AIR QUALITY IMPACT ASSESSMENT:
REMEDIATION WORKS AT PASMINCO COCKLE CREEK SMELTER

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Prepared for
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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Fitzwalter Group who are in turn acting on behalf of Pasminco Cockle Creek Smelter (PCCS). PCCS are seeking approval to carry out remediation works on land surrounding the Cockle Creek Smelter site at Boolaroo, near Newcastle. The purpose of this report is to quantitatively assess air quality impacts of the proposed works.

This assessment has taken into consideration the Director-General's Environmental Assessment requirements under Part 3A of the *Environmental Planning and Assessment Act 1979*. The requirements for air quality and health impacts include, but are not limited to, the following:

- *"The Environmental Assessment must include a comprehensive assessment of the air quality impacts of the project in accordance with the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (EPA, 2001). The Assessment must specifically focus on the impacts of heavy metals and particulates on ambient air quality, from a project-specific and cumulative perspective. Consideration of the impacts of particulates must include ambient air quality and dust deposition implications."*

- *"The Environmental Assessment must assess the health implications of the project, both during remediation of the site and in an on-going context once the site is remediated and potentially redeveloped in future. Assessment of health impacts must detail and justify appropriate human exposure scenarios, including for both adults and infants, and demonstrate that the project will not have unacceptable acute or chronic health effects, during or after the remediation works."*

Emissions of dust and lead in the dust are the main air quality issues. Lead arising from the remediation works has been given particular focus since impacts of this pollutant have undergone continual investigations both when the smelter was operational and following closure of the smelter in 2003. It is considered that managing impacts of lead will correspondingly manage any other of the metal contaminants on the PCCS site.

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

The assessment is based on a conventional approach following the procedures outlined in the Department of Environment and Conservation's (DEC) document titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005a**). This is consistent with the requirements for environmental assessments under Part 3A of the *Environmental Planning and Assessment Act 1979*.

In summary, the report provides information on the following:

- A description of the proposed operations and the local setting;
- Air quality goals that need to be met to protect the air quality environment;
- Meteorological and climatic conditions in the area;
- A discussion as to the likely existing air quality conditions in the area;
- The methods used to estimate dust emissions and the way in which emissions from the proposal would disperse and fallout;
- The expected dispersion and fallout patterns due to emissions from the operations and a comparison between the predicted concentration and fallout levels and the relevant air quality criteria; and
- Potential control methods to be used to reduce dust impacts.

2. LOCAL SETTING PROJECT DESCRIPTION

The smelter ceased operation in September 2003. Remediation is now proposed to restore the site to accommodate industrial, residential or recreational activities. The site is bounded by the residential areas of Boolaroo and Speers Point to the south, Argenton to the north and Macquarie Hills to the east. To the west is the suburb of Teralba.

Remediation of the PCCS site will involve excavating or otherwise removing contaminated material from various parts of the site and transporting the material to a designated containment cell, in the central area of the site. **Figure 1** shows the project location including the extents of the containment cell. **Figure 2** shows a pseudo three-dimensional representation of the local terrain. The most prominent feature is Munibung Hill, to the southeast of the PCCS site. The presence of this hill may have some influence on the wind patterns in the area. Wind patterns are discussed in **Section 4.1**.

In summary, the remediation works will involve the following:

- Excavation of contaminated soils and concrete slab removal
- Construction of a containment cell
- Treatment of excavated materials as required
- Emplacement of excavated materials into the containment cell
- Capping of the containment cell, and
- Installation of temporary and permanent environmental controls

It is proposed to remediate the site at a relatively constant rate over a period of five years. Remediation plans have been developed to illustrate the progress of the works which separate the process into 10 stages, each of six months duration. **Figure 3** shows each stage of the proposed works.

A 20 to 30 tonne excavator will be used to excavate material in each stage and load to 18 t haul trucks. Material will then be transported to an interim storage area which will be located within the proposed cell footprint where it will be placed using loaders. At this point the material will be mixed and treated as required before being transported to the containment cell for final placement. Sampling and analysis will be conducted in order to characterise the material being removed from the site.

Construction of the containment cell will occur concurrently with the excavation activities. The containment cell will be developed and filled progressively from east to west.

The rate of excavation and placement of the material in the containment cell is estimated at 750 m^3 per day. Approximately 75,000 m^3 of excavation material will be placed in the cell per six month period. Activities will occur Monday to Friday and only during daylight hours. On average, excavation activities will occur for 200 days per year.

Proposed equipment on the site at each work area typically includes:

- One 20 to 30 tonne excavator
- One front-end-loader or equivalent, and
- Up to three 18 t trucks for material haulage

Material characteristics have been found to vary across the site. Moisture contents of excavation material are between 8 and 14% with silt content at around 2 to 5%. Lead concentrations are in the range 500 to 3,000 ppm although there are some localised "hotspots", due to the presence of slag, where concentrations could be up to 40,000 ppm. Average lead levels are assumed at around 6,000 ppm for the purpose of this report. Material density in most areas of the site are of the order of 1.8 tonnes per cubic metre (t/m^3).

The areas of slag have slightly higher densities, say 2.3 t/m^3, and lead concentrations can be up to about 45,000 ppm or 4.5% by weight. Silt content of the slag is in the range 2 to 5%.

Dust emissions will arise from the excavating, loading, hauling and emplacing material as well as wind erosion from exposed areas.

3. AIR QUALITY GOALS

Air quality standards or goals are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects. The DEC have set air quality impact assessment criteria as part of their approved methods (**DEC, 2005a**), including goals for particulate matter and lead.

Table 1 summarises the air quality assessment criteria that are relevant to this study. The air quality goals relate to the total burden in the air and not just the contribution from the project. In other words, some consideration of background levels needs to be made when using these goals to assess impacts. This will be discussed later (see **Section 4.3**).

Table 1 : Air quality assessment criteria

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NHMRC
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	DEC
	30 $\mu g/m^3$	Annual mean	DEC
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	NEPM
Particulate matter < 2.5 μm ($PM_{2.5}$)	8 $\mu g/m^3$	Annual mean	NEPM*
	25 $\mu g/m^3$	24-hour maximum	NEPM*
Deposited dust	2 g/m^2/month	Annual mean (maximum increase in deposited dust level)	DEC
	4 g/m^2/month	Annual mean (maximum total dust level)	DEC
Lead	0.5 $\mu g/m^3$	Annual mean	NEPM

** Long-term reporting goal, not applied to projects in NSW. Australia has no ambient goal for $PM_{2.5}$ applied on a project basis.*

Lead is a cumulative poison which exerts its toxic effects on the kidneys, blood and central nervous system. It is now generally agreed, that while the effects are not readily discernible on an individual basis, on a population basis, lead exposure in young children can lead to an IQ deficit of between 2 to 3 points for each 10 $\mu g/dL$ increment in blood lead (**EPA, 1993**). As environmental lead has emerged as a public health issue, governments in Australia have developed strategies to reduce the levels of lead exposure.

In the early 1990s it was estimated (**ABS, 1992**) that about 90% of the lead in air arose from motor vehicle emissions, apart from areas where there are significant local lead industries. However ingestion, rather than inhalation is the more significant route of lead intake for young children who absorb lead very efficiently; up to 50% of ingested lead compared to 10-15% in adults.

With the successive reduction and eventual elimination of lead in petrol, emissions from motor vehicles have reduced to a point where lead is often not detectable in urban environments. The DEC have discontinued their lead monitoring in Sydney.

Most ingested lead is from contaminated soil and dust which children take in through exploratory hand to mouth activities. Some measures to reduce lead intake through ingestion include washing of children's hands and faces before meals, regular washing of outside toys and planting grass or ground cover on exposed areas of soil in the yard.

The NEPM standard for lead is 0.5 $\mu g/m^3$ on an annual basis. Since the closure of the PCCS operations in 2003 there has been a steady and unambiguous decline in ambient lead concentrations and lead deposition rates in the study area. This has substantially reduced the lead exposure of local residents. Further discussion of ambient lead concentrations is provided in **Section 4.3**.

4. EXISTING ENVIRONMENT

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

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. Meteorological data collected in the study area are discussed below.

The data available for the purposes of this study were collected at the Pasminco site in 1995. There were 7,968 hourly records which represents 91% of the year. These data have been prepared into a form suitable for the ISCST3 dispersion model.

Annual and seasonal wind-roses prepared from the 1995 data are shown in **Figure 4**. It can be seen from the wind-roses that, annually, the most common winds are from the SSW although winds from most other sectors are present. Winds from the WSW, ESE and SE occur the least often. In the summer months winds from the N and SSW prevail while winds in winter are predominantly from the WNW and NW. Calm periods, when winds were 0.5 m/s or less, occur for approximately 11% of the time.

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 (a measure of the fluctuation of the horizontal wind direction) according to the method recommended by the US EPA (**US EPA, 1986**). **Table 2** summarises the Pasminco wind data and shows the frequency of occurrence of the stability categories expected in the area. The most common stability occurrences at the Pasminco site were calculated to be F class stabilities (26%) which suggests that pollutant emissions into the area will disperse slowly for a significant proportion of the time.

[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 might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[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.

Table 2 : Summary of Pasminco meteorological data

Year	Pasminco, 1995 data
Hours available for year	7,968
Mean wind speed (m/s)	2.5
Percentage of winds less than or equal to 0.5 m/s (%)	11.4
Percentage occurrence of A class stabilities (%)	9.5
Percentage occurrence of B class stabilities (%)	13.2
Percentage occurrence of C class stabilities (%)	11.2
Percentage occurrence of D class stabilities (%)	21.0
Percentage occurrence of E class stabilities (%)	19.1
Percentage occurrence of F class stabilities (%)	25.9

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time conditions and an approach described by **Venkatram** (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data.

Given the proximity of the monitoring site to the area of interest, these data are considered to contain meteorological conditions that are representative of the conditions experienced at the project site. Joint wind speed, wind direction and stability class frequency tables for the Pasminco 1995 data are presented in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology collects climatic information from Nobbys Head Signal Station at Newcastle. A range of meteorological data collected from this station are presented in **Table 3** (**Bureau of Meteorology, 2005**).

Temperature data show that January is typically the warmest month with a mean daily maximum of 25.6°C. July is the coldest month with a mean daily minimum of 8.4°C. Rainfall data collected at Nobbys Head show that March is the wettest month with a mean rainfall of 122 mm over 12 rain days. Annually the area experiences, on average, 1,145 mm of rain per year.

Table 3 : Climate information for the study area

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean daily maximum temperature - deg C	25.6	25.4	24.7	22.8	19.9	17.4	16.7	18	20.1	22.1	23.5	24.9	21.8
Mean no. of days where Max Temp >= 40.0 deg C	0	0	0	0	0	0	0	0	0	0	0.1	0	0.1
Highest daily Max Temp - deg C	40.8	40.9	39	36.8	28.5	26.1	26.3	29.9	34.4	36.7	41	42	42
Mean daily minimum temperature - deg C	19.1	19.3	18.2	15.3	11.9	9.6	8.4	9.2	11.4	13.9	16	18	14.2
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0	0	0	0	0	0	0	0	0	0	0
Lowest daily Min Temp - deg C	12	10.3	11.1	7.4	4.7	3	1.8	3.3	5	6.5	7.2	11	1.8
Mean 9am air temp - deg C	21.9	21.8	20.8	18	14.6	12	10.8	12.1	15	17.8	19.5	21.1	17.1
Mean 9am wet bulb temp – deg C	19.2	19.5	18.5	15.7	12.6	10.2	8.9	9.7	12.1	14.5	16.4	18.2	14.6
Mean 9am dew point - deg C	17.5	18.2	16.9	14.1	10.9	8.3	6.5	7	9	11.5	13.8	16.2	12.6
Mean 9am relative humidity - %	76	80	78	78	79	79	77	73	70	68	71	74	75
Mean 9am wind speed - km/h	21.2	21.2	21.1	21.6	23.9	26.9	26.9	26.1	25.6	24	23.5	21.9	23.7
Mean 3pm air temp - deg C	23.3	23.5	22.9	21.3	18.8	16.5	15.9	16.9	18.5	19.8	20.9	22.4	20.1
Mean 3pm wet bulb temp - deg C	19.9	20.3	19.5	17.3	14.9	12.7	11.7	12.3	13.9	15.6	17.2	18.8	16.2
Mean 3pm dew point - deg C	17.7	18.5	17.2	14.3	11.6	9.3	7.2	7.5	9.3	12.1	14.3	16.3	13
Mean 3pm relative humidity - %	72	74	72	66	64	63	59	56	59	64	68	71	66
Mean 3pm wind speed - km/h	33.9	33.2	31.1	28.3	26.6	28.9	29.5	31	34.7	35	36.1	35.9	32
Mean monthly rainfall – mm	91.4	105.6	121.9	115.9	118.6	117.8	97.2	76.2	73.7	74.3	69.5	82.4	1144.6
Median (5th decile) monthly rainfall - mm	72.2	84.4	95.6	90.9	103.4	84.8	80.8	59	57.4	63.7	63.3	62.7	1068
Mean no. of raindays	11.1	11.1	12.2	11.9	12.1	11.7	10.8	10.3	10	10.9	10.5	10.5	133
Highest monthly rainfall – mm	404	559.2	544.4	546.4	441.3	485.7	351.1	545.3	283.1	277.5	203.9	326.5	
Lowest monthly rainfall – mm	2	0.5	2.8	0	2.1	3.6	0	0.8	1.6	4.6	2.4	4.6	
Highest recorded daily rainfall – mm	144.8	252.7	283.7	231.1	181.9	190.3	118.6	168.9	157.5	96.5	103.7	177.5	283.7
Mean no. of clear days	6.3	5.3	6.4	7.4	6.9	7.5	9.7	10.8	9.3	7.4	5.5	6.3	88.7
Mean no. of cloudy days	12.4	12.1	11.7	10.7	11.9	11.7	9.5	8.3	9	12.1	12.3	11.7	133.4
Highest recorded wind gust - km/h	142.6	140.8	137.2	114.8	170.6	151.9	139	135.4	131.4	140.8	144.7	129.6	170.6

Climate averages for Station: 061055 Newcastle Nobbys Signal station. Commenced: 1862; Last record: 2004; Latitude (deg S): 32.9185; Longitude (deg E): 151.7985; State: NSW

Source : Bureau of Meteorology (2005)

4.3 Existing air quality

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

Particulate Matter

The DEC operate air quality monitoring stations at Beresfield, Newcastle and Wallsend. These three sites all measure concentrations of PM_{10} by high volume air sampler (HVAS) and tapered element oscillating microbalance (TEOM) however, no TSP measurements are made. Summaries of these data are published in quarterly air quality monitoring reports by the DEC (**DEC, 2005b**). Monitoring data from the three DEC monitoring locations in the Lower Hunter since 2000 are shown below in **Table 4**.

One of the main reasons for analysing monitoring data is to determine existing air quality so that the assessment criteria can be determined in accordance with the DEC's modelling guidelines (**DEC, 2005a**).

At Beresfield the annual average PM_{10} concentration by HVAS has ranged between 18 and 25 $\mu g/m^3$ for the years 2000 to 2003. Using a TEOM the range was between 18 and 26 $\mu g/m^3$. The Beresfield site is located at a school, approximately 15 km to the north of the site.

At Newcastle the annual average PM_{10} concentration by HVAS has ranged between 20 and 23 $\mu g/m^3$, for all complete years, and has been 22 $\mu g/m^3$ since monitoring using a TEOM commenced in October 2004. The Newcastle site is located at the athletics field, approximately 12 km to the east of the site.

At Wallsend the annual average PM_{10} concentration has ranged between 17 and 21 $\mu g/m^3$ using both the HVAS and TEOM. The Wallsend site is located near the Wallsend swimming pool, approximately 7 km to the northeast of the site.

All annual averages for complete years were below the DEC air quality goal of 30 $\mu g/m^3$.

Maximum 24-hour average PM_{10} concentrations have been above the DEC 50 $\mu g/m^3$ goal on several occasions at all three monitoring locations using either the HVAS or TEOM. The highest 24-hour average PM_{10} concentrations were generally measured in the warmer months of the year. The summer months are generally when bushfires prevail.

Table 4 : Summary of PM_{10} monitoring in the project area

Month	Beresfield (µg/m³)				Newcastle (µg/m³)				Wallsend (µg/m³)			
	HVAS		TEOM		HVAS		TEOM		HVAS		TEOM	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Jan-00	21.0	21.0	17.0		24	32			26	31	18	
Feb-00	25.0	33.0	20.0		29	40			18	32	19	
Mar-00	18.0	24.0	18.0		20	27			16	19	17	
Apr-00	15.0	17.0	16.0		17	20			14	17	15	
May-00	18.0	30.0	17.0		17	26			15	26	15	
Jun-00	17.0	22.0	16.0		18	26			17	25	13	
Jul-00	15.0	22.0	16.0		14	22			14	19		
Aug-00	14.0	31.0	15.0		16	25			12	20		
Sep-00	19.0	35.0	24.0		23	41			17	31		
Oct-00	18.0	33.0	19.0		20	42			16	34		
Nov-00	15.0	18.0	17.0		19	25			15	17	15	
Dec-00	20.0	35.0	20.0		24	40			21	33	20	
Annual	**17.9**	**35.0**	**17.9**		**20.1**	**42.0**			**16.8**	**34.0**	**16.5**	
Jan-01	23.0	44.0	21.0		24	33			24	34	22	
Feb-01	14.0	24.0	19.0		19	28			15	24	20	
Mar-01	20.0	30.0	19.0		26	36			22	33	19	
Apr-01	16.0	23.0	21.0		18	26			15	19	18	
May-01	14.0	19.0	17.0		14	19			13	17	15	
Jun-01	21.0	31.0	22.0		23	34			19	28	16	
Jul-01	22.0	33.0	18.0		17	24			14	22	13	
Aug-01	17.0	26.0	21.0		14	19			14	22	15	
Sep-01	18.0	35.0	20.0		16	23			15	19	16	
Oct-01	16.0	20.0	30.0		15	24			12	16	15	
Nov-01	23.0	50.0	22.0		22	30			16	24	18	
Dec-01	24.0	38.0	30.0		33	**68**			27	**52**	27	
Annual Ave	**19.0**	**50.0**	**21.7**		**20.1**	**68.0**			**17.2**	**52.0**	**17.8**	

Month	Beresfield (µg/m³)				Newcastle (µg/m³)				Wallsend (µg/m³)			
	HVAS		TEOM		HVAS		TEOM		HVAS		TEOM	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Jan-02	25	43	27	**59**	22	34			19	25	24	**64**
Feb-02	20	25	16	25	20	24			19	24	16	23
Mar-02	27	41	23	**55**	25	36			26	33	19	38
Apr-02	14	15	18	35	18	20			12	14	15	22
May-02	18	23	19	38	15	19			14	17	15	24
Jun-02	14	25	20	**51**	20	33			18	23	17	**51**
Jul-02	25	34	26	47	16	23			18	28	19	30
Aug-02	19	26	23	36	19	24			16	23	18	24
Sep-02	25	31	26	**52**	23	36			21	34	19	41
Oct-02	30	45	41	**149**	29	43			23	36	29	45
Nov-02	54	**81**	40	**83**	43	**57**			39	**54**	33	**60**
Dec-02	29	**58**	31	**166**	29	**52**			22	39	30	**157**
Annual Ave	**25.0**	**81.0**	**25.8**	**166.0**	**23.3**	**57.0**			**20.6**	**54.0**	**21.2**	**157.0**
Jan-03	27	38			32	45			20	30	31	**89**
Feb-03	25	35	20	39	26	35			15	25	21	49
Mar-03	25	**53**	19	**59**	25	43			16	31	17	41
Apr-03	17	31	16	34	19	32			11	18	11	17
May-03	17	22	16	30	20	25			13	18	13	21
Jun-03	20	28	18	31	20	34			14	21	14	24
Jul-03	18	29	17	27	15	19			13	18	13	19
Aug-03	19	35	20	35	18	26			17	21	18	31
Sep-03	26	41	25	**51**	27	40			21	32	21	44
Oct-03	29	**82**	17	**88**	29	**72**			24	**76**	17	**105**
Nov-03	21	45	17	49	21	42			18	34	17	37
Dec-03	16	24	20	34	18	22			15	19	19	32
Annual Ave	**21.7**	**82.0**	**18.6**	**88.0**	**22.5**	**72.0**			**16.4**	**76.0**	**17.7**	**105.0**
Jan-04			20	33							22	29
Feb-04			25	44							24	43
Mar-04			22	40							21	34
Apr-04			22	48							19	34

Month	Beresfield (µg/m³)				Newcastle (µg/m³)				Wallsend (µg/m³)			
	HVAS		TEOM		HVAS		TEOM		HVAS		TEOM	
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
May-04			28	44							20	38
Jun-04			19	34							15	20
Jul-04			19	38							15	25
Aug-04			17	33							15	29
Sep-04			16	30							15	29
Oct-04			18	49			20	26			18	43
Nov-04			22	38			22	44			19	36
Dec-04			22	**56**			25	47			21	**53**
Annual Ave			**20.8**	**56.0**			**22.3**	**47.0**			**18.7**	**53.0**
Jan-05			20	35	39		22	**85**			21	35
Feb-05			25	**53**	43		26	**189**			24	36
Mar-05			16	30	29		20	**93**			15	26
Apr-05			20	46	38		24	**149**			18	28
May-05			20	40	32		21	**93**			16	25
Jun-05			20	38	39		21	**91**			17	28
Jul-05												
Aug-05												
Sep-05												
Oct-05												
Nov-05												
Dec-05												
Annual Ave			**20.2**	**53.0**	**36.7**		**22.3**	**189.0**			**18.5**	**36.0**

Neither TSP concentrations nor dust deposition are measured by the DEC in the Lower Hunter however dust deposition data are collected around the Pasminco site. **Figure 1** shows the dust deposition monitoring sites and **Table 5** summarises the annual averages from each location.

Table 5 : Dust deposition monitoring from the area

Site	g/m²/month									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
10 First St	1.2	1.1	0.7	1.1	1.4	0.8	0.8	0.9	0.9	1.0
First St west	0.6	0.7	0.4	0.3	0.5	0.4	0.6	0.8	1.1	0.6
Fourth St	1.2	3.6	***5.9***	1.1	0.9	0.7	0.8	0.5	0.8	1.7
School	1.0	0.9	0.5	0.8	0.7	0.3	0.7	1.0	0.8	0.7
Argy monitor	0.9	1.2	1.2	0.4	0.4	0.2	0.5	0.4	0.6	0.6
Munibung	3.3	0.4	0.4	0.7	1.6	0.6	0.7	1.0	0.8	1.0
Mine pump station	0.9	0.7	1.1	0.5	0.5	0.3	0.4	0.7	0.9	0.7
Macquarie Hills	N/A	N/A	N/A	N/A	N/A	0.2	N/A	N/A	N/A	0.2
Fairfax Road	N/A	N/A	N/A	0.5	0.4	0.3	0.6	0.6	1.0	0.6
25 Second St	1.3	1.1	0.7	1.1	0.9	0.7	0.7	0.7	0.8	0.9
Sixth St	0.7	0.6	0.4	0.5	0.6	0.3	0.7	0.8	1.0	0.6
19A Eighth St	1.2	0.8	0.4	0.4	0.4	0.3	0.6	0.9	1.0	0.7
Argy Hawkes	0.8	4.1	0.5	0.3	0.4	0.3	0.5	0.4	0.7	0.9
Edgeworth	0.4	0.8	0.2	0.4	0.8	0.5	1.2	2.6	***4.1***	1.2
Salt Water	1.1	0.9	0.4	0.5	0.5	0.6	0.8	1.1	1.4	0.8
Mines Rescue	1.7	2.1	0.9	0.4	0.4	0.3	0.4	0.5	1.2	0.9
Munibung_S	3.3	3.8	2.4	1.8	0.7	0.8	1.1	0.6	0.7	1.7
Montgomery St	0.4	1.7	0.3	0.5	0.9	0.6	0.7	0.9	1.5	0.8
Rankin Park	2.1	2.2	0.6	1.5	0.7	0.2	0.6	1.4	2.1	1.3
Verron Nth	N/A	2.3	0.4	0.4	0.8	0.6	0.5	0.8	1.4	0.9
Verron Sth	N/A	3.8	0.3	0.4	0.4	0.4	0.7	0.9	0.9	1.0
Wetland	N/A	N/A	1.4	1.6	1.2	0.4	0.9	1.2	1.1	1.1

The dust deposition data show that annual average levels at almost all gauges have been below the DEC goal of 4 g/m²/month. There were, however, occasions when very high monthly levels contributed to exceedances of the 4 g/m²/month goal at the Fourth Street monitoring in 1998 and at the Edgeworth monitor in 2004. The high monthly deposition levels were likely to be from localised activities near the monitors since other sites did not record levels of the same magnitude (by examination of the monthly data). The average of all the data from all gauges is 0.9 g/m²/month.

Figure 5 shows the annual average dust deposition from each site since 1996. There is a slight downward trend at all sites from 1996 to, say, 2002. Measured levels then generally appear to have increased from 2002 to 2004 which may be attributed to plant demolition and/or site clean-up activities.

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

- Annual average TSP of 53 µg/m³
- Annual average PM_{10} of 21 µg/m³
- Annual average dust deposition of 1 g/m²/month

The value of 53 µg/m³ for annual average TSP has been derived from the annual average PM_{10} (21 µg/m³) and assumes that 40% of the TSP is PM_{10}. Annual average dust deposition has been taken to be 1 g/m²/month, based on the average from all monitoring sites.

In addition, the DEC guidelines require an assessment against 24-hour PM_{10} concentrations. This assessment adopts the approach that the predicted 24-hour average PM_{10} concentration from the development should be less than 50 µg/m³ at the nearest residences.

Lead

Lead deposition has been monitored with the dust deposition. **Table 6** summarises the annual averages from each monitoring location and **Figure 6** shows these data graphically. It can be seen from **Figure 6** that, generally, there has been a steady decline in measured lead deposition levels at each site since 1996. The most apparent reduction to measured levels was from 2003 to 2004, which coincides with the closure of the smelter.

Table 6 : Lead deposition monitoring from the area

Site	mg/m²/month									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	Average
10 First St	103.2	82.1	105.7	158.5	73.4	85.9	81.1	74.1	8.5	85.8
First St west	18.2	24.3	28.9	30.8	22.3	11.9	19.8	27.9	16.9	22.3
Fourth St	72.7	64.3	72.7	101.9	57.4	79.9	64.7	32.5	10.1	61.8
School	40.1	32.8	38.0	54.7	35.2	18.0	28.5	38.2	3.8	32.1
Argy monitor	33.2	60.2	37.1	39.8	29.5	16.8	30.2	14.6	4.1	29.5
Munibung	19.5	10.3	18.0	18.3	12.4	16.1	16.3	11.6	5.5	14.2
Mine pump station	34.1	16.6	25.6	29.1	27.2	17.7	19.7	21.0	6.3	21.9
Macquarie Hills	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	15.4	**N/A**	**N/A**	**N/A**	15.4
Fairfax Road	**N/A**	**N/A**	**N/A**	11.2	7.4	6.9	6.8	8.5	1.8	7.1
25 Second St	112.4	110.7	104.6	123.2	54.7	61.8	55.6	51.0	6.5	75.6
Sixth St	29.2	22.7	27.9	39.9	31.4	28.2	34.3	18.3	2.0	26.0
19A Eighth St	23.7	20.1	15.9	25.4	14.7	17.4	11.8	12.5	4.0	16.2
Argy Hawkes	43.7	33.1	30.9	38.2	32.5	25.7	29.4	23.7	5.2	29.2
Edgeworth	9.3	5.9	6.0	16.2	6.3	8.0	4.3	5.5	2.3	7.1
Salt Water	30.0	26.8	34.5	32.8	18.8	10.2	17.5	19.1	3.4	21.5
Mines Rescue	40.0	38.5	33.3	27.3	22.9	20.6	14.2	16.3	3.4	24.0
Munibung_S	12.3	12.4	17.7	17.9	19.7	9.8	8.0	7.6	3.6	12.1
Montgomery St	11.7	12.4	4.8	7.9	21.0	5.9	11.9	3.0	3.2	9.1
Rankin Park	7.5	5.4	3.0	3.7	1.5	8.0	2.3	2.3	1.5	3.9
Verron Nth	**N/A**	15.7	4.0	24.6	17.8	20.9	11.5	13.7	4.5	14.1

Verron Sth	N/A	11.1	10.3	32.9	17.9	11.2	17.3	12.9	5.9	14.9
Wetland	N/A	N/A	134.9	317.6	186.5	112.7	132.2	151.0	34.0	152.7
ALL SITES	**37.7**	**31.9**	**37.7**	**54.9**	**33.8**	**27.7**	**29.4**	**26.9**	**6.5**	**31.7**

The average lead deposition level from all sites in 2004 was 6.5 $mg/m^2/month$.

5. ESTIMATED DUST EMISSIONS

Dust emissions will arise from a range of activities associated with the remediation works. Total dust emissions due to the project have been estimated by analysing the activities taking place at various stages of the project. Stages 1, 3 and 5 have been chosen for the dispersion modelling to cover a range of locations where dust generating activities will take place.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. There were significant revisions to the US EPA emission factors for dust generating activities 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 operational description for the project has been used to determine material quantities, equipment locations, stockpile locations and areas, activity operating hours and other details that are necessary to estimate dust emissions.

The most significant dust generating activities from the project have been identified and the dust emission estimates are presented below in **Table 7**. Details of the calculations of the dust emissions are provided in **Appendix B**.

Table 7 : Estimated dust emissions due to the Project

Activity	***TSP emission rate (kg/y)***		
	Stage 1	***Stage 3***	***Stage 5***
Excavator/FEL loading to trucks	138	138	138
Hauling to interim storage area	43,800	65,700	43,800
Emplacing to interim storage area	138	138	138
Load trucks at interim storage area	138	138	138
Hauling to cell	16,425	16,425	16,425
Emplacing to cell	138	138	138
Hauling in backfill	0	0	0
Emplacing backfill	0	0	0
Wind erosion from exposed areas	43,740	50,853	32,725
TOTAL	**104,516**	**133,529**	**93,500**

The annual TSP emissions have been calculated by assuming that 750 m^3 of material will be excavated and transported to the containment cell for every day of the year. This is a conservative assumption since activities will only take place for about 200 days per year. Annual average model predictions will therefore be overestimated.

It can be seen from **Table 7** that the most significant dust generating activities will be haulage of material over unsealed surfaces and wind erosion from exposed areas. All haul roads have been taken to be unsealed for the purposes of the dust emission estimates, however it should be noted that some haul roads will be sealed. This is a conservative approach. Watering of haul roads has been taken into consideration for the calculation of emissions.

6. APPROACH TO ASSESSMENT

In August 2005 the DEC published new guidelines for the assessment of air pollution sources using dispersion models (**DEC, 2005a)**. 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 in this assessment follows as closely as possible the approaches suggested by the guidelines.

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). AUSPLUME is the DEC's model of first choice but it has had limited use in dust modelling applications. Also, the way that the external time-varying emissions file in AUSPLUME is structured means that it is not able to handle the large number of sources that were chosen to represent the emissions from the operations. Comparisons between ISCST3 and AUSPLUME for dust predictions (see for example, **Holmes Air Sciences, 2003**) have shown that ISCST3 is generally more conservative than AUSPLUME, especially for short-term, say 24-hour predictions.

The modelling has been based on the use of three particle-size categories (0 to 2.5 µm - referred to as $PM_{2.5}$, 2.5 to 10 µm - referred to as CM (coarse matter) and 10 to 30 µm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work (see **Appendix B**).

The distribution of particles has been derived from measurements in the **SPCC (1986)** study. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.68% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

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

The ISCST3 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 dust generating industries where wind speed is an important factor in determining the rate at which dust is generated.

For the current study the operations were represented by a series of volume sources located according to the site layout. **Figure 7** shows the location of the modelled sources. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the ISCST3 model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at a site would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted in the vicinity of the project area. Local terrain has been taken to be flat for the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. Predictions were made at 124 discrete receptors around the site. The locations of these receptors were chosen to provide finer model resolution near the dust sources and coarser resolution further from the sources. This approach provides a balance between higher resolution where needed without resulting in excessive model run times.

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

The dust sources have been modelled for 8-hours per day except for wind erosion sources which have been assumed to emit for 24-hours per day.

Lead predictions have been derived from the TSP predictions and by assuming 0.6% (6,000 ppm by weight) of the off-site TSP concentrations will be lead. This represents double the average lead concentration (3,000 ppm) which has been measured in the soil across the site.

7. ASSESSMENT OF IMPACTS

7.1 Preamble

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

Dust concentrations and deposition rates due to the proposed activities have been presented as isopleth diagrams in **Figures 8** to **10** showing the following:

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

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

7.2 Assessment of Dust Impacts

The stages chosen for the modelling scenarios (that is, Stages 1, 3 and 5) would be considered to lead to the highest off-site dust impacts since activities would be closest to the nearest residential areas. Other stages of the remediation works would be expected to have equal to, or lower impacts than Stages 1, 3 and 5.

Figure 8 includes a plot showing the predicted maximum 24-hour average PM_{10} concentrations due to proposed remediation activities in Stage 1 – months 0 to 6. The dispersion modelling suggests that there is a potential for PM_{10} concentrations to exceed the 50 $\mu g/m^3$ goal at the nearest residential areas. At the nearest residential areas of Boolaroo to the south of the site, the maximum 24-hour average PM_{10} concentrations are of the order of 100 $\mu g/m^3$ or less. During Stage 1 some excavation activities will be only a few hundred metres from residential areas. Excavation activities will need to be managed by a real-time management system involving measures that would minimise high dust generating activities at times when adverse weather conditions occurred. In this context adverse weather means unfavourable winds for particular residential areas when conditions are dry.

Annual average PM_{10} concentrations for Stage 1 activities (see **Figure 8**) are predicted to be less than 5 $\mu g/m^3$ at the nearest residential areas. Compliance with the DEC's 30 $\mu g/m^3$ goal would be anticipated even when considering that background levels are of the order of 21 $\mu g/m^3$. Also, as discussed in **Section 5**, annual averages are likely to be overly conservative.

Annual average TSP concentrations for Stage 1 activities are predicted to be less than 20 $\mu g/m^3$ at the nearest residential areas. Compliance with the DEC's 90 $\mu g/m^3$

goal would be anticipated even when considering that background levels are of the order of 53 $\mu g/m^3$. Similarly, dust deposition levels due to Stage 1 activities are less than 1 g/m^2/month at residential areas. This is less than the 2 g/m^2/month "project only" goal. Addition of existing levels of 1 g/m^2/month would also result in a total dust deposition level less than 4 g/m^2/month at residential areas.

Model predictions due to Stage 3 and Stage 5 activities are shown in **Figures 9** and **10** respectively. Predictions due to these stages are of similar magnitude to the Stage 1 predictions, with Stage 3 representing slightly higher air quality impacts than the other stages. Again, in Stages 3 and 5 there is the potential for exceedances of the 24-hour average PM_{10} goal to be observed at the nearest residential areas. The implementation of a real-time management system will ensure that high dust generating events are kept to a minimum.

Annual average PM_{10} concentrations in Stages 3 and 5 are of the order of 10 $\mu g/m^3$ at nearest residential areas. Given that the annual average PM_{10} predictions are considered to be very conservative, since almost double the actual working days has been modelled (that is, 365/200), compliance with the 30 $\mu g/m^3$ goal would be anticipated.

Examination of the annual average TSP and dust deposition levels due to Stage 3 and Stage 5 activities suggests that impacts will be less than the associated air quality goals, including the addition of background levels.

7.3 Assessment of Lead Impacts

Model predictions of lead in the ambient air due to remediation activities are presented in **Figures 11** to **13**. In order to generate predictions of annual average lead concentrations it has been assumed that the lead concentration in the soil is constant at 6,000 ppm (by weight). Lead predictions have then been derived from the TSP predictions.

It can be seen from the figures that the highest annual average lead concentration off-site is less than 0.1 $\mu g/m^3$ in Stage 3. This is below the DEC assessment criteria of 0.5 $\mu g/m^3$.

Off-site lead deposition rates (refer **Figures 14** to **16**) are predicted to be between 5 and 10 mg/m^2/month. This level of deposition is similar to the lead deposition rates currently measured at the monitoring locations. The predicted levels are substantially below those experienced while the smelter was operating.

The health impacts associated with the remediation would therefore be well within acceptable levels. The strategies proposed to control dust exposure will also reduce lead exposure. This includes more intense watering of the haul roads than assumed in the modelling, and a reactive strategy during adverse weather conditions.

8. CONCLUSIONS

This report has assessed the air quality impacts associated with the proposed remediation of the PCCS site at Boolaroo, near Newcastle. Dispersion modelling has been used to assess the impact that dust emissions from the operations would have on the local air quality. The potential for lead impacts due to the disturbance of the soil has also been addressed.

The modelled scenarios were chosen to represent the stages that would have the greatest potential for air quality impacts at the nearest residential areas.

It is concluded that there is the potential for short-term exceedances of the PM_{10} goal (24-hour average of 50 $\mu g/m^3$) at nearest residential areas due to proposed activities. Exceedances of the goal may arise when dust generating activities are taking place in close proximity to residential areas and when meteorological conditions are unfavourable. Excavation activities will need to be managed by a real-time management system involving measures that would minimise high dust generating activities at times when adverse weather conditions occurred.

Conservative model predictions of annual averages suggest that cumulative TSP, PM_{10} and dust deposition would be below relevant air quality criteria at residential areas during remediation activities. The implementation of stringent dust control measures, such as regular watering of haul roads and rehabilitation of disturbed land as quickly as practicable, should ensure that air quality impacts are lower than those predicted in this study.

The dispersion modelling has also suggested that the disturbance of lead in the soil will not present any adverse health impacts at nearest residential areas, based on compliance with the air quality goal for lead. Off-site lead deposition due to the remediation activities are predicted to be similar to currently measured levels at monitoring locations around the site and much lower than those experienced while the smelter was operating. The control measures to reduce off-site dust impacts would also reduce lead exposure.

The assessment has considered the Director-General's Environmental Assessment requirements under Part 3A of the *Environmental Planning and Assessment Act 1979*. Impacts from a project-specific and cumulative perspective were investigated. The dispersion modelling results suggested that the health effects of the Project would be acceptable.

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

STATISTICS FOR FILE: C:\Jobs\PCCS\metdata\WS-95CL.ISC
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.001757	0.003012	0.000753	0.000251	0.000000	0.000000	0.000000	0.000000	0.005773
NE	0.002008	0.002761	0.001381	0.000628	0.000000	0.000000	0.000000	0.000000	0.006777
ENE	0.000377	0.001506	0.000753	0.000753	0.000000	0.000000	0.000000	0.000000	0.003389
E	0.000502	0.001004	0.000753	0.000628	0.000000	0.000000	0.000000	0.000000	0.002887
ESE	0.000251	0.002259	0.001130	0.000251	0.000000	0.000000	0.000000	0.000000	0.003891
SE	0.000000	0.003263	0.003514	0.000377	0.000000	0.000000	0.000000	0.000000	0.007154
SSE	0.000126	0.002008	0.001883	0.000251	0.000000	0.000000	0.000000	0.000000	0.004267
S	0.001506	0.002510	0.000251	0.000126	0.000000	0.000000	0.000000	0.000000	0.004393
SSW	0.002636	0.002887	0.001757	0.000502	0.000000	0.000000	0.000000	0.000000	0.007781
SW	0.001506	0.002887	0.001004	0.000000	0.000000	0.000000	0.000000	0.000000	0.005397
WSW	0.002259	0.001381	0.000628	0.000251	0.000000	0.000000	0.000000	0.000000	0.004518
W	0.001632	0.001883	0.000126	0.000126	0.000000	0.000000	0.000000	0.000000	0.003765
WNW	0.003012	0.001757	0.000502	0.000126	0.000000	0.000000	0.000000	0.000000	0.005397
NW	0.002636	0.005522	0.002761	0.001632	0.000000	0.000000	0.000000	0.000000	0.012550
NNW	0.002134	0.002887	0.000502	0.000377	0.000000	0.000000	0.000000	0.000000	0.005899
N	0.002761	0.002134	0.000753	0.000126	0.000000	0.000000	0.000000	0.000000	0.005773
CALM									0.005648
TOTAL	0.025100	0.039659	0.018449	0.006401	0.000000	0.000000	0.000000	0.000000	0.095256

MEAN WIND SPEED (m/s) = 2.26
NUMBER OF OBSERVATIONS = 759

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	0.001255	0.002134	0.002008	0.000251	0.000000	0.000000	0.000000	0.000000	0.005648
NE	0.001632	0.002259	0.001506	0.000251	0.000000	0.000000	0.000000	0.000000	0.005648
ENE	0.000628	0.001632	0.001130	0.000879	0.000000	0.000000	0.000000	0.000000	0.004267
E	0.000879	0.001130	0.002259	0.000502	0.000000	0.000000	0.000000	0.000000	0.004769
ESE	0.000628	0.002134	0.003138	0.000251	0.000000	0.000000	0.000000	0.000000	0.006150
SE	0.000126	0.001883	0.003765	0.000879	0.000000	0.000000	0.000000	0.000000	0.006652
SSE	0.000377	0.004142	0.008158	0.002761	0.000000	0.000000	0.000000	0.000000	0.015437
S	0.000628	0.002385	0.001757	0.001004	0.000000	0.000000	0.000000	0.000000	0.005773
SSW	0.000879	0.005020	0.005271	0.001004	0.000000	0.000000	0.000000	0.000000	0.012174
SW	0.000628	0.002887	0.004267	0.002761	0.000000	0.000000	0.000000	0.000000	0.010542
WSW	0.001004	0.000753	0.000753	0.000879	0.000000	0.000000	0.000000	0.000000	0.003389
W	0.000377	0.001130	0.000753	0.000377	0.000000	0.000000	0.000000	0.000000	0.002636
WNW	0.001506	0.004895	0.002761	0.001632	0.000000	0.000000	0.000000	0.000000	0.010793
NW	0.003138	0.008158	0.006526	0.005773	0.000000	0.000000	0.000000	0.000000	0.023594
NNW	0.001506	0.002259	0.002134	0.000377	0.000000	0.000000	0.000000	0.000000	0.006275
N	0.001632	0.002510	0.000879	0.000377	0.000000	0.000000	0.000000	0.000000	0.005397
CALM									0.003263
TOTAL	0.016817	0.045306	0.047063	0.019955	0.000000	0.000000	0.000000	0.000000	0.132405

MEAN WIND SPEED (m/s) = 3.01
NUMBER OF OBSERVATIONS = 1055

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	0.001130	0.002510	0.001883	0.000502	0.000000	0.000000	0.000000	0.000000	0.006024
NE	0.000000	0.000628	0.000126	0.000000	0.000000	0.000000	0.000000	0.000000	0.000753
ENE	0.000000	0.001255	0.000628	0.000753	0.000000	0.000000	0.000000	0.000000	0.002636
E	0.000251	0.001130	0.005899	0.005271	0.000000	0.000000	0.000000	0.000000	0.012550
ESE	0.000251	0.001506	0.002761	0.001757	0.000000	0.000000	0.000000	0.000000	0.006275
SE	0.000000	0.000251	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000251
SSE	0.000126	0.000879	0.002385	0.000879	0.000000	0.000000	0.000000	0.000000	0.004267
S	0.001255	0.006903	0.011170	0.006777	0.000000	0.000000	0.000000	0.000000	0.026104
SSW	0.000628	0.002887	0.008409	0.004016	0.000000	0.000000	0.000000	0.000000	0.015939
SW	0.000000	0.000251	0.000000	0.000126	0.000000	0.000000	0.000000	0.000000	0.000377
WSW	0.000126	0.000000	0.000502	0.000126	0.000000	0.000000	0.000000	0.000000	0.000753
W	0.000126	0.003514	0.001381	0.002008	0.000000	0.000000	0.000000	0.000000	0.007028
WNW	0.000628	0.003263	0.001757	0.000753	0.000000	0.000000	0.000000	0.000000	0.006401
NW	0.000251	0.000502	0.000126	0.000377	0.000000	0.000000	0.000000	0.000000	0.001255
NNW	0.002259	0.002259	0.002636	0.000628	0.000000	0.000000	0.000000	0.000000	0.007781
N	0.002134	0.004267	0.002510	0.001255	0.000000	0.000000	0.000000	0.000000	0.010166
CALM									0.003138
TOTAL	0.009162	0.032003	0.042169	0.025226	0.000000	0.000000	0.000000	0.000000	0.111697

MEAN WIND SPEED (m/s) = 3.35
NUMBER OF OBSERVATIONS = 890

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	0.003640	0.002510	0.002008	0.000628	0.000879	0.000000	0.000000	0.000000	0.009664
NE	0.000000	0.000502	0.000251	0.000502	0.000377	0.000000	0.000000	0.000000	0.001632
ENE	0.001004	0.003514	0.005899	0.002385	0.001506	0.000000	0.000000	0.000000	0.014307
E	0.000126	0.003263	0.004393	0.002385	0.001632	0.000000	0.000000	0.000000	0.011797
ESE	0.000753	0.003891	0.002259	0.000628	0.000126	0.000000	0.000000	0.000000	0.007656
SE	0.000000	0.000251	0.000000	0.000879	0.000251	0.000000	0.000000	0.000000	0.001381
SSE	0.000000	0.002385	0.002636	0.001757	0.000251	0.000000	0.000000	0.000000	0.007028
S	0.000126	0.006903	0.009036	0.004895	0.005773	0.001130	0.000000	0.000000	0.027861
SSW	0.000000	0.007405	0.016817	0.006526	0.004518	0.001506	0.000000	0.000000	0.036772
SW	0.000000	0.000126	0.003138	0.002008	0.003389	0.000628	0.000628	0.000502	0.010417
WSW	0.000126	0.001757	0.001632	0.001381	0.001381	0.000251	0.000000	0.000000	0.006526
W	0.000377	0.001004	0.002008	0.000628	0.001757	0.000251	0.000000	0.000000	0.006024
WNW	0.000000	0.003640	0.002636	0.001632	0.002385	0.001004	0.000000	0.000000	0.011295
NW	0.000000	0.000377	0.000126	0.001004	0.005397	0.000879	0.000126	0.000000	0.007907
NNW	0.002385	0.005146	0.003012	0.001130	0.000251	0.000000	0.000000	0.000000	0.011923
N	0.004267	0.009915	0.004518	0.001381	0.001381	0.000000	0.000000	0.000000	0.021461
CALM									0.016817
TOTAL	0.012801	0.052585	0.060366	0.029744	0.031250	0.005648	0.000753	0.000502	0.210467

MEAN WIND SPEED (m/s) = 3.76
NUMBER OF OBSERVATIONS = 1677

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	0.003138	0.006526	0.001004	0.000251	0.000000	0.000000	0.000000	0.000000	0.010919
NE	0.001255	0.005773	0.006150	0.000502	0.000000	0.000000	0.000000	0.000000	0.013680
ENE	0.005773	0.006903	0.002636	0.000502	0.000000	0.000000	0.000000	0.000000	0.015813
E	0.002887	0.004142	0.000628	0.000000	0.000000	0.000000	0.000000	0.000000	0.007656
ESE	0.002008	0.004142	0.000377	0.000000	0.000000	0.000000	0.000000	0.000000	0.006526
SE	0.000000	0.002259	0.004769	0.000126	0.000000	0.000000	0.000000	0.000000	0.007154
SSE	0.000502	0.005020	0.007781	0.001757	0.000000	0.000000	0.000000	0.000000	0.015060
S	0.000879	0.002636	0.002134	0.000126	0.000000	0.000000	0.000000	0.000000	0.005773
SSW	0.002134	0.008032	0.004016	0.000753	0.000000	0.000000	0.000000	0.000000	0.014935
SW	0.000753	0.005773	0.010417	0.000753	0.000000	0.000000	0.000000	0.000000	0.017696
WSW	0.002636	0.001255	0.000377	0.000000	0.000000	0.000000	0.000000	0.000000	0.004267
W	0.004518	0.004393	0.000879	0.000000	0.000000	0.000000	0.000000	0.000000	0.009789
WNW	0.003765	0.004142	0.001004	0.000126	0.000000	0.000000	0.000000	0.000000	0.009036
NW	0.001255	0.002134	0.002385	0.000628	0.000000	0.000000	0.000000	0.000000	0.006401
NNW	0.003891	0.003138	0.001130	0.000377	0.000000	0.000000	0.000000	0.000000	0.008534
N	0.006275	0.002636	0.002134	0.000377	0.000000	0.000000	0.000000	0.000000	0.011421
CALM									0.026230
TOTAL	0.041667	0.068901	0.047816	0.006275	0.000000	0.000000	0.000000	0.000000	0.190889

MEAN WIND SPEED (m/s) = 2.17
NUMBER OF OBSERVATIONS = 1521

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	0.014809	0.004267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.019076
NE	0.016943	0.015186	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.032129
ENE	0.006903	0.003514	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010417
E	0.002636	0.001632	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004267
ESE	0.002636	0.001004	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003640
SE	0.002636	0.004267	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006903
SSE	0.003389	0.005146	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008534
S	0.004895	0.003012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007907
SSW	0.007405	0.006401	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013805
SW	0.007279	0.007028	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.014307
WSW	0.007279	0.001883	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.009162
W	0.006401	0.000502	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006903
WNW	0.008283	0.003012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011295
NW	0.014558	0.006526	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.021084
NNW	0.014935	0.002887	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.017821
N	0.012048	0.001255	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013303
CALM									0.058735
TOTAL	0.133032	0.067520	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.259287

MEAN WIND SPEED (m/s) = 1.10
NUMBER OF OBSERVATIONS = 2066

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	0.025728	0.020959	0.007656	0.001883	0.000879	0.000000	0.000000	0.000000	0.057103
NE	0.021837	0.027108	0.009413	0.001883	0.000377	0.000000	0.000000	0.000000	0.060617
ENE	0.014684	0.018323	0.011044	0.005271	0.001506	0.000000	0.000000	0.000000	0.050828
E	0.007279	0.012299	0.013931	0.008785	0.001632	0.000000	0.000000	0.000000	0.043926
ESE	0.006526	0.014935	0.009664	0.002887	0.000126	0.000000	0.000000	0.000000	0.034137
SE	0.002761	0.012174	0.012048	0.002259	0.000251	0.000000	0.000000	0.000000	0.029493
SSE	0.004518	0.019578	0.022841	0.007405	0.000251	0.000000	0.000000	0.000000	0.054593
S	0.009287	0.024347	0.024347	0.012927	0.005773	0.001130	0.000000	0.000000	0.077811
SSW	0.013680	0.032631	0.036270	0.012801	0.004518	0.001506	0.000000	0.000000	0.101406
SW	0.010166	0.018951	0.018825	0.005648	0.003389	0.000628	0.000628	0.000502	0.058735
WSW	0.013429	0.007028	0.003891	0.002636	0.001381	0.000251	0.000000	0.000000	0.028614
W	0.013429	0.012425	0.005146	0.003138	0.001757	0.000251	0.000000	0.000000	0.036145
WNW	0.017194	0.020708	0.008660	0.004267	0.002385	0.001004	0.000000	0.000000	0.054217
NW	0.021837	0.023218	0.011923	0.009413	0.005397	0.000879	0.000126	0.000000	0.072791
NNW	0.027108	0.018574	0.009413	0.002887	0.000251	0.000000	0.000000	0.000000	0.058233
N	0.029116	0.022716	0.010793	0.003514	0.001381	0.000000	0.000000	0.000000	0.067520
CALM									0.113830
TOTAL	0.238579	0.305974	0.215863	0.087600	0.031250	0.005648	0.000753	0.000502	1.000000

MEAN WIND SPEED (m/s) = 2.48
NUMBER OF OBSERVATIONS = 7968

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

- A : 9.5%
- B : 13.2%
- C : 11.2%
- D : 21.0%
- E : 19.1%
- F : 25.9%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0002	0001	0004	0070	0095	0160
02	0002	0005	0000	0078	0100	0147
03	0006	0002	0002	0076	0095	0151
04	0005	0006	0004	0069	0093	0155
05	0002	0010	0006	0074	0085	0155
06	0024	0039	0024	0052	0075	0118
07	0056	0071	0053	0035	0046	0071
08	0097	0106	0075	0042	0006	0006
09	0067	0120	0089	0042	0007	0007
10	0059	0113	0100	0044	0005	0011
11	0076	0103	0094	0041	0010	0008
12	0089	0093	0082	0049	0008	0011
13	0087	0093	0076	0055	0009	0012
14	0074	0095	0082	0052	0014	0015
15	0053	0093	0086	0063	0014	0023
16	0038	0075	0071	0068	0040	0040
17	0022	0030	0042	0112	0074	0052
18	0000	0000	0000	0128	0121	0083
19	0000	0000	0000	0112	0117	0103
20	0000	0000	0000	0096	0105	0131
21	0000	0000	0000	0093	0103	0136
22	0000	0000	0000	0083	0104	0145
23	0000	0000	0000	0076	0103	0153
24	0000	0000	0000	0067	0092	0173

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0145	0222	0174	0273	1422	2015
<=1000 m	0281	0420	0337	0233	0028	0027
<=1500 m	0333	0413	0379	0559	0071	0024
<=2000 m	0000	0000	0000	0272	0000	0000
<=3000 m	0000	0000	0000	0256	0000	0000
>3000 m	0000	0000	0000	0084	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	0102	0106	0053	0008	0024	0033	0006
02	0103	0084	0074	0009	0026	0034	0002
03	0104	0094	0063	0010	0027	0033	0001
04	0108	0091	0065	0009	0030	0028	0001
05	0156	0070	0041	0007	0034	0023	0001
06	0090	0099	0112	0005	0019	0006	0001
07	0087	0053	0089	0086	0017	0000	0000
08	0005	0052	0100	0154	0019	0002	0000
09	0005	0003	0072	0158	0093	0001	0000
10	0008	0006	0004	0175	0136	0003	0000
11	0007	0008	0004	0097	0214	0002	0000
12	0008	0005	0006	0069	0243	0001	0000
13	0008	0006	0008	0001	0309	0000	0000
14	0011	0008	0008	0001	0300	0004	0000
15	0011	0014	0009	0001	0291	0006	0000
16	0014	0017	0014	0001	0275	0010	0001
17	0021	0041	0027	0003	0221	0018	0001
18	0039	0064	0057	0004	0130	0035	0003
19	0058	0087	0081	0002	0028	0068	0008
20	0076	0087	0081	0002	0029	0053	0004
21	0080	0102	0068	0005	0026	0045	0006
22	0100	0083	0076	0004	0031	0032	0006
23	0106	0093	0069	0005	0024	0029	0006
24	0110	0104	0060	0006	0023	0021	0008

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : PCCS REMEDIATION

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

Loading, unloading and transferring material

The dust emission from this activity will depend on wind speed according to the **US EPA (1985)** emission factor equation. This means that the emissions will vary with wind speed. The actual emission is given by Equation 1.

Equation 1

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

where,

E_{TSP} = *TSP emissions*

$k = 0.74$

U = *wind speed(m/s)*

M = *moisture content (%)*

[where $0.25 \leq M \leq 4.8$]

Hauling material on unsealed surfaces

It has been assumed that all haul roads will be unsealed. Watering of haul roads will be undertaken for dust mitigation. 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).

Wind erosion from exposed areas and stockpiles

The emission factor for wind erosion is given in Equation 2 below.

Equation 2

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

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

Emissions inventory: PCCS remediation works

ACTIVITY	TSP emission / year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
STAGE 1											
Excavator/FEL loading to trucks	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to interim storage area	43800	492750	t/y	0.08889	kg/t	18	t/truck load	1.6	km/return trip	1.0	kg/VKT
Emplacing to interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Load trucks at interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to cell	16425	492750	t/y	0.03333	kg/t	18	t/truck load	0.6	km/return trip	1.0	kg/VKT
Emplacing to cell	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling in backfill	0	0	t/y	0.11111	kg/t	18	t/truck load	2	km/return trip	1.0	kg/VKT
Emplacing backfill	0	0	t/y	0.00195	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
Wind erosion from exposed areas	43740	46	ha	948.9	kg/ha/y	133	Average number of raindays	5	silt content in %	6.237	% of winds above 5.4 m/s
STAGE 3											
Excavator/FEL loading to trucks	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to interim storage area	65700	492750	t/y	0.13333	kg/t	18	t/truck load	2.4	km/return trip	1.0	kg/VKT
Emplacing to interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Load trucks at interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to cell	16425	492750	t/y	0.03333	kg/t	18	t/truck load	0.6	km/return trip	1.0	kg/VKT
Emplacing to cell	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling in backfill	0	0	t/y	0.11111	kg/t	18	t/truck load	2	km/return trip	1.0	kg/VKT
Emplacing backfill	0	0	t/y	0.00195	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		

ACTIVITY	TSP emission / year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
Wind erosion from exposed areas	50853	54	ha	948.9	kg/ha/y	133	Average number of raindays	5	silt content in %	6.237	% of winds above 5.4 m/s
STAGE 5											
Excavator/FEL loading to trucks	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to interim storage area	43800	492750	t/y	0.08889	kg/t	18	t/truck load	1.6	km/return trip	1.0	kg/VKT
Emplacing to interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Load trucks at interim storage area	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling to cell	16425	492750	t/y	0.03333	kg/t	18	t/truck load	0.6	km/return trip	1.0	kg/VKT
Emplacing to cell	138	492750	t/y	0.00028	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	8	moisture content in %		
Hauling in backfill	0	0	t/y	0.11111	kg/t	18	t/truck load	2	km/return trip	1.0	kg/VKT
Emplacing backfill	0	0	t/y	0.00195	kg/t	1.643	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
Wind erosion from exposed areas	32725	34	ha	948.9	kg/ha/y	133	Average number of raindays	5	silt content in %	6.237	% of winds above 5.4 m/s

A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below. The location of the sources can be obtained from **Figure 7**. Details for Stage 1 are provided below. Information for the other modelled stages can be provided on request.

```
 ------------------------------     28-Apr-2006 08:30
  DUST EMISSION CALCULATIONS V2
 ------------------------------

 Output emissions file  : C:\Jobs\PCCS\iscst3\s1\emiss.dat
 Meteorological file    : C:\Jobs\PCCS\metdata\WS-95CL.ISC
 Number of dust sources : 27
 Number of activities   : 9
 Wind sensitive factor  : 1.270 (1.643 adjusted for activity hours)
 Wind erosion factor    : 40.813

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Excavator/FEL loading to trucks
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 138 kg/y
 FROM SOURCES  : 15
1 2 3 4 5 16 17 18 19 20 21 22 23 24 25
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling to interim storage area
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 43800 kg/y
 FROM SOURCES  : 11
3 6 7 8 9 10 12 23 25 26 27
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Emplacing to interim storage area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 138 kg/y
 FROM SOURCES  : 1
11
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Load trucks at interim storage area
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 138 kg/y
 FROM SOURCES  : 1
11
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling to cell
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 16425 kg/y
 FROM SOURCES  : 6
10 11 12 13 14 15
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Emplacing to cell
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 138 kg/y
 FROM SOURCES  : 3
13 14 15
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Hauling in backfill
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 15
1 2 3 4 5 16 17 18 19 20 21 22 23 24 25
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Emplacing backfill
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 15
1 2 3 4 5 16 17 18 19 20 21 22 23 24 25
 HOURS OF DAY  :
0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0

 ACTIVITY NAME : Wind erosion from exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 43740 kg/y
 FROM SOURCES  : 21
1 2 3 4 5 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
 HOURS OF DAY  :
```

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

APPENDIX C
ISCST3 MODEL INPUT FILE

ISCST3 MODEL INPUT FILE:

```
**  ISCST3 model input runstream : Dust
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL Error.MSG
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  371030 6353535 0
   LOCATION  POINT2  VOLUME  371167 6353514 0
   LOCATION  POINT3  VOLUME  371226 6353599 0
   LOCATION  POINT4  VOLUME  371146 6353710 0
   LOCATION  POINT5  VOLUME  371098 6353594 0
   LOCATION  POINT6  VOLUME  371353 6353630 0
   LOCATION  POINT7  VOLUME  371453 6353720 0
   LOCATION  POINT8  VOLUME  371580 6353815 0
   LOCATION  POINT9  VOLUME  371723 6353921 0
   LOCATION  POINT10  VOLUME  371835 6354027 0
   LOCATION  POINT11  VOLUME  371962 6354159 0
   LOCATION  POINT12  VOLUME  372068 6354269 0
   LOCATION  POINT13  VOLUME  372121 6354153 0
   LOCATION  POINT14  VOLUME  372025 6354053 0
   LOCATION  POINT15  VOLUME  371946 6353937 0
   LOCATION  POINT16  VOLUME  372269 6354787 0
   LOCATION  POINT17  VOLUME  372428 6354813 0
   LOCATION  POINT18  VOLUME  372285 6354660 0
   LOCATION  POINT19  VOLUME  372433 6354666 0
   LOCATION  POINT20  VOLUME  372529 6354528 0
   LOCATION  POINT21  VOLUME  372311 6354534 0
   LOCATION  POINT22  VOLUME  372497 6354417 0
   LOCATION  POINT23  VOLUME  372364 6354423 0
   LOCATION  POINT24  VOLUME  372454 6354248 0
   LOCATION  POINT25  VOLUME  372412 6354528 0
   LOCATION  POINT26  VOLUME  372232 6354449 0
   LOCATION  POINT27  VOLUME  372105 6354365 0
   LOCATION  POINT28  VOLUME  371030 6353535 0
   LOCATION  POINT29  VOLUME  371167 6353514 0
   LOCATION  POINT30  VOLUME  371226 6353599 0
   LOCATION  POINT31  VOLUME  371146 6353710 0
   LOCATION  POINT32  VOLUME  371098 6353594 0
   LOCATION  POINT33  VOLUME  371353 6353630 0
   LOCATION  POINT34  VOLUME  371453 6353720 0
   LOCATION  POINT35  VOLUME  371580 6353815 0
   LOCATION  POINT36  VOLUME  371723 6353921 0
   LOCATION  POINT37  VOLUME  371835 6354027 0
   LOCATION  POINT38  VOLUME  371962 6354159 0
   LOCATION  POINT39  VOLUME  372068 6354269 0
   LOCATION  POINT40  VOLUME  372121 6354153 0
   LOCATION  POINT41  VOLUME  372025 6354053 0
   LOCATION  POINT42  VOLUME  371946 6353937 0
   LOCATION  POINT43  VOLUME  372269 6354787 0
   LOCATION  POINT44  VOLUME  372428 6354813 0
   LOCATION  POINT45  VOLUME  372285 6354660 0
   LOCATION  POINT46  VOLUME  372433 6354666 0
   LOCATION  POINT47  VOLUME  372529 6354528 0
   LOCATION  POINT48  VOLUME  372311 6354534 0
   LOCATION  POINT49  VOLUME  372497 6354417 0
   LOCATION  POINT50  VOLUME  372364 6354423 0
   LOCATION  POINT51  VOLUME  372454 6354248 0
   LOCATION  POINT52  VOLUME  372412 6354528 0
   LOCATION  POINT53  VOLUME  372232 6354449 0
   LOCATION  POINT54  VOLUME  372105 6354365 0
   LOCATION  POINT55  VOLUME  371030 6353535 0
   LOCATION  POINT56  VOLUME  371167 6353514 0
   LOCATION  POINT57  VOLUME  371226 6353599 0
   LOCATION  POINT58  VOLUME  371146 6353710 0
   LOCATION  POINT59  VOLUME  371098 6353594 0
   LOCATION  POINT60  VOLUME  371353 6353630 0
   LOCATION  POINT61  VOLUME  371453 6353720 0
   LOCATION  POINT62  VOLUME  371580 6353815 0
   LOCATION  POINT63  VOLUME  371723 6353921 0
   LOCATION  POINT64  VOLUME  371835 6354027 0
   LOCATION  POINT65  VOLUME  371962 6354159 0
   LOCATION  POINT66  VOLUME  372068 6354269 0
   LOCATION  POINT67  VOLUME  372121 6354153 0
   LOCATION  POINT68  VOLUME  372025 6354053 0
   LOCATION  POINT69  VOLUME  371946 6353937 0
   LOCATION  POINT70  VOLUME  372269 6354787 0
   LOCATION  POINT71  VOLUME  372428 6354813 0
   LOCATION  POINT72  VOLUME  372285 6354660 0
   LOCATION  POINT73  VOLUME  372433 6354666 0
   LOCATION  POINT74  VOLUME  372529 6354528 0
   LOCATION  POINT75  VOLUME  372311 6354534 0
   LOCATION  POINT76  VOLUME  372497 6354417 0
   LOCATION  POINT77  VOLUME  372364 6354423 0
```

```
   LOCATION  POINT78  VOLUME  372454 6354248 0
   LOCATION  POINT79  VOLUME  372412 6354528 0
   LOCATION  POINT80  VOLUME  372232 6354449 0
   LOCATION  POINT81  VOLUME  372105 6354365 0
** Point Source       QS   RH  IL   IV
** Parameters        ----  --- ---  ---
   HOUREMIS  C:\Jobs\PCCS\iscst3\s1\emiss.dat POINT1-POINT81
   SRCPARAM  POINT1   1.0 2.0  20.  2.
   SRCPARAM  POINT2   1.0 2.0  20.  2.
   SRCPARAM  POINT3   1.0 2.0  20.  2.
   SRCPARAM  POINT4   1.0 2.0  20.  2.
   SRCPARAM  POINT5   1.0 2.0  20.  2.
   SRCPARAM  POINT6   1.0 2.0  20.  2.
   SRCPARAM  POINT7   1.0 2.0  20.  2.
   SRCPARAM  POINT8   1.0 2.0  20.  2.
   SRCPARAM  POINT9   1.0 2.0  20.  2.
   SRCPARAM  POINT10   1.0 2.0  20.  2.
   SRCPARAM  POINT11   1.0 2.0  20.  2.
   SRCPARAM  POINT12   1.0 2.0  20.  2.
   SRCPARAM  POINT13   1.0 2.0  20.  2.
   SRCPARAM  POINT14   1.0 2.0  20.  2.
   SRCPARAM  POINT15   1.0 2.0  20.  2.
   SRCPARAM  POINT16   1.0 2.0  20.  2.
   SRCPARAM  POINT17   1.0 2.0  20.  2.
   SRCPARAM  POINT18   1.0 2.0  20.  2.
   SRCPARAM  POINT19   1.0 2.0  20.  2.
   SRCPARAM  POINT20   1.0 2.0  20.  2.
   SRCPARAM  POINT21   1.0 2.0  20.  2.
   SRCPARAM  POINT22   1.0 2.0  20.  2.
   SRCPARAM  POINT23   1.0 2.0  20.  2.
   SRCPARAM  POINT24   1.0 2.0  20.  2.
   SRCPARAM  POINT25   1.0 2.0  20.  2.
   SRCPARAM  POINT26   1.0 2.0  20.  2.
   SRCPARAM  POINT27   1.0 2.0  20.  2.
   SRCPARAM  POINT28   1.0 2.0  20.  2.
   SRCPARAM  POINT29   1.0 2.0  20.  2.
   SRCPARAM  POINT30   1.0 2.0  20.  2.
   SRCPARAM  POINT31   1.0 2.0  20.  2.
   SRCPARAM  POINT32   1.0 2.0  20.  2.
   SRCPARAM  POINT33   1.0 2.0  20.  2.
   SRCPARAM  POINT34   1.0 2.0  20.  2.
   SRCPARAM  POINT35   1.0 2.0  20.  2.
   SRCPARAM  POINT36   1.0 2.0  20.  2.
   SRCPARAM  POINT37   1.0 2.0  20.  2.
   SRCPARAM  POINT38   1.0 2.0  20.  2.
   SRCPARAM  POINT39   1.0 2.0  20.  2.
   SRCPARAM  POINT40   1.0 2.0  20.  2.
   SRCPARAM  POINT41   1.0 2.0  20.  2.
   SRCPARAM  POINT42   1.0 2.0  20.  2.
   SRCPARAM  POINT43   1.0 2.0  20.  2.
   SRCPARAM  POINT44   1.0 2.0  20.  2.
   SRCPARAM  POINT45   1.0 2.0  20.  2.
   SRCPARAM  POINT46   1.0 2.0  20.  2.
   SRCPARAM  POINT47   1.0 2.0  20.  2.
   SRCPARAM  POINT48   1.0 2.0  20.  2.
   SRCPARAM  POINT49   1.0 2.0  20.  2.
   SRCPARAM  POINT50   1.0 2.0  20.  2.
   SRCPARAM  POINT51   1.0 2.0  20.  2.
   SRCPARAM  POINT52   1.0 2.0  20.  2.
   SRCPARAM  POINT53   1.0 2.0  20.  2.
   SRCPARAM  POINT54   1.0 2.0  20.  2.
   SRCPARAM  POINT55   1.0 2.0  20.  2.
   SRCPARAM  POINT56   1.0 2.0  20.  2.
   SRCPARAM  POINT57   1.0 2.0  20.  2.
   SRCPARAM  POINT58   1.0 2.0  20.  2.
   SRCPARAM  POINT59   1.0 2.0  20.  2.
   SRCPARAM  POINT60   1.0 2.0  20.  2.
   SRCPARAM  POINT61   1.0 2.0  20.  2.
   SRCPARAM  POINT62   1.0 2.0  20.  2.
   SRCPARAM  POINT63   1.0 2.0  20.  2.
   SRCPARAM  POINT64   1.0 2.0  20.  2.
   SRCPARAM  POINT65   1.0 2.0  20.  2.
   SRCPARAM  POINT66   1.0 2.0  20.  2.
   SRCPARAM  POINT67   1.0 2.0  20.  2.
   SRCPARAM  POINT68   1.0 2.0  20.  2.
   SRCPARAM  POINT69   1.0 2.0  20.  2.
   SRCPARAM  POINT70   1.0 2.0  20.  2.
   SRCPARAM  POINT71   1.0 2.0  20.  2.
   SRCPARAM  POINT72   1.0 2.0  20.  2.
   SRCPARAM  POINT73   1.0 2.0  20.  2.
   SRCPARAM  POINT74   1.0 2.0  20.  2.
   SRCPARAM  POINT75   1.0 2.0  20.  2.
   SRCPARAM  POINT76   1.0 2.0  20.  2.
   SRCPARAM  POINT77   1.0 2.0  20.  2.
   SRCPARAM  POINT78   1.0 2.0  20.  2.
   SRCPARAM  POINT79   1.0 2.0  20.  2.
   SRCPARAM  POINT80   1.0 2.0  20.  2.
   SRCPARAM  POINT81   1.0 2.0  20.  2.
   PARTDIAM  POINT1-POINT27  1.0
   PARTDIAM  POINT28-POINT54  5.0
   PARTDIAM  POINT55-POINT81  17.3
   MASSFRAX  POINT1-POINT81  1.0
```

```
   PARTDENS  POINT1-POINT81  2.5
   SRCGROUP  FP  POINT1-POINT27
   SRCGROUP  CM  POINT28-POINT54
   SRCGROUP  REST  POINT55-POINT81
SO FINISHED

RE STARTING
RE DISCCART 371391 6354051 0
RE DISCCART 371189 6353864 0
RE DISCCART 371001 6353670 0
RE DISCCART 370922 6353461 0
RE DISCCART 371088 6353454 0
RE DISCCART 371290 6353433 0
RE DISCCART 371506 6353390 0
RE DISCCART 371521 6353311 0
RE DISCCART 371701 6353275 0
RE DISCCART 371694 6353167 0
RE DISCCART 371687 6353030 0
RE DISCCART 371816 6353073 0
RE DISCCART 371953 6353009 0
RE DISCCART 372119 6353009 0
RE DISCCART 372249 6353109 0
RE DISCCART 372307 6353181 0
RE DISCCART 372199 6353296 0
RE DISCCART 372300 6353418 0
RE DISCCART 372336 6353576 0
RE DISCCART 372357 6353763 0
RE DISCCART 372429 6353943 0
RE DISCCART 372516 6354094 0
RE DISCCART 372552 6354310 0
RE DISCCART 372581 6354496 0
RE DISCCART 372581 6354647 0
RE DISCCART 372509 6354748 0
RE DISCCART 372523 6354906 0
RE DISCCART 372328 6354856 0
RE DISCCART 372163 6354806 0
RE DISCCART 372011 6354691 0
RE DISCCART 371881 6354554 0
RE DISCCART 371708 6354425 0
RE DISCCART 371542 6354295 0
RE DISCCART 371391 6354252 0
RE DISCCART 372415 6355021 0
RE DISCCART 372206 6354964 0
RE DISCCART 372004 6354892 0
RE DISCCART 371816 6354741 0
RE DISCCART 371650 6354583 0
RE DISCCART 371449 6354453 0
RE DISCCART 371182 6354116 0
RE DISCCART 370871 6353900 0
RE DISCCART 370807 6353584 0
RE DISCCART 370742 6353339 0
RE DISCCART 371016 6353303 0
RE DISCCART 371232 6353289 0
RE DISCCART 371470 6353160 0
RE DISCCART 371564 6352951 0
RE DISCCART 371824 6352851 0
RE DISCCART 372098 6352771 0
RE DISCCART 372365 6352901 0
RE DISCCART 372502 6353282 0
RE DISCCART 372559 6353612 0
RE DISCCART 372653 6353943 0
RE DISCCART 372783 6354281 0
RE DISCCART 372768 6354583 0
RE DISCCART 372740 6354870 0
RE DISCCART 372516 6355208 0
RE DISCCART 372148 6355187 0
RE DISCCART 371795 6355079 0
RE DISCCART 371456 6354841 0
RE DISCCART 371167 6354561 0
RE DISCCART 370828 6354310 0
RE DISCCART 370511 6353785 0
RE DISCCART 370374 6353332 0
RE DISCCART 370641 6353016 0
RE DISCCART 371102 6352966 0
RE DISCCART 371326 6352764 0
RE DISCCART 371852 6352455 0
RE DISCCART 372639 6352477 0
RE DISCCART 373093 6353116 0
RE DISCCART 373064 6353519 0
RE DISCCART 373122 6353886 0
RE DISCCART 373194 6354425 0
RE DISCCART 373129 6354870 0
RE DISCCART 372934 6355352 0
RE DISCCART 372321 6355560 0
RE DISCCART 371925 6355431 0
RE DISCCART 371420 6355294 0
RE DISCCART 370821 6354949 0
RE DISCCART 370309 6354216 0
RE DISCCART 370244 6352728 0
RE DISCCART 370763 6352398 0
RE DISCCART 371412 6352196 0
RE DISCCART 371917 6352125 0
```

```
RE DISCCART 372942 6352160 0
RE DISCCART 373483 6352110 0
RE DISCCART 373786 6352419 0
RE DISCCART 373692 6352915 0
RE DISCCART 373584 6353275 0
RE DISCCART 373692 6353713 0
RE DISCCART 373706 6354475 0
RE DISCCART 373555 6355337 0
RE DISCCART 373021 6355884 0
RE DISCCART 373721 6355805 0
RE DISCCART 371773 6355869 0
RE DISCCART 370799 6355826 0
RE DISCCART 370345 6355575 0
RE DISCCART 370273 6354741 0
RE DISCCART 370107 6352081 0
RE DISCCART 371838 6353275 0
RE DISCCART 372105 6353260 0
RE DISCCART 371989 6353160 0
RE DISCCART 371961 6353490 0
RE DISCCART 372148 6353677 0
RE DISCCART 372278 6354022 0
RE DISCCART 372401 6354360 0
RE DISCCART 372357 6354619 0
RE DISCCART 372127 6354640 0
RE DISCCART 372242 6354317 0
RE DISCCART 371997 6354461 0
RE DISCCART 372090 6354044 0
RE DISCCART 371881 6354310 0
RE DISCCART 371737 6354180 0
RE DISCCART 371917 6354087 0
RE DISCCART 371499 6354151 0
RE DISCCART 371614 6353965 0
RE DISCCART 371831 6353763 0
RE DISCCART 371708 6353562 0
RE DISCCART 371564 6353727 0
RE DISCCART 371376 6353914 0
RE DISCCART 371247 6353742 0
RE DISCCART 371506 6353555 0
RE DISCCART 371146 6353598 0
RE FINISHED

ME STARTING
   INPUTFIL  C:\Jobs\PCCS\metdata\WS-95CL.ISC
   ANEMHGHT  10  METERS
   SURFDATA  99999 1995
   UAIRDATA  99999 1995
ME FINISHED

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

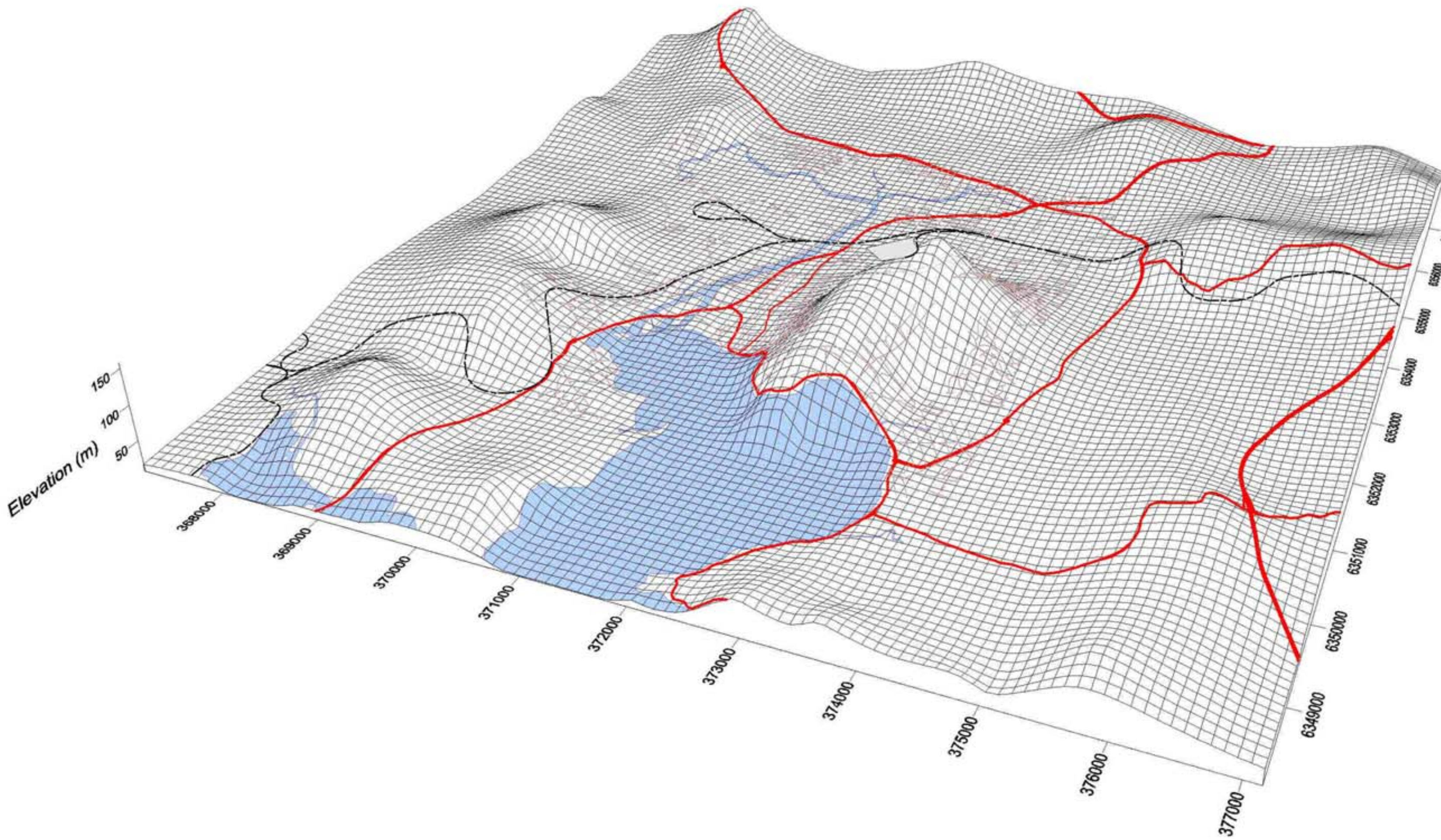
FIGURES

MGA coordinates (GDA94) Zone 56

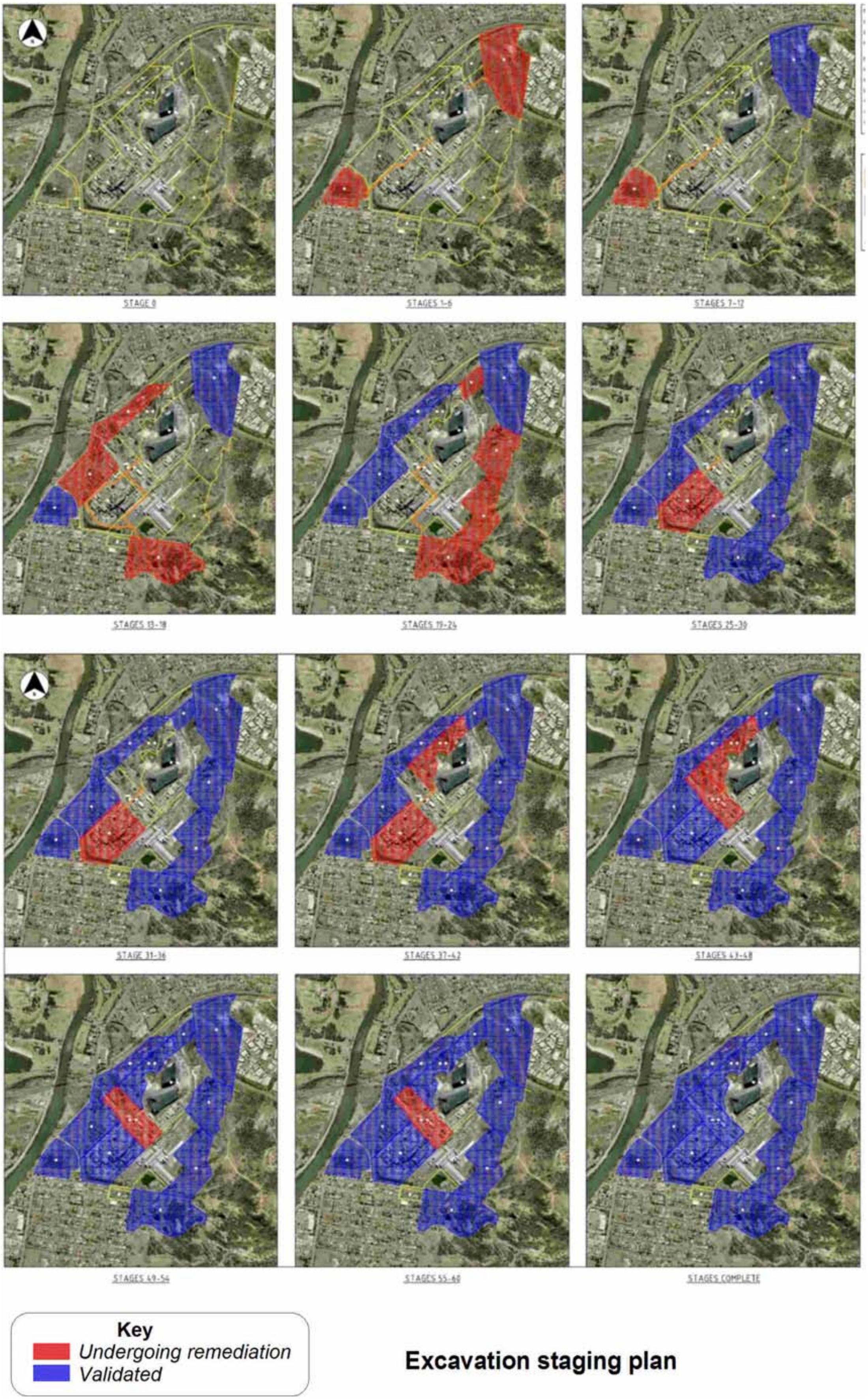
Location of study area

FIGURE 1

FIGURE 2



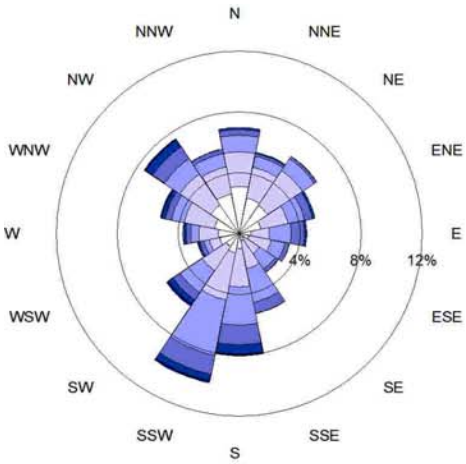
Pseudo 3-dimensional representation of terrain in the study area



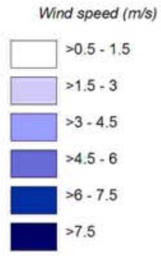
Excavation staging plan

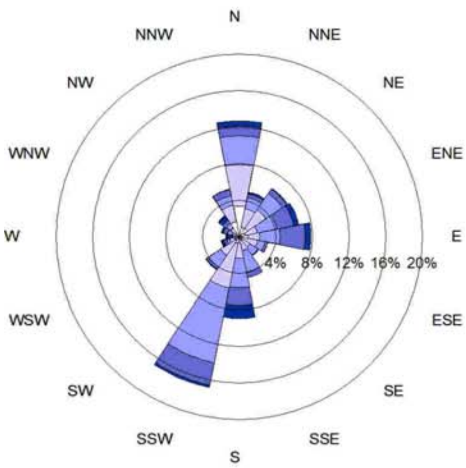
FIGURE 3

Annual and seasonal windroses for Pasminco (1995)

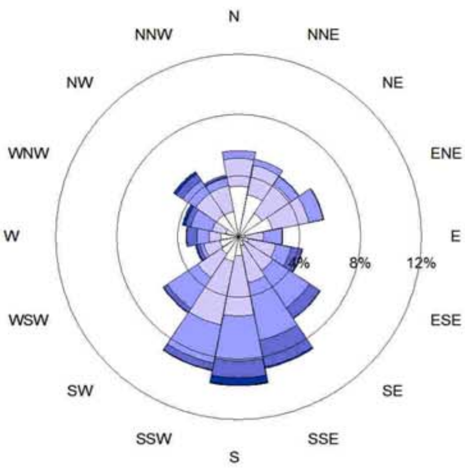


Annual
Calms = 11.4%

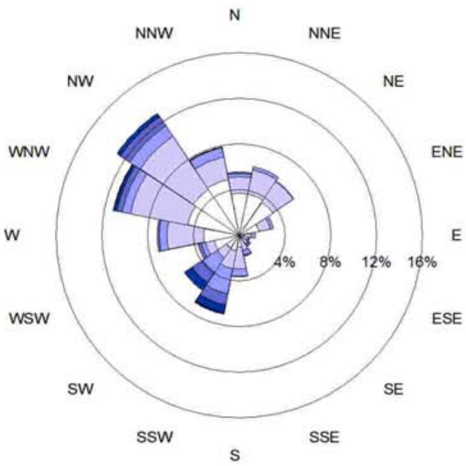




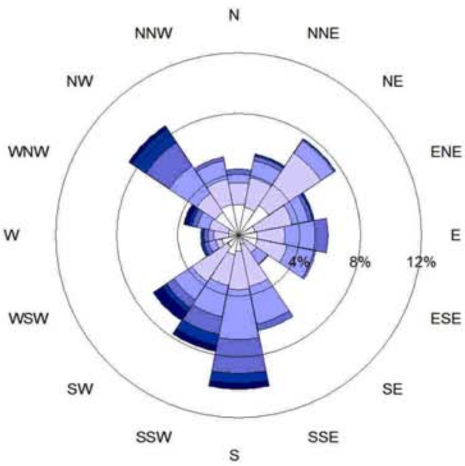
Summer
Calms = 7.6%



Autumn
Calms = 12.2%

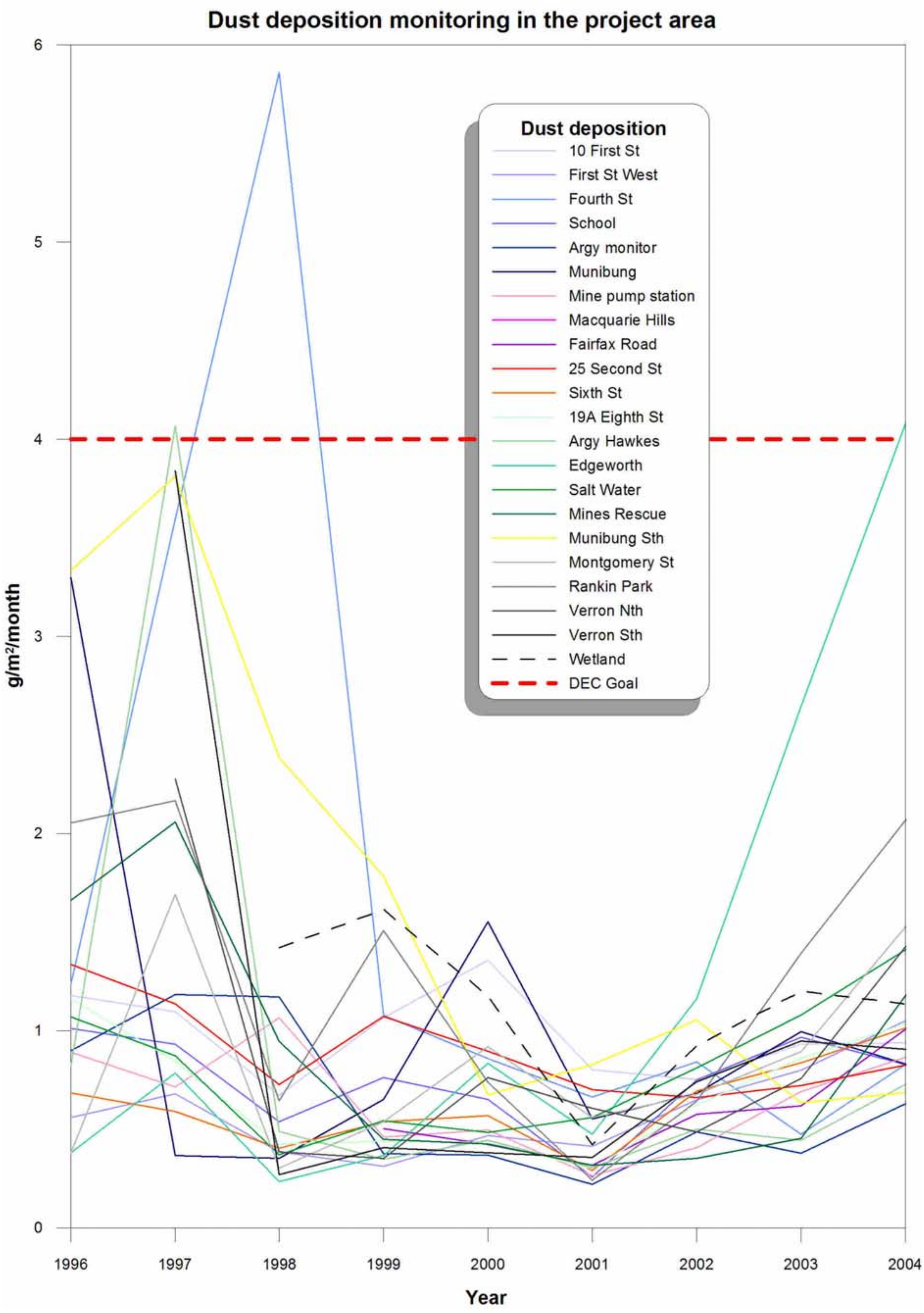


Winter
Calms = 14.8%



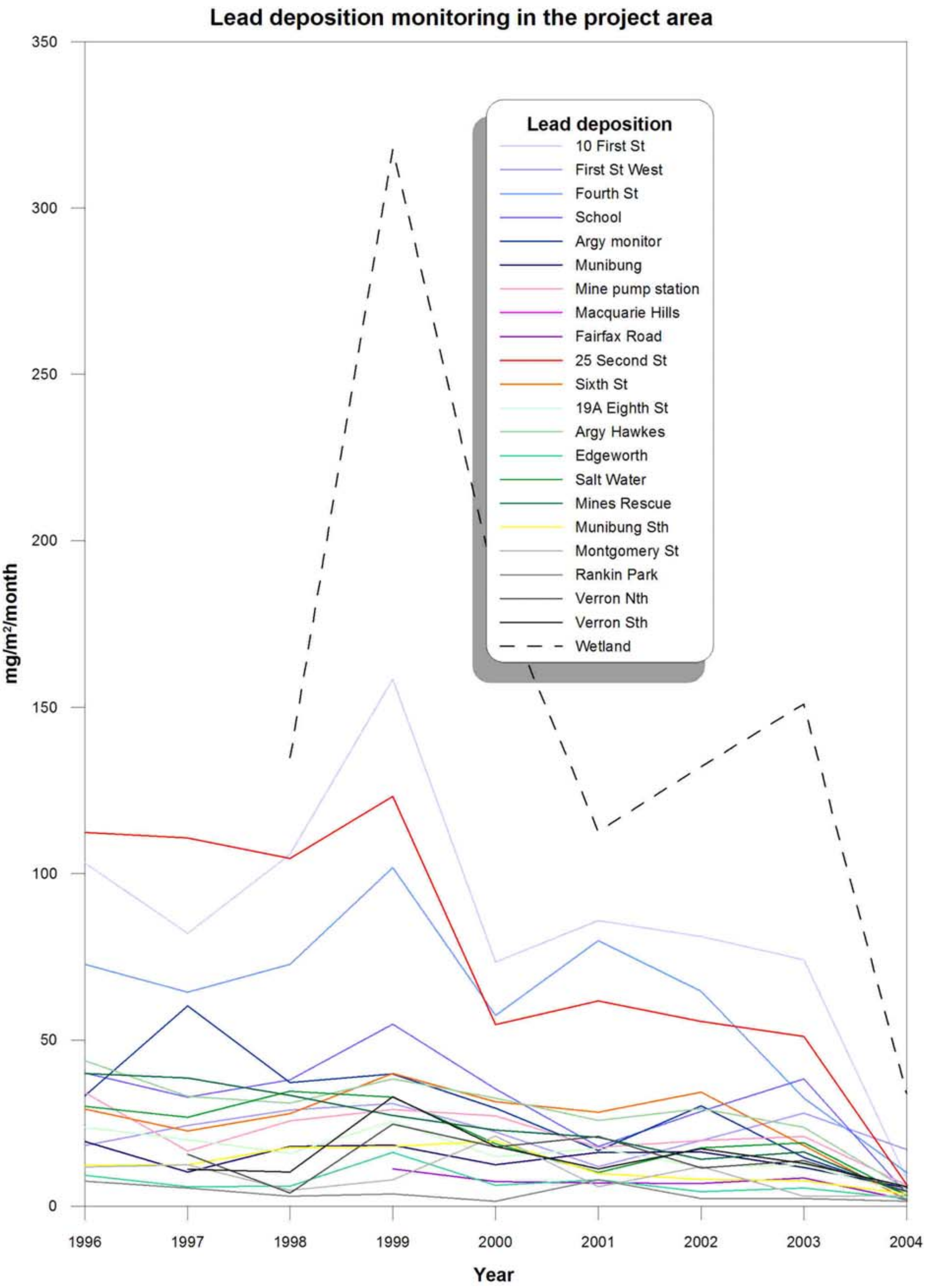
Spring
Calms = 10.5%

FIGURE 4



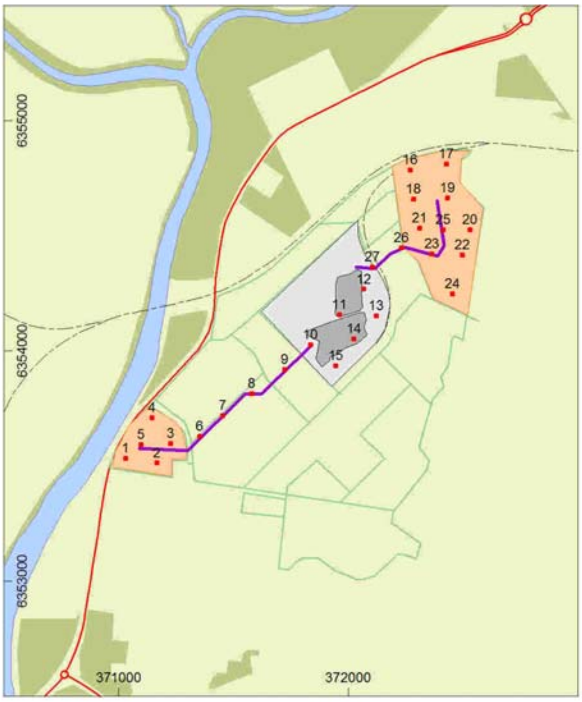
Dust deposition monitoring in the project area
Dust deposition
10 First St
First St West
Fourth St
School
Argy monitor
Munibung
Mine pump station
Macquarie Hills
Fairfax Road
25 Second St
Sixth St
19A Eighth St
Argy Hawkes
Edgeworth
Salt Water
Mines Rescue
Munibung Sth
Montgomery St
Rankin Park
Verron Nth
Verron Sth
Wetland
DEC Goal
g/m²/month
0
1
2
3
4
5
6
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

FIGURE 5

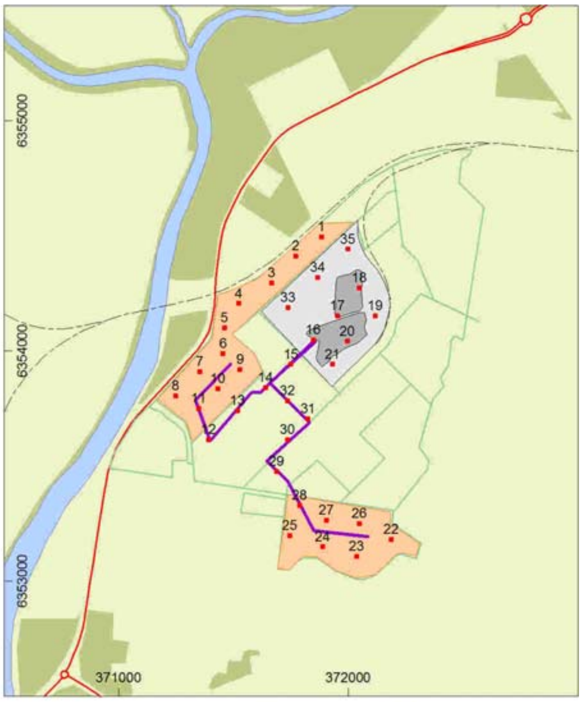


Lead deposition monitoring in the project area
350
300
250
200
150
100
50
0
mg/m²/month
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Lead deposition
10 First St
First St West
Fourth St
School
Argy monitor
Munibung
Mine pump station
Macquarie Hills
Fairfax Road
25 Second St
Sixth St
19A Eighth St
Argy Hawkes
Edgeworth
Salt Water
Mines Rescue
Munibung Sth
Montgomery St
Rankin Park
Verron Nth
Verron Sth
Wetland

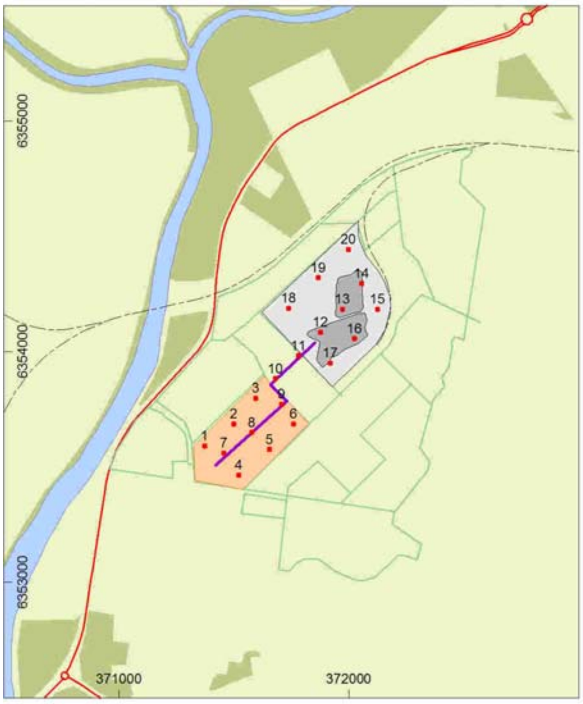
FIGURE 6



Stage 1 (months 0 to 6)



Stage 3 (months 13 to 18)



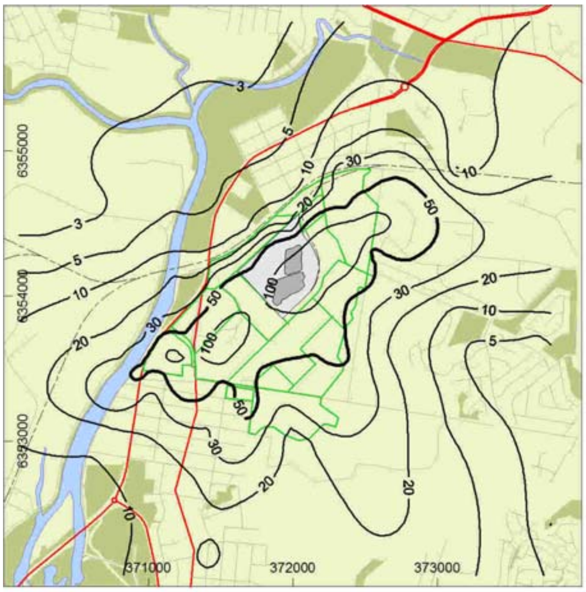
Stage 5 (months 25 to 30)

Areas undergoing remediation

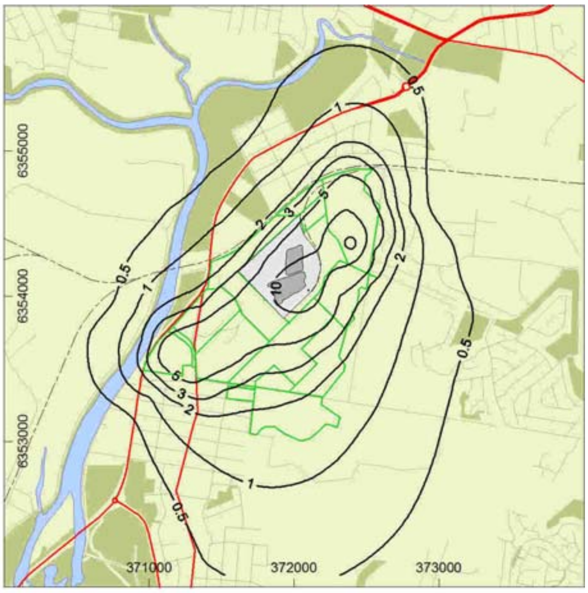
Haul route to containment cell

Staging plan and location of modelled dust sources

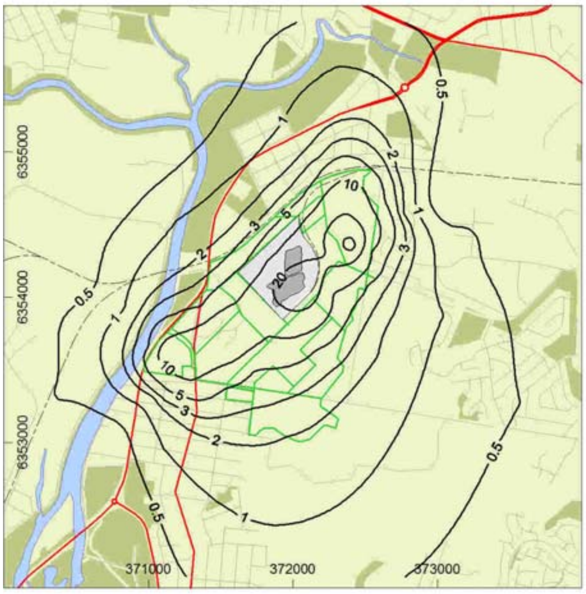
FIGURE 7



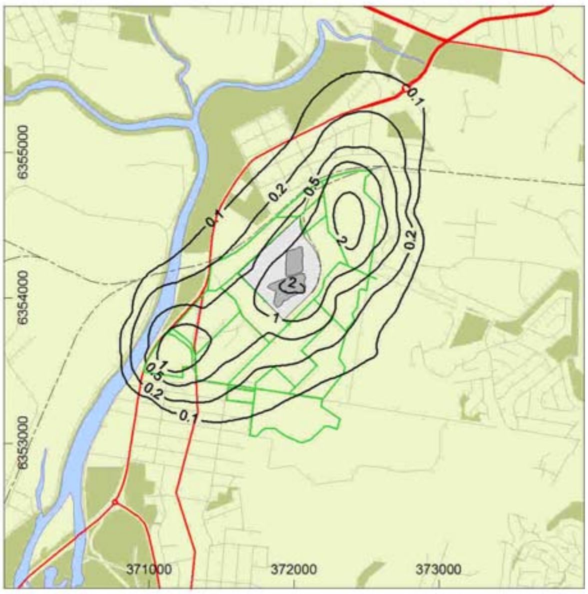
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



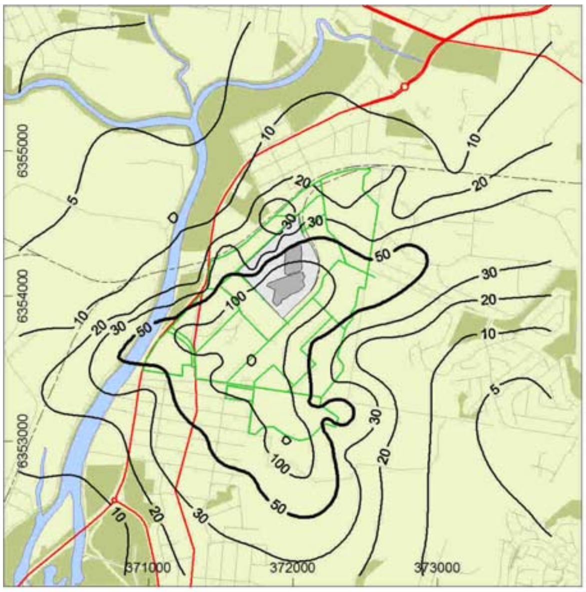
Annual average TSP - µg/m^3



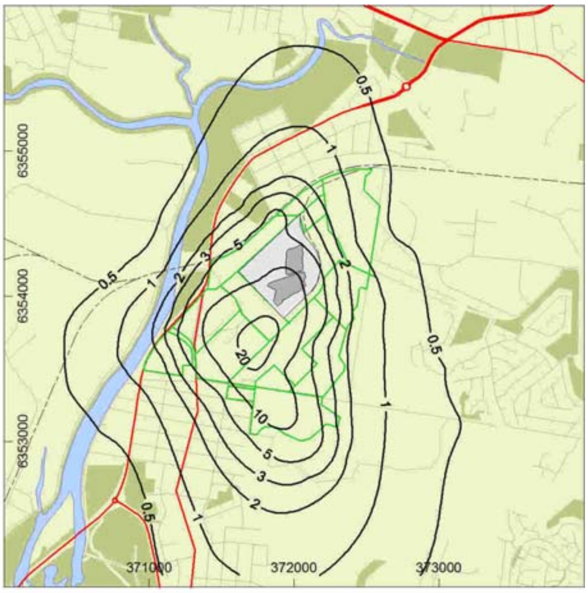
Annual average dust deposition - g/m^2/month

Dispersion model predictions for Stage 1 (months 0 to 6) operations

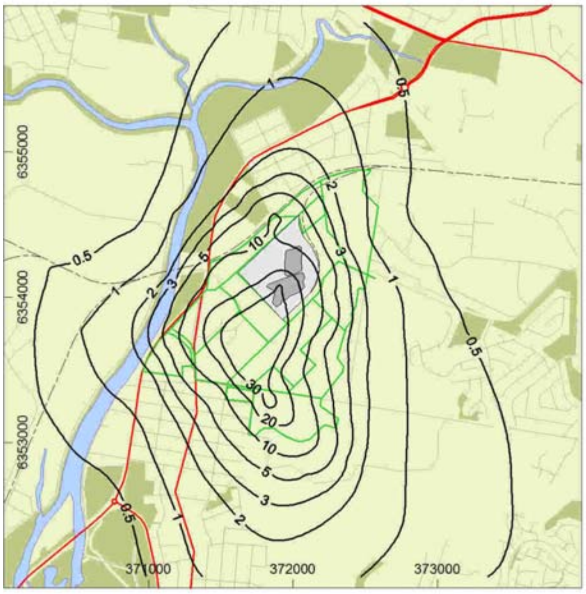
FIGURE 8



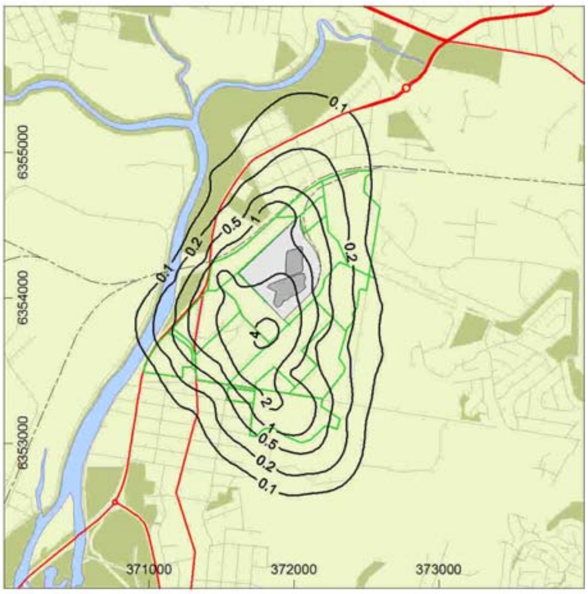
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



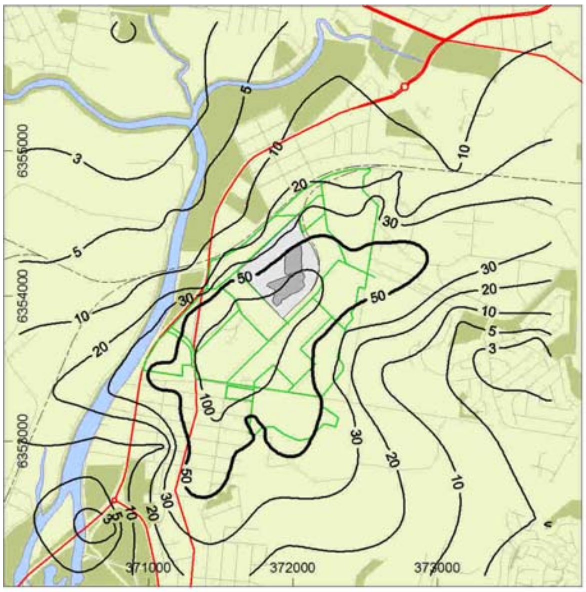
Annual average TSP - µg/m^3



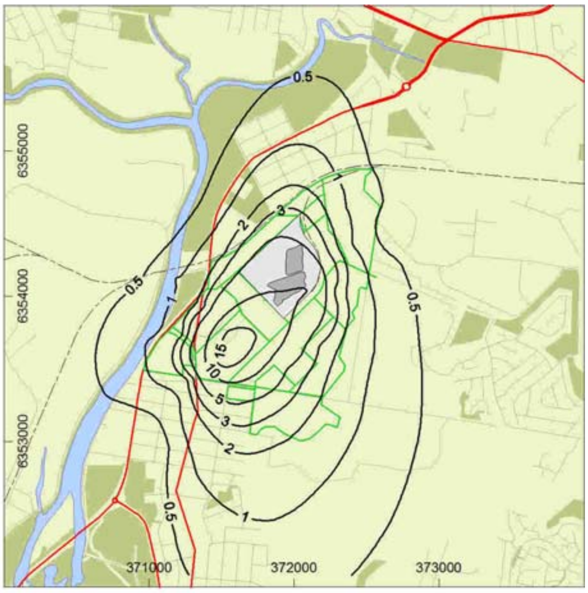
Annual average dust deposition - g/m^2/month

Dispersion model predictions for Stage 3 (months 13 to 18) operations

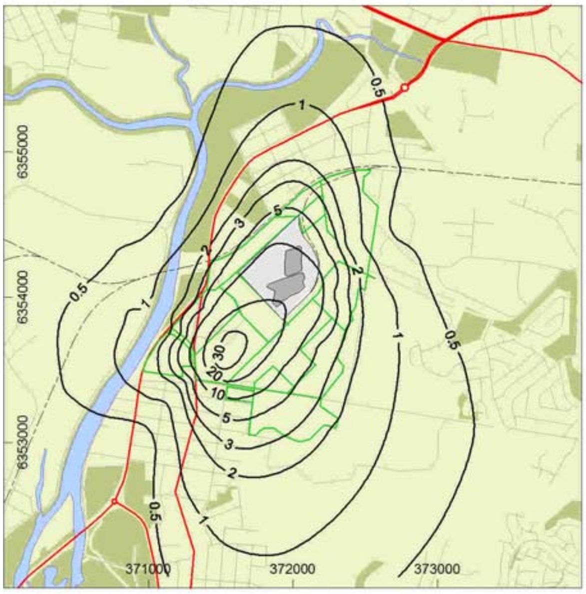
FIGURE 9



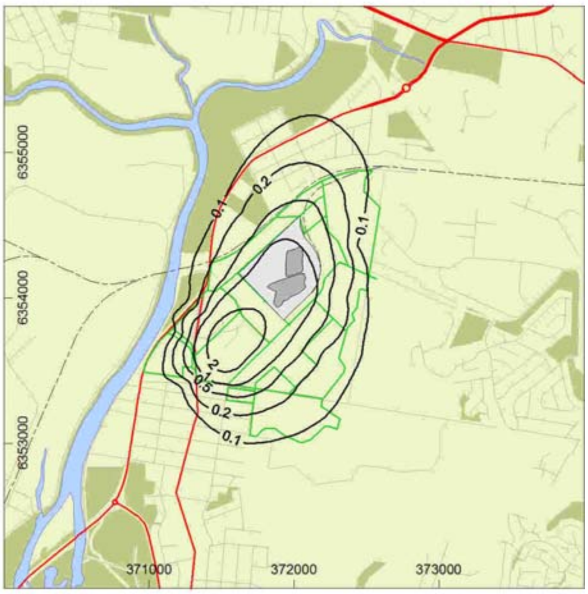
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



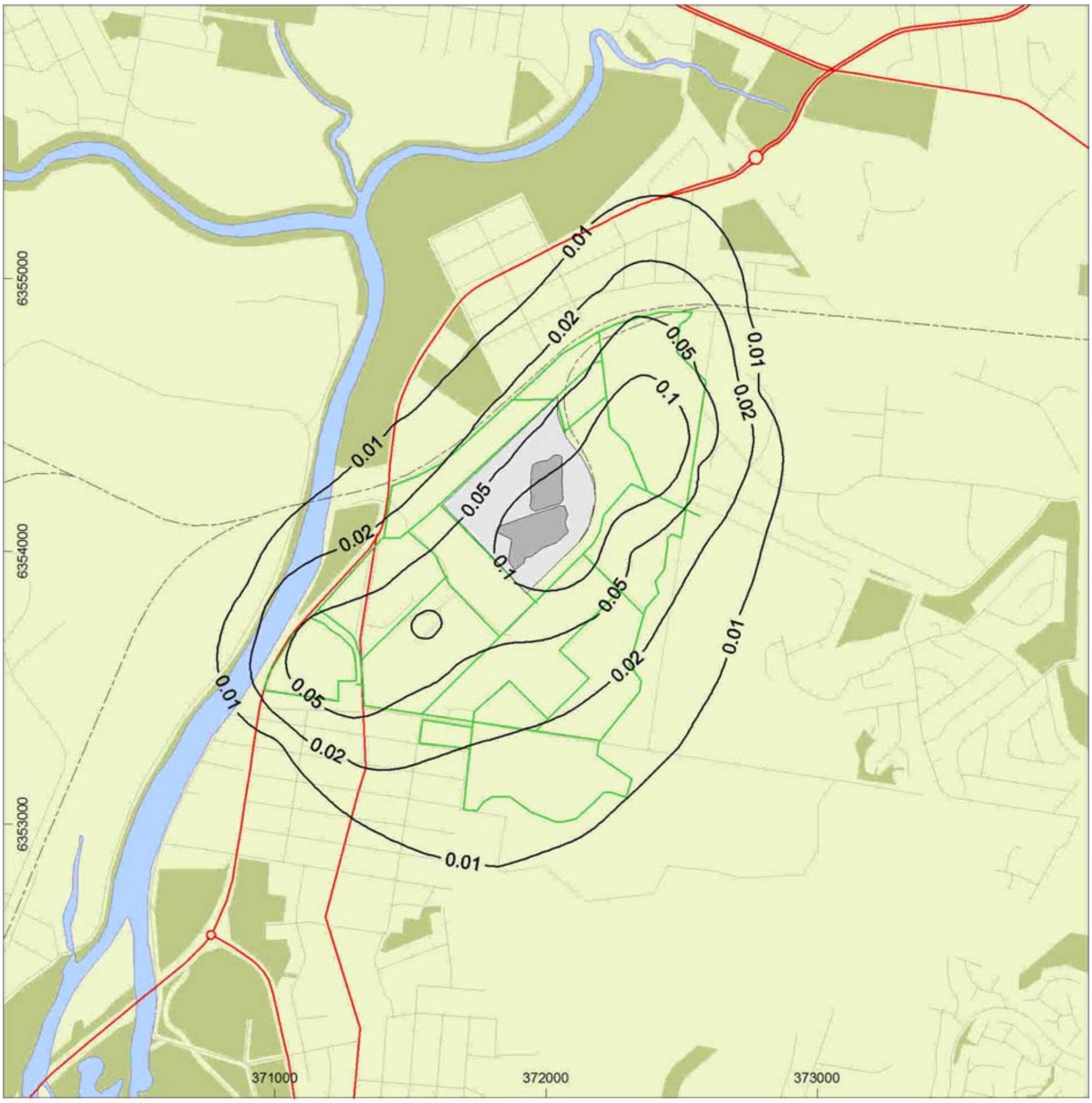
Annual average TSP - µg/m^3



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

Dispersion model predictions for Stage 5 (months 25 to 30) operations

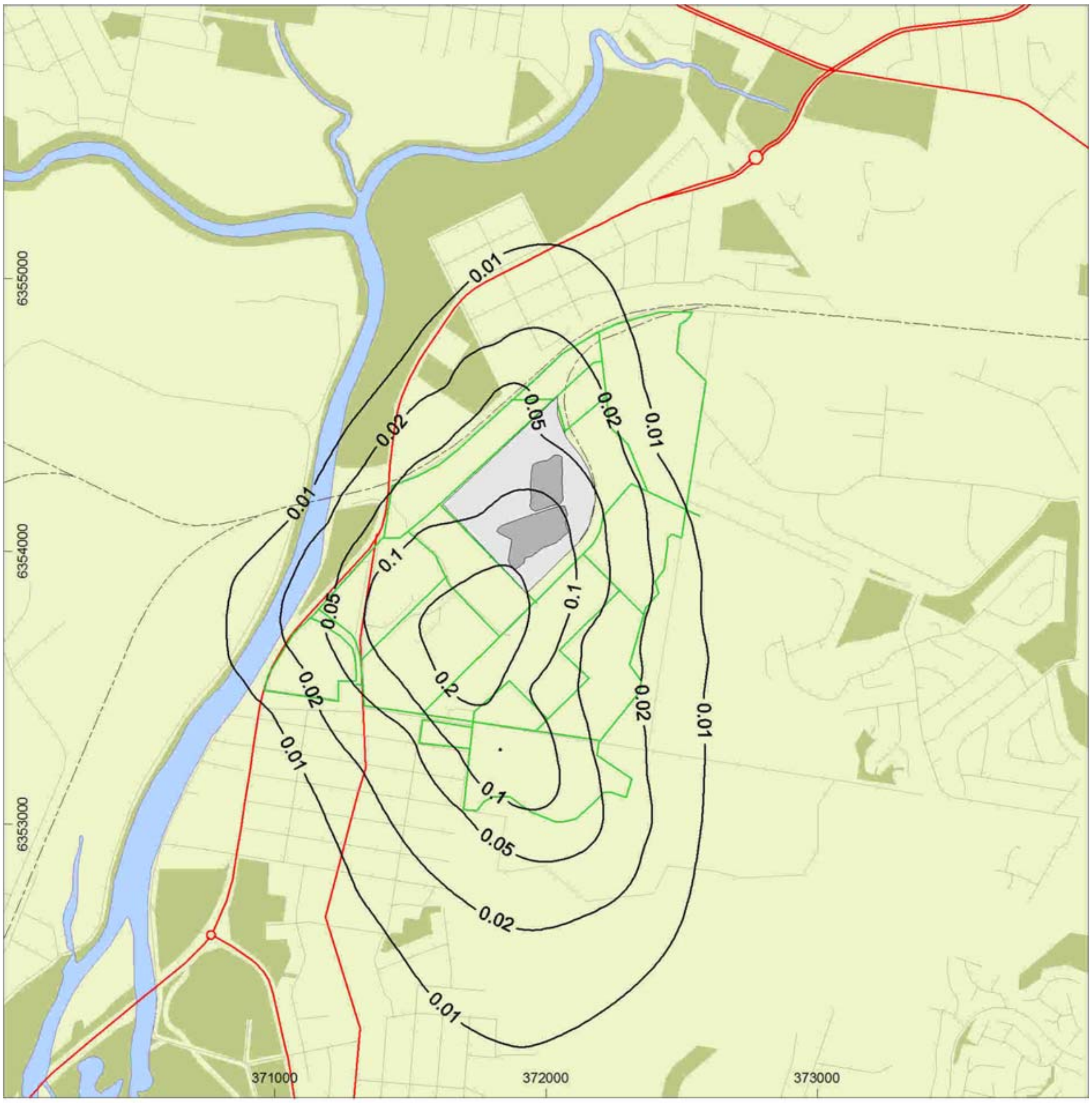
FIGURE 10



Predicted annual average lead concentration due to Stage 1 (months 0 to 6) operations (µg/m^3)

(Assumes lead concentration in soil is constant across site at 6,000 ppm)

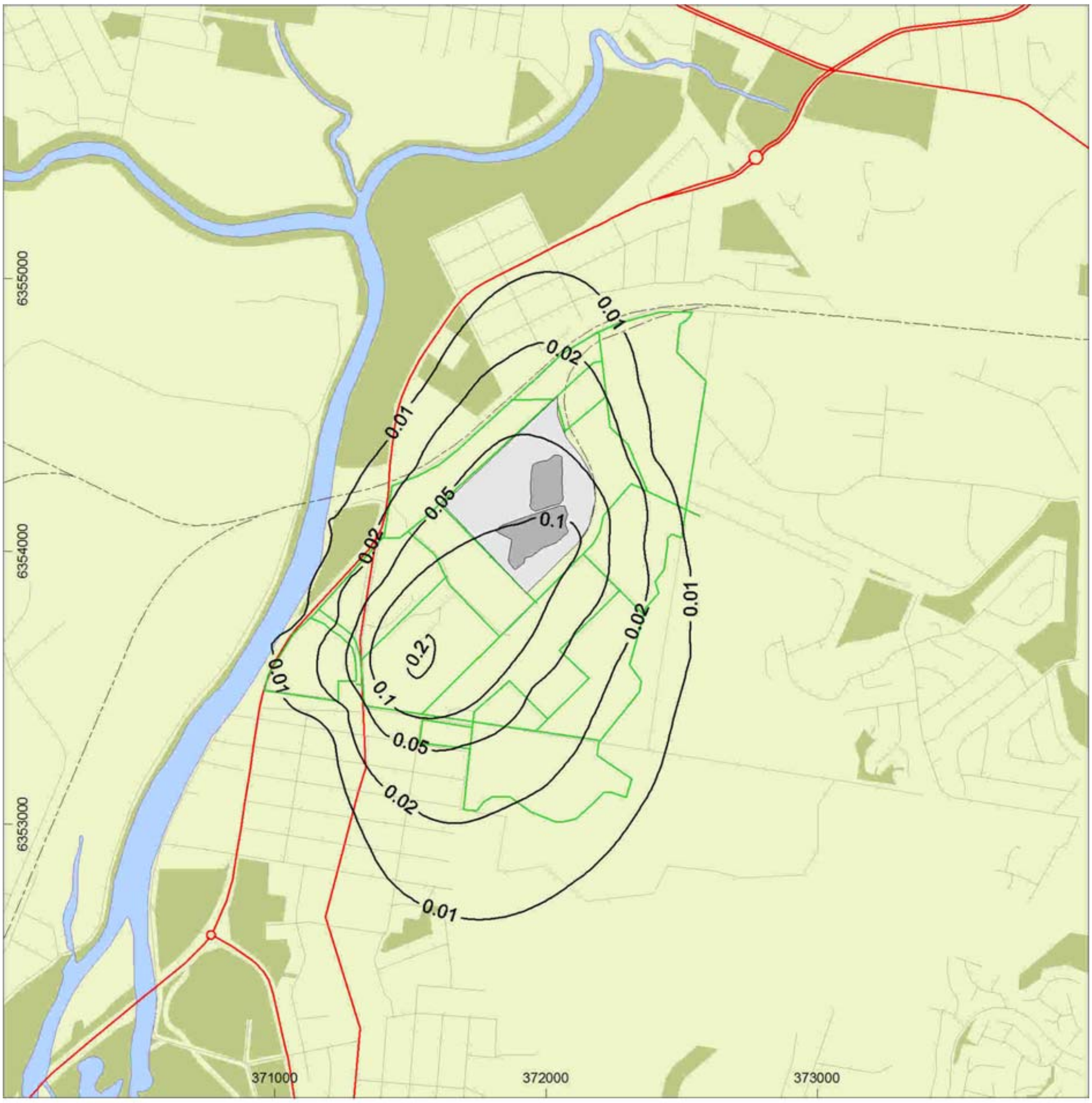
FIGURE 11



Predicted annual average lead concentration due to Stage 3 (months 13 to 18) operations (µg/m³)

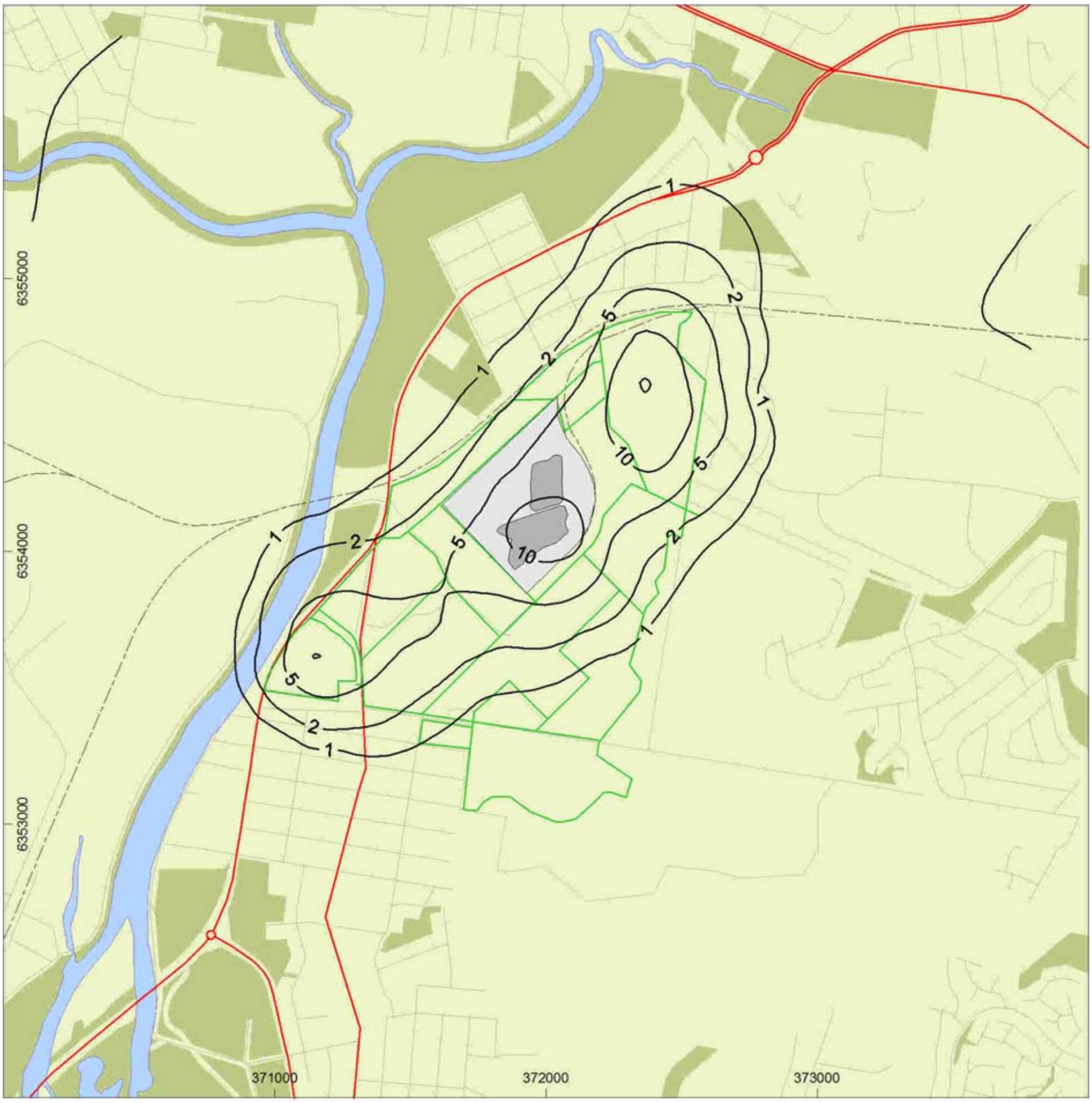
(Assumes lead concentration in soil is constant across site at 6,000 ppm)

FIGURE 12



Predicted annual average lead concentration due to Stage 3 (months 25 to 30) operations (µg/m^3)

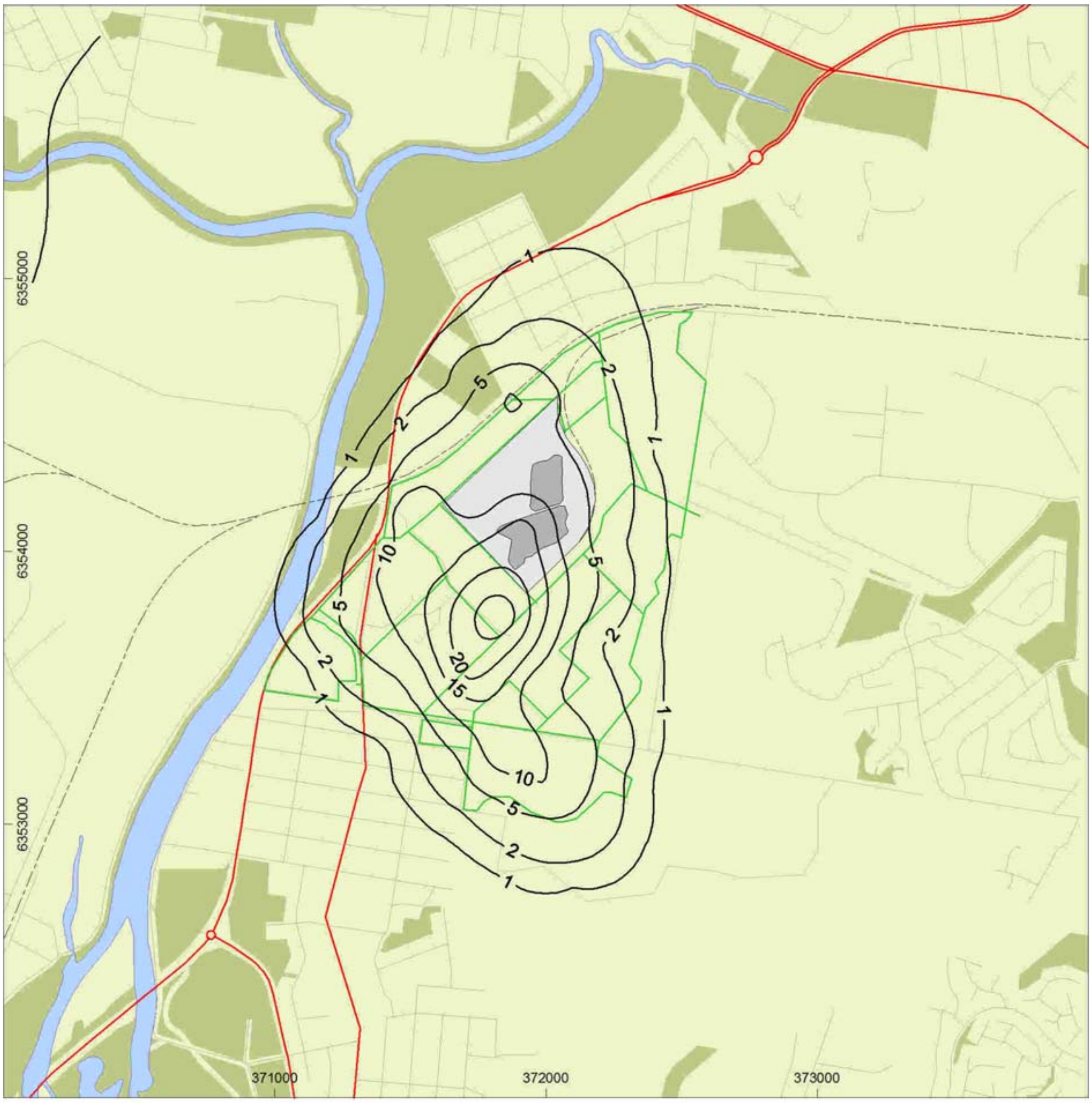
(Assumes lead concentration in soil is constant across site at 6,000 ppm)



Predicted annual average lead deposition due to Stage 1 (months 0 to 6) operations (mg/m^2/month)

(Assumes lead concentration in soil is constant across site at 6,000 ppm)

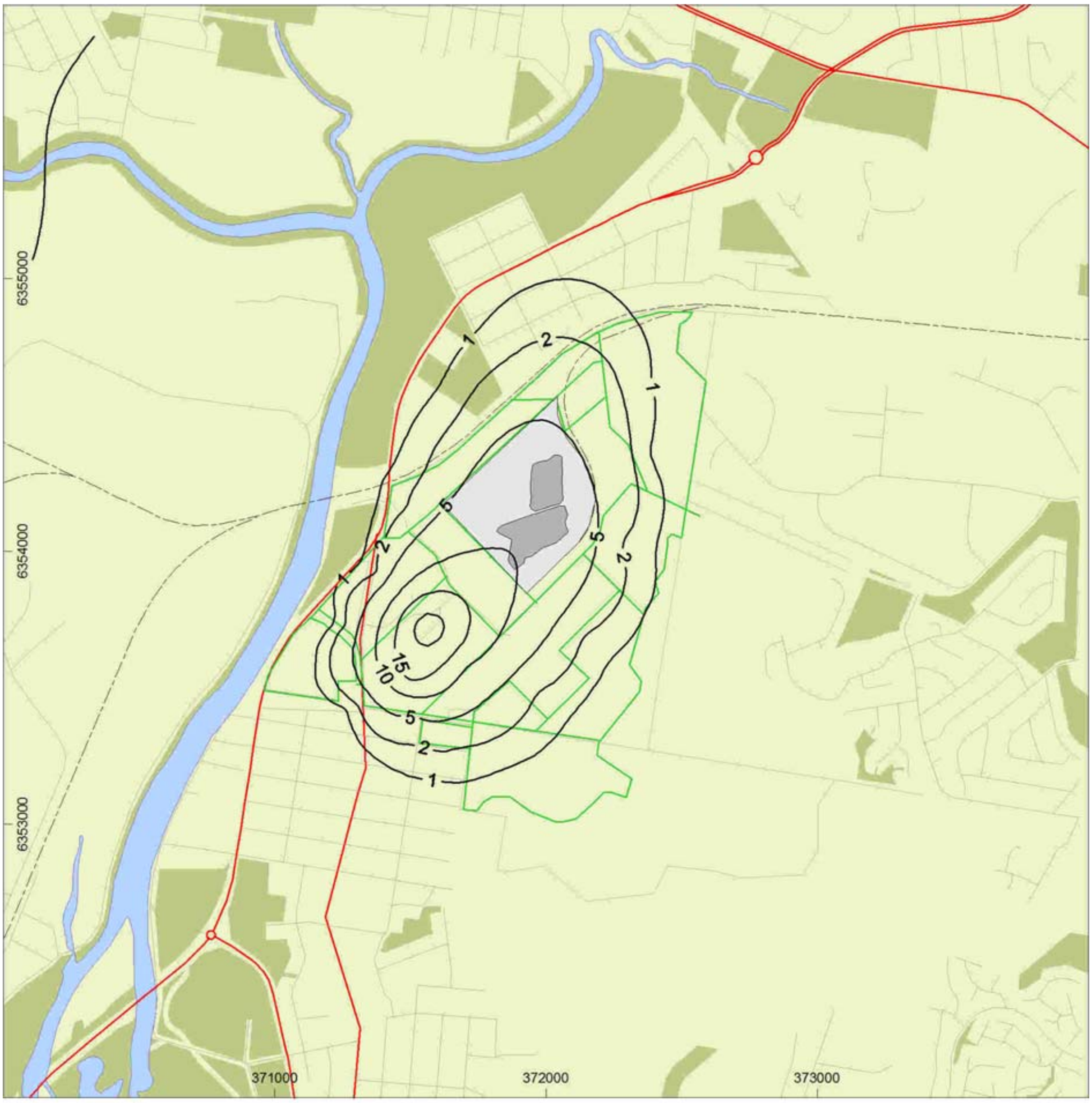
FIGURE 14



Predicted annual average lead deposition due to Stage 3 (months 13 to 18) operations (mg/m^2/month)

(Assumes lead concentration in soil is constant across site at 6,000 ppm)

FIGURE 15



Predicted annual average lead deposition due to Stage 5 (months 25 to 30) operations ($mg/m^2/month$)

(Assumes lead concentration in soil is constant across site at 6,000 ppm)

FIGURE 16