SSW	0.001281	0.002378	0.002561	0.001464	0.000000	0.000000	0.000000	0.000000	0.007684
SW	0.000732	0.000915	0.000732	0.000915	0.000000	0.000183	0.000000	0.000000	0.003476
WSW	0.004025	0.005488	0.006403	0.004208	0.004757	0.001281	0.000915	0.000000	0.027076
W	0.006769	0.011709	0.016831	0.041712	0.057629	0.044823	0.017380	0.007135	0.203988
WNW	0.002195	0.011160	0.010794	0.015734	0.020490	0.011343	0.005123	0.001098	0.077936
NW	0.001647	0.005123	0.005123	0.001647	0.002744	0.000183	0.000000	0.000000	0.016465
NNW	0.001281	0.003476	0.004025	0.000183	0.000000	0.000000	0.000000	0.000000	0.008965
N	0.001647	0.005488	0.002927	0.000366	0.000000	0.000000	0.000000	0.000000	0.010428
CALM									0.011526
TOTAL	0.047750	0.111416	0.111965	0.090560	0.091475	0.057995	0.023417	0.008233	0.554336

MEAN WIND SPEED (m/s) = 4.77
NUMBER OF OBSERVATIONS = 3030

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002012	0.001647	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
NE	0.002012	0.000549	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.002744
ENE	0.004940	0.001647	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006586
E	0.004574	0.012441	0.007501	0.000549	0.000000	0.000000	0.000000	0.000000	0.025064
ESE	0.002744	0.012075	0.010062	0.000549	0.000000	0.000000	0.000000	0.000000	0.025430
SE	0.000549	0.002195	0.000915	0.000000	0.000000	0.000000	0.000000	0.000000	0.003659
SSE	0.000183	0.000732	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.001098
S	0.000183	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000366
SSW	0.000366	0.000366	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000915
SW	0.000915	0.000915	0.002012	0.000366	0.000000	0.000000	0.000000	0.000000	0.004208
WSW	0.003842	0.002012	0.002927	0.000183	0.000000	0.000000	0.000000	0.000000	0.008965
W	0.005671	0.008416	0.023783	0.007501	0.000000	0.000000	0.000000	0.000000	0.045371
WNW	0.004208	0.006769	0.010062	0.002012	0.000000	0.000000	0.000000	0.000000	0.023052
NW	0.001829	0.002012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
NNW	0.001647	0.001647	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003293
N	0.001829	0.002378	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.004391
CALM									0.019393
TOTAL	0.037505	0.055982	0.058178	0.011160	0.000000	0.000000	0.000000	0.000000	0.182217

MEAN WIND SPEED (m/s) = 2.46
NUMBER OF OBSERVATIONS = 996

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002378	0.000549	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002927
NE	0.001829	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
ENE	0.000915	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001281
E	0.001098	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001281
ESE	0.000732	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000915
SE	0.000366	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000549
SSE	0.000366	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000549
S	0.000366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000366
SSW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
SW	0.001281	0.000183	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001464
WSW	0.004208	0.000549	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004757
W	0.008050	0.013172	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.021222
WNW	0.002927	0.006952	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009879
NW	0.002012	0.001281	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003293
NNW	0.003476	0.000915	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004391
N	0.002927	0.000915	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
CALM									0.042078
TOTAL	0.032931	0.025796	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.100805

MEAN WIND SPEED (m/s) = 1.10
NUMBER OF OBSERVATIONS = 551

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.007501	0.017380	0.014636	0.001829	0.000000	0.000000	0.000000	0.000000	0.041347
NE	0.010245	0.014270	0.008965	0.000183	0.000000	0.000000	0.000000	0.000000	0.033663
ENE	0.015734	0.019759	0.008416	0.000183	0.000000	0.000000	0.000000	0.000000	0.044091
E	0.015551	0.042627	0.036956	0.012075	0.001098	0.000000	0.000000	0.000000	0.108306
ESE	0.007318	0.024881	0.029455	0.010245	0.002927	0.000000	0.000000	0.000000	0.074826
SE	0.004391	0.008599	0.004757	0.002012	0.000366	0.000183	0.000000	0.000000	0.020307
SSE	0.002561	0.006952	0.002744	0.000183	0.000000	0.000000	0.000000	0.000000	0.012441
S	0.002561	0.004391	0.002561	0.001281	0.001464	0.000000	0.000000	0.000000	0.012258
SSW	0.003476	0.004574	0.004025	0.001464	0.000000	0.000000	0.000000	0.000000	0.013538
SW	0.003842	0.004757	0.003476	0.002012	0.000000	0.000183	0.000000	0.000000	0.014270
WSW	0.013538	0.015917	0.014087	0.005854	0.004757	0.001281	0.000915	0.000000	0.056348
W	0.022320	0.040981	0.045005	0.050677	0.057629	0.044823	0.017380	0.007135	0.285950
WNW	0.010245	0.029272	0.023052	0.021405	0.020490	0.011343	0.005123	0.001098	0.122027
NW	0.006586	0.011160	0.009696	0.003842	0.002744	0.000183	0.000000	0.000000	0.034211
NNW	0.007135	0.008599	0.006037	0.000549	0.000000	0.000000	0.000000	0.000000	0.022320
N	0.007501	0.014270	0.004391	0.000366	0.000000	0.000000	0.000000	0.000000	0.026528
CALM									0.077570
TOTAL	0.140505	0.268386	0.218258	0.114160	0.091475	0.057995	0.023417	0.008233	1.000000

MEAN WIND SPEED (m/s) = 3.64
NUMBER OF OBSERVATIONS = 5466

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 5.6%
B : 3.0%
C : 7.6%
D : 55.4%
E : 18.2%
F : 10.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0105	0073	0050
02	0000	0000	0000	0098	0072	0058
03	0000	0000	0000	0091	0077	0060
04	0000	0000	0000	0092	0080	0056
05	0000	0000	0000	0100	0086	0042
06	0007	0004	0011	0114	0059	0033
07	0010	0004	0025	0142	0027	0020
08	0019	0010	0039	0152	0005	0003
09	0025	0013	0039	0150	0000	0000
10	0027	0022	0041	0137	0000	0000
11	0047	0015	0038	0127	0000	0000
12	0043	0019	0044	0121	0000	0000
13	0047	0014	0046	0120	0000	0000
14	0029	0020	0042	0136	0000	0000
15	0022	0022	0039	0145	0000	0000
16	0016	0013	0033	0161	0005	0000
17	0011	0007	0014	0169	0022	0005
18	0004	0002	0006	0154	0049	0013
19	0000	0000	0000	0138	0068	0022
20	0000	0000	0000	0134	0059	0035
21	0000	0000	0000	0126	0068	0034
22	0000	0000	0000	0106	0084	0038
23	0000	0000	0000	0112	0073	0043
24	0000	0000	0000	0100	0089	0039

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0033	0014	0056	0644	0927	0542
<=1000 m	0104	0058	0166	1032	0028	0002
<=1500 m	0170	0093	0195	0903	0041	0007
<=2000 m	0000	0000	0000	0164	0000	0000
<=3000 m	0000	0000	0000	0251	0000	0000
>3000 m	0000	0000	0000	0036	0000	0000

Wangi (2000) data

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001025	0.003757	0.002163	0.000569	0.000000	0.000000	0.000000	0.000000	0.007514
NE	0.002277	0.004212	0.001138	0.000569	0.000000	0.000000	0.000000	0.000000	0.008197
ENE	0.001708	0.003074	0.002163	0.000228	0.000000	0.000000	0.000000	0.000000	0.007172
E	0.002505	0.003188	0.001366	0.000342	0.000000	0.000000	0.000000	0.000000	0.007400
ESE	0.000797	0.003871	0.000569	0.000114	0.000000	0.000000	0.000000	0.000000	0.005351
SE	0.000797	0.002960	0.001252	0.000000	0.000000	0.000000	0.000000	0.000000	0.005009
SSE	0.000911	0.001594	0.000797	0.000114	0.000000	0.000000	0.000000	0.000000	0.003415
S	0.001366	0.002732	0.000911	0.000114	0.000000	0.000000	0.000000	0.000000	0.005123
SSW	0.001025	0.002505	0.000683	0.000114	0.000000	0.000000	0.000000	0.000000	0.004326
SW	0.000797	0.002391	0.000797	0.000228	0.000000	0.000000	0.000000	0.000000	0.004212
WSW	0.000911	0.002732	0.001025	0.000114	0.000000	0.000000	0.000000	0.000000	0.004781
W	0.001252	0.001708	0.001138	0.000228	0.000000	0.000000	0.000000	0.000000	0.004326
WNW	0.001025	0.002732	0.001138	0.000228	0.000000	0.000000	0.000000	0.000000	0.005123
NW	0.001480	0.002618	0.001138	0.000455	0.000000	0.000000	0.000000	0.000000	0.005692
NNW	0.000569	0.002049	0.002049	0.000342	0.000000	0.000000	0.000000	0.000000	0.005009
N	0.000797	0.002960	0.002049	0.000569	0.000000	0.000000	0.000000	0.000000	0.006375
CALM									0.007741
TOTAL	0.019240	0.045082	0.020378	0.004326	0.000000	0.000000	0.000000	0.000000	0.096767

MEAN WIND SPEED (m/s) = 2.33
NUMBER OF OBSERVATIONS = 850

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000228	0.001935	0.003529	0.003757	0.000000	0.000000	0.000000	0.000000	0.009449
NE	0.000569	0.001138	0.002960	0.001480	0.000000	0.000000	0.000000	0.000000	0.006148
ENE	0.000228	0.002163	0.001935	0.001025	0.000000	0.000000	0.000000	0.000000	0.005351
E	0.000569	0.001935	0.002960	0.001138	0.000000	0.000000	0.000000	0.000000	0.006603
ESE	0.000455	0.001252	0.002505	0.000911	0.000000	0.000000	0.000000	0.000000	0.005123
SE	0.000455	0.001594	0.002277	0.000228	0.000000	0.000000	0.000000	0.000000	0.004554
SSE	0.000000	0.001594	0.000569	0.000342	0.000000	0.000000	0.000000	0.000000	0.002505
S	0.000228	0.001821	0.001708	0.000569	0.000000	0.000000	0.000000	0.000000	0.004326
SSW	0.000228	0.001480	0.001366	0.001025	0.000000	0.000000	0.000000	0.000000	0.004098
SW	0.000342	0.001252	0.002163	0.001025	0.000000	0.000000	0.000000	0.000000	0.004781
WSW	0.000114	0.001708	0.002049	0.000683	0.000000	0.000000	0.000000	0.000000	0.004554
W	0.000342	0.000797	0.003757	0.000797	0.000000	0.000000	0.000000	0.000000	0.005692
WNW	0.000569	0.001480	0.001821	0.001138	0.000000	0.000000	0.000000	0.000000	0.005009
NW	0.000683	0.002049	0.002732	0.001935	0.000000	0.000000	0.000000	0.000000	0.007400
NNW	0.000455	0.001935	0.003301	0.002960	0.000000	0.000000	0.000000	0.000000	0.008652
N	0.000683	0.002960	0.003757	0.004554	0.000000	0.000000	0.000000	0.000000	0.011954
CALM									0.002732
TOTAL	0.006148	0.027095	0.039390	0.023566	0.000000	0.000000	0.000000	0.000000	0.098930

MEAN WIND SPEED (m/s) = 3.51
NUMBER OF OBSERVATIONS = 869

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000569	0.001821	0.001594	0.001821	0.000000	0.000000	0.000000	0.000000	0.005806
NE	0.000455	0.001480	0.001935	0.001252	0.000000	0.000000	0.000000	0.000000	0.005123
ENE	0.000683	0.001708	0.001708	0.000797	0.000000	0.000000	0.000000	0.000000	0.004895
E	0.000683	0.002618	0.001708	0.001480	0.000000	0.000000	0.000000	0.000000	0.006489
ESE	0.000228	0.000911	0.002391	0.001366	0.000000	0.000000	0.000000	0.000000	0.004895
SE	0.000455	0.001252	0.001025	0.001025	0.000000	0.000000	0.000000	0.000000	0.003757
SSE	0.000000	0.001708	0.001366	0.002391	0.000000	0.000000	0.000000	0.000000	0.005464
S	0.000114	0.001480	0.001138	0.002960	0.000000	0.000000	0.000000	0.000000	0.005692
SSW	0.000569	0.002391	0.003529	0.001821	0.000000	0.000000	0.000000	0.000000	0.008311
SW	0.000455	0.002846	0.004098	0.001366	0.000000	0.000000	0.000000	0.000000	0.008766
WSW	0.000455	0.002277	0.003643	0.001138	0.000000	0.000000	0.000000	0.000000	0.007514
W	0.000797	0.002732	0.003529	0.002732	0.000000	0.000000	0.000000	0.000000	0.009791
WNW	0.000683	0.003074	0.004212	0.004895	0.000000	0.000000	0.000000	0.000000	0.012864
NW	0.000000	0.001252	0.003415	0.003301	0.000000	0.000000	0.000000	0.000000	0.007969
NNW	0.000455	0.002505	0.002618	0.001366	0.000000	0.000000	0.000000	0.000000	0.006944
N	0.000797	0.001480	0.002163	0.001480	0.000000	0.000000	0.000000	0.000000	0.005920
CALM									0.002505
TOTAL	0.007400	0.031535	0.040073	0.031193	0.000000	0.000000	0.000000	0.000000	0.112705

MEAN WIND SPEED (m/s) = 3.57
NUMBER OF OBSERVATIONS = 990

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003415	0.002505	0.005351	0.003643	0.004440	0.002163	0.000455	0.000114	0.022086
NE	0.003415	0.002618	0.003757	0.002163	0.004668	0.001594	0.000455	0.000114	0.018784
ENE	0.002391	0.003757	0.003074	0.001138	0.001480	0.000342	0.000114	0.000000	0.012295
E	0.002277	0.003985	0.002391	0.001138	0.001935	0.001025	0.000228	0.000000	0.012978
ESE	0.002277	0.004668	0.002391	0.001138	0.000911	0.000342	0.000114	0.000114	0.011954
SE	0.001252	0.003415	0.003529	0.000911	0.001821	0.000342	0.000228	0.000114	0.011612
SSE	0.000228	0.003415	0.003415	0.000911	0.002163	0.000911	0.000228	0.000000	0.011270
S	0.001594	0.004781	0.005123	0.001935	0.002277	0.001821	0.000569	0.000228	0.018329
SSW	0.002163	0.007741	0.006034	0.002505	0.002732	0.001594	0.000455	0.000228	0.023452
SW	0.006375	0.009335	0.006489	0.002049	0.001138	0.000455	0.000342	0.000228	0.026412
WSW	0.004554	0.008197	0.008311	0.002049	0.001935	0.001025	0.000228	0.000228	0.026526
W	0.006603	0.013547	0.011612	0.007628	0.003643	0.002049	0.000683	0.000455	0.046220
WNW	0.004668	0.012181	0.011043	0.006261	0.007969	0.003757	0.001935	0.000228	0.048042
NW	0.003188	0.006148	0.007286	0.005009	0.007172	0.003188	0.000797	0.000569	0.033356
NNW	0.001025	0.004554	0.007172	0.002391	0.004440	0.002732	0.001252	0.000455	0.024021
N	0.003188	0.003871	0.008083	0.002732	0.006375	0.002960	0.001138	0.000114	0.028461
CALM									0.013434
TOTAL	0.048611	0.094718	0.095059	0.043602	0.055100	0.026298	0.009221	0.003188	0.389230

MEAN WIND SPEED (m/s) = 4.05
NUMBER OF OBSERVATIONS = 3419

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.004895	0.003985	0.000683	0.000000	0.000000	0.000000	0.000000	0.000000	0.009563
NE	0.004098	0.004098	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.008311
ENE	0.004440	0.001594	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.006261
E	0.002960	0.002049	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005009
ESE	0.002049	0.002846	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.005009
SE	0.001138	0.001594	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.002846
SSE	0.001025	0.001594	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.002732
S	0.002846	0.002505	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.005578
SSW	0.002391	0.004440	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.007172
SW	0.005692	0.003529	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.009563
WSW	0.004781	0.006944	0.001594	0.000000	0.000000	0.000000	0.000000	0.000000	0.013320
W	0.008994	0.010246	0.005237	0.000228	0.000000	0.000000	0.000000	0.000000	0.024704
WNW	0.006831	0.006261	0.001594	0.000228	0.000000	0.000000	0.000000	0.000000	0.014913
NW	0.005806	0.004212	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.010246
NNW	0.003074	0.003985	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.007172
N	0.002960	0.004895	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.007969
CALM									0.016052
TOTAL	0.063980	0.064777	0.011157	0.000455	0.000000	0.000000	0.000000	0.000000	0.156421

MEAN WIND SPEED (m/s) = 1.64
NUMBER OF OBSERVATIONS = 1374

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.005237	0.002618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007855
NE	0.004326	0.001138	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005464
ENE	0.003529	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004326
E	0.003643	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004440
ESE	0.001935	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002960
SE	0.002960	0.000683	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003643
SSE	0.001935	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002960
S	0.003643	0.001138	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004781
SSW	0.005237	0.001594	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006831
SW	0.006034	0.002049	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008083
WSW	0.008311	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009335
W	0.009677	0.002960	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012637
WNW	0.008652	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011384
NW	0.008197	0.002163	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010360
NNW	0.003301	0.002049	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005351
N	0.003529	0.004781	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008311
CALM									0.037227
TOTAL	0.080146	0.028575	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.145947

MEAN WIND SPEED (m/s) = 1.06
NUMBER OF OBSERVATIONS = 1282

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.015369	0.016621	0.013320	0.009791	0.004440	0.002163	0.000455	0.000114	0.062272
NE	0.015141	0.014686	0.009904	0.005464	0.004668	0.001594	0.000455	0.000114	0.052026
ENE	0.012978	0.013092	0.009107	0.003188	0.001480	0.000342	0.000114	0.000000	0.040301
E	0.012637	0.014572	0.008424	0.004098	0.001935	0.001025	0.000228	0.000000	0.042919
ESE	0.007741	0.014572	0.007969	0.003529	0.000911	0.000342	0.000114	0.000114	0.035291
SE	0.007058	0.011498	0.008197	0.002163	0.001821	0.000342	0.000228	0.000114	0.031421
SSE	0.004098	0.010929	0.006261	0.003757	0.002163	0.000911	0.000228	0.000000	0.028347
S	0.009791	0.014458	0.009107	0.005578	0.002277	0.001821	0.000569	0.000228	0.043830
SSW	0.011612	0.020150	0.011954	0.005464	0.002732	0.001594	0.000455	0.000228	0.054189
SW	0.019695	0.021403	0.013889	0.004668	0.001138	0.000455	0.000342	0.000228	0.061817
WSW	0.019126	0.022883	0.016621	0.003985	0.001935	0.001025	0.000228	0.000228	0.066029
W	0.027664	0.031990	0.025273	0.011612	0.003643	0.002049	0.000683	0.000455	0.103370
WNW	0.022427	0.028461	0.019809	0.012750	0.007969	0.003757	0.001935	0.000228	0.097336
NW	0.019353	0.018443	0.014800	0.010701	0.007172	0.003188	0.000797	0.000569	0.075023
NNW	0.008880	0.017077	0.015255	0.007058	0.004440	0.002732	0.001252	0.000455	0.057149
N	0.011954	0.020947	0.016166	0.009335	0.006375	0.002960	0.001138	0.000114	0.068989
CALM									0.079690
TOTAL	0.225524	0.291781	0.206056	0.103142	0.055100	0.026298	0.009221	0.003188	1.000000

MEAN WIND SPEED (m/s) = 2.96
NUMBER OF OBSERVATIONS = 8784

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 9.7%
B : 9.9%
C : 11.3%
D : 38.9%
E : 15.6%
F : 14.6%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0153	0110	0103
02	0000	0000	0000	0140	0109	0117
03	0000	0000	0000	0146	0118	0102
04	0000	0000	0000	0140	0116	0110
05	0000	0000	0000	0148	0108	0110
06	0015	0010	0017	0161	0080	0083
07	0036	0042	0058	0130	0043	0057
08	0056	0069	0090	0117	0009	0025
09	0082	0076	0119	0089	0000	0000
10	0089	0076	0118	0083	0000	0000
11	0089	0101	0090	0086	0000	0000
12	0098	0097	0077	0094	0000	0000
13	0105	0086	0080	0095	0000	0000
14	0101	0079	0075	0111	0000	0000
15	0090	0080	0095	0101	0000	0000
16	0057	0080	0086	0130	0009	0004
17	0027	0048	0063	0188	0030	0010
18	0005	0024	0022	0226	0057	0032
19	0000	0000	0000	0223	0088	0055
20	0000	0000	0000	0201	0085	0080
21	0000	0000	0000	0175	0109	0082
22	0000	0001	0000	0171	0104	0090
23	0000	0000	0000	0154	0094	0118
24	0000	0000	0000	0157	0105	0104

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0134	0117	0192	0854	1319	1258
<=1000 m	0280	0352	0410	1275	0018	0009
<=1500 m	0436	0400	0388	1052	0037	0015
<=2000 m	0000	0000	0000	0164	0000	0000
<=3000 m	0000	0000	0000	0073	0000	0000
>3000 m	0000	0000	0000	0001	0000	0000

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : LYNWOOD QUARRY OPERATIONS

Year 2

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**13020**	930	h/y	14.0	kg/h						
Loading topsoil to trucks	**190**	71538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**2432**	71538	t/y	0.03400	kg/t	100	t/truck load	3.4	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**190**	71538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock and overburden	**5015**	8500	holes/y	0.59	kg/hole						
Blasting rock and overburden	**658**	50	blasts/y	13	kg/blast	1530	Area of blast in square metres				
FEL loading overburden to trucks	**3439**	1294482	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**44012**	1294482	t/y	0.03400	kg/t	100	t/truck load	3.4	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**3439**	1294482	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**17472**	1248	h/y	14.0	kg/h						
FEL loading rock to trucks	**8067**	3400000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**47600**	3400000	t/y	0.01400	kg/t	100	t/truck load	1.4	km/return trip	1	kg/VKT
Dumping rock to hopper	**8067**	3400000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**5168**	3400000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**103836**	3400000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**103836**	3400000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**5712**	3000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**112177**	19	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**24464**	4	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**23867**	4	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**611**	230000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm

Hauling excess product to emplacement area	**9200**	230000	t/y	0.04000	kg/t	50	t/truck load	2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**611**	230000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 5

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**9380**	670	h/y	14.0	kg/h						
Loading topsoil to trucks	**137**	51538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**2062**	51538	t/y	0.04000	kg/t	100	t/truck load	4	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**137**	51538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock and overburden	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**1644**	618771	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**24751**	618771	t/y	0.04000	kg/t	100	t/truck load	4	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**1644**	618771	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**17472**	1248	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**78400**	5600000	t/y	0.01400	kg/t	100	t/truck load	1.4	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	5600000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	3500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**227935**	38	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**21003**	4	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**17901**	3	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s

Wind erosion from Western EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**14000**	350000	t/y	0.04000	kg/t	50	t/truck load	2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 10

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**5320**	380	h/y	14.0	kg/h						
Loading topsoil to trucks	**78**	29231	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**1578**	29231	t/y	0.05400	kg/t	100	t/truck load	5.4	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**78**	29231	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock and overburden	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**1960**	737767	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**39839**	737767	t/y	0.05400	kg/t	100	t/truck load	5.4	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**1960**	737767	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**17472**	1248	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**380800**	5600000	t/y	0.06800	kg/t	100	t/truck load	6.8	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	5600000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	3500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**436775**	73	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**41768**	7	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s

Wind erosion from Western OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**34608**	6	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**14000**	350000	t/y	0.04000	kg/t	50	t/truck load	2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 15

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**10920**	780	h/y	14.0	kg/h						
Loading topsoil to trucks	**159**	60000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**2760**	60000	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**159**	60000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock and overburden	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**2871**	1080600	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**49708**	1080600	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**2871**	1080600	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**17472**	1248	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**168000**	5600000	t/y	0.03000	kg/t	100	t/truck load	3	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	5600000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	3500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**619206**	104	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s

Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**17901**	3	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**6683**	1	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**8400**	350000	t/y	0.02400	kg/t	50	t/truck load	1.2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 20

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**6300**	450	h/y	14.0	kg/h						
Loading topsoil to trucks	**92**	34615	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**1592**	34615	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**92**	34615	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock and overburden	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**756**	284478	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**13086**	284478	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**756**	284478	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**17472**	1248	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**257600**	5600000	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	5600000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	3500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm

Wind erosion from exposed pit areas	**643826**	108	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**23867**	4	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**30312**	5	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**8400**	350000	t/y	0.02400	kg/t	50	t/truck load	1.2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 25

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**700**	50	h/y	14.0	kg/h						
Loading topsoil to trucks	**10**	3846	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**177**	3846	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**10**	3846	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**0**	0	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**0**	0	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**257600**	5600000	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	5600000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	5600000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	5600000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm

Transport product off-site (sealed rd)	**67200**	150000 0	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	350000 0	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**649196**	109	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**49167**	8	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**8400**	350000	t/y	0.02400	kg/t	50	t/truck load	1.2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Year 30

ACTIVITY	**TSP (kg/y)**	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**0**	0	h/y	14.0	kg/h						
Loading topsoil to trucks	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling topsoil to stockpiles	**0**	0	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping topsoil to stockpiles	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Drilling rock	**9272**	15716	holes/y	0.59	kg/hole						
Blasting rock	**1623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling overburden to emplacement area	**0**	0	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping overburden to emplacement area	**0**	0	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping overburden dump	**0**	0	h/y	14.0	kg/h						
FEL loading rock to trucks	**13287**	560000 0	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling rock to hopper	**257600**	560000 0	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1	kg/VKT
Dumping rock to hopper	**13287**	560000 0	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Primary crushing and screening	**8512**	560000 0	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171024**	560000 0	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171024**	560000 0	t/y	0.15270	kg/t	90	%reduction	2	No. stages		

Loading to product stockpiles	**9519**	5000000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Loading product to road trucks	**792**	1500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Transport product off-site (sealed rd)	**67200**	1500000	t/y	0.04480	kg/t	30	t/truck load	6.72	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1848**	3500000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	0	bcm
Wind erosion from exposed pit areas	**649196**	109	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from product stockpiles	**8355**	2	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Rail OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western OEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Eastern EOEA	**0**	0	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Wind erosion from Western EOEA	**53463**	9	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s
Loading excess product to trucks from plant	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Hauling excess product to emplacement area	**8400**	350000	t/y	0.02400	kg/t	50	t/truck load	1.2	km/return trip	1	kg/VKT
Dumping excess product to emplacement area	**930**	350000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	0	bcm
Dozer shaping excess product emplacement area	**17472**	1248	h/y	14.0	kg/h						
Grading roads	**21566**	35040	km	0.61547	kg/VKT	8	speed of graders in km/h				

The dust emission inventories have has been formulated from the operational description of the proposed quarry activities provided by Umwelt. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

Dozers stripping topsoil and shaping dumps
An emission rate of 14 kg/h has been used for dozers stripping topsoil and shaping overburden dumps (SPCC, 1983).

Loading material / dumping material
Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 1 shows the relationship between these variables.

Equation 1

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2} \right)^{1.3}}{\left(\frac{M}{2} \right)^{1.4}} \right) \quad kg/t$$

where,
E_{TSP} = *TSP emissions*
$k = 0.74$
U = *wind speed (m/s)*
M = *moisture content (%)*
[where $0.25 \leq M \leq 4.8$]

Hauling material / product on road surfaces
After the application of water the emission factor used for trucks hauling overburden or rock on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT). For sealed surfaces the emission factor used was 0.2 kg/VKT.

Drilling rock and overburden
The emission factor used for drilling has been taken to be 0.59 kg/hole (US EPA, 1985 and updates).

Blasting rock and overburden
TSP emissions from blasting were estimated using the US EPA (1985 and updates) emission factor equation given in Equation 2.

Equation 2

$$E_{TSP} = 0.00022 \times A^{1.5} \quad \text{kg/blast}$$

where,
A = area to be blasted in m^2

Primary crushing of material
The emission factor used for primary crushing of material has been taken to be 0.0152 kg/t (US EPA, 1985 and updates). It has been assumed that there would be a reduction to TSP emissions from the use of enclosures. The reduction uses the same relationship between the controlled and uncontrolled US EPA emission factors (that is, 90%). ***(Enclosed?)***

Secondary and tertiary crushing of material
The emission factor used for secondary and tertiary crushing of material has been taken to be 0.1527 kg/t (US EPA, 1985 and updates). It has been assumed that there would be a reduction to TSP emissions from the use of enclosures. The reduction uses the same relationship between the controlled and uncontrolled US EPA emission factors (that is, 90%).

Wind erosion
The emission factor for wind erosion is given in Equation 3 below.

Equation 3

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \qquad \text{kg/ha/day}$$

where,
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time that wind speed is above 5.4 m/s

Grading roads
Estimated of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (Equation 4).

Equation 4

$$E_{TSP} = 0.0034 \times S^{2.5} \qquad \text{kg/VKT}$$

where,
S = speed of the grader in km/h (taken to be 8 km/h)

APPENDIX C
ISCST3 MODEL INPUT FILE

ISCST3 INPUT FILE:

```
**  Lynwood Quarry - Year 2 operations
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL Error.MSG
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  771271 6156182 655.0
   LOCATION  POINT2  VOLUME  771381 6156146 661.0
   LOCATION  POINT3  VOLUME  771432 6156007 661.0
   LOCATION  POINT4  VOLUME  771600 6155926 663.2
   LOCATION  POINT5  VOLUME  771783 6155868 661.0
   LOCATION  POINT6  VOLUME  771710 6155773 661.0
   LOCATION  POINT7  VOLUME  771556 6155809 646.0
   LOCATION  POINT8  VOLUME  771768 6155597 668.2
   LOCATION  POINT9  VOLUME  771812 6155444 662.1
   LOCATION  POINT10  VOLUME  771878 6155334 661.8
   LOCATION  POINT11  VOLUME  771790 6155327 676.8
   LOCATION  POINT12  VOLUME  771607 6155451 671.5
   LOCATION  POINT13  VOLUME  771417 6155619 671.1
   LOCATION  POINT14  VOLUME  771066 6155334 669.0
   LOCATION  POINT15  VOLUME  771220 6155488 667.4
   LOCATION  POINT16  VOLUME  771213 6155305 667.5
   LOCATION  POINT17  VOLUME  771359 6155290 662.5
   LOCATION  POINT18  VOLUME  771330 6155195 661.1
   LOCATION  POINT19  VOLUME  771191 6155217 665.9
   LOCATION  POINT20  VOLUME  771381 6155085 658.1
   LOCATION  POINT21  VOLUME  771476 6154917 659.1
   LOCATION  POINT22  VOLUME  771672 6154884 656.8
   LOCATION  POINT23  VOLUME  771895 6154906 658.3
   LOCATION  POINT24  VOLUME  772118 6154870 657.2
   LOCATION  POINT25  VOLUME  772214 6154873 658.3
   LOCATION  POINT26  VOLUME  772010 6154961 661.5
   LOCATION  POINT27  VOLUME  771571 6154742 661.7
   LOCATION  POINT28  VOLUME  771776 6154486 662.0
   LOCATION  POINT29  VOLUME  772097 6154318 657.0
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   LOCATION  POINT53  VOLUME  771381 6155085 658.1
   LOCATION  POINT54  VOLUME  771476 6154917 659.1
   LOCATION  POINT55  VOLUME  771672 6154884 656.8
   LOCATION  POINT56  VOLUME  771895 6154906 658.3
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   LOCATION  POINT58  VOLUME  772214 6154873 658.3
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   LOCATION  POINT77  VOLUME  771790 6155327 676.8
   LOCATION  POINT78  VOLUME  771607 6155451 671.5
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   LOCATION  POINT82  VOLUME  771213 6155305 667.5
   LOCATION  POINT83  VOLUME  771359 6155290 662.5
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   LOCATION  POINT86  VOLUME  771381 6155085 658.1
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   LOCATION  POINT89  VOLUME  771895 6154906 658.3
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   SRCPARAM  POINT21   1.0 2.0  20.  2.
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   SRCGROUP  CM  POINT34-POINT66
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RE DISCCART 770776 6153328 713.4
RE DISCCART 773730 6156151 662.0
RE DISCCART 773920 6153884 641.7
RE DISCCART 773131 6152758 654.3
RE DISCCART 773862 6154674 638.8
RE DISCCART 772692 6152816 654
RE DISCCART 773058 6153094 647
RE DISCCART 773306 6153211 642
RE DISCCART 772911 6152626 658
RE DISCCART 773423 6152977 647
RE DISCCART 772443 6152992 663
RE DISCCART 772063 6153226 681
RE DISCCART 771785 6153489 688
RE DISCCART 771303 6153460 695
RE DISCCART 771054 6153796 691
RE DISCCART 771083 6154191 679
RE DISCCART 771332 6154498 668
RE DISCCART 771142 6154820 662
RE DISCCART 770937 6155054 665
RE DISCCART 770732 6155288 668
RE DISCCART 770805 6155624 665
RE DISCCART 770835 6156048 655
RE DISCCART 771171 6156429 662
RE DISCCART 771551 6156531 670
RE DISCCART 772019 6156502 699
RE DISCCART 772239 6156151 698
RE DISCCART 772385 6155902 673
RE DISCCART 772677 6155639 665
RE DISCCART 772999 6155507 650
RE DISCCART 773131 6155858 664
RE DISCCART 773452 6155888 660
RE DISCCART 773599 6155551 662
RE DISCCART 773540 6155156 642
RE DISCCART 773306 6154922 642
RE DISCCART 772751 6154820 644
RE DISCCART 772385 6154937 649
RE DISCCART 772019 6155098 651
RE DISCCART 771917 6154805 661
RE DISCCART 772224 6154542 652
RE DISCCART 772443 6154220 653
RE DISCCART 772473 6153826 660
RE DISCCART 772619 6153518 673
RE DISCCART 773043 6153387 653
RE DISCCART 772941 6154411 652
RE DISCCART 772970 6153869 669
RE DISCCART 773511 6154542 642
RE DISCCART 773555 6154001 646
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RE DISCCART 773613 6153504 635
RE DISCCART 774111 6154615 644
RE DISCCART 773979 6153943 636
RE DISCCART 774271 6154367 640
RE DISCCART 774418 6154820 640
RE DISCCART 774081 6155566 630
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RE DISCCART 774476 6155756 632
RE DISCCART 774418 6155098 638
RE DISCCART 774739 6155229 639
RE DISCCART 775427 6155244 640
RE DISCCART 775032 6154791 643
RE DISCCART 773935 6156282 656
RE DISCCART 772838 6156370 698
RE DISCCART 771800 6156897 687
RE DISCCART 770952 6156882 672
RE DISCCART 770469 6156370 656
RE DISCCART 770279 6155683 647
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RE DISCCART 770484 6154308 669
RE DISCCART 770557 6153621 706
RE DISCCART 770922 6152992 702
RE DISCCART 771610 6152890 703
RE DISCCART 772297 6152524 669
RE DISCCART 773189 6152275 646
RE DISCCART 773950 6152656 631
RE DISCCART 774418 6153416 630
RE DISCCART 774754 6154337 640
RE DISCCART 775164 6155712 630
RE DISCCART 774579 6156516 639
RE DISCCART 773350 6156955 700
RE DISCCART 772370 6157101 700
RE DISCCART 771405 6157365 709
RE DISCCART 772122 6157569 690
RE DISCCART 773043 6157642 659
RE DISCCART 774184 6157452 640
RE DISCCART 775281 6156955 630
RE DISCCART 770454 6157292 673
RE DISCCART 769943 6154995 659
RE DISCCART 769782 6156370 650
RE DISCCART 770016 6153913 675
RE DISCCART 769153 6155595 640
RE DISCCART 768963 6154206 655
RE DISCCART 769694 6152802 697
RE DISCCART 770659 6152261 705
RE DISCCART 771712 6152100 680
RE DISCCART 772677 6151807 649
RE DISCCART 775032 6153021 635
RE DISCCART 775558 6154235 649
RE DISCCART 775090 6158184 621
RE DISCCART 773686 6158535 639
RE DISCCART 772019 6158622 683
RE DISCCART 770732 6158461 690
RE DISCCART 769299 6157950 661
RE DISCCART 768553 6156984 633
RE DISCCART 768261 6155112 640
RE DISCCART 768378 6152977 700
RE DISCCART 769431 6151529 690
RE DISCCART 771025 6151354 685
RE DISCCART 774476 6151486 620
RE DISCCART 775734 6152100 648
RE DISCCART 768363 6158681 628
RE DISCCART 768000 6151000 691
RE DISCCART 776000 6159000 640
RE DISCCART 771902 6153840 679
RE DISCCART 771771 6154278 660
RE DISCCART 771492 6153942 682
RE DISCCART 772355 6155419 667
RE DISCCART 770849 6156457 656
RE DISCCART 772589 6156677 709
RE DISCCART 773774 6154819 637
RE DISCCART 772750 6156838 699
RE DISCCART 770907 6154512 671
RE FINISHED

ME STARTING
   INPUTFIL  C:\Jobs\LynwoodQ\metdata\Marulan\ElfData\marul00.isc
   ANEMHGHT  10  METERS
   SURFDATA  99999 2000
   UAIRDATA  99999 2000
ME FINISHED

OU STARTING
   RECTABLE  ALLAVE  FIRST-SECOND
   MAXTABLE  ALLAVE  50
   PLOTFILE  24 FP FIRST  FP1D.PLO
   PLOTFILE  24 CM FIRST  CM1D.PLO
   PLOTFILE  24 REST FIRST  RE1D.PLO
   PLOTFILE  PERIOD  FP  FP1Y.PLO
   PLOTFILE  PERIOD  CM  CM1Y.PLO
   PLOTFILE  PERIOD  REST  RE1Y.PLO
OU FINISHED
```

A summary of the ISCST3 emission file used as input to the above model input file is provided below.

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 EMISSION FILE SUMMARY
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Emission file name   : C:\Jobs\LynwoodQ\iscst3\Y02\emiss.dat
Emission file type   : ISCST3
Number of sources    : 99

 -----EMISSION SUMMARY-----
Source,Source, Average,   Maximum,      Total,  Source
Number,  Type,emission,  emission,  emissions,  ID
   01 ,Vol,   6.80E-01,  2.79E+00,   5.97E+03,  POINT1
   02 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT2
   03 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT3
   04 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT4
   05 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT5
   06 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT6
   07 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT7
   08 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT8
   09 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT9
   10 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT10
   11 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT11
   12 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT12
   13 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT13
   14 ,Vol,   2.09E-02,  1.35E-01,   1.84E+02,  POINT14
   15 ,Vol,   6.59E+00,  6.59E+00,   5.78E+04,  POINT15
   16 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT16
   17 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT17
   18 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT18
   19 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT19
   20 ,Vol,   3.86E-01,  7.94E-01,   3.39E+03,  POINT20
   21 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT21
   22 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT22
   23 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT23
   24 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT24
   25 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT25
   26 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT26
   27 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT27
   28 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT28
   29 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT29
   30 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT30
   31 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT31
   32 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT32
   33 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT33
   34 ,Vol,   6.80E-01,  2.79E+00,   5.97E+03,  POINT34
   35 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT35
   36 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT36
   37 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT37
   38 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT38
   39 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT39
   40 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT40
   41 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT41
   42 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT42
   43 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT43
   44 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT44
   45 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT45
   46 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT46
   47 ,Vol,   2.09E-02,  1.35E-01,   1.84E+02,  POINT47
   48 ,Vol,   6.59E+00,  6.59E+00,   5.78E+04,  POINT48
   49 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT49
   50 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT50
   51 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT51
   52 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT52
   53 ,Vol,   3.86E-01,  7.94E-01,   3.39E+03,  POINT53
   54 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT54
   55 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT55
   56 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT56
   57 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT57
   58 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT58
   59 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT59
   60 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT60
   61 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT61
   62 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT62
   63 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT63
   64 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT64
   65 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT65
   66 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT66
   67 ,Vol,   6.80E-01,  2.79E+00,   5.97E+03,  POINT67
   68 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT68
   69 ,Vol,   5.38E-01,  1.50E+00,   4.73E+03,  POINT69
   70 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT70
   71 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT71
   72 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT72
   73 ,Vol,   1.05E+00,  1.74E+01,   9.19E+03,  POINT73
   74 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT74
   75 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT75
   76 ,Vol,   6.65E-01,  1.63E+01,   5.84E+03,  POINT76
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77 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT77
78 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT78
79 ,Vol,   6.45E-01,  9.31E+00,   5.66E+03,  POINT79
80 ,Vol,   2.09E-02,  1.35E-01,   1.84E+02,  POINT80
81 ,Vol,   6.59E+00,  6.59E+00,   5.78E+04,  POINT81
82 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT82
83 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT83
84 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT84
85 ,Vol,   1.04E-01,  2.32E+00,   9.13E+02,  POINT85
86 ,Vol,   3.86E-01,  7.94E-01,   3.39E+03,  POINT86
87 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT87
88 ,Vol,   7.59E-02,  1.66E-01,   6.66E+02,  POINT88
89 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT89
90 ,Vol,   2.65E-01,  6.10E+00,   2.33E+03,  POINT90
91 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT91
92 ,Vol,   5.53E-01,  6.82E+00,   4.86E+03,  POINT92
93 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT93
94 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT94
95 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT95
96 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT96
97 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT97
98 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT98
99 ,Vol,   2.66E-01,  2.66E-01,   2.34E+03,  POINT99
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