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Tomingley Gold Project

Air Quality Assessment

September 2011

Prepared by

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Tomingley Gold Project

Air Quality Assessment

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EXECUTIVE SUMMARY

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited on behalf of Alkane Resources Ltd. The purpose of the study is to assess the likely air quality impacts of the proposed Tomingley Gold Project ("the Project"), located in the central west of New South Wales. The proposed development would include four open cut mining operations, one underground mining operation, three waste rock emplacement areas, a residue storage facility and a processing plant, including a standard carbon-in-leach circuit.

The dust modelling results show that the predicted annual average PM_{10}, TSP and dust deposition levels at nearest sensitive receptors during all modelled scenarios would be below the NSW Office of Environment and Heritage (OEH) assessment criteria. When existing background levels are included, some receptors are predicted to receive 24-hour PM_{10} concentrations above the OEH assessment criterion.

A greenhouse gas assessment has been conducted using the National Greenhouse Accounts Factors. A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, the Project would be subject to the reporting under the system. For the life of the Project, it has been estimated that the development would release approximately 0.38Mt/y CO_2-e (all scope emissions). The maximum annual increase of emissions would be in Years 1, 2 and 3 which would represent an approximate contribution of 0.04% (all scope emissions) to baseline 2008 NSW emissions.

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1 INTRODUCTION

This report has been prepared by PAEHolmes for R.W. Corkery & Co. Pty Limited on behalf of Alkane Resources Ltd (Alkane). The purpose of this study is to assess the likely air quality impacts of the proposed Tomingley Gold Project (hereafter referred to as the Project) located in the Central West of New South Wales.

The Project incorporates three component activities, namely:

- the mining, processing and ancillary operations of "the Mine Site";
- the construction and operation of a water pipeline between the Mine Site and a borefield approximately 46km to the northeast near Narromine; and
- an electricity transmission line between the Mine Site and Peak Hill.

This report is restricted to an assessment of the activities on the Mine Site.

The Mine Site is centred on four gold ore bodies, located approximately 15km north of the Peak Hill Gold Mine (opened and operated by Alkane until 2006). The Mine Site would include four open cut mines, one underground mine, three waste rock emplacement areas, a residue storage facility and a processing plant, including a standard carbon-in-leach circuit.

In summary, this report provides information on (and assessment of):

- relevant air quality criteria;
- meteorological and climatic conditions in the area;
- the existing air quality conditions in the area;
- the methods used to estimate dust emissions from on-site activities;
- the expected dispersion and dust fallout patterns due to emissions from the Project and a comparison with the NSW Office of Environment and Heritage (OEH) assessment criteria; and
- greenhouse gas emissions attributable to the Project.

2 LOCAL AREA AND PROJECT DESCRIPTION

The Project is located in the central west of New South Wales, immediately south of the village of Tomingley, approximately 53km to the southwest of Dubbo and approximately 15km to the north of Peak Hill (see **Figure 1**).

Figure 2 shows the local terrain surrounding the Mine Site which is generally flat with few distinguishing features. The terrain does, however, become increasingly undulating towards the east.

The village of Tomingley lies to the immediate north of the Mine Site. There are twenty-nine sensitive receptors in the vicinity of the Mine Site as shown in **Figure 3**. The impact of emissions from the Project at these locations is specifically addressed.

The Project would include the following components (see **Figure 4** for Mine Site layout).

- Establishment of infrastructure required for the Project, including a water supply pipeline, an underpass beneath the Newell Highway, and vegetated amenity bunds.
- Extraction of waste rock and ore material from four open cut areas, namely:
  - Caloma Open Cut (approximately 19ha);
  - Caloma Two Open Cut (indicative design approximately 9ha);
  - Wyoming Three Open Cut (approximately 10ha); and
  - Wyoming One Open Cut (approximately 19ha).

  Friable waste rock and ore would be extracted using an excavator, or alternatively, ripped and pushed up using a bulldozer. This material would then be loaded into haul trucks for transportation to a waste rock emplacement or Run-of-Mine (ROM) pad. Drilling and blasting would be used to fracture harder rock and ore and would be similarly loaded and transported to a waste rock emplacement or the ROM pad.
- Extraction of waste rock and ore material from the Wyoming One Underground. All waste rock removed during underground mining operations would be re-used underground to backfill the mining stopes.
- Construction of three waste rock emplacements covering a combined area of approximately 129ha. Bulldozers would be used to shape and profile each waste rock emplacement.
- Construction and use of various haul roads and a run-of-mine (ROM) pad.
- Construction and use of a processing plant and office area, incorporating the ROM pad, crushing and grinding circuit, a standard carbon-in-leach (CIL) processing plant, site offices, workshops, ablutions facilities, stores, car parking, and associated infrastructure.

From the ROM pad, ore material would be sent through a crusher, then screened and then transported via a set of conveyors. Ore crushed to <23mm would be delivered to the surge bin for delivery to the gold extraction circuit. Oversize material would be delivered to a secondary crusher to further reduce the size of the material before delivery to the surge bin.

Material from the surge bin would be conveyed to the grinding circuit within the processing plant. The ore would be combined with water and steel balls with the revolving motion able to further reduce the size of the ore.

Following crushing and grinding, ore material would be processed to extract the gold. The remaining residue would then be pumped to the residue storage facility (RSF). The RSF would be designed and operated to ensure no significant pooling of process water on the surface.

- Construction and use of a residue storage facility (approximately 49ha).
- Construction and use of a transformer and electrical distribution network within the Mine Site (from the 20km of 66kV electricity transmission line from Peak Hill to the Mine Site to be constructed and operated under separate approval).

- Construction and use of an approximately 46km water pipeline, from a licensed bore located approximately 7km to the east of Narromine, to the Mine Site.
- Relocation of existing items of infrastructure, including a 22kV power line which currently passes over the area of the Caloma and Caloma Two Open Cuts.
- Re-routing (node to node) of a 4.2km section of a Nextgen Network fibre optic cable (telecommunications line).
- Construction and use of ancillary infrastructure, including the Main Site Access Road and intersection with Tomingley West Road.
- Construction of soil stockpiles (for use in rehabilitation works).
- Construction of the Eastern Surface Water Diversion Structure to divert surface water flows to the east of mining and waste rock emplacement activities. Additional surface water management structures would be constructed within the Project Site to control surface water flows within the Mine Site.
- Construction and use of dewatering ponds to store water accumulating in and pumped from the open cuts.

Disturbance associated with the mining and associated activities would be progressively rehabilitated to create a geotechnically stable final landform, suitable for a final land use of nature conservation, agriculture, tourism and/or light industry.

It is noted that the design of the proposed Caloma Two Open Cut is an indicative design only, with additional drilling required to further define the mineralisation. As a result, the indicative design for the Caloma Two Open Cut presented in this document represents the maximum area that would be developed. The development of this maximum impact footprint has been taken into account in all other aspects of the Project, including the required capacity, layout and design of the waste rock emplacements and residue storage facility, and the life of the Project. Approval is sought for the proposed design, acknowledging that the final design of the open cut would be the same size or smaller than that displayed on **Figure 4**.

In addition, throughout the life of the Project, the Proponent proposes to undertake additional exploration drilling to further identify mineralisation. Should further mineable mineralisation be identified, and once sufficient information is available to adequately identify the proposed activities, a subsequent application for approval to extract these resources may be prepared.

3 AIR QUALITY ASSESSMENT CRITERIA

In the "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" ("*Approved Methods*"), OEH specifies air quality assessment criteria relevant for assessing impacts from air pollution (**NSW DEC, 2005**).

Table 3.1 summarises the air quality criteria for concentrations of particulate matter that are relevant to this study. The air quality criteria for Total Suspended Particulates (TSP) and airborne particulate matter <10µm in diameter (PM_{10}) relate to the total dust burden in the air and not just the dust from the Project.

Table 3.1
Air Quality Impact Assessment Criteria for Particulate Matter Concentrations

Pollutant	Averaging period	Standard / Goal	Agency
Total suspended particulate matter (TSP)	Annual mean	90 $\mu g/m^3$	NHMRC
Particulate matter with an equivalent aerodynamic diameter less than 10 μm (PM_{10})	24-hour maximum	50 $\mu g/m^3$	NSW OEH impact assessment criteria NEPM reporting goal, allows five exceedances per year for bushfires and dust storms
	Annual mean	30 $\mu g/m^3$	NSW OEH impact assessment criteria

In other words, consideration of background dust levels needs to be made when using these criteria to assess potential impacts. This is discussed further in **Section 5.4**.

These criteria are consistent with the *National Environment Protection Measures for Ambient Air Quality* (referred to as the Ambient Air-NEPM) (see **NEPC, 1998**). However, the NSW DECCW's criteria include averaging periods, which are not included in the Ambient Air-NEPMs, and also references to other measures of air quality, namely dust deposition and total suspended particulate matter.

The National Environment Protection Council (NEPC) has also developed a set of NEPM advisory reporting standards goals for $PM_{2.5}$ as shown in **Table 3.2** (**NEPC, 2003**). These goals have not been adopted in NSW for assessment of projects.

Table 3.2
Advisory Reporting Standards for $PM_{2.5}$ Concentrations

Pollutant	**Averaging period**	**Criteria**	**AGENCY**
Particulate matter < 2.5μm ($PM_{2.5}$)	Annual mean	8$\mu g/m^3$	NEPM*
	24-hour maximum	25$\mu g/m^3$	NEPM*

**Not included as assessment criteria for projects in NSW*

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and/or on vegetation/crops.

Table 3.3 shows the dust deposition criteria set out in the OEH procedures for modelling air pollutants from sources (**NSW DEC, 2005**).

Table 3.3
NSW OEH Criteria for Dust (Insoluble Solids) Fallout

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

4 CLIMATE AND METEOROLOGY

Meteorological conditions affect the dispersion of dust from an emissions source. This section describes the local meteorology and climatic conditions in the area that may influence dispersion.

4.1 LONG-TERM CLIMATE AVERAGES

4.1.1 Data Source

The closest Bureau of Meteorology (BOM) site that collects climatic information is at Peak Hill Post Office, approximately 15km south of the Mine Site. The data are summarised in **Table 4.1** which presents information on temperature, relative humidity, and rainfall (**Bureau of Meteorology, 2009**).

Table 4.1
Temperature, Humidity and Rainfall Data for Peak Hill Post Office

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Temperature (^oC) and Relative Humidity (%)													
Dry-bulb	24.8	24.0	21.9	18.6	13.8	10.1	8.8	10.7	14.3	18.6	20.7	23.8	17.5
Humidity	52	57	58	60	74	80	81	73	64	55	54	49	63
3pm Mean Temperature (^oC) and Relative Humidity (%)													
Dry-bulb	31.5	31.0	28.1	23.9	18.9	15.2	14.2	16.0	19.2	23.4	26.6	29.9	23.2
Humidity	32	36	38	41	53	61	59	50	44	39	36	31	43
Daily Maximum Temperature (^oC)													
Mean	33.1	32.5	29.4	25.1	20.0	16.2	15.2	16.9	20.4	24.6	28.0	31.4	24.4
Daily Minimum Temperature (^oC)													
Mean	19.1	19.2	16.3	12.2	8.8	6.0	4.7	5.8	7.9	11.4	14.2	17.2	11.9
Rainfall (mm)													
Monthly mean - mm	59.6	50.0	49.2	42.2	45.2	42.6	44.5	43.4	37.6	48.5	47.2	49.2	559.3
Rain days (Number)													
Mean no. of rain days	5.0	4.6	4.4	4.3	5.7	7.1	7.2	6.9	6.0	6.2	5.2	5.0	67.6
Station number: 050031 Commenced 1890; Last record May 2009; Elevation: 285m AHD; Latitude: 32.72; Longitude: 148.19													
Source: **Bureau of Meteorology (2009)**													

4.1.2 Temperature

On average, January is the warmest month with a mean daily maximum temperature of 33.1^{o}C and July the coolest with a mean daily minimum of 4.7^{o}C.

4.1.3 Relative Humidity

Relative humidity is highest in July with 81% (observed at 9am), and the lowest in December at 31% (observed at 3pm).

4.1.4 Rainfall

Mean annual rainfall is 559.3mm with the wettest month, on average, being January with a mean monthly rainfall of 59.6mm over five rain days. The driest month is September with a mean monthly rainfall of 37.6mm over six rain days.

4.2 METEOROLOGICAL DATA

4.2.1 Wind Speed and Direction

The dispersion model ISCMOD (a modified version of the US EPA ISCST3 model) used in this assessment requires a year of meteorological data. Data were provided by Alkane from the two meteorological stations closest to the Mine Site, namely, Peak Hill (15km south of the Mine Site) and Toongi (35km northeast of the Mine Site) (see **Figure 1**).

The Peak Hill station is owned and operated by Alkane and is located approximately 15km south of the Mine Site. A review of the Peak Hill data was conducted and 2003 was selected as the most representative year of meteorological data (personal communication with P. Zib, 2009).

Annual and seasonal wind roses for the Peak Hill Meteorological Station are presented in **Figure** 5. On an annual basis winds are predominantly from the south and also with a large portion of winds from the eastern quadrant. This pattern is evident in all seasons to different degrees. On an annual basis there are unusually high levels of calms (winds less than 0.5m/s) at 24.6%. This may be due to the station's proximity to a portable building and trees.

Alkane also owns and operates a meteorological station located in Toongi, approximately 35km northeast of the Mine Site. Data from the Toongi meteorological station for 2003 have been prepared into annual and seasonal wind roses as presented in **Figure 6**. When compared with the Peak Hill data, winds showed different patterns with small similarities. Annually, winds are predominantly from the south-southwest, south and the east-northeast and the northeast. On an annual basis there are 1% of calms. These differences between the two data sets may be due to Toongi meteorological station's distance from the Mine Site and the distinct contrast in topography. Therefore, the Toongi data were not considered representative of the meteorological conditions at the Mine Site and are considered inappropriate for use in the modelling.

Due to the high percentage of calms in the Peak Hill data, the approach taken in this assessment was to create a set of site-specific, synthetic meteorological data for the Tomingley site using The Air Pollution Model (TAPM) developed by CSIRO for 2003.

TAPM is a prognostic model which includes synoptic information determined from the six hourly Limited Area Prediction System (LAPS) (**Puri et al., 1997)**. The model is discussed further in the user manual which accompanies the model (see **Hurley, 1999**).

A summary of the parameters used as part of the meteorological component of this study are shown in **Table 4.2**.

Table 4.2
Summary of Meteorological Parameters used in this Study

TAPM (v. 4.0)	
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Number of grid point	25 x 25 x 25
Year of analysis	Jan 2003 to Dec 2003
Centre of analysis	32°37' S, 148°12' E

The TAPM meteorological data have been prepared into annual and seasonal wind roses as presented in **Figure 7**. On an annual basis, winds are predominantly from the northeast and east-northeast with fewer winds to the southwest. When compared with the Peak Hill data, winds show similar patterns, particularly the dominant winds from the eastern direction. However, on an annual basis the TAPM data shows 0.9% of calms which is distinctly different to 24.6% of calms annually in the Peak Hill data. TAPM has a tendency to under-predict low wind speeds and results in low levels of calms leading to under prediction of dust levels in near field regions.

Although the Peak Hill data show high levels of calms, as previously stated, it also shows similar wind patterns to the TAPM Tomingley data. Therefore TAPM was then run again in data assimilation mode with Peak Hill data included as observations. In this way, the meteorological data would include real world measurements adding a level of higher accuracy to the synthetic data.

The TAPM generated wind roses with observations are presented in **Figure 8**. The wind roses show the frequency of wind speeds and wind directions. On an annual basis the predominant winds are from the north and east. Winds from the east are less prominent in winter and spring with spring, also showing a higher percentage of winds from the south. The annual average wind speed is 1.8 m/s and on an annual basis there are 8.9% of calms.

4.2.2 Atmospheric Stability

Gaussian dispersion models require information about the dispersion characteristics of the area. In particular, data are required on topography, wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. 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.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. **Table 4.3** shows the frequency of occurrence of the stability categories from the 2003 TAPM data.

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[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 4.3
Frequency of Atmospheric Stability Classes

Pasquill Gifford stability class	**Frequency (%)**
A	15.3
B	12.5
C	9.6
D	40.3
E	9.8
F	12.6
TOTAL	100.1*

* Values do not add up to 100 exactly due to rounding.

The most common stability class for the Tomingley area was determined to be D-class at 35.4%. This would suggest that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time. The frequency of E and F class conditions (slow dispersal conditions) was slightly lower at 31.8%.

Joint wind speed, wind direction and stability class frequency tables for the Tomingley site are presented in **Appendix 1.**

5 EXISTING AIR QUALITY

5.1 INTRODUCTION

Air quality criteria refer to pollutant levels which include sources attributable to Project activities as well as existing sources. To fully assess impacts against all the relevant air quality criteria (detailed in **Section 3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the vicinity of the Mine Site.

There are no NSW OEH air quality monitoring sites located close to the Mine Site. Dust monitoring has, however, been conducted by Alkane at a number of locations within Peak Hill, approximately 14km south of the Mine Site, and immediate surrounds. The stations have recorded measurements of dust deposition using dust deposition monitors and dust concentration as total suspended particles (TSP) using High Volume Air Samplers (HVAS). The dust deposition monitors and HVAS measuring TSP are shown in **Figure 9**.

Mining activities at Peak Hill, which would have contributed to local dust levels, ceased in late 2002, although processing activities continued until 2006. TSP data have been analysed for the period during which the Peak Hill mine was operating (1996 to 2002).

Dust deposition data have been supplied for 1996 and the period from 2001 to 2006, covering a period of time when the mine was operational and when mining activities had ceased. These dust gauges are located on the “Tomingley”, “Wyoming” and “Dunoon” properties near Tomingley village and the others located in close proximity to each other in Peak Hill. Additional sources of particulate matter in the area would include traffic on unsealed roads, wind erosion from exposed soils in farmlands and other areas, cereal crop harvesting, animal grazing and to a lesser extent traffic from the Newell Highway.

5.2 DUST DEPOSITION

Dust deposition was monitored using dust deposition gauges at eleven locations (see **Figure** 9). Dust deposition gauges use a funnel and bottle to measure the rate at which dust settles onto the surface over periods approximating one month.

Data collected from the "Tomingley", "Wyoming" and "Dunoon" property monitoring stations are summarised in **Table 5.1**. This table also presents dust deposition data from the eight other sites monitored during the life of the Peak Hill Gold Mine. These measurements include the effects of all relevant background sources. All dust deposition data are shown in **Appendix 2**.

Table 5.1
Dust Deposition Monitoring Results (g/m^2/month)

	'Dunoon'	'Wyoming'	'Tomingley'	41 Euchie St	'Little Oakleigh'	59 Euchie St	'Cowabunga'	Warrigal Rd	2 Caswell St	Frazer court hotel	'Towalba'	Average for all sites
1996	-	-	-	2.6	2.1	3.3		2.9	3.1		3.4	2.9
1997-2000	-	-	-	-	-	-	-	-	-	-	-	-
2001	-	-	-	1.0	1.0	0.9	2.0	1.6	1.2	1.5	-	1.3
2002	2.1	4.1	1.7	1.7	-	1.9	0.9	1.7	1.5	1.6	-	1.9
2003	2.1	3.4	3.3	-	-	-	-	-	-	-	-	2.9
2004	1.6	2.6	1.8	-	-	-	-	-	-	-	-	2.0
2005	1.2	1.9*	1.3	-	-	-	-	-	-	-	-	1.3
2006	0.9	1.7	1.6	-	-	-	-	-	-	-	-	1.4
Average	1.7	2.9	2.0	1.8	1.5	2.0	1.5	2.1	1.9	1.5	3.4	**2.0**

* Contaminated samples.

The data in **Table 5.1**, which accounts for the removal of some sampling data due to contamination of the samples, show that no location has reported an average level above the OEH's 4g/m^2/month dust fallout criteria. The annual average over all sampling locations is 2g/m^2/month.

5.3 TSP CONCENTRATION

Measurements of TSP concentrations are available for the years 1996 to 2000 at the 59 Euchie Street monitoring site and at Frazer Court, from 2001 to 2002. These monitoring sites are shown on **Figure 9**.

TSP data are shown below in **Table 5.2**. The highest annual average TSP concentration is 71μg/m^3 measured in 1997 at the 59 Euchie Street monitoring site. The data in **Table 5.2** show that no location has reported an average level above the NSW OEH's TSP criterion of 90μg/m^3. The annual average TSP level over both monitoring sites is 51μg/m^3. **Figure 10** presents these data graphically.

Table 5.2
TSP Monitoring Results (µg/m³)

	59 Euchie Street	Frazer Court
1996	58.7	-
1997	71.0	-
1998	47.2	-
1999	50.9	-
2000	43.7	-
2001	-	36.3
2002	-	50.2
Average	54.3	47.2

There have been no PM_{10} data collected, however, extensive monitoring and analysis in the Hunter Valley indicates that where mining activities are a significant source of the particulate matter, then on an annual basis, approximately 40% of the TSP will be in the form of PM_{10}. Assuming that PM_{10} constitutes 40% of the TSP at Peak Hill, the annual average PM_{10} level would be 20µg/m³ for the 59 Euchie Street and Frazer Court sites for 1996 to 2002.

All TSP data are shown in **Appendix 2**.

5.4 SUMMARY OF BACKGROUND DATA

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

- Annual average TSP of 51µg/m³;
- Annual average PM_{10} of 20µg/m³;
- Annual average dust deposition of 2g/m²/month.

These assumed background levels are conservative in that they include data from years when mining and processing activities were occurring at Peak Hill. It is anticipated that actual background levels would be lower than these levels.

In addition, the OEH guidelines require an assessment of cumulative 24-hour PM_{10} concentrations. 24-hour PM_{10} concentrations in NSW fluctuate considerably, and can be elevated in times of drought and windy conditions.

This assessment adopts the approach that the predicted 24-hour average PM_{10} concentration from the Project and other sources should be less than 50µg/m³ at the nearest sensitive receptors. Monitoring data have been analysed and a conservative approach has been taken when assessing cumulative PM_{10} 24-hour impacts. This is further addressed in **Section 8.2**.

6 APPROACH TO ASSESSMENT

In August 2005, the then Department of Environment and Conservation (DEC) (now OEH) published '*Approved Methods for the Modelling and Assessment of Air Pollution in NSW*' (**NSW DEC, 2005**). The document specifies how assessments based on the use of air dispersion models should be undertaken. They include methods 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 to the approaches suggested by the 'Approved Methods'.

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

The model used was a modified version of the US EPA ISCST3 model (ISCMOD). ISCST3 is fully described in the user manual and the accompanying technical description (**US EPA, 1995a**).

The ISCST3 model has a tendency to overestimate short-term (24-hour) PM_{10} concentrations (**Holmes et al., 2007**). To overcome this difficulty the modelling algorithms were modified to create ISCMOD. ISCMOD is identical to ISC except that the horizontal plume spreading dispersion curves have been modified to adopt the recommendations of the American Meteorological Society's (AMS) expert panel on dispersion curves (**Hanna, 1977**) and the suggestions made by **Arya (1999).** The suggested changes were recommended because, as the AMS panel notes, the original horizontal dispersion curves relate to an averaging time of three minutes and they recommend that these be adjusted to the one hour curves required by ISC. The change involves increasing the horizontal plume widths by a factor of 1.82 (60 minutes / 3 minute)$^{0.2}$. The modifications improve the performance of the model in predicting 24-hour concentrations and make almost no difference to the annual average predictions.

A similar adjustment has been applied to account for the local surface roughness being different at the sites compared with the site where the original curves were developed. The sites have been taken to have a surface roughness of 0.3m compared with 0.03m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of (0.3m/ 0.03m)$^{0.2}$ namely 1.6.

The modelling has been based on the use of three particle-size categories (0 to 2.5µm - referred to as $PM_{2.5}$, 2.5 to 10µm - referred to as CM (coarse matter) and 10 to 30µm - referred to as the Rest). Emission rates of TSP have been calculated using emission factors developed both within NSW and by the US EPA (see **Appendix 3**). The distribution of particles has been derived from measurements published by the SPCC (**SPCC, 1986**). The distribution of particles in each particle size range is:

- $PM_{2.5}$ (FP) is 4.7% 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 ISC 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 1µm.

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

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 ISC 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 emissions rates will be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken into account, the model has the potential to significantly overstate impacts.

Three scenarios were assessed as follows:

- Scenario 2 - representative of operations at the end of Year 1.
- Scenario 3 - representative of operations at the end of Year 2.
- Scenario 4 - representative of operations at the end of Year 4.

It is noted that Scenario 1 is representative of operations during construction of the Project and has not been assessed. Scenarios 2, 3 and 4 were selected based on information provided by the Proponent as being 'worst-case' scenarios.

The location of volume sources are presented in **Figure 11** to **Figure 13**. A more detailed description of those scenarios is presented in the *Environmental Assessment*.

Dust concentrations and deposition rates have been predicted in the vicinity of the Mine Site for the three scenarios that were modelled. The local terrain has been taken into consideration for the modelling.

The modelling has been performed using the meteorological data discussed in **Section 4.2** and the dust emission estimates from **Section 7**. As an example, an ISCMOD input file is provided in **Appendix 3**.

All activities have been modelled for 24 hours per day, with the following exceptions.

- Blasting has been assumed to occur between the hours of 9am and 5pm; and
- Dozers working on waste dumps have been assumed to occur between the hours of 6am and 7pm.

Section 7 provides details of dust emissions and allocation of sources for each activity.

To assess the air quality impacts of the proposed mining operations alone, the activities associated with the Project have been modelled in isolation. Contour plots were created and also the results at specific receptor locations were determined in order to assess the contribution of mining activities to local air quality. Model predictions were then compared to the OEH criteria for deposited dust and 24-hour $PM_{10.}$

For assessment of the cumulative impacts of the proposed mining operations, a separate set of model results have been presented which consider the contribution of other dust sources in the area through the use of a constant background level for 24-hour PM_{10}, annual average TSP, PM_{10} and dust deposition (see **Section 5.4**).

7 ESTIMATED EMISSIONS OF PARTICULATE MATTER

The operation of the Project has been analysed and estimates of dust emissions for the individual activities for modelled scenarios have been made. Total dust emissions due to the Project have been estimated by analysing the proposed activities during each of the proposed scenarios.

The identified activities have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. The emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. The plans for the Project have been analysed and detailed emissions inventories have been prepared for each of the three scenarios.

Table 8.1 presents the emission inventories for each scenario modelled. These emissions inventories provide information on the equations used, the basic assumptions about material properties (e.g. moisture content, silt content etc.), information on the way in which equipment would be used to undertake different operations and the quantities of materials that would be handled in each operation. **Figure 11** to **Figure 13** show the numbered locations that represent dust sources assumed in the modelling. The activities that are associated with each of the numbered locations are identified in **Appendix 3**.

8 ASSESSMENT OF IMPACTS

8.1 INTRODUCTION

The air quality criteria used for identifying which sensitive receptors are likely to experience air quality impacts are those specified by the OEH. These have been discussed in **Section 3**.

The following sub-sections provide a summary of the modelling results for each modelled scenario at each of the sensitive receptors in the proximity of the Mine Site. The locations of these receptors are shown in **Figure 3**. The results include predicted impacts from the Project alone and the cumulative impacts with existing background levels as outlined in **Section 5.4**.

Table 8.1
Estimated Dust Emissions from the Tomingley Gold Project

ACTIVITY	TSP emission Scenario 2 in (kg/y)	TSP emission Scenario 3 in (kg/y)	TSP emission Scenario 4 in (kg/y)
OB – Drilling	68,424	66,050	15,138
OB – Blasting	16,330	15,775	3,613
OB - Excavator loading OB to haul truck	5,193	3,977	1,088
OB - Hauling from Caloma OC to WRE 3	90,270	69,137	-
OB - Hauling from Caloma 2 OC to WRE 3	-	-	21,773
OB - Hauling from Wyoming 1 OC to WRE 1	6,200	4,749	5,348
OB - Hauling from Wyoming 3 OC to WRE 2	20,789	15,922	-
OB - Emplacing at WRE 3	2,337	1,790	326
OB - Emplacing at WRE 1	883	676	761
OB - Emplacing at WRE 2	1,973	1,511	-
OB - Dozers on OB	36,640	36,640	36,640
ORE – Drilling	1,277	928	2,114
ORE – Blasting	806	589	2,989
ORE - Dozers ripping/pushing/clean-up	109,963	109,963	109,963
ORE - Sh/Ex/FELs loading open pit ore to trucks	132,623	106,550	118,303
ORE - Hauling open pit ore from Caloma OC to ROM pad	15,374	12,352	-
ORE - Hauling open pit ore from Caloma 2 OC to ROM pad	-	-	13,298
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	8,184	6,575	30,060
ORE - Hauling open pit ore from Wyoming 3 to ROM pad	7,081	5,689	-
ORE - Unloading ROM to ROM stockpiles	442	355	394
ORE - FEL unloading ROM from stockpiles to ROM bin	442	355	394
ORE - Primary Crushing	30,041	24,135	26,797
ORE - Conveying to Screen Building	46	46	46
ORE - Unloading ore from conveyor to Screen Building	442	355	394
ORE – Screening	1,878	1,508	1,675
ORE - Conveying oversized material to Crushing Building	46	46	46
ORE - Unloading oversized ore from conveyor to Crushing Building	126	101	112
ORE - Secondary Crushing	85,616	68,784	76,371
ORE - Conveying oversized material to Screen Building	46	46	46
ORE - Conveying undersized material to Surge Bin	27	27	27
ORE - Unloading undersized ore from conveyor to Surge Bin	7	5	6
ORE - Conveying undersized material from Surge Bin to ball mill	44	44	44
ORE - Unloading undersized ore from conveyor to ball mill	22	18	20
REHAB - Dozers on rehab	-	3,861	3,861
WE - OB dump areas	245,280	223,730	223,730
WE - Residue Storage	51,824	51,824	51,824
WE - Open pit	198,677	198,677	198,677
WE - ROM stockpiles	1,402	1,402	1,402
Grading roads	86,264	86,264	86,264
Total	**1,227,019**	**1,120,458**	**1,033,545**

Note: OB – Overburden WE – Wind Erosion OC = Open Cut

Dust concentrations due to mining, processing and waste management operations have been presented as isopleth diagrams showing the following.

- Predicted maximum 24-hour average PM_{10} concentration.
- Predicted annual average PM_{10} concentration.
- Predicted annual average TSP concentration.
- Predicted annual average dust deposition.

In examining the maximum 24-hour average contour plots, it should be noted that plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that would occur at each location for the worst day in the modelled year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions. It should also be noted that the plots show the assessment criteria as a red contour line. Plots which consist of concentrations too low do not show the assessment criteria contour.

8.1.1 Scenario 2 – End Year 1

Figure 14 shows the predicted maximum 24-hour average PM_{10} concentration for operations in Scenario 2. **Figure 15** to **Figure 20** show the predicted annual average PM_{10}, TSP concentrations and dust deposition levels for operations in Scenario 2 for the Project alone and the Project and other sources.

Table 8.2 presents a summary of the Scenario 2 predicted concentrations at each of the nearby sensitive receptors, due to the operations of the Project alone and the Project and other sources.

Modelling results for Scenario 2 show no exceedances of the air quality criteria at any sensitive receptor surrounding the Mine Site.

8.1.2 Scenario 3 – End Year 2

Figure 21 shows the predicted maximum 24-hour average PM_{10} concentration for operations in Scenario 3. **Figure 22** to **Figure 27** show the predicted annual average PM_{10}, TSP concentrations and dust deposition levels for operations in Scenario 3 for the Project alone and the Project and other sources.

Table 8.3 presents a summary of the Scenario 3 predicted concentrations at each of the nearby sensitive receptors, due to the operations of the Project alone and the Project and other sources.

Table 8.2
Scenario 2 Model Predictions due to the Project Alone and the Project and Other Sources

Sensitive Receptor ID	Scenario 2 – Project alone				Scenario 2 - Project and other sources		
	PM10 (µg/m³)		TSP (µg/m³)	Dust Deposition (g/m²/month)	PM10 (µg/m³)	TSP (µg/m³)	Dust Deposition (g/m²/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	N/A	*N/A*	*N/A*	*2*	*30*	*90*	*4*
R1	16	3	3	0.1	23	54	2.1
R2	11	1	1	0.0	21	52	2.0
R3	34	5	6	0.2	25	57	2.2
R4	21	2	3	0.0	22	54	2.0
R5	21	3	4	0.1	23	55	2.1
R6	21	3	4	0.2	23	55	2.2
R8	6	1	1	0.0	21	52	2.0
R9	8	1	1	0.0	21	52	2.0
R10	15	2	2	0.1	22	53	2.1
R11	14	2	2	0.1	22	53	2.1
R12	8	1	1	0.0	21	52	2.0
R13	15	2	3	0.1	22	54	2.1
R16	19	3	3	0.1	23	54	2.1
R17	21	3	3	0.1	23	54	2.1
R18	10	1	2	0.1	21	53	2.1
R19	21	3	3	0.1	23	54	2.1
R21	20	3	3	0.2	23	54	2.2
R22	11	1	2	0.1	21	53	2.1
R23	23	3	4	0.2	23	55	2.2
R24	11	1	1	0.1	21	52	2.1
R25	23	3	4	0.2	23	55	2.2
R26	23	3	4	0.2	23	55	2.2
R27	12	1	1	0.1	21	52	2.1
R28	32	5	5	0.2	25	56	2.2
R29	33	5	6	0.2	25	57	2.2
R32	29	4	5	0.2	24	56	2.2
R33	26	4	4	0.2	24	55	2.2
R35	25	3	4	0.1	23	55	2.1
R37	22	3	3	0.1	23	54	2.1
R40	30	4	5	0.2	24	56	2.2

Modelling results for Scenario 3 show no exceedances of the air quality criteria at any sensitive receptor surrounding the Mine Site.

8.1.3 Scenario 4 – End Year 4

Figure 28 shows the predicted maximum 24-hour average PM_{10} concentration for operations in Scenario 4. **Figure 29** to **Figure 34** show the predicted annual average PM_{10}, TSP concentrations and dust deposition levels for operations in Scenario 4 for the Project alone and the Project and other sources.

Table 8.4 presents a summary of the Scenario 4 predicted concentrations at each of the nearby sensitive receptors, due to the operations of the Project alone and the Project and other sources.

Modelling results for Scenario 4 show no exceedances of the air quality criteria at any sensitive receptor surrounding the Mine Site.

Table 8.3
Scenario 3 Model Predictions due to the Project Alone and the Project and Other Sources

Sensitive Receptor ID	Scenario 3 – Project alone				Scenario 3 - Project and other sources		
	PM_{10} (µg/m^3)		TSP (µg/m^3)	Dust Deposition (g/m^2/month)	PM_{10} (µg/m^3)	TSP (µg/m^3)	Dust Deposition (g/m^2/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	N/A	*N/A*	*N/A*	*2*	*30*	*90*	*4*
R1	16	3	3	0.1	23	54	2.1
R2	11	1	1	0.0	21	52	2.0
R3	34	5	6	0.2	25	57	2.2
R4	21	2	3	0.0	22	54	2.0
R5	21	3	4	0.1	23	55	2.1
R6	21	3	4	0.2	23	55	2.2
R8	6	1	1	0.0	21	52	2.0
R9	8	1	1	0.0	21	52	2.0
R10	15	2	2	0.1	22	53	2.1
R11	14	2	2	0.1	22	53	2.1
R12	8	1	1	0.0	21	52	2.0
R13	15	2	3	0.1	22	54	2.1
R16	19	3	3	0.1	23	54	2.1
R17	21	3	3	0.1	23	54	2.1
R18	10	1	2	0.1	21	53	2.1
R19	21	3	3	0.1	23	54	2.1
R21	20	3	3	0.2	23	54	2.2
R22	11	1	2	0.1	21	53	2.1
R23	23	3	4	0.2	23	55	2.2
R24	11	1	1	0.1	21	52	2.1
R25	23	3	4	0.2	23	55	2.2
R26	23	3	4	0.2	23	55	2.2
R27	12	1	1	0.1	21	52	2.1
R28	32	5	5	0.2	25	56	2.2
R29	33	5	6	0.2	25	57	2.2
R32	29	4	5	0.2	24	56	2.2
R33	26	4	4	0.2	24	55	2.2
R35	25	3	4	0.1	23	55	2.1
R37	22	3	3	0.1	23	54	2.1
R40	30	4	5	0.2	24	56	2.2

8.2 PM_{10} 24-HOUR CUMULATIVE IMPACTS

It is important to note that it is not possible to accurately predict cumulative 24-hour PM_{10} concentrations many years into the future using dispersion modelling, in particular due to the variability in ambient levels and spatial and temporal variation in any day to day anthropogenic activity, including any future mining.

Experience shows that the worst-case 24-hour PM_{10} concentrations are strongly influenced by other sources in the area, such as bushfires and dust storms, which are essentially unpredictable. However, this does not mean that no action should be taken to control Project dust emissions.

Table 8.4
Scenario 4 Model Predictions due to the Project Alone and the Project and Other Sources

Sensitive Receptor ID	Scenario 4 – Project alone				Scenario 4 - Project and other sources		
	PM_{10} (µg/m³)		TSP (µg/m³)	Dust Deposition (g/m²/month)	PM_{10} (µg/m³)	TSP (µg/m³)	Dust Deposition (g/m²/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	N/A	***N/A***	***N/A***	***2***	***30***	***90***	***4***
R1	15	2	2	0.1	22	53	2.1
R2	10	1	1	0.0	21	52	2.0
R3	26	3	4	0.2	23	55	2.2
R4	16	2	2	0.0	22	53	2.0
R5	18	3	4	0.1	23	55	2.1
R6	21	3	4	0.3	23	55	2.3
R8	6	1	1	0.0	21	52	2.0
R9	7	1	1	0.0	21	52	2.0
R10	12	1	2	0.1	21	53	2.1
R11	11	1	1	0.0	21	52	2.0
R12	7	1	1	0.0	21	52	2.0
R13	14	2	2	0.1	22	53	2.1
R16	17	2	2	0.1	22	53	2.1
R17	19	2	3	0.1	22	54	2.1
R18	10	1	1	0.1	21	52	2.1
R19	18	2	3	0.1	22	54	2.1
R21	18	2	3	0.1	22	54	2.1
R22	10	1	1	0.1	21	52	2.1
R23	20	3	3	0.1	23	54	2.1
R24	11	1	1	0.1	21	52	2.1
R25	20	2	3	0.1	22	54	2.1
R26	19	2	3	0.1	22	54	2.1
R27	11	1	1	0.1	21	52	2.1
R28	25	3	4	0.1	23	55	2.1
R29	26	3	4	0.1	23	55	2.1
R32	23	3	3	0.1	23	54	2.1
R33	22	3	3	0.1	23	54	2.1
R35	20	3	3	0.1	23	54	2.1
R37	18	2	3	0.1	22	54	2.1
R40	24	3	3	0.1	23	54	2.1

As discussed in **Section 5.3**, there are currently no continuous measurements of PM_{10} available in the area that could be considered background, that is, ambient concentration due to all other sources excluding the emissions from the Project. However, extensive monitoring and analysis in the Hunter Valley indicates that where mining activities are a significant source of the particulate matter, then on an annual basis, approximately 40% of the TSP will be in the form of PM_{10}. In order to estimate PM_{10} concentrations in the area, it has been assumed that this is applicable to the available TSP data.

The Approved Methods describe two methods for assessing cumulative air quality impacts (see Section 11.2 of the Approved Methods).

The Level 1 assessment (suitable for a screening assessment) requires that the highest predicted concentration from a proposal is added to the highest observed concentration in a data set which provides measurements of PM_{10} concentrations representative of conditions at the site being assessed. As discussed above, due to a lack of PM_{10} monitoring data, 40% of TSP has been assumed to be PM_{10}. When this is applied, the maximum PM_{10} value across all of the HVAS monitored data would be a PM_{10} concentration of 93µg/m³. This concentration is already above the impact assessment criterion of 50µg/m³. Furthermore, these data are considered to be conservative as they were collected in close proximity to the Peak Hill Mine which was operating during monitoring.

A Level 2 assessment, contemporaneously adds observed and predicted 24-hour PM_{10} concentrations on the same day. This provides a more rigorous approach.

The Level 1 and Level 2 methods require that a data set exists that can provide information on 24-hour PM_{10} concentrations representative of the sites being assessed.

As previously discussed, continuous records of 24-hour PM_{10} concentrations are not available for this site. As the site has HVAS monitors recording TSP only there are no PM_{10} data available. It could be assumed that 40% of the HVAS TSP data is PM_{10}, however, the final year of TSP observations is 2002, whereas the meteorological file used for the dispersion modelling for the Project is. Therefore, these data could not be matched up and would not comply with a Level 2 DECCW assessment.

It is noted that the OEH operate a TEOM at Bathurst approximately 153 kilometres southeast of the Mine Site. Due to its distance and location in a densely populated urban city, which is a stark contrast to the rural setting of the Mine Site, data from this site would not be representative of ambient background levels surrounding the Project.

Due to reasons stated above, it would not be appropriate to follow the methodology in the Approved Methods as there are no continuous monitored PM_{10} data available. As such, the approach recommended by the Victorian EPA has been applied to the data (**VEPA, 2001**).

VEPA recommends that the monitored 70^{th} percentile PM_{10} concentration (in this case $25µg/m^3$) be added to the maximum prediction at each sensitive receptor. Applying this method provides an indication of PM_{10} concentrations in the absence of anomalous data due to extreme events such as bushfires and dust storms. It does, however, provide a potentially high estimation of 24-hour average background PM_{10} concentrations as adding this value to Project modelling results assumes that this level of $25µg/m^3$ will occur every day, which is clearly not the case as by definition background levels will be lower for 70% of the time.

Using the VEPA 70^{th} percentile approach, a level of $25µg/m^3$ can be added to the maximum 24-hour average modelling predictions for each receptor. This would mean that for a receptor to exceed the criterion, it would have to predict a concentration of $25µg/m^3$ from the Project alone.

Table 8.5 presents a summary of 24-hour PM_{10} predicted results for the Project alone and Project and other sources for all modelled scenarios. It is clear that the majority of receptors have recorded 24-hour PM_{10} concentrations of well below 25 $µg/m^3$. There are however, some predicted exceedances of the criteria when an assumed background level of $25µg/m^3$ (using the VEPA approach) is added to predicted concentrations. In Scenario 2 and 3 results for Receptors 3, 28, 29, 32, 33 and 40 are predicted to be above the 24-hour PM_{10} cumulative criterion. In Scenario 4 Receptors 3 and 29 are above the criterion.

Due to predicted exceedances of the PM_{10} 24-hour criterion shown at sensitive receptors, further analysis has been undertaken.

Figure 35 to **Figure 37** present histograms showing the percentage frequency of predicted PM_{10} 24-hour average concentrations (for mine only) at each of the receptors shown to exceed the cumulative criterion in **Table 8.5**.

Table 8.5
24-hour PM_{10} Project Alone and Cumulative Results for Each Modelled Scenario (Using VEPA 70th Percentile Method)

Residence ID	Scenario 2		Scenario 3		Scenario 4	
	Project alone PM_{10} (µg/m³) 24-hour	Cumulative PM_{10} (µg/m³) 24-hour	Project alone PM_{10} (µg/m³) 24-hour	Cumulative PM_{10} (µg/m³) 24-hour	Project alone PM_{10} (µg/m³) 24-hour	Cumulative PM_{10} (µg/m³) 24-hour
	Assessment Criteria					
	N/A	*50*	*N/A*	*50*	*N/A*	*50*
R1	16	41	16	41	15	40
R2	11	36	11	36	10	35
R3	34	**59**	34	**59**	26	**51**
R4	21	46	21	46	16	41
R5	21	46	21	46	18	43
R6	21	46	21	46	21	46
R8	6	31	6	31	6	31
R9	8	33	8	33	7	32
R10	15	40	15	40	12	37
R11	14	39	14	39	11	36
R12	8	33	8	33	7	32
R13	15	40	15	40	14	39
R16	19	44	19	44	17	42
R17	21	46	21	46	19	44
R18	10	35	10	35	10	35
R19	21	46	21	46	18	43
R21	20	45	20	45	18	43
R22	11	36	11	36	10	35
R23	23	48	23	48	20	45
R24	11	36	11	36	11	36
R25	23	48	23	48	20	45
R26	23	48	23	48	19	44
R27	12	37	12	37	11	36
R28	32	**57**	32	**57**	25	50
R29	33	**58**	33	**58**	26	**51**
R32	29	**54**	29	**54**	23	48
R33	26	**51**	26	**51**	22	47
R35	25	50	25	50	20	45
R37	22	47	22	47	18	43
R40	30	**55**	30	**55**	24	49

Figure 35 and **Figure 36** show that in Scenarios 2 and 3, greater than 60% of concentrations over the modelled year are below 5µg/m³ for all receptors. **Figure 37** shows that in Scenario 4 greater than 70% of concentrations over the modelled year are below 5µg/m³ for all receptors.

Adopting a background of 25µg/m³ (as per previous discussion), the predicted 24-hour PM_{10} concentration will need to be below 25µg/m³ in order for impacted properties to comply with the 50µg/m³ criterion. Modelling results show that there is only one day (0.3% of the time) where the criterion is predicted to be exceeded throughout the year at each receptor and in each Scenario.

There is a 30% probability of the background level being over 25µg/m³ and a 0.3% probability of the Project contribution being over 25µg/m³. The probability of these two events occurring simultaneously is therefore approximately 0.09% of the time annually, or about one day in three years. This predicted frequency of exceedances of the 24-hour PM_{10} criterion (50µg/m³) indicates that the Project is unlikely to pose any significant risk to receptors in Scenarios 2, 3 and 4.

9 MITIGATION MEASURES

9.1 INTRODUCTION

The modelling results presented above are based on the assumption that Alkane applies the control measures discussed in **Section 9.2** to minimise dust emissions. This section outlines procedures proposed for the management and control of dust emissions.

9.2 PROPOSED DUST MANAGEMENT AND CONTROL PROCEDURES

The term "best practice" is frequently used in pollution control and pollution management. However, what constitutes "best practice" is difficult to define in practical situations. In 1998, Environment Australia published a series of booklets to assist the mining industry with incorporating best practice environmental management through all phases of mineral production from exploration through construction and eventual closure. In the booklet for Dust Control (**Environment Australia, 1998**) "best practice" is defined as follows:

> *"Best Practice can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations and by identifying and controlling dust sources during the active phases of all mining operations."*

This document has since been updated by the Department of Energy, Resources and Tourism (DERT) who have published the handbook *Leading Practice Sustainable Development Program for the Mining Industry* (**DERT, 2009**). This new handbook introduces the term "leading practice", which:

> "...*considers the latest and most appropriate technology applied in order to seek better financial, social and environmental outcomes for present stakeholders and future generations*."

Specific best practice measures for coal mining operations are outlined in the recent DECCW document *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, 2010* (**Katestone, 2010**). Whilst not specific to gold mining operations, the open-cut nature of the proposed Project would result in the generation of dust emissions from similar sources. As such **Katestone (2010)** provides valuable guidance on controlling emissions from the Project.

Dust emissions from the Mine Site would be generated from two primary sources:

- Wind-blown dust from exposed areas; and
- Dust generated by mining activities.

The following procedures are proposed for the management of dust emissions from the Project. The aim of these is to minimise the emission of dust in a cost effective manner. The effects of these controls are included in the model simulations. The proposed controls have been considered against those determined to be best or leading practice in **DERT (2009)**.

Table 9.1 and **Table 9.2** list the different sources of wind-blown and mining-generated dust respectively, together with the proposed best-practice controls.

Table 9.1
Best Practice Control Procedures for Wind-blown Dust

Source	Control Procedures	To be Applied
Areas disturbed by mining	Disturb only the minimum area necessary for mining. Reshape, topsoil and rehabilitate completed overburden emplacement areas as soon as practicable after the completion of overburden tipping.	Yes
Ore handling areas / stockpiles	Maintain ore handling areas / stockpiles in a moist condition as required using water carts to minimise wind-blown and traffic-generated dust.	Yes
ROM Stockpiles	Have available water carts on ROM stockpiles to minimise the generation of dust.	Yes

Table 9.2
Best Practice Controls for mine-generated dust

Source	Control procedures	To be Applied
Haul Road Dust	All roads and trafficked areas will be watered as required using water trucks to minimise the generation of dust. All haul roads will have edges clearly defined with marker posts or equivalent to control their locations, especially when crossing large overburden emplacement areas. Obsolete roads will be ripped and re-vegetated.	Yes
Minor roads	Development of minor roads will be limited and the locations of these will be clearly defined. Minor roads used regularly for access etc. will be watered. Obsolete roads will be ripped and re-vegetated.	Yes
Topsoil Stripping	Access tracks used by topsoil stripping equipment during their loading and unloading cycle will be watered.	Yes
Topsoil Stockpiling	Long term topsoil stockpiles, not regularly used will be re-vegetated.	Yes
Drilling	Dust aprons will be lowered during drilling. Drills will be equipped with dust extraction cyclones, or water injection systems. Water injection or dust suppression sprays will be used when high levels of dust are being generated.	Yes
Blasting	Meteorological conditions will be assessed prior to blasting. Adequate stemming will be used at all times.	Yes
Transfer Points	All transfer points will be enclosed.	Yes
Processing	Activities in the processing plant will be dust controlled with the use of fabric filters, sprays, covers or dust collectors.	Yes

10 GREENHOUSE GAS ASSESSMENT

10.1 INTRODUCTION

Greenhouse gas emissions have been estimated based upon the methods outlined in the following documents:

- The World Resources Institute/World Business Council for Sustainable Development Greenhouse Gas Protocol (WBCSD/WRI 2004);
- National Greenhouse and Energy Reporting (Measurement) Determination 2008; and
- The Australian Government Department of Climate Change and Energy Efficiency (DCCEE) National Greenhouse Accounts Factors 2010.

The Greenhouse Gas Protocol establishes an international standard for accounting and reporting of greenhouse gas emissions. The Greenhouse Gas Protocol has been adopted by the International Standard Organisation, endorsed by greenhouse gas initiatives (such as the Carbon Disclosure Project) and is compatible with existing greenhouse gas trading schemes.

Three ‘scopes’ of emissions (scope 1, scope 2 and scope 3) are defined for greenhouse gas accounting and reporting purposes. This terminology has been adopted in Australian greenhouse reporting and measurement methods and has been employed in this assessment. The ‘scope’ of an emission is relative to the reporting entity, indirect scope 2 and scope 3 emissions will be reportable as direct scope 1 emissions from another facility.

1) Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources, the principal source of greenhouse emissions associated with the operation of the Project;
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials, e.g., the manufacture of cement, aluminium, etc.;
- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars); and
- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting); HFC emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

2) Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that account for greenhouse gas emissions from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity.

Scope 2 in relation to the Project covers purchased electricity, defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity. Scope 2 emissions physically occur at the facility where electricity is generated. Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as scope 2.

3) Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the Greenhouse Gas Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

The Greenhouse Gas Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and Scope 2. However, the Greenhouse Gas Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary.

Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The Greenhouse Gas Protocol also recognises that compliance regimes are more likely to focus on the "point of release" of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.

10.2 GREENHOUSE GAS ASSESSMENT POLICY SUMMARY

The *National Greenhouse and Energy Reporting Act 2007 (*NGER Act) was passed in September 2007. The NGER Act establishes a mandatory corporate reporting system for greenhouse gas emissions, energy consumption and production. The NGER scheme consolidates existing greenhouse reporting schemes. The NGER Act is underpinned by a number of legislative instruments that provide greater detail about obligations, which in conjunction with the NGER Act, form the National Greenhouse and Energy Reporting System, as follows:

- The National Greenhouse and Energy Reporting Regulations 2008; and
- The National Greenhouse and Energy Reporting (Measurement) Determination 2008.

NGER is seen as an important first step in the establishment of a domestic emissions trading scheme. Companies must register and report if they emit greenhouse emissions or produce/consume energy at or above the following trigger thresholds:

- If they own facilities that emit greater than 25 kilotonnes (kt) greenhouse emissions (expressed as CO_2-e) or produce consume greater than 100 terajoules (TJ) of energy; and
- If the corporate group emits greater than 125 kt of greenhouse emissions (expressed as CO_2-e) or produce consume greater than 500 TJ of energy.

Scope 1 and Scope 2 greenhouse gas emissions are required to be reported under the NGER Act.

10.3 GREENHOUSE GAS EMISSION ESTIMATES

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (referred to as global warming potentials) and emission factors take into account the global warming potentials of the gases created during combustion. The estimated emissions are referred to in terms of carbon dioxide equivalent or CO_2-equivalent (CO_2-e) emissions by applying the relevant global warming potential.

The greenhouse gas assessment has been conducted using the National Greenhouse Accounts (NGA) Factors, published by the Department of Climate Change and Energy Efficiency (**DCCEE, 2010**). Project-related greenhouse gas sources included in the assessment are as follows:

- Diesel combustion during mine operations - Scope 1;
- Indirect emissions resulting from off-site diesel extraction and transport - Scope 3;
- Explosives (ANFO) used in blasting - Scope 1;
- LPG used in processing operations - Scope 1; and
- Indirect emissions resulting from the consumption of purchased electricity - Scope 2 and Scope 3.

Emissions from the shipping of product are not included in this assessment due to the difficulties in emission estimates, including uncertainty in export markets and destination of product into the future and limited data on emission factors and / or fuel consumption for ocean going vessels.

10.3.1 Emission Factors

Data provided in the National Greenhouse Accounts (NGA) Factors, published by the Commonwealth Department of Climate Change (DCC) (**DCC, 2009a**) were used. DCC defines three ‘scopes’ (or emission categories):

Table 10.1 provides a summary of the emission factors used.

Table 10.1
Summary of Emission Factors for Greenhouse Gas Assessment

Emission Source	Emission Factor		Energy Content		Scope	Source
Diesel - Non-transport activities	69.5	kg CO_2-e/GJ	38.6	GJ/kL	1	Table 3 (**DCC, 2009a**)
	5.3	kg CO_2-e/GJ	39.6	GJ/kL	3	Table 38 (**DCC, 2009a**)
LPG - Processing	59.9	kg CO_2-e/GJ	25.7	GJ/kL	1	Table 3 (**DCC, 2009a**)
Electricity	0.89	kg CO_2-e/kWh	-	-	2	Table 39 (**DCC, 2009a**)
	0.18	kg CO_2-e/kWh	-	-	3	Table 3 (**DCC, 2009a**)
Explosives (ANFO)*	0.17	CO_2/tonne product	-	-	1	Table 4 (**DCC, 2008a**)

* It is noted that the AGO Factors and Methods were replaced by the NGA Factors (**DCC, 2009a**), however the emission factor for explosives was dropped from the latest version. Emissions from explosives do not have to be reported under NGERS.

10.3.2 Scope 1 Emissions

10.3.2.1 Fuel Consumption

Based on information provided by Alkane, **Table 10.2** presents a summary of annual on-site diesel and LPG fuel usage.

Table 10.2
Summary of On-site Diesel and LPG Usage

Operational year	Diesel usage per year (L)	LPG usage per year (L)
Construction (4-5 months)*	446,206	-
Year 1	5,569,152	418,080
Year 2	5,579,844	418,080
Year 3	5,668,976	418,080
Year 4	5,438,036	418,080
Year 5	4,058,756	418,080
Year 6	1,354,689	418,080
Year 7	340,000	418,080
Year 8	340,000	418,080
Total (L)	**28,795,659**	**3,344,640**

* There will be a total of 12 months construction at the site however; the Project will begin operating within 4-5 months of construction commencing. It has been assumed that all fuel used during the initial construction period will be diesel.
N.B: Years 6, 7 and 8 will be underground mining only.
Source: **Alkane Resources Ltd**

Energy content factors used are provided in **Table 10.1**.

The following formula (**DCC, 2009a**) was used to estimate the greenhouse gas emissions from fuel usage:

$$GHG\ Emissions\ \ tCO_2 - e\ = \frac{Q \times EC \times EF}{1000} \qquad \text{Equation 1}$$

Where:
Q = quantity of fuel in tonnes or thousands of litres
EC = energy content of the fuel in GJ/tonne or GJ/kL
EF = relevant emission factor in kg CO_2-e/GJ

Fuel consumption emission factors used are provided in **Table 10.1**.

The projected GHG emissions from Diesel and LPG usage are presented in **Table 10.3**.

Table 10.3
Estimated (Scope 1) CO_2-e Emissions from Consumption of Fuels on the Mine Site

Operational year	Diesel CO_2-e emissions (t CO_2-e/y)	LPG CO_2-e emissions (t CO_2-e/y)
Construction (4-5 months)	1,197	-
Year 1	14,940	644
Year 2	14,969	644
Year 3	15,208	644
Year 4	14,589	644
Year 5	10,888	644
Year 6	3,634	644
Year 7	912	644
Year 8	912	644
Total	**77,250**	**5,149**

10.3.2.2 ANFO Usage

Based on information provided by Alkane, **Table 10.4** presents a summary of annual on-site explosives (ANFO) usage.

Table 10.4
Summary of On-site ANFO Usage (t/y)

Operational year	ANFO usage per year (t/y)
Construction (4-5 months)	280
Year 1	2,948
Year 2	2,816
Year 3	1,940
Year 4	1,285
Year 5	81
Year 6	276
Year 7	408
Year 8	239
Total	**10,273**

To calculate emissions from explosives, the following equation was used:

GHG Emissions = Q x EF$GHG\ Emissions\ \ tCO_2 - e\ = Q \times \frac{EF}{1000}$

Equation 3

Where:

Q = explosives used in t

EF = relevant emission factor in t CO_2/t product

Explosives usage emission factors used are provided in **Table 10.1**.

The projected GHG emissions from explosives (ANFO) usage are presented in **Table 10.5**.

Table 10.5
Estimated (Scope 1) CO_2-e Emissions from Explosives (ANFO) Use on the Mine Site

Operational year	Explosives (ANFO) CO_2-e emissions (t CO_2-e/y)
Construction (4-5 months)	48
Year 1	501
Year 2	479
Year 3	330
Year 4	218
Year 5	14
Year 6	47
Year 7	69
Year 8	41
Total	**1,746**

10.3.3 Scope 2 Emissions

10.3.3.1 Electricity Consumption

Based on information provided by Alkane, electricity consumption on-site would be approximately 34.5GWhr/yr with a total usage of 276GWhr for the life of the Project.

Table 10.6 presents a summary of purchased electricity consumption.

Table 10.6
Summary of Consumption of Purchased Electricity (GWh)

Operational year	Electricity consumption per year (GWh)
Construction (4-5 months)	-
Year 1	34.5
Year 2	34.5
Year 3	34.5
Year 4	34.5
Year 5	34.5
Year 6	34.5
Year 7	34.5
Year 8	34.5
Total	**276**

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ \ tCO_2 - e\ = Q \times \frac{EF}{1000} \qquad \text{Equation 2}$$

Where:
Q = electricity consumed in GJ
EF = relevant emission factor in kg CO_2-e/GJ

Electricity consumption (Scope 2) emission factors used are provided in **Table 10.1**.

The projected GHG emissions from purchased electricity usage are presented in **Table 10.7**.

Table 10.7
Estimated (Scope 2) CO_2-e Emissions from Electricity Consumption

Operational year	Electricity CO_2-e emissions (t CO_2-e/y)
Construction (4-5 months)	-
Year 1	30,705
Year 2	30,705
Year 3	30,705
Year 4	30,705
Year 5	30,705
Year 6	30,705
Year 7	30,705
Year 8	30,705
Total	**245,640**

10.3.4 Scope 3 Emissions

10.3.4.1 Diesel Extraction and Transport

Based on information provided by Alkane, **Table 10.2** presents a summary of diesel consumption at the Project site. These values are used to calculate the GHG emissions from diesel extraction and transport before use by the proponent. Equation 1 in **Section 10.4.3.1** was used to calculate emissions from diesel extraction and transport.

Diesel extraction and transport (Scope 3) emission factors used are provided in **Table 10.1**.

The projected GHG emissions from the extraction and transport of diesel are presented in **Table 10.8**.

Table 10.8
Estimated (Scope 3) CO_2-e Emissions from the Extraction and Transport of Diesel

Operational year	Diesel CO_2-e emissions (t CO_2-e/y)
Construction (4-5 months)	91
Year 1	1,139
Year 2	1,142
Year 3	1,160
Year 4	1,113
Year 5	830
Year 6	277
Year 7	70
Year 8	70
Total	**5,891**

10.3.4.2 Generation of Purchased Electricity

Based on information provided by Alkane, **Table 10.6** presents a summary of purchased electricity consumption at the Project site. These values are used to calculate the GHG emissions from electricity generated off-site before purchase by the proponent. Equation 2 in **Section 10.4.5.1** was used to calculate emissions from electricity generation.

Electricity generation emission factors used are provided in **Table 10.1**.

The projected GHG emissions from the generation of purchased electricity usage are presented in **Table 10.9**.

Table 10.9
Estimated (Scope 3) CO_2-e Emissions from the Generation of Purchased Electricity Use

Operational year	Electricity CO_2-e emissions (t CO_2-e/y)
Construction (4-5 months)	-
Year 1	6,210
Year 2	6,210
Year 3	6,210
Year 4	6,210
Year 5	6,210
Year 6	6,210
Year 7	6,210
Year 8	6,210
Total	**49,680**

10.4 GREENHOUSE GAS EMISSIONS RESULTS

A summary of the total GHG emissions associated with the Project are presented in **Table 10.10**.

Table 10.10
Summary of Estimated CO_2-e Emissions (t CO_2-e/y)

Year	Scope 1	Scope 2	Scope 3	Total
Construction (4-5 months)	1,245	-	91	1,336
Year 1	16,085	30,705	7,349	54,139
Year 2	16,091	30,705	7,352	54,148
Year 3	16,182	30,705	7,370	54,256
Year 4	15,451	30,705	7,323	53,478
Year 5	11,546	30,705	7,040	49,291
Year 6	4,325	30,705	6,487	41,517
Year 7	1,625	30,705	6,280	38,610
Year 8	1,596	30,705	6,280	38,581
Total	**84,145**	**245,640**	**55,571**	**385,356**

The annual greenhouse emissions in NSW for 2008 were 156.4Mt (**DCCEE, 2010**). **Table 10.11** presents the CO_2-e emission percentage increase for each year of the Project's operations above the NSW 2008 greenhouse emission estimate. These estimates include all scope emissions.

Table 10.11
Summary of Estimated Percentage Increase CO_2-e Emissions (t CO_2-e/y)

Year	% Increase from NSW 2008 greenhouse emissions
Construction (4-5 months)	0.001
Year 1	0.035
Year 2	0.035
Year 3	0.035
Year 4	0.034
Year 5	0.032
Year 6	0.027
Year 7	0.025
Year 8	0.025

For the life of the Project, it has been estimated that the development would release approximately 0.38Mt CO_2-e (all scopes emissions). The maximum annual increase of emissions would be in Years 1, 2 and 3 which would represent an approximate annual contribution of 0.04% to baseline 2008 NSW emissions.

11 CONCLUSIONS

This report has assessed the air quality associated with the proposed Tomingley Gold Project in central west New South Wales.

Three operating scenarios have been assessed to represent the potential air quality impacts that the Project would have on sensitive receptors (e.g. residences) in the proximity of the Mine Site.

Dispersion modelling has been used to assess the impact that dust emissions from the operation would have on the local air quality. The emissions inventories developed for each of the three stages have been used with local meteorological data and a modified version of the US EPA's ISCST3 model to predict the maximum 24-hour PM_{10}, annual average PM_{10}, annual average TSP and annual average dust deposition (insoluble solids). The modelling has been undertaken to show the effects of the Tomingley Gold Project alone and with background dust levels considered.

It is concluded that air quality impacts would not exceed the annual assessment criteria at any of the surrounding sensitive receptors.

Based on a conservative assessment, modelling results for cumulative PM_{10} 24-hour impacts show predicted exceedances of the criterion at the following sensitive receptors:

- Scenario 2 – Receptors 3, 28, 29, 32, 33 and 40.
- Scenario 3 – Receptors 3, 28, 29, 32, 33 and 40.
- Scenario 4 – Receptors 3 and 29.

A greenhouse gas assessment has been conducted using the National Greenhouse Accounts Factors. A project is required to report to the NGER system if it will emit greater than 25kt of greenhouse emissions. As such, the Project would be subject to the reporting under the system. For the life of the Project, it has been estimated that the development would release approximately 0.38Mt CO_2-e (all scope emissions). The maximum annual increase of emissions would be in Years 1, 2 and 3 which would represent an approximate contribution of 0.04% (all scope emissions) to baseline 2008 NSW emissions.

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FIGURES

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(Note: Figures 15 to 34 are provided in colour on the Project CD)

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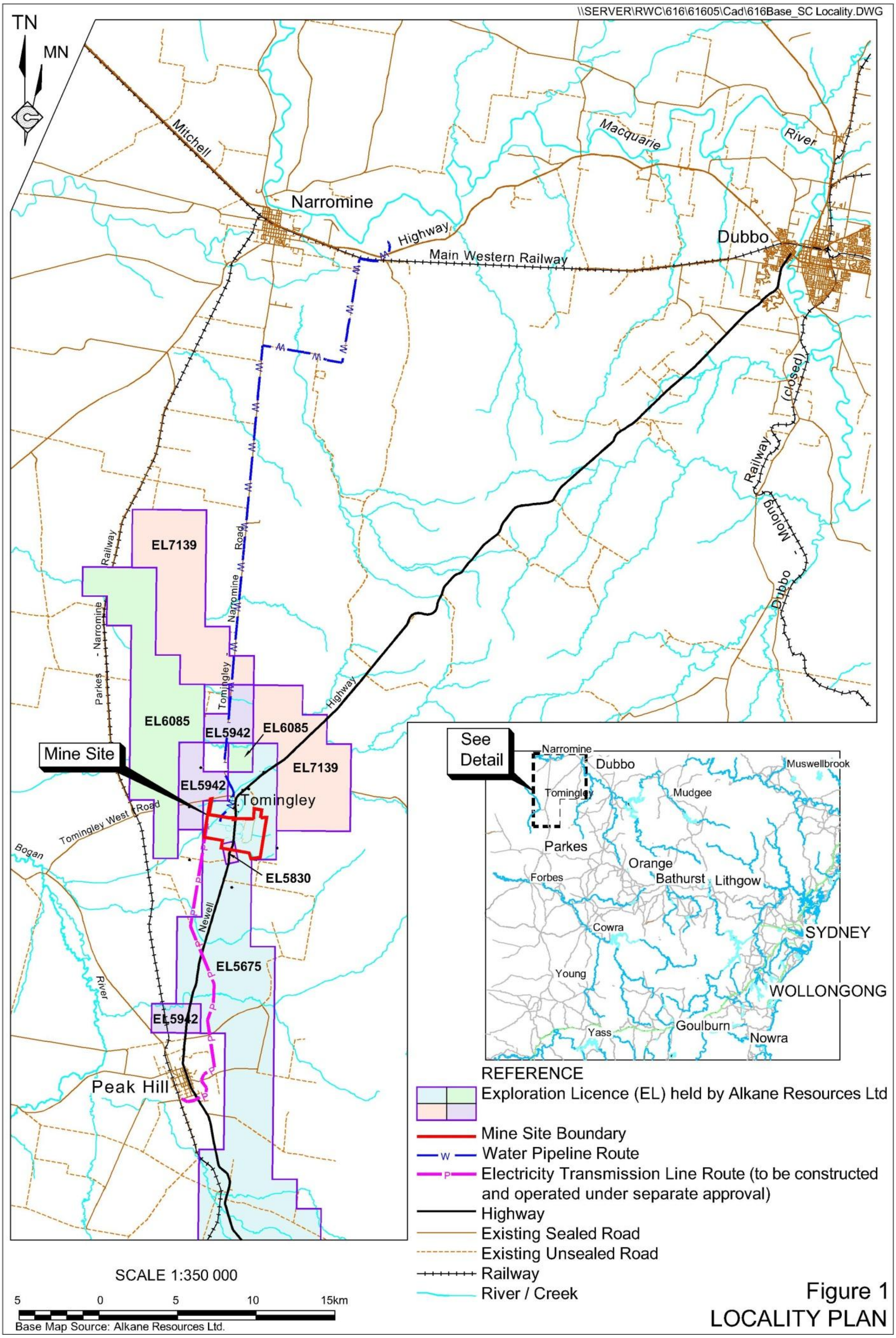

Figure 1
LOCALITY PLAN

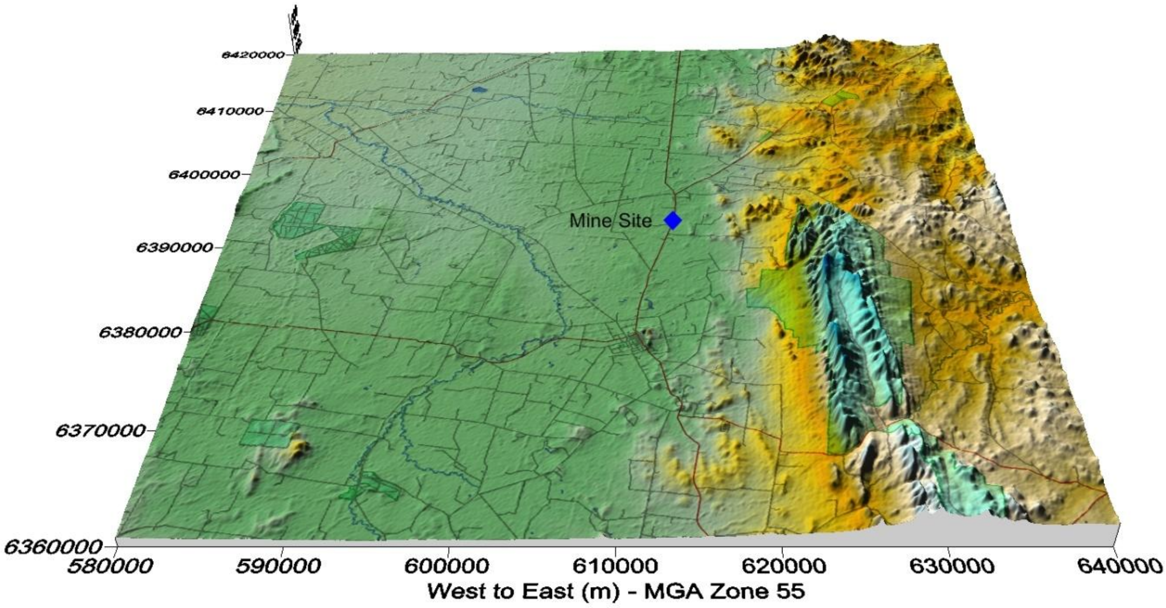

Figure 2: Pseudo 3D plot of local terrain

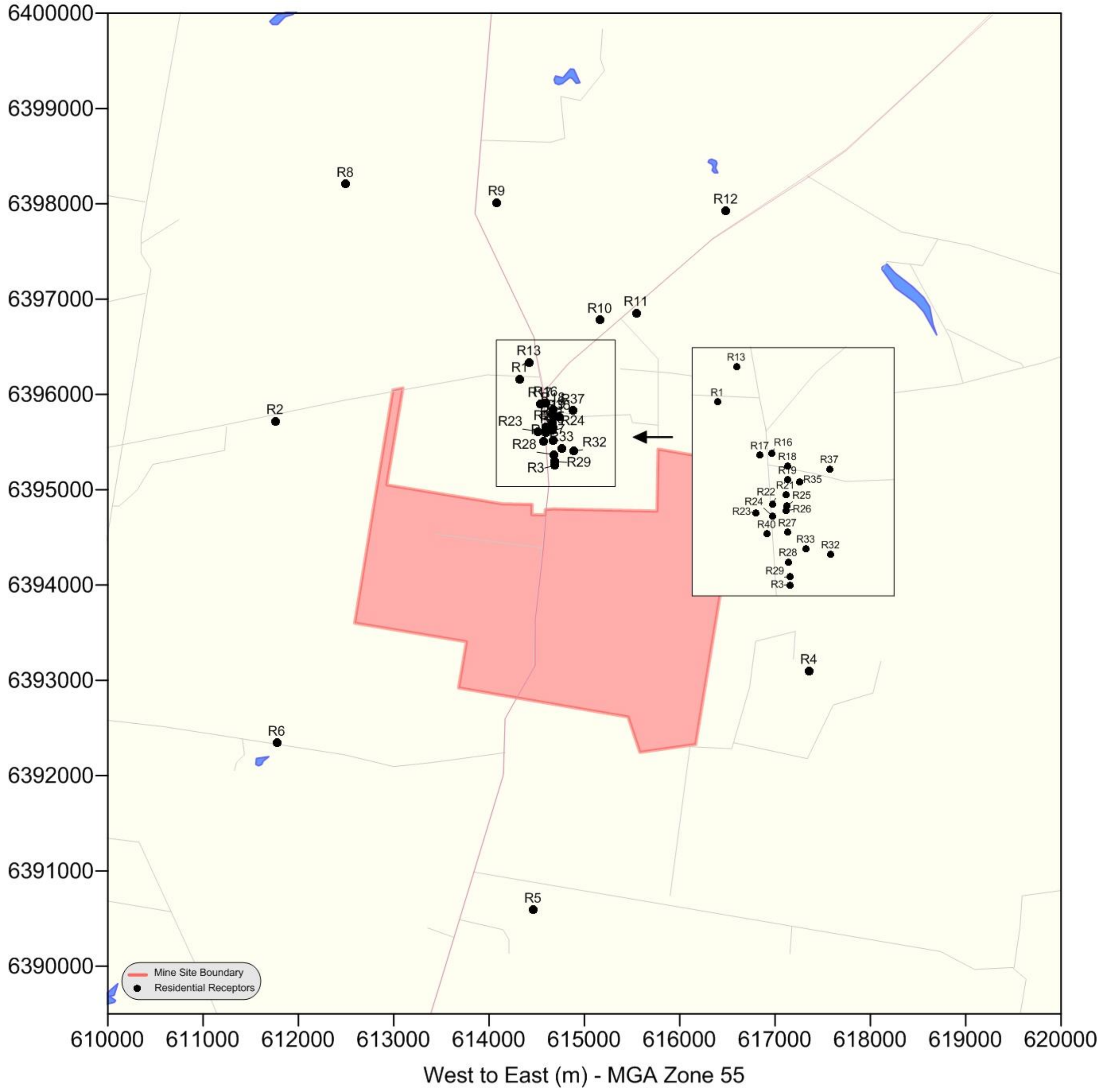

Figure 3: Location of Sensitive Receptors

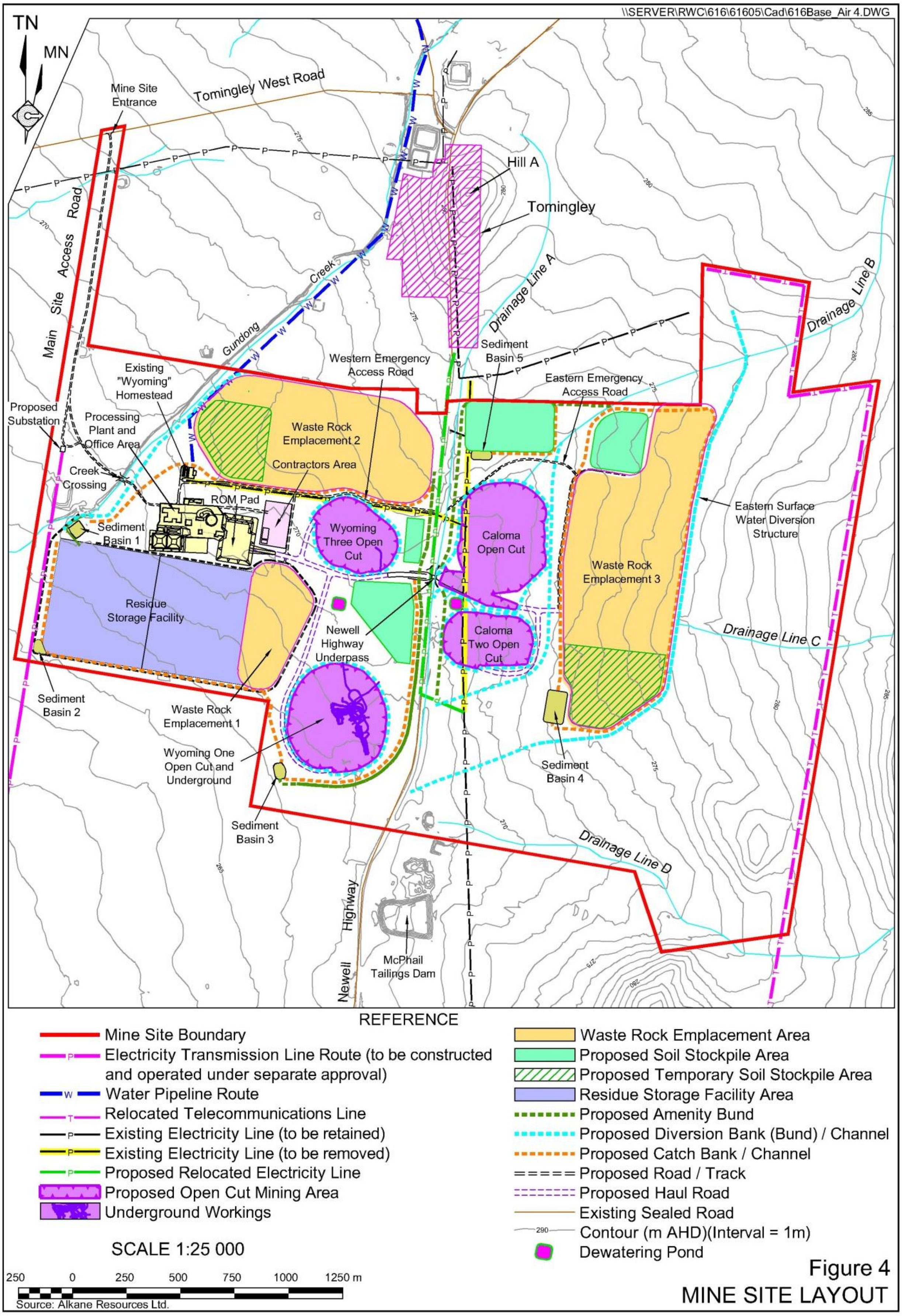

Figure 4
MINE SITE LAYOUT

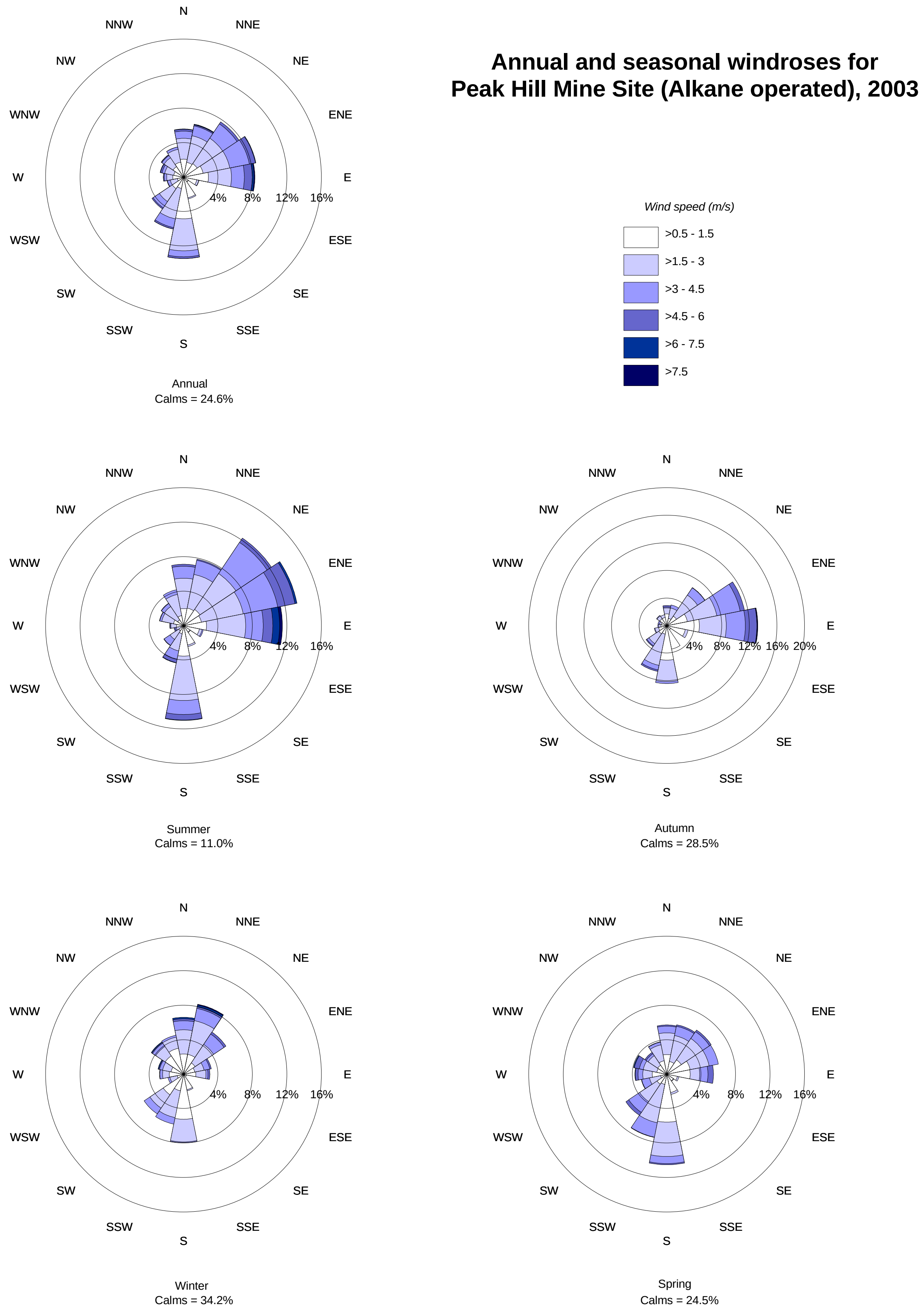

Figure 5: Wind Rose for Peak Hill Mine Site (Alkane operated) Meteorological Station, 2003

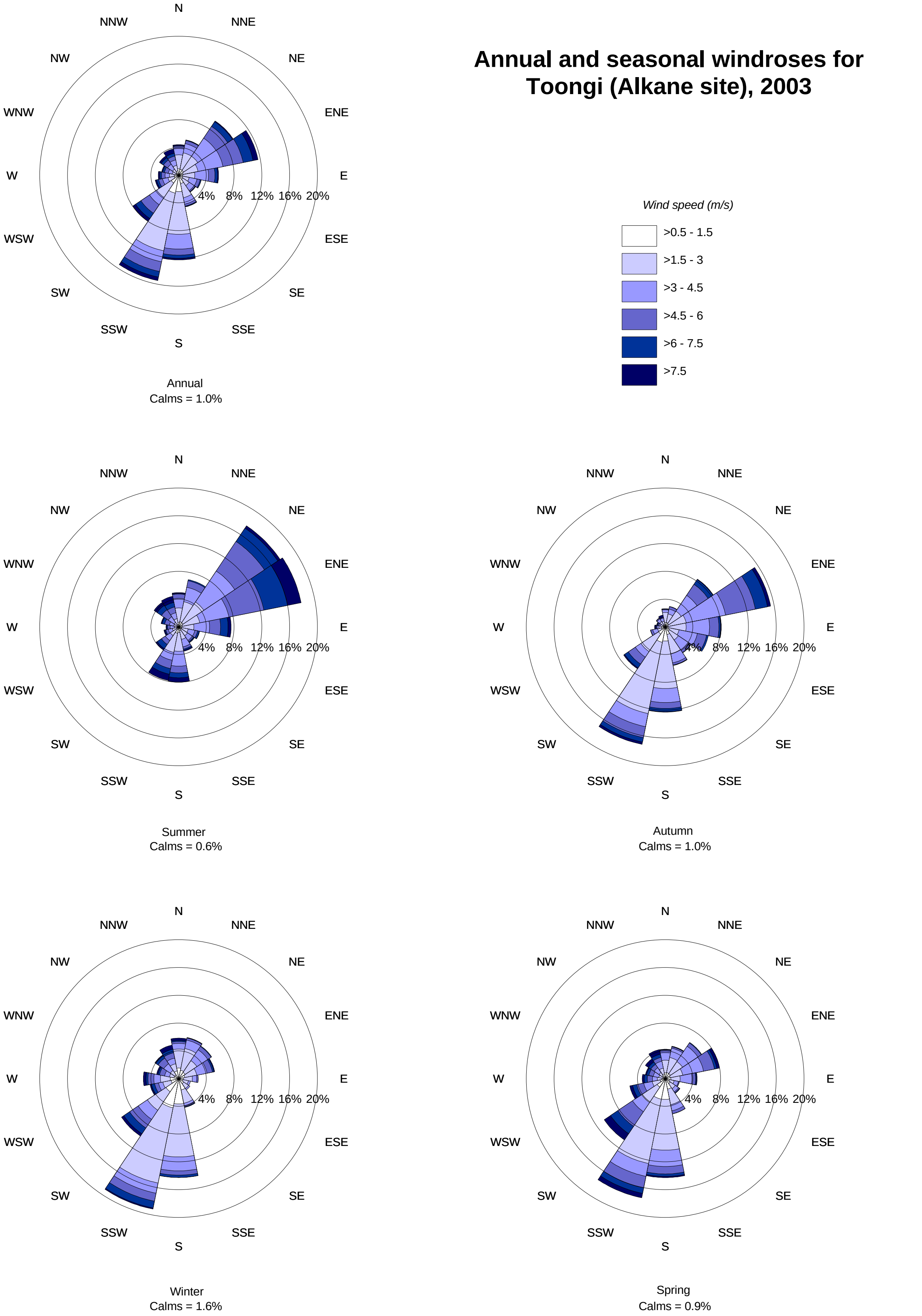

Figure 6: Wind Rose for Toongi (Alkane operated) Meteorological Station, 2003

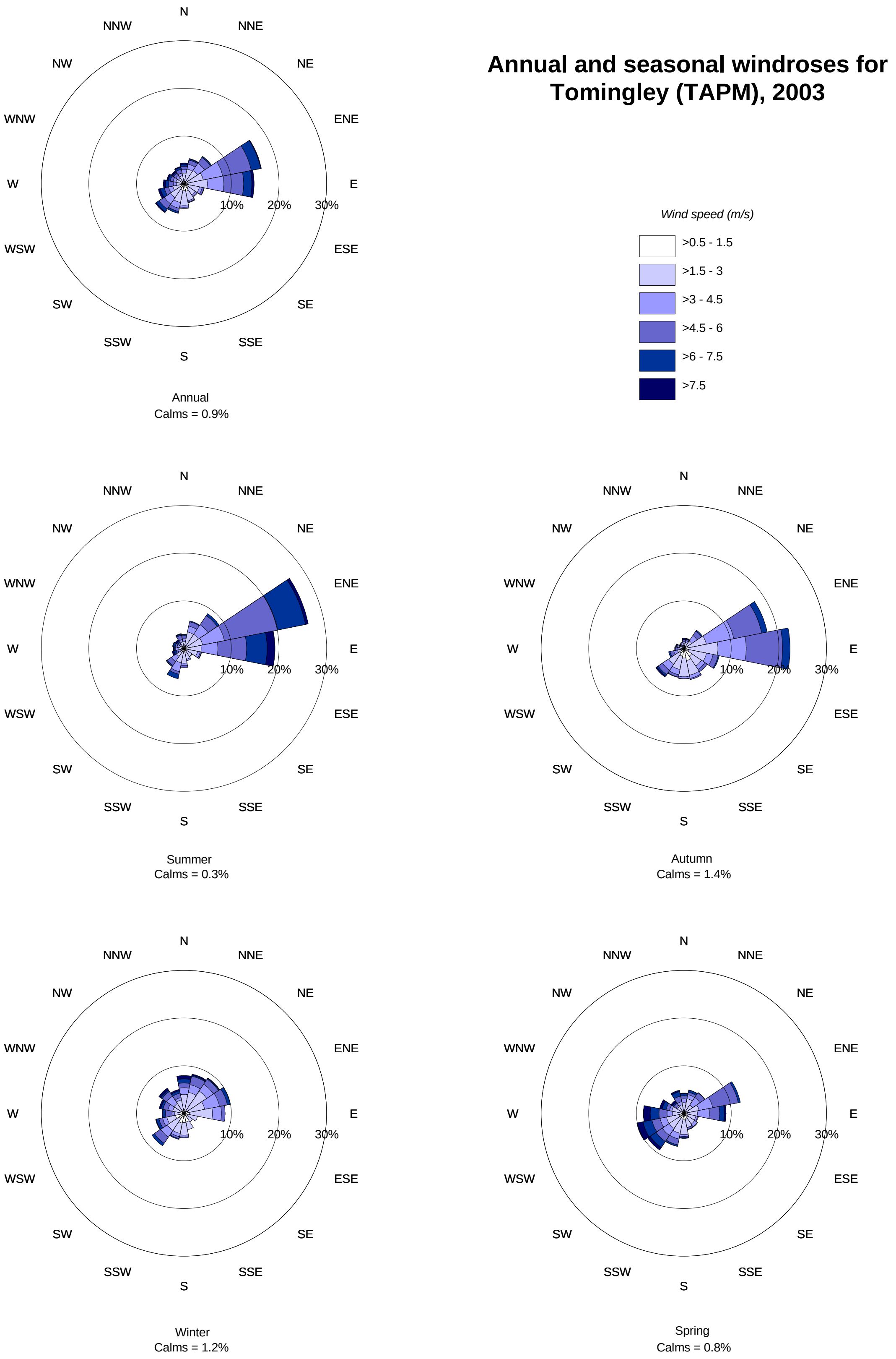

Figure 7: Wind Rose for Tomingley – TAPM generated, 2003

Figure 8: Wind Rose for Tomingley (TAPM) with Peak Hill (Alkane operated) observations, 2003

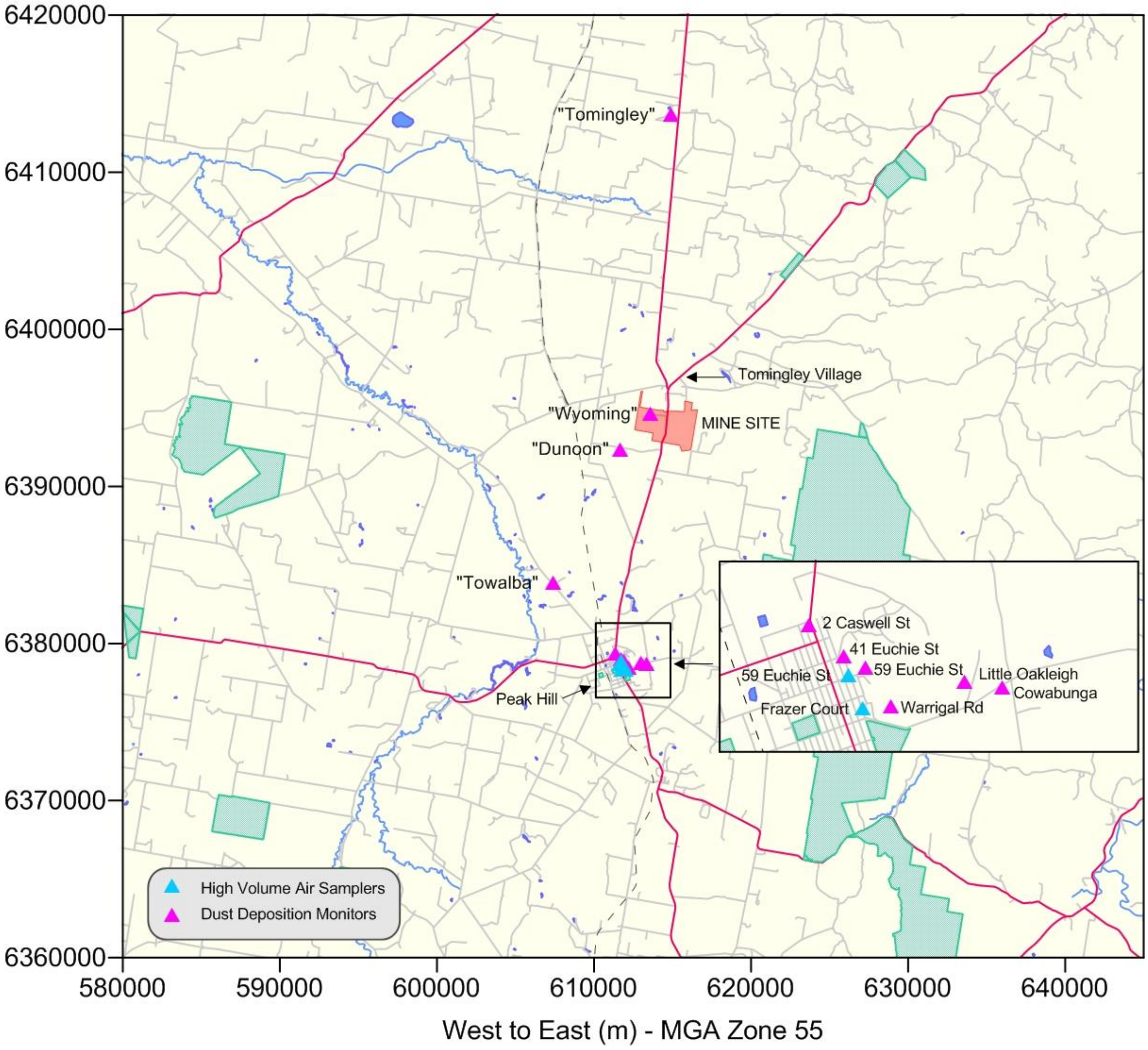

Figure 9: Location of Dust Deposition Monitors and High Volume Air Samplers (HVAS)

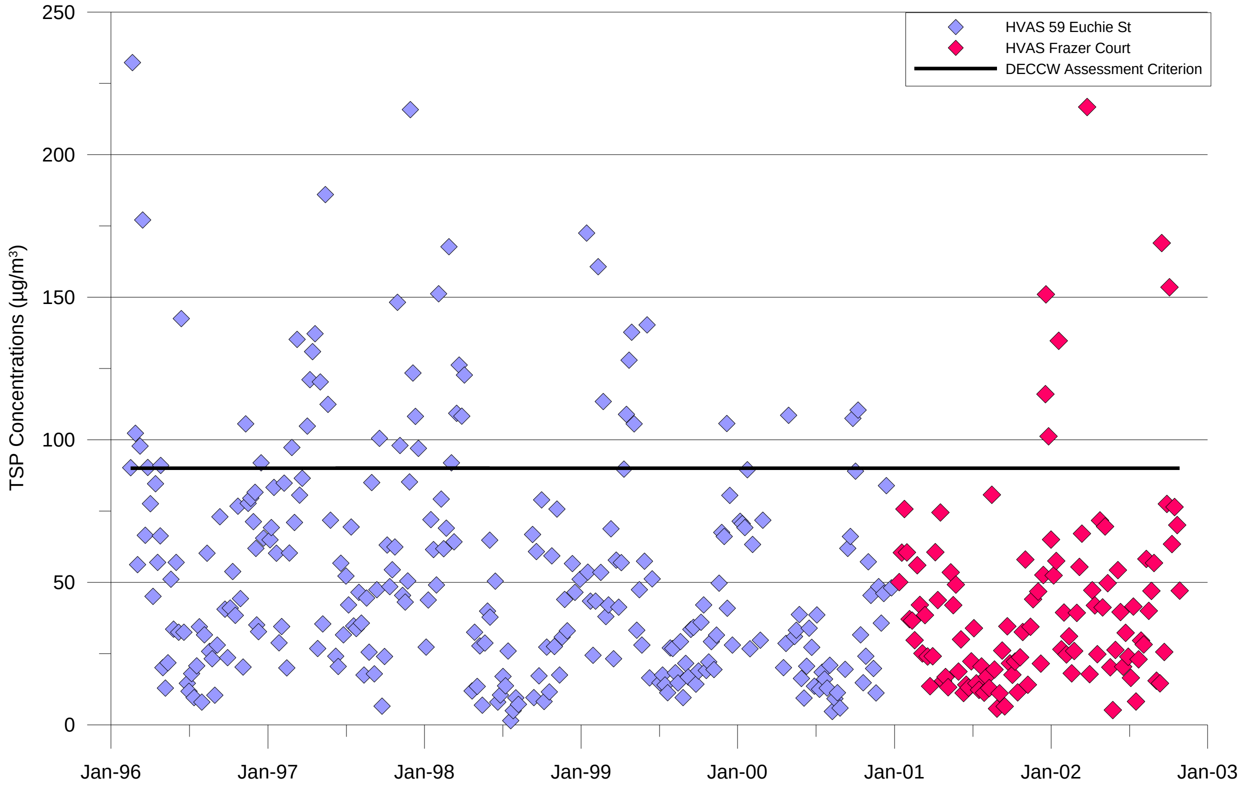

Figure 10: High Volume Air Sampler (HVAS) TSP Concentrations

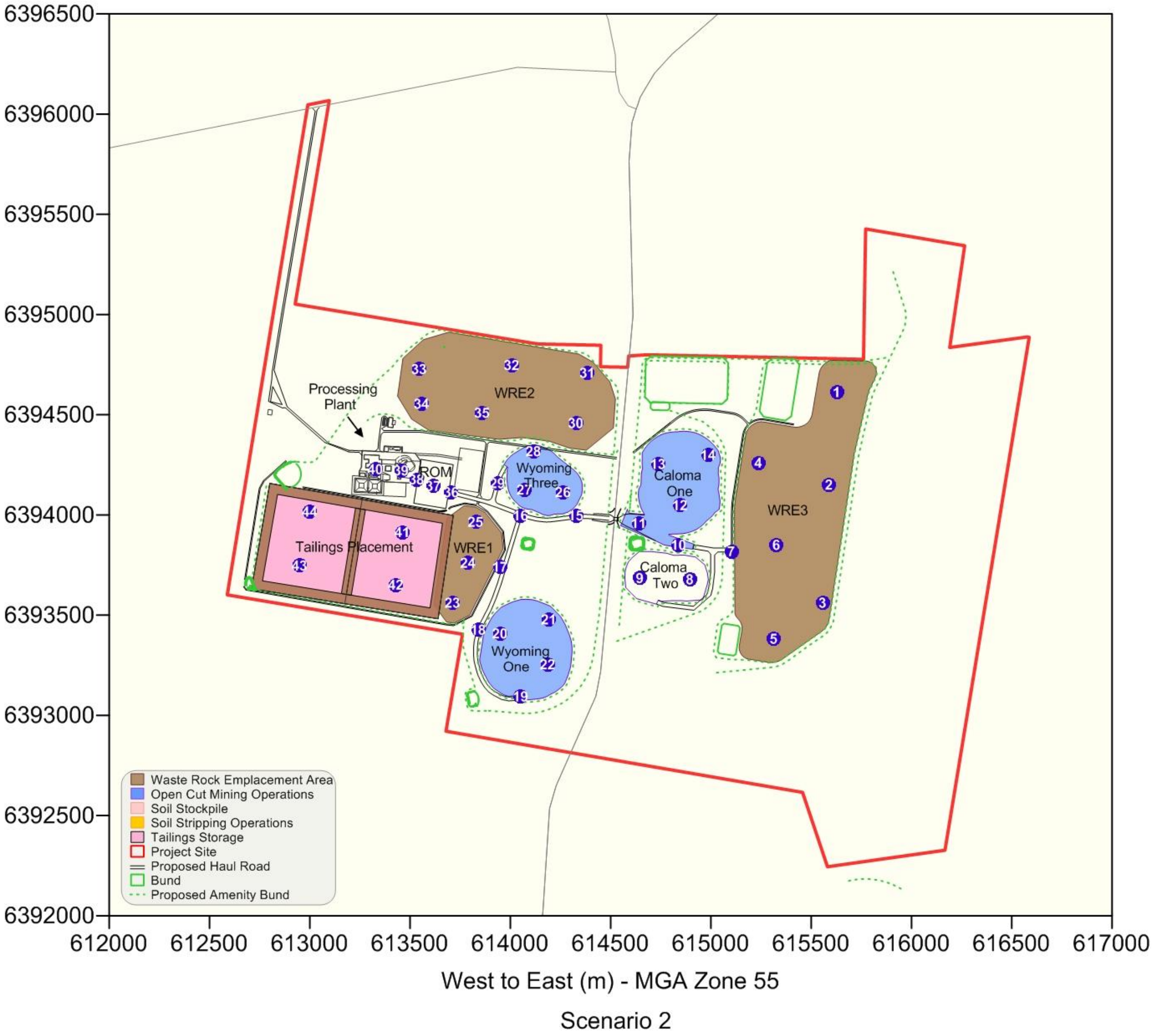

Figure 11: Modelling Source Locations – Scenario 2

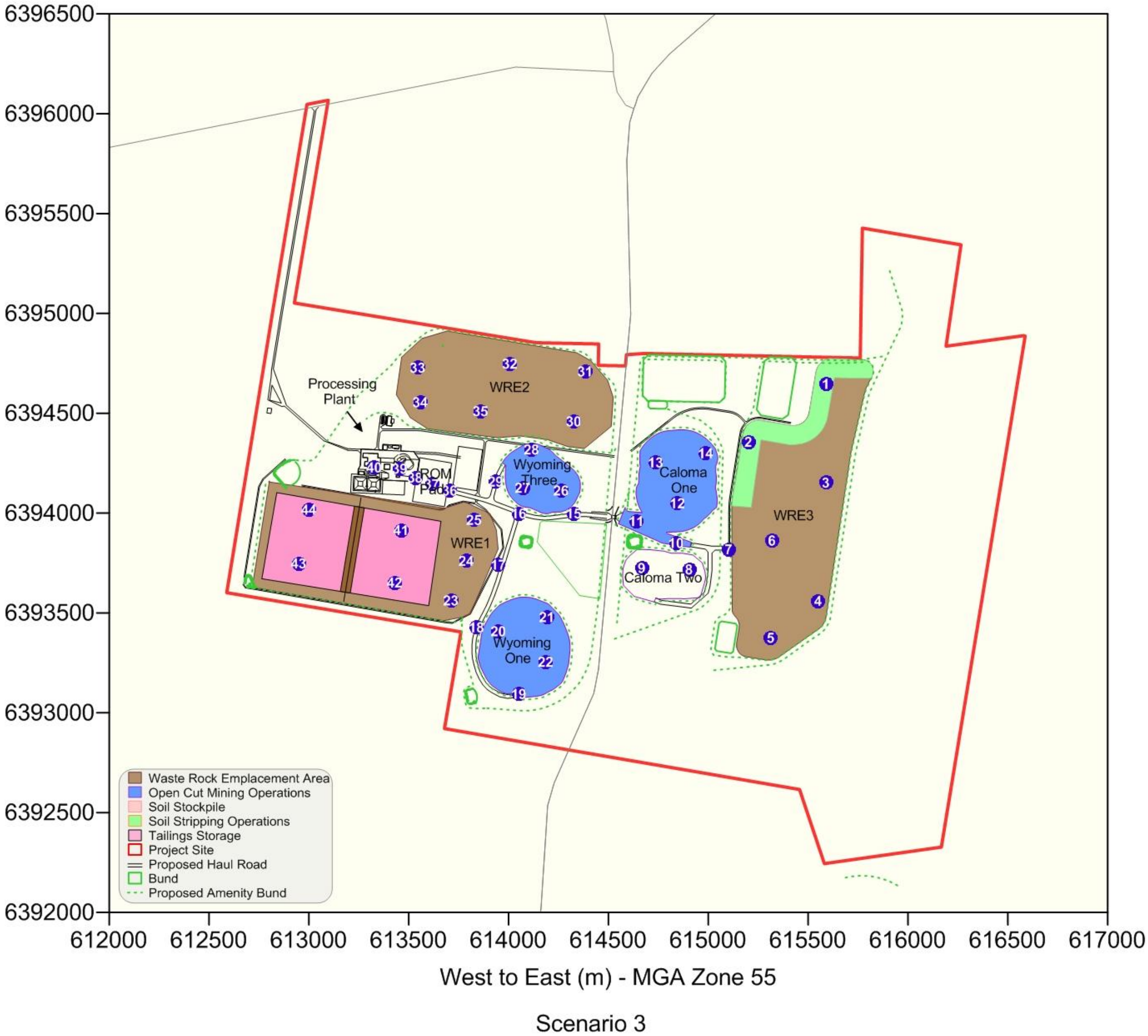

Figure 12: Modelling Source Locations – Scenario 3

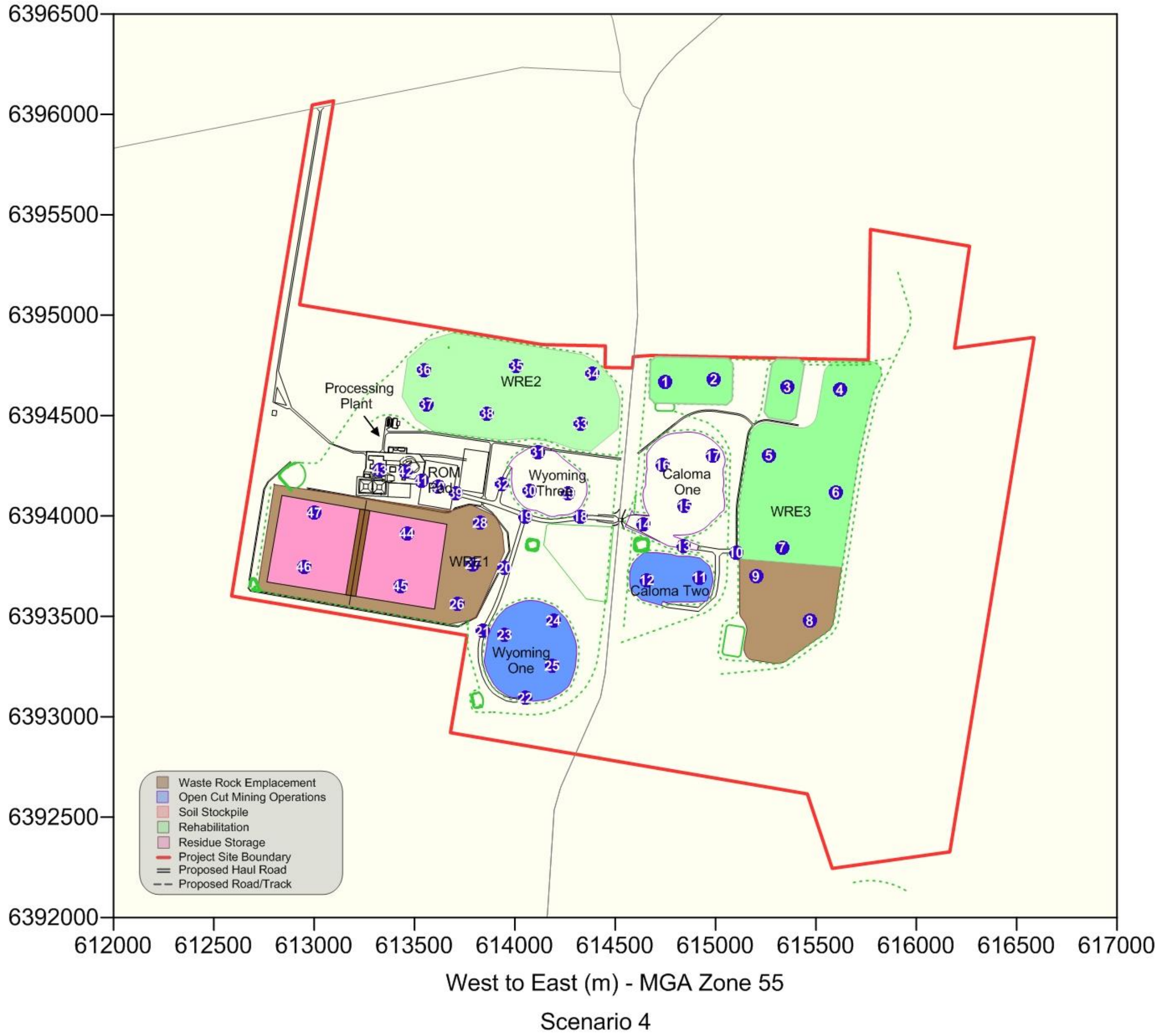

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Figure 13: Modelling Source Locations – Scenario 4

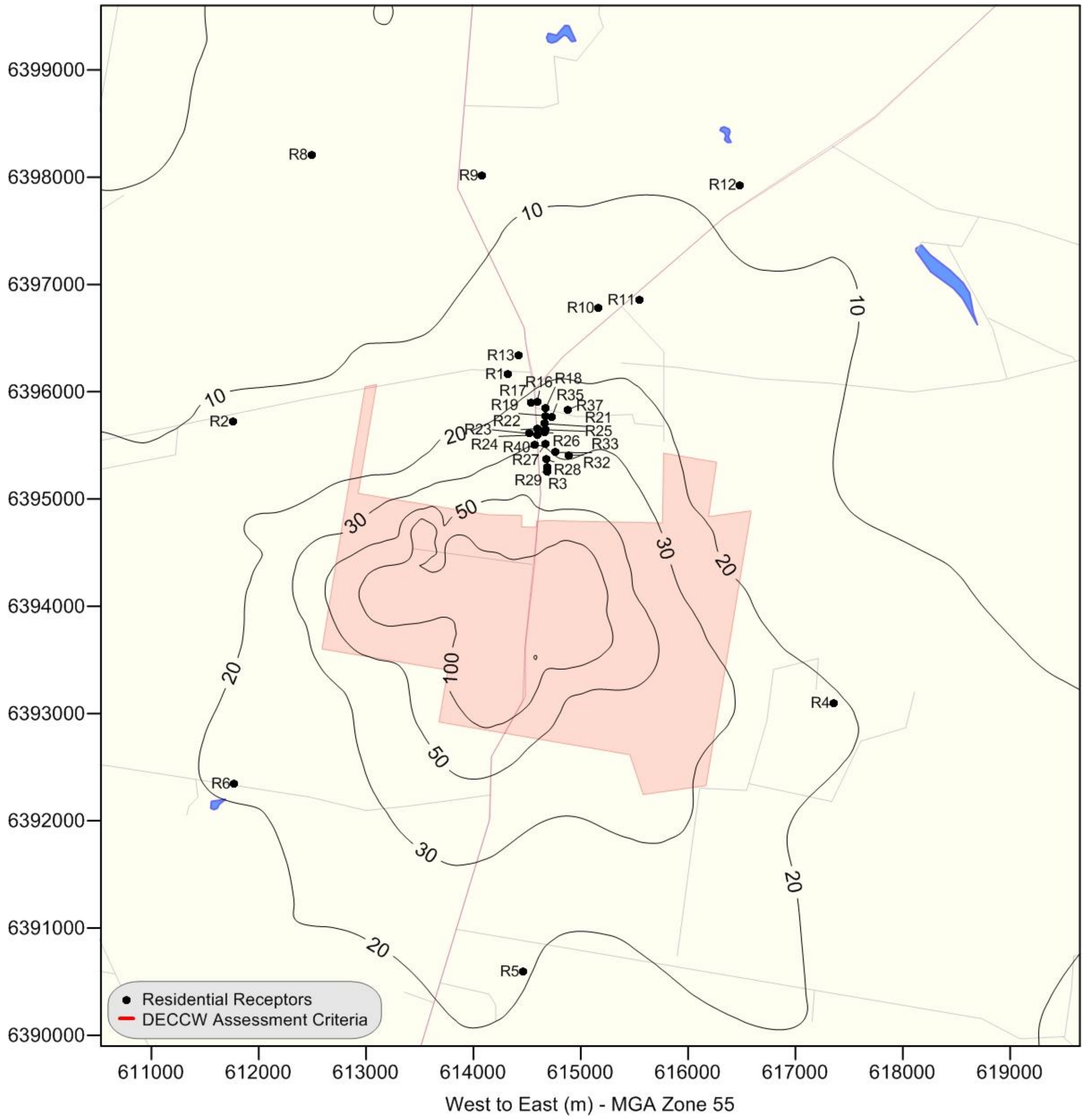

Figure 14: Scenario 2 - Predicted 24-hour average PM_{10} concentrations (µg/m^3) due to emissions from the Project alone

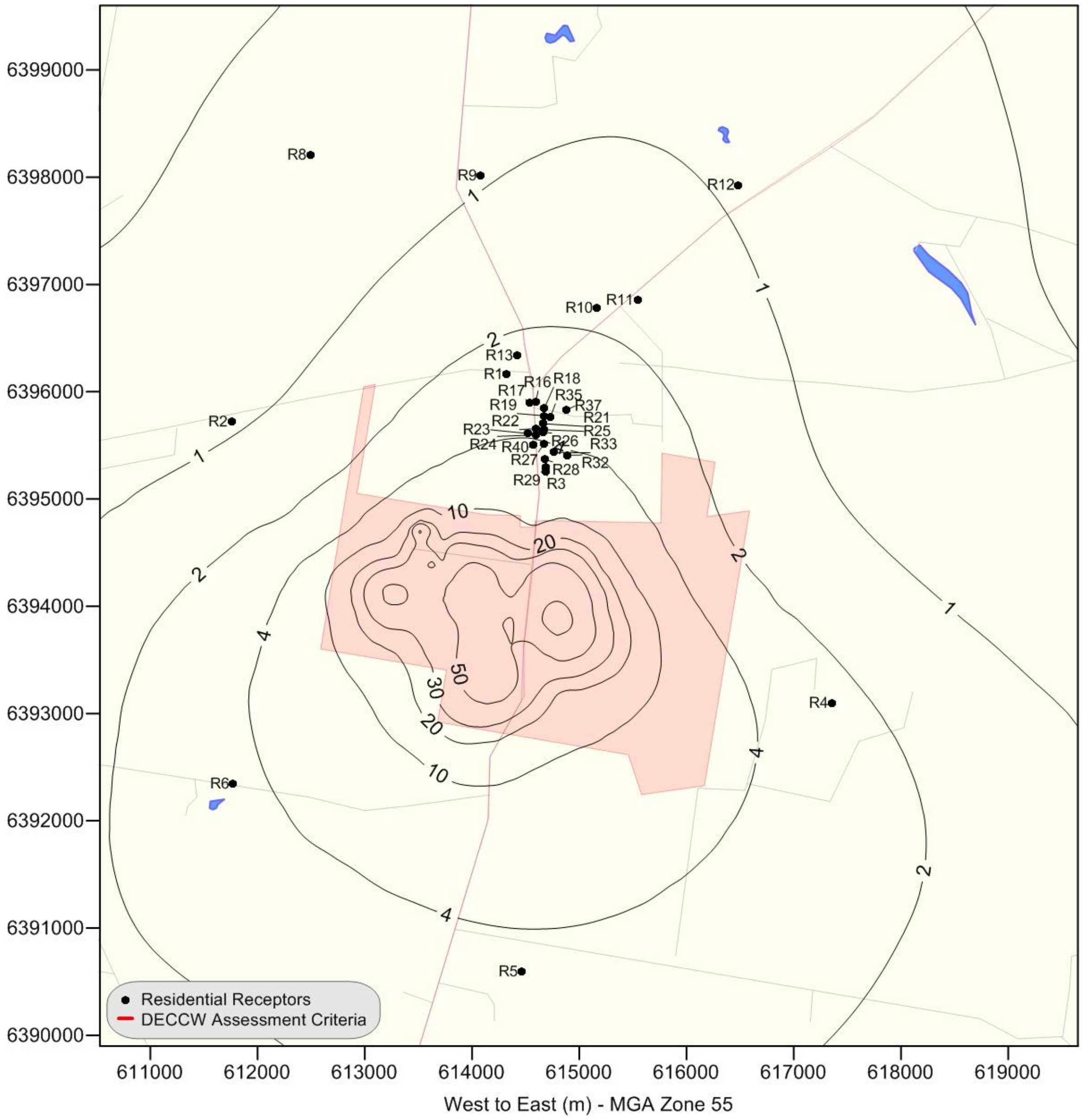

Figure 15: Scenario 2 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project alone

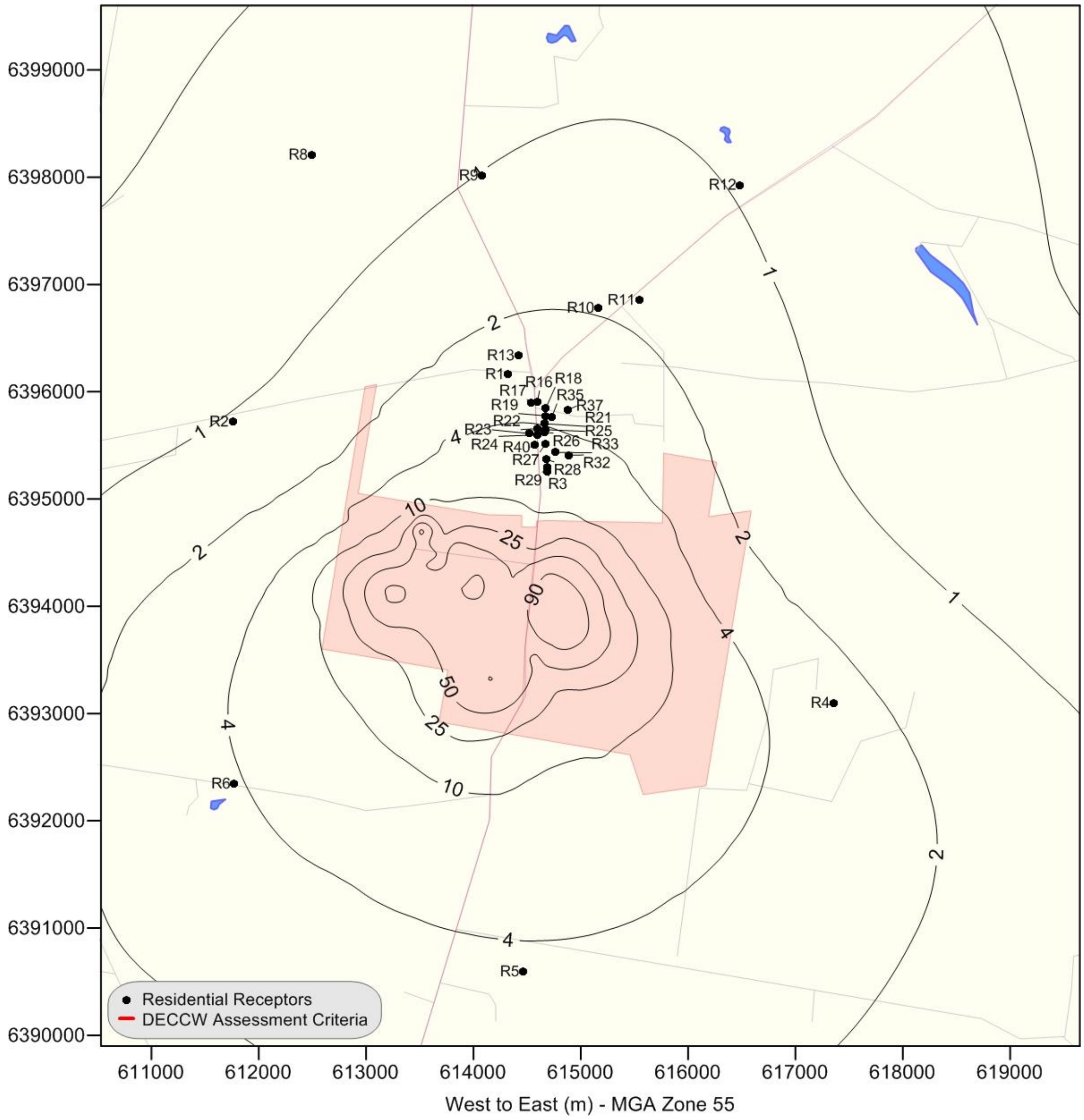

Figure 16: Scenario 2 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project alone

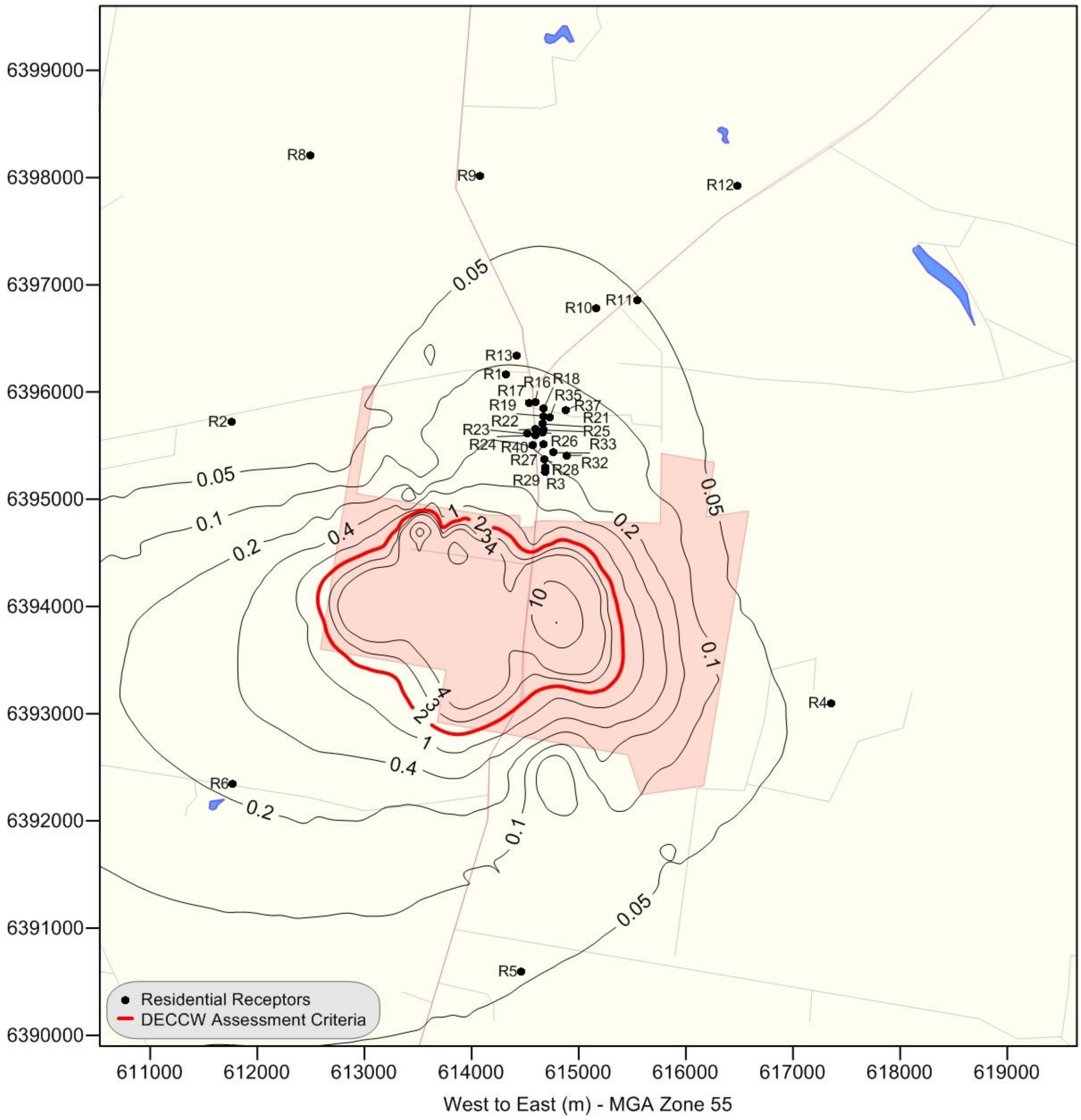

Figure 17: Scenario 2 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project alone

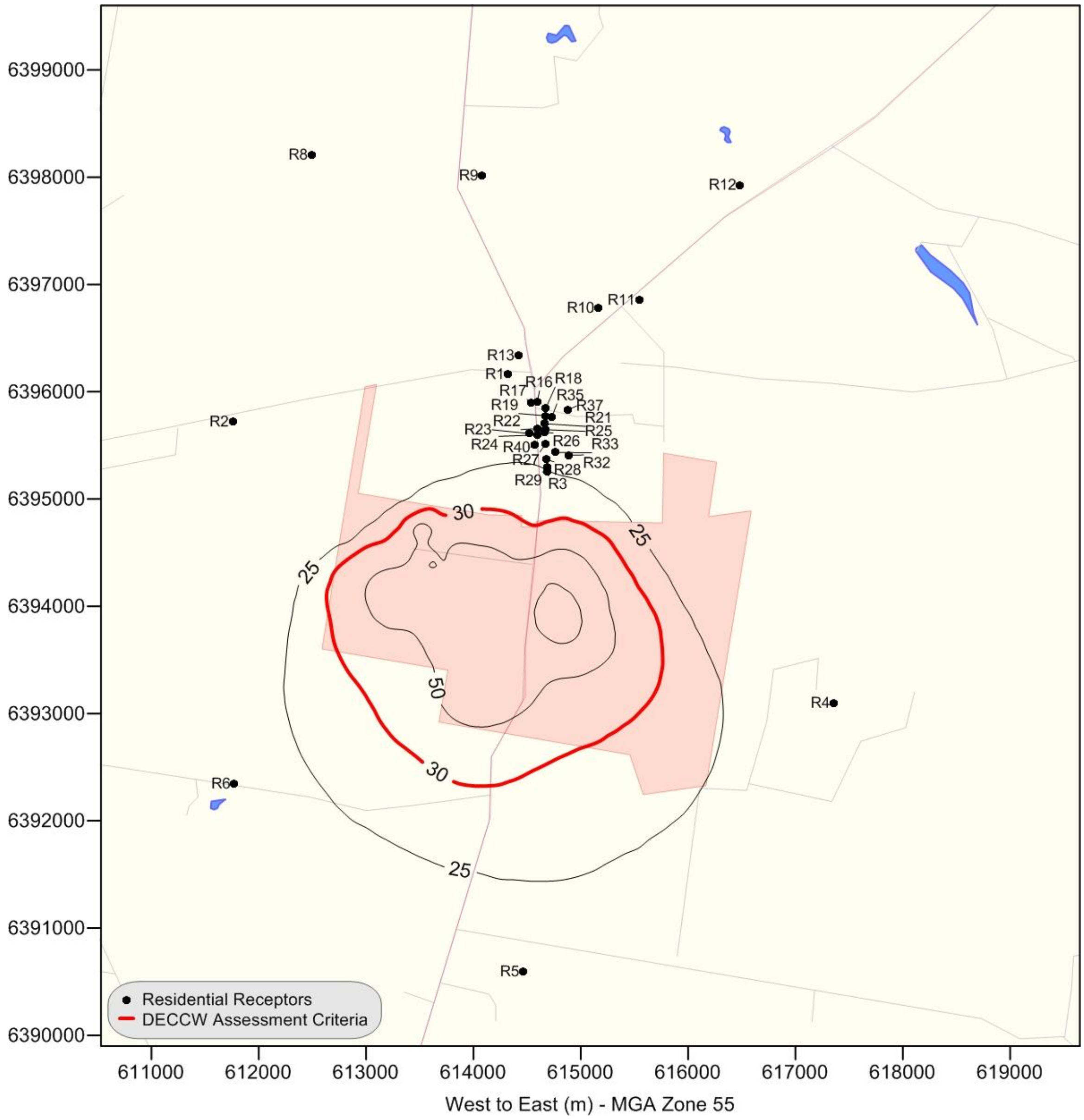

Figure 18: Scenario 2 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project and other sources

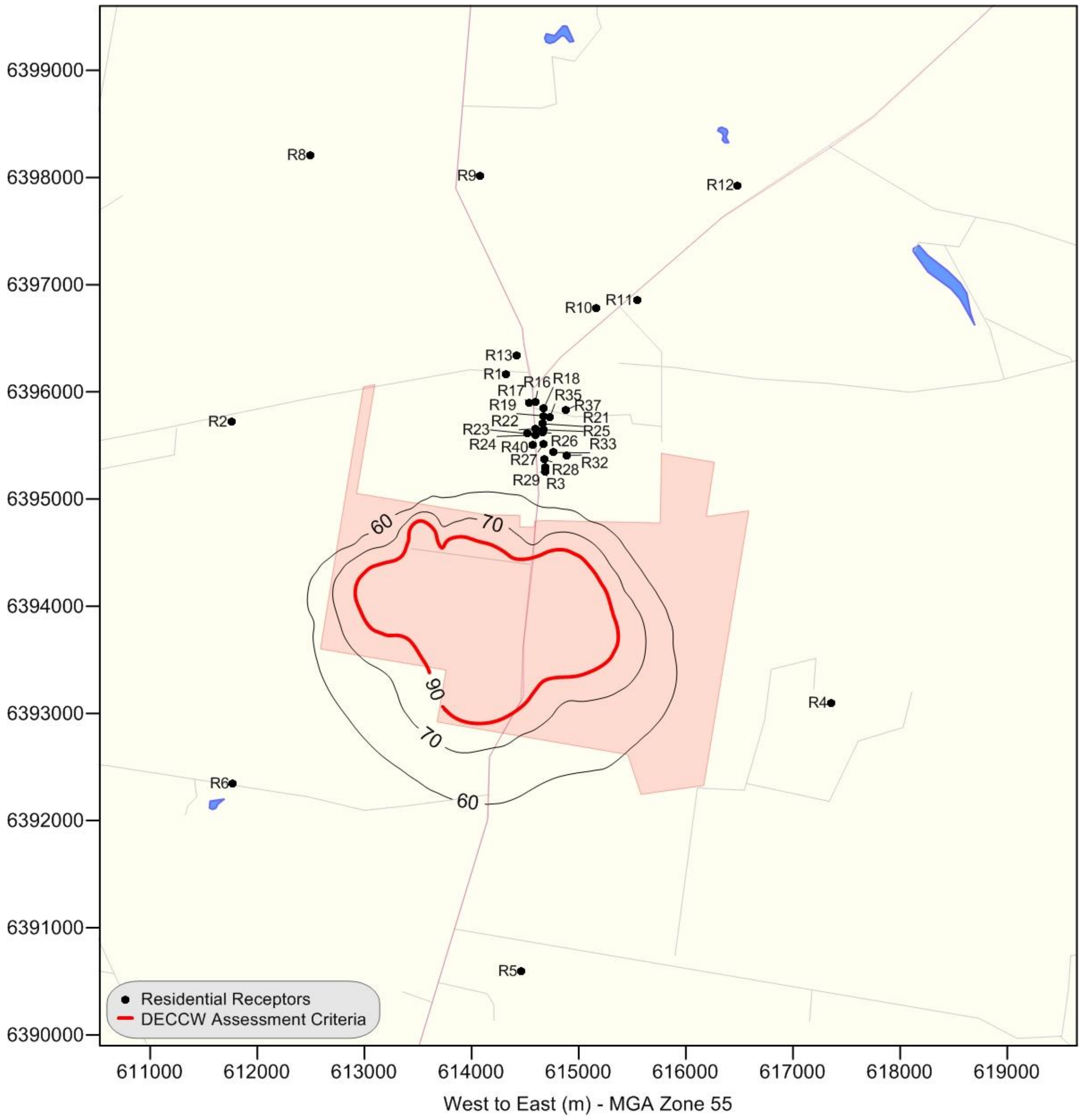

Figure 19: Scenario 2 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project and other sources

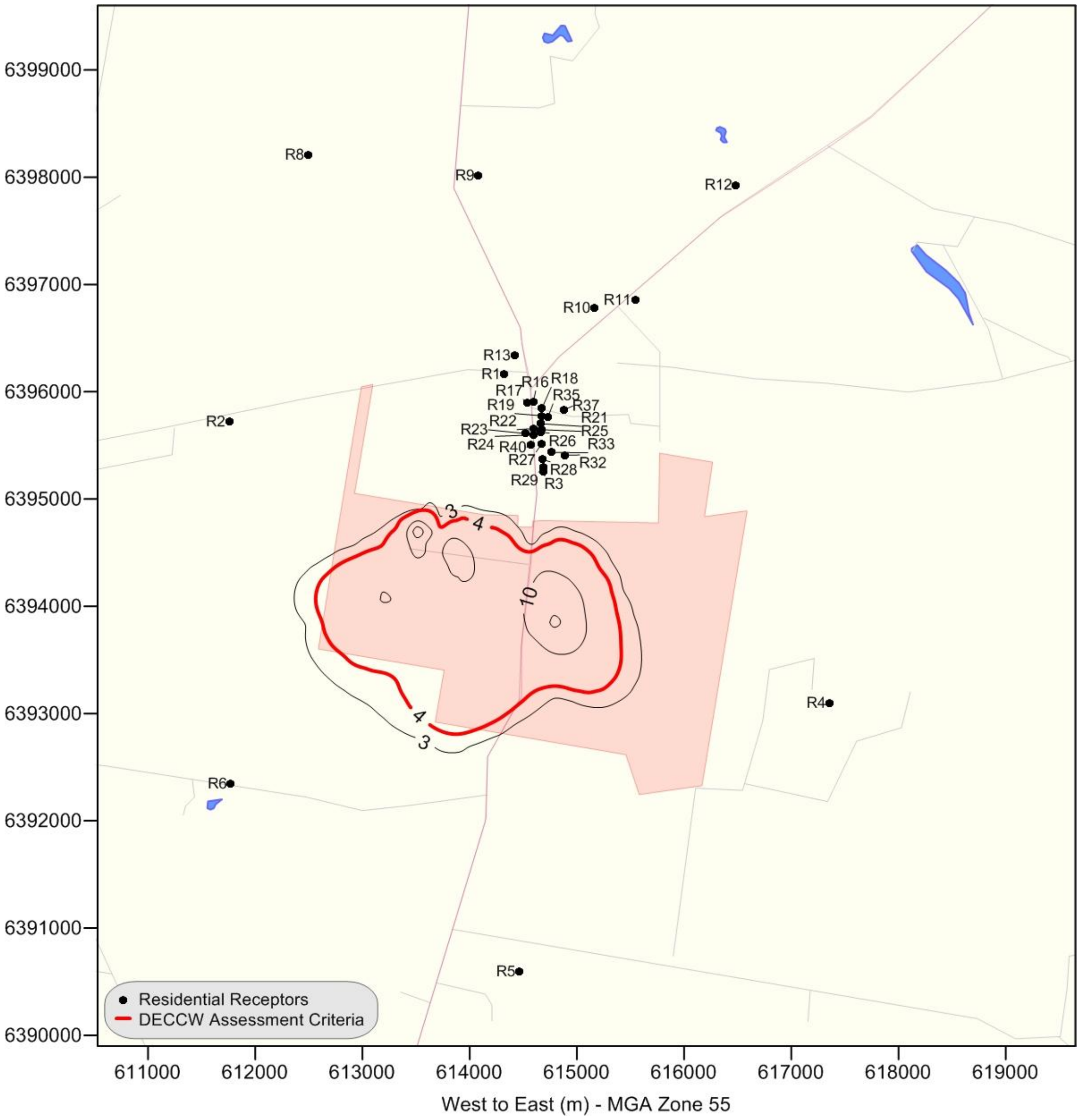

Figure 20: Scenario 2 - Predicted dust deposition levels (g/m²/month) due to emissions from the Project and other sources

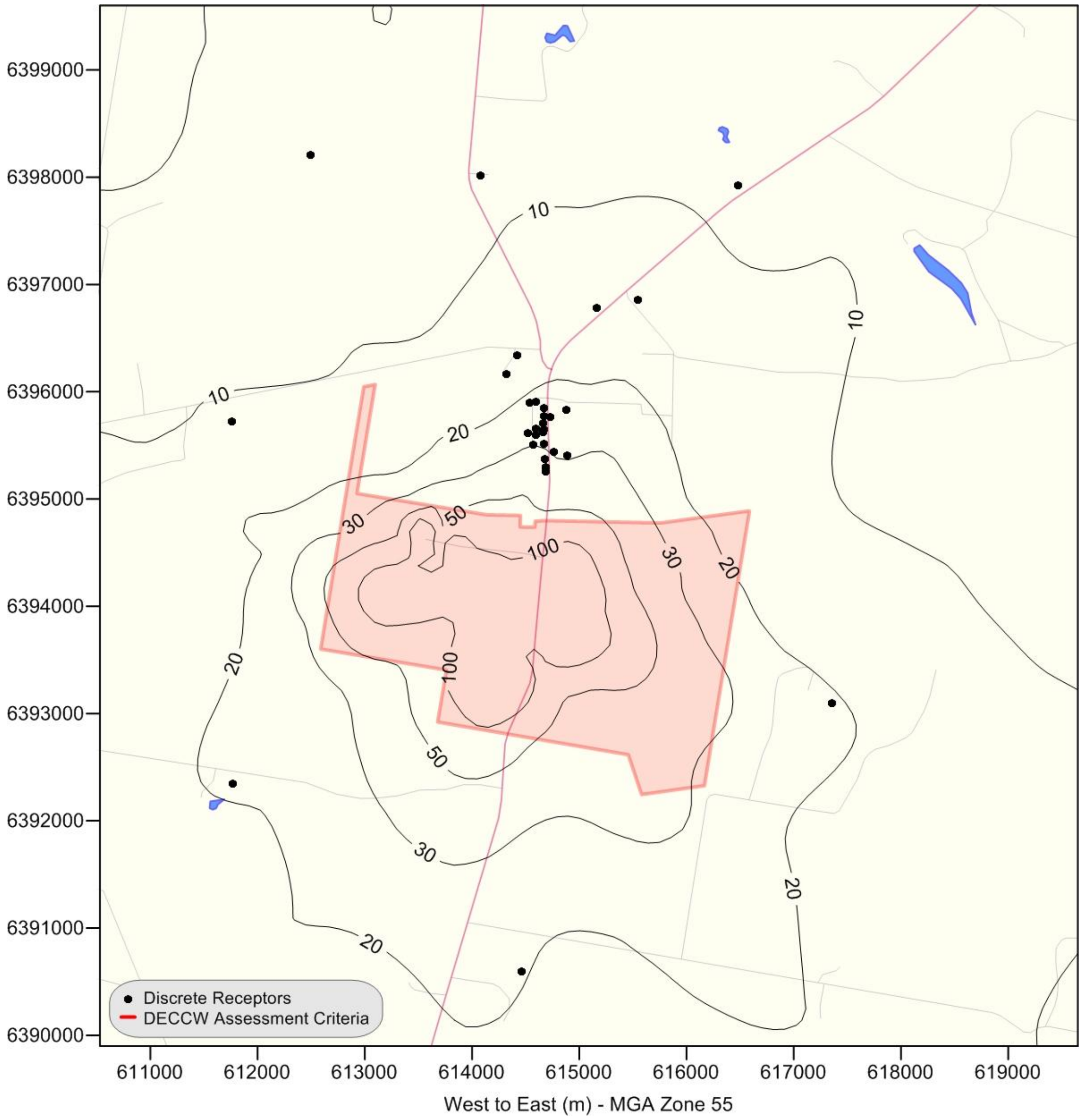

Figure 21: Scenario 3 - Predicted 24-hour average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project alone

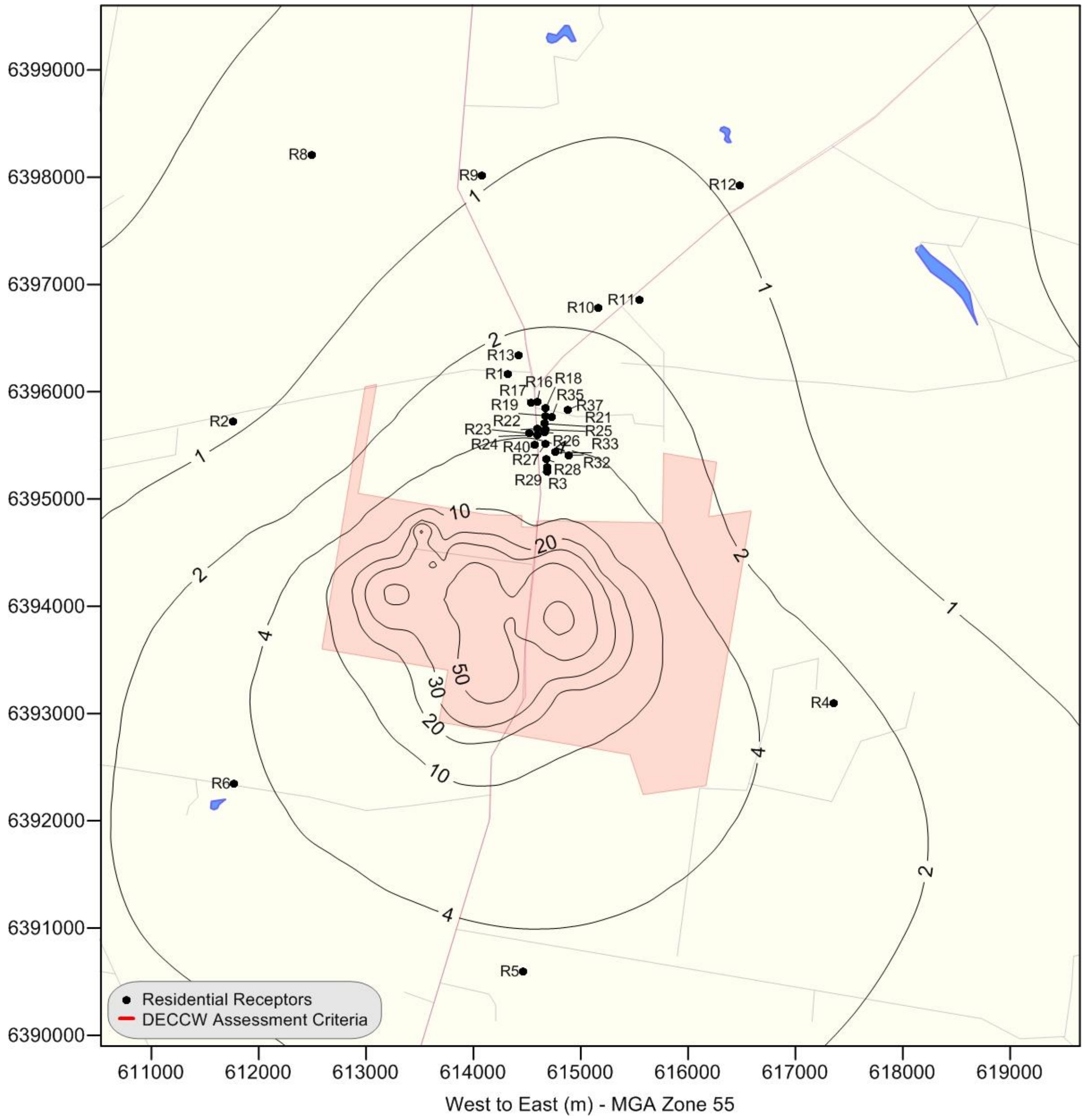

Figure 22: Scenario 3 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project alone

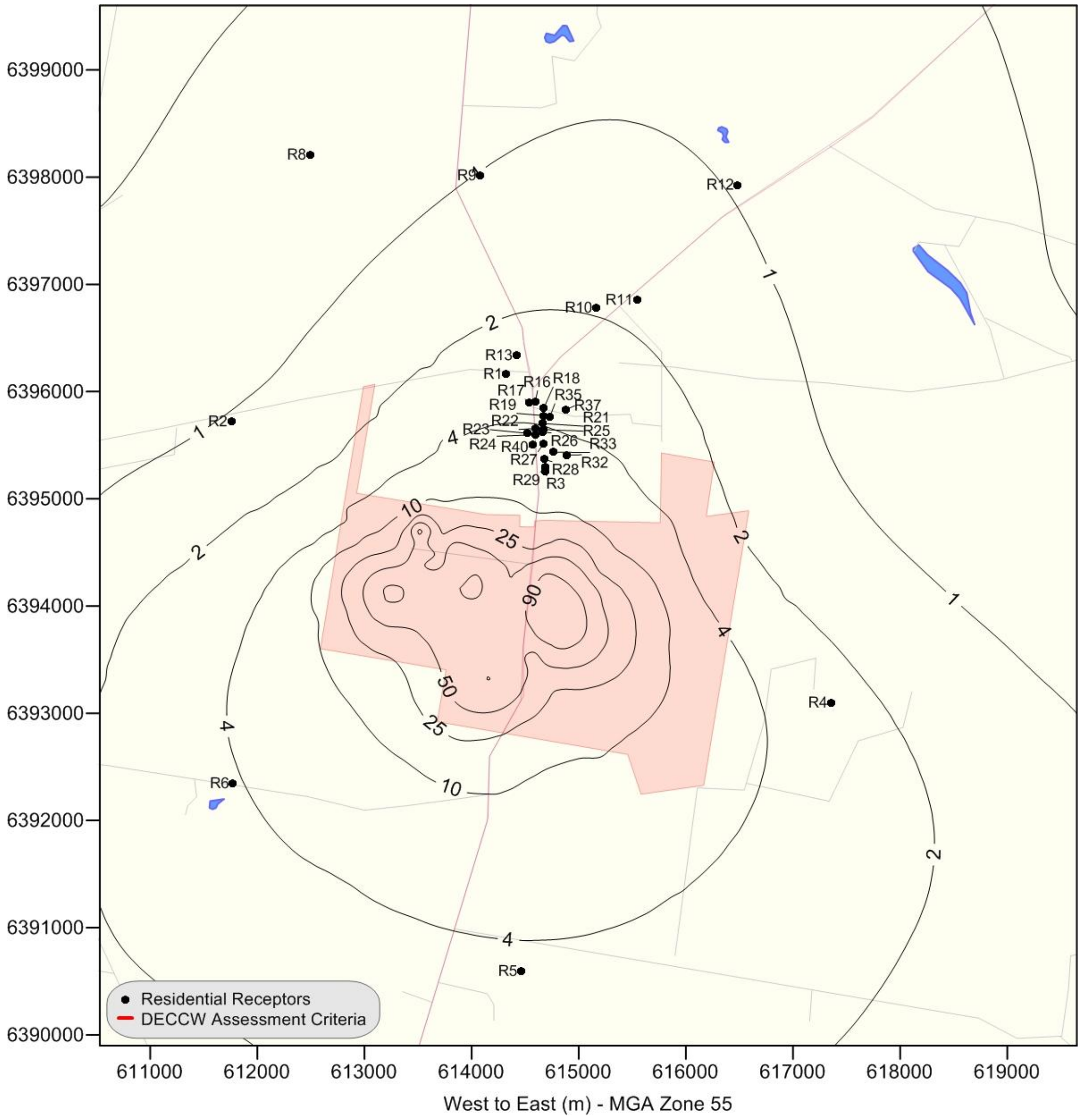

Figure 23: Scenario 3 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project alone

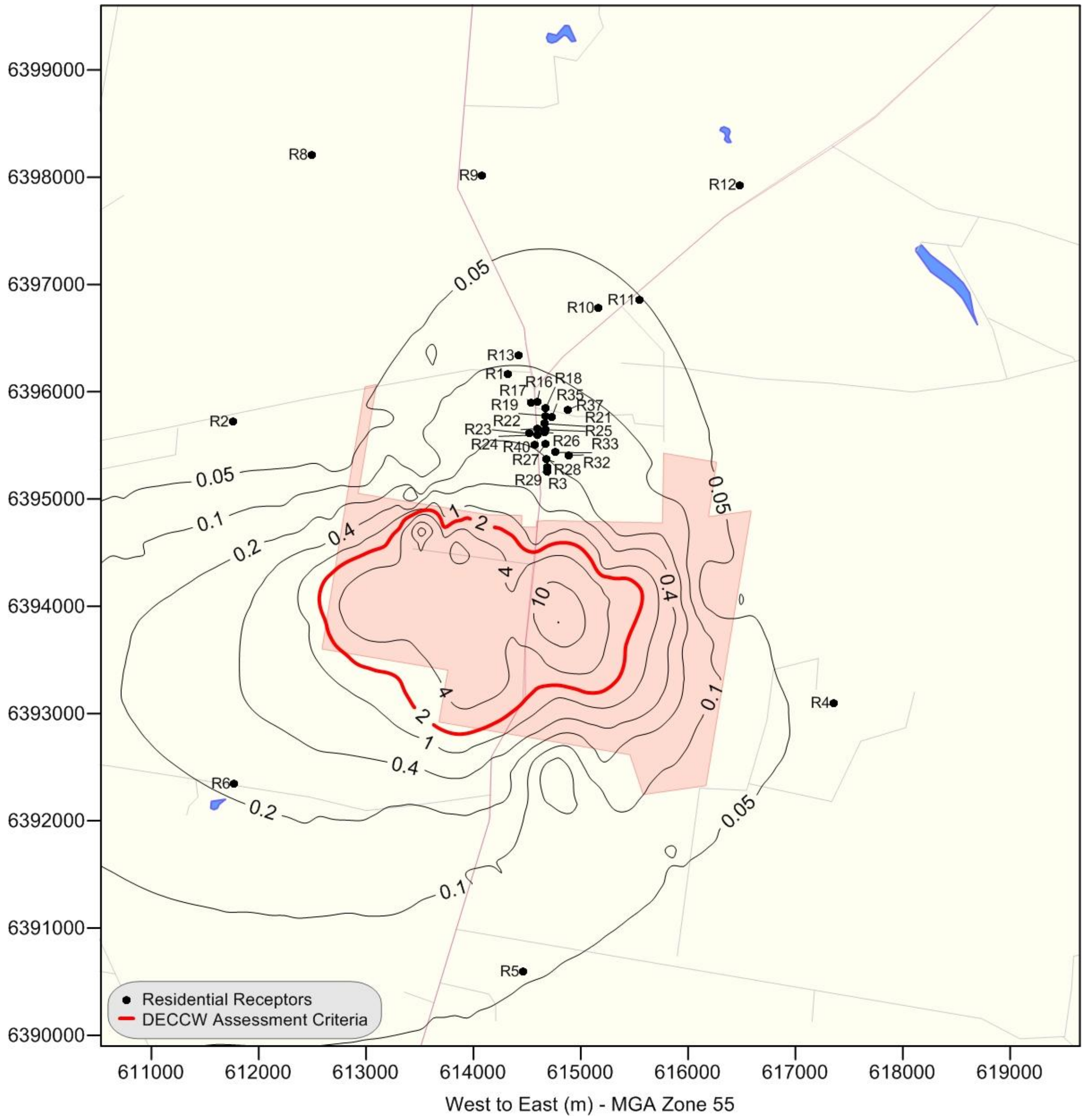

Figure 24: Scenario 3 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project alone

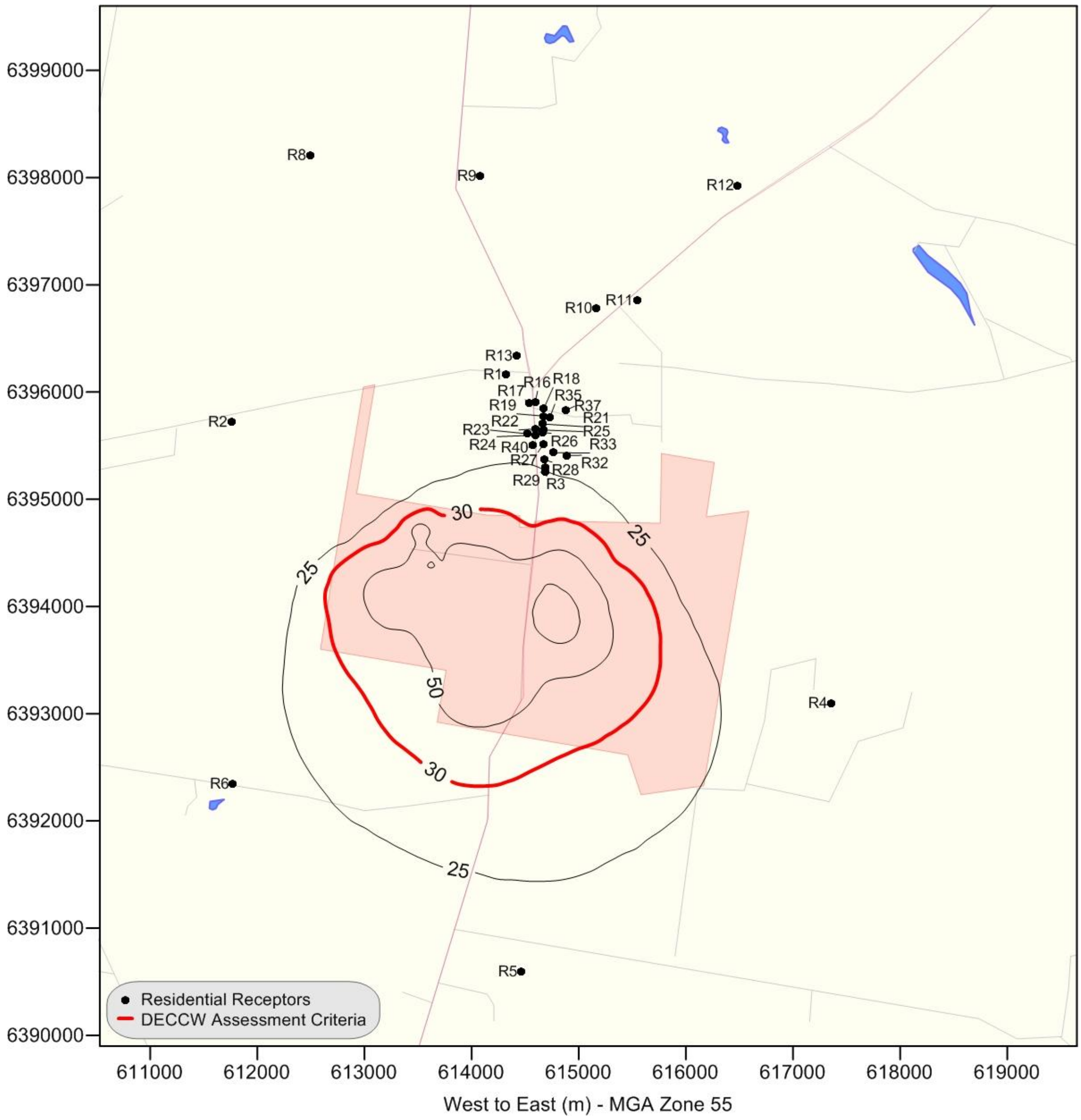

Figure 25: Scenario 3 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project and other sources

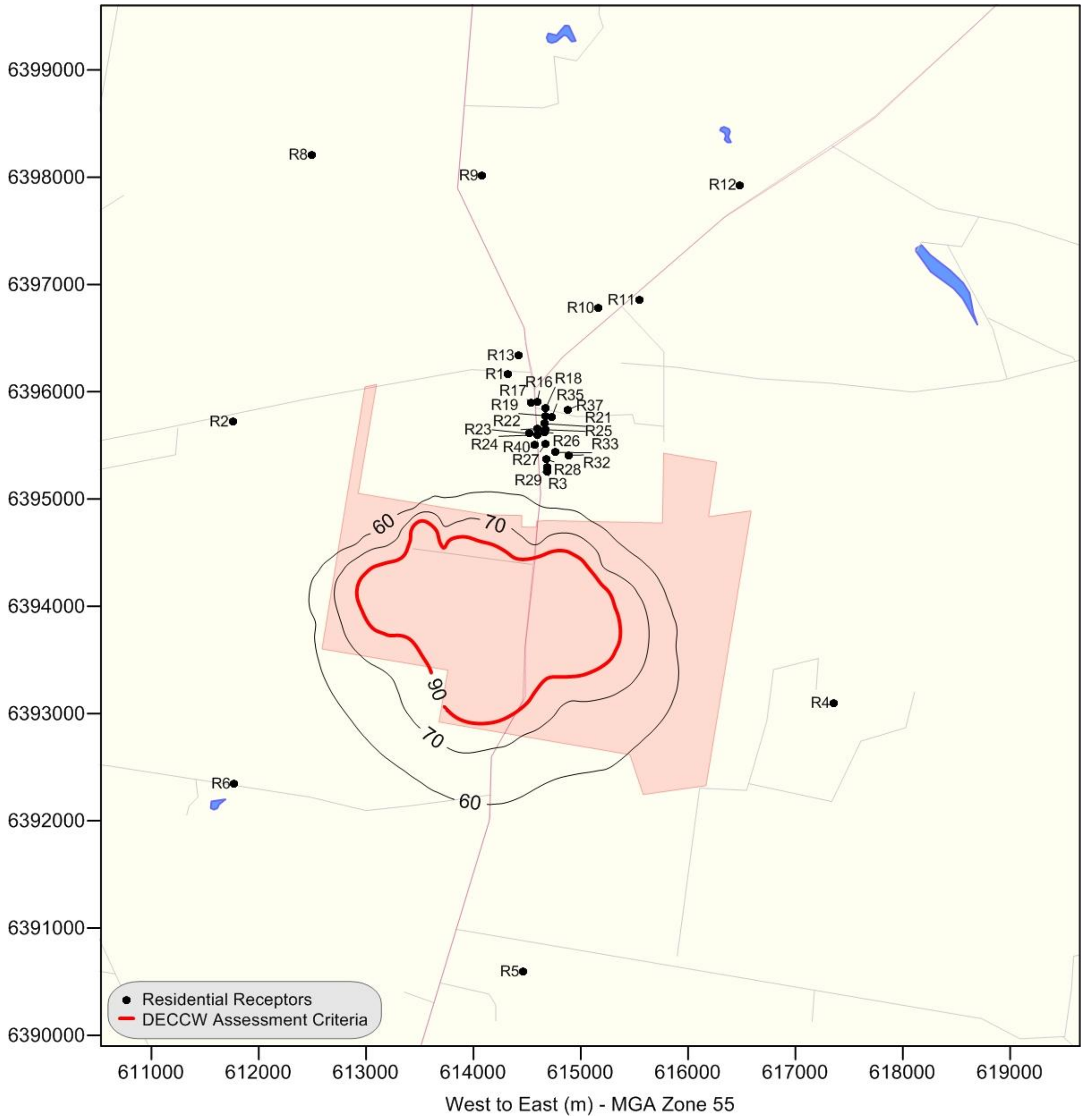

Figure 26: Scenario 3 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project and other sources

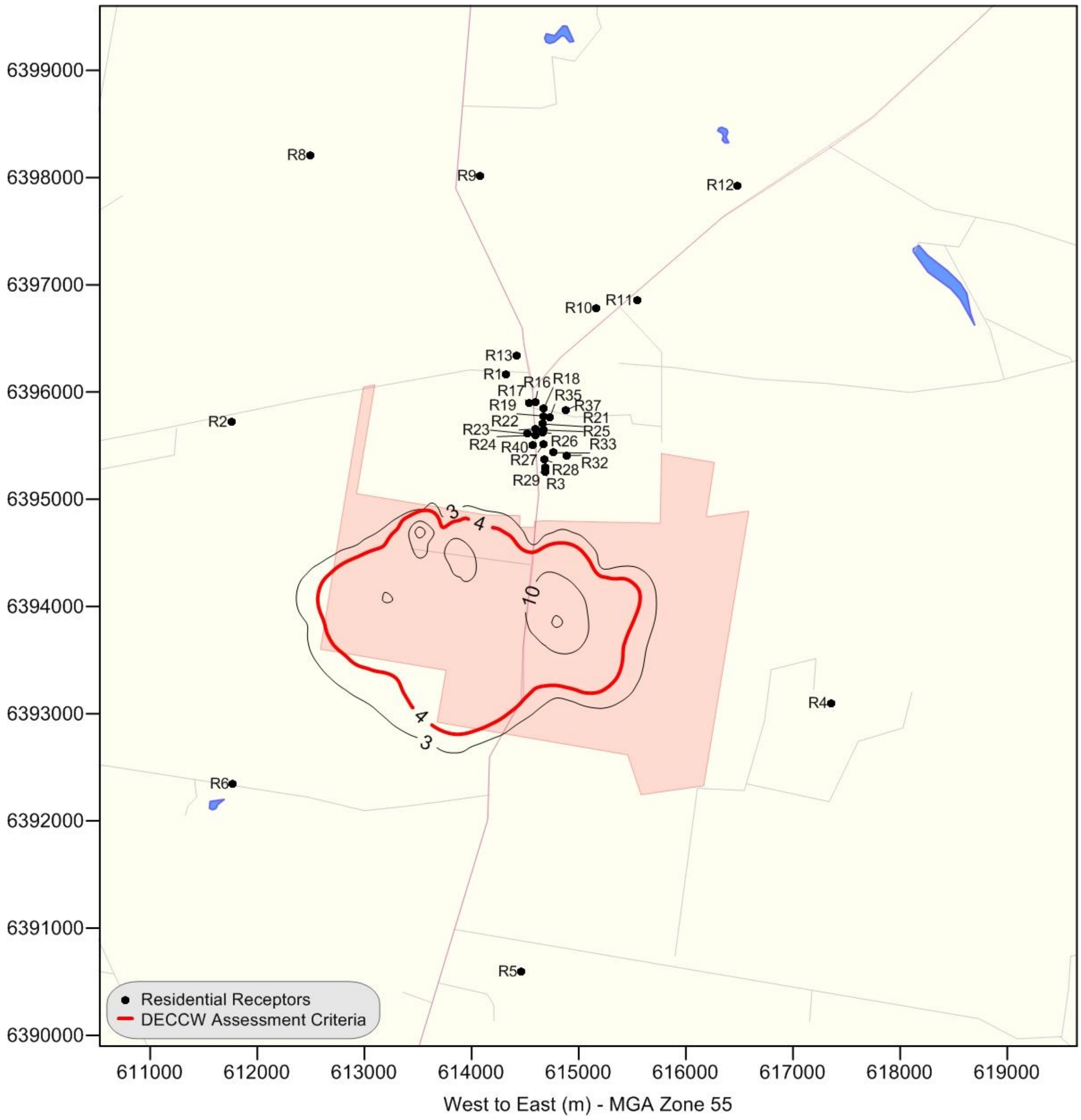

Figure 27: Scenario 3 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project and other sources

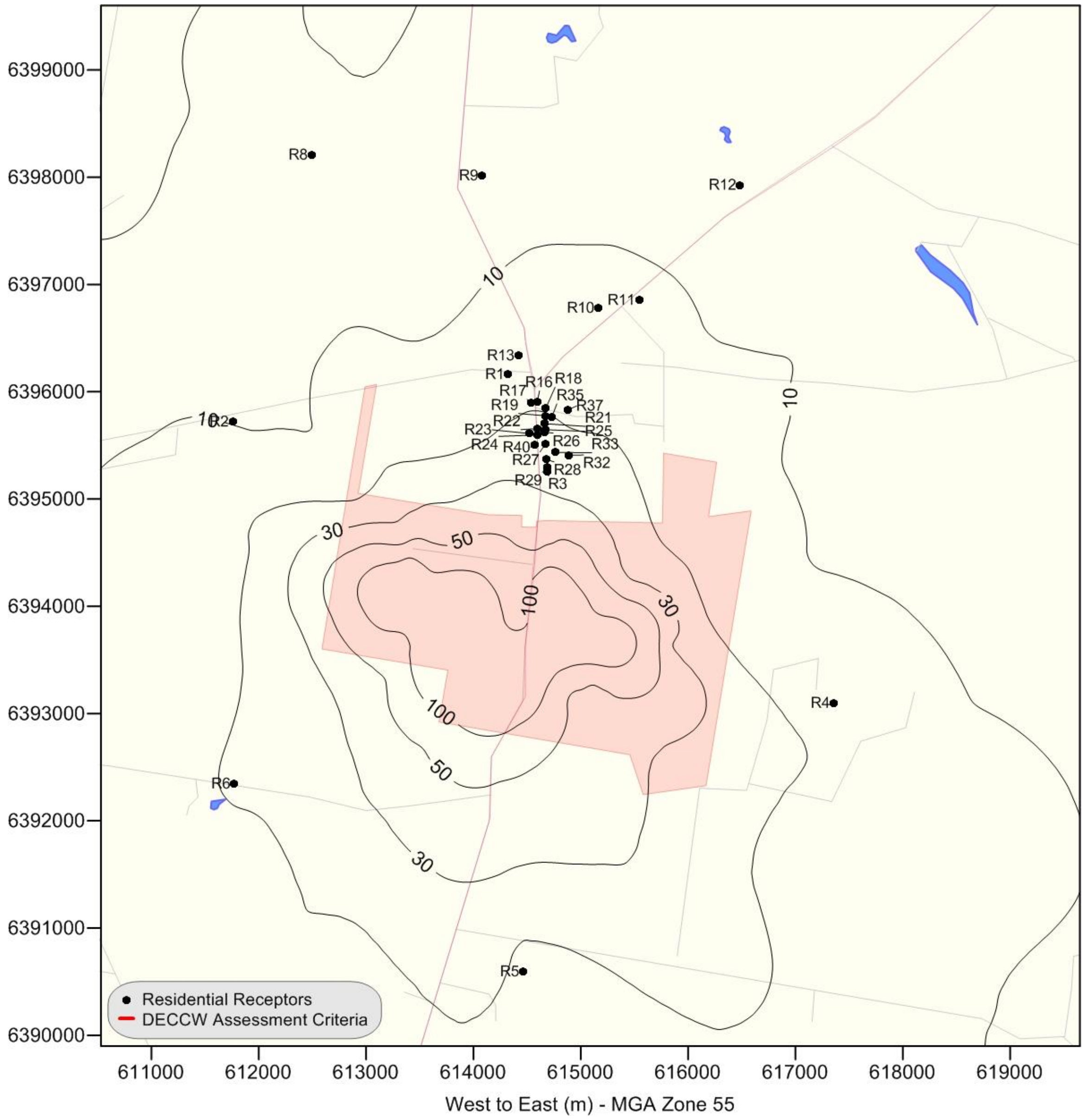

Figure 28: Scenario 4 - Predicted 24-hour average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project alone

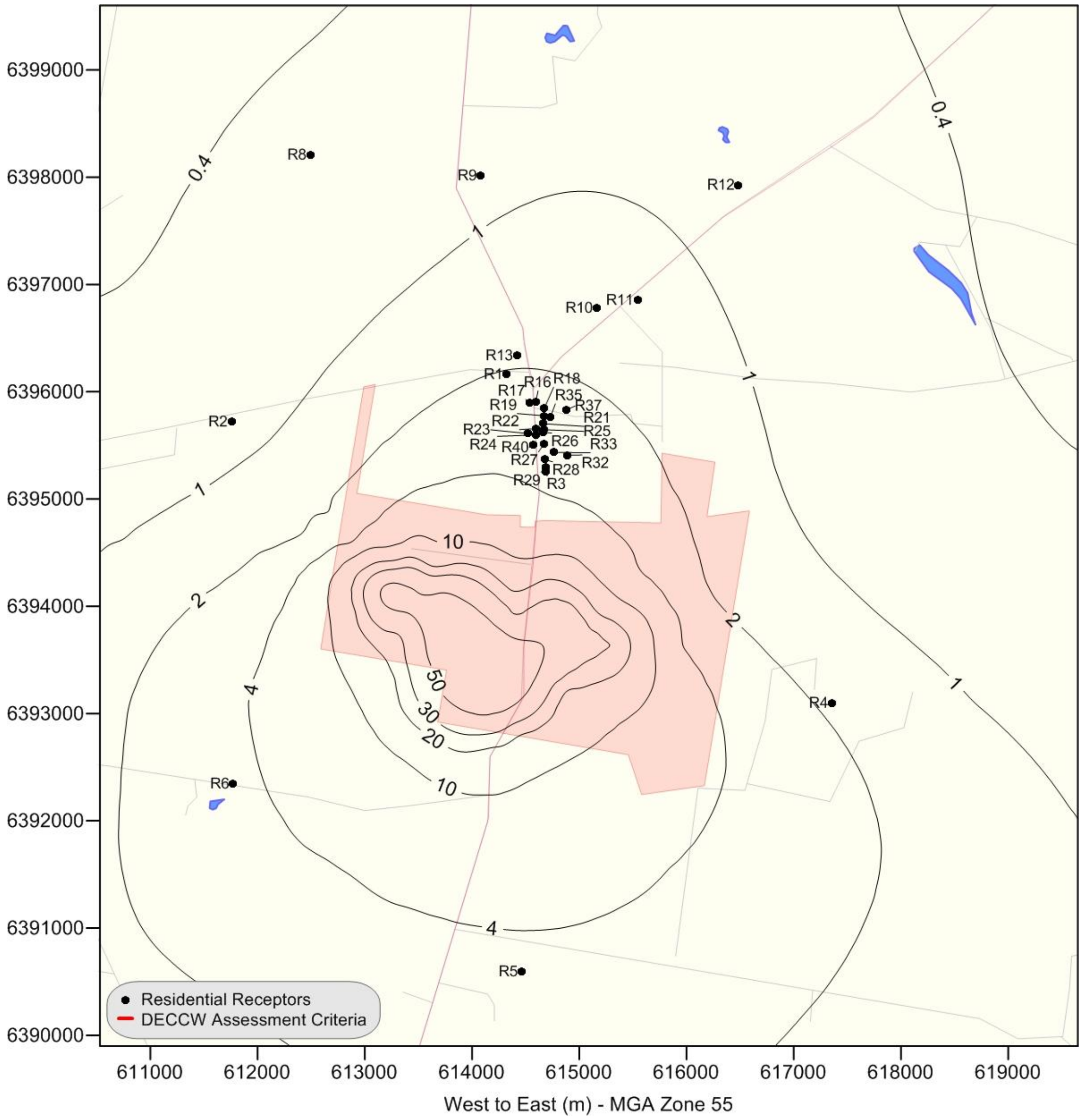

Figure 29: Scenario 4 - Predicted annual average PM_{10} concentrations ($\mu g/m^3$) due to emissions from the Project alone

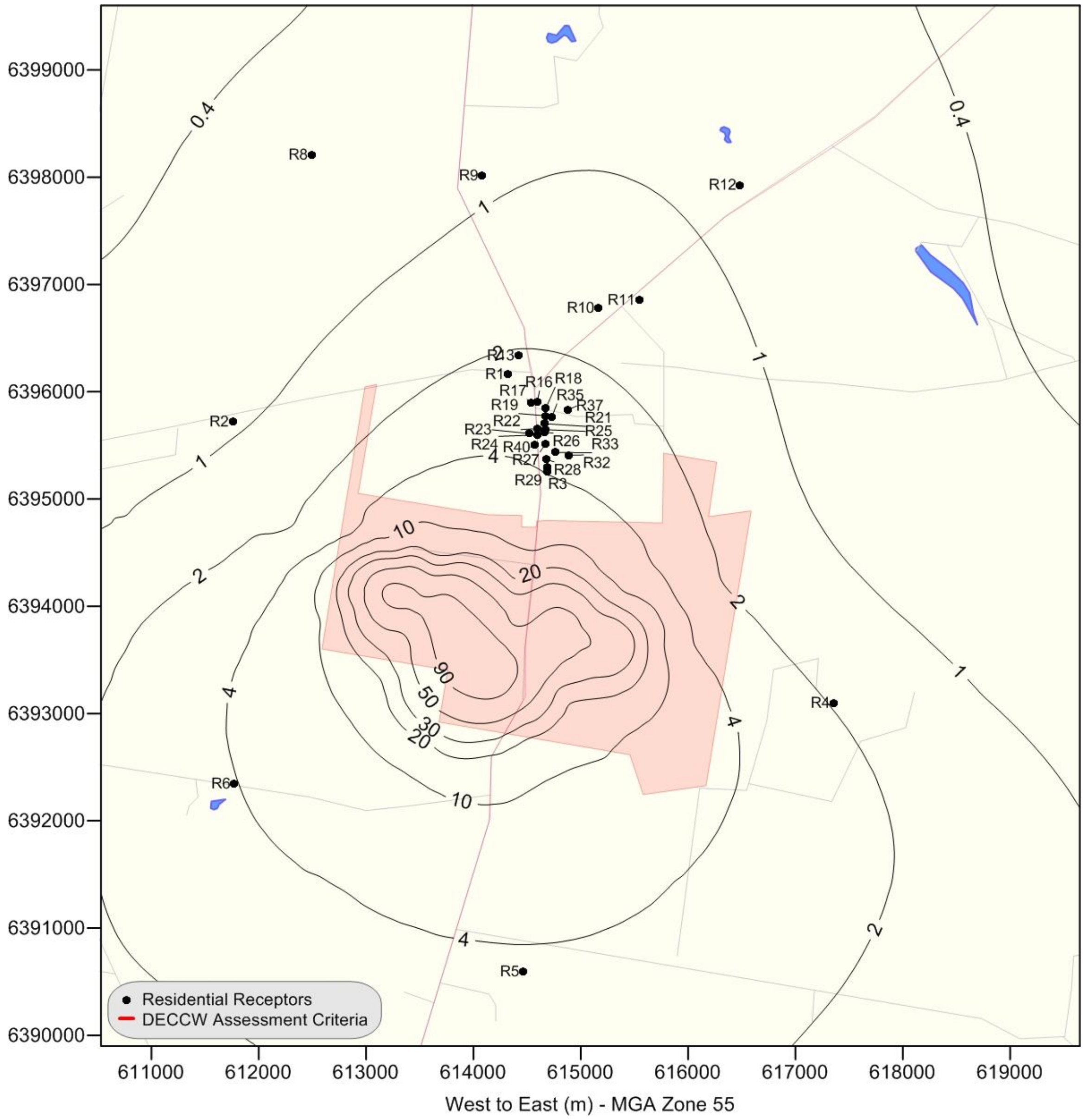

Figure 30: Scenario 4 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project alone

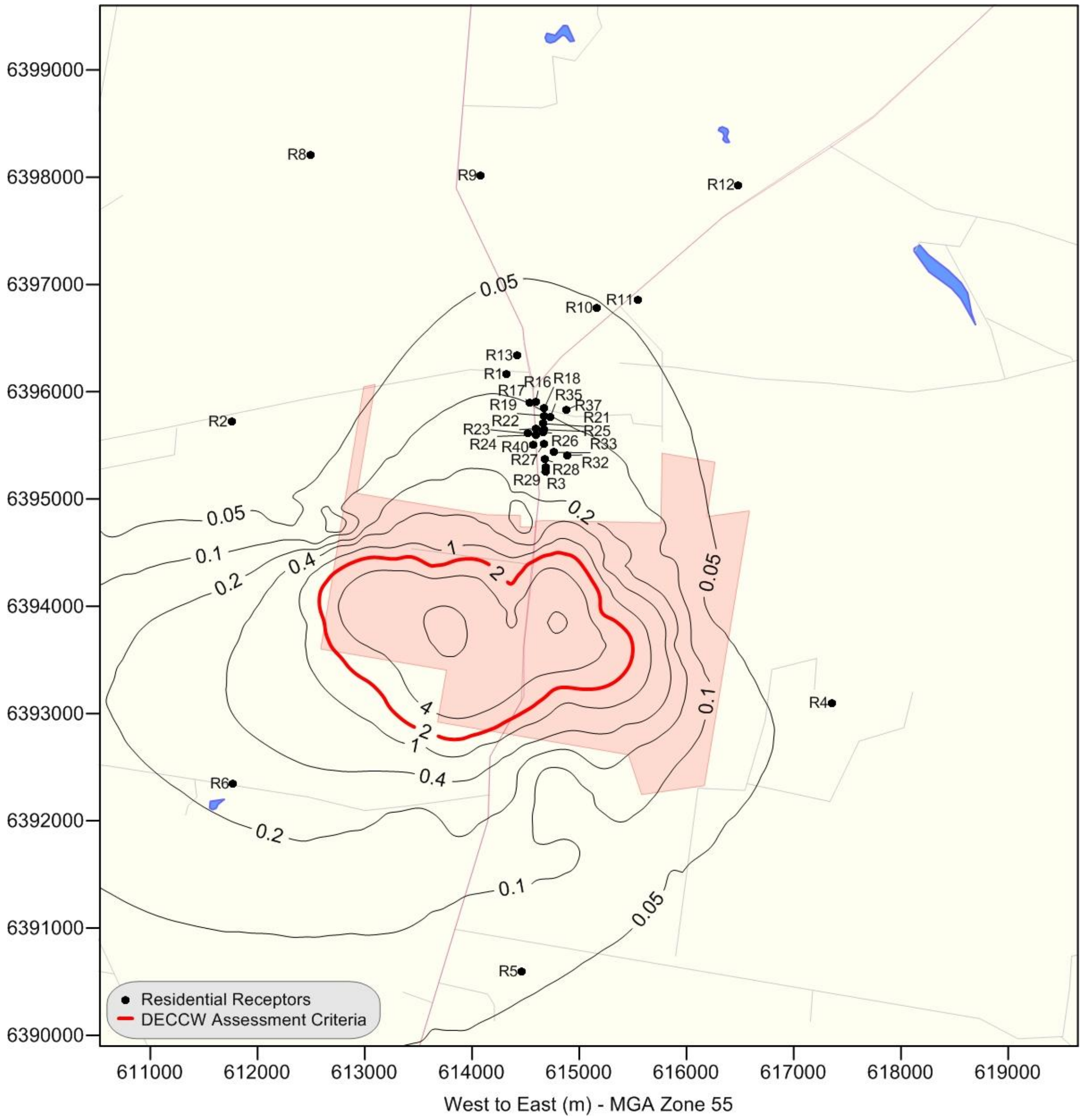

Figure 31: Scenario 4 - Predicted dust deposition concentrations (g/m²/month) due to emissions from the Project alone

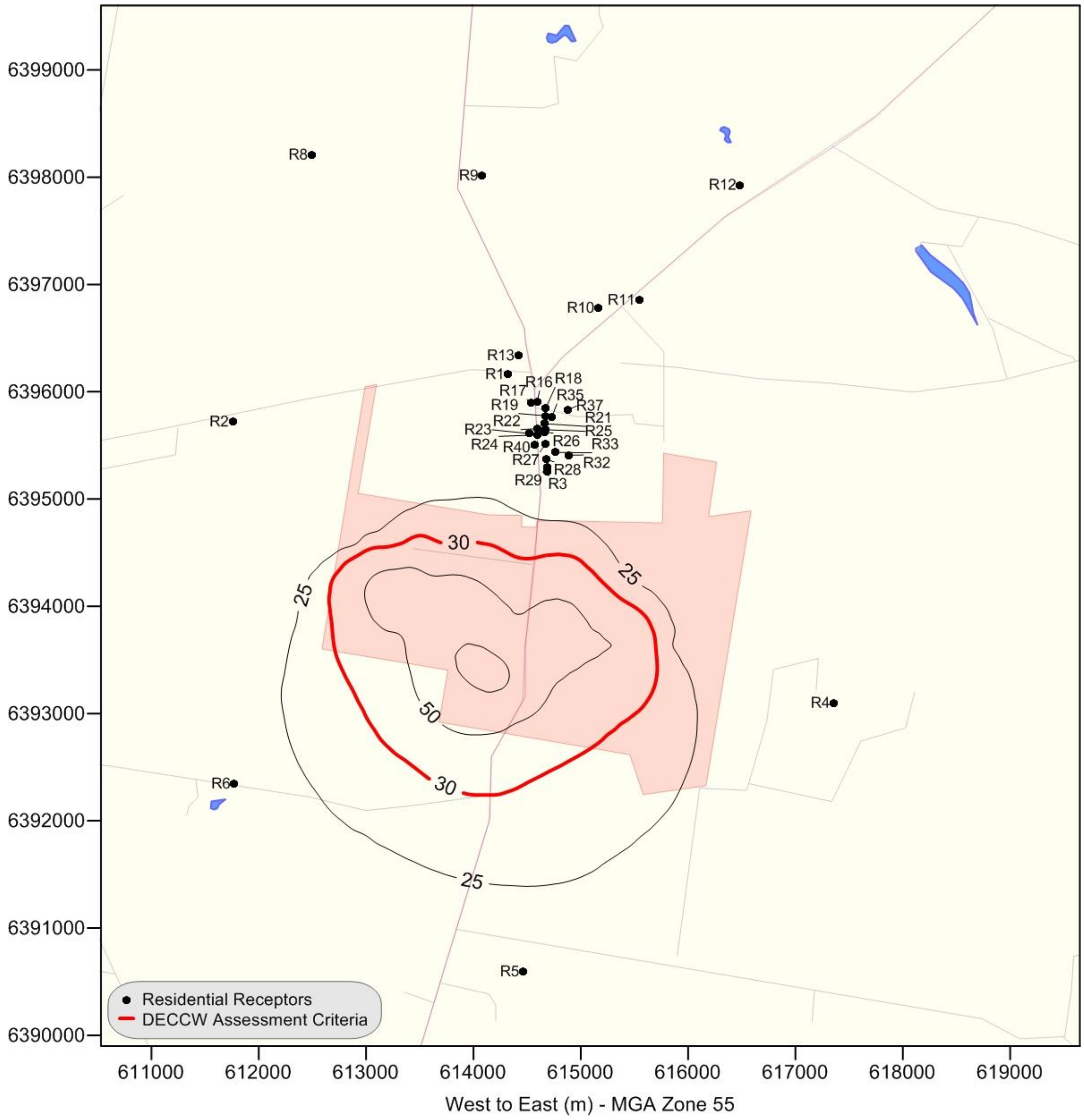

Figure 32: **Scenario 4 - Predicted annual average PM_{10} concentrations (µg/m^3) due to emissions from the Project and other sources**

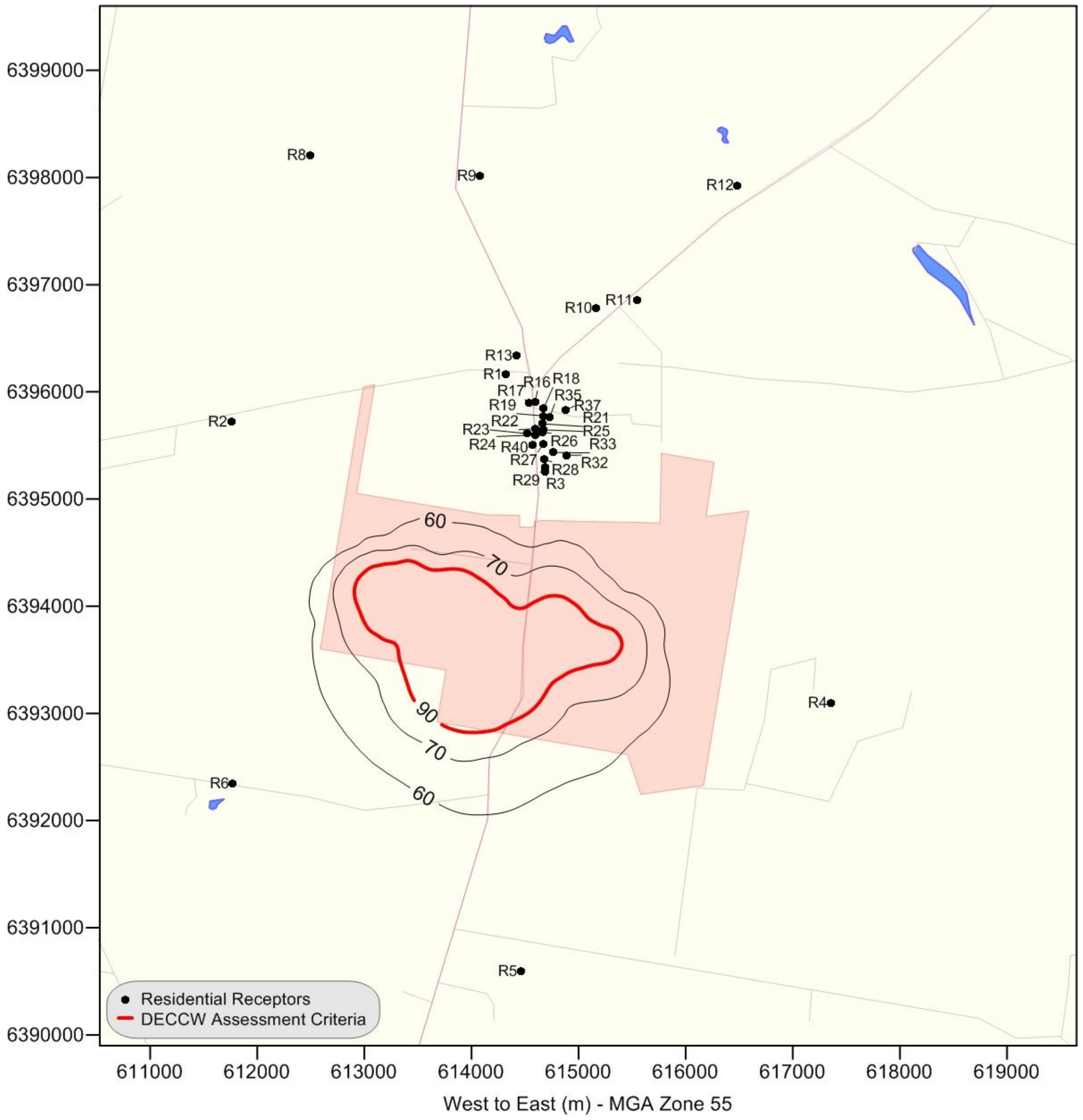

Figure 33: Scenario 4 - Predicted annual average TSP concentrations (µg/m^3) due to emissions from the Project and other sources

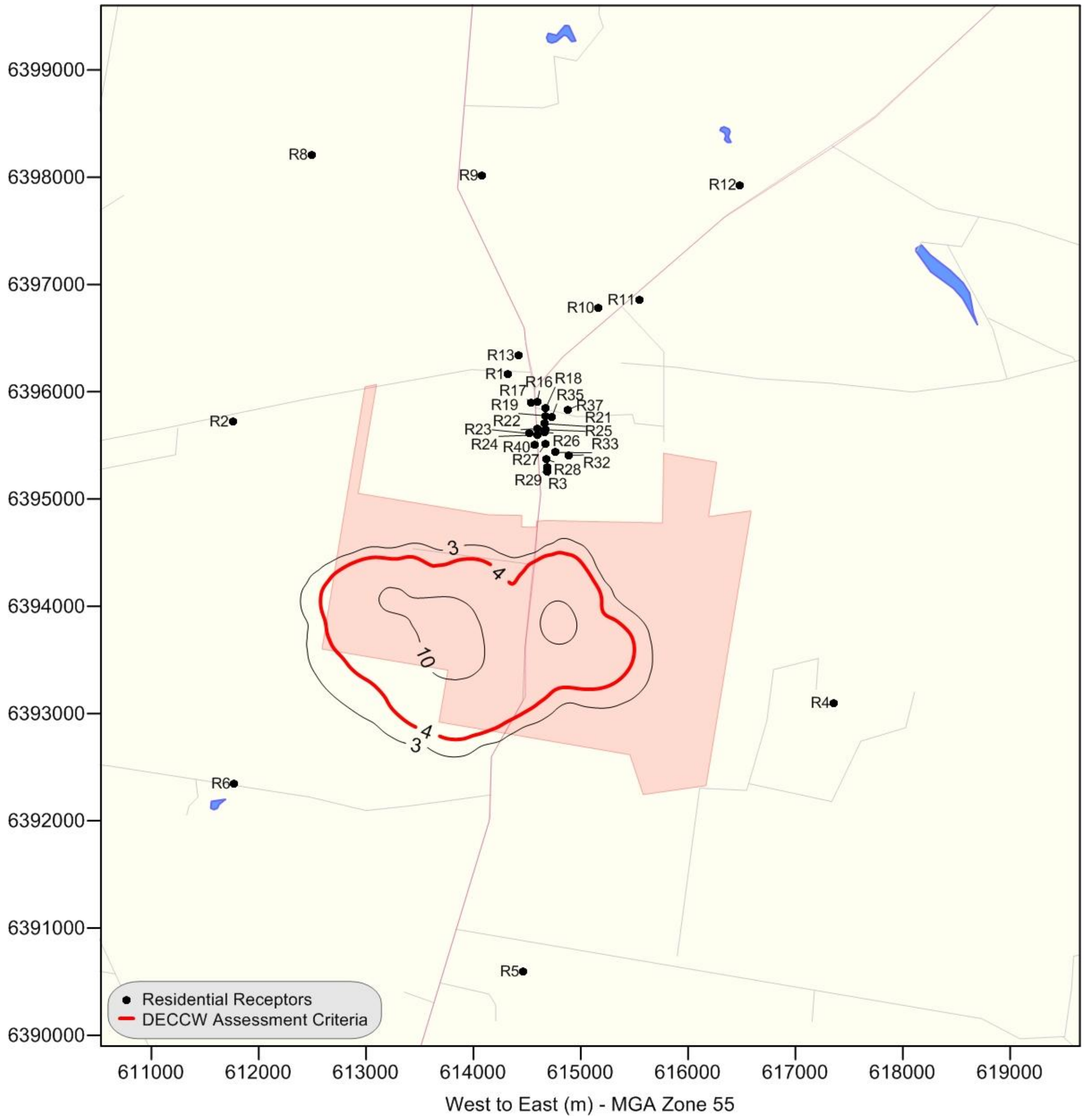

Figure 34: **Scenario 4 - Predicted dust deposition levels (g/m^2/month) due to emissions from the Project and other sources**

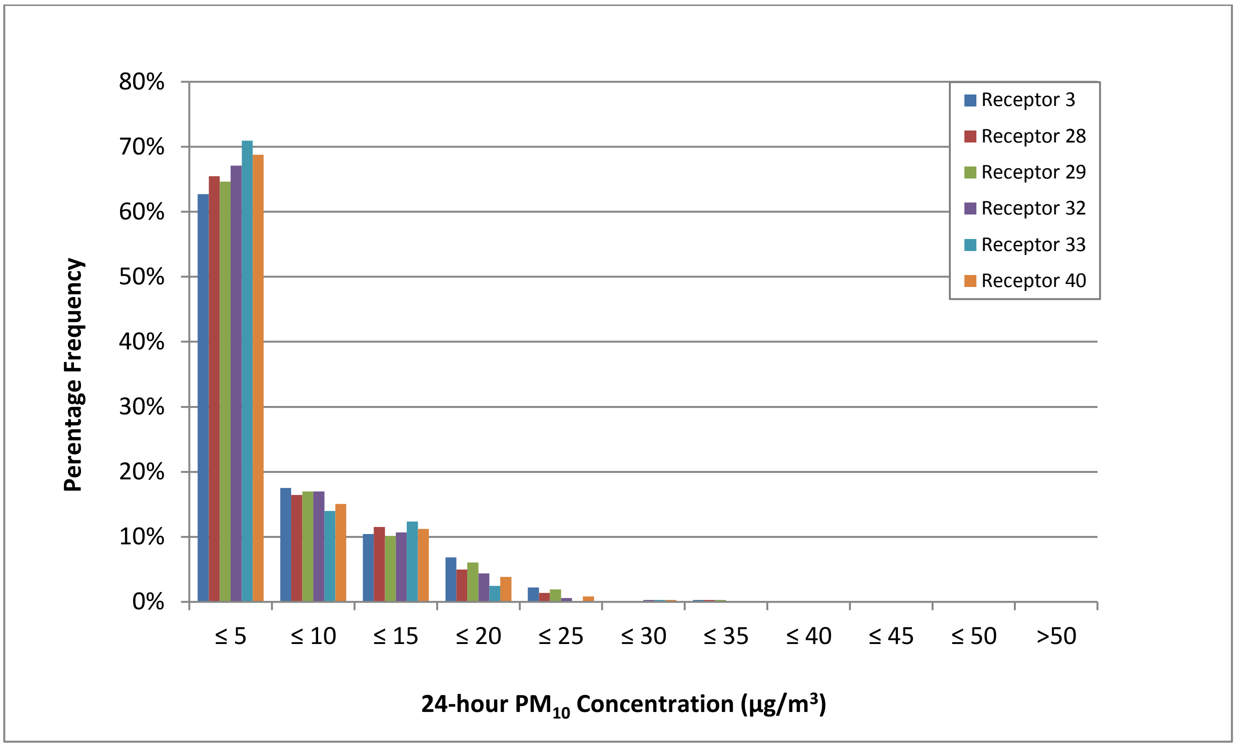

Figure 35: Percentage frequency of incremental 24-hour PM_{10} concentrations for sensitive receptors in Scenario 2

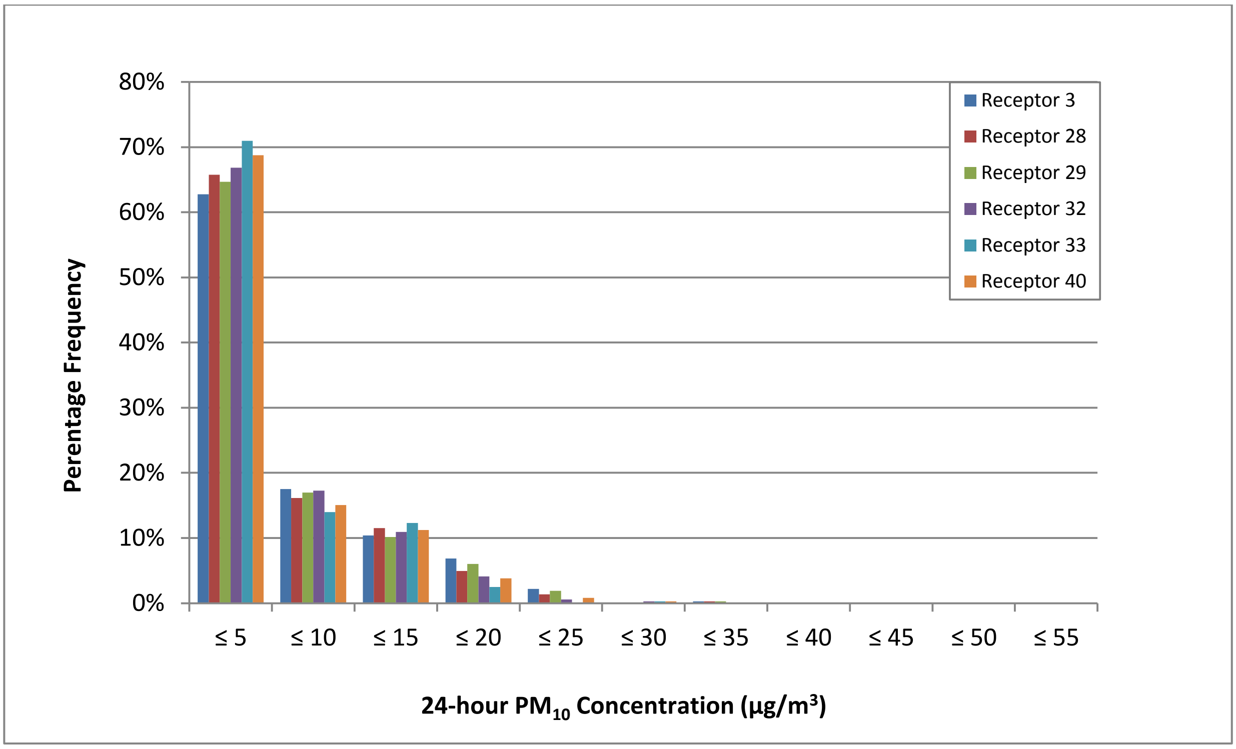

Figure 36: Percentage frequency of incremental 24-hour PM_{10} concentrations for sensitive receptors in Scenario 3

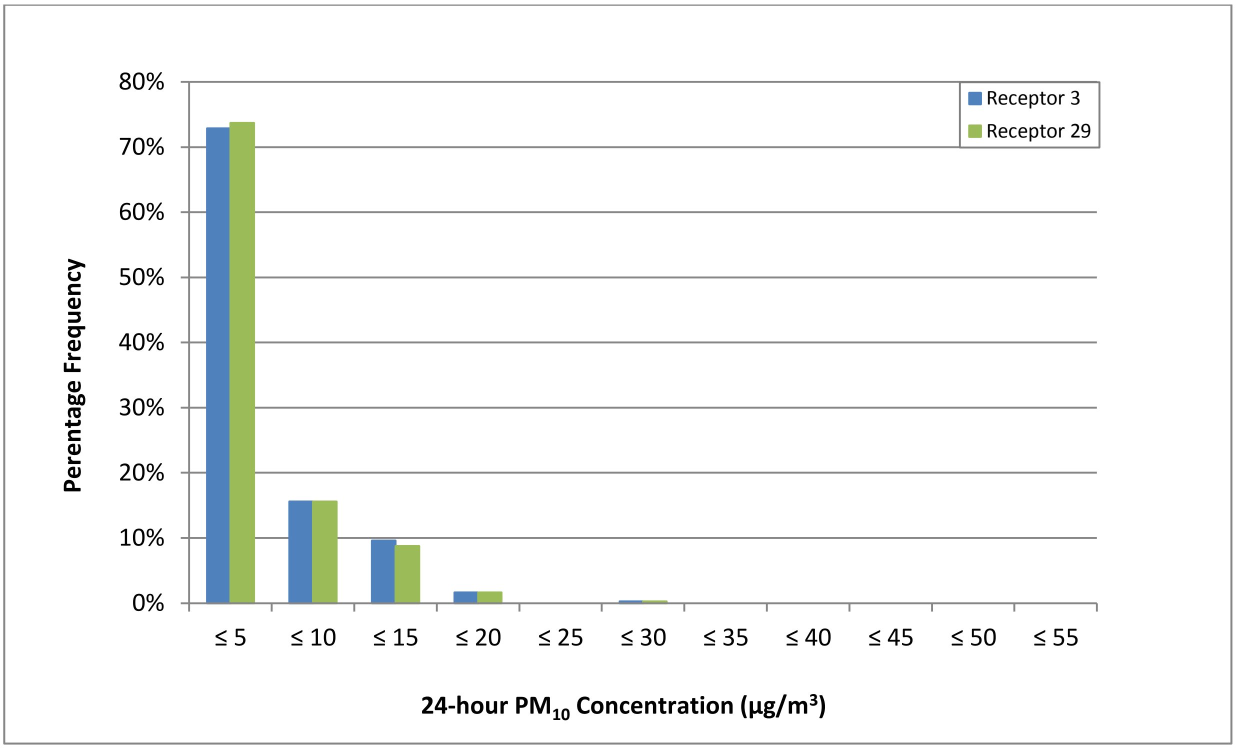

Figure 37: Percentage frequency of 24-hour PM_{10} concentrations for sensitive receptors in Scenario 4

APPENDICES

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Appendix 1

Joint Wind Speed, Wind Direction and Stability Class Frequency Tables

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(A copy of this Appendix is available on the Project CD)

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STATISTICS FOR FILE: C:\Jobs\Tomingley Gold\Met\Tomingley_TAPM_met_2003\TomingleyGold_1km_rev.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	0.000799	0.001598	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.002626
NE	0.000228	0.003082	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.004452
ENE	0.000799	0.003196	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.005479
E	0.001142	0.003196	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.004680
ESE	0.000457	0.001256	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.002169
SE	0.000799	0.002511	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.003653
SSE	0.000685	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001598
S	0.000571	0.000913	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001712
SSW	0.000457	0.001484	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.002511
SW	0.000571	0.001941	0.000799	0.000000	0.000000	0.000000	0.000000	0.000000	0.003311
WSW	0.001484	0.001142	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
W	0.000685	0.001256	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.002626
WNW	0.000571	0.001370	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.002283
NW	0.000685	0.001598	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
NNW	0.000571	0.000571	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001370
N	0.000457	0.001598	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.002626
CALM									0.001370
TOTAL	0.010959	0.027626	0.007991	0.000000	0.000000	0.000000	0.000000	0.000000	0.047945

MEAN WIND SPEED (m/s) = 2.19
NUMBER OF OBSERVATIONS = 420

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	0.000457	0.001598	0.003082	0.000799	0.000000	0.000000	0.000000	0.000000	0.005936
NE	0.000228	0.002626	0.006621	0.001826	0.000000	0.000000	0.000000	0.000000	0.011301
ENE	0.000457	0.002283	0.007192	0.001484	0.000000	0.000000	0.000000	0.000000	0.011416
E	0.000228	0.002055	0.005137	0.001256	0.000000	0.000000	0.000000	0.000000	0.008676
ESE	0.000571	0.001826	0.001256	0.000457	0.000000	0.000000	0.000000	0.000000	0.004110
SE	0.000114	0.001256	0.001484	0.000457	0.000000	0.000000	0.000000	0.000000	0.003311
SSE	0.000457	0.002055	0.000799	0.000457	0.000000	0.000000	0.000000	0.000000	0.003767
S	0.000685	0.002169	0.002055	0.000571	0.000000	0.000000	0.000000	0.000000	0.005479
SSW	0.000685	0.002740	0.006621	0.001256	0.000000	0.000000	0.000000	0.000000	0.011301
SW	0.001142	0.003995	0.005137	0.002169	0.000000	0.000000	0.000000	0.000000	0.012443
WSW	0.000457	0.001027	0.002968	0.000913	0.000000	0.000000	0.000000	0.000000	0.005365
W	0.000342	0.001027	0.002968	0.000913	0.000000	0.000000	0.000000	0.000000	0.005251
WNW	0.000457	0.001370	0.002968	0.000571	0.000000	0.000000	0.000000	0.000000	0.005365
NW	0.000114	0.001598	0.002397	0.001370	0.000000	0.000000	0.000000	0.000000	0.005479
NNW	0.000457	0.001484	0.002169	0.001826	0.000000	0.000000	0.000000	0.000000	0.005936
N	0.000457	0.001712	0.002511	0.000913	0.000000	0.000000	0.000000	0.000000	0.005594
CALM									0.001256
TOTAL	0.007306	0.030822	0.055365	0.017237	0.000000	0.000000	0.000000	0.000000	0.111986

MEAN WIND SPEED (m/s) = 3.40
NUMBER OF OBSERVATIONS = 981

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	0.000114	0.000913	0.001027	0.002968	0.001256	0.000228	0.000000	0.000000	0.006507
NE	0.000571	0.001027	0.003196	0.007877	0.001370	0.000114	0.000000	0.000000	0.014155
ENE	0.000571	0.001598	0.005023	0.014612	0.004452	0.000114	0.000000	0.000000	0.026370
E	0.000457	0.000571	0.003196	0.007306	0.003881	0.000799	0.000000	0.000000	0.016210
ESE	0.000799	0.001712	0.000571	0.001370	0.000685	0.000000	0.000000	0.000000	0.005137
SE	0.000342	0.000913	0.001484	0.001142	0.000000	0.000000	0.000000	0.000000	0.003881
SSE	0.000457	0.001142	0.001027	0.001142	0.000228	0.000000	0.000000	0.000000	0.003995
S	0.000571	0.001027	0.001256	0.001256	0.000457	0.000000	0.000000	0.000000	0.004566
SSW	0.001027	0.001484	0.001941	0.003767	0.001941	0.000114	0.000000	0.000000	0.010274
SW	0.000571	0.001826	0.002283	0.007991	0.004566	0.000342	0.000000	0.000000	0.017580
WSW	0.000913	0.000799	0.001027	0.004452	0.005822	0.001027	0.000000	0.000000	0.014041
W	0.000342	0.000685	0.001142	0.005023	0.003881	0.001712	0.000000	0.000000	0.012785
WNW	0.000228	0.000685	0.001142	0.002169	0.002511	0.000799	0.000000	0.000000	0.007534
NW	0.000571	0.000457	0.001484	0.002626	0.001484	0.000799	0.000000	0.000000	0.007420
NNW	0.000228	0.000685	0.001484	0.003311	0.002283	0.000571	0.000000	0.000000	0.008562
N	0.000342	0.000913	0.002397	0.002055	0.001941	0.000571	0.000000	0.000000	0.008219
CALM									0.001484
TOTAL	0.008105	0.016438	0.029680	0.069064	0.036758	0.007192	0.000000	0.000000	0.168721

MEAN WIND SPEED (m/s) = 4.96
NUMBER OF OBSERVATIONS = 1478

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	0.002283	0.006050	0.001484	0.002740	0.001142	0.000685	0.000114	0.000000	0.014498
NE	0.001598	0.006507	0.002283	0.004224	0.001142	0.000228	0.000000	0.000000	0.015982
ENE	0.002740	0.006507	0.008790	0.034247	0.015868	0.001370	0.000000	0.000000	0.069521
E	0.003881	0.008333	0.004680	0.023402	0.013242	0.004224	0.000000	0.000000	0.057763
ESE	0.004110	0.004795	0.001142	0.001826	0.000114	0.000000	0.000000	0.000000	0.011986
SE	0.007534	0.003311	0.000685	0.000114	0.000000	0.000000	0.000000	0.000000	0.011644
SSE	0.010502	0.005251	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.016438
S	0.008447	0.005594	0.000342	0.000342	0.000000	0.000000	0.000000	0.000000	0.014726
SSW	0.006393	0.006050	0.002169	0.001142	0.001941	0.000000	0.000000	0.000000	0.017694
SW	0.004224	0.004110	0.005137	0.002626	0.002283	0.001484	0.000571	0.000000	0.020434
WSW	0.004909	0.002854	0.001826	0.003425	0.002397	0.002626	0.001027	0.000000	0.019064
W	0.002626	0.001712	0.001256	0.003311	0.002854	0.001256	0.001484	0.000228	0.014726
WNW	0.001941	0.002626	0.000685	0.002740	0.002169	0.001027	0.000685	0.000342	0.012215
NW	0.001712	0.001941	0.002169	0.000913	0.001256	0.001256	0.001142	0.000114	0.010502
NNW	0.002397	0.003995	0.000913	0.001941	0.001941	0.001027	0.000000	0.000342	0.012557
N	0.002511	0.003539	0.000685	0.002968	0.002169	0.001598	0.000685	0.000228	0.014384
CALM									0.005365
TOTAL	0.067808	0.073174	0.034932	0.085959	0.048516	0.016781	0.005708	0.001256	0.339498

MEAN WIND SPEED (m/s) = 4.02
NUMBER OF OBSERVATIONS = 2974

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	0.000685	0.001712	0.002854	0.002283	0.000000	0.000000	0.000000	0.000000	0.007534
NE	0.000571	0.000913	0.003995	0.000799	0.000000	0.000000	0.000000	0.000000	0.006279
ENE	0.001712	0.001598	0.014612	0.010731	0.000000	0.000000	0.000000	0.000000	0.028653
E	0.000913	0.003653	0.013813	0.009475	0.000000	0.000000	0.000000	0.000000	0.027854
ESE	0.000457	0.003196	0.000913	0.000114	0.000000	0.000000	0.000000	0.000000	0.004680
SE	0.000799	0.002055	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
SSE	0.002055	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003881
S	0.001598	0.001598	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.003539
SSW	0.001712	0.001370	0.000685	0.000571	0.000000	0.000000	0.000000	0.000000	0.004338
SW	0.001598	0.000685	0.001142	0.000342	0.000000	0.000000	0.000000	0.000000	0.003767
WSW	0.000799	0.001027	0.001941	0.000342	0.000000	0.000000	0.000000	0.000000	0.004110
W	0.000457	0.000799	0.000685	0.000228	0.000000	0.000000	0.000000	0.000000	0.002169
WNW	0.000571	0.000571	0.000685	0.000457	0.000000	0.000000	0.000000	0.000000	0.002283
NW	0.000457	0.000571	0.000799	0.000571	0.000000	0.000000	0.000000	0.000000	0.002397
NNW	0.000228	0.000799	0.000457	0.000913	0.000000	0.000000	0.000000	0.000000	0.002397
N	0.000457	0.001941	0.001256	0.000457	0.000000	0.000000	0.000000	0.000000	0.004110
CALM									0.000000
TOTAL	0.015068	0.024315	0.044178	0.027283	0.000000	0.000000	0.000000	0.000000	0.110845

MEAN WIND SPEED (m/s) = 3.40
NUMBER OF OBSERVATIONS = 971

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	0.000799	0.014384	0.001712	0.000000	0.000000	0.000000	0.000000	0.000000	0.016895
NE	0.000913	0.015183	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.017237
ENE	0.000228	0.019064	0.004566	0.000000	0.000000	0.000000	0.000000	0.000000	0.023858
E	0.000799	0.023402	0.007534	0.000000	0.000000	0.000000	0.000000	0.000000	0.031735
ESE	0.000571	0.012900	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.014954
SE	0.001027	0.007192	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.008333
SSE	0.001712	0.009018	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.010845
S	0.002397	0.019178	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.021689
SSW	0.003196	0.013242	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.016781
SW	0.001142	0.012900	0.001142	0.000000	0.000000	0.000000	0.000000	0.000000	0.015183
WSW	0.000799	0.007991	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.009703
W	0.000685	0.005251	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.006279
WNW	0.000457	0.006735	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.007648
NW	0.000913	0.003653	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.004795
NNW	0.000571	0.005479	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.006164
N	0.000799	0.007648	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.008904
CALM									0.000000
TOTAL	0.017009	0.183219	0.020776	0.000000	0.000000	0.000000	0.000000	0.000000	0.221005

MEAN WIND SPEED (m/s) = 2.19
NUMBER OF OBSERVATIONS = 1936

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	0.005137	0.026256	0.010388	0.008790	0.002397	0.000913	0.000114	0.000000	0.053995
NE	0.004110	0.029338	0.018379	0.014726	0.002511	0.000342	0.000000	0.000000	0.069406
ENE	0.006507	0.034247	0.041667	0.061073	0.020320	0.001484	0.000000	0.000000	0.165297
E	0.007420	0.041210	0.034703	0.041438	0.017123	0.005023	0.000000	0.000000	0.146918
ESE	0.006963	0.025685	0.005822	0.003767	0.000799	0.000000	0.000000	0.000000	0.043037
SE	0.010616	0.017237	0.004110	0.001712	0.000000	0.000000	0.000000	0.000000	0.033676
SSE	0.015868	0.020205	0.002626	0.001598	0.000228	0.000000	0.000000	0.000000	0.040525
S	0.014269	0.030479	0.004338	0.002169	0.000457	0.000000	0.000000	0.000000	0.051712
SSW	0.013470	0.026370	0.012329	0.006735	0.003881	0.000114	0.000000	0.000000	0.062900
SW	0.009247	0.025457	0.015639	0.013128	0.006849	0.001826	0.000571	0.000000	0.072717
WSW	0.009361	0.014840	0.009132	0.009132	0.008219	0.003653	0.001027	0.000000	0.055365
W	0.005137	0.010731	0.007078	0.009475	0.006735	0.002968	0.001484	0.000228	0.043836
WNW	0.004224	0.013356	0.006279	0.005936	0.004680	0.001826	0.000685	0.000342	0.037329
NW	0.004452	0.009817	0.007192	0.005479	0.002740	0.002055	0.001142	0.000114	0.032991
NNW	0.004452	0.013014	0.005365	0.007991	0.004224	0.001598	0.000000	0.000342	0.036986
N	0.005023	0.017352	0.007877	0.006393	0.004110	0.002169	0.000685	0.000228	0.043836
CALM									0.009475
TOTAL	0.126256	0.355594	0.192922	0.199543	0.085274	0.023973	0.005708	0.001256	1.000000

MEAN WIND SPEED (m/s) = 3.55
NUMBER OF OBSERVATIONS = 8760

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 4.8%
B : 11.2%
C : 16.9%
D : 33.9%
E : 11.1%
F : 22.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0120	0082	0163
02	0000	0000	0000	0127	0083	0155
03	0000	0000	0000	0136	0078	0151
04	0000	0000	0000	0132	0090	0143
05	0000	0000	0000	0133	0103	0129
06	0000	0000	0000	0233	0058	0074
07	0000	0000	0013	0311	0010	0031
08	0000	0015	0125	0225	0000	0000
09	0002	0081	0178	0104	0000	0000
10	0027	0124	0179	0035	0000	0000
11	0051	0141	0139	0034	0000	0000
12	0079	0132	0116	0038	0000	0000
13	0088	0118	0116	0043	0000	0000
14	0083	0110	0125	0047	0000	0000
15	0061	0109	0138	0057	0000	0000
16	0027	0095	0156	0087	0000	0000
17	0002	0056	0123	0184	0000	0000
18	0000	0000	0069	0239	0024	0033
19	0000	0000	0001	0192	0053	0119
20	0000	0000	0000	0069	0095	0201
21	0000	0000	0000	0084	0079	0202
22	0000	0000	0000	0101	0079	0185
23	0000	0000	0000	0120	0063	0182
24	0000	0000	0000	0123	0074	0168

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0011	0230	0419	2278	0962	1932
<=1000 m	0053	0186	0206	0284	0009	0004
<=1500 m	0173	0283	0495	0234	0000	0000
<=2000 m	0112	0147	0207	0116	0000	0000
<=3000 m	0071	0135	0149	0059	0000	0000
>3000 m	0000	0000	0002	0003	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	0073	0182	0092	0014	0004	0000	0000
02	0068	0175	0104	0016	0002	0000	0000
03	0064	0170	0111	0016	0004	0000	0000
04	0061	0159	0123	0019	0003	0000	0000
05	0068	0150	0128	0016	0003	0000	0000
06	0067	0141	0138	0017	0002	0000	0000
07	0078	0157	0110	0019	0001	0000	0000
08	0082	0140	0113	0026	0004	0000	0000
09	0066	0084	0112	0091	0012	0000	0000
10	0009	0065	0074	0148	0068	0001	0000
11	0001	0009	0059	0100	0178	0018	0000
12	0001	0004	0009	0066	0223	0062	0000
13	0001	0001	0007	0023	0226	0107	0000
14	0001	0001	0004	0013	0196	0150	0000
15	0000	0002	0008	0011	0183	0160	0001
16	0002	0002	0006	0013	0163	0177	0002
17	0001	0008	0018	0054	0120	0163	0001
18	0051	0064	0037	0035	0100	0078	0000
19	0079	0160	0051	0035	0031	0009	0000
20	0107	0199	0036	0015	0007	0001	0000
21	0099	0209	0043	0010	0003	0001	0000
22	0094	0200	0057	0011	0002	0001	0000
23	0089	0189	0071	0014	0002	0000	0000
24	0083	0187	0081	0008	0006	0000	0000

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Appendix 2

TSP and Dust Deposition Monitoring Data

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Table 1
Dust Deposition Monitoring Data (g/m^2/month)

Year	Month	Deposition Gauge ID										
		'Dunoon'	**'Wyoming'**	**'Tomingley'**	**41 Euchie St**	**'Little Oakleigh'**	**59 Euchie St**	**'Cowabunga'**	**Warrigal Rd**	**2 Caswell St**	**Frazer court Hotel**	**'Towalba'**
1996	January	-	-	-	1.4	1.1	1.4	-	1.5	1.1	-	-
	February	-	-	-	9.3	7	10.2	-	7.9	7.8	-	-
	March	-	-	-	2.1	*8.4	3.5	-	2.8	2.6	-	-
	April	-	-	-	3.7	*5.5	3.7	-	3.2	3.4	-	-
	May	-	-	-	0.5	0.9	0.8	-	0.7	0.6	-	-
	June	-	-	-	1.4	0.5	2.4	-	1.1	1.7	-	-
	July	-	-	-	1.3	1.1	1.7	-	1.3	1	-	-
	August	-	-	-	1.4	1.8	1.9	-	2.5	1.7	-	-
	September	-	-	-	2.8	*4.5	3.2	-	2.8	2.7	-	-
	October	-	-	-	0.7	0.7	0.8	-	1.1	1.2	-	-
	November	-	-	-	2.8	4.3	6.3	-	7.2	8.3	-	4.7
	December	-	-	-	1.6	1.1	*155.0	-	2.8	*18.4	-	2.1
	Average	**-**	**-**	**-**	**2.4**	**2.1**	**3.3**	**-**	**2.9**	**2.9**	**-**	**3.4**
2001	January	-	-	-	0.5	1.7	0.6	-	1.0	0.6	1.0	-
	February	-	-	-	1.7	0.6	2.0	-	1.7	1.4	1.8	-
	March	-	-	-	1.0	0.7	1.1	-	1.3	0.9	0.9	-
	April	-	-	-	1.9	1.3	1.5	-	2.1	1.6	2.0	-
	May	-	-	-	0.4	0.6	0.6	-	1.4	0.6	1.0	-
	June	-	-	-	1.2	1.5	0.8	-	1.0	1.2	0.5	-
	July	-	-	-	0.3	0.5	0.6	-	1.4	0.6	1.3	-
	August	-	-	-	1.4	1.5	1.5	-	2.0	1.7	2.1	-
	September	-	-	-	1.4	1.0	1.2	-	1.9	1.0	1.3	-
	October	-	-	-	0.7	0.3	0.3	-	1.0	0.7	0.9	-
	November	-	-	-	0.7	1.2	1.0	-	1.5	0.9	1.6	-
	December	-	-	-	*3.2	-	-	2.0	2.6	3.2	3.5	-
	Average	**-**	**-**	**-**	**1.0**	**1.0**	**1.0**	**2.0**	**1.6**	**1.2**	**1.5**	**-**
2002	January	2.6	9.2	2.0	-	-	3.7	1.6	2.6	2.7	2.4	-
	February	2.1	2.7	1.0	2.0	-	2.1	1.2	2.0	1.3	2.1	-
	March	1.5	3.9	1.4	2.1	-	2.0	0.9	1.8	1.5	2.2	-
	April	0.7	2	1.9	0.7	-	1.0	0.3	0.8	1.1	1.0	-
	May	0.7	1.3	0.9	1.4	-	1.6	0.5	1.7	1.1	1.3	-
	June	0.5	4.3	0.6	1.8	-	0.9	0.7	1.7	0.7	1.1	-
	July	0.3	1.2	0.4	0.8	-	0.8	0.4	1.0	0.6	0.5	-
	August	1.5	2	1.6	3.0	-	1.1	1.0	1.7	1.5	1.5	-
	September	1.9	6.2	2.7	2.5	-	3.8	2.5	3.0	3.0	3.4	-
	October	2.5	2.3	1.3	1.0	-	1.7	0.3	0.9	1.3	0.9	-
	November	4	7.3	2.5	-	-	-	-	-	-	-	-
	December	5.5	7.8	5.3	-	-	-	-	-	-	-	-
	Average	**2.0**	**4.2**	**1.8**	**1.7**	**-**	**1.9**	**0.9**	**1.7**	**1.5**	**1.6**	**-**
2003	January	1.5	1.2	1.8	-	-	-	-	-	-	-	-
	February	12.2	11.3	25.8	-	-	-	-	-	-	-	-
	March	1.5	4.2	2	-	-	-	-	-	-	-	-
	April	0.7	1.9	0.8	-	-	-	-	-	-	-	-
	May	0.7	2.8	0.8	-	-	-	-	-	-	-	-
	June	0.9	3.7	0.4	-	-	-	-	-	-	-	-
	July	0.3	0.5	1.6	-	-	-	-	-	-	-	-

Year	Month	Deposition Gauge ID										
		'Dunoon'	'Wyoming'	'Tomingley'	41 Euchie St	'Little Oakleigh'	59 Euchie St	'Cowabunga'	Warrigal Rd	2 Caswell St	Frazer court Hotel	'Towalba'
	August	0.3	1.3	0.3	-	-	-	-	-	-	-	-
	September	1.1	2.3	0.9	-	-	-	-	-	-	-	-
	October	1.5	1.4	1.2	-	-	-	-	-	-	-	-
	November	2.1	5.1	1.8	-	-	-	-	-	-	-	-
	December	1.9	4.7	1.7	-	-	-	-	-	-	-	-
	Average	**2.1**	**3.4**	**3.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	January	1.3	2.6	1.4	-	-	-	-	-	-	-	-
	February	3.4	5.7	4.1	-	-	-	-	-	-	-	-
	March	1.2	1.8	3.8	-	-	-	-	-	-	-	-
	April	2.9	4	1.5	-	-	-	-	-	-	-	-
	May	0.9	2.1	0.9	-	-	-	-	-	-	-	-
	June	0.5	2	1.5	-	-	-	-	-	-	-	-
2004	July	0.8	0.7	1.4	-	-	-	-	-	-	-	-
	August	1.4	2.5	1.6	-	-	-	-	-	-	-	-
	September	0.4	0.9	0.5	-	-	-	-	-	-	-	-
	October	1.2	1.1	1	-	-	-	-	-	-	-	-
	November	2	2.1	0.9	-	-	-	-	-	-	-	-
	December	2.8	5.6	2.4	-	-	-	-	-	-	-	-
	Average	**1.6**	**2.6**	**1.8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	January	2.8	*30.1	4	-	-	-	-	-	-	-	-
	February	2.9	2.6	2.7	-	-	-	-	-	-	-	-
	March	0.9	1.8	1.3	-	-	-	-	-	-	-	-
	April	0.6	0.8	1.2	-	-	-	-	-	-	-	-
	May	1.6	1.7	0.6	-	-	-	-	-	-	-	-
	June	1.2	1.6	1.3	-	-	-	-	-	-	-	-
2005	July	0.3	0.2	0.3	-	-	-	-	-	-	-	-
	August	0.4	0.8	0.8	-	-	-	-	-	-	-	-
	September	0.3	0.6	0.6	-	-	-	-	-	-	-	-
	October	1.1	1	1	-	-	-	-	-	-	-	-
	November	0.7	1.2	0.7	-	-	-	-	-	-	-	-
	December	1.1	8.6	1	-	-	-	-	-	-	-	-
	Average	**1.2**	**1.9**	**1.3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	January	0.4	0.9	1.5	-	-	-	-	-	-	-	-
	February	1.5	1.6	4	-	-	-	-	-	-	-	-
	March	0.8	1.1	1.2	-	-	-	-	-	-	-	-
	April	0.8	1.8	0.5	-	-	-	-	-	-	-	-
	May	0.8	2.9	0.7	-	-	-	-	-	-	-	-
	June	-	-	-	-	-	-	-	-	-	-	-
2006	July	-	-	-	-	-	-	-	-	-	-	-
	August	-	-	-	-	-	-	-	-	-	-	-
	September	-	-	-	-	-	-	-	-	-	-	-
	October	-	-	-	-	-	-	-	-	-	-	-
	November	-	-	-	-	-	-	-	-	-	-	-
	December	-	-	-	-	-	-	-	-	-	-	-
	Average	**0.9**	**1.7**	**1.6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

* Site contaminated by bird droppings or organic matter

Table 2
HVAS TSP Monitoring Data (µg/m^3)

Date	Monitoring location ID	
	59 Euchie St	Frazer Court
16-Feb-96	90.2	
20-Feb-96	232.3	
27-Feb-96	102.3	
03-Mar-96	56.2	
09-Mar-96	97.8	
15-Mar-96	177.1	
21-Mar-96	66.5	
27-Mar-96	90.3	
02-Apr-96	77.6	
08-Apr-96	45.1	
14-Apr-96	84.6	
19-Apr-96	57.0	
25-Apr-96	66.3	
26-Apr-96	91.0	
01-May-96	20.1	
07-May-96	12.9	
13-May-96	21.8	
20-May-96	51.1	
26-May-96	33.6	
01-Jun-96	57.0	
07-Jun-96	32.5	
13-Jun-96	142.5	
19-Jun-96	32.5	
27-Jun-96	14.6	
01-Jul-96	11.8	
07-Jul-96	18.0	
13-Jul-96	9.6	
19-Jul-96	20.7	
25-Jul-96	34.4	
31-Jul-96	8.0	
06-Aug-96	31.6	
12-Aug-96	60.2	
18-Aug-96	25.8	
24-Aug-96	23.2	
27-Aug-96	*33.9	
30-Aug-96	10.4	
05-Sep-96	28.0	
11-Sep-96	73.0	
17-Sep-96	80.0	
19-Sep-96	65.5	
23-Sep-96	40.6	
26-Sep-96	38.3	
29-Sep-96	23.6	
05-Oct-96	41.0	
11-Oct-96	53.8	
17-Oct-96	38.4	
23-Oct-96	76.7	
29-Oct-96	44.3	
02-Nov-96	160.1	
04-Nov-96	20.3	
10-Nov-96	105.6	
16-Nov-96	77.7	
22-Nov-96	79.5	
25-Nov-96	51.1	
28-Nov-96	71.3	
02-Dec-96	81.6	
04-Dec-96	61.9	
06-Dec-96	35.1	
10-Dec-96	32.7	
16-Dec-96	91.9	
22-Dec-96	65.5	
06-Jan-97	64.9	
09-Jan-97	69.2	
15-Jan-97	83.3	
21-Jan-97	60.2	
27-Jan-97	28.8	
02-Feb-97	34.5	
08-Feb-97	84.8	
14-Feb-97	20.0	
20-Feb-97	60.3	
26-Feb-97	97.3	
04-Mar-97	71.0	

Date	Monitoring location ID	
	59 Euchie St	Frazer Court
10-Mar-97	135.2	
16-Mar-97	80.6	
22-Mar-97	86.5	
03-Apr-97	104.8	
09-Apr-97	121.1	
15-Apr-97	130.9	
21-Apr-97	137.2	
27-Apr-97	26.8	
03-May-97	120.3	
06-May-97	116.5	
09-May-97	35.4	
15-May-97	186.0	
21-May-97	112.4	
27-May-97	71.8	
02-Jun-98	64.8	
08-Jun-97	24.1	
14-Jun-97	20.5	
20-Jun-97	56.7	
26-Jun-97	31.6	
02-Jul-97	52.2	
08-Jul-97	42.1	
14-Jul-97	69.4	
20-Jul-97	34.7	
26-Jul-97	33.8	
01-Aug-97	46.5	
07-Aug-97	35.7	
13-Aug-97	17.5	
19-Aug-97	44.5	
21-Aug-97	68.8	
25-Aug-97	25.5	
31-Aug-97	85.0	
06-Sep-97	17.9	
12-Sep-97	47.4	
18-Sep-97	100.5	
24-Sep-97	6.6	
30-Sep-97	24.0	
06-Oct-97	63.1	
12-Oct-97	48.5	
18-Oct-97	54.4	
24-Oct-97	62.4	
30-Oct-97	148.2	
05-Nov-97	98.0	
11-Nov-97	45.4	
17-Nov-97	43.1	
23-Nov-97	50.5	
27-Nov-97	85.2	
29-Nov-97	215.8	
05-Dec-97	123.4	
11-Dec-97	108.2	
18-Dec-97	97.0	
05-Jan-98	27.3	
10-Jan-98	43.8	
16-Jan-98	72.0	
22-Jan-98	61.5	
29-Jan-98	49.1	
03-Feb-98	151.2	
09-Feb-98	79.2	
15-Feb-98	61.8	
21-Feb-98	69.0	
27-Feb-98	167.7	
05-Mar-98	91.9	
11-Mar-98	64.2	
17-Mar-98	109.3	
23-Mar-98	126.2	
29-Mar-98	108.3	
04-Apr-98	122.7	
22-Apr-98	11.9	
28-Apr-98	32.5	
04-May-98	13.5	
10-May-98	27.7	
16-May-98	6.9	
22-May-98	28.7	
28-May-98	39.9	
03-Jun-98	37.8	
15-Jun-98	50.4	
21-Jun-98	8.0	
27-Jun-98	10.5	
03-Jul-98	17.0	
09-Jul-98	13.7	

Date	Monitoring location ID	
	59 Euchie St	**Frazer Court**
15-Jul-98	25.9	
21-Jul-98	1.5	
27-Jul-98	5.0	
02-Aug-98	9.5	
08-Aug-98	7.2	
10-Sep-98	66.8	
13-Sep-98	9.6	
19-Sep-98	60.8	
25-Sep-98	17.2	
29-Sep-98	67.3	
01-Oct-98	78.9	
07-Oct-98	8.2	
13-Oct-98	27.3	
19-Oct-98	11.6	
25-Oct-98	59.3	
31-Oct-98	27.5	
06-Nov-98	75.7	
12-Nov-98	17.5	
18-Nov-98	30.8	
24-Nov-98	44.0	
30-Nov-98	33.0	
06-Dec-98	54.5	
08-Dec-98	86.4	
12-Dec-98	56.6	
18-Dec-98	46.5	
30-Dec-98	51.1	
14-Jan-99	172.5	
17-Jan-99	53.6	
23-Jan-99	43.4	
29-Jan-99	24.4	
04-Feb-99	43.4	
10-Feb-99	160.7	
16-Feb-99	53.5	
22-Feb-99	113.4	
28-Feb-99	38.0	
06-Mar-99	42.1	
12-Mar-99	68.8	
18-Mar-99	23.2	
24-Mar-99	57.8	
30-Mar-99	41.3	
05-Apr-99	56.9	
11-Apr-99	89.7	
17-Apr-99	108.9	
23-Apr-99	127.9	
29-Apr-99	137.7	
05-May-99	105.6	
11-May-99	33.2	
17-May-99	47.4	
23-May-99	28.0	
29-May-99	57.4	
04-Jun-99	140.3	
10-Jun-99	16.5	
16-Jun-99	51.2	
29-Jun-99	52.4	
04-Jul-99	14.8	
10-Jul-99	17.5	
16-Jul-99	14.0	
22-Jul-99	11.3	
28-Jul-99	27.0	
03-Aug-99	26.8	
09-Aug-99	18.3	
15-Aug-99	14.7	
21-Aug-99	29.2	
27-Aug-99	9.6	
02-Sep-99	21.6	
08-Sep-99	16.8	
14-Sep-99	33.5	
20-Sep-99	34.2	
26-Sep-99	14.3	
02-Oct-99	18.9	
08-Oct-99	36.0	
14-Oct-99	42.1	
20-Oct-99	19.1	
26-Oct-99	22.1	
01-Nov-99	29.2	
07-Nov-99	19.4	
13-Nov-99	31.5	
19-Nov-99	49.7	

Date	Monitoring location ID	
	59 Euchie St	Frazer Court
25-Nov-99	67.5	
01-Dec-99	66.1	
07-Dec-99	105.7	
08-Dec-99	40.9	
14-Dec-99	80.5	
20-Dec-99	28.0	
07-Jan-00	71.4	
12-Jan-00	70.6	
18-Jan-00	69.2	
24-Jan-00	89.5	
30-Jan-00	26.7	
05-Feb-00	63.3	
10-Feb-00	88.7	
23-Feb-00	29.7	
29-Feb-00	71.8	
06-Mar-00	68.5	
17-Apr-00	20.1	
23-Apr-00	28.6	
29-Apr-00	108.6	
13-May-00	31.0	
17-May-00	33.2	
24-May-00	38.7	
29-May-00	16.3	
04-Jun-00	9.4	
10-Jun-00	20.6	
16-Jun-00	33.9	
22-Jun-00	27.2	
28-Jun-00	13.6	
04-Jul-00	38.6	
10-Jul-00	12.5	
16-Jul-00	18.5	
22-Jul-00	16.1	
28-Jul-00	12.9	
03-Aug-00	20.9	
09-Aug-00	4.7	
15-Aug-00	9.2	
21-Aug-00	11.3	
27-Aug-00	5.9	
02-Sep-00	8.7	
08-Sep-00	19.5	
14-Sep-00	61.9	
20-Sep-00	66.1	
26-Sep-00	107.5	
02-Oct-00	89.0	
08-Oct-00	110.4	
14-Oct-00	31.6	
20-Oct-00	14.8	
26-Oct-00	24.1	
01-Nov-00	57.2	
07-Nov-00	45.4	
13-Nov-00	19.8	
19-Nov-00	11.2	
25-Nov-00	48.5	
01-Dec-00	35.7	
07-Dec-00	46.1	
13-Dec-00	83.9	
19-Dec-00	49	
25-Dec-00	48.1	
12-Jan-01		50.1
18-Jan-01		60.4
24-Jan-01		75.7
30-Jan-01		60.5
01-Feb-01		46
05-Feb-01		37.1
11-Feb-01		36.6
17-Feb-01		29.7
23-Feb-01		56.0
01-Mar-01		42.1
07-Mar-01		25.1
13-Mar-01		38.5
19-Mar-01		24.0
25-Mar-01		13.6
31-Mar-01		24.1
06-Apr-01		60.6
12-Apr-01		43.8
18-Apr-01		74.5
24-Apr-01		15.4
30-Apr-01		16.8
06-May-01		13.2

Date	Monitoring location ID	
	59 Euchie St	Frazer Court
12-May-01		53.5
18-May-01		42.0
24-May-01		49.2
30-May-01		18.7
05-Jun-01		30.0
11-Jun-01		11.2
17-Jun-01		14.1
23-Jun-01		13.1
29-Jun-01		22.3
05-Jul-01		33.9
11-Jul-01		14.6
17-Jul-01		12.3
23-Jul-01		20.5
29-Jul-01		11.3
04-Aug-01		16.9
10-Aug-01		12.9
16-Aug-01		80.7
22-Aug-01		19.4
28-Aug-01		5.7
03-Sep-01		11.1
09-Sep-01		26.1
15-Sep-01		6.5
21-Sep-01		34.6
27-Sep-01		21.6
03-Oct-01		17.6
09-Oct-01		22.2
15-Oct-01		11.4
21-Oct-01		23.7
27-Oct-01		32.6
02-Nov-01		58.0
08-Nov-01		14.1
14-Nov-01		34.4
20-Nov-01		44.1
02-Dec-01		46.8
08-Dec-01		21.5
10-Dec-01		43.8
14-Dec-01		52.6
19-Dec-01		116.0
20-Dec-01		151.0
26-Dec-01		101.2
01-Jan-02		65.0
07-Jan-02		52.4
13-Jan-02		57.5
19-Jan-02		134.7
22-Jan-02		44.5
25-Jan-02		26.5
31-Jan-02		39.4
06-Feb-02		24.7
12-Feb-02		31.1
18-Feb-02		18.1
24-Feb-02		25.9
02-Mar-02		39.3
08-Mar-02		55.4
14-Mar-02		67.1
26-Mar-02		216.7
01-Apr-02		17.8
07-Apr-02		47.2
13-Apr-02		41.9
19-Apr-02		24.8
25-Apr-02		71.7
01-May-02		41.2
07-May-02		69.6
09-May-02		66.1
13-May-02		49.7
19-May-02		20.2
25-May-02		5.2
31-May-02		26.3
06-Jun-02		54.3
12-Jun-02		39.6
18-Jun-02		20.4
24-Jun-02		32.3
30-Jun-02		23.9
06-Jul-02		16.5
12-Jul-02		41.5
18-Jul-02		8.2
24-Jul-02		23.0
30-Jul-02		29.6
05-Aug-02		28.2

Date	Monitoring location ID	
	59 Euchie St	Frazer Court
11-Aug-02		58.2
17-Aug-02		40.0
23-Aug-02		47.0
29-Aug-02		56.8
04-Sep-02		15.5
12-Sep-02		14.6
16-Sep-02		169.0
22-Sep-02		25.6
28-Sep-02		77.5
04-Oct-02		153.5
10-Oct-02		63.4
16-Oct-02		76.4
22-Oct-02		70.1
23-Oct-02		*461.7
28-Oct-02		47.1

* Dust storm

Appendix 3

Estimated Dust Emissions

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Note: A colour version of this Appendix is available on the Project CD

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Tomingley Gold Project Emissions Inventory

Description of operations

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by R.W. Corkery & Co.

Topsoil would be removed using dozers and excavators then loaded to trucks for emplacement at various waste emplacement areas. Following removal of the waste rock, the exposed ore would be cleaned using a dozer and/or grader. The ore would then be ripped, loaded into haul trucks using an excavator or front-end-loader (FEL) and transported to the ROM pad where it will then move through a series of conveyors. The ore will go through various stages of crushing and screening before moving onto the processing plant. The ore will then be transported off-site via light and medium vehicles.

Emission estimates

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.

All activities have been modelled for 24 hours per day, with a few exceptions. Topsoil removal has been assumed to occur between the hours of 5am and 7pm. Blasting has been assumed to occur between the hours of 9am and 5pm and dozers working on waste dumps has been assumed to occur between the hours of 7am and 7pm.

Dust from wind erosion is assumed to occur over 24 hours per day, however, wind erosion is also assumed to be proportional to the third power of wind speed. This will mean that most wind erosion occurs in the day when wind speeds are highest.

Dozers on topsoil

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

Equation 1

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

where,

$E_{TSP} = TSP \ \ emissions$

$\mathrm{s = silt\ content\ (\%), and}$

$\mathrm{M = moisture\ (\%)}$

Based on information provided by Alkane, it was assumed the silt content of the topsoil is 10% and the moisture content is 8.4%. This gives an emission factor of 2.6 kg/h.

Drilling overburden

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

The number of holes per year was calculated based on information provided.

Blasting overburden

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

Equation 2

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

where,

A = area to be blasted in m^2

The area to be blasted per blast and number of blasts per year were calculated based on information provided.

Loading material / dumping topsoil and overburden using shovels/excavators/FELs

Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. **Equation 3** shows the relationship between these variables.

Equation 3

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

where,

E_{TSP} = *TSP emissions*

$k = 0.74$

U = *wind speed(m/s)*

M = *moisture content (%)*

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

The wind speed value was taken from the 2003 meteorological dataset described in **Section 4.2**. The moisture content for overburden was assumed to be 8.4% for topsoil and 4.8% for overburden.

Hauling material / product on unsealed surfaces

The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 4**.

Equation 4

$$E = k\ (s/12)^a (W/3)^b$$

Where,

k = 1.38

s = surface material silt content (%)

^{a} = 0.7

W = mean vehicle weight (tons)

^{b} = 0.45

Dozers on overburden
Emissions from dozers on overburden have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**), per **Equation 1**.

The silt content in the overburden was assumed to be 10%, and the moisture content 4.8%. This results in an emission factor of 5.362 kg/h.

Loading/unloading material
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in **Equation 4**.

Equation 5

$$E_{TSP} = \frac{0.580}{M^{1.2}} \qquad \text{kg/t}$$

where,

$E_{TSP} = TSP\ \ emissions$

$M = \text{moisture}\ \ (\%)$

The moisture content for both overburden and ore was assumed to be 4.8%.

Wind erosion
The emission factor for wind erosion was assumed to be 0.4kg/ha/h as per **SPCC (1983).**

Grading roads
Estimations of TSP emissions from grading roads have been made using the **US EPA (1985 and updates**) emission factor equation (**Equation 6**).

Equation 6

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

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

Primary and secondary crushing of material
The emission factor used for primary crushing of material has been taken to be 0.2 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing). It has been assumed that there would be a reduction of TSP emissions due to it being an enclosed area. A 90% control has been applied.

The emission factor used for secondary crushing of material has been taken to be 0.6 kg/t (NPI Emission Estimation Technique Manual for Gold Ore Processing). It has been assumed that there would be a reduction of TSP emissions due to it being an enclosed area. A 90% control has been applied.

Conveying of material
The emission factor used for the conveying of material has been taken to be 0.4kg/t (**NPI, 2006**).

Table A3.1
Scenario 1 – Detailed Emission Estimation

ACTIVITY	TSP emission/Scenario 2 in (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling	68,424	115,972	holes/y	0.59	kg/hole												
OB - Blasting	16,330	1,160	blasts/y	14	kg/blast	1600	Area of blast in square metres	100	holes/blast								
OB - Excavator loading OB to haul truck	5,193	17,638,772	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
OB - Hauling from Caloma 1 OC to WRE 3	90,270	7,937,447	t/y	0.0114	kg/t	90.9	t/load	119	Vehicle gross mas	1.1	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB - Hauling from Wyoming 1 OC to WRE 1	6,200	2,998,591	t/y	0.0021	kg/t	90.9	t/load	119	Vehicle gross mas	0.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB - Hauling from Wyoming 3 OC to WRE 2	20,789	6,702,733	t/y	0.0031	kg/t	90.9	t/load	119	Vehicle gross mas	0.3	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB- Emplacing at WRE 3	2,337	7,937,447	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
OB- Emplacing at WRE 1	883	2,998,591	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
OB- Emplacing at WRE 2	1,973	6,702,733	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
OB - Dozers on OB	36,640	6,833	h/y	5.362	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Drilling	1,277	12,770	holes/y	0.1	kg/hole												
ORE - Blasting	806	57	blasts/y	14	kg/blast	1600	Area of blast in square metres	223	holes/blast								
ORE - Dozers ripping/pushing/clean-up	109,963	1,752	h/y	62.7642	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Sh/Ex/FELs loading open pit ore to trucks	132,623	1,502,037	t/y	0.08830	kg/t	4.8	moisture content in %										
ORE - Hauling open pit ore from Caloma 1 to ROM	15,374	675,917	t/y	0.0227	kg/t	90.9	t/load	119	Vehicle gross mas	2.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Hauling open pit ore from Wyoming 1 to ROM p	8,184	255,346	t/y	0.0321	kg/t	90.9	t/load	119	Vehicle gross mas	3.1	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Hauling open pit ore from Wyoming 3 to ROM p	7,081	570,774	t/y	0.0124	kg/t	90.9	t/load	119	Vehicle gross mas	1.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Unloading ROM to ROM stockpiles	442	1,502,037	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
ORE - FEL unloading ROM from stockpiles to ROM	442	1,502,037	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content in %								
ORE - Primary Crushing	30,041	1,502,037	t/y	0.2	kg/t					0.1	%control						
ORE - Conveying to Screen Building	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading ore from conveyor to Screen	442	1,502,037	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content i	0.3	%control						
ORE - Screening	1,878	1,502,037	t/y	0.0125	kg/t					0.1	%control						
ORE - Conveying oversized material to Crushing	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading oversized ore from conveyor to	126	1,426,935	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content i	0.3	%control						
ORE - Secondary Crushing	85,616	1,426,935	t/y	0.6	kg/t					0.1	%control						
ORE - Conveying oversized material to Screen	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Conveying undersized material to Surge Bin	27	0.0078	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to	7	75,102	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content i	0.3	%control						
ORE - Conveying undersized material from Surge	44	0.0125	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to	22	75,102	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^	4.8	moisture content i	0.1	%control						
WE - OB dump areas	245,280	140	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
WE - Residue Storage	51,824	49	ha	0.4	kg/ha/h	8760	h/y			0.3	%control						
WE - Open pit	198,677	57	ha	0.4	kg/ha/h	8760	h/y										
WE - ROM stockpiles	1,402	1	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
Grading roads	86,264	140,160	km	0.6155	kg/VKT	8	speed of graders in km/h										

Table A3.2
Scenario 2 - Source allocation

ACTIVITY	Source ID																		
OB - Drilling	10	11	12	13	14	19	20	21	22	26	27	28							
OB - Blasting	10	11	12	13	14	19	20	21	22	26	27	28							
OB - Excavator loading OB to haul truck	10	11	12	13	14	19	20	21	22	26	27	28							
OB - Hauling from Caloma 1 OC to WRE 3	6	7	10	11	12	13	14												
OB - Hauling from Wyoming 1 OC to WRE 1	18	19	21	22	23	24	25												
OB - Hauling from Wyoming 3 OC to WRE 2	26	27	28	31	33	35													
OB- Emplacing at WRE 3	1	2	3	4	5	6	7												
OB- Emplacing at WRE 1	23	24	25																
OB- Emplacing at WRE 2	30	31	32	33	34	35													
OB - Dozers on OB	1	2	3	4	5	6	7	23	24	25	30	31	32	33	34	35			
ORE - Drilling	10	11	12	13	14	19	20	21	22	26	27	28							
ORE - Blasting	10	11	12	13	14	19	20	21	22	26	27	28							
ORE - Dozers ripping/pushing/clean-up	10	11	12	13	14	19	20	21	22	26	27	28							
ORE - Sh/Ex/FELs loading open pit ore to trucks	10	11	12	13	14	19	20	21	22	26	27	28							
ORE - Hauling open pit ore from Caloma 1 to ROM pad	11	12	14	15	16	36	37												
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	16	17	18	19	21	22	36	37											
ORE - Hauling open pit ore from Wyoming 3 to ROM pad	26	28	29	36	37														
ORE - Unloading ROM to ROM stockpiles	37																		
ORE - FEL unloading ROM from stockpiles to ROM bin	37																		
ORE - Primary Crushing	38																		
ORE - Conveying to Screen Building	39																		
ORE - Unloading ore from conveyor to Screen Building	40																		
ORE - Screening	40																		
ORE - Conveying oversized material to Crushing Building	39																		
ORE - Unloading oversized ore from conveyor to Crushing Building	39																		
ORE - Secondary Crushing	40																		
ORE - Conveying oversized material to Screen Building	40																		
ORE - Conveying undersized material to Surge Bin	39																		
ORE - Unloading undersized ore from conveyor to Surge Bin	39																		
ORE - Conveying undersized material from Surge Bin to ball mill	40																		
ORE - Unloading undersized ore from conveyor to ball mill	40																		
WE - OB dump areas	1	2	3	4	5	6	7	8	9	10	23	24	25	30	31	32	33	34	35
WE - Residue Storage	41	42	43	44															
WE - Open pit	8	9	10	11	12	13	14	19	20	21	22	26	27	28					
WE - ROM stockpiles	37																		
Grading roads	7	15	16	17	18	19	29	36											

Refer to **Figure 11** for source locations.

Table A3.3
Scenario 3 – Detailed Emission Estimation

ACTIVITY	TSP emission/Scenario 3 in (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling	66,050	111,950	holes/y	0.59	kg/hole												
OB - Blasting	15,775	1,120	blasts/y	14	kg/blast	1600	Area of blast in square metres	100	holes/blast								
OB - Excavator loading OB to haul truck	3,977	13,509,385	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB - Hauling from Caloma 1 OC to WRE 3	69,137	6,079,223	t/y	0.0114	kg/t	90.9	t/load	119	Vehicle gross mass (t)	1.1	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB - Hauling from Wyoming 1 OC to WRE 1	4,749	2,296,595	t/y	0.0021	kg/t	90.9	t/load	119	Vehicle gross mass (t)	0.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB - Hauling from Wyoming 3 OC to WRE 2	15,922	5,133,566	t/y	0.0031	kg/t	90.9	t/load	119	Vehicle gross mass (t)	0.3	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB- Emplacing at WRE 3	1,790	6,079,223	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB- Emplacing at WRE 1	676	2,296,595	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB- Emplacing at WRE 2	1,511	5,133,566	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB - Dozers on OB	36,640	6,833	h/y	5.362	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Drilling	928	9,281	holes/y	0.1	kg/hole												
ORE - Blasting	589	42	blasts/y	14	kg/blast	1600	Area of blast in square metres	222	holes/blast								
ORE - Dozers ripping/pushing/clean-up	109,963	1,752	h/y	62.7642	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Sh/Ex/FELs loading open pit ore to trucks	106,550	1,206,742	t/y	0.08830	kg/t	4.8	moisture content in %										
ORE - Hauling open pit ore from Caloma 1 to ROM pad	12,352	543,034	t/y	0.0227	kg/t	90.9	t/load	119	Vehicle gross mass (t)	2.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	6,575	205,146	t/y	0.0321	kg/t	90.9	t/load	119	Vehicle gross mass (t)	3.1	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Hauling open pit ore from Wyoming 3 to ROM pad	5,689	458,562	t/y	0.0124	kg/t	90.9	t/load	119	Vehicle gross mass (t)	1.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Unloading ROM to ROM stockpiles	355	1,206,742	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
ORE - FEL unloading ROM from stockpiles to ROM bin	355	1,206,742	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
ORE - Primary Crushing	24,135	1,206,742	t/y	0.2	kg/t					0.1	%control						
ORE - Conveying to Screen Building	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading ore from conveyor to Screen Building	355	1,206,742	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Screening	1,508	1,206,742	t/y	0.0125	kg/t					0.1	%control						
ORE - Conveying oversized material to Crushing	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading oversized ore from conveyor to	101	1,146,405	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Secondary Crushing	68,784	1,146,405	t/y	0.6	kg/t					0.1	%control						
ORE - Conveying oversized material to Screen Building	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Conveying undersized material to Surge Bin	27	0.0078	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to	5	60,337	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Conveying undersized material from Surge Bin to	44	0.0125	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to ball	18	60,337	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.1	%control						
REHAB - Dozers on rehab	3,861	720	h/y	5.362	kg/h	10	silt content in %	4.8	moisture content in %			1					
WE - OB dump areas	223,730	128	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
WE - Residue Storage	51,824	49	ha	0.4	kg/ha/h	8760	h/y			0.3	%control						
WE - Open pit	198,677	57	ha	0.4	kg/ha/h	8760	h/y										
WE - ROM stockpiles	1,402	1	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
Grading roads	86,264	140,160	km	0.6155	kg/VKT	8	speed of graders in km/h										

Table A3.4
Scenario 3 - Source allocation

ACTIVITY	**Source ID**													
OB - Drilling	10	11	12	13	14	19	20	21	22	26	27	28		
OB - Blasting	10	11	12	13	14	19	20	21	22	26	27	28		
OB - Excavator loading OB to haul truck	10	11	12	13	14	19	20	21	22	26	27	28		
OB - Hauling from Caloma 1 OC to WRE 3	6	7	10	12	13	14								
OB - Hauling from Wyoming 1 OC to WRE 1	18	19	21	22	23	24	25							
OB - Hauling from Wyoming 3 OC to WRE 2	26	27	28	30	32	34								
OB- Emplacing at WRE 3	3	4	5	6	7									
OB- Emplacing at WRE 1	23	24	25											
OB- Emplacing at WRE 2	30	31	32	33	34	35								
OB - Dozers on OB	3	4	5	6	7	23	24	25	30	31	32	33	34	35
ORE - Drilling	10	11	12	13	14	19	20	21	22	26	27	28		
ORE - Blasting	10	11	12	13	14	19	20	21	22	26	27	28		
ORE - Dozers ripping/pushing/clean-up	10	11	12	13	14	19	20	21	22	26	27	28		
ORE - Sh/Ex/FELs loading open pit ore to trucks	10	11	12	13	14	19	20	21	22	26	27	28		
ORE - Hauling open pit ore from Caloma 1 to ROM pad	11	12	13	14	15	16	36	37						
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	16	17	18	19	21	22	36	37						
ORE - Hauling open pit ore from Wyoming 3 to ROM pad	26	28	29	36	37									
ORE - Unloading ROM to ROM stockpiles	37													
ORE - FEL unloading ROM from stockpiles to ROM bin	37													
ORE - Primary Crushing	38													
ORE - Conveying to Screen Building	39													
ORE - Unloading ore from conveyor to Screen Building	40													
ORE - Screening	40													
ORE - Conveying oversized material to Crushing Building	39													
ORE - Unloading oversized ore from conveyor to Crushing Building	39													
ORE - Secondary Crushing	40													
ORE - Conveying oversized material to Screen Building	40													
ORE - Conveying undersized material to Surge Bin	39													
ORE - Unloading undersized ore from conveyor to Surge Bin	39													
ORE - Conveying undersized material from Surge Bin to ball mill	40													
ORE - Unloading undersized ore from conveyor to ball mill	40													
REHAB - Dozers on rehab	1	2												
WE - OB dump areas	3	4	5	6	7	23	24	25	30	31	32	33	34	35
WE - Residue Storage	41	42	43	44										
WE - Open pit	8	9	10	11	12	13	14	19	20	21	22	26	27	28
WE - ROM stockpiles	37													
Grading roads	7	15	16	17	18	19	29	36						

Refer to **Figure 12** for source locations.

Table A3.5
Scenario 4 – Detailed Emission Estimation

ACTIVITY	TSP emission/Scenario 4 in (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
OB - Drilling	15,138	25,657	holes/y	0.59	kg/hole												
OB - Blasting	3,613	257	blasts/y	14	kg/blast	1600	Area of blast in square metres	100	holes/blast								
OB - Excavator loading OB to haul truck	1,088	3,694,680	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB - Hauling from Caloma 2 OC to WRE 3	21,773	1,108,404	t/y	0.0196	kg/t	90.9	t/load	119	Vehicle gross mass (t)	1.9	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB - Hauling from Wyoming 1 OC to WRE 1	5,348	2,586,276	t/y	0.0021	kg/t	90.9	t/load	119	Vehicle gross mass (t)	0.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
OB- Emplacing at WRE 3	326	1,108,404	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB- Emplacing at WRE 1	761	2,586,276	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
OB - Dozers on OB	36,640	6,833	h/y	5.362	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Drilling	2,114	21,143	holes/y	0.1	kg/hole												
ORE - Blasting	2,989	212	blasts/y	14	kg/blast	1600	Area of blast in square metres	100	holes/blast								
ORE - Dozers ripping/pushing/clean-up	109,963	1,752	h/y	62.7642	kg/h	10	silt content in %	4.8	moisture content in %								
ORE - Sh/Ex/FELs loading open pit ore to trucks	118,303	1,339,849	t/y	0.08830	kg/t	4.8	moisture content in %										
ORE - Hauling open pit ore from Caloma 2 to ROM pad	13,298	401,955	t/y	0.0331	kg/t	90.9	t/load	119	Vehicle gross mass (t)	3.2	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	30,060	937,894	t/y	0.0321	kg/t	90.9	t/load	119	Vehicle gross mass (t)	3.1	km/return t	3.76	kg/VKT	5	% silt conte	75	% control
ORE - Unloading ROM to ROM stockpiles	394	1,339,849	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
ORE - FEL unloading ROM from stockpiles to ROM bin	394	1,339,849	t/y	0.00029	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %								
ORE - Primary Crushing	26,797	1,339,849	t/y	0.2	kg/t					0.1	%control						
ORE - Conveying to Screen Building	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading ore from conveyor to Screen Building	394	1,339,849	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Screening	1,675	1,339,849	t/y	0.0125	kg/t					0.1	%control						
ORE - Conveying oversized material to Crushing	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading oversized ore from conveyor to	112	1,272,857	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Secondary Crushing	76,371	1,272,857	t/y	0.6	kg/t					0.1	%control						
ORE - Conveying oversized material to Screen Building	46	0.0132	ha	0.4	kg/ha/h	8760	h/y										
ORE - Conveying undersized material to Surge Bin	27	0.0078	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to	6	66,992	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.3	%control						
ORE - Conveying undersized material from Surge Bin to	44	0.0125	ha	0.4	kg/ha/h	8760	h/y										
ORE - Unloading undersized ore from conveyor to ball	20	66,992	t/y	0.0003	kg/t	0.847	average of (wind speed/2.2)^1.3	4.8	moisture content in %	0.1	%control						
REHAB - Dozers on rehab	3,861	720	h/y	5.362	kg/h	10	silt content in %	4.8	moisture content in %			1					
WE - OB dump areas	223,730	128	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
WE - Residue Storage	51,824	49	ha	0.4	kg/ha/h	8760	h/y			0.3	%control						
WE - Open pit	198,677	57	ha	0.4	kg/ha/h	8760	h/y										
WE - ROM stockpiles	1,402	1	ha	0.4	kg/ha/h	8760	h/y			0.5	%control						
Grading roads	86,264	140,160	km	0.6155	kg/VKT	8	speed of graders in km/h										

Table A3.6
Scenario 4 - Source allocation

ACTIVITY	Source ID													
OB - Drilling	11	12	20	21	22	23	24	25						
OB - Blasting	11	12	20	21	22	23	24	25						
OB - Excavator loading OB to haul truck	11	12	20	21	22	23	24	25						
OB - Hauling from Caloma 2 OC to WRE 3	8	9	10	11	12									
OB - Hauling from Wyoming 1 OC to WRE 1	21	22	24	25	26	27	28							
OB- Emplacing at WRE 3	8	9												
OB- Emplacing at WRE 1	26	27	28											
OB - Dozers on OB	8	9	26	27	28									
ORE - Drilling	11	12	20	21	22	23	24	25						
ORE - Blasting	11	12	20	21	22	23	24	25						
ORE - Dozers ripping/pushing/clean-up	11	12	20	21	22	23	24	25						
ORE - Sh/Ex/FELs loading open pit ore to trucks	11	12	20	21	22	23	24	25						
ORE - Hauling open pit ore from Caloma 2 to ROM pad	11	12	13	14	18	19	39	40						
ORE - Hauling open pit ore from Wyoming 1 to ROM pad	21	22	24	25	26	27	28	39	40					
ORE - Unloading ROM to ROM stockpiles	40													
ORE - FEL unloading ROM from stockpiles to ROM bin	40													
ORE - Primary Crushing	41													
ORE - Conveying to Screen Building	42													
ORE - Unloading ore from conveyor to Screen Building	43													
ORE - Screening	43													
ORE - Conveying oversized material to Crushing Building	42													
ORE - Unloading oversized ore from conveyor to Crushing Building	42													
ORE - Secondary Crushing	43													
ORE - Conveying oversized material to Screen Building	43													
ORE - Conveying undersized material to Surge Bin	42													
ORE - Unloading undersized ore from conveyor to Surge Bin	42													
ORE - Conveying undersized material from Surge Bin to ball mill	43													
ORE - Unloading undersized ore from conveyor to ball mill	43													
REHAB - Dozers on rehab	1	2	3	4	5	6	7	33	34	35	36	37	38	
WE - OB dump areas	8	9	26	27	28									
WE - Residue Storage	44	45	46	47										
WE - Open pit	11	12	13	14	15	16	17	22	23	24	25	29	30	31
WE - ROM stockpiles	40													
Grading roads	10	18	19	20	21	22	32	39						

Refer to **Figure 13** for source locations.

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Appendix 4

Example ISCMOD Input File

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```
**  ISCST3 model input runstream : Dust
CO STARTING
   TITLEONE ISCST3 Dust Model Run
   MODELOPT RURAL CONC DDEP DRYDPLT HE>ZI
   AVERTIME 24 PERIOD
   POLLUTID TSP
   ERRORFIL C:\Jobs\3363A\ISC\Scenario2\error.log
   TERRHGTS ELEV
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  POINT1  VOLUME  615628 6394612 276.2
   LOCATION  POINT2  VOLUME  615590 6394151 276.1
   LOCATION  POINT3  VOLUME  615558 6393561 276.5
   LOCATION  POINT4  VOLUME  615237 6394260 273.6
   LOCATION  POINT5  VOLUME  615314 6393382 274.9
   LOCATION  POINT6  VOLUME  615327 6393850 275.0
   LOCATION  POINT7  VOLUME  615103 6393818 273.0
   LOCATION  POINT8  VOLUME  614896 6393678 271.2
   LOCATION  POINT9  VOLUME  614647 6393684 269.4
   LOCATION  POINT10  VOLUME  614840 6393850 271.0
   LOCATION  POINT11  VOLUME  614642 6393958 270.1
   LOCATION  POINT12  VOLUME  614847 6394048 271.2
   LOCATION  POINT13  VOLUME  614738 6394253 271.1
   LOCATION  POINT14  VOLUME  614988 6394298 271.9
   LOCATION  POINT15  VOLUME  614328 6393997 269.4
   LOCATION  POINT16  VOLUME  614052 6393997 269.9
   LOCATION  POINT17  VOLUME  613950 6393741 268.6
   LOCATION  POINT18  VOLUME  613841 6393427 267.0
   LOCATION  POINT19  VOLUME  614052 6393093 266.7
   LOCATION  POINT20  VOLUME  613950 6393407 267.1
   LOCATION  POINT21  VOLUME  614193 6393478 268.4
   LOCATION  POINT22  VOLUME  614187 6393254 267.4
   LOCATION  POINT23  VOLUME  613713 6393561 268.4
   LOCATION  POINT24  VOLUME  613790 6393760 266.1
   LOCATION  POINT25  VOLUME  613828 6393965 269.0
   LOCATION  POINT26  VOLUME  614264 6394112 269.1
   LOCATION  POINT27  VOLUME  614071 6394125 269.6
   LOCATION  POINT28  VOLUME  614116 6394317 271.3
   LOCATION  POINT29  VOLUME  613937 6394157 268.7
   LOCATION  POINT30  VOLUME  614328 6394458 271.2
   LOCATION  POINT31  VOLUME  614385 6394708 272.9
   LOCATION  POINT32  VOLUME  614007 6394747 272.0
   LOCATION  POINT33  VOLUME  613546 6394727 270.0
   LOCATION  POINT34  VOLUME  613559 6394554 270.0
   LOCATION  POINT35  VOLUME  613860 6394510 271.0
   LOCATION  POINT36  VOLUME  613706 6394112 269.1
   LOCATION  POINT37  VOLUME  613617 6394144 269.3
   LOCATION  POINT38  VOLUME  613533 6394176 269.0
   LOCATION  POINT39  VOLUME  613456 6394221 268.6
   LOCATION  POINT40  VOLUME  613328 6394228 268.6
   LOCATION  POINT41  VOLUME  613463 6393914 267.7
   LOCATION  POINT42  VOLUME  613431 6393651 266.7
   LOCATION  POINT43  VOLUME  612950 6393747 268.0
   LOCATION  POINT44  VOLUME  613002 6394016 266.8
   LOCATION  POINT45  VOLUME  615628 6394612 276.2
   LOCATION  POINT46  VOLUME  615590 6394151 276.1
   LOCATION  POINT47  VOLUME  615558 6393561 276.5
   LOCATION  POINT48  VOLUME  615237 6394260 273.6
   LOCATION  POINT49  VOLUME  615314 6393382 274.9
   LOCATION  POINT50  VOLUME  615327 6393850 275.0
   LOCATION  POINT51  VOLUME  615103 6393818 273.0
   LOCATION  POINT52  VOLUME  614896 6393678 271.2
   LOCATION  POINT53  VOLUME  614647 6393684 269.4
   LOCATION  POINT54  VOLUME  614840 6393850 271.0
   LOCATION  POINT55  VOLUME  614642 6393958 270.1
   LOCATION  POINT56  VOLUME  614847 6394048 271.2
   LOCATION  POINT57  VOLUME  614738 6394253 271.1
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LOCATION  POINT59  VOLUME  614328 6393997 269.4
LOCATION  POINT60  VOLUME  614052 6393997 269.9
LOCATION  POINT61  VOLUME  613950 6393741 268.6
LOCATION  POINT62  VOLUME  613841 6393427 267.0
LOCATION  POINT63  VOLUME  614052 6393093 266.7
LOCATION  POINT64  VOLUME  613950 6393407 267.1
LOCATION  POINT65  VOLUME  614193 6393478 268.4
LOCATION  POINT66  VOLUME  614187 6393254 267.4
LOCATION  POINT67  VOLUME  613713 6393561 268.4
LOCATION  POINT68  VOLUME  613790 6393760 266.1
LOCATION  POINT69  VOLUME  613828 6393965 269.0
LOCATION  POINT70  VOLUME  614264 6394112 269.1
LOCATION  POINT71  VOLUME  614071 6394125 269.6
LOCATION  POINT72  VOLUME  614116 6394317 271.3
LOCATION  POINT73  VOLUME  613937 6394157 268.7
LOCATION  POINT74  VOLUME  614328 6394458 271.2
LOCATION  POINT75  VOLUME  614385 6394708 272.9
LOCATION  POINT76  VOLUME  614007 6394747 272.0
LOCATION  POINT77  VOLUME  613546 6394727 270.0
LOCATION  POINT78  VOLUME  613559 6394554 270.0
LOCATION  POINT79  VOLUME  613860 6394510 271.0
LOCATION  POINT80  VOLUME  613706 6394112 269.1
LOCATION  POINT81  VOLUME  613617 6394144 269.3
LOCATION  POINT82  VOLUME  613533 6394176 269.0
LOCATION  POINT83  VOLUME  613456 6394221 268.6
LOCATION  POINT84  VOLUME  613328 6394228 268.6
LOCATION  POINT85  VOLUME  613463 6393914 267.7
LOCATION  POINT86  VOLUME  613431 6393651 266.7
LOCATION  POINT87  VOLUME  612950 6393747 268.0
LOCATION  POINT88  VOLUME  613002 6394016 266.8
LOCATION  POINT89  VOLUME  615628 6394612 276.2
LOCATION  POINT90  VOLUME  615590 6394151 276.1
LOCATION  POINT91  VOLUME  615558 6393561 276.5
LOCATION  POINT92  VOLUME  615237 6394260 273.6
LOCATION  POINT93  VOLUME  615314 6393382 274.9
LOCATION  POINT94  VOLUME  615327 6393850 275.0
LOCATION  POINT95  VOLUME  615103 6393818 273.0
LOCATION  POINT96  VOLUME  614896 6393678 271.2
LOCATION  POINT97  VOLUME  614647 6393684 269.4
LOCATION  POINT98  VOLUME  614840 6393850 271.0
LOCATION  POINT99  VOLUME  614642 6393958 270.1
LOCATION  POINT100  VOLUME  614847 6394048 271.2
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LOCATION  POINT104  VOLUME  614052 6393997 269.9
LOCATION  POINT105  VOLUME  613950 6393741 268.6
LOCATION  POINT106  VOLUME  613841 6393427 267.0
LOCATION  POINT107  VOLUME  614052 6393093 266.7
LOCATION  POINT108  VOLUME  613950 6393407 267.1
LOCATION  POINT109  VOLUME  614193 6393478 268.4
LOCATION  POINT110  VOLUME  614187 6393254 267.4
LOCATION  POINT111  VOLUME  613713 6393561 268.4
LOCATION  POINT112  VOLUME  613790 6393760 266.1
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   PLOTFILE  PERIOD  CM  C:\Jobs\3363A\ISC\Scenario2\CM1Y.PLO
   PLOTFILE  PERIOD  REST  C:\Jobs\3363A\ISC\Scenario2\RE1Y.PLO
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Appendix 5

Director-General's Requirements

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Table A4.1
Air Quality
Coverage of Director-General's Requirements in the *Environmental Assessment*

Page 1 of 2

Government Agency	Paraphrased Requirement	Relevant Section(s)
	GENERAL	
	• **Air Quality**;	
	AIR QUALITY	
DECCW (28/08/09)	Identify all sources of air emissions from the development. *Note: emissions can be classed as either:* • *point (e.g. emissions from stack or vent) or* • *fugitive (from wind erosion, leakages or spillages, associated with loading or unloading, conveyors, storage facilities, plant and yard operation, vehicle movements (dust from road, exhausts, loss from load), land clearing and construction works).*	Section 7
	Provide details of the project that are essential for predicting and assessing air impacts including: a) the quantities and physio-chemical parameters (e.g. concentration, moisture content, bulk density, particle sizes etc.) of materials to be used, transported, produced or stored b) an outline of procedures for handling, transport, production and storage c) the management of solid, liquid and gaseous waste streams with potential for significant air impacts.	Section 2
	Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.	Section 2
	Describe surrounding buildings that may affect plume dispersion.	N/A
	Provide and analyse site representative data on following meteorological parameters: d) temperature and humidity e) rainfall, evaporation and cloud cover f) wind speed and direction g) atmospheric stability class h) mixing height (the height that emissions will be ultimately mixed in the atmosphere) i) katabatic air drainage j) air re-circulation.	Section 4

Table A4.1
Air Quality
Coverage of Director-General's Requirements in the *Environmental Assessment*

Page 2 of 2

Government Agency	Paraphrased Requirement	Relevant Section(s)
DECCW (28/08/09)	Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data.	Section 5
	Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 7
	Estimate the resulting ground level concentrations of all pollutants. Where necessary (e.g. potentially, significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the DECCW.	Section 8
	Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 8
	Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.	Section 10
	For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with EPA/DECCW procedures). Use sampling and analysis techniques for individual or complex odours and for point or diffuse sources, as appropriate.	N/A
	Outline specifications of pollution control equipment (including manufacturers performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.	Section 9
CUMULATIVE IMPACTS		
DECCW (28/08/09)	Identify the extent that the receiving environment is already stressed by existing development and background levels of emissions to which this proposal will contribute.	Section 5
	Assess the impact of the proposal against the long term air, noise and water quality objectives for the area or region.	Section 8
	Identify infrastructure requirements flowing from the proposal (eg. water and sewerage services, transport infrastructure upgrades).	Section 2
	Assess likely impacts from such additional infrastructure and measures reasonably available to the proponent to contain such requirements or mitigate their impacts (e.g. travel demand management strategies).	N/A