COWAL GOLD MINE E42 MODIFICATION AIR QUALITY ASSESSMENT

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Prepared for
Barrick Australia Limited

by

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G1. INTRODUCTION

Barrick Australia Limited (Barrick) is proposing to modify a number of components of the approved Cowal Gold Mine (CGM), located within Mining Lease (ML) 1535, approximately 38 kilometres (km) north-east of West Wyalong in central New South Wales (NSW). Changes are proposed to the approved CGM (that is, the E42 modification) which would result in the modified CGM.

This report has been prepared by Holmes Air Sciences for Barrick. The purpose of this report is to provide a quantitative assessment of the potential air quality impacts associated with the modified CGM.

The assessment follows the procedures outlined by the NSW Department of Environment and Climate Change (DECC) in their guidance document titled *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**Department of Environment and Conservation [DEC], 2005**). A computer-based dispersion model has been used to predict ground-level dust concentrations and deposition levels in the vicinity of the mine. Model predictions have been compared to relevant air quality criteria.

In summary, the report provides information on the following:

- The way in which mining is to be undertaken, with a focus on describing those aspects that would assist in understanding how the mine would potentially affect air quality;
- Air quality criteria relevant to the modified CGM;
- Meteorological and climatic conditions in the area;
- Existing air quality conditions in the area, with consideration of emissions from the approved CGM;
- The methods used to estimate dust emissions;
- Expected dispersion and dust fallout patterns due to emissions from the modified CGM and comparison of model predictions with relevant air quality assessment criteria;
- Potential cumulative impacts;
- Estimated greenhouse gas emissions from the modified CGM;
- Control methods and measures which can be used to reduce potential emissions and air quality impacts; and
- Potential odour emissions from the modified CGM.

G2. E42 MODIFICATION DESCRIPTION

The CGM is located approximately 38 km north-east of West Wyalong in central NSW. **Figure G-1** shows the location of the CGM and nearest receptors. The area is sparsely populated with the closest residence located approximately 2.5 km south-west of the ML 1535 boundary.

Figure G-2 shows the local topography, which is generally flat with some low isolated hills.

Approved CGM

The major components of approved CGM include an open pit, a process plant to extract gold from mineralised ore, waste rock emplacement areas and two tailings storage facilities. Gold is extracted from the ore using a conventional carbon-in-leach cyanide leaching circuit. The mine is currently approved to produce up to approximately 2.7 million ounces (Moz) of gold from some 76 million tonnes (Mt) of ore. Up to 6.9 Mt of ore is processed per year.

The mine adopts conventional open cut mining methods utilising hydraulic excavators, off-road haul trucks and wheel and track dozers. Blasting is required approximately once per day. Mining activities occur for 24 hours per day, seven days per week. There would be no change to the gold extraction methods with the E42 Modification.

E42 Modification

The modified CGM is scheduled to commence in approximately Year 5 of CGM operations. The main changes to the approved CGM as a result of the E42 modification would include those listed below:

- Increasing the operational mine life from 13 years to approximately 24 years.
- Increasing total production from approximately 76 Mt of ore, to approximately 129 Mt of ore.
- Increasing gold production from approximately 2.7 Moz of gold to approximately 3.5 Moz of gold.
- Increasing the maximum ore processing rate from approximately 6.9 million tonnes per annum (Mtpa) to approximately 7.5 Mtpa.
- Increasing the area of the open pit from approximately 70 hectares (ha) to approximately 130 ha, with final pit dimensions increased from approximately 1,000 metres (m) long, 850 m wide and 325 m deep to approximately 1,250 m long, 1,350 m wide and 440 m deep.
- Increasing the total quantity of waste rock mined from approximately 128 Mt to approximately 184 Mt.
- Increasing the height and area of the northern waste emplacement to an approximate final height of relative level (RL) 275 m Australian Height Datum (AHD) (increased from RL 243 m AHD) and area of approximately 320 ha (increased from approximately 160 ha).
- Increasing the height and area of the southern waste emplacement to an approximate final height of RL 255 m AHD (increased from RL 223 m AHD) and area of approximately 140 ha (increased from approximately 120 ha).
- A reduction in the height of the perimeter waste emplacement in places.

- Increasing the total surface area of the low grade ore stockpile from approximately 35 ha to approximately 60 ha.
- Increasing the volume of tailings produced over the life of the mine from approximately 76 Mt to 129 Mt.
- Increasing the height of the northern and southern tailings storages to a final RL of 252 m (from approximately RL 233.5 m AHD) and 256 m (from approximately RL 241.5 m AHD), respectively.
- Extraction of saline water from a saline groundwater supply borefield located within ML 1535.
- Other associated minor changes to infrastructure, plant, equipment and activities.

Mining operations would continue to be conducted up to 24 hours per day, seven days per week.

In addition to the open cut mining activities there would continue to be activities associated with tailings storage facilities embankment lifts. These activities are required for approximately six months each year and would occur during the day. For the purposes of this assessment the tailings embankment lift activities have been assumed to occur all year round.

A provisional mining and processing schedule for the modified CGM is provided in **Table G-1**. Two air quality modelling scenarios have been developed (highlighted cells), based on this schedule. Year 7 and 9 represent near maximum quantities of ore and waste mined as well as ore processed. In Year 7 the tailings lift fleet is assumed to be working at the southern tailings storage facility while in Year 9 this fleet is assumed to be at the northern tailings storage facility. The two modelling scenarios were selected to predict the maximum potential air quality impacts of the modified CGM.

Figure G-3 shows the conceptual general arrangements for Year 7 and 9.

Table G-1 : Provisional mining and ore processing schedule for the Modified CGM

Phase	Year*	Ore mine (Mt)	Waste mined (Mt)	Total mined (Mt)	Ore processed (Mt)
Mining and ore processing	5	17	13	30	6.9
	6	9.7	23.1	32.8	6.9
	7	8.6	24.4	33	7.5
	8	8.8	23.2	32	6.9
	9	8.4	26.9	35.3	6.5
	10	8.4	26.3	34.7	6.9
	11	9.1	22.3	31.4	6.9
	12	8.4	8.5	16.9	6.5
	13	8.4	4.7	13.1	6.9
	14	8.4	3.6	12	6.9
	15	9.4	2.6	12	6.9
	16	10	2	12	6.7
	17	7.9	2.1	10	6.6
	18	6.5	0.9	7.4	6.6
Ore processing	19	0	0	0	6.6
	20	0	0	0	6.6
	21	0	0	0	6.6
	22	0	0	0	6.6
	23	0	0	0	6.9
	24^	0	0	0	0.1
Total	**-**	**129**	**184**	**313**	**129**

Note: shaded rows indicate years of maximum ore and waste mining and/or ore processing.

* The modified CGM is scheduled to commence in approximately Year 5 of CGM operations (that is, 2009).

^ Year 24 would be a partial operational year only (that is, ore processing would occur in the first quarter only).

G3. AIR QUALITY CRITERIA

Table G-2 and **Table G-3** summarise the current air quality assessment criteria noted by the DECC (**DEC, 2005**), which are relevant to this study. Generally, the air quality criteria relate to the total burden of dust 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 criteria to assess potential impacts. The estimation of appropriate background levels is discussed further in **Section G4.3**.

The criteria in **Table G-2** have been developed to protect against potential adverse health effects. Particulate matter less than 2.5 microns (µm) in size ($PM_{2.5}$) has not been assessed as part of this study as NSW has no ambient criteria for $PM_{2.5}$ applied on a project basis.

Table G-2 : DECC assessment criteria for particulate matter concentrations

Pollutant	Criterion	Averaging period
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24-hour maximum*
	30 µg/m^3	Annual mean

** This goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best-practice dust control measures.*
µg/m^3 = micrograms per cubic metre

In addition to potential health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table G-3** shows the DECC's maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against potential nuisance impacts (**DEC, 2005**).

Table G-3 : DECC 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

g/m^2/month = grams per square metre per month.

G4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing air quality in the area. The existing air quality conditions (that is, the background conditions) are influenced by various activities in the region. These activities may include traffic on unsealed roads, agricultural activities and activities associated with the existing operations at the approved CGM.

G4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2].

The DECC have listed requirements for meteorological data that are used for air dispersion modelling in their *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**DEC, 2005**). The requirements are as follows:

- Data must span at least one year;
- Data must be at least 90% complete; and
- Data must be representative of the area in which emissions are modelled.

A weather station has been installed at the mine (refer to **Figure G-4** for location) and data from September 2006 to September 2007 have been made available for the purposes of this assessment. The data included 15-minute records of temperature, wind speed, wind direction and sigma-theta (the standard deviation of the horizontal wind direction). These data contained all the necessary parameters required to determine stability class and were processed into a file containing hourly averages, suitable for the dispersion model. There were 8,448 hourly records available which satisfies the DECC's requirement of 90% data recovery in the year (8,448 hours represents 96% of one year).

Annual and seasonal windroses have been prepared from the on-site meteorological data and are shown in **Figure G-5**. Over the year, the area experiences winds from all directions but most commonly from the south-west. In summer and spring, the south-westerly winds prevail, while in autumn and winter, the most common winds are from the south-southeast. The area does not experience low wind speeds very often with calm periods (that is, winds less than or equal to 0.5 metres per second [m/s]) measured only 1.3% of the time. The mean wind speed from the 2006/2007 data was 3.8 m/s.

[1] 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 those that 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 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.

[2] 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.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. A stability class was calculated for each hour of the meteorological data using sigma-theta according to the method recommended by the United States Environmental Protection Agency (US EPA) (**US EPA, 1986**). **Table G-4** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class in the area was determined to be D class at 44.3%. Under D class conditions, pollutant emissions disperse rapidly.

Table G-4 : Frequency of occurrence of stability classes in the study area

Stability Class	Frequency of occurrence (%) CGM (data collected between 27 Sep 2006 to 26 Sep 2007)
A	8.0
B	3.5
C	6.4
D	44.3
E	30.8
F	7.0
Total	100

Joint wind speed, wind direction and stability class frequency tables for the on-site meteorological data are provided in **Attachment GA**.

G4.2 Local Climatic Conditions

The Bureau of Meteorology (BOM) collects climatic information at Wyalong Post Office Station (station number 073054) approximately 30 km to the south of CGM. A range of climatic information collected from the Wyalong site is presented in **Table G-5** (**BOM, 2008**).

Temperature data from **Table G-5** indicate that the warmest month is January with a mean maximum temperature of 32.5°C. July is typically the coolest month with a mean minimum temperature of 3°C.

Humidity data indicate that the mean of the 9 am relative humidity observations are highest in July and lowest in December and January, with values of 88% and 55% respectively. The mean of the 3 pm observations are highest in June and July (62%) and lowest in January (33%) (**Table G-5**).

Table G-5 : Climate information for Wyalong Post Office

Statistic Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (Degrees C)	32.5	31.9	28.8	23.6	18.6	14.9	14	15.9	19.4	23.3	27	30.6	23.4	49
Mean minimum temperature (Degrees C)	17.3	17.4	14.4	10	6.8	4	3	3.9	6.1	9.3	12.2	15.3	10	49
Mean rainfall (millimeters [mm])	42.6	37.3	36.1	35.8	39.7	42.5	41.9	39.4	36.9	46	36.2	42.7	477	100
Mean number of days of rain	4.8	4.3	4.5	4.8	6.7	8.6	9.7	9	7.5	6.9	5.4	5.4	77.6	97
Mean 9am temperature (Degrees C)	22.9	22.1	19.7	15.9	11.2	7.6	6.6	8.7	12.4	16.7	18.8	21.7	15.4	39
Mean 9am relative humidity (%)	55	61	63	67	79	87	88	79	70	59	58	55	68	20
Mean 3pm temperature (Degrees C)	31.2	30.7	27.5	22.9	18	14.2	13.3	15.3	18.3	22.5	25.9	29.1	22.4	39
Mean 3pm relative humidity (%)	33	36	37	44	52	62	62	53	48	40	36	35	45	20

Climate averages for Station: 073054 Wyalong Post Office, Commenced: 1895; Last record: 2007; Latitude (deg S): -33.93; Longitude (deg E): 147.24; State: NSW. Source: ***BOM (2008)*** *website.*

Over the year, rain falls on approximately 78 days with the average monthly rainfall ranging between 35.8 mm in April to 46 mm in October (**Table G-5**).

Other statistical measures of climate in the area are also shown in **Table G-5**.

G4.3 Existing Air Quality

The DECC's air quality criteria generally refer to pollutant levels which include the contribution from specific projects as well as existing sources. To fully assess potential impacts against all the relevant air quality criteria (refer to **Section G3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the modified CGM is likely to contribute to these levels.

Dust concentration (TSP) and dust deposition data are collected in the study area. The locations of the monitoring sites are shown in **Figure G-4**. There is currently one high volume air sampler (HV1) measuring TSP, and 18 dust deposition gauges.

G4.3.1 Dust Concentration

Figure G-6 shows a time series of the TSP monitoring by high volume air sampler at HV1. The monitor is located approximately 3 km to the north of the approved CGM (refer **Figure G-4**) and measures the contribution from a range of particulate matter sources, including traffic on unsealed roads, agricultural activities and dust sources associated with the approved CGM. Data have been collected on every sixth day since 6 May 2004.

PM_{10} concentrations have been inferred from the daily TSP data by assuming that 40% of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**).

Typically, the TSP and PM_{10} concentrations in the area are lowest in the cooler, winter months and highest in the warmer, summer months. This seasonal cycle is evident in all four years of available monitoring data. As noted in the review of climatic data (**Section G4.2**), the summer months tend to be drier than the winter months and the occurrence of bushfires and dust storms would be more common.

The monitoring shows that the 24-hour average PM_{10} concentrations (inferred from the TSP concentrations) have been above the DECC's assessment criterion of 50 µg/m^3 on approximately seven days in the past four years. The highest PM_{10} concentration to date was approximately 151 µg/m^3, on 12 January 2008. An analysis of meteorological monitoring data from the automatic weather station within ML 1535 showed the prevailing winds on 12 January 2008 were from the north-west. Based on the mine location relative to the monitor, the mine is unlikely to have contributed to the exceedance on this day.

In NSW, it is quite common to measure 24-hour average concentrations above the DECC criterion of 50 µg/m^3 on occasions. Events such as bushfires or dust storms are often the cause of elevated PM_{10} concentrations, which can be observed over large geographical areas.

Table G-6 summarises the annual average TSP and PM_{10} concentrations for HV1. In the past four years the inferred annual average PM_{10} concentrations have ranged between 10 and 17 µg/m^3. These levels are below the DECC's annual average criterion of 30 µg/m^3. Measured TSP concentrations have been below the DECC assessment criterion of 90 µg/m^3 for the past four years.

Table G-6 : Measured dust concentrations in the study area

Dust classification	Criteria (µg/m^3)	Annual average concentration (µg/m^3)			
		2004	2005	2006	2007
TSP	90	24	43	43	43
PM_{10} (inferred from TSP)	30	10	17	17	17

For the purposes of establishing background levels for this assessment, annual averages of 43 and 17 µg/m^3 were taken to be representative of TSP and PM_{10} concentrations respectively at all residences.

G4.3.2 Dust Deposition

Prior to the development of the approved CGM, monthly dust deposition was measured at three locations for a one year period (1993 to 1994). All three sites were located within ML 1535 and annual average dust deposition ranged between 1 and 1.6 g/m^2/month (**Barrick, 2003**). These levels were below the 4 g/m^2/month criterion currently noted by the DECC.

The current dust deposition monitoring includes gauges at various locations in the vicinity of the CGM (refer **Figure G-4**). Annual averages from data collected between January 2004 and December 2007 (excluding monitors within ML 1535) are presented in **Table G-7**.

Table G-7 : Measured dust deposition in the study area

Site	Site description	Annual average dust deposition (insoluble solids) (g/m^2/month) DECC criterion = 4 g/m^2/month*#			
		2004	2005	2006	2007
McLintocks	General monitoring site	4.0	2.4	2.0	3.8
Lakeside	General monitoring site	3.5	3.2	2.1	3.6
I5	General monitoring site	**5.9**	1.9	2.7	3.8
DG1	Coniston residence	1.7	1.2	1.8	2.3
DG2	Bird breeding area	**5.9**	0.9	1.2	1.7
DG3	General monitoring site	**13.3**	1.5	1.7	1.8
DG4	Native flora area and bird breeding area	**5.3**	1.9	1.9	2.2
DG6	Gumbelah residence	**4.1**	**4.1**	**4.1**	**4.7**[1]
DG7	Lake Cowal residence	3.8	3.6	1.6	2.4
DG8	Native flora area	3.0	2.2	2.8	3.2
DG9	Native flora area	2.6	1.3	1.7	1.6
DG10	Native flora area	3.2	2.0	3.5	**7.2**[1]
Annual average	Across all sites	4.7	2.2	2.3	3.2

* *Source:* ***Barrick (2005, 2006, 2007 and 2008)****.*

\# *Data from monitoring sites DG5 and Site Office have been excluded on the basis of erroneous historic data (Barrick, 2005).*

1 *Examining the average masses of insoluble solids when combustible solids such as insects, bird droppings and vegetative matter are excluded, these monitoring sites would not have recorded values greater than 4 g/m^2/month for 2007 (****University of Sydney, 2008****).*

The monitoring results presented in **Table G-7** show that the area generally experiences, on average, dust deposition levels below 4 g/m^2/month. For the purposes of this assessment, a value of 3.1 g/m^2/month (average at receptors in **Table G-7** over the last four years [2004 to 2007]) has been taken to be the background dust deposition level that would apply at all receptors.

Interestingly, the gauges that have recorded annual average levels above 4 g/m^2/month in the past (that is, I5, DG2, DG3, DG4 and DG6) are generally located further from the mine than gauges located closer to the mine and which have recorded annual average levels below 4 g/m^2/month. The pattern of results suggests that most of the dust deposition gauges are largely influenced by activities taking place very close to each gauge.

G5. ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at open cut mines. Total dust emissions have been estimated by analysing the activities that would take place at the site during Years 7 and 9 of the modified CGM. These two scenarios represent the maximum potential for annual dust emissions from the mine due to the amount of material mined and processed during these years (**Table G-1**).

Modelling for Year 7 would represent the maximum potential air quality impacts for receptors to the south of the modified CGM as the tailings embankment lift works would occur at the southern tailings storage facility. In contrast, modelling for Year 9 would represent maximum potential impacts for receptors to the north of the modified CGM as the tailings embankment lift works would occur at the northern tailings storage facility.

The operations which apply in each case have been combined with emission factors developed, both locally and by the **US EPA (1985 and updates)**, to estimate the amount of dust produced by each activity. This study draws on US EPA emission factors for mining operations that were subject to significant revisions in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The modified CGM activities have been reviewed to determine material quantities, haul road distances and routes, stockpile areas and locations, activity operating hours, truck sizes and other details necessary to estimate dust emissions.

The most significant dust generating activities from the modified CGM operations have been identified and the dust emission estimates for the two scenarios selected (that is, Years 7 and 9) are presented below in **Table G-8**.

Details of the dust emission calculations are presented in **Attachment GB**. The estimated emissions take account of existing and proposed air pollution controls including passive controls such as stockpile size and alignment and length of haul roads. Active controls such as the intensity of dust suppression watering are also considered in the emission calculations.

Table G-8 : Estimated dust emissions due to the Modified CGM

ACTIVITY	Annual TSP emission rate (kilograms per year [kg/y])	
	Year 7	Year 9
Tailings storage facilities construction - Scrapers/dozers clearing topsoil	163,520	163,520
Tailings storage facilities construction - Loading trucks	2,028	2,028
Tailings storage facilities construction - Trucks hauling	78,200	78,200
Tailings storage facilities construction - Trucks dumping	2,028	2,028
Drilling	75,373	75,373
Blasting	68,561	68,561
Loading waste to trucks	63,268	69,751
Hauling waste to emplacement area	1,027,252	1,132,503
Emplacing waste at emplacements	63,268	69,751
Dozer working on waste emplacements, open pit and stockpiles	319,060	319,060
Loading ore to trucks	22,299	21,781
Hauling ore to run-of-mine (ROM) pad	180,789	176,585
Unloading ore to ROM pad	22,299	21,781
Rehandling ore to crusher	22,299	21,781
Primary and secondary ore crushing	130,720	127,680
Loading to coarse ore stockpile	22,299	21,781
Ore processing in mill	19,447	16,854
Wind erosion, open pit	411,865	411,865
Wind erosion, waste emplacement areas	1,512,602	1,512,602
Wind erosion, stockpiles and exposed areas	345,307	345,307
Wind erosion, tailings storage facilities	637,844	637,844
Grading roads - whole site	43,132	43,132
TOTAL ANNUAL DUST (kilograms [kg])	**5,233,463***	**5,339,767***

* *Calculated from spreadsheets without rounding to nearest integer value.*

G6. APPROACH TO ASSESSMENT

In August 2005, the DECC published guidelines for the assessment of air pollution sources using dispersion models (**DEC, 2005**). 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 to be used in dispersion models, 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 by this assessment follows as closely as practicable to the approaches suggested by the guidelines.

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

Off-site dust concentration and dust deposition levels due to the modified CGM have been predicted using AUSPLUME (Version 6.0). AUSPLUME is an advanced Gaussian dispersion model developed on behalf of the Victorian Environmental Protection Agency (**VEPA, 1986**) and is based on the US EPA's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the model required for use by the DECC unless project characteristics dictate otherwise (**DEC, 2005**).

The modelling has been based on the use of three particle size categories; namely $PM_{2.5}$ (particles in size range 0 to 2.5 µm), $PM_{2.5-10}$ (particles in size range 2.5 to 10 µm) and PM_{10-30} (particles in size range 10 to 30 µm). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the **US EPA (1985 and updates)** work (see **Attachment GB**).

The distribution of particles has been derived from measurements published by the State Pollution Control Commission (SPCC). The distribution of particles in each particle size range (**SPCC, 1986**) is as follows:

- $PM_{2.5}$ is 4.7% of the TSP;
- $PM_{2.5-10}$ is 34.4% of TSP; and
- PM_{10-30} is 60.9% of TSP.

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

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

For this assessment, mining operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. The location of the modelled sources, to which the dust generating activities listed in **Table G-8** are assigned, are provided in **Attachment GB**.

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 AUSPLUME 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 mine site would correspond with periods of low dust generation because wind erosion and other wind dependent emission rates would be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken into account then the model has the potential to significantly overstate potential impacts.

Pit retention (that is, retention of dust particles within the open pit) was considered an important factor to include in the dispersion modelling given the large elevation difference between the local ground-level and the floor of the pit. For the purposes of the dispersion modelling the calculation determines the fraction of dust emitted in the pit which would escape the pit. The relationship used is dependent on the gravitational settling velocity of the particles and wind speed and is given by **Equation 1** below (**US EPA, 1995**).

$$\varepsilon = \frac{1}{\left(1 + \frac{v_g}{(\alpha U_r)}\right)}$$

Equation 1

where:
ε = escaped fraction for the particle size category
V_g = gravitational settling velocity (m/s)
U_r = approach wind speed at 10 m (m/s)
α = proportionality constant in the relationship between flux from the pit and the product of U_r and concentration in the pit (0.029)

To model the effect of pit retention, the emissions from sources within the pit have therefore been reduced to account for the fact that much of the coarser dust would remain trapped in the pit.

As an example of modelling emissions with pit retention, particles in the $PM_{2.5}$ category are taken to have a gravitational settling velocity of 0.0000914 m/s. For a 1 m/s approach wind speed, the fraction of particles that escape the pit is estimated by Equation 1 to be 0.997 – that is, almost all of the particles in this size range escape the pit. Under the same wind conditions the escaped fraction for the PM_{10-30} particles, with an assumed gravitational settling velocity of 0.106328 m/s, would be 0.21 – that is, only 21% of these particles escape the pit.

Dust concentrations and deposition rates have been predicted in the vicinity of the modified CGM. Model predictions have been made at 140 discrete receptors located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearby sensitive receptors, whilst still maintaining acceptable model run times.

The modelling has been performed using the meteorological data discussed in **Section G4.1** and the dust emission estimates from **Section G5**. Local terrain has been included in the modelling. Emissions associated with the tailings lifts and blasting activities have been modelled during daytime hours (8 am to 6 pm). The tailings lift activities are assumed to occur all year round, which is a conservative approach, in terms of estimated annual dust emissions. All other activities have been modelled assuming 24 hour per day operation, with all plant items operating concurrently to provide for a conservative estimate of dust emissions from the mine. **Attachment GB** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

G7. ASSESSMENT OF POTENTIAL IMPACTS

G7.1 Preamble

To assess the potential air quality impacts of the modified CGM, the emissions have been modelled and predictions have been compared with the current DECC air quality assessment criteria. Results for "project only" emissions have been compared with the "project only" assessment criteria.

In addition, the potential cumulative impacts of the modified CGM have been assessed by adding model predictions made at nearest privately-owned residences (see **Figure G-1**) to levels measured by the air quality monitors (refer **Section G4.3**) to account for emissions from other activities and developments in the area. Although there are no other major developments in the area, the dominant landuse of agriculture can be a significant source of dust. Predictions including these background levels were then compared with the current DECC assessment criteria, where appropriate, to represent potential cumulative impacts.

Dust concentrations and dust deposition rates of modelled dust emissions from the modified CGM for the selected years of assessment (that is, Year 7 and Year 9) have been presented as isopleth diagrams in **Figures G-7** and **G-8**. These figures illustrate the following:

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

The maximum 24-hour average PM_{10} concentration contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration at each location. The maxima are used to show the highest concentrations predicted to be reached under the modelled conditions.

The contour plots show predicted concentrations and deposition levels relating only to emissions from modelled dust sources associated with the modified CGM and do not include contributions from other sources. Predictions with background concentrations and deposition levels are discussed below.

The air quality criteria used for deciding which areas are likely to experience potential air quality impacts are those specified by the DECC. The air quality criteria are listed in **Table G-2** and **Table G-3** and are summarised as follows:

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

G7.2 Assessment of Potential Impacts

Dispersion model predictions for Years 7 and 9 of the modified CGM are shown in **Figures G-7** and **G-8**, respectively. Model results for Year 9 (see **Figure G-8**) show a similar pattern of dispersion to Year 7 predictions but are slightly higher, due to an increase in estimated annual dust emissions (see **Table G-8**).

The model predictions for residences in the vicinity of the modified CGM are summarised in **Table G-9** to **Table G-12**.

To assess potential cumulative air quality impacts, the background PM_{10}, TSP and deposition levels have been added to the model predictions and the results are also shown in **Table G-9** to **Table G-12**. This approach provides for a conservative cumulative assessment because the measured (that is, background) levels would include some contribution of dust emissions from the approved CGM. Adding the background levels to modified CGM levels would therefore involve some double-counting.

Table G-9 : Predicted maximum 24-hour average PM_{10} concentrations

Location	Year 7	Year 9	Air quality criteria
Predicted maximum 24-hour average PM_{10} concentrations ($\mu g/m^3$) (Refer to text for predictions with background [i.e. cumulative] levels)			
McLintock	18	19	50
Laurel Park	16	17	50
Coniston	31	33	50
The Glen	17	18	50
Bramboyne	10	10	50
Wamboyne	8	8	50
Baaloo Park	6	7	50
Clairinch	5	6	50
Lakeview II	8	8	50
Lakeview	8	8	50
Westella	9	9	50
Thistleview	7	7	50
Hillview	6	6	50
Melrose	6	6	50
Westlea	19	20	50
Lake Cowal	7	8	50
Billabong	4	5	50
Koobah	5	6	50
Mattiske	10	11	50
Cowal North	7	7	50
Moora Moora	6	6	50
Lana	7	7	50
Wilga Vale	7	8	50

Table G-10 : Predicted annual average PM_{10} concentrations

Location	Year 7	Year 9	Air quality criteria
Predicted annual average PM_{10} concentrations (µg/m^3) (Predictions with background [i.e. cumulative] levels are shown in parentheses)			
McLintock	2.0 (19.0)	2.1 (19.1)	30
Laurel Park	2.1 (19.1)	2.2 (19.2)	30
Coniston	4.2 (21.2)	4.4 (21.4)	30
The Glen	2.2 (19.2)	2.3 (19.3)	30
Bramboyne	1.2 (18.2)	1.3 (18.3)	30
Wamboyne	1.0 (18.0)	1.0 (18.0)	30
Baaloo Park	0.6 (17.6)	0.6 (17.6)	30
Clairinch	0.5 (17.5)	0.5 (17.5)	30
Lakeview II	0.9 (17.9)	1 (18)	30
Lakeview	1 (18)	1 (18)	30
Westella	1 (18)	1.1 (18.1)	30
Thistleview	0.6 (17.6)	0.6 (17.6)	30
Hillview	0.3 (17.3)	0.3 (17.3)	30
Melrose	0.3 (17.3)	0.3 (17.3)	30
Westlea	1.4 (18.4)	1.5 (18.5)	30
Lake Cowal	0.6 (17.6)	0.6 (17.6)	30
Billabong	0.3 (17.3)	0.4 (17.4)	30
Koobah	0.4 (17.4)	0.4 (17.4)	30
Mattiske	0.7 (17.7)	0.8 (17.8)	30
Cowal North	1 (18)	1 (18)	30
Moora Moora	0.4 (17.4)	0.5 (17.5)	30
Lana	0.7 (17.7)	0.7 (17.7)	30
Wilga Vale	0.8 (17.8)	0.8 (17.8)	30

Table G-11 : Predicted annual average TSP concentrations

Location	Year 7	Year 9	Air quality criteria
Predicted annual average TSP concentrations (µg/m^3) (Predictions with background [i.e. cumulative] levels are shown in parentheses)			
McLintock	2.2 (45.2)	2.3 (45.3)	90
Laurel Park	2.3 (45.3)	2.4 (45.4)	90
Coniston	4.6 (47.6)	4.8 (47.8)	90
The Glen	2.3 (45.3)	2.4 (45.4)	90
Bramboyne	1.2 (44.2)	1.3 (44.3)	90
Wamboyne	1 (44)	1.1 (44.1)	90
Baaloo Park	0.6 (43.6)	0.6 (43.6)	90
Clairinch	0.5 (43.5)	0.5 (43.5)	90
Lakeview II	1 (44)	1 (44)	90
Lakeview	1 (44)	1.1 (44.1)	90
Westella	1.1 (44.1)	1.2 (44.2)	90
Thistleview	0.7 (43.7)	0.7 (43.7)	90
Hillview	0.3 (43.3)	0.3 (43.3)	90
Melrose	0.3 (43.3)	0.4 (43.4)	90
Westlea	1.6 (44.6)	1.6 (44.6)	90
Lake Cowal	0.6 (43.6)	0.6 (43.6)	90
Billabong	0.4 (43.4)	0.4 (43.4)	90
Koobah	0.4 (43.4)	0.4 (43.4)	90
Mattiske	0.8 (43.8)	0.8 (43.8)	90

Location	Year 7	Year 9	Air quality criteria
Cowal North	1.1 (44.1)	1.1 (44.1)	90
Moora Moora	0.5 (43.5)	0.5 (43.5)	90
Lana	0.7 (43.7)	0.7 (43.7)	90
Wilga Vale	0.8 (43.8)	0.8 (43.8)	90

Table G-12 : Predicted annual average dust deposition

Location	Year 7	Year 9	Air quality criteria
Predicted annual average dust deposition (g/m²/month)* (Predictions with background [i.e. cumulative] levels are shown in parentheses)			
McLintock	0.13 (3.23)	0.13 (3.23)	2 (4 – cumulative)
Laurel Park	0.07 (3.17)	0.07 (3.17)	2 (4 – cumulative)
Coniston	0.25 (3.35)	0.25 (3.35)	2 (4 – cumulative)
The Glen	0.11 (3.21)	0.11 (3.21)	2 (4 – cumulative)
Bramboyne	0.03 (3.13)	0.03 (3.13)	2 (4 – cumulative)
Wamboyne	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)
Baaloo Park	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)
Clairinch	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)
Lakeview II	0.04 (3.14)	0.04 (3.14)	2 (4 – cumulative)
Lakeview	0.04 (3.14)	0.04 (3.14)	2 (4 – cumulative)
Westella	0.05 (3.15)	0.05 (3.15)	2 (4 – cumulative)
Thistleview	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)
Hillview	0.01 (3.11)	0.01 (3.11)	2 (4 – cumulative)
Melrose	0.01 (3.11)	0.01 (3.11)	2 (4 – cumulative)
Westlea	0.06 (3.16)	0.06 (3.16)	2 (4 – cumulative)
Lake Cowal	0.04 (3.14)	0.04 (3.14)	2 (4 – cumulative)
Billabong	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)
Koobah	0.03 (3.13)	0.03 (3.13)	2 (4 – cumulative)
Mattiske	0.04 (3.14)	0.04 (3.14)	2 (4 – cumulative)
Cowal North	0.09 (3.19)	0.1 (3.2)	2 (4 – cumulative)
Moora Moora	0.03 (3.13)	0.03 (3.13)	2 (4 – cumulative)
Lana	0.01 (3.11)	0.02 (3.12)	2 (4 – cumulative)
Wilga Vale	0.02 (3.12)	0.02 (3.12)	2 (4 – cumulative)

** A prediction of 0.00 g/m²/month means less than 0.005 g/m²/month.*

Based on comparison of model predictions with DECC assessment criteria, no exceedances of 24-hour or annual average air quality criteria are expected from Year 7 or Year 9 of operations. Given that these two mining years represent maximum activity rates, it follows that other years would have lower potential air quality impacts.

Predicted Maximum 24-hour Average PM_{10} Concentrations

The dispersion model predictions for maximum 24-hour average PM_{10} concentrations at receptors in the vicinity of the modified CGM are presented in **Table G-9** (contour plots are provided in **Figures G-7** and **G-8**). Maximum 24-hour average PM_{10} concentrations from the modified CGM are predicted to be less than 50 μg/m³ at all receptors. As expected, the highest levels are predicted to be closest to the active mining operations. The highest predicted maximum 24-hour average PM_{10} concentration is 33 μg/m³ at "Coniston" in Year 9. It should be noted that this prediction has been estimated to occur in Year 9 only and would be less for other years of the mine. **Table G-9** also shows that the estimated concentrations from the modified CGM reduce quickly with distance from the mine (for example, the next highest maximum concentration is 20 μg/m³ at "Westlea" in Year 9).

The measurement data (refer **Section G4.3.1**) have shown that the region has experienced exceedances of 50 μg/m^3 criterion in the past. It is likely that these exceedances were due to widespread naturally occurring events such as dust storms or bushfires, which can occur on a number of occasions each year.

For assessment of cumulative 24-hour average PM_{10} concentrations, the approach of adding maximum measured to maximum predicted would not demonstrate compliance with the 50 μg/m^3 criterion. This is because the maximum measured value of approximately 151 μg/m^3 (refer **Section G4.3.1**) does not permit any mine contribution before 50 μg/m^3 is exceeded.

Existing PM_{10} concentrations vary from day to day but if it were assumed that the existing annual average PM_{10} concentration (17 μg/m^3, see below) occurred every day of the year then the assessment would be very much simplified as a maximum modified CGM contribution of 33 μg/m^3 or more would be the point at which potential air quality impacts would be observed - assuming 50 μg/m^3 is the level at which potential impacts occur. No residences are predicted to exceed 33 μg/m^3.

The probability of the modified CGM causing an exceedance of 50 μg/m^3 increases, with increasing background levels.

Predicted Annual Average PM_{10} Concentrations
The dispersion model predictions for annual average PM_{10} concentrations at receptors in the vicinity of the modified CGM are presented in **Table G-10** (contour plots are provided in **Figures G-7** and **G-8**). The highest contribution from the modified CGM is predicted to be 4.4 μg/m^3 at the "Coniston" residence in Year 9. Background annual average PM_{10} concentrations for the area have been estimated to be 17 μg/m^3 which, when added to the model predictions, would demonstrate compliance with the DECC's air quality criterion of 30 μg/m^3 at all receptors. As stated above, the approach used here provides for a conservative cumulative assessment because the background levels are likely to include some contribution from the approved CGM.

Predicted Annual Average TSP Concentrations
The dispersion model predictions for annual average TSP at receptors in the vicinity of the modified CGM are presented in **Table G-11** (contour plots are provided in **Figures G-7** and **G-8**). The highest contribution from the modified CGM is predicted to be 4.8 μg/m^3 at the "Coniston" residence in Year 9. Background annual average TSP concentrations for the area have been estimated to be 43 μg/m^3 which, when added to the model predictions, would demonstrate compliance with the DECC's air quality criterion of 90 μg/m^3 at all receptors. As stated above, the approach used here provides for a conservative cumulative assessment because the background levels are likely to include some contribution from the approved CGM.

Predicted Annual Average Dust Deposition
The dispersion model predictions for annual average dust deposition at receptors in the vicinity of the modified CGM are presented in **Table G-12** (contour plots are provided in **Figures G-7** and **G-8**). The highest contribution from the modified CGM is predicted to be 0.25 g/m^2/month at the "Coniston" residence in Year 9. Background annual average dust deposition for the area have been estimated to be 3.1 g/m^2/month which, when added to the model predictions, would demonstrate compliance with the DECC's air quality criterion of 4 g/m^2/month at all receptors. As stated above, the approach used here provides for a conservative cumulative assessment because the background levels are likely to include some contribution from the approved CGM.

G8. ODOUR

Odour intensity from the approved CGM is considered to be very weak or not discernable at the boundary of ML 1535 (**The Odour Unit, 2008**). The source of odours and intensity of odours is not expected to increase as a result of the modified CGM. Consequently, potential off-site odour impacts would not be expected to change.

The following potential odorants are added, and would continue to be added, to the ore slurry during ore processing.

Potassium amyl xanthate (PAX)

PAX is a collection reagent used in the collection of minerals in floatation units. It has an odour character much like carbon disulfide from which xanthates are derived. This chemical does not appear to contribute to the odour emissions from the process plant (**The Odour Unit, 2008**).

Interfroth

Interfroth is a frothing agent used to encourage formation of air bubbles in floatation units. It has an alcoholic odour character. This chemical's odour character has been observed to be a dominant odour emission from the process plant (**The Odour Unit, 2008**).

CMS46

CMS46 (or sodium-2-mercaptobenzothiazole) is a promoting agent used in the floatation circuit. It has an acetone odour character. This chemical's odour character has been observed to be a dominant odour emission from the process plant (**The Odour Unit, 2008**).

G9. GREENHOUSE ISSUES

The Commonwealth Department of Climate Change (DCC) *National Greenhouse Accounts Factors* (the NGA Factors) (**DCC, 2008**) defines two types of greenhouse gas emissions, as follows:

> ***Direct emissions*** *are produced from sources within the boundary of an organisation and as a result of the organisation's activities.*
>
> …
>
> ***Indirect emissions*** *are emissions generated in the wider community as a consequence of an organisation's activities (particularly from its demand of goods and services, but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity…*

To help delineate direct and indirect emissions, the NGA Factors defines "scopes" of emissions for emission accounting purposes. The scope that emissions are reported under in the NGA Factors is determined by whether the activity is within the organisation's boundary (that is direct-scope 1) or outside it (for example, indirect-scope 2), with an "emission factor" relevant to each activity (**DCC, 2008**). The NGA Factors adopts the emission factors listed in the *Technical Guidelines from the Estimation of Greenhouse Emissions and Energy at Facility-Level* (**DCC, 2007**), as follows:

- ***Direct (or point source) emission factors*** *give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate* ***scope 1 emissions.***

- ***Indirect emission factors*** *are used to calculate* ***scope 2 emissions*** *from the generation of electricity (or steam or heating/cooling)* ***purchased and consumed*** *by the reporting organisation as Kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fossil fuels (coal, natural gas, etc) at the power station or facility.*

Operation of the modified CGM would result in a number of direct (Scope 1) and indirect (Scope 2) emissions. The major direct (Scope 1) emission of the modified CGM would be associated with the combustion of diesel fuel used in diesel-powered equipment. In addition, the use of electrically-powered mining equipment would result in indirect (Scope 2) emissions.

A summary of the emissions that have been calculated for the modified CGM is provided in **Table G-13**.

Table G-13 : Summary of Modified CGM CO_2-e emission sources

E42 Modification Component	Direct Emissions (Scope 1)	Indirect Emissions (Scope 2)
Operations – Transport (Diesel)	Emissions from the combustion of diesel during operation of the modified CGM.	N/A
Operations – Stationary Activities (Diesel)	Emissions from the combustion of diesel during operation of the modified CGM.	N/A
Operations – Stationary Activities (liquefied petroleum gas [LPG])	Emissions from the combustion of LPG during the operation of the modified CGM.	N/A
Tailings Lifts –Transport (Diesel)	Emissions from the combustion of diesel during the raising of the tailings embankments for the modified CGM.	N/A
Operations – Stationary Activities (Electricity)	N/A	Emissions from the generation of the electricity consumed during operation of the modified CGM.
Explosives Detonation (ammonium nitrate-fuel oil [ANFO])	Emissions from the detonation of explosives for the modified CGM.	N/A

To estimate emissions from the sources identified in **Table G-13**, the electrical and fuel (for example, diesel, LPG and petrol) requirements for each year over the life of the mine have been estimated using data supplied by Barrick.

Relevant emission factors from the NGA Factors (**DCC, 2008**) have been applied to estimate the CO_2-e emissions. These emission factors have been applied to both direct/point emissions and indirect emissions. Both direct (Scope 1) emissions and indirect (Scope 2) emissions have been calculated to provide a conservative estimate of greenhouse gas emissions from the modified CGM.

The estimated emission of greenhouse gases over the life of the mine is shown in **Table G-14**. The total lifetime direct (Scope 1) emissions from the modified CGM is estimated to be approximately 1,439,319 tonnes (t) CO_2-e, which is an average of approximately 71,966 t CO_2-e per year over the life of the modified CGM. The total lifetime direct (Scope 1) and indirect (Scope 2) emissions from the modified CGM is estimated to be approximately 5,797,866 t CO_2-e, which is an average of approximately 289,894 t CO_2-e per year over the life of the mine (**Table G-14**).

Table G-14 : Summary of estimated Modified CGM CO_2-e emissions

E42 Modificiation Component	Emissions (t CO_2-e)		
	Direct emissions (Scope 1)	Indirect emissions (Scope 2)	Total Emissions (Scope 1 and Scope 2)
Operations – Transport (Diesel)	1,356,962	N/A	1,356,962
Operations – Stationary Activities (Diesel)	11,822	N/A	11,822
Operations – Stationary Activities (LPG)	4,906	N/A	4,906
Tailings Lifts –Transport (Diesel)	49,992	N/A	49,992
Operations – Stationary Activities (Electricity)	N/A	4,358,567	4,358,567
Explosives Detonation (ANFO)	15,637	N/A	15,637
Total	**1,439,319**	**4,358,567**	**5,797,866**

The estimated annual average direct (Scope 1) and indirect (Scope 2) emissions of approximately 289,894 t CO_2-e per year (0.29 Mt of CO_2-e) over the life of the mine (that is, for the 20 years from commencement of works associated with the modified CGM) can be compared with the following 2005 estimates provided by the Australian Greenhouse Office (AGO) in the latest Australian National Greenhouse Gas Inventory report (**AGO, 2007**):

- Current estimate of Australia's 2005 net emissions, 559.1 Mt CO_2-e;
- Current estimate of Australia's 2005 net emissions for the energy sector, which is the major contributor to carbon-dioxide emissions, was 391 Mt CO_2-e; and
- Current estimate of Australia's 2005 net emissions for the industrial sector was 29.5 Mt CO_2-e.

G10. MONITORING AND MITIGATION MEASURES

Dust Emissions

Emissions associated with the operation of the modified CGM would be generated from two primary sources as follows:

- wind blown dust from exposed areas and from locations where there is no vegetation cover; and
- dust generated by mining activities including the mechanical disturbance of soils and waste rock when using conventional mining equipment, the haulage of materials within the ML and particles from diesel exhausts in activities where diesel powered equipment is used.

Management and mitigation measures currently implemented at the CGM to control wind blown and mine generated dust include the procedures outlined in **Table G-15** and **Table G-16**.

Table G-15 : Control methods for exposed area dust sources

Source	Control Methods
General Areas Disturbed by Mining	• Areas for soil stripping would be minimised to reduce the area of exposed ground at any one time. • Exposed areas would be reshaped, topsoiled and revegetated as soon as practicable to minimise the generation of wind erosion dust.
Waste Emplacement Areas	• Exposed active work areas on waste emplacement surfaces would be watered to suppress dust where practicable.
Soil Stockpiles	• Long-term soil stockpiles would be revegetated with a cover crop.
Material Handling and Stockpiles	• Prevention of truck overloading to reduce spillage during ore loading/unloading and hauling. • The coarse ore stockpile would be protected by a hood to prevent wind erosion of its surface. • All conveyors would incorporate wind covers as necessary. • The surface of all stockpiles would be sufficiently treated to minimise dust emissions. Such treatment may include application of a dust suppressant, regular dust suppression watering or establishment of vegetation on longer term stockpiles (e.g. the low grade ore stockpile).

Source: ***Barrick (2003)***

Table G-16 : Control methods for mine generated dust sources

Source	Control Methods
Haul Road	• All roads and trafficked areas would have water or sealant (e.g. Petro Tac, a water emulsified bitument sealant) using water trucks or other methods and regularly maintained (using graders) to minimise the generation of dust. • Routes would be clearly marked. • Obsolete roads would be ripped and re-vegetated.
Minor Roads	• Development of minor roads would be limited and the locations of these would be clearly defined. • Regularly used minor roads would be watered and regularly maintained. • Obsolete minor roads would be ripped and re-vegetated.
Materials Handling	• Prevention of truck overloading to reduce spillage during ore loading/unloading and hauling. • A water spray dust suppression system would be used at the primary crusher bin during truck dumping of raw ore. • All conveyors would incorporate wind covers as necessary. • Freefall height during ore/waste stockpiling would be limited.
Soil Stripping	• Access tracks used for soil stripping during the loading and unloading cycle would be watered. • Soil stripping would be limited to areas required for mining operations.
Drilling	• Dust aprons would be lowered during drilling for collection of fine dust. • Water injection or dust suppression sprays would be used when high levels of dust are being generated.
Blasting	• Fine material collected during drilling would not be used for blast stemming. • Adequate stemming would be used at all times.
Equipment Maintenance	• Emissions from mobile equipment exhausts would be minimised by the implementation of a maintenance programme to service equipment in accordance with the equipment manufacturer specifications.
Process Plant	• A baghouse and associated collection hood/ducting would be used to filter off-gas emissions (i.e. to remove dust particles) from the gold room doré melt furnace. This control method reduces the potential for any minor environmental emissions from the gold smelting process and maximises the retention of gold product.

Source: after ***Barrick (2003)***

These management and mitigation measures would be continued for the modified CGM.

The approved CGM air quality monitoring programme includes:

- An on-site meteorological station;
- A network of 18 static dust gauges within and surrounding the approved CGM area (including gauges proximal to nearby residences, bird breeding areas, native flora areas and Lake Cowal) (**Figure G-4**);
- Analysis of metals in dust samples;
- Dust deposition monitoring within Lake Cowal;
- Surface water monitoring within Lake Cowal;
- TSP monitoring to the north of the approved CGM; and
- An air quality monitoring review.

The air quality monitoring programme would be continued for the modified CGM.

Greenhouse Gas Emissions
It should be noted that mitigation of greenhouse gas emissions is inherent in the development of the mine plan. For example, reducing fuel usage by mobile plant is an objective of mine planning. Hence, significant savings of greenhouse gas emissions can be attributed to appropriate mine planning.

Additional management/minimisation of greenhouse gas emissions associated with the modified CGM would be employed via:

- Regular maintenance of plant and equipment to minimise fuel consumption; and
- Consideration of energy efficiency in plant and equipment selection/purchase.

G11. CONCLUSIONS

This report has assessed the potential air quality impacts of the modified CGM. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities associated with the proposal. The dispersion modelling took account of meteorological conditions and terrain information and used dust emission estimates to predict the potential air quality impacts for two future mining scenarios.

Air quality monitoring data have shown that annual average TSP concentrations have been (and continue to be) below the DECC's current air quality criteria at the monitored location. Average concentrations of PM_{10}, inferred from the TSP concentrations, also show compliance with the current DECC criterion.

Some exceedances of the DECC's 24-hour average PM_{10} criterion have been measured in the past. It is possible however that widespread events, such as bushfires and regional dust storms, may cause elevated background levels in the future.

Results from the dispersion modelling suggest that the dust concentrations and deposition levels would be in compliance with the DECC's air quality assessment criteria at all sensitive receptor locations. Best practice dust mitigation measures should ensure that potential off-site air quality impacts are minimised.

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ATTACHMENT GA
JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES

STATISTICS FOR FILE: C:\Jobs\Cowal\metdata\cow0607.aus
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	0.000237	0.002367	0.001184	0.000118	0.000000	0.000000	0.000000	0.000000	0.003906
NE	0.001065	0.002841	0.001065	0.000710	0.000000	0.000000	0.000000	0.000000	0.005682
ENE	0.000829	0.002604	0.000237	0.000118	0.000000	0.000000	0.000000	0.000000	0.003788
E	0.000592	0.002604	0.000237	0.000118	0.000000	0.000000	0.000000	0.000000	0.003551
ESE	0.000355	0.002723	0.000473	0.000355	0.000000	0.000000	0.000000	0.000000	0.003906
SE	0.000947	0.003196	0.000592	0.000237	0.000000	0.000000	0.000000	0.000000	0.004972
SSE	0.000592	0.003078	0.000355	0.000237	0.000000	0.000000	0.000000	0.000000	0.004261
S	0.000118	0.002012	0.000710	0.000118	0.000000	0.000000	0.000000	0.000000	0.002959
SSW	0.000355	0.002604	0.000473	0.000237	0.000000	0.000000	0.000000	0.000000	0.003670
SW	0.000355	0.001894	0.002131	0.000473	0.000000	0.000000	0.000000	0.000000	0.004853
WSW	0.000355	0.003078	0.002486	0.000473	0.000000	0.000000	0.000000	0.000000	0.006392
W	0.000710	0.003433	0.001184	0.000118	0.000000	0.000000	0.000000	0.000000	0.005445
WNW	0.000473	0.004853	0.000947	0.000237	0.000000	0.000000	0.000000	0.000000	0.006510
NW	0.000710	0.004735	0.002486	0.000473	0.000000	0.000000	0.000000	0.000000	0.008404
NNW	0.000355	0.002367	0.001065	0.000000	0.000000	0.000000	0.000000	0.000000	0.003788
N	0.000829	0.004143	0.001065	0.000355	0.000000	0.000000	0.000000	0.000000	0.006392
CALM									0.001184
TOTAL	0.008878	0.048532	0.016690	0.004380	0.000000	0.000000	0.000000	0.000000	0.079664

MEAN WIND SPEED (m/s) = 2.58
NUMBER OF OBSERVATIONS = 673

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	0.000118	0.001302	0.001657	0.000118	0.000000	0.000000	0.000000	0.000000	0.003196
NE	0.000000	0.000473	0.000710	0.000355	0.000000	0.000000	0.000000	0.000000	0.001539
ENE	0.000710	0.000710	0.000592	0.000237	0.000000	0.000000	0.000000	0.000000	0.002249
E	0.000592	0.001657	0.000592	0.000237	0.000000	0.000000	0.000000	0.000000	0.003078
ESE	0.000473	0.000592	0.000592	0.000237	0.000000	0.000000	0.000000	0.000000	0.001894
SE	0.000237	0.000829	0.000237	0.000000	0.000000	0.000000	0.000000	0.000000	0.001302
SSE	0.000237	0.000829	0.000237	0.000000	0.000000	0.000000	0.000000	0.000000	0.001302
S	0.000000	0.000947	0.000355	0.000000	0.000000	0.000000	0.000000	0.000000	0.001302
SSW	0.000118	0.000592	0.001184	0.000355	0.000000	0.000000	0.000000	0.000000	0.002249
SW	0.000118	0.000710	0.001184	0.000592	0.000000	0.000000	0.000000	0.000000	0.002604
WSW	0.000237	0.000473	0.001776	0.000829	0.000000	0.000000	0.000000	0.000000	0.003314
W	0.000118	0.000473	0.000592	0.000237	0.000000	0.000000	0.000000	0.000000	0.001420
WNW	0.000118	0.000473	0.000947	0.000237	0.000000	0.000000	0.000000	0.000000	0.001776
NW	0.000237	0.000829	0.001184	0.000355	0.000000	0.000000	0.000000	0.000000	0.002604
NNW	0.000118	0.000355	0.001184	0.000237	0.000000	0.000000	0.000000	0.000000	0.001894
N	0.000355	0.001065	0.000947	0.000829	0.000000	0.000000	0.000000	0.000000	0.003196
CALM									0.000355
TOTAL	0.003788	0.012311	0.013968	0.004853	0.000000	0.000000	0.000000	0.000000	0.035275

MEAN WIND SPEED (m/s) = 3.18
NUMBER OF OBSERVATIONS = 298

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	0.000355	0.003078	0.002959	0.001302	0.000000	0.000000	0.000000	0.000000	0.007694
NE	0.000592	0.001657	0.001894	0.000829	0.000000	0.000000	0.000000	0.000000	0.004972
ENE	0.000355	0.001539	0.001657	0.000710	0.000000	0.000000	0.000000	0.000000	0.004261
E	0.000355	0.000947	0.001065	0.001184	0.000000	0.000000	0.000000	0.000000	0.003551
ESE	0.000592	0.001420	0.001184	0.001539	0.000000	0.000000	0.000000	0.000000	0.004735
SE	0.000592	0.000710	0.000473	0.000000	0.000000	0.000000	0.000000	0.000000	0.001776
SSE	0.000000	0.001894	0.001184	0.000473	0.000000	0.000000	0.000000	0.000000	0.003551
S	0.000237	0.000118	0.000710	0.000710	0.000000	0.000000	0.000000	0.000000	0.001776
SSW	0.000118	0.000237	0.001184	0.001894	0.000000	0.000000	0.000000	0.000000	0.003433
SW	0.000355	0.000473	0.001420	0.002367	0.000000	0.000000	0.000000	0.000000	0.004616
WSW	0.000000	0.001065	0.001420	0.002249	0.000000	0.000000	0.000000	0.000000	0.004735
W	0.000118	0.000592	0.000473	0.000947	0.000000	0.000000	0.000000	0.000000	0.002131
WNW	0.000355	0.000710	0.000947	0.001420	0.000000	0.000000	0.000000	0.000000	0.003433
NW	0.000237	0.000947	0.001302	0.000473	0.000000	0.000000	0.000000	0.000000	0.002959
NNW	0.000118	0.000947	0.000947	0.001539	0.000000	0.000000	0.000000	0.000000	0.003551
N	0.000592	0.001065	0.003196	0.002012	0.000000	0.000000	0.000000	0.000000	0.006866
CALM									0.000237
TOTAL	0.004972	0.017401	0.022017	0.019650	0.000000	0.000000	0.000000	0.000000	0.064276

MEAN WIND SPEED (m/s) = 3.66
NUMBER OF OBSERVATIONS = 543

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002012	0.007694	0.005563	0.005800	0.003433	0.000000	0.000118	0.000592	0.025213
NE	0.002959	0.006274	0.005800	0.002012	0.000592	0.000118	0.000118	0.000000	0.017874
ENE	0.003906	0.006155	0.003078	0.002131	0.000592	0.000237	0.000000	0.000000	0.016098
E	0.003314	0.005682	0.004025	0.004261	0.003551	0.000947	0.000355	0.000237	0.022372
ESE	0.003078	0.005563	0.003314	0.006866	0.005563	0.002604	0.000592	0.000118	0.027699
SE	0.003551	0.007931	0.004143	0.005208	0.004616	0.001184	0.000473	0.000000	0.027107
SSE	0.003551	0.009233	0.007221	0.003433	0.004143	0.001420	0.000118	0.000000	0.029119
S	0.002249	0.005445	0.004972	0.004853	0.002249	0.002841	0.002367	0.002249	0.027225
SSW	0.000710	0.002012	0.009233	0.015980	0.008759	0.003078	0.001894	0.002249	0.043916
SW	0.000473	0.003078	0.005800	0.012547	0.010772	0.005327	0.003906	0.003314	0.045218
WSW	0.001065	0.004143	0.003551	0.008404	0.006392	0.002723	0.000710	0.002249	0.029238
W	0.001657	0.002841	0.003314	0.004972	0.005682	0.002959	0.002012	0.001539	0.024976
WNW	0.002249	0.002604	0.003078	0.004972	0.005208	0.002131	0.000592	0.001776	0.022609
NW	0.002249	0.003314	0.002723	0.006984	0.004972	0.001420	0.000355	0.001420	0.023438
NNW	0.003196	0.003314	0.002841	0.002841	0.003788	0.002249	0.000592	0.001184	0.020005
N	0.002604	0.005208	0.007813	0.008404	0.008641	0.002249	0.001184	0.001894	0.037997
CALM									0.002604
TOTAL	0.038826	0.080492	0.076468	0.099669	0.078954	0.031487	0.015388	0.018821	0.442708

MEAN WIND SPEED (m/s) = 5.05
NUMBER OF OBSERVATIONS = 3740

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	0.003906	0.004735	0.005208	0.000710	0.000000	0.000000	0.000000	0.000000	0.014560
NE	0.003788	0.002367	0.000473	0.000000	0.000000	0.000000	0.000000	0.000000	0.006629
ENE	0.001894	0.002841	0.000473	0.000118	0.000000	0.000000	0.000000	0.000000	0.005327
E	0.002841	0.007576	0.004380	0.001065	0.000000	0.000000	0.000000	0.000000	0.015862
ESE	0.004261	0.005563	0.004735	0.001302	0.000000	0.000000	0.000000	0.000000	0.015862
SE	0.005563	0.008759	0.006984	0.001420	0.000000	0.000000	0.000000	0.000000	0.022727
SSE	0.003433	0.012074	0.019886	0.001776	0.000000	0.000000	0.000000	0.000000	0.037169
S	0.001539	0.005445	0.021307	0.005445	0.000000	0.000000	0.000000	0.000000	0.033736
SSW	0.001302	0.003433	0.021544	0.005919	0.000000	0.000000	0.000000	0.000000	0.032197
SW	0.000592	0.008286	0.018584	0.002959	0.000000	0.000000	0.000000	0.000000	0.030421
WSW	0.002486	0.008996	0.007576	0.000947	0.000000	0.000000	0.000000	0.000000	0.020005
W	0.003433	0.008049	0.006629	0.001184	0.000000	0.000000	0.000000	0.000000	0.019295
WNW	0.002012	0.007694	0.004616	0.000592	0.000000	0.000000	0.000000	0.000000	0.014915
NW	0.003078	0.004616	0.004616	0.001420	0.000000	0.000000	0.000000	0.000000	0.013731
NNW	0.002249	0.003196	0.002367	0.000237	0.000000	0.000000	0.000000	0.000000	0.008049
N	0.001420	0.006392	0.005327	0.000592	0.000000	0.000000	0.000000	0.000000	0.013731
CALM									0.003551
TOTAL	0.043797	0.100024	0.134706	0.025687	0.000000	0.000000	0.000000	0.000000	0.307765

MEAN WIND SPEED (m/s) = 2.96
NUMBER OF OBSERVATIONS = 2600

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	0.001302	0.000473	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001776
NE	0.001420	0.000710	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002131
ENE	0.001065	0.000947	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
E	0.001657	0.000710	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002367
ESE	0.001539	0.001894	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003433
SE	0.003788	0.004498	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008286
SSE	0.002131	0.006274	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008404
S	0.003078	0.004380	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007457
SSW	0.001657	0.001657	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003314
SW	0.001420	0.005208	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006629
WSW	0.001657	0.006155	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007813
W	0.001420	0.001539	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002959
WNW	0.001539	0.001302	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002841
NW	0.001302	0.000947	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002249
NNW	0.000592	0.000710	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001302
N	0.001065	0.000947	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002012
CALM									0.005327
TOTAL	0.026634	0.038352	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.070313

MEAN WIND SPEED (m/s) = 1.69
NUMBER OF OBSERVATIONS = 594

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	0.007931	0.019650	0.016572	0.008049	0.003433	0.000000	0.000118	0.000592	0.056345
NE	0.009825	0.014323	0.009943	0.003906	0.000592	0.000118	0.000118	0.000000	0.038826
ENE	0.008759	0.014796	0.006037	0.003314	0.000592	0.000237	0.000000	0.000000	0.033736
E	0.009351	0.019176	0.010298	0.006866	0.003551	0.000947	0.000355	0.000237	0.050781
ESE	0.010298	0.017756	0.010298	0.010298	0.005563	0.002604	0.000592	0.000118	0.057528
SE	0.014678	0.025923	0.012429	0.006866	0.004616	0.001184	0.000473	0.000000	0.066170
SSE	0.009943	0.033381	0.028883	0.005919	0.004143	0.001420	0.000118	0.000000	0.083807
S	0.007221	0.018348	0.028054	0.011127	0.002249	0.002841	0.002367	0.002249	0.074455
SSW	0.004261	0.010535	0.033617	0.024384	0.008759	0.003078	0.001894	0.002249	0.088778
SW	0.003314	0.019650	0.029119	0.018939	0.010772	0.005327	0.003906	0.003314	0.094342
WSW	0.005800	0.023911	0.016809	0.012902	0.006392	0.002723	0.000710	0.002249	0.071496
W	0.007457	0.016927	0.012192	0.007457	0.005682	0.002959	0.002012	0.001539	0.056226
WNW	0.006747	0.017637	0.010535	0.007457	0.005208	0.002131	0.000592	0.001776	0.052083
NW	0.007813	0.015388	0.012311	0.009706	0.004972	0.001420	0.000355	0.001420	0.053385
NNW	0.006629	0.010890	0.008404	0.004853	0.003788	0.002249	0.000592	0.001184	0.038589
N	0.006866	0.018821	0.018348	0.012192	0.008641	0.002249	0.001184	0.001894	0.070194
CALM									0.013258
TOTAL	0.126894	0.297112	0.263849	0.154238	0.078954	0.031487	0.015388	0.018821	1.000000

MEAN WIND SPEED (m/s) = 3.82
NUMBER OF OBSERVATIONS = 8448

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 8.0%
B : 3.5%
C : 6.4%
D : 44.3%
E : 30.8%
F : 7.0%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0103	0203	0046
02	0000	0000	0000	0119	0186	0047
03	0000	0000	0000	0115	0198	0039
04	0000	0000	0000	0118	0199	0035
05	0000	0000	0000	0117	0187	0048
06	0000	0000	0000	0110	0204	0038
07	0005	0004	0012	0182	0120	0029
08	0018	0012	0019	0249	0041	0013
09	0015	0020	0041	0276	0000	0000
10	0028	0016	0065	0243	0000	0000
11	0055	0028	0067	0202	0000	0000
12	0072	0040	0081	0159	0000	0000
13	0095	0046	0055	0156	0000	0000
14	0110	0034	0063	0145	0000	0000
15	0103	0038	0054	0157	0000	0000
16	0097	0034	0043	0178	0000	0000
17	0055	0017	0030	0186	0054	0010
18	0020	0009	0013	0174	0109	0027
19	0000	0000	0000	0155	0144	0053
20	0000	0000	0000	0140	0173	0039
21	0000	0000	0000	0112	0194	0046
22	0000	0000	0000	0116	0192	0044
23	0000	0000	0000	0113	0197	0042
24	0000	0000	0000	0115	0199	0038

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0028	0023	0051	0839	2528	0548
<=1000 m	0162	0097	0216	1308	0043	0005
<=1500 m	0483	0178	0276	0962	0029	0041
<=2000 m	0000	0000	0000	0308	0000	0000
<=3000 m	0000	0000	0000	0252	0000	0000
>3000 m	0000	0000	0000	0071	0000	0000

MIXING HEIGHT BY HOUR OF DAY

Hour	0000 to 0100	0100 to 0200	0200 to 0400	0400 to 0800	0800 to 1600	1600 to 3200	Greater than 3200
01	0037	0084	0136	0027	0023	0038	0007
02	0031	0092	0129	0029	0025	0043	0003
03	0027	0096	0135	0024	0035	0032	0003
04	0033	0089	0127	0040	0023	0036	0004
05	0030	0102	0118	0040	0019	0039	0004
06	0070	0131	0103	0026	0008	0014	0000
07	0080	0088	0113	0062	0003	0006	0000
08	0000	0105	0112	0135	0000	0000	0000
09	0000	0000	0124	0161	0067	0000	0000
10	0000	0000	0000	0238	0114	0000	0000
11	0000	0000	0000	0161	0191	0000	0000
12	0000	0000	0000	0092	0260	0000	0000
13	0000	0000	0000	0053	0299	0000	0000
14	0000	0000	0000	0000	0352	0000	0000
15	0000	0000	0000	0000	0352	0000	0000
16	0000	0000	0000	0000	0352	0000	0000
17	0000	0000	0000	0000	0352	0000	0000
18	0002	0050	0062	0015	0201	0022	0000
19	0023	0069	0085	0008	0114	0049	0004
20	0021	0090	0110	0022	0035	0070	0004
21	0024	0101	0128	0020	0009	0067	0003
22	0027	0085	0138	0021	0025	0050	0006
23	0033	0090	0127	0023	0022	0051	0006
24	0033	0089	0124	0027	0027	0044	0008

ATTACHMENT GB
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : Modified CGM

Year 7:

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Tailings storage facilities construction - Scrapers/dozers clearing topsoil	163,520	11,680	h/y	14.0	kg/h						
Tailings storage facilities construction - Loading trucks	2,028	782,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Tailings storage facilities construction - Trucks hauling	78,200	782,000	t/y	0.10000	kg/t	40	t/load	4.0	km/return trip	1.0	kg/VKT
Tailings storage facilities construction - Trucks dumping	2,028	782,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Drilling	75,373	127,750	holes/y	0.59	kg/hole						
Blasting	68,561	365	blasts/y	188	kg/blast	9000	Area of blast - m2				
Loading waste to trucks	63,268	24,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Hauling waste to emplacement area	1,027,252	24,400,000	t/y	0.04210	kg/t	177	t/load	7.5	km/return trip	1.0	kg/VKT
Emplacing waste at emplacements	63,268	24,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Dozer working on waste amplacements, open pit and stockpiles	319,060	43,800	h/y	7.3	kg/h	5	silt content - %	2	moisture content - %		
Loading ore to trucks	22,299	8,600,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Hauling ore to ROM pad	180,789	8,600,000	t/y	0.02102	kg/t	177	t/load	3.7	km/return trip	1.0	kg/VKT
Unloading ore to ROM pad	22,299	8,600,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Rehandling ore to crusher	22,299	8,600,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Primary and secondary ore crushing	130,720	8,600,000	t/y	0.01520	kg/t	90	%reduction (high moisture)				
Loading to coarse ore stockpile	22,299	8,600,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Ore processing in mill	19,447	7,500,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Wind erosion, open pit	411,865	113	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, waste emplacement areas	1,512,602	415	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, stockpiles and exposed areas	345,307	95	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, tailings storage facilities	637,844	175	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Grading roads - whole site	43,132	70,080	km	0.61547	kg/VKT	8	Grader speed - km/h				

h/y = hours per year
t/y = tonnes per year
kg/t = kilograms per tonne
kg/ha/yr = kilograms per hectare per year
kg/VKT = kilogram per vehicle kilometre travelled
km/h = kilometre per hour

Year 9:

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Tailings storage facilities construction - Scrapers/dozers clearing topsoil	163,520	11,680	h/y	14.0	kg/h						
Tailings storage facilities construction - Loading trucks	2,028	782,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Tailings storage facilities construction - Trucks hauling	78,200	782,000	t/y	0.10000	kg/t	40	t/load	4.0	km/return trip	1.0	kg/VKT
Tailings storage facilities construction - Trucks dumping	2,028	782,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Drilling	75,373	127,750	holes/y	0.59	kg/hole						
Blasting	68,561	365	blasts/y	188	kg/blast	9000	Area of blast - m2				
Loading waste to trucks	69,751	26,900,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Hauling waste to emplacement area	1,132,503	26,900,000	t/y	0.04210	kg/t	177	t/load	7.5	km/return trip	1.0	kg/VKT
Emplacing waste at emplacements	69,751	26,900,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Dozer working on waste emplacements, open pit and stockpiles	319,060	43,800	h/y	7.3	kg/h	5	silt content - %	2	moisture content - %		
Loading ore to trucks	21,781	8,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Hauling ore to ROM pad	176,585	8,400,000	t/y	0.02102	kg/t	177	t/load	3.7	km/return trip	1.0	kg/VKT
Unloading ore to ROM pad	21,781	8,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Rehandling ore to crusher	21,781	8,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Primary and secondary ore crushing	127,680	8,400,000	t/y	0.01520	kg/t	90	%reduction (high moisture)				
Loading to coarse ore stockpile	21,781	8,400,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Ore processing in mill	16,854	6,500,000	t/y	0.00259	kg/t	2.19	average (ws/2.2)^1.3	2	moisture content - %		
Wind erosion, open pit	411,865	113	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, waste emplacement areas	1,512,602	415	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, stockpiles and exposed areas	345,307	95	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Wind erosion, tailings storage facilities	637,844	175	ha	3644.8	kg/ha/y	78	Av no. of raindays	5	silt content - %	19.3655	% of winds above 5.4 m/s
Grading roads - whole site	43,132	70,080	km	0.61547	kg/VKT	8	Grader speed - km/h				

h/y = hours per year
t/y = tonnes per year
kg/t = kilograms per tonne
kg/ha/yr = kilograms per hectare per year
kg/VKT = kilogram per vehicle kilometre travelled
km/h = kilometre per hour

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by Barrick. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factor equations used for the study are described below. The emission factor derived from the application of the equation, with variables applicable to the Modified CGM, are shown in the fifth column of the table above.

Stripping topsoil
An emission rate of 14 kg/h has been used for stripping topsoil (**SPCC, 1983**).

Loading/unloading to trucks and stockpiles
Each tonne of material loaded/unloaded would generate a quantity of TSP that would depend on the wind speed and the moisture content. Equation 1 (**US EPA, 1985 and updates**) shows the relationship between these variables.

Equation 1

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

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

Hauling material by truck
After the application of water the emission factor used for trucks hauling material on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT).

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

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

Equation 2

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

where,
A = area to be blasted in square metre (m^2)

Primary and secondary ore crushing
There are currently no specific emission factors for these activities however, in practice, these would form a very small contribution of the overall dust emissions from the mine. In the absence of specific emission factors, US EPA emission factors for tertiary crushing and screening were used (0.0125 + 0.0027 kg/t) (**US EPA, 1985 and updates**).

Dozers on stockpiles and in-pit
Emissions from dozers have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**). The equation is as follows:

Equation 3

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \qquad \text{kg/hour}$$

where,

$E_{TSP} = TSP \ emissions$

s = silt content (%), and

M = moisture (%)

Wind erosion from stockpiles
The emission factor for wind erosion is given in Equation 4 below.

Equation 4

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

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

Grading roads
Estimates of TSP emissions from grading roads have been made using the US EPA emission factor equation below (**US EPA, 1985 and updates**).

Equation 5

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

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

Summary of modelled activities, emissions and locations

A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below. Also include is the location of the modelled dust sources. The AUSPLUME model input files, can be provided on request.

Year 7

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-------------------------------      15-May-2008 22:07
  DUST EMISSION CALCULATIONS V2
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 Output emissions file  : C:\Jobs\Cowal\ausplume\y07\emiss.src
 Meteorological file    : C:\Jobs\Cowal\metdata\cow0607.aus
 Number of dust sources : 29
 Number of activities   : 22
 No-blast conditions    : None
 Wind sensitive factor  : 2.190 (2.254 adjusted for activity hours)
 Wind erosion factor    : 142.940

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : TC - Scrapers/dozers clearing topsoil
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 163520 kg/y
 FROM SOURCES  : 2
28 29
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Loading trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2028 kg/y
 FROM SOURCES  : 2
28 29
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Trucks hauling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 78200 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 28 29
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Trucks dumping
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2028 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 28 29
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Drilling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 75373 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 : Blasting
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 68561 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading waste to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 63268 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 waste to emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1027252 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19
 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 : Emplacing waste at dump
 ACTIVITY TYPE : Wind sensitive
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 DUST EMISSION : 63268 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 16 17 18 19
 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 working on waste dumps, pits and stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 319060 kg/y
 FROM SOURCES  : 19
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
 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 ore to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 22299 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 ore to ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 180789 kg/y
 FROM SOURCES  : 9
7 8 9 10 11 12 13 14 15
 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 : Unloading ore to ROM pad
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 22299 kg/y
 FROM SOURCES  : 1
7
 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 : Rehandling ore to crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 22299 kg/y
 FROM SOURCES  : 2
7 9
 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 : Primary and secondary ore crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 130720 kg/y
 FROM SOURCES  : 1
9
 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 coarse ore stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 22299 kg/y
 FROM SOURCES  : 1
9
 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 : Ore processing in mill
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 19447 kg/y
 FROM SOURCES  : 1
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, open pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 411865 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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, emplacement areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1512602 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 16 17 18 19
 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, stockpiles and exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 345307 kg/y
 FROM SOURCES  : 10
6 7 8 9 20 21 22 23 24 25
 HOURS OF DAY  :
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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, Tailings storage dams
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 637844 kg/y
 FROM SOURCES  : 4
26 27 28 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 : Grading roads - whole site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 43132 kg/y
 FROM SOURCES  : 29
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 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

 Pit retention sources: 6
10 11 12 13 14 15
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Year 9

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-------------------------------      15-May-2008 22:08
  DUST EMISSION CALCULATIONS V2
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 Output emissions file  : C:\Jobs\Cowal\ausplume\y09\emiss.src
 Meteorological file    : C:\Jobs\Cowal\metdata\cow0607.aus
 Number of dust sources : 29
 Number of activities   : 22
 No-blast conditions    : None
 Wind sensitive factor  : 2.190 (2.254 adjusted for activity hours)
 Wind erosion factor    : 142.940

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : TC - Scrapers/dozers clearing topsoil
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 163520 kg/y
 FROM SOURCES  : 2
26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Loading trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2028 kg/y
 FROM SOURCES  : 2
26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Trucks hauling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 78200 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : TC - Trucks dumping
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2028 kg/y
 FROM SOURCES  : 7
21 22 23 24 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Drilling
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 75373 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 : Blasting
 ACTIVITY TYPE : Blasting
 DUST EMISSION : 68561 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : Loading waste to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 69751 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 : Hauling waste to emplacement area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1132503 kg/y
 FROM SOURCES  : 18
1 2 3 4 5 7 8 9 10 11 12 13 14 15 16 17 18 19
 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 : Emplacing waste at dump
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 69751 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 16 17 18 19
 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 working on waste dumps, pits and stockpiles
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 319060 kg/y
 FROM SOURCES  : 19
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
 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 ore to trucks
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21781 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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 ore to ROM pad
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 176585 kg/y
 FROM SOURCES  : 9
7 8 9 10 11 12 13 14 15
 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 : Unloading ore to ROM pad
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21781 kg/y
 FROM SOURCES  : 1
7
 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 : Rehandling ore to crusher
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21781 kg/y
 FROM SOURCES  : 2
7 9
 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 : Primary and secondary ore crushing
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 127680 kg/y
 FROM SOURCES  : 1
9
 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 coarse ore stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 21781 kg/y
 FROM SOURCES  : 1
9
 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 : Ore processing in mill
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 16854 kg/y
 FROM SOURCES  : 1
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, open pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 411865 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 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, emplacement areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 1512602 kg/y
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 FROM SOURCES  : 9
1 2 3 4 5 16 17 18 19
 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, stockpiles and exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 345307 kg/y
 FROM SOURCES  : 10
6 7 8 9 20 21 22 23 24 25
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion, Tailings storage dams
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 637844 kg/y
 FROM SOURCES  : 4
26 27 28 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 : Grading roads - whole site
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 43132 kg/y
 FROM SOURCES  : 29
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 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

 Pit retention sources: 6
10 11 12 13 14 15
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Source locations (MGA Coordinates):

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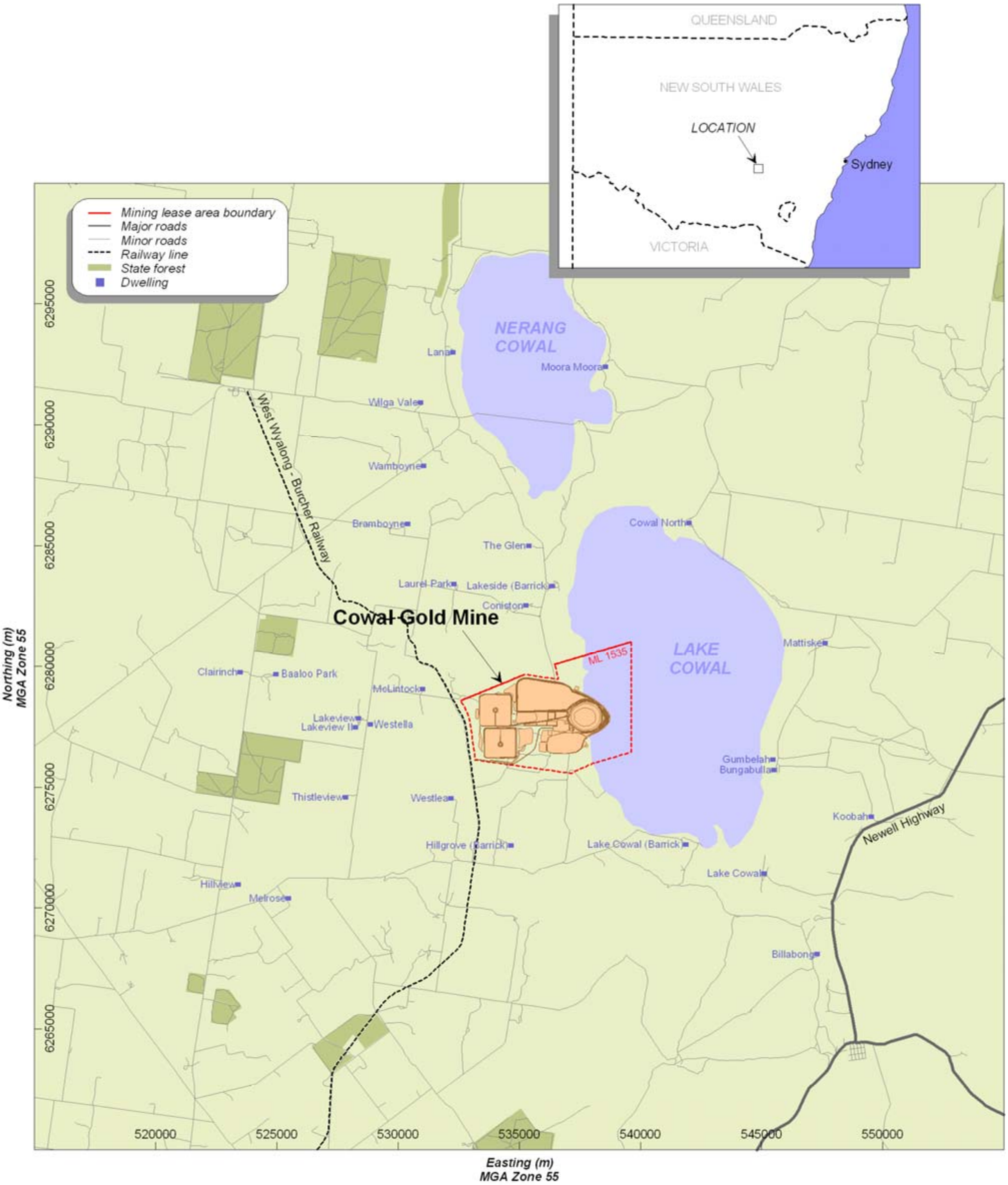
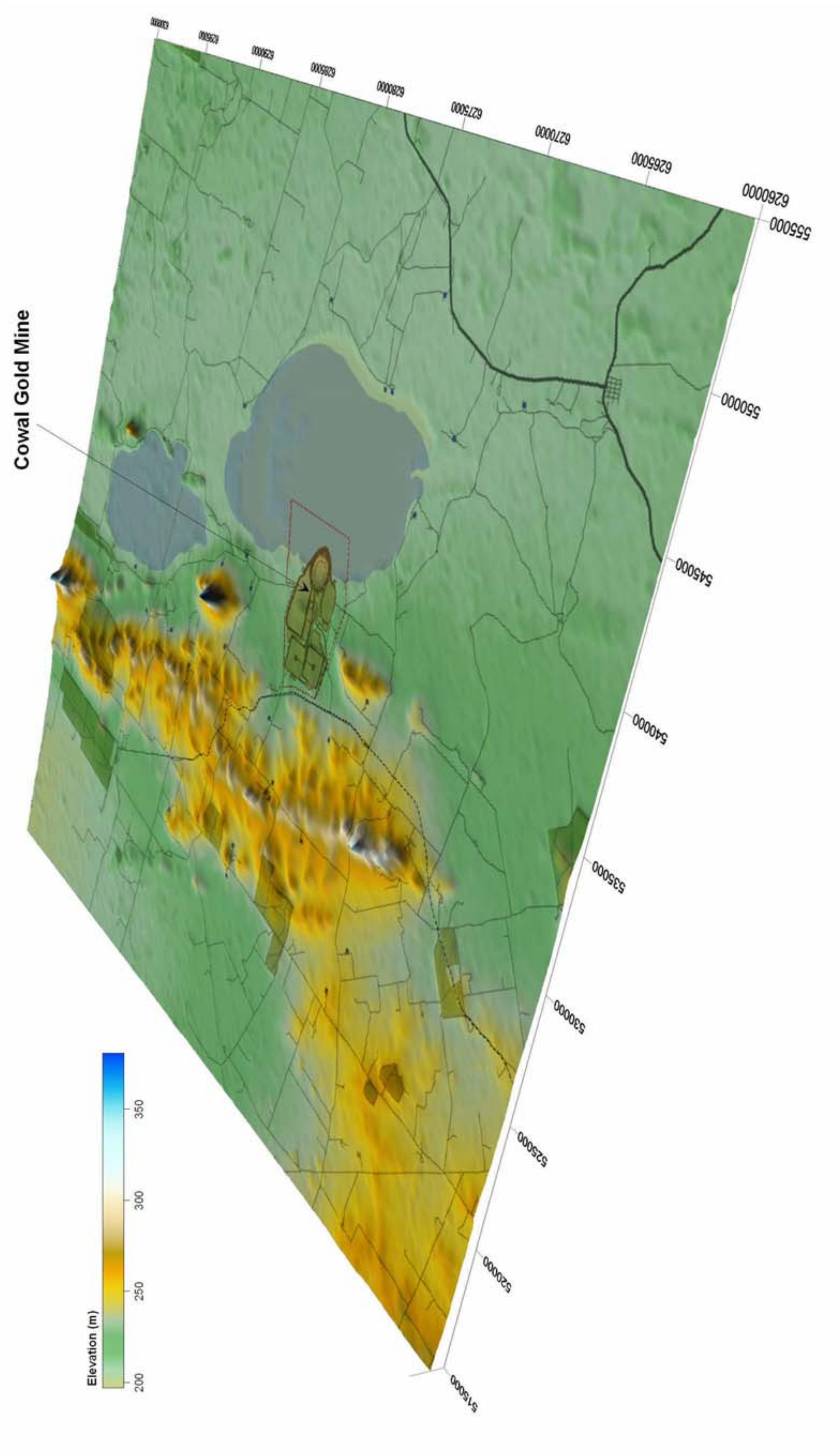
Easting,Northing,Elevation,ID
535236, 6279236, 212.4,  1
536015, 6279154, 210.9,  2
536927, 6278858, 208.1,  3
535492, 6278582, 213.7,  4
536455, 6278562, 211.6,  5
536035, 6277909, 212.7,  6
536732, 6278021, 212.4,  7
536916, 6277491, 212.8,  8
536998, 6277848, 213.8,  9
537388, 6277542, 211.4, 10
537992, 6277531, 203.0, 11
538146, 6278052, 203.0, 12
537736, 6278246, 203.9, 13
537337, 6278042, 210.6, 14
537716, 6277899, 204.5, 15
537367, 6277011, 213.0, 16
536732, 6277052, 215.6, 17
537019, 6276643, 212.7, 18
536445, 6276603, 215.2, 19
535964, 6276654, 215.7, 20
535175, 6276950, 217.0, 21
535359, 6277297, 216.0, 22
535513, 6277909, 213.8, 23
535082, 6277868, 215.6, 24
534713, 6279021, 214.0, 25
533678, 6277929, 221.3, 26
534396, 6277919, 217.4, 27
533832, 6277164, 223.7, 28
534549, 6277174, 221.7, 29
```

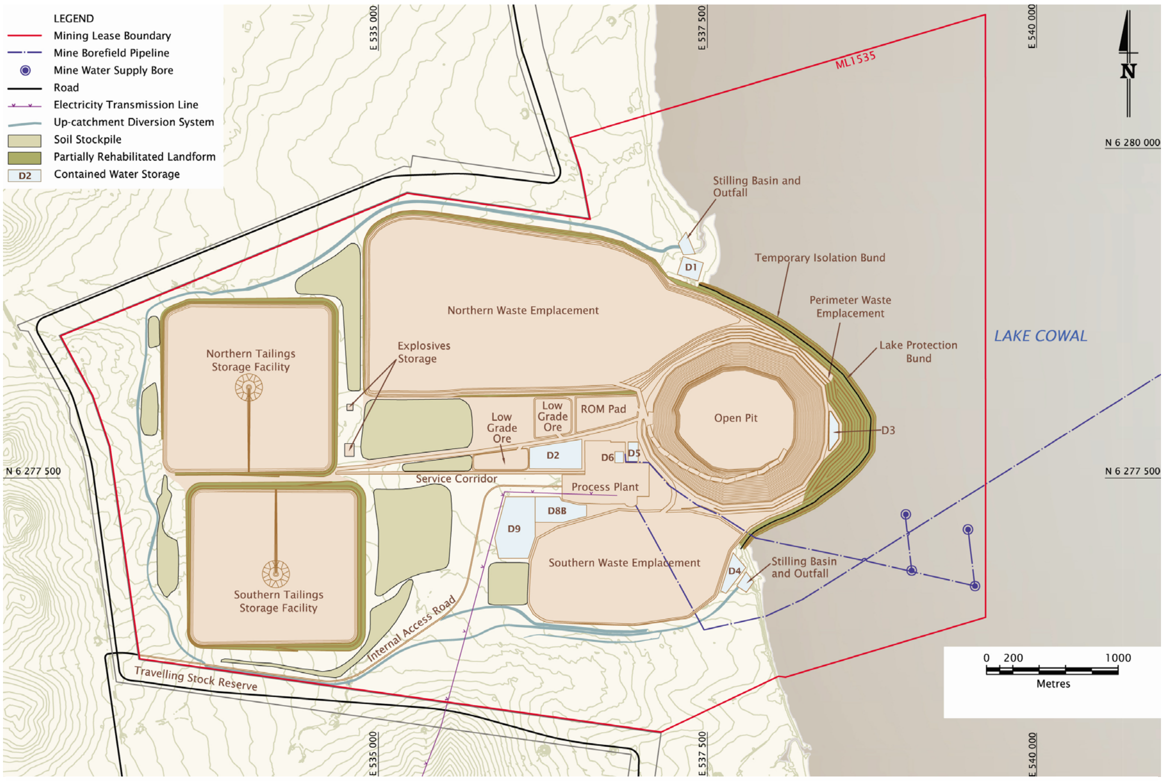
FIGURES



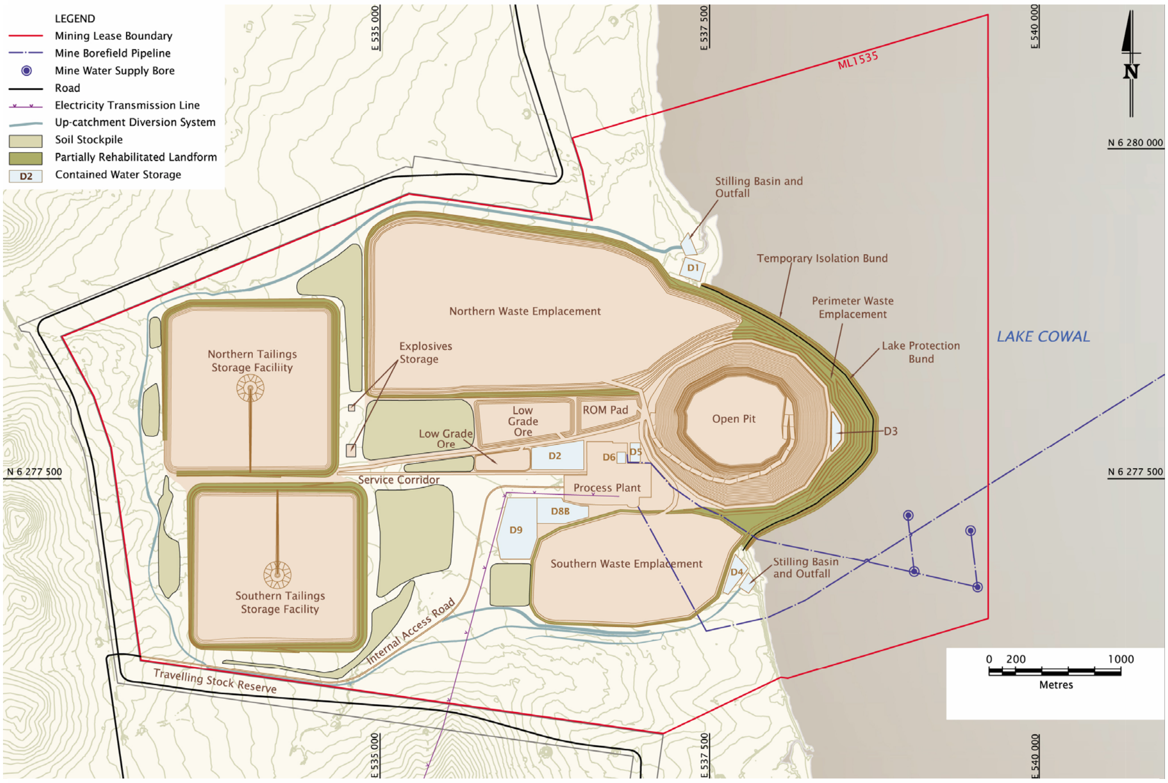
Location of study area



Pseudo three-dimensional representation of the local terrain



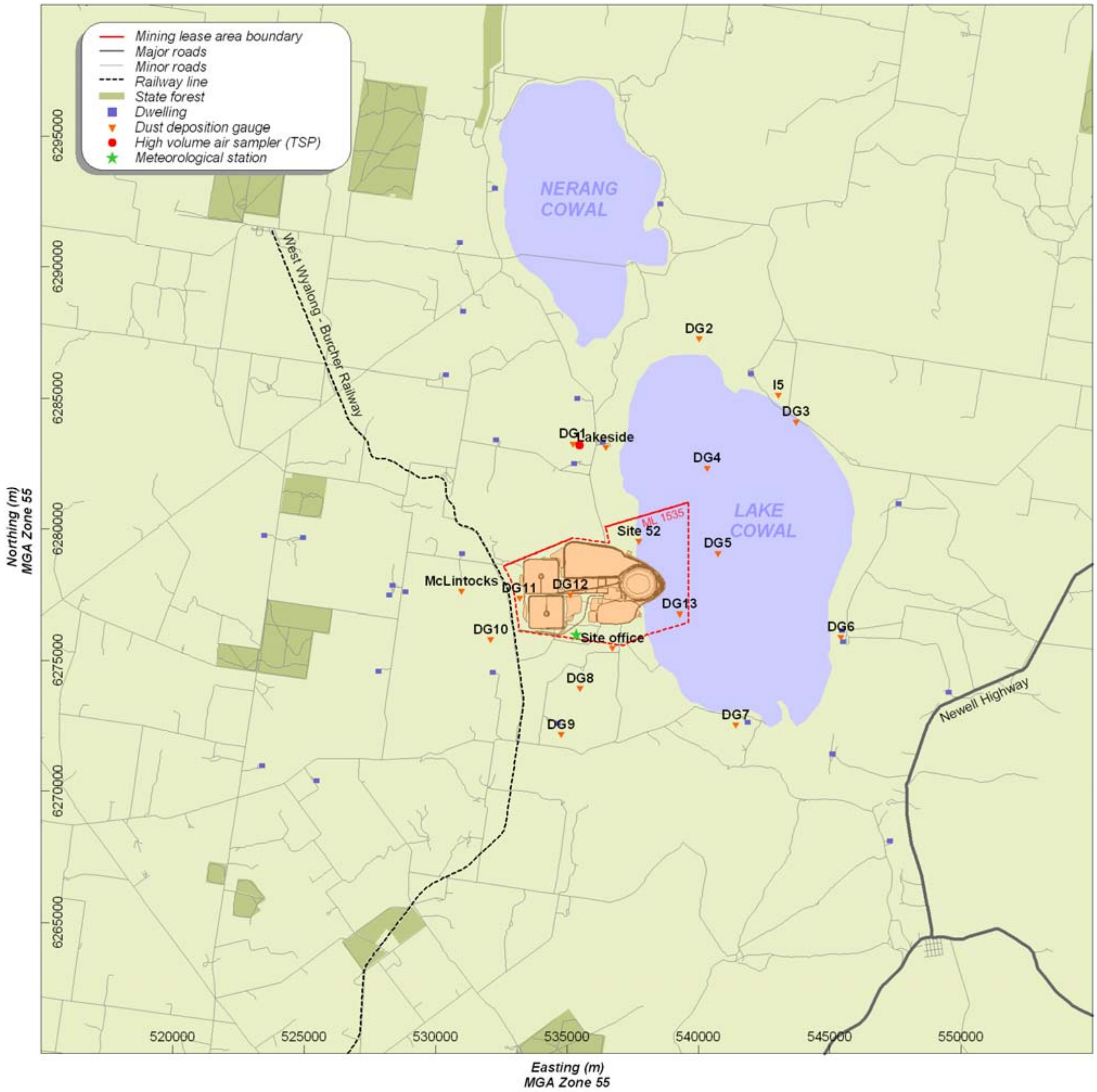
Year 7 conceptual general arrangement



Year 9 conceptual general arrangement

Year 7 and 9 conceptual general arrangements

FIGURE G-3



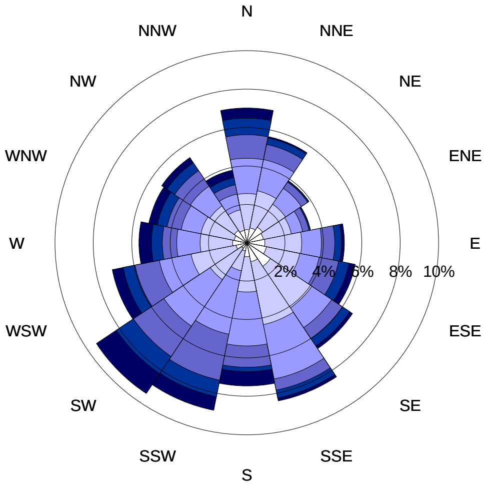
Location of monitoring sites for the Cowal Gold Mine

FIGURE G-4

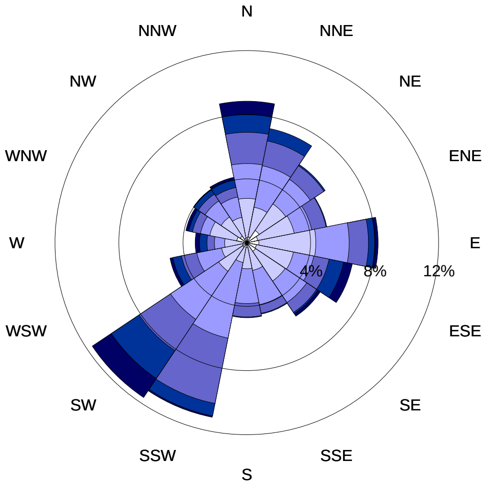
Annual and seasonal windroses for Cowal Gold Mine (27 Sep 2006 to 26 Sep 2007)

Wind speed (m/s)

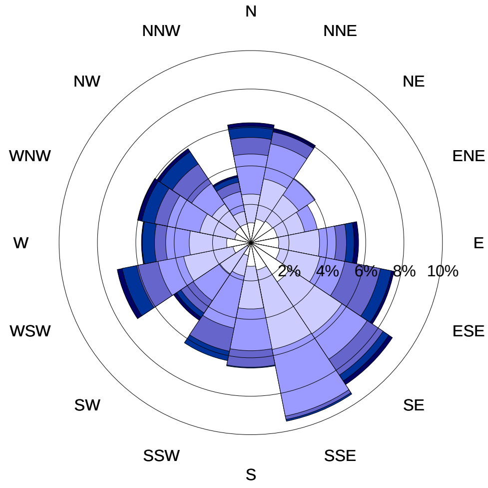
- >0.5 - 1.5
- >1.5 - 3
- >3 - 4.5
- >4.5 - 6
- >6 - 7.5
- >7.5



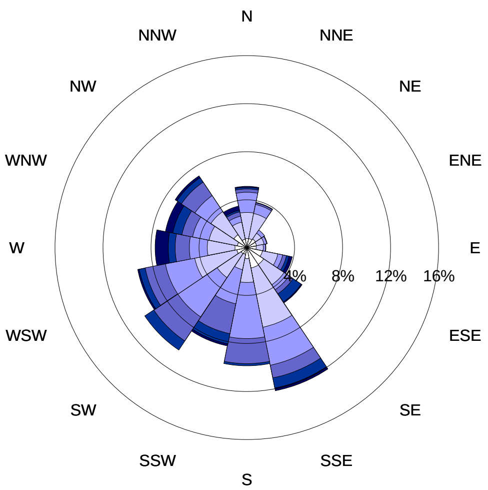
Annual
Calms = 1.3%



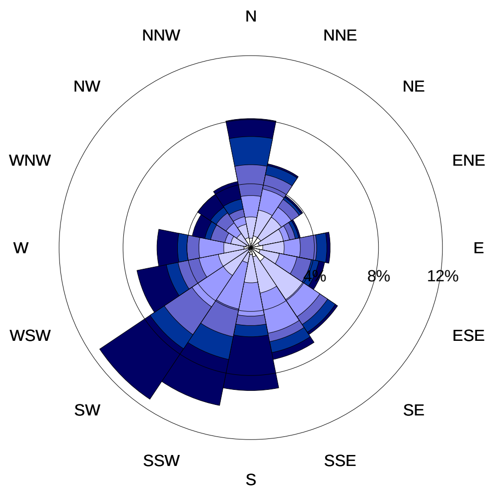
Summer
Calms = 0.3%



Autumn
Calms = 2.6%

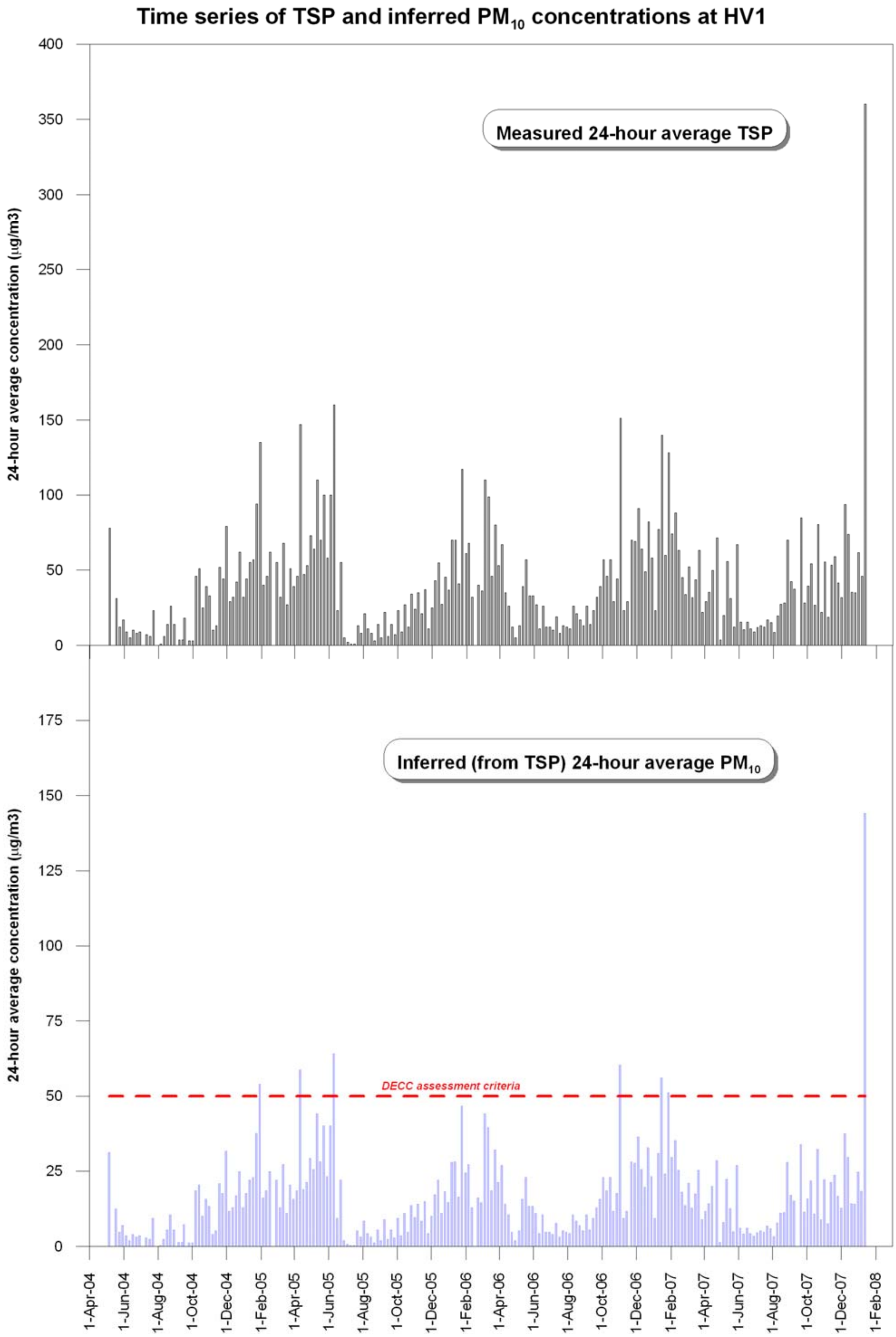


Winter
Calms = 1.4%



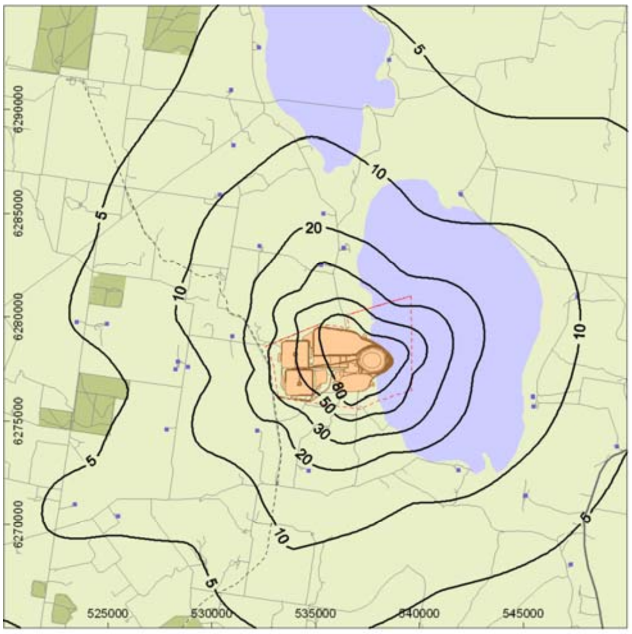
Spring
Calms = 0.8%

FIGURE G-5

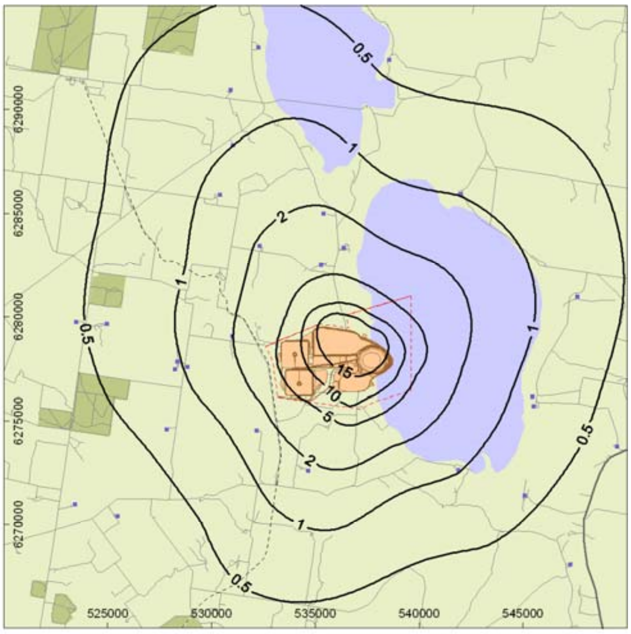


Time series of TSP and inferred PM10 concentrations at HV1
Measured 24-hour average TSP
Inferred (from TSP) 24-hour average PM10
DECC assessment criteria
24-hour average concentration (µg/m3)
1-Apr-04
1-Jun-04
1-Aug-04
1-Oct-04
1-Dec-04
1-Feb-05
1-Apr-05
1-Jun-05
1-Aug-05
1-Oct-05
1-Dec-05
1-Feb-06
1-Apr-06
1-Jun-06
1-Aug-06
1-Oct-06
1-Dec-06
1-Feb-07
1-Apr-07
1-Jun-07
1-Aug-07
1-Oct-07
1-Dec-07
1-Feb-08

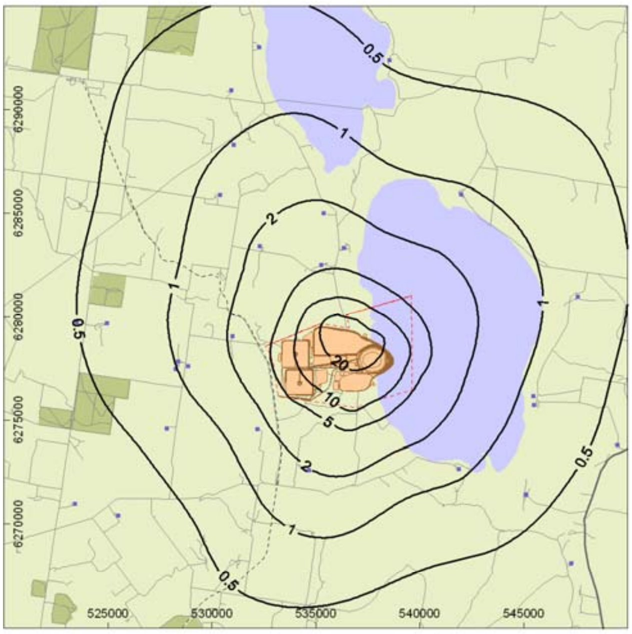
FIGURE G-6



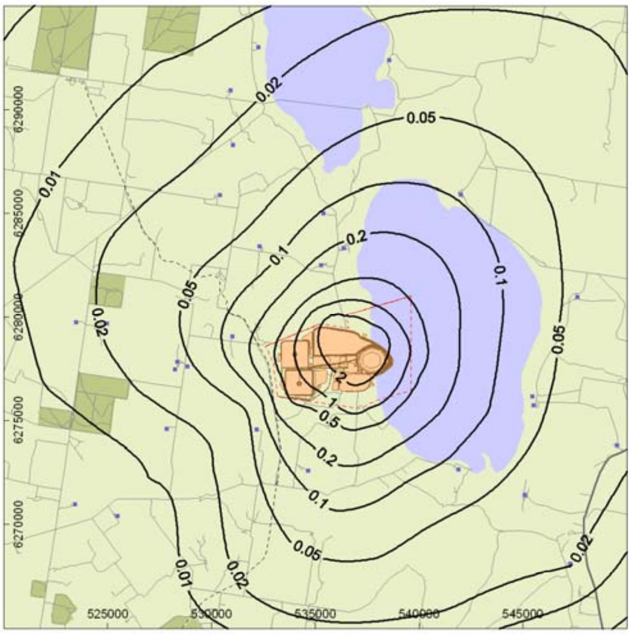
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



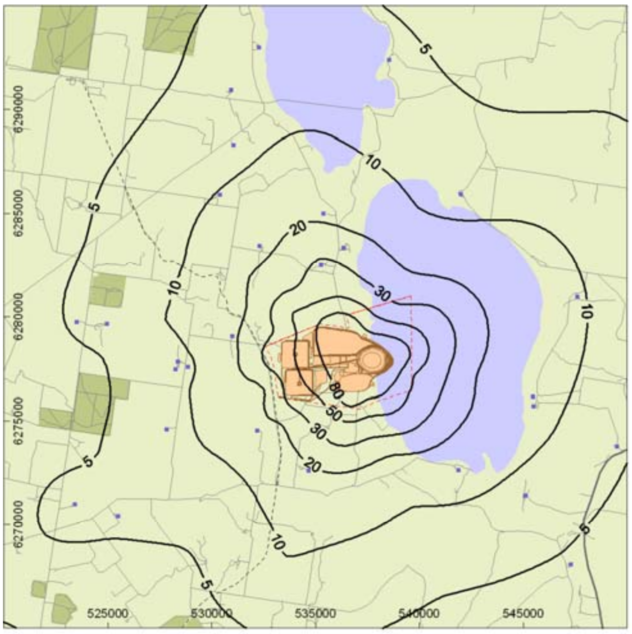
Annual average TSP - µg/m^3



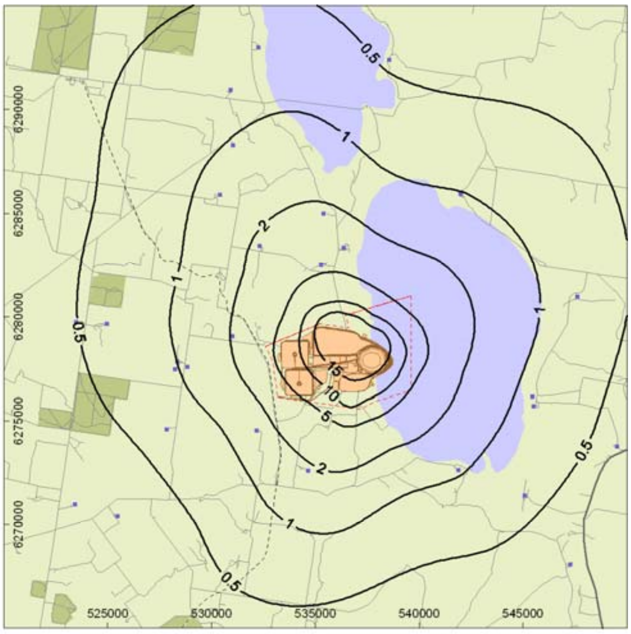
Annual average dust deposition - g/m^2/month

Predicted dust concentration and deposition levels due to Year 7 operations

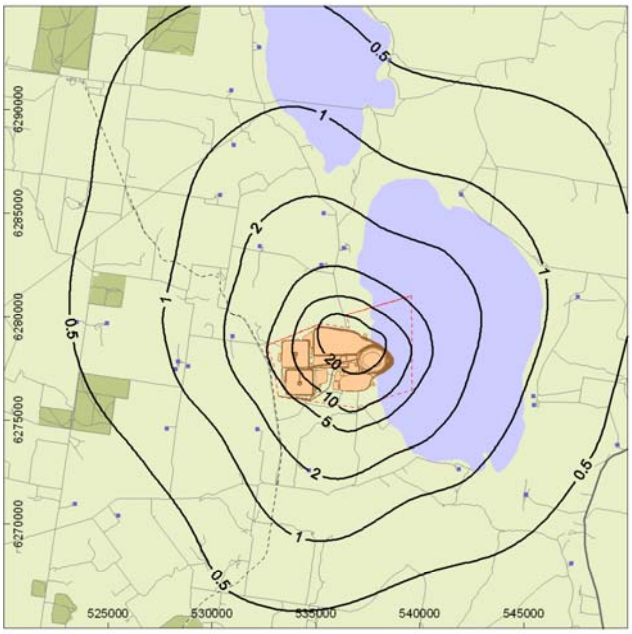
FIGURE G-7



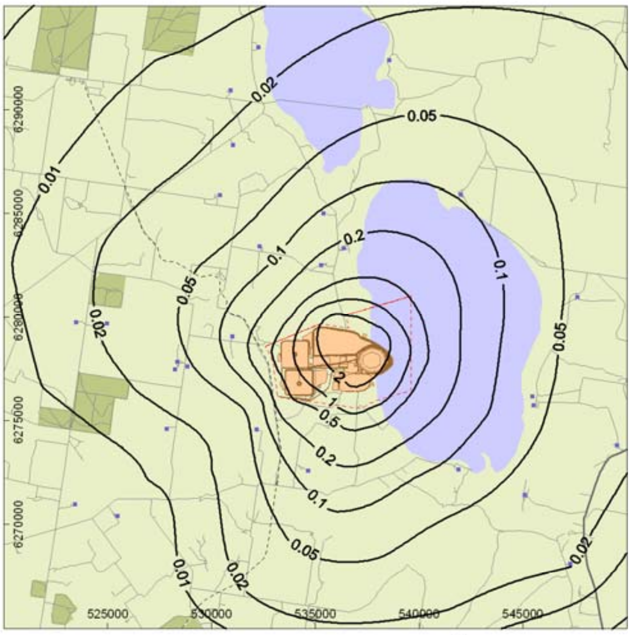
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3



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

Predicted dust concentration and deposition levels due to Year 9 operations

FIGURE G-8