AIR QUALITY IMPACT ASSESSMENT

PROPOSED MINOR MODIFICATION

LYNWOOD QUARRY

Umwelt (Australia) Pty Limited

Job No: 2880A

27 August 2010

A PEL Company

PROJECT TITLE:	PROPOSED MINOR MODIFICATION – LYNWOOD QUARRY
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1 INTRODUCTION

Holcim Australia (formerly CEMEX and Readymix) is seeking approval for minor modifications to its consent conditions for an approved hard rock quarry near Marulan (DA 128-5-2005) in the Southern Tablelands region of NSW. The location of the quarry, known as Lynwood Quarry, is shown in **Figure 2.1**.

In May 2005, Holmes Air Sciences prepared an air quality assessment (**Holmes Air Sciences, 2005**) for Umwelt (Australia) Pty Limited who were in turn acting on behalf of Holcim to prepare an Environmental Impact Statement (EIS) for the project. The project was subsequently approved by the NSW Minister for Planning in December 2005. A further air quality assessment was carried out by PAEHolmes (formerly Holmes Air Sciences) in 2008 (**PAEHolmes, 2008**) for a modified quarry design, which was also approved.

The purpose of this report is to quantitatively assess the air quality impacts of this proposed arrangement and determine whether or not the modified project complies with the relevant air quality criteria.

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 follows the procedures outlined by the NSW Department of Environment, Climate Change and Water (DECCW, formerly the Department of Environment and Conservation [DEC]) in their guidance document titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005**).

This report is not intended to reiterate the bulk of the material covered in the original assessment (**Holmes Air Sciences, 2005**), but rather to outline the proposed changes and present the modelling results predicted for those changes. Results from this assessment will be compared to the currently approved design for the quarry (as presented in **PAEHolmes, 2008**).

In summary, the report provides information on the following:

- a description of the changes to the quarrying activities including extraction, processing and transportation operations;
- air quality goals that need to be met to protect air quality; and
- 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.

Three modelling scenarios have been assessed for the new proposal. These are Year 5, Year 10 and Year 30. These years were selected as they were considered to be representative of the range of operations at the quarry.

2 MODIFIED PROJECT DESCRIPTION

The approved hard rock quarry is located on a property known as "Lynwood". **Figure 2.1** 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 2.2**.

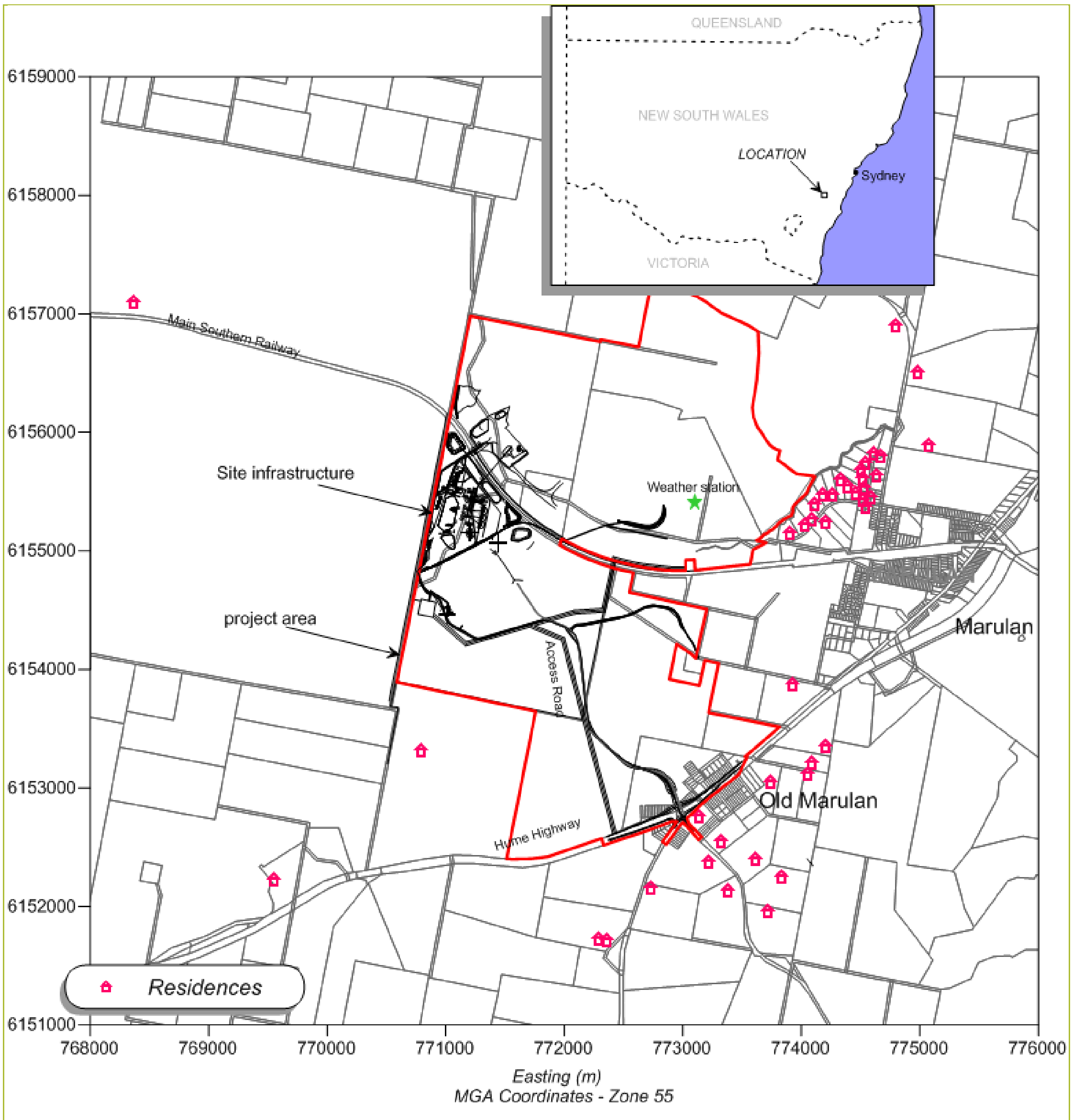

Figure 2.1: Location of Lynwood Quarry

Holcim Australia is proposing to modify its development consent (DA 128-5-2005) for the Lynwood Quarry. As part of the detailed design process for the Quarry, Holcim Australia has identified opportunities to improve the plant set up and optimise the site layout. As a result of this detailed review, changes are proposed that are primarily aimed at obtaining operational efficiencies and product quality benefits, but will also result in cost savings, both operational & capital.

The overall nature, components and approved production rate of 5 million tonnes per annum (Mtpa) remains unchanged, including the extent of the approved 30 year Quarry pit. **Figure 2.3** shows the 30-year extents of the quarry including overburden, product stockpiles and the new locations of the site infrastructure and facilities. The key minor changes proposed as part of this project include:

- Reconfiguration of the rail line from a balloon loop to a rail spur.
- Change from a mobile to fixed in-pit primary crusher for the early years of the project.
- Relocation of the secondary crusher and associated elements to the southern side of the Main Southern Railway.
- Change in initial quarry pit development as a result of the fixed in-pit primary crusher being utilised for the early years of the project.
- Relocation of the office and amenities away from the operational areas of the quarry.
- A slight change to the western excess product emplacement area to allow for the relocated offices and amenities.
- Realignment of the access road to eliminate the need for a bridge over the rail siding.

As a result of the proposed reconfiguration of the rail line and the associated changes to the Quarry infrastructure layout, a small increase to the approved disturbance footprint for the quarry of approximately 10.5 hectares will be required, although the proposed area is within the approved Project Area for the Lynwood Quarry.

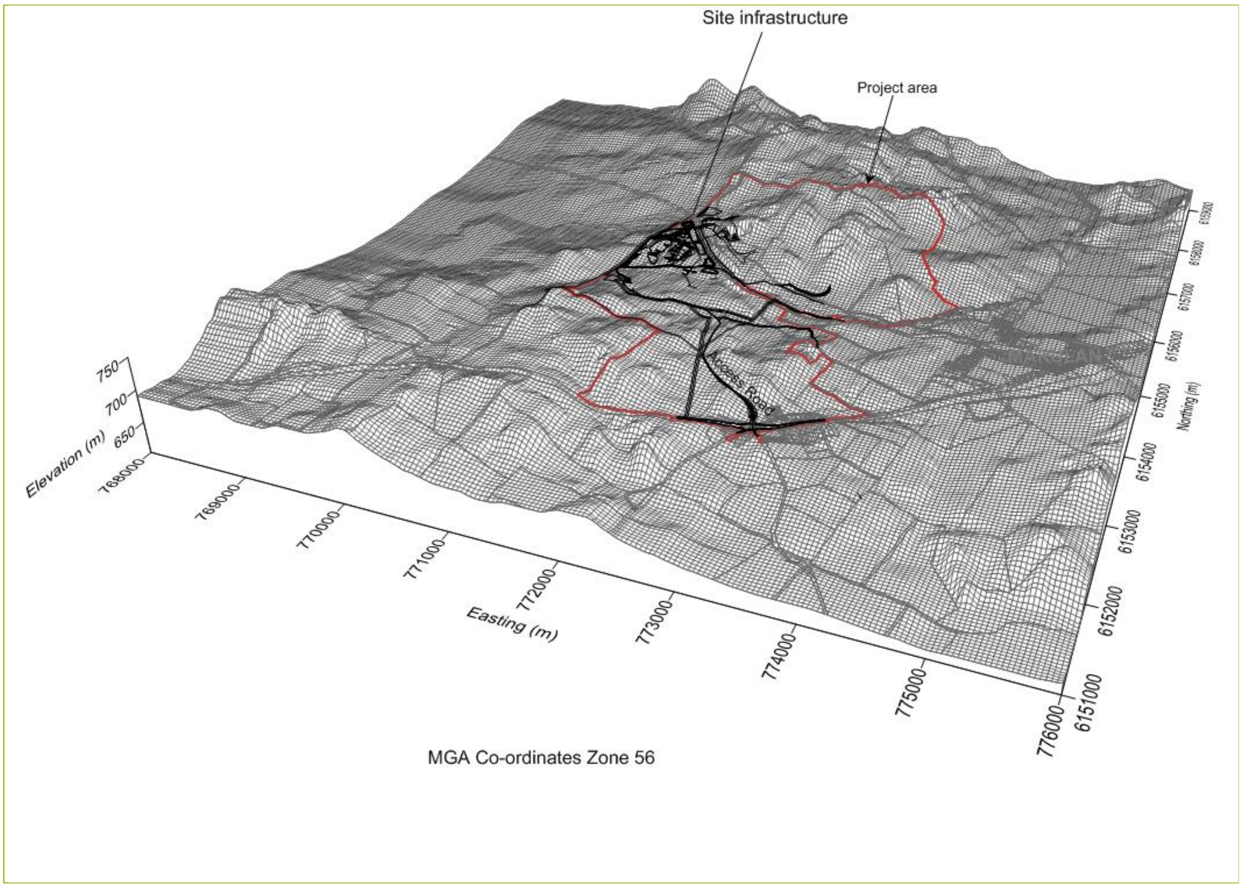

Figure 2.2: Terrain of project area

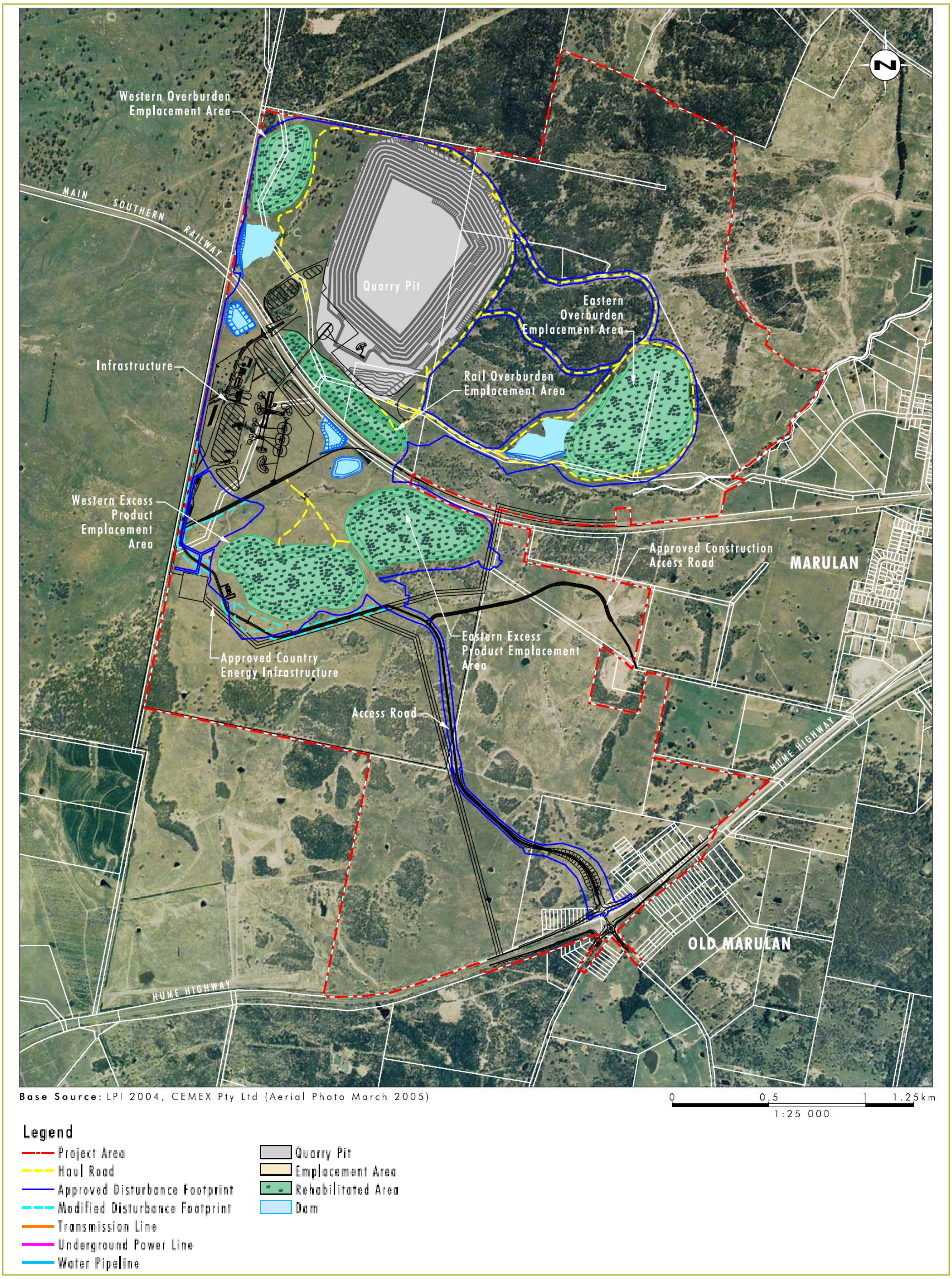

Figure 2.3: 30-year extent of Lynwood Quarry with Proposed Modifications

3 AIR QUALITY GOALS

Table 3.1 and **Table 3.2** 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 4.2.3**.

Table 3.1: Air quality assessment criteria for particulate matter concentrations

Pollutant	Standard / goal	Averaging period	Agency
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean	National Health & Medical Research Council
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24-hour maximum (project only)	DECCW
	30 µg/m^3	Annual mean	DECCW long-term reporting goal
	50 µg/m^3	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3.2** 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**).

Table 3.2: NSW DECCW 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

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 7**.

4 EXISTING ENVIRONMENT

4.1 Meteorological Data

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[a] and mixing height[b]. Data collected by Holmes Air Sciences at

[a] 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.

the property known as "Wangi" were used in the 2005 and 2008 assessments and for consistency will be used in this assessment also. This site is approximately 8 km to the southwest of the Lynwood site and these data have been processed into a form suitable for use in the ISCST3 dispersion model. In 2000 there was 100% data recovery from this site and **Figure 4.1** shows the windroses compiled from these data.

To use the wind data to assess dispersion it is necessary to also have available data on atmospheric stability. 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 4.1** shows the frequency of occurrence of the stability categories expected in the area. 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. **Appendix A** shows joint wind speed, wind direction and stability class frequency tables for these data.

Table 4.1: Frequency of occurrence of stability classes at "Wangi"

Stability Class	"Wangi" (2000)
A	7.1
B	7.9
C	15.8
D	39.0
E	15.7
F	14.5
Total	**100**

[b] 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.

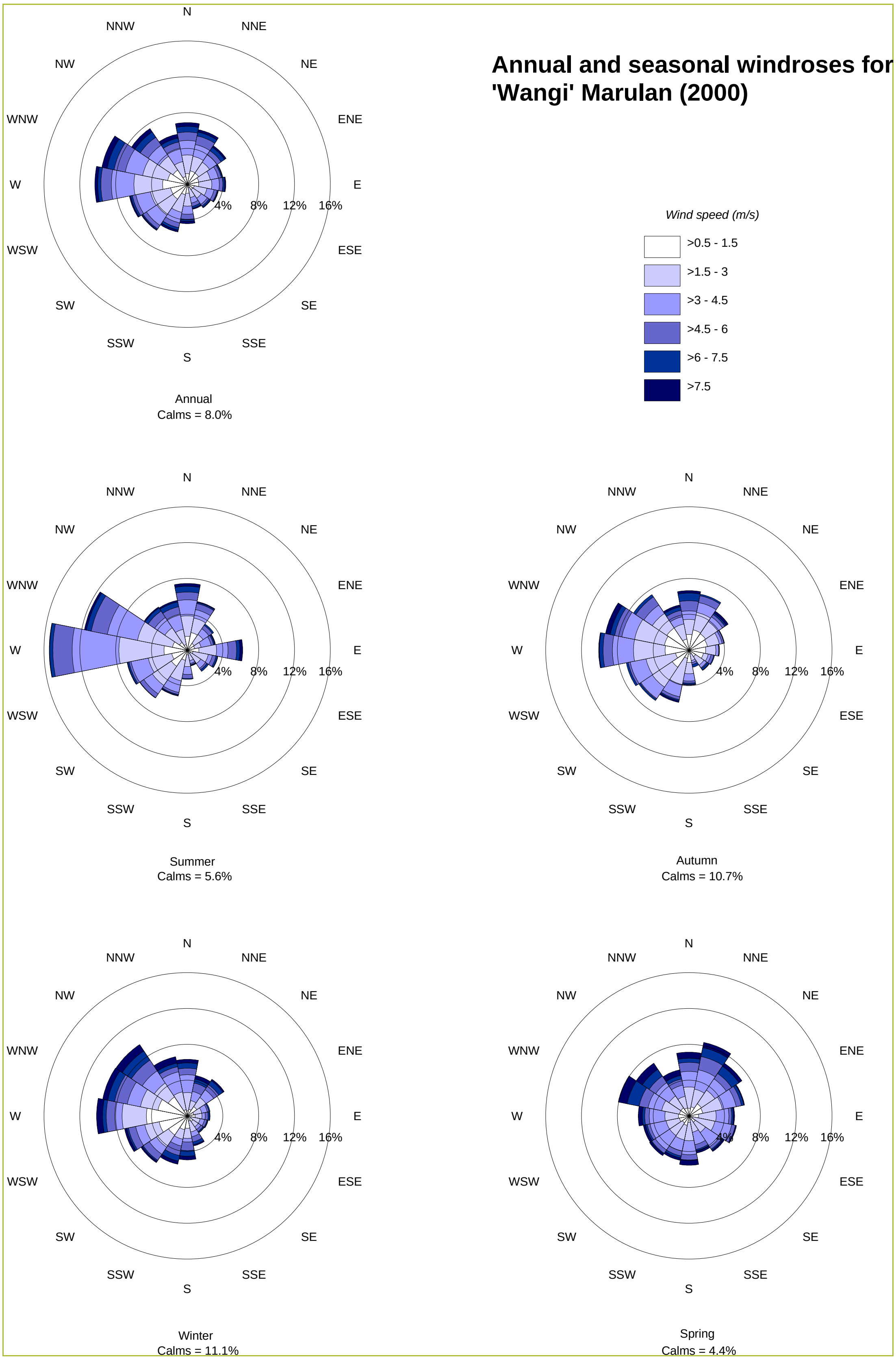

Figure 4.1: Annual and seasonal windroses for 'Wangi' Marulan (2000)

4.2 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 was conducted in the area as part of the project which included the measurement of dust deposition and dust concentration (as PM_{10}). **Figure 4.2** shows the location of the monitoring sites. Available data spans from July 2004 to July 2010.

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. Other local dust sources would include the Johniefelds quarry, 1 km to the north and the Gunlake quarry 2 km to the north. The effects of these emissions, to the extent that they occur, would of course be captured by the existing monitoring program.

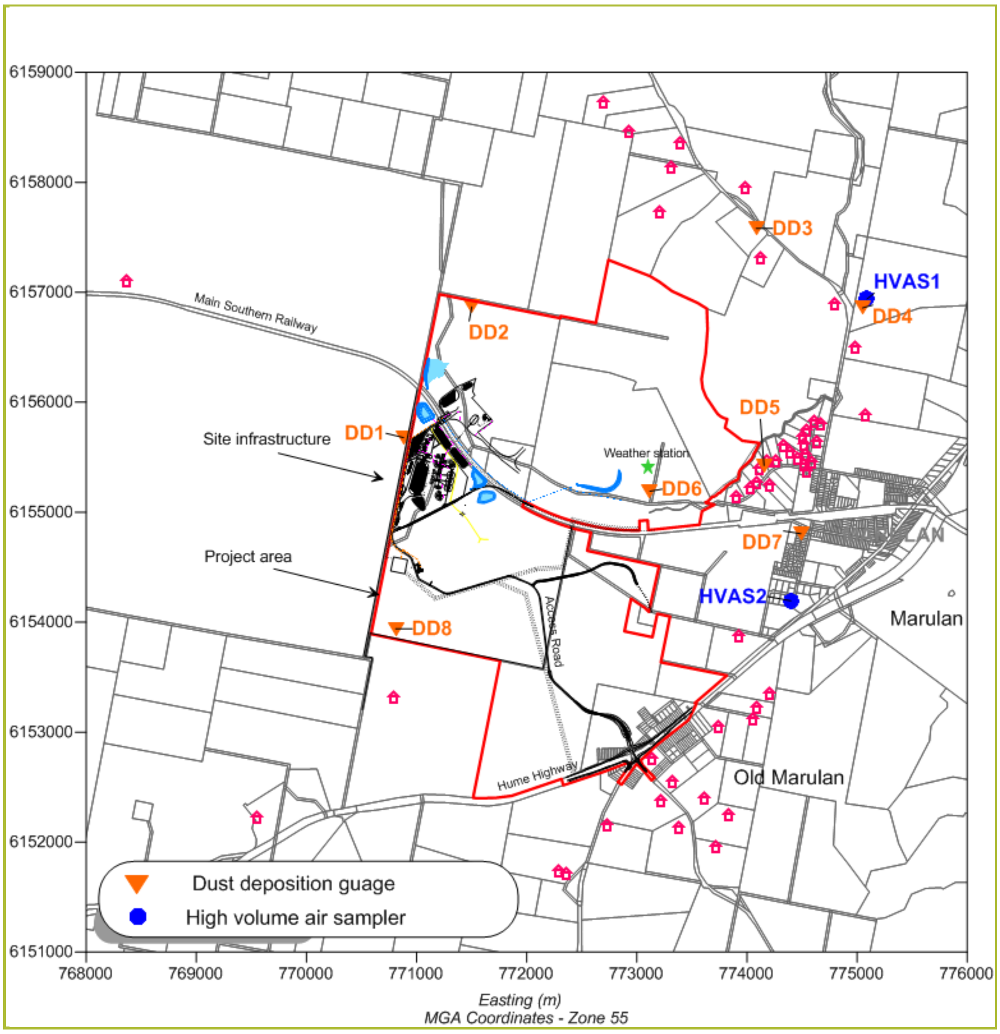

Figure 4.2: Air quality monitoring locations

4.2.1 Dust Deposition

Dust deposition was monitored using dust deposition gauges at eight locations around the Lynwood site (refer to **Figure 4.2**). Dust deposition gauges use a funnel and bottle to measure the rate at which dust settles onto the surface over periods approximating one month. Annual average dust deposition for each of the eight gauges is shown in **Table 4.2**. These measurements include the effects of all background sources relevant to that location.

Table 4.2: Annual average dust deposition data for Lynwood Quarry

Year	Insoluble Solids ($g/m^2/month$)							
	D1	D2	D3	D4	D5	D6	D7	D8
2004	1.0	2.2	0.9	0.9	0.9	3.2	0.7	0.9
2005	1.4	3.7	1.3	1.2	1.4	5.9	1.2	1.5
2006	1.0	4.8	1.5	2.0	1.3	11.7	1.5	1.1
2007	2.4	2.6	1.2	1.0	1.9	6.4	1.4	1.1
2008	2.0	7.7	1.8	1.6	1.6	14.0	1.4	2.4
2009	3.3	4.4	3.3	2.3	2.3	9.8	1.3	1.0
2010	1.7	1.6	1.4	1.2	1.2	10.8	1.1	1.6
Average	**1.8**	**3.9**	**1.6**	**1.5**	**1.5**	**8.8**	**1.2**	**1.4**

The data in **Table 4.2** show that seven of the eight sites reported average levels below the DECCW 4 $g/m^2/month$ dust fallout criterion. However, gauges D6 and D2 experience noticeably higher deposition levels compared with the other sites. The reason for the relatively elevated readings at D6 is likely to be the proximity of the unsealed road, which runs close to the monitoring site. It is not clear why the D2 levels are high, although at both sites there are some months where levels are unusually high and may indicate a problem with the sample collected. Very high monthly values preceded and followed by more reasonable values can indicate a problem with either the sample or the gauge itself, or an extreme weather event such as a dust storm or bushfire. It is likely to be a local source relevant to that location alone and not an indication of levels in the general area. In 2009, samples at all gauges were affected by bushfires in the region (January 2009, **Emergency Management NSW, 2010**) and by the state-wide dust storm in September 2009 (**Environment Australia, 2009**).

In terms of estimating an existing background deposition level (**Section 4.2.3**) the values for D2 and D6 have been removed from the sample as they are not likely to be representative of general ambient conditions in the area. The average background dust deposition level over all remaining gauges is therefore 1.5 $g/m^2/month$, however, a background of 1.6 $g/m^2/month$ has been assumed to be consistent with previous assessments for the proposed Lynwood Quarry.

4.2.2 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. The locations of these monitoring sites are shown as HVAS1 and HVAS2, respectively, in **Figure 4.2**. 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 in **Figure 4.3** and are also summarised in **Table 4.3**. The highest 24-hour average PM_{10} concentration since monitoring began was 921.5 $\mu g/m^3$ at HVAS1, measured on 23 September 2009 (268.0 $\mu g/m^3$ at

HVAS2 on this same date). A severe dust storm affected the whole of NSW on this date (**Environment Australia, 2009**). This dust storm is considered an extreme event and data from this date have not been included in calculations of background dust levels as they are not representative of ambient conditions in the area. The next highest 24-hour average PM_{10} concentrations were recorded on 22 November 2009 (83.5 µg/m^3 at HVAS1) and 28 November 2009 (71.1 µg/m^3 at HVAS2). These dates were also associated with regional dust activity (**Environment Australia, 2009**). However, apart from the 23 September 2009, HVAS 2 did not record any levels above 30 µg/m^3. This suggests that either HVAS2 is somehow sheltered from the full effects of these regional dust events or that some localised source has influenced dust levels at HVAS1 in November 2009, such as an exposed area of land. Apart from these dates, the highest 24-hour average PM_{10} concentration was at HVAS1 with 61.4 µg/m^3 on 17 June 2004. In total there have been four occasions in six years of monitoring when the dust levels were above the 50 µg/m^3 DECCW 24-hour goal suggesting that there are existing localised or regional sources of dust which contribute to elevated concentrations.

Annual average PM_{10} concentrations are well below the DECCW criterion of 30 µg/m^3 for both sites in all years, as shown in **Table 4.3**.

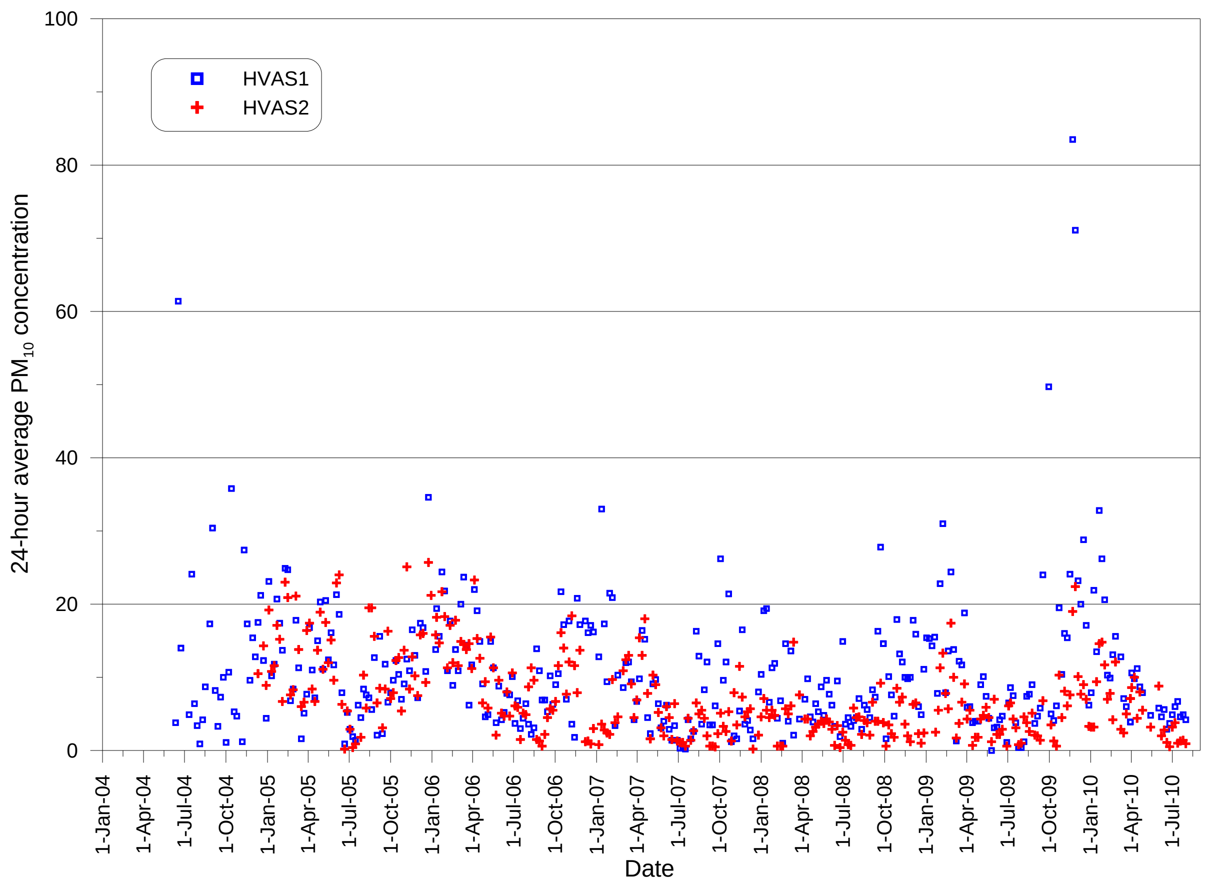

Figure 4.3: Measured PM_{10} levels at High Volume Air Samplers between 2004 and 2010

Table 4.3: Measured PM_{10} levels at Lynwood Quarry

Year	HVAS Site 1		HVAS Site 2	
	Maximum	Annual average	Maximum	Annual average
2004	61.4	13.2	-	-
2005	34.6	11.6	25.7	12.1
2006	24.4	11.3	23.3	9.7
2007	33.0	8.2	18.0	5.0
2008	27.8	8.7	14.8	3.9
2009	83.5	13.1	22.4	5.6
2010	32.8	9.7	14.8	3.9

4.2.3 Estimates of Background Levels

For the purposes of establishing the existing air quality, a value of 13 µg/m^3 has been taken to be the annual average PM_{10} background level to apply over the entire study area. This is the maximum annual average over the monitoring period and so is a conservative estimate of background conditions. Assuming that PM_{10} constitutes 40% of the TSP (**NSW Minerals Council, 2000**), an annual average background TSP level would be 33 µg/m^3.

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

- Annual average PM_{10} of 13 µg/m^3
- Annual average TSP pf 33 µg/m^3
- Annual average dust deposition of 1.6 g/m^2/month

In addition, the DECCW 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 µg/m^3 at the nearest residences. A background concentration estimate is therefore not required for the short-term assessment.

5 ESTIMATED DUST EMISSIONS FROM MODIFIED QUARRY OPERATIONS

The estimated dust emissions due to the proposed modified Lynwood Quarry Operations are shown in **Table 5.1** for each scenario; Year 5, Year 10 and Year 30. Details of the calculation of these dust emission levels are included in **Appendix B** (Emissions inventories) and **Appendix C** (emissions summary for sources used in the modelling).

Table 5.1: Estimated dust emissions due to proposed modified Lynwood Quarry operations

Activity	TSP emission rate (kg/y)		
	Year 5	Year 10	Year 30
Dozer stripping topsoil	9,380	5,320	-
Loading topsoil to trucks	137	78	-
Hauling topsoil to stockpiles	2,062	1,578	-
Dumping topsoil to stockpiles	137	78	-
Drilling rock and overburden	9,272	9,272	9,272
Blasting rock and overburden	1,623	1,623	1,623
FEL loading overburden to trucks	1,644	1,960	-
Hauling overburden to emplacement area	24,751	39,839	-
Dumping overburden to emplacement area	1,644	1,960	-
Dozer shaping overburden dump	17,472	17,472	-
FEL loading rock to trucks	7,972	13,287	13,287
Hauling rock to hopper	94,080	168,000	224,000
FEL Loading rock to hopper	7,972	13,287	13,287
Primary crushing and screening	5,107	8,512	8,512
Secondary crushing and screening	102,614	171,024	171,024
Tertiary crushing and screening	102,614	171,024	171,024
Loading to product stockpiles	5,712	9,519	9,519
Loading product to road trucks	792	792	792
Transport product off-site (sealed road)	100,000	100,000	100,000
Loading product to trains by conveyor	792	1,848	1,848
Wind erosion from exposed pit areas	291,183	408,731	537,019
Wind erosion from product stockpiles	10,343	10,343	10,343
Wind erosion from Rail OEA	-	-	-
Wind erosion from Eastern OEA	21,003	41,768	-
Wind erosion from Western OEA	-	-	-
Wind erosion from Eastern EOEA	17,901	34,608	-
Wind erosion from Western EOEA	-	-	53,463
Loading excess product to trucks from plant	558	930	930
Hauling excess product to emplacement area	10,080	14,000	8,400
Dumping excess product to emplacement area	558	930	930
Dozer shaping excess product emplacement area	17,472	17,472	17,472
Grading roads	21,566	21,566	21,566
TOTAL DUST (kg)	**886,441**	**1,286,821**	**1,374,311**

Of the years selected for the assessment Year 30 is estimated to generate the most dust. This is predominantly due to the large amount of exposed area subject to wind erosion.

6 APPROACH TO ASSESSMENT

In August 2001, the DECCW (then DEC) published new guidelines for the assessment of air pollution sources using dispersion models. 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 and is described in detail in the original assessment in 2005.

Operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 6.1** shows the location of the modelled sources for each assessment year. 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**. Whilst many activities are proposed to occur during daylight hours, load and haul of primary raw feed will occur until 10 pm and the crushing, screening, hauling 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 123 discrete receptors located in and around the project area. The locations of these receptors have been chosen to provide finer resolution closer to the quarry dust sources and nearby residences.

A calibration study was undertaken as part of the EIS for the Warkworth mine in the Hunter Valley (**Holmes Air Sciences, 2002**), in order to investigate the possible overprediction of short-term concentrations by the ISCST3 model. 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.

Figure 6.1: Location of sources used in dispersion modelling

As was shown in the 2005 air quality assessment for this project, the average extent of over prediction was a factor of 2.6. That is, unadjusted model predictions overpredict 24-hour PM_{10} concentrations by 260%. This factor has been used in this assessment to adjust the model predictions downwards and obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for the three years assessed.

The model ISCST3 has been the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the DECCW's model of choice but it has had limited use in dust modelling applications. Comparisons of model predictions (refer to **Holmes Air Sciences, 2002** 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. This approach is consistent with the approach used for the original assessment of air quality impacts in 2005 and again in 2008 for the approved quarry.

7 ASSESSMENT OF IMPACTS

7.1 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:

- Predicted maximum 24-hour average PM_{10} concentration
- Predicted annual average PM_{10} concentration
- Predicted annual average TSP concentration
- 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 contributions from existing non-quarry sources.

Model predictions for each assessment year have also been presented in tabular form for the nearest residences and potential future residential locations that are not on Holcim owned land (**Table 7.1**). These nearest residential locations, as listed in **Table 7.1**, are shown (circled) in **Figure 7.1**, which shows the identification label given to each assessment location. Interpretation and analysis of the model predictions for each assessment scenario are provided below. Note that the locations in **Figure 7.1** labelled as "R5" and "R8" are intended to represent possible future residential locations.

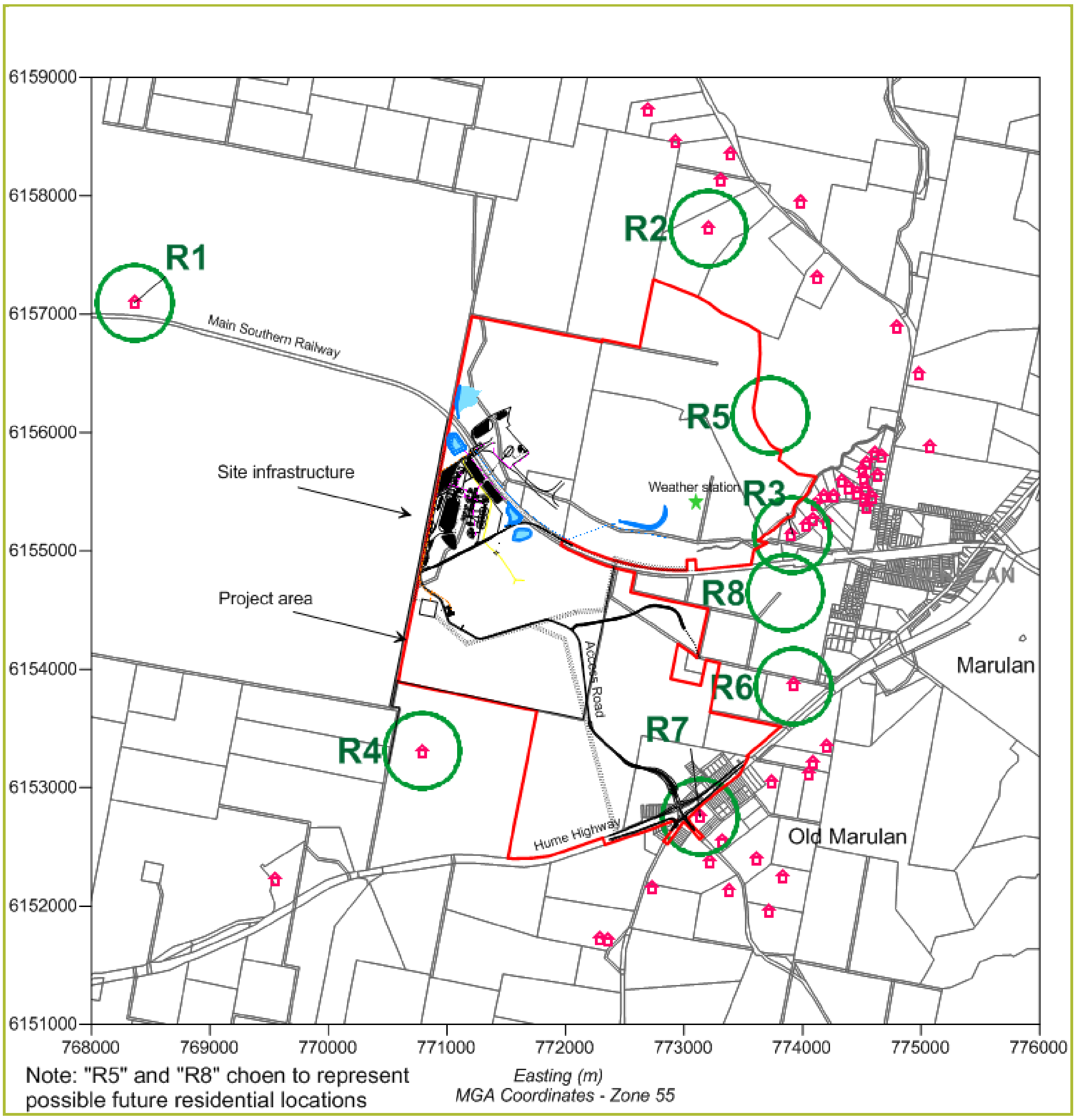

Figure 7.1: Locations of the nearest residences

7.2 Assessment Criteria

The air quality criteria used for deciding which properties are likely to experience air quality impacts are those specified in the DECCW's modelling guidelines (refer to **Table 3.1** and **Table 3.2**).

These criteria are:

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

7.3 Assessment of Impacts

Dispersion model predictions for each year of operations assessed are presented in **Figure 7.2**, **Figure 7.3** and **Figure 7.4**. **Table 7.1** provides a summary of results for the nearest residences and also provides a comparison between the predicted dust levels from the approved quarry compared to the proposed modified site layout. The residences and potential future residential locations have been selected to represent the most potentially affected areas for various wind directions.

It can be seen in **Table 7.1** that the predictions for the current layout scenario are not greatly different to those predictions made in 2008. Due to the modified layout of the site, the levels predicted at some residences are higher than previously assessed, whereas at other residences they are predicted to be lower than previously assessed.

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 µg/m^3 goal at all the nearest residences.
- Annual average PM_{10} concentrations due to the operations are below the 30 µg/m^3 goal at all residences. If an annual average background PM_{10} of 13 µg/m^3 is added to the model predictions, concentrations at all residences are still below the 30 µg/m^3 goal.
- Annual average TSP concentrations due to the operations are below the 90 µg/m^3 goal at all residences. If an annual average background TSP of 33 µg/m^3 is added to the model predictions, concentrations at all residences are still below the 90 µg/m^3 goal.
- The predicted contribution of the quarry to dust deposition levels is 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 1.6 g/m^2/month is added.

Model predictions have been presented as contour plots, shown in **Figure 7.2**, **Figure 7.3** and **Figure 7.4**. 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 as the background monitoring data includes the effects of all existing sources.

Table 7.1: Model predictions at selected locations due to quarry operations

	Year 5			Year 10			Year 30		
	Proposed layout	2005 layout	2008 layout	Proposed layout	2005 layout	2008 layout	Proposed layout	2005 layout	2008 layout
Predicted maximum 24-hour average PM_{10} concentrations ($\mu g/m^3$). Goal = 50 $\mu g/m^3$									
R1	5.5	7.5	4.1	10.6	9.7	6.9	8.0	8.3	7.2
R2	6.8	10.0	6.5	11.2	16.4	11.6	12.1	13.8	14.5
R3	12.5	17.8	8.4	24.7	17.8	14.6	16.1	14.7	12.3
R4	15.0	16.1	7.3	23.0	16.7	11.1	23.1	16.8	12.3
R5	14.9	22.3	9.2	23.4	24.8	16.8	22.1	21.6	18.2
R6	8.9	15.5	6.3	18.4	14.5	9.7	13.8	13.8	9.2
R7	8.5	10.2	8.4	13.9	10.7	9.4	10.5	11.4	10.3
R8	9.0	14.1	5.8	18.8	13.9	9.3	13.5	13.4	9.3

	Year 5						Year 10						Year 30					
	Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout	
Predicted annual average PM_{10} concentrations ($\mu g/m^3$). Goal = 30 $\mu g/m^3$																		
(Model predictions with estimated background (13 $\mu g/m^3$) are shown in grey)																		
R1	0.5	13.5	0.7	13.7	0.4	13.4	0.9	13.9	1.0	14.0	0.7	13.7	0.8	13.8	0.9	13.9	0.9	13.9
R2	2.1	15.1	2.5	15.5	1.7	14.7	3.3	16.3	4.0	17.0	3.0	16.0	3.5	16.5	3.7	16.7	3.7	16.7
R3	4.6	17.6	4.9	17.9	3.6	16.6	8.2	21.2	6.5	19.5	5.1	18.1	5.6	18.6	5.5	18.5	5.3	18.3
R4	3.6	16.6	3.4	16.4	2.3	15.3	4.9	17.9	4.2	17.2	3.4	16.4	5.1	18.1	4.2	17.2	4.0	17.0
R5	4.7	17.7	4.9	17.9	3.4	16.4	7.1	20.1	8.0	21.0	6.0	19.0	7.1	20.1	7.1	20.1	7.2	20.2
R6	2.9	15.9	3.2	16.2	2.2	15.2	4.9	17.9	4.0	17.0	3.2	16.2	3.7	16.7	3.6	16.6	3.4	16.4
R7	2.7	15.7	2.9	15.9	2.4	15.4	3.9	16.9	3.4	16.4	3.0	16.0	3.3	16.3	3.3	16.3	3.2	16.2
R8	4.2	17.2	4.4	17.4	3.2	16.2	6.9	19.9	5.6	18.6	4.5	17.5	5.0	18.0	4.8	17.8	4.6	17.6

	Year 5						Year 10						Year 30					
	Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout	
Predicted annual average TSP concentrations (µg/m³). Goal = 90 µg/m³																		
(Model predictions with estimated background (33 µg/m³) are shown in grey)																		
R1	0.6	33.6	0.7	33.7	0.5	33.5	1.0	34.0	1.2	34.2	0.8	33.8	0.9	33.9	1.0	34.0	1.0	34.0
R2	2.4	35.4	2.8	35.8	1.8	34.8	3.7	36.7	4.5	37.5	3.4	36.4	3.9	36.9	4.2	37.2	4.2	37.2
R3	5.7	38.7	6.0	39.0	4.5	37.5	9.8	42.8	8.0	41.0	6.4	39.4	6.6	39.6	6.4	39.4	6.2	39.2
R4	4.0	37.0	3.8	36.8	2.6	35.6	5.5	38.5	4.7	37.7	3.8	36.8	5.7	38.7	4.7	37.7	4.5	37.5
R5	5.4	38.4	5.5	38.5	3.8	36.8	8.2	41.2	9.1	42.1	6.7	39.7	8.2	41.2	8.2	41.2	8.2	41.2
R6	3.3	36.3	3.6	36.6	2.5	35.5	5.5	38.5	4.5	37.5	3.6	36.6	4.3	37.3	4.1	37.1	3.8	36.8
R7	3.1	36.1	3.3	36.3	2.7	35.7	4.3	37.3	4.0	37.0	3.4	36.4	3.8	36.8	3.8	36.8	3.7	36.7
R8	4.9	37.9	5.1	38.1	3.7	36.7	7.9	40.9	6.7	39.7	5.4	38.4	5.8	38.8	5.5	38.5	5.3	38.2

	Year 5						Year 10						Year 30					
	Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout		Proposed layout		2005 layout		2008 layout	
Annual average dust deposition (g/m²/month). Goal = 2 g/m²/month for Project only and 4 g/m²/month with estimated background																		
(Model predictions with estimated background (1.6 g/m²/month) are shown in grey)																		
R1	0.03	1.63	0.02	1.62	0.02	1.62	0.04	1.64	0.03	1.63	0.03	1.63	0.05	1.65	0.05	1.65	0.05	1.65
R2	0.12	1.72	0.06	1.66	0.06	1.66	0.18	1.78	0.12	1.72	0.12	1.72	0.21	1.81	0.21	1.91	0.20	1.80
R3	0.50	2.10	0.37	1.97	0.37	1.97	0.77	2.37	0.56	2.16	0.56	2.16	0.50	2.10	0.50	2.2	0.47	2.07
R4	0.17	1.77	0.10	1.70	0.10	1.70	0.24	1.84	0.16	1.76	0.16	1.76	0.27	1.87	0.26	1.96	0.24	1.84
R5	0.33	1.93	0.15	1.75	0.15	1.75	0.53	2.13	0.31	1.91	0.31	1.91	0.53	2.13	0.55	2.25	0.52	2.12
R6	0.20	1.80	0.14	1.74	0.14	1.74	0.29	1.89	0.22	1.82	0.22	1.82	0.26	1.86	0.26	1.96	0.24	1.84
R7	0.16	1.76	0.13	1.73	0.13	1.73	0.20	1.80	0.18	1.78	0.18	1.78	0.21	1.81	0.23	1.93	0.21	1.81
R8	0.38	1.98	0.26	1.86	0.26	1.86	0.56	2.16	0.42	2.02	0.42	2.02	0.40	2.00	0.42	2.1	0.37	1.97

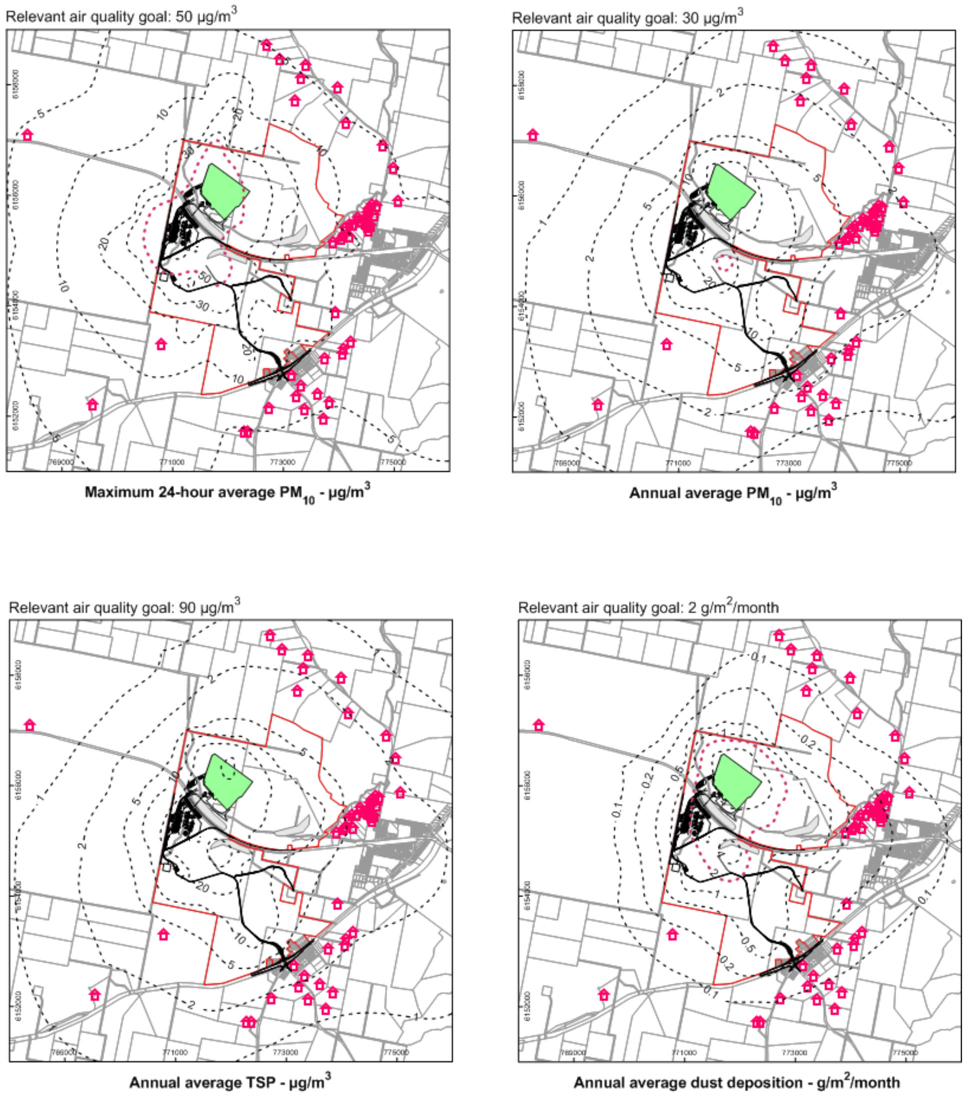

Figure 7.2: Dust Contours – Year 5

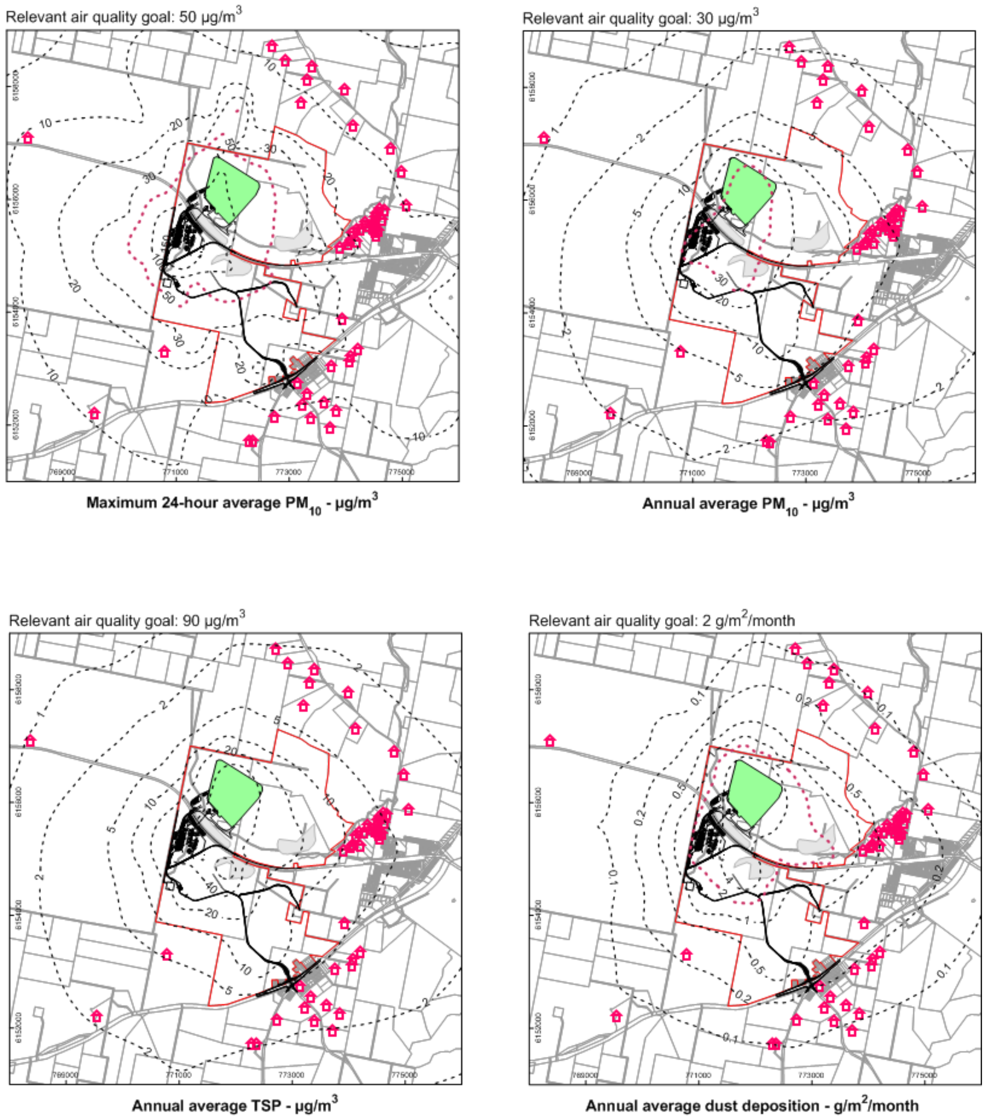

Figure 7.3: Dust Contours – Year 10

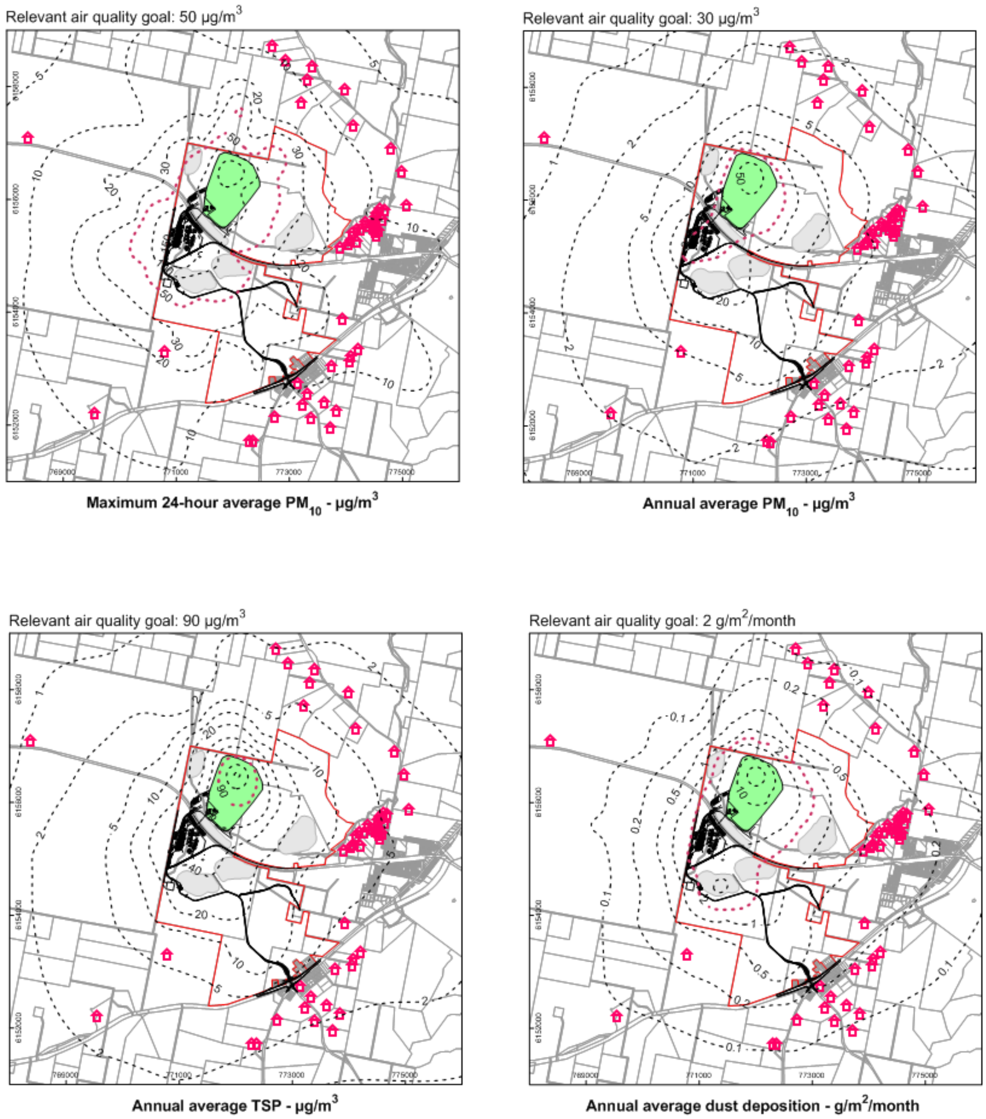

Figure 7.4: Dust Contours – Year 30

8 CRYSTALLINE SILICA

8.1 Introduction

Silica (SiO_2) is a naturally occurring mineral composed of silicon and oxygen. It exists in crystalline and amorphous forms depending on the structural arrangement of the oxygen and silicon atoms. Only the crystalline forms are known to be fibrogenic[c] 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.

There are a number of size-based descriptors used in describing particulate matter and it is useful to define these for the following discussion. The descriptors are:

- PM_{10} – particles with an equivalent aerodynamic diameter of less than approximately 10 µm. The largest of these are inhalable.
- PM_7 – particles with an equivalent aerodynamic diameter of less than approximately 7 µm. The largest of these can reach the thoracic region of the respiratory system.
- PM_4 – particles with an equivalent aerodynamic diameter of less than approximately 4 µm. The largest of these can reach the alveoli.
- $PM_{2.5}$ – particles with an equivalent aerodynamic diameter of less than approximately 2.5 µm. These are the fine particle fraction.

Particles described as PM_7 are a sub-component of PM_{10}, PM_4 particles are a sub-component of PM_7 and PM_{10}, and $PM_{2.5}$ particles are a sub-component of PM_4, PM_7 and PM_{10}.

The three most common types of crystalline silica are quartz, tridymite and cristobalite. Human exposure to crystalline silica occurs most often during occupational activities that involve the working of materials containing crystalline silica products (e.g. masonry, concrete, sandstone) or use or manufacture of crystalline silica-containing products. Activities that involve cutting, grinding or breaking of these materials can result in the liberation of particles in PM_{10}, PM_7, PM_4 and $PM_{2.5}$ size ranges. Ambient crystalline silica dust can occur due to natural, industrial and agricultural activities.

Repeated and prolonged exposure to relatively high concentrations of 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. Occurrences of silicosis are highly correlated to occupations where particles of crystalline silica are released to the atmosphere (e.g. mining, quarrying, sandblasting). Silicosis is becoming less common in industrialised nations due to the stringent controls on airborne dust and the use of protective devices.

[c] Fibrogenic dust is dust which may cause an increase of fibrotic (scar) tissue after deposition in the gas exchange region of the lung.

8.2 Assessment Criteria

General community (non-occupational) exposure to respirable crystalline silica is typically well below the national exposure standards and consequently is unlikely to present significant risks to public health. The World Health Organization's Concise International Chemical Assessment Document on Crystalline Silica, Quartz (**CICAD, 2000**) states that "*there are no known adverse health effects associated with the non-occupational exposure to quartz*".

The proportion of crystalline silica within the dust that will be liberated by the Lynwood Quarry is not known. However testing on the source rock shows that it has a crystalline silica content of between 35 and 40%. Not all of this will be liberated to the air during the quarrying operations. For estimation of crystalline silica impacts it has been assumed that 35% of the PM_{10} emissions are crystalline silica and the model predictions have been assessed for the year of maximum dust generation (Year 30).

In Australia, the occupational exposure standards for respirable crystalline silica are defined by the National Occupational Health and Safety Commission (NOHSC). The national exposure standard for respirable crystalline silica is 100 µg/m^3 (Time Weighted Average (TWA))[d]. Although the occupational standard is not applicable to the assessment of the ambient air quality, provided the standard is met for workers near the source, the risk of silicosis among people living in surrounding areas would generally be very small.

The NSW DECCW has not set any impact assessment criteria for crystalline silica. The Victorian EPA has adopted an ambient assessment criterion for mining and extractive industries of 3 µg/m^3 (annual average as $PM_{2.5}$) (**VEPA, 2007**). This has been derived from the Reference Exposure Level (REL)[e] set by the California EPA Office of Environmental Health Hazard Assessment of 3 µg/m^3 (annual average as PM_4) (**OEHHA, 2005**).

The **US EPA (1996)** examined the non-cancer epidemiological literature on crystalline silica induced diseases. From the extensive data available, which examined the medical histories of thousands of miners, they concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000 µg/m^3.years.

Cumulative exposure is the average respirable crystalline silica concentration a person is exposed to over a period of time, multiplied by the number of years exposed. For example, an exposure of 1000 µg/m^3.years, would be experienced by an individual exposed to 14.3 µg/m^3 (annual average PM_4) per year for 70 years. For cumulative exposures less than 1000 µg/m^3.years, the US EPA concludes that the risk of developing silicosis is zero.

[d] TWA - the average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.

[e] RELs are used by the California Environmental Protection Agency as indicators of potential adverse health effects. A REL is a concentration level (g/m^3) or dose (mg/kg/day) at (or below) which no adverse health effects are anticipated for a specified time period. RELs are generally based on the most sensitive adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of margins of safety.

8.3 Impact Assessment

The methodology defined by the US EPA has been applied to the predicted impacts at the nearby residences to Lynwood Quarry, to determine the cumulative risk.

The California EPA REL applies to PM_4 and therefore the predicted impacts of PM_{10} concentrations need to be adjusted to PM_4 concentrations before they can be compared with the standard. In our analysis we have assumed that the crystalline silica fraction of PM_{10} is the same for PM_4. Therefore, it has been assumed that 35% of PM_{10} emissions from quarrying activities are crystalline silica. This is a conservative assumption as not all of the crystalline silica will be released from the rock during these activities.

As noted above, in order to compare the predicted impacts with the Californian EPA REL it is necessary to estimate the PM_4 concentrations of crystalline silica arising from the Project. The ratio of PM_4/PM_{10} assumed here is 0.3 (**SPCC, 1986**), therefore the predicted annual average PM_{10} concentrations have been converted to annual average PM_4 concentrations by multiplying by the ratio of PM_4/PM_{10} (that is, 0.3). The crystalline silica content has been estimated by multiplying this value by the conservatively estimated average crystalline silica in the PM_{10} emissions (that is, 0.35).

The predicted crystalline silica concentrations using the method described above are shown in **Figure 8.1**. At the most affected residence the predicted annual average PM_{10} concentration was 7.1 µg/m^3 (see **Table 7.1**). Therefore, the estimated annual average respirable (PM_4) concentration of crystalline silica was 0.7 µg/m^3 [7.1 µg/m^3 x 0.3 x 0.35 = 0.7 µg/m^3]. This is less than the Californian REL of 3 µg/m^3.

As exposure to crystalline silica is primarily an occupational health hazard, very little monitoring has been conducted to measure ambient concentrations. Data collected in Victoria estimated the background concentration to be 0.7 µg/m^3 (**Toxikos, 2005**). This is comparable to the ambient level in a Californian rural area of 0.6 µg/m^3 (**OEHHA, 2005**). In the absence of any local data, it has been assumed the background level of 0.7 µg/m^3 as measured in Victoria applies in the Project area. The cumulative risk related to the exposure of crystalline silica is therefore as presented below.

- Existing background respirable crystalline silica = 0.7 µg/m^3
- Increase in respirable crystalline silica at most affected receptor = 0.7 µg/m^3
- Total annual respirable crystalline silica = 1.4 µg/m^3

Based on the assumption that the quarry has a proposed life of 30 years, the respirable crystalline silica exposure during the operation of the quarry is 42 µg/m^3.years [1.4 µg/m^3 x 30 years].

If an individual were to live for the remaining 40 years of their assumed 70 year lifetime in the same area without the quarry operating, the exposure to respirable crystalline silica would be 28 µg/m^3.years [0.7 µg/m^{3}x 40 years].

The total lifetime exposure from background concentrations and the proposed project combined would be 70 µg/m^3.years [42 µg/m^3.years+ 28 µg/m^3.years].

As discussed above, the US EPA concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000 µg/m^3.years. The estimated total lifetime cumulative exposure for the proposed Quarry is approximately 14 times lower than this, even with the very conservative estimates used.

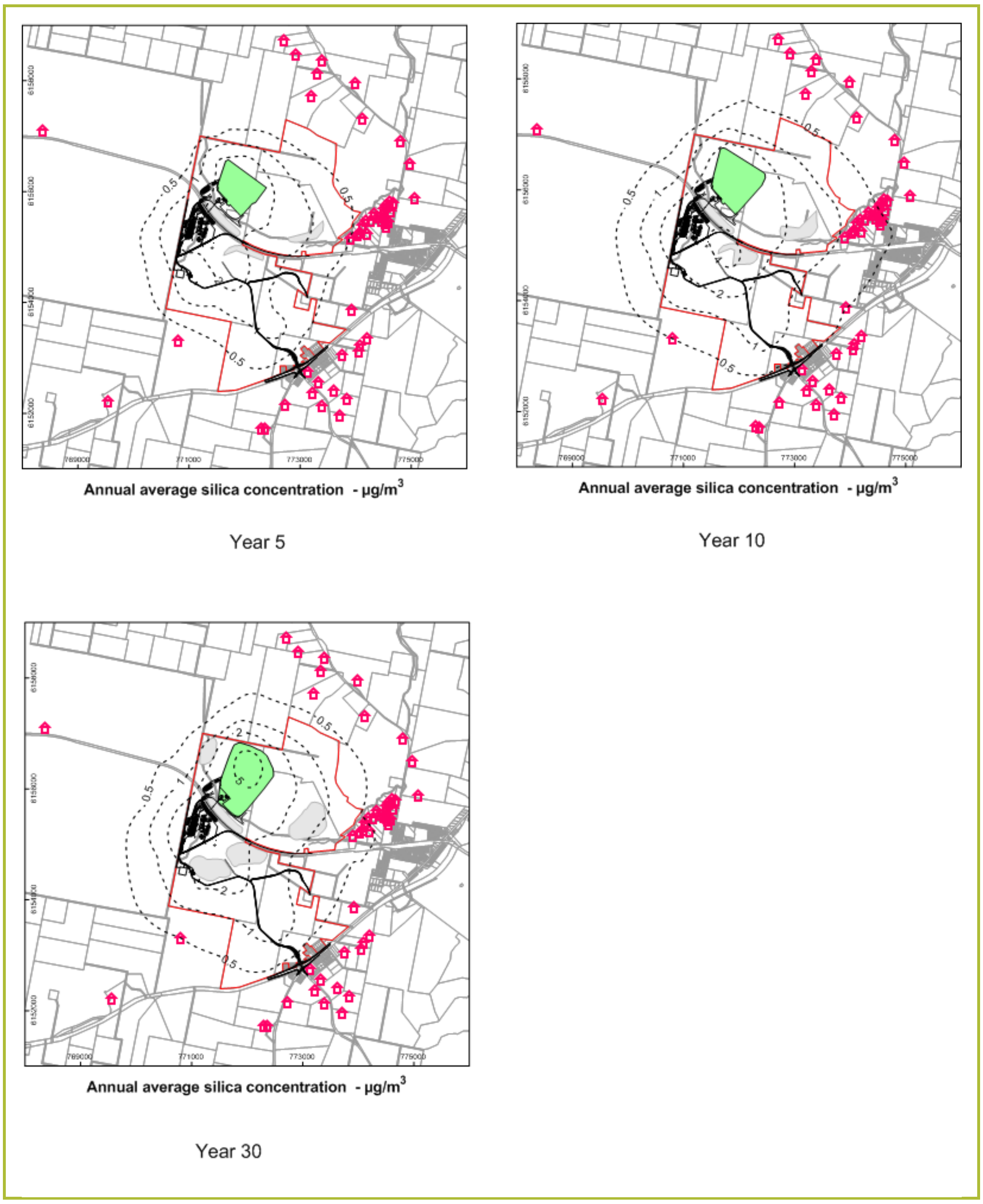

Figure 8.1: Predicted silica contours due to Lynwood Quarry operations

9 CUMULATIVE IMPACTS

It is noted that a number of existing quarries are located within the regional context of the proposed site. Holcim operates 1 km to the north of the proposed Lynwood quarry on the Johniefelds property and the Gunlake Quarry operates 2 km to the north on the Lynwood property.

The Johnifields and Gunlake quarries are each expected to produce up to 500,000 t of product per year (**Heggies, 2008**). As discussed in **Section 4.2**, dust monitoring data is available for the site. The available data spans the period from 2004 to 2010. Monitored dust levels would include all existing dust sources in the region, including the existing Johniefelds and Gunlake quarries, unsealed roads and natural sources of dust.

The contribution of Lynwood Quarry to the total dust burden has been represented by predicted concentrations from Receptor 2 (see **Section 7** and **Figure 7.1**), lying to the north of the Lynwood site; as this is the closest receptor to the other quarries.

9.1 24-hour PM_{10}

Impact assessment of cumulative 24-hour PM_{10} levels is not precise for proposed projects, for the following reasons:

- For sites near quarries, actual dust impacts that occur over an hour or a day are often heavily influenced by just one or a few of the many sources operating on a quarry. It is not possible to reliably predict the position of all such sources for each hour of the year for one quarry, leading to a high degree of uncertainty in the location and time of potential impacts over a year.
- Regulatory air dispersion models, inherently must not under-predict potential impacts (i.e. they are inherently designed to over-predict the actual case). Also, the models tend to produce greater over-predictions at greater distances from the source.

Therefore, comparison to 24-hour criteria should be in general used as a management tool to determine what additional management practices and monitoring may be required.

It should also be noted that for the Lynwood Quarry project there were no site specific daily PM_{10} data (such as measured by a TEOM). The only data available were from two HVAS sites which do not measure on a daily basis, but every sixth day. Because data are recorded every sixth day it is not possible to apply other statistical measures for background, such as the 70th percentile as recommended by the Victorian EPA.

In summary, 24-hour cumulative PM_{10} concentrations are impossible to predict reliably, and further uncertainty occurs when choosing an appropriate background. The "proposal only" 24-hour criterion of 50 ug/m^3 (as listed in **Table 3.1**) is reasonable and practical.

9.2 Annual Average PM_{10}, TSP and Deposition

Cumulative impacts are more meaningful for annual average predictions and are reliant on good monitoring data. Six years of monitoring data are available for this study and are discussed in **Section 4.2**. The annual average background PM_{10} was determined to be approximately 13 µg/m^3 and 33 µg/m^3 for TSP. For dust deposition the annual average background level was determined to be approximately 1.6 g/m^2/month. As was shown in **Section 7.3** and **Table 7.1**, the model results added to these background levels were predicted to be below all the relevant air quality assessment criteria.

9.3 Silica

The estimated annual average respirable (PM_4) background concentration of crystalline silica was assumed to be approximately 0.7 µg/m^3 (see **Section 8**). The estimated annual average respirable concentration of crystalline silica due to the Lynwood Quarry at Receptor 2 was predicted to be 0.4 µg/m^3. At the receptor closest to the Lynwood Quarry, the estimated annual average respirable concentration of crystalline silica due to the Gunlake Quarry was 0.23 µg/m^3. It is reasonable to assume that the contribution of the Johnifields Quarry would be similar to that from the Gunlake Quarry (0.23 µg/m^3). Thus the cumulative effect of the three quarries and other background sources is estimated at around 1.6 µg/m^3. This is less than the Californian REL of 3 µg/m^3.

If each quarry were to operate simultaneously for 30 years, the respirable crystalline silica exposure during the operation of the three quarries is 26 µg/m^3.years [0.86 µg/m^3 x 30 years].

If an individual were to live for the remaining 40 years of their assumed 70 year lifetime in the same area without the quarry operating, the exposure to respirable crystalline silica would be 28 µg/m^3.years [0.7 µg/m^{3}x 40 years].

The total lifetime exposure from background concentrations and the proposed project combined would be 54 µg/m^3.years [26 µg/m^3.years+ 28 µg/m^3.years].

As discussed in **Section 8**, the US EPA concluded that the cumulative risk of developing silicosis is zero for cumulative exposures of less than 1000 µg/m^3.years. The estimated total lifetime cumulative exposure is approximately 18 times lower than this.

10 CONCLUSIONS AND RECOMMENDATIONS

This report has assessed the air quality impacts associated with the proposed modifications to the approved Lynwood Quarry near Marulan. This operation was originally assessed by Holmes Air Sciences in 2005 and again for proposed modifications, by PAEHolmes in 2008. The purpose of this report was to determine if the current proposed changes in layout and extent of the pit would change the outcome of the previou assessments.

Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to emissions from the proposed modified project. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for three operational scenarios. The scenarios were selected to cover a range of quarry production, overburden extraction and pit location combinations.

Background 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 DECCW'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 in which these elevated levels occurred.

The assessment concluded that:

- air quality goals were not predicted to be exceeded at nearby residences due to the proposed modified quarry operations;
- particulate matter concentrations arising from non-Quarry related sources such as bushfires and regional dust storms, may continue to result in elevated short-term concentrations on occasions;
- the proposed changes to the layout of on-site infrastructure and the pit layout are not anticipated to cause adverse impacts off-site;
- the cumulative risk of developing silicosis was determined to be zero. The estimated total lifetime cumulative exposure for the proposed project is approximately 14 times lower than the US EPA standard, even with the very conservative estimates used; and
- cumulative assessment of annual average dust impacts considering the Lynwood Quarry together with the Gunlake and Johnifelds quarries indicated that total dust levels were within DECCW criteria.

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 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 and therefore some gauges should be relocated to residential locations.

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Appendix A: Joint wind speed, wind direction and stability class frequency tables for Marulan – 2000

STATISTICS FOR FILE: C:\Jobs\LynQ2008\metdata\marul00.isc
MONTHS: All
HOURS : All
OPTION: Frequency

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	0.003529	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004554
NE	0.002277	0.004212	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006489
ENE	0.002049	0.003188	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005237
E	0.002277	0.003188	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005464
ESE	0.000569	0.003985	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004554
SE	0.000797	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003529
SSE	0.000911	0.001594	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002505
S	0.001138	0.002846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003985
SSW	0.001025	0.002505	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003529
SW	0.000911	0.002505	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003415
WSW	0.000911	0.002618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003529
W	0.001138	0.001708	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002846
WNW	0.001025	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003757
NW	0.001594	0.002618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004212
NNW	0.000569	0.001935	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002505
N	0.000797	0.002846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003643
CALM									0.006944
TOTAL	0.019012	0.044740	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.070697

MEAN WIND SPEED (m/s) = 1.75
NUMBER OF OBSERVATIONS = 621

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	0.003643	0.000000	0.000000	0.000000	0.000000	0.000000	0.005806
NE	0.000569	0.001025	0.003529	0.000000	0.000000	0.000000	0.000000	0.000000	0.005123
ENE	0.000228	0.002163	0.003415	0.000000	0.000000	0.000000	0.000000	0.000000	0.005806
E	0.000569	0.001821	0.002960	0.000000	0.000000	0.000000	0.000000	0.000000	0.005351
ESE	0.000569	0.001138	0.002846	0.000000	0.000000	0.000000	0.000000	0.000000	0.004554
SE	0.000342	0.001708	0.002277	0.000000	0.000000	0.000000	0.000000	0.000000	0.004326
SSE	0.000000	0.001594	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.002618
S	0.000228	0.001935	0.001935	0.000000	0.000000	0.000000	0.000000	0.000000	0.004098
SSW	0.000228	0.001708	0.001480	0.000000	0.000000	0.000000	0.000000	0.000000	0.003415
SW	0.000342	0.000911	0.002277	0.000000	0.000000	0.000000	0.000000	0.000000	0.003529
WSW	0.000114	0.001708	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.004554
W	0.000455	0.000797	0.003074	0.000000	0.000000	0.000000	0.000000	0.000000	0.004326
WNW	0.000569	0.001480	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.004781
NW	0.000683	0.001708	0.002505	0.000000	0.000000	0.000000	0.000000	0.000000	0.004895
NNW	0.000569	0.002163	0.004098	0.000000	0.000000	0.000000	0.000000	0.000000	0.006831
N	0.000797	0.002618	0.003415	0.000000	0.000000	0.000000	0.000000	0.000000	0.006831
CALM									0.002391
TOTAL	0.006489	0.026412	0.043944	0.000000	0.000000	0.000000	0.000000	0.000000	0.079235

MEAN WIND SPEED (m/s) = 2.85
NUMBER OF OBSERVATIONS = 696

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	0.004212	0.006148	0.000000	0.000000	0.000000	0.000000	0.012750
NE	0.000455	0.001366	0.002618	0.003301	0.000000	0.000000	0.000000	0.000000	0.007741
ENE	0.000683	0.001935	0.002505	0.002277	0.000000	0.000000	0.000000	0.000000	0.007400
E	0.000683	0.002505	0.003188	0.002846	0.000000	0.000000	0.000000	0.000000	0.009221
ESE	0.000228	0.000911	0.002960	0.002391	0.000000	0.000000	0.000000	0.000000	0.006489
SE	0.000342	0.001252	0.002391	0.001252	0.000000	0.000000	0.000000	0.000000	0.005237
SSE	0.000000	0.001594	0.001480	0.003074	0.000000	0.000000	0.000000	0.000000	0.006148
S	0.000000	0.001252	0.002049	0.003529	0.000000	0.000000	0.000000	0.000000	0.006831
SSW	0.000569	0.002618	0.004212	0.003074	0.000000	0.000000	0.000000	0.000000	0.010474
SW	0.000569	0.002505	0.004895	0.002618	0.000000	0.000000	0.000000	0.000000	0.010587
WSW	0.000455	0.002277	0.004212	0.002163	0.000000	0.000000	0.000000	0.000000	0.009107
W	0.000683	0.002846	0.004781	0.003985	0.000000	0.000000	0.000000	0.000000	0.012295
WNW	0.000797	0.002960	0.004781	0.006375	0.000000	0.000000	0.000000	0.000000	0.014913
NW	0.000114	0.001252	0.004554	0.005464	0.000000	0.000000	0.000000	0.000000	0.011384
NNW	0.000683	0.002277	0.004326	0.005123	0.000000	0.000000	0.000000	0.000000	0.012409
N	0.000683	0.001480	0.004326	0.006603	0.000000	0.000000	0.000000	0.000000	0.013092
CALM									0.002163
TOTAL	0.007514	0.030852	0.057491	0.060223	0.000000	0.000000	0.000000	0.000000	0.158242

MEAN WIND SPEED (m/s) = 3.93
NUMBER OF OBSERVATIONS = 1390

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	0.003529	0.002732	0.005578	0.003643	0.004554	0.002391	0.000569	0.000114	0.023110
NE	0.003415	0.002163	0.003985	0.001821	0.004781	0.001594	0.000455	0.000114	0.018329
ENE	0.002618	0.003757	0.003074	0.001252	0.001480	0.000342	0.000114	0.000000	0.012637
E	0.001935	0.003871	0.002505	0.000911	0.001935	0.001025	0.000228	0.000000	0.012409
ESE	0.002391	0.004554	0.002505	0.001252	0.001025	0.000342	0.000114	0.000114	0.012295
SE	0.001366	0.003074	0.003415	0.001025	0.001708	0.000455	0.000228	0.000114	0.011384
SSE	0.000228	0.003871	0.003301	0.001025	0.002277	0.000911	0.000228	0.000000	0.011840
S	0.001366	0.004781	0.005009	0.001821	0.002391	0.001708	0.000683	0.000228	0.017987
SSW	0.002277	0.007741	0.006034	0.002732	0.002960	0.001594	0.000455	0.000228	0.024021
SW	0.006034	0.008766	0.006831	0.001935	0.001025	0.000342	0.000455	0.000228	0.025615
WSW	0.004554	0.008424	0.008538	0.002277	0.001935	0.001366	0.000228	0.000228	0.027550
W	0.006489	0.013092	0.011726	0.007628	0.003643	0.001708	0.000797	0.000455	0.045537
WNW	0.004895	0.012295	0.011270	0.006148	0.008083	0.003871	0.001935	0.000228	0.048725
NW	0.003074	0.005920	0.007741	0.005123	0.007172	0.003188	0.000797	0.000569	0.033584
NNW	0.001138	0.004554	0.007058	0.002277	0.004440	0.002960	0.001366	0.000455	0.024249
N	0.003074	0.003188	0.008766	0.002505	0.006034	0.003074	0.001138	0.000114	0.027892
CALM									0.012523
TOTAL	0.048383	0.092782	0.097336	0.043374	0.055442	0.026867	0.009791	0.003188	0.389686

MEAN WIND SPEED (m/s) = 4.04
NUMBER OF OBSERVATIONS = 3423

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	0.005009	0.003985	0.000683	0.000000	0.000000	0.000000	0.000000	0.000000	0.009677
NE	0.004212	0.004212	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.008538
ENE	0.004326	0.001821	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.006375
E	0.003074	0.002049	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005123
ESE	0.002277	0.002846	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.005237
SE	0.001025	0.001594	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.002732
SSE	0.001025	0.001935	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.003074
S	0.002732	0.002277	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.005237
SSW	0.002732	0.004668	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.007741
SW	0.005351	0.003643	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.009449
WSW	0.005009	0.006944	0.001708	0.000000	0.000000	0.000000	0.000000	0.000000	0.013661
W	0.009221	0.010360	0.005351	0.000114	0.000000	0.000000	0.000000	0.000000	0.025046
WNW	0.007058	0.006489	0.001821	0.000342	0.000000	0.000000	0.000000	0.000000	0.015710
NW	0.005692	0.004326	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.010246
NNW	0.003074	0.004212	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.007400
N	0.002732	0.005009	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.007855
CALM									0.014117
TOTAL	0.064549	0.066371	0.011726	0.000455	0.000000	0.000000	0.000000	0.000000	0.157218

MEAN WIND SPEED (m/s) = 1.63
NUMBER OF OBSERVATIONS = 1381

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	0.005464	0.002732	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008197
NE	0.004326	0.001366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005692
ENE	0.003415	0.001138	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004554
E	0.003871	0.000797	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004668
ESE	0.001708	0.001366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003074
SE	0.002960	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003985
SSE	0.002049	0.001025	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003074
S	0.003529	0.001366	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004895
SSW	0.005237	0.001935	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007172
SW	0.006375	0.001821	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008197
WSW	0.008994	0.000911	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009904
W	0.009904	0.002505	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012409
WNW	0.008766	0.002960	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011726
NW	0.008197	0.002163	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010360
NNW	0.003529	0.002277	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005806
N	0.003757	0.004781	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008538
CALM									0.032673
TOTAL	0.082081	0.030168	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.144923

MEAN WIND SPEED (m/s) = 1.04
NUMBER OF OBSERVATIONS = 1273

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	0.015824	0.016735	0.014117	0.009791	0.004554	0.002391	0.000569	0.000114	0.064094
NE	0.015255	0.014344	0.010246	0.005123	0.004781	0.001594	0.000455	0.000114	0.051913
ENE	0.013320	0.014003	0.009221	0.003529	0.001480	0.000342	0.000114	0.000000	0.042008
E	0.012409	0.014230	0.008652	0.003757	0.001935	0.001025	0.000228	0.000000	0.042236
ESE	0.007741	0.014800	0.008424	0.003643	0.001025	0.000342	0.000114	0.000114	0.036202
SE	0.006831	0.011384	0.008197	0.002277	0.001708	0.000455	0.000228	0.000114	0.031193
SSE	0.004212	0.011612	0.005920	0.004098	0.002277	0.000911	0.000228	0.000000	0.029258
S	0.008994	0.014458	0.009221	0.005351	0.002391	0.001708	0.000683	0.000228	0.043033
SSW	0.012067	0.021175	0.012067	0.005806	0.002960	0.001594	0.000455	0.000228	0.056352
SW	0.019581	0.020150	0.014458	0.004554	0.001025	0.000342	0.000455	0.000228	0.060792
WSW	0.020036	0.022883	0.017190	0.004440	0.001935	0.001366	0.000228	0.000228	0.068306
W	0.027892	0.031307	0.024932	0.011726	0.003643	0.001708	0.000797	0.000455	0.102459
WNW	0.023110	0.028916	0.020606	0.012864	0.008083	0.003871	0.001935	0.000228	0.099613
NW	0.019353	0.017987	0.015027	0.010587	0.007172	0.003188	0.000797	0.000569	0.074681
NNW	0.009563	0.017418	0.015597	0.007400	0.004440	0.002960	0.001366	0.000455	0.059199
N	0.011840	0.019923	0.016621	0.009107	0.006034	0.003074	0.001138	0.000114	0.067851
CALM									0.070811
TOTAL	0.228028	0.291325	0.210496	0.104053	0.055442	0.026867	0.009791	0.003188	1.000000

MEAN WIND SPEED (m/s) = 2.95
NUMBER OF OBSERVATIONS = 8784

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 7.1%
B : 7.9%
C : 15.8%
D : 39.0%
E : 15.7%
F : 14.5%

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	0111	0115
03	0000	0000	0000	0146	0118	0102
04	0000	0000	0000	0140	0116	0110
05	0000	0000	0000	0148	0108	0110
06	0015	0011	0017	0162	0080	0081
07	0036	0039	0061	0130	0043	0057
08	0054	0060	0102	0118	0008	0024
09	0075	0055	0147	0089	0000	0000
10	0071	0063	0149	0083	0000	0000
11	0064	0080	0136	0086	0000	0000
12	0074	0069	0129	0094	0000	0000
13	0069	0078	0124	0095	0000	0000
14	0063	0079	0113	0111	0000	0000
15	0053	0066	0146	0101	0000	0000
16	0030	0059	0132	0131	0010	0004
17	0013	0027	0098	0188	0030	0010
18	0004	0010	0036	0227	0057	0032
19	0000	0000	0000	0223	0088	0055
20	0000	0000	0000	0201	0085	0080
21	0000	0000	0000	0175	0110	0081
22	0000	0000	0000	0171	0106	0089
23	0000	0000	0000	0154	0096	0116
24	0000	0000	0000	0157	0105	0104

Appendix B: Emissions Inventories

Emissions Inventory for Year 5

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**9,380**	670	h/y	14.0	kg/h						
Loading topsoil to trucks	**137**	51,538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling topsoil to stockpiles	**2,062**	51,538	t/y	0.04000	kg/t	100	t/truck load	4	km/return trip	1.0	kg/VKT
Dumping topsoil to stockpiles	**137**	51,538	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Drilling rock and overburden	**9,272**	15,716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1,623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**1,644**	618,771	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling overburden to emplacement area	**24,751**	618,771	t/y	0.04000	kg/t	100	t/truck load	4	km/return trip	1.0	kg/VKT
Dumping overburden to emplacement area	**1,644**	618,771	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping overburden dump	**17,472**	1,248	h/y	14.0	kg/h						
FEL loading rock to trucks	**7,972**	3,360,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling rock to hopper	**94,080**	3,360,000	t/y	0.02800	kg/t	100	t/truck load	2.8	km/return trip	1.0	kg/VKT
FEL Loading rock to hopper	**7,972**	3,360,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Primary crushing and screening	**5,107**	3,360,000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**102,614**	3,360,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**102,614**	3,360,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**5,712**	3,000,000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Loading product to road trucks	**792**	1,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Transport product off-site (sealed rd)	**100,000**	1,500,000	t/y	0.06667	kg/t	30	t/truck load	10	km/return trip	0.2	kg/VKT

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Loading product to trains by conveyor	**792**	1,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Wind erosion from exposed pit areas	**291,183**	48.8	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	**10,343**	2.6	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	**-**	-	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	**21,003**	3.5	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	**-**	-	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	**17,901**	3.0	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	**-**	-	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	**558**	210,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling excess product to emplacement area	**10,080**	210,000	t/y	0.04800	kg/t	50	t/truck load	2.4	km/return trip	1.0	kg/VKT
Dumping excess product to emplacement area	**558**	210,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping excess product emplacement area	**17,472**	1,248	h/y	14.0	kg/h						
Grading roads	**21,566**	35,040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Emissions Inventory for Year 10

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	**5,320**	80	h/y	14.0	kg/h						
Loading topsoil to trucks	**78**	29,231	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling topsoil to stockpiles	**1,578**	29,231	t/y	0.05400	kg/t	100	t/truck load	5.4	km/return trip	1.0	kg/VKT
Dumping topsoil to stockpiles	**78**	29,231	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Drilling rock and overburden	**9,272**	15,716	holes/y	0.59	kg/hole						
Blasting rock and overburden	**1,623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	**1,960**	737,767	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling overburden to emplacement area	**39,839**	37,767	t/y	0.05400	kg/t	100	t/truck load	5.4	km/return trip	1.0	kg/VKT
Dumping overburden to emplacement area	**1,960**	737,767	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping overburden dump	**17,472**	1,248	h/y	14.0	kg/h						
FEL loading rock to trucks	**13,287**	5,600,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Hauling rock to hopper	**168,000**	5,600,000	t/y	0.03000	kg/t	100	t/truck load	3	km/return trip	1.0	kg/VKT
Dumping rock to hopper	**13,287**	5,600,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Primary crushing and screening	**8,512**	5,600,000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171,024**	5,600,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171,024**	5,600,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9,519**	5,000,000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Loading product to road trucks	**792**	1,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Transport product off-site (sealed rd)	**100,000**	1,500,000	t/y	0.06667	kg/t	30	t/truck load	10	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1,848**	3,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Wind erosion from exposed pit areas	**408,731**	68.5	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	**10,343**	2.6	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	**-**	-	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	**41,768**	7.0	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	**-**	-	ha	5966.9	kg/ha/y	126	Average number of raindays	15	silt content (%)	12.69	% of winds above 5.4 m/s

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Wind erosion from Eastern EOEA	**34,608**	5.8	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	**-**	-	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**	350,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling excess product to emplacement area	**14,000**	350,000	t/y	0.04000	kg/t	50	t/truck load	2	km/return trip	1.0	kg/VKT
Dumping excess product to emplacement area	**930**	350,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping excess product emplacement area	**17,472**	1,248	h/y	14.0	kg/h						
Grading roads	**21,566**	35,040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Emissions Inventory for Year 30

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Dozer stripping topsoil	-	-	h/y	14.0	kg/h						
Loading topsoil to trucks	-	-	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling topsoil to stockpiles	-	-	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1.0	kg/VKT
Dumping topsoil to stockpiles	-	-	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Drilling rock	**9,272**	15,716	holes/y	0.59	kg/hole						
Blasting rock	**1,623**	52	blasts/y	31	kg/blast	2720	Area of blast in square metres				
FEL loading overburden to trucks	-	-	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling overburden to emplacement area	-	-	t/y	0.04600	kg/t	100	t/truck load	4.6	km/return trip	1.0	kg/VKT
Dumping overburden to emplacement area	-	-	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping overburden dump	-	-	h/y	14.0	kg/h						

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
FEL loading rock to trucks	**13,287**	5,600,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling rock to hopper	**224,000**	5,600,000	t/y	0.04000	kg/t	100	t/truck load	4	km/return trip	1.0	kg/VKT
Dumping rock to hopper	**13,287**	5,600,000	t/y	0.00237	kg/t	2.004	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Primary crushing and screening	**8,512**	5,600,000	t/y	0.01520	kg/t	90	%reduction				
Secondary crushing and screening	**171,024**	5,600,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Tertiary crushing and screening	**171,024**	5,600,000	t/y	0.15270	kg/t	90	%reduction	2	No. stages		
Loading to product stockpiles	**9,519**	5,000,000	t/y	0.00190	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Loading product to road trucks	**792**	1,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Transport product off-site (sealed rd)	**100,000**	1,500,000	t/y	0.06667	kg/t	30	t/truck load	10	km/return trip	0.2	kg/VKT
Loading product to trains by conveyor	**1,848**	3,500,000	t/y	0.00053	kg/t	1.608	average of (wind speed/2.2)^1.3 in m/s	5	moisture content (%)	-	bcm
Wind erosion from exposed pit areas	**537,019**	90.0	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 product stockpiles	**10,343**	2.6	ha	3977.9	kg/ha/y	126	Average number of raindays	10	silt content (%)	12.69	% of winds above 5.4 m/s

ACTIVITY	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Wind erosion from Rail OEA	**-**	-	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	**-**	-	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	**-**	-	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	**-**	-	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	**53,463**	9.0	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**	350,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Hauling excess product to emplacement area	**8,400**	350,000	t/y	0.02400	kg/t	50	t/truck load	1.2	km/return trip	1.0	kg/VKT
Dumping excess product to emplacement area	**930**	350,000	t/y	0.00266	kg/t	2.244	average of (wind speed/2.2)^1.3 in m/s	2	moisture content (%)	-	bcm
Dozer shaping excess product emplacement area	**17,472**	1,248	h/y	14.0	kg/h						
Grading roads	**21,566**	35,040	km	0.61547	kg/VKT	8	speed of graders in km/h				

Appendix C: Emission summary for sources used in the modelling

Emissions Summary Year 5

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 11-Aug-2010 16:34
  DUST EMISSION CALCULATIONS V2
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 Output emissions file   :
C:\iscruns\y5\y5emisR.dat
 Meteorological file     : C:\iscruns\marul00.isc
 Number of dust sources : 42
 Number of activities   : 32
 No-blast conditions    : None
 Wind sensitive factor  : 1.602 (1.808 adjusted
for activity hours)
 Wind erosion factor    : 74.639

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Dozer stripping topsoil
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9380 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading topsoil to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 137 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling topsoil to stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2062 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping topsoil to stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 137 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Drilling rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9272 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1623 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1644 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling overburden to emplacement
area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 24751 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping overburden to emplacement
area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1644 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dozer shaping overburden dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17472 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 7972 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Hauling rock to hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 94080 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : FEL Loading rock to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 7972 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Primary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5107 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0
```

```
ACTIVITY NAME : Secondary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 102614 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Tertiary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 102614 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 5712 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to road trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 792 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transport product off-site
(sealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 100000 kg/y
 FROM SOURCES  : 6
36 37 38 39 40 41
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trains by
conveyor
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 792 kg/y
 FROM SOURCES  : 1
23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from exposed pit
areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 291183 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product
stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 10343 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Rail OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1


ACTIVITY NAME : Wind erosion from Eastern OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 21003 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Eastern EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 17901 kg/y
 FROM SOURCES  : 2
30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading excess product to trucks
from plant
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 558 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling excess product to
emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 10800 kg/y
 FROM SOURCES  : 4
29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dumping excess product to
emplacement area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 558 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Dozer shaping excess product
emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17472 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1


 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 21566 kg/y
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
29 30 31 32 33
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

Emissions Summary Year 10

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11-Aug-2010 16:09
  DUST EMISSION CALCULATIONS V2
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 Output emissions file  : C:\iscruns\y10\y10emisR.dat
 Meteorological file    : C:\iscruns\marul00.isc
 Number of dust sources : 42
 Number of activities   : 32
 No-blast conditions    : None
 Wind sensitive factor  : 1.602 (1.808 adjusted for
activity hours)
 Wind erosion factor    : 74.639

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Dozer stripping topsoil
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5320 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading topsoil to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 78 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling topsoil to stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1578 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping topsoil to stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 78 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0



 ACTIVITY NAME : Drilling rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9272 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1623 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1960 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

ACTIVITY NAME : Hauling overburden to emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 39839 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 6 7 8 11 12 13 14 15 16 17 18 19 20
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping overburden to emplacement area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1960 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dozer shaping overburden dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17472 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13287 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Hauling rock to hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 168000 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : FEL Loading rock to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13287 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Primary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8512 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Secondary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 171024 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Tertiary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 171024 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9519 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

```
 ACTIVITY NAME : Loading product to road trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 792 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Transport product off-site (sealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 100000 kg/y
 FROM SOURCES  : 6
36 37 38 39 40 41
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trains by conveyor
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1848 kg/y
 FROM SOURCES  : 1
23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from exposed pit areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 408731 kg/y
 FROM SOURCES  : 8
1 2 3 4 5 6 7 8
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 10343 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Rail OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Eastern OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 41768 kg/y
 FROM SOURCES  : 4
13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Eastern EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 34608 kg/y
 FROM SOURCES  : 2
30 31
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading excess product to trucks from
plant
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 930 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling excess product to emplacement
area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 14000 kg/y
 FROM SOURCES  : 4
29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dumping excess product to emplacement
area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 930 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer shaping excess product emplacement
area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17472 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 21566 kg/y
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 29 30
31 32 33
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```

Emissions Summary Year 30

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  -------------------------------
  11-Aug-2010 16:18
  DUST EMISSION CALCULATIONS V2
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 Output emissions file  : C:\iscruns\y30\y30emisR.dat
 Meteorological file    : C:\iscruns\marul00.isc
 Number of dust sources : 42
 Number of activities   : 32
 No-blast conditions    : None
 Wind sensitive factor  : 1.602 (1.808 adjusted for
activity hours)
 Wind erosion factor    : 74.639

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Dozer stripping topsoil
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading topsoil to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling topsoil to stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping topsoil to stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Drilling rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 9272 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Blasting rock and overburden
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1623 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading overburden to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Hauling overburden to emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dumping overburden to emplacement area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Dozer shaping overburden dump
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : FEL loading rock to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13287 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Hauling rock to hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 224000 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : FEL Loading rock to hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 13287 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Primary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8512 kg/y
 FROM SOURCES  : 1
9
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0

 ACTIVITY NAME : Secondary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 171024 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Tertiary crushing and screening
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 171024 kg/y
 FROM SOURCES  : 2
21 22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading to product stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9519 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to road trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 792 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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ACTIVITY NAME : Transport product off-site (sealed rd)
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 100000 kg/y
 FROM SOURCES  : 6
36 37 38 39 40 41
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading product to trains by conveyor
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 1848 kg/y
 FROM SOURCES  : 1
23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from exposed pit areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 537019 kg/y
 FROM SOURCES  : 10
1 2 3 4 5 6 7 8 9 10
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from product stockpiles
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 10343 kg/y
 FROM SOURCES  : 4
24 25 26 27
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Rail OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Eastern OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western OEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Eastern EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from Western EOEA
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 53463 kg/y
 FROM SOURCES  : 1
29
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

ACTIVITY NAME : Loading excess product to trucks from
plant
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 930 kg/y
 FROM SOURCES  : 1
25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Hauling excess product to emplacement
area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 8400 kg/y
 FROM SOURCES  : 4
29 30 31 32
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dumping excess product to emplacement
area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 930 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Dozer shaping excess product emplacement
area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 17472 kg/y
 FROM SOURCES  : 2
29 30
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Grading roads
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 21566 kg/y
 FROM SOURCES  : 25
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 29 30
31 32 33
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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