Appendix C

Air Quality assessment

Intended for
Dial-a-Dump Industries
C/- EMM Consulting

Document type
Report

Date
August 2018

Project No.
318000225

AIR QUALITY IMPACT ASSESSMENT
GENESIS XERO WASTE FACILITY MODIFICATION 6

RAMBOLL

AIR QUALITY IMPACT ASSESSMENT
GENESIS XERO WASTE FACILITY MODIFICATION 6

Revision	Date	Made by	Checked by	Approved by	Signed
Draft V1.1	3/08/2017	R.Kellaghan	S. Fishwick		
Draft V1.2	04/10/2017	R.Kellaghan	S. Fishwick	R. Kellaghan	
Final V3	29/08/2018	R.Kellaghan	S. Fishwick	R. Kellaghan	

Rambol Australia Pty Ltd
Level 3, 100 Pacific Highway
PO Box 560
North Sydney
NSW 2060
Australia
T +61 2 9954 8100
F +61 2 9954 8150
www.ramboll.com

Project No. 318000225

EXECUTIVE SUMMARY

Introduction

An air quality impact assessment has been prepared for a modification to the Genesis Zero Waste Facility at Eastern Creek (the Facility), which is owned and operated by Dial a Dump Industries Pty Limited (the proponent). The modification seeks to alter the hours of operation and increase the annual landfill cap limit of 700,000 tonnes to 1,000,000 tonnes (whilst not increasing the overall tonnes that may be accepted at the Facility.

Study approach

Local air quality impacts from the modification are assessed using a Level 2 assessment approach in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016). Emissions are estimated for all activities and dispersion modelling is used to predict ground level concentrations at surrounding receptors. Cumulative impacts are assessed by combining the contribution from the modification with the existing ambient baseline.

Existing environment

Baseline meteorology is described with reference to the closest Bureau of Meteorology (BoM) automatic weather stations (AWS) and NSW Office of Environment and Heritage (OEH) monitoring sites. Surface observations from regional monitoring sites are included in the meteorological modelling using CALMET. Baseline air quality is described with reference to OEH monitoring sites at Prospect and St Marys and a monitoring site operated by the facility in the suburb of Minchinbury. Annual mean PM_{10} concentrations across the three sites are 61% to 76% of the impact assessment criteria, while annual mean $PM_{2.5}$ concentrations for the region are 98%-108% of the impact assessment criteria (i.e. already at or above the impact assessment). Elevated concentrations of $PM_{2.5}$ for the Western Sydney region are strongly influenced by vehicle emissions (cars, trucks and off-road equipment) and from wood heaters during winter months. Exceedances of the 24-hour average criteria occur on occasion in Western Sydney, typically associated with periods of bushfire, hazard reduction and/or dust storms (NSW EPA, 2016).

Emissions

Modification 6 seeks to increase the landfill limit from 700,000 tpa to 1,000,000 tpa, to improve the operational flexibility to respond to market demand. A worst-case emissions assessment is considered based on a 50/50 split between the MPC and landfill. Modelling a scenario with 1,000,000 tpa hauled to landfill provides a conservative worst-case assessment of impacts, as hauling along the unsealed access road to the pit is the largest potential source.

Emissions inventories were developed for Total suspended particulate matter (TSP), PM_{10} and $PM_{2.5}$. A conservative worst-case odour emission scenario was modelled, for landfilling at 1 Mpta plus greenwaste processing and composting at the MPC.

Results and conclusion

The predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all receptor locations. With the addition of existing background, there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion at any receptor location.

The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed.

The cumulative 24-hour average $PM_{2.5}$ concentrations result in additional exceedances of the impact assessment criterion at residential and commercial receptor locations. This is caused by a combination of elevated background with the additional dust emissions from the modification. It is noted that the background $PM_{2.5}$ concentration on this day is already close to the impact assessment criterion (24.4 µg/m³). Additional statistical analysis shows that the probability or risk of any additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion does not increase significantly, above what is already caused by background (i.e. up to one additional day as a worst case).

Cumulative annual average TSP concentrations comply with the impact assessment criterion at all receptor locations. Similarly, predicted dust deposition levels comply with both the incremental and cumulative impact assessment criteria at all receptor locations.

The worst case potential odour impact from landfilling at 1 Mtpa combined with greenwaste processing and composting, would not result in exceedances of the odour goal of 2 OU at any residential receptor.

To better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary.

It is noted that the modelling scenarios presented in this report are unlikely from an operational point of view; as the Facility will continue to recycle as much waste as possible with limited amounts transferred to landfill.

CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

APPENDICES

Appendix 1
Figures

Appendix 2
Model settings

Appendix 3
Wind roses

Appendix 4
Emissions inventory development

Appendix 5
Contour Plots

1. INTRODUCTION

Dial A Dump Industries Pty Limited (the proponent) operates the Genesis Zero Waste Facility (the Facility) at Eastern Creek in the Blacktown Local Government Area (LGA) (**Figure A1-1**). The facility is at 1 Kangaroo Avenue and comprises a Materials Processing Centre (MPC) and a general solid waste (non-putrescible) landfill (**Figure A1-2**).

The original project approval for the site was granted by the Minister for Planning in 2009 (MP 06_0139) under Section 75J of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The operations commenced in 2012 and the project approval has been modified five times, most recently in March 2016.

The Facility is approved to accept up to 2 million tonnes per annum (Mtpa) of construction, demolition, commercial and industrial waste. The majority of the waste is directed to the MPC for sorting, processing and resale as products suitable for application to land such as road base. Material which is not suitable for recycling is disposed in the landfill, which is approved to accept up to 700,000 tonnes per annum (tpa) of rejects from the and waste received from offsite.

The proponent proposes to modify the project approval to alter the hours of operation and increase the landfill limit from 700,000 tonnes per annum to 1,000,000 tonnes per annum (excluding waste generated by recycling processes within the MPC.

This will enable the facility to have flexibility to accept the waste streams that will likely be generated during planned major construction projects in Sydney, some of which will be generated outside standard construction hours.

Ramboll has been commissioned to prepare an air quality impact assessment (AQIA) to support the environmental assessment (EA) prepared by EMM Consulting Pty Limited (EMM) for the modification.

1.1 Overview of Modification 6

1.1.1 Operating hours

The construction and operating hours are proposed to be changed to meet the demand of large infrastructure 24-hour construction projects such as motorways and commercial/residential development and to enable maintenance and cleaning outside of standard hours. The approved construction and operating hours from the project approval (Table 5 of Condition 39) are in **Table 1-1**.

Table 1-1: Approved hours

Activity	Days	Hours
Construction	Monday-Friday	7am-6pm
	Saturday	8am-4pm
	Sunday and public holidays	Nil
Operations (waste deliveries and use of chute)	Monday-Friday	7am-6pm
	Saturday, Sunday and public holidays	8am-4pm
Operations (MPC)	Monday-Friday	6am-10pm
	Saturday, Sunday and public holidays	6am-4pm

The proposed revised operating hours are in **Table 1-2**, which is proposed to replace Table 5 of Condition 39.

Table 1-2: Proposed hours

Activity	Sub-activity	Days	Hours
Construction		Monday-Friday	6am-6pm
		Saturday	8am-4pm
		Sunday and public holidays	Nil
Operations (waste deliveries, processing and landfilling)			
MPC and PSE	Receive materials	Monday-Sunday	24 hours
	Operations	Monday-Sunday	24 hours
SMA	Receive materials	Monday-Sunday	24 hours
	Crushing and screening	Monday-Sunday	6am-6pm
Landfill	Receive materials by truck	Monday-Sunday[1]	5am-9pm
	Convey waste from MPC to landfill via chute	Monday-Sunday	24 hours
Maintenance			
MPC, PSE and landfill	Repair machinery	Monday-Sunday	24 hours
SMA	Cleaning and machinery repairs	Monday-Sunday	24 hours
Chute	Clearing of blockages and general repairs	Monday-Sunday	24 hours

1.1.2 Landfill limit

The 700,000 tpa limit on landfilling is proposed to be increased to 1,000,000 tpa (excluding waste generated by recycling processes within the MPC and the Pre-Sort Building (PSB), which are the two stages of sorting materials in the co-mingled waste recycling stream). This will enable the Facility to provide waste disposal services for Sydney's current and proposed major construction projects including those in Western Sydney, which are likely to contain large volumes of material which cannot be recycled such as asbestos containing material.

1.2 Study objectives and requirements

The AQIA has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs), issued by NSW Department of Planning and Environment (DP&E) on 3 April 2017, as well as specific requirements provided by the NSW Environment Protection Authority (EPA) and Blacktown Council.

Table 1-3 provides a summary of the SEARs and agency comments relevant to this study and where the requirement has been addressed in this report.

Table 1-3: Summary of SEARs for air quality

Requirement	How requirement is addressed
SEARs	
Air Quality – including an assessment of the impacts of air emissions on all surrounding receivers, including dust, odour and other potential pollutants.	Report prepared in accordance with the Approved Methods (refer **Section** 2).
NSW EPA's requirement	
Impacts of air emissions on all receivers, including odour from the Premises must be assessed.	Report prepared in accordance with the Approved Methods (refer **Section** 2).
The EPA is concerned that the proposal to increase operating hours and removal of the landfill cap of 700,000 tonnes per annum will dramatically increase the volume of waste material entering the Premises, and as a result will potentially be generating an increase of pollutants discharged to air. The Proponent must demonstrate effective control of dust, odour and other potential pollutants from the Premises in particular how it will be managed during the increased hours of operation.	It is noted that the modification seeks to increase the landfill limit from 700,000 tpa to 1,000,000 tpa. A worse case modelling scenario is assessed based on 1 Mtpa being processed through the MPC and 1 Mtpa directed to landfill.
In addition the preliminary proposal states odour is never an issue during MPC operations. There have been odour complaints relating to the Premises from the public. The complaints register on the Proponents website also confirms this. The Proponent must consider odour from the MPC and the Landfill and all potential pollutants which may be generated. The Proponent must prepare an assessment of the impacts of odour from the Premises, in particular from the landfill. The assessment must consider the impact that the increased operational activities within the landfill will have on odour as it must be considered that it would be possible for the proponent to landfill up to 2 million tonnes of waste per year.	It is noted that the modification seeks to increase the landfill limit from 700,000 tpa to 1,000,000 tpa. Worst case potential odour emissions and impacts are discussed and presented in **Section 6.2** and **Section 7.4**
Blacktown Councils response	
Potential odour impacts of the 24/7 operation including machinery emissions and greenwaste activities (given the stockpiling of green waste is approved in this application. Should greenwaste no longer form part of this project, it should be deleted from the application).	Odour from 24/7 operations, including greenwaste processing is addressed in **Section 6.2** and **7.4**

2. STUDY APPROACH

2.1 Assessment approach

The approach to the assessment follows guidelines recommended in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") (NSW EPA, 2016). Local air quality impacts are assessed using a Level 2 assessment approach (i.e. refined dispersion modelling technique using site-representative input data). The assessment approach is summarised as follows:

- Key pollutant indicators are identified, in this case dust and odour.
- Emissions are estimated for all dust generating activities associated with the facility.
- Dispersion modelling is undertaken using a regulatory dispersion model to predict ground level concentrations (GLCs) for key pollutants at nearby sensitive receptors.
- Cumulative impacts are assessed by taking into account the combined effect of facility with existing baseline air quality and/or other local sources of emissions.

2.2 Assessment scenarios

Modification 6 seeks to increase the landfill limit from 700,000 tpa to 1,000,000 tpa, to improve the operational flexibility to respond to market demand. For typical operations, 60%-80% of material enters the MPC and 20% to 40% of material is directed to landfill. A worst-case emissions assessment is considered based on a 50/50 split between the MPC and landfill. Modelling a scenario with 1,000,000 tpa hauled to landfill provides a conservative worst-case assessment of impacts, as hauling along the unsealed access road to the pit is the largest potential source.

2.3 Pollutant indicators

The key pollutants of concern during the operation of the Genesis facility are:

- Fugitive dust / particulate matter (PM), generated from waste receipt, handling, processing and product dispatch.
- Odour from greenwaste processing, landfilling and leachate management.

The combustion of diesel in trucks and other equipment would result in combustion-related emissions including PM, oxides of nitrogen (NOx), sulfur dioxide (SO2), carbon dioxide (CO2), carbon monoxide (CO) and volatile organic compounds (VOCs).

Combustion derived PM has been included as part of the overall site emissions, as for $PM_{2.5}$, in particular, it can be a relatively important component of total site emissions. Other combustion derived emissions however have not been quantitatively assessed, as they would not result in significant off-site concentrations.

The air quality indicators that have been considered in this report are summarised in **Table 2-1**.

Table 2-1: Air quality indicators for assessment

Emission source	Air quality indicator
Waste handling, processing and product dispatch	Particulate matter (TSP[1], PM_{10}[2] and $PM_{2.5}$[3])
	Nuisance dust (dust deposition)
Diesel fuel combustion	PM_{10} and $PM_{2.5}$
Greenwaste processing, landfilling and leachate management	Odour

Note:
[1] Total Suspended Particulate matter
[2] Particulate matter less than 10 microns in aerodynamic diameter
[3] Particulate matter less than 2.5 microns in aerodynamic diameter

2.4 Assessment criteria

2.4.1 Particulate matter

When first regulated, airborne PM was assessed based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometres (µm) in diameter. As air sampling technology improved and the importance of particle size and chemical composition become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$.

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the 'Approved Methods', gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

For the purpose of this report, predicted ground level concentrations (GLCs) are assessed against the NSW EPA's impact assessment criteria presented in **Table 2-2**.

Table 2-2: Impact assessment criteria for PM

PM metric	Averaging period	Concentration (µg/m³)
TSP	Annual	90
PM_{10}	24 hour	50
	Annual	25
$PM_{2.5}$	24 hour	25
	Annual	8

Note: µg/m³ = micrograms per cubic metre.

The Approved Methods specifies that the impact assessment criteria for 'criteria pollutants[1]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (consideration of existing ambient background concentration is required).

The Approved Methods also prescribes nuisance based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. The NSW EPA impact assessment criteria for dust deposition are summarised in **Table 2-3**, illustrating the maximum increase and total dust deposition rates which would be acceptable so that dust nuisance can be avoided.

Table 2-3: Dust deposition criteria

Pollutant	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust (assessed as insoluble solids)	2 g/m²/month	4 g/m²/month

Note: g/m² = grams per square metre.

[1] 'Criteria pollutants' is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods, the criteria pollutants are TSP, PM_{10}, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), deposited dust, hydrogen fluoride and lead.

2.4.2 Odour

Dynamic olfactometry is the accepted method of odour measurement and involves a sample of odorous air being presented to a panel of people with decreasing quantities of clean odour-free air. The panellists note when the smell becomes detectable and the correlation between the known dilution ratios and the panellists' responses are used to calculate the number of dilutions required to achieve the odour detection threshold. The units for odour measurement are "odour units" (ou), which, according to the method described above, are effectively "dilutions to threshold".

The odour nuisance level can be as low as 2 ou and as high as 10 ou (for less offensive odours), whereas an odour assessment criterion of 7 ou is likely to represent the level below which 'offensive' odours should not occur. The NSW EPA's *Technical framework - Assessment and management of odour from stationary sources in NSW* (NSW EPA, 2006a) recommends that, as a design criterion, no individual should be exposed to ambient odour levels of greater than 7 ou.

The Approved Methods prescribes odour goals which take into account the population density for a particular area. The most stringent odour goal of 2 ou is acceptable for the whole population and therefore appropriate for urban areas (NSW EPA, 2016).

The 2 ou odour goal should be compared against the 99th percentile of the dispersion modelling predictions. The 1-hour average dispersion modelling prediction is converted to a peak (i.e. 1-second 'nose response average') based on a peak to mean ratio of 2.3, in accordance with the Approved Methods.

2.5 Overview of modelling approach

The modelling for this assessment uses a combination of TAPM and CALMET/CALPUFF, as follows:

- TAPM is used to generate gridded three-dimensional upper air data for each hour of the model run period for input into CALMET.
- CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data using a combination of surface observations and the prognostic TAPM upper air data.
- CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

2.6 Cumulative impacts

Cumulative impacts are assessed by combining the contribution from the Facility with the existing ambient air quality environment, described based on baseline monitoring data for the region (refer to **Section 5**). The derived baseline is assumed to account for all existing emissions sources in the local airshed.

3. LOCAL SETTING AND ASSESSMENT LOCATIONS

3.1 Location

The facility is on a site that comprises 52 hectares (ha) at the following lots (**Figure A1-2**):

- Lot 1 DP 1145808; and
- Lot 8 DP 1200048.

The site address is 1 Kangaroo Avenue. It is accessed from Kangaroo Avenue. The volume of the final quarry void was estimated to be 11 million m^3.

3.2 Surrounding land use

The site is in an area being developed for commercial and industrial use under State Environmental Planning Policy (Western Sydney Employment Area) 2009. Adjacent landowners are:

- Australand, which owns and leases warehousing to the north-east;
- Hanson, which owns an asphalt batching plant to the south-east;
- NSW Department of Planning and Infrastructure, which owns vacant land to the south-west; and
- Sargents, which is developing land to the west.

The site is surrounded by Kangaroo Avenue to the east and north-east, the M4 Western Motorway to the north, Archbold Road to the west and the future Precinct Road to the south.

Further afield there is residential development in Minchinbury beyond the Western Motorway to the north and in Erskine Park beyond Archbold Road to the west, and predominantly undeveloped land containing high voltage powerlines to the west and south-west.

3.3 Sensitive receivers

The residential areas of Minchinbury are approximately 430 m north and of Erskine Park approximately 1,200 m west of the nearest site boundaries. The nearest commercial premises are adjacent to the northern boundary of the site. Locations representative of these sensitive receivers have been identified and selected as discrete sensitive receptors (refer to **Figure A5-1** in **Appendix 5**).

Nearby residences and industrial / commercial facilities not identified as discrete sensitive receptors can be assessed with reference to the contour plots presented in this report, which show predicted ground level concentrations of key pollutants across all areas in the vicinity of the facility.

4. OVERVIEW OF LOCAL AND REGIONAL METEOROLOGY

4.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Analysis of meteorology for region is presented based on the closest Bureau of Meteorology (BoM) automatic weather station (AWS) and NSW Office of Environment and Heritage (OEH) monitoring sites, as follows:

- St Marys OEH site – located approximately 6 km west of the site.
- Horsley Park Equestrian Centre AWS– located approximately 6 km southeast of the site.
- Badgerys Creek AWS – located approximately 14 km southwest of the site.
- Penrith Lakes AWS – located approximately 16.5 km west of the site.
- Bankstown Airport AWS – located approximately 19 km southeast of the site.
- Holsworthy Control Range AWS – located approximately 21.5 km southeast of the site.
- Sydney Olympic Park AWS - located approximately 22 km southeast of the site.
- Richmond RAAF AWS - located approximately 23 km northwest of the site.
- Camden Airport AWS – located approximately 29 km southwest of the site.

These surface observation sites are included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind field. It is noted that the proponent operates an on-site weather station, however the station is used for operational dust control (i.e. to trigger water sprays) and the siting makes it unsuitable for the purposes of dispersion modelling. It is also noted that another OEH monitoring site at Prospect, located 8 km east of the site, has not been used for data assimilation. This site is compared to CALMET meteorology to review and evaluate the accuracy and representativeness of the predicted wind field (**Section 4.4**).

In the absence of upper air measurements, CALMET is run using prognostic upper air data (three-dimensional '3D.dat' file generated using TAPM), used to drive an 'initial guess' wind field. The model then incorporates mesoscale and local scale effects, including the surface observations, to adjust the final wind field. This modelling approach is known as the "hybrid" approach (TRC, 2011). TAPM and CALMET model settings are described in **Appendix 2**, selected in accordance with recommendations in the Approved Methods and in TRC (2011).

4.2 Selecting a representative year for modelling

To select a representative year for modelling, five years of monitoring data were reviewed from the sites closest to the Genesis facility (Horsley Park and St Marys). These sites are those most likely to influence CALMET modelling, based on the selected radius of influence (R1 and RMAX, as described in **Appendix 2**).

Annual wind roses for the period 2012 to 2016 for both Horsley Park and St Marys are presented in **Figure 4-1** and **Figure 4-2**. The wind roses demonstrate a high degree of consistency in winds across the five years, in terms of wind direction, average winds speed and percentage occurrence of calms conditions. Based on this review, the calendar year 2016 is selected as a suitable representative year for modelling.

Furthermore, ambient temperature recorded during 2016 is compared with long-term records at the BoM Prospect Reservoir long term monitoring station and shown to correlate well with the long-term trends. The minimum, maximum, mean and upper and lower quartile temperatures for each month of the modelling year (2016) are presented as a box and whisker plot shown in **Figure 4-3**, and show that the upper and lower quartile and mean temperatures fall within the long term mean monthly maximum and minimum temperatures.

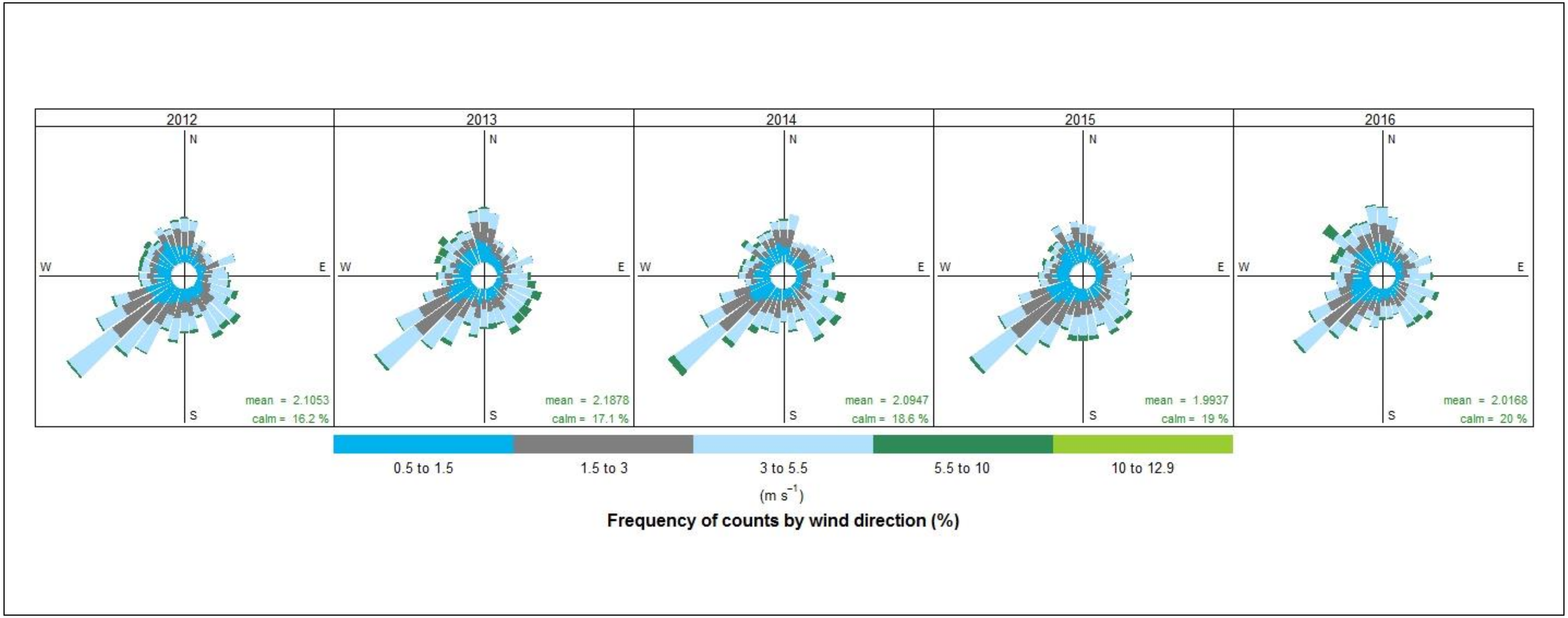


Figure 4-1: Annual wind rose for Horsley Park BoM site – 2012 - 2016

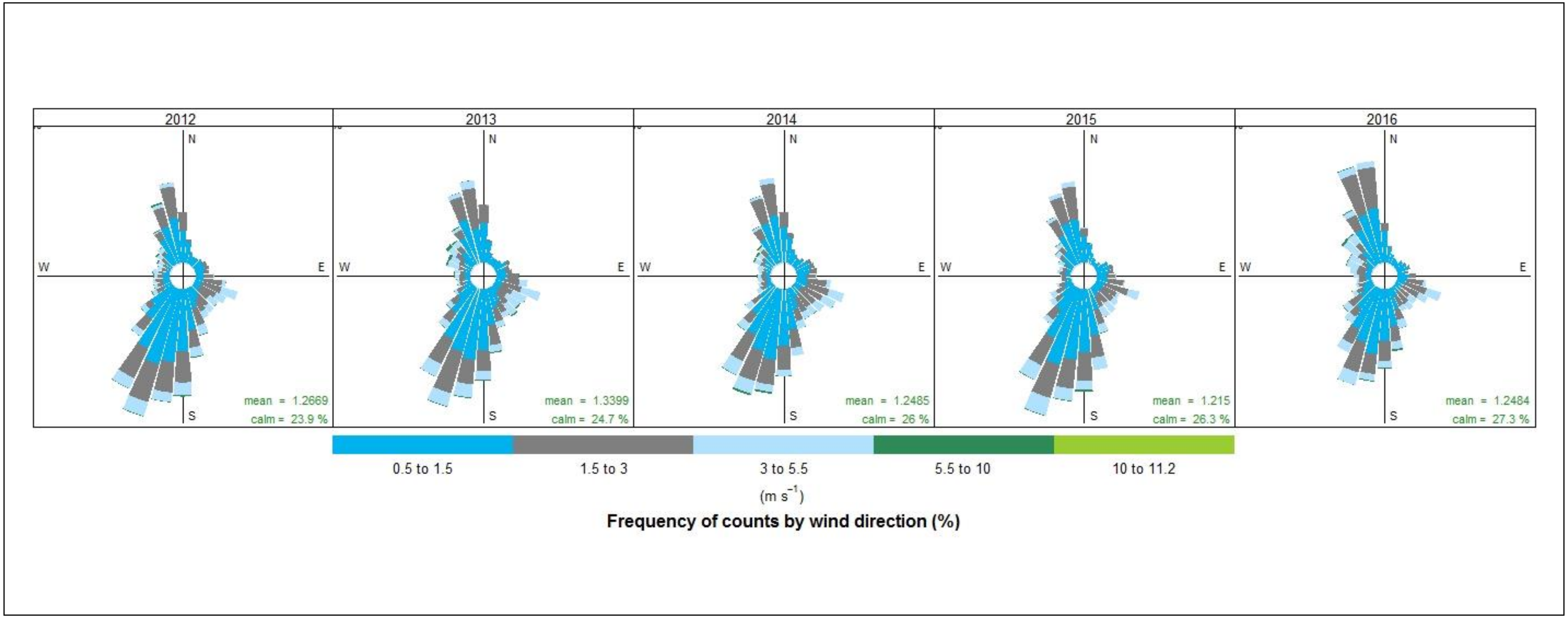
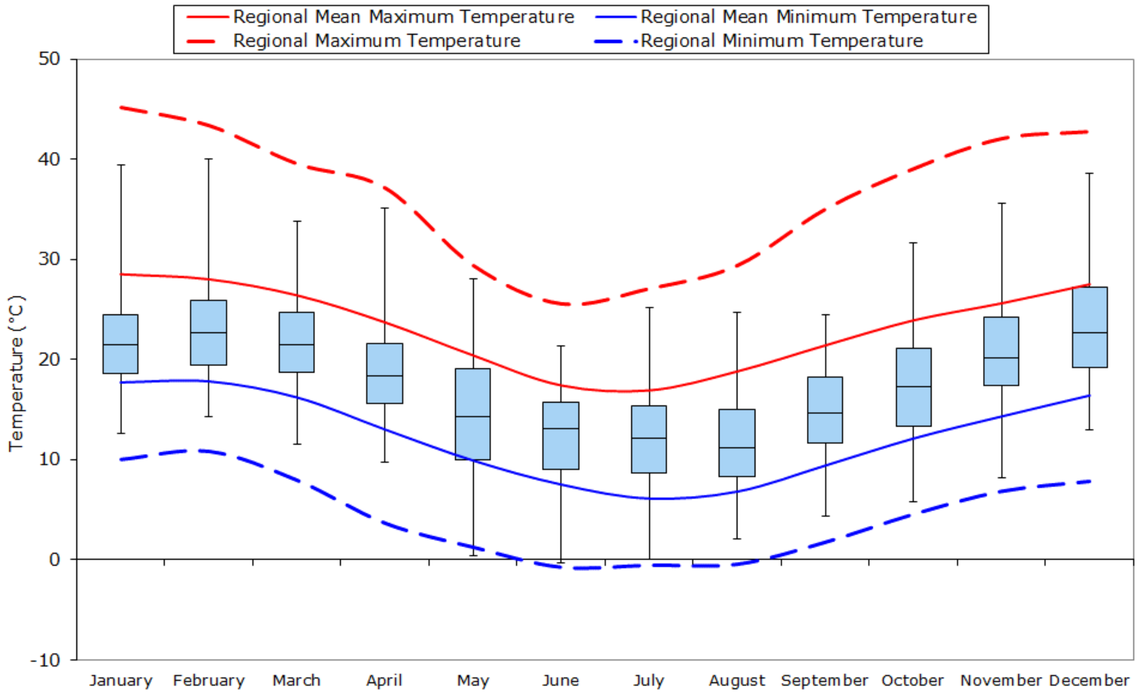


Figure 4-2: Annual wind rose for St Marys OEH site – 2012 - 2016



2016 data are illustrated by the 'box and whisker' plot. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values.

Figure 4-3: Comparison of long-term temperature records with modelling period

4.3 Prevailing winds for the region

The 2016 annual wind rose for each surface observation site is presented in **Figure 4-4**. The dominant prevailing wind pattern varies across the region. At some of the observations sites, it appears that local features influence the prevailing winds (for example Sydney Olympic Park and St Marys).

Across many of the sites there is a dominant southwest component to the annual wind rose, although winds from all directions are recorded for a small percentage of time. Average wind speeds range from 2 to 3 metres per second (m/s) while the percentage occurrence of calm winds (<0.5 m/s) ranges from low at Holsworthy (7%) to high St Marys (33%).

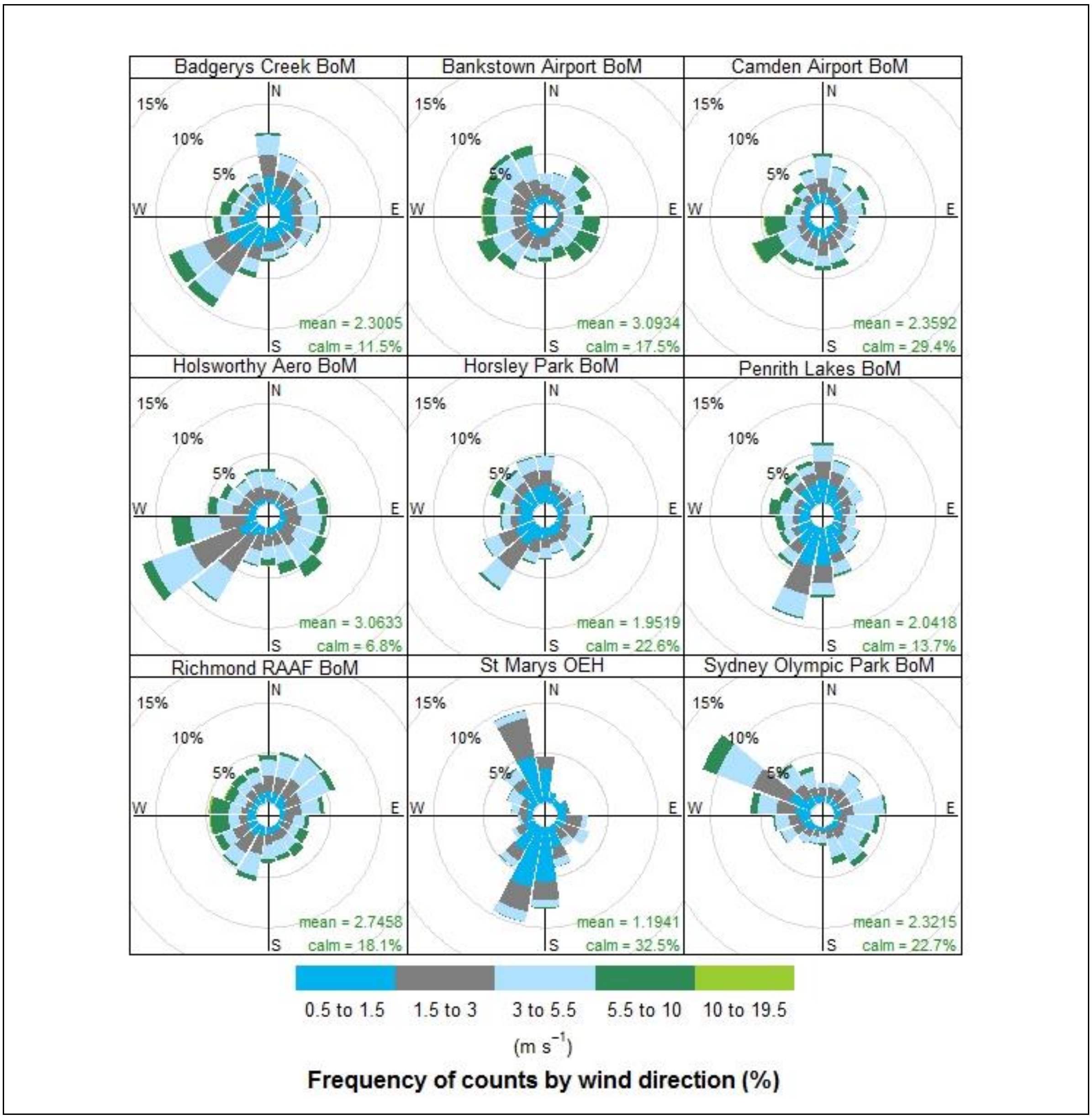


Figure 4-4: Annual wind roses for the region

4.4 Evaluation of CALMET predicted winds

CALMET is a non-steady state model which generates a temporal and spatial varying wind field across the modelling domain; therefore, no single wind rose is representative of the dispersion conditions used by the model. However, an evaluation of CALMET performance is presented in **Figure 4-5**, comparing predicted CALMET winds with observations at the Badgerys Creek BoM site.

To facilitate this comparison, the CALMET model was run without data assimilation for the Badgerys Creek BoM site. The wind rose presented in **Figure 4-5** shows comparable wind directions, wind speeds and percentage occurrence of calm winds between observed and predicted and based on this comparison, it is concluded the model predicts regional wind conditions with a suitable level of accuracy.

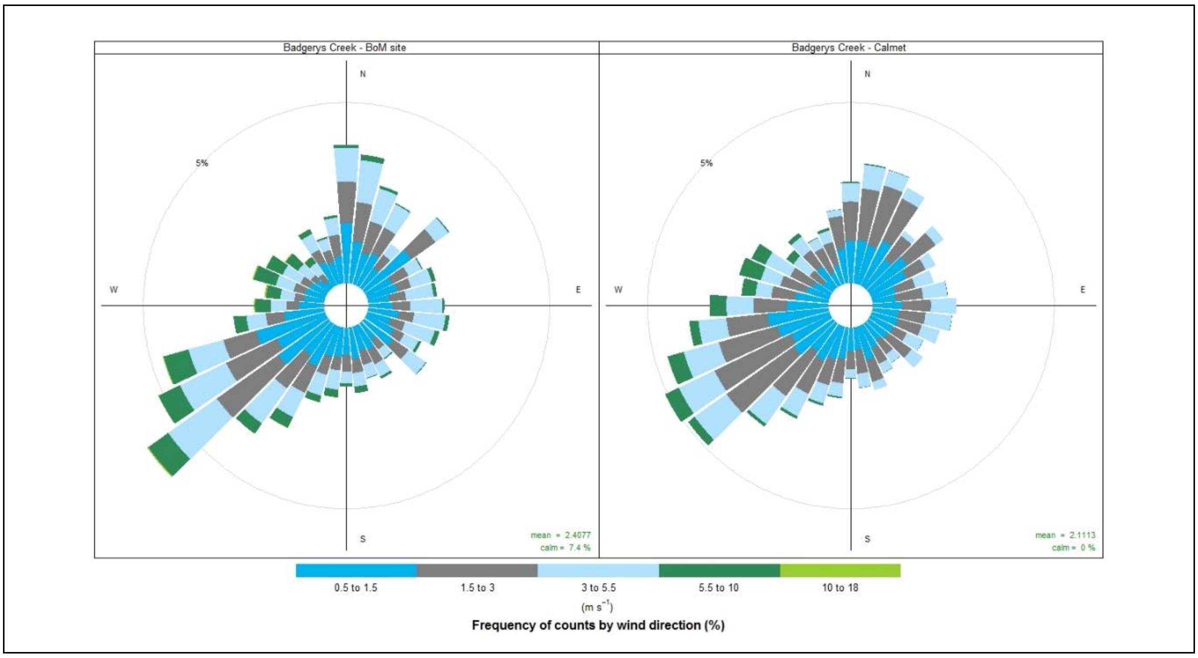


Figure 4-5: Comparisons of observed and CALMET predicted winds for the Badgerys Creek BoM site

A further comparison is presented in **Figure 4-6**, showing CALMET winds at the Genesis site (indicative of dispersion conditions in the immediate vicinity of the emission source) and observations at Prospect, approximately 8 km to the east. Prospect was not included as a data assimilation site for modelling.

The wind roses display similar patterns, with winds recorded from most directions and a slightly higher frequency of occurrence from the south west quadrant at both sites. Prospect records a slightly higher frequency of occurrence from the north and northwest quadrant, compared to CALMET. Annual average wind speeds are comparable (1.5 m/s and 1.8 m/s) while the percentage occurrence of calm winds is higher onsite (19%) compared to Prospect (10%). Based on this comparison, it is concluded that the CALMET derived wind field provides a suitable representation of local meteorology for the assessment. Seasonal and diurnal wind roses for CALMET at the Genesis site are shown in **Appendix 3**.

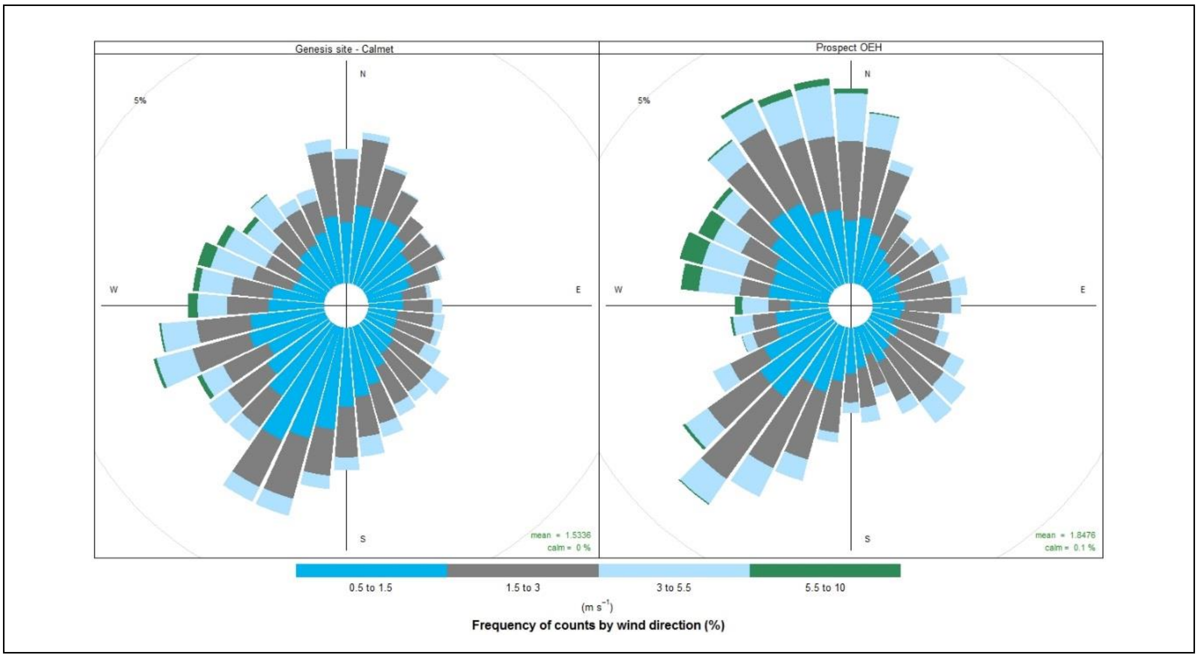


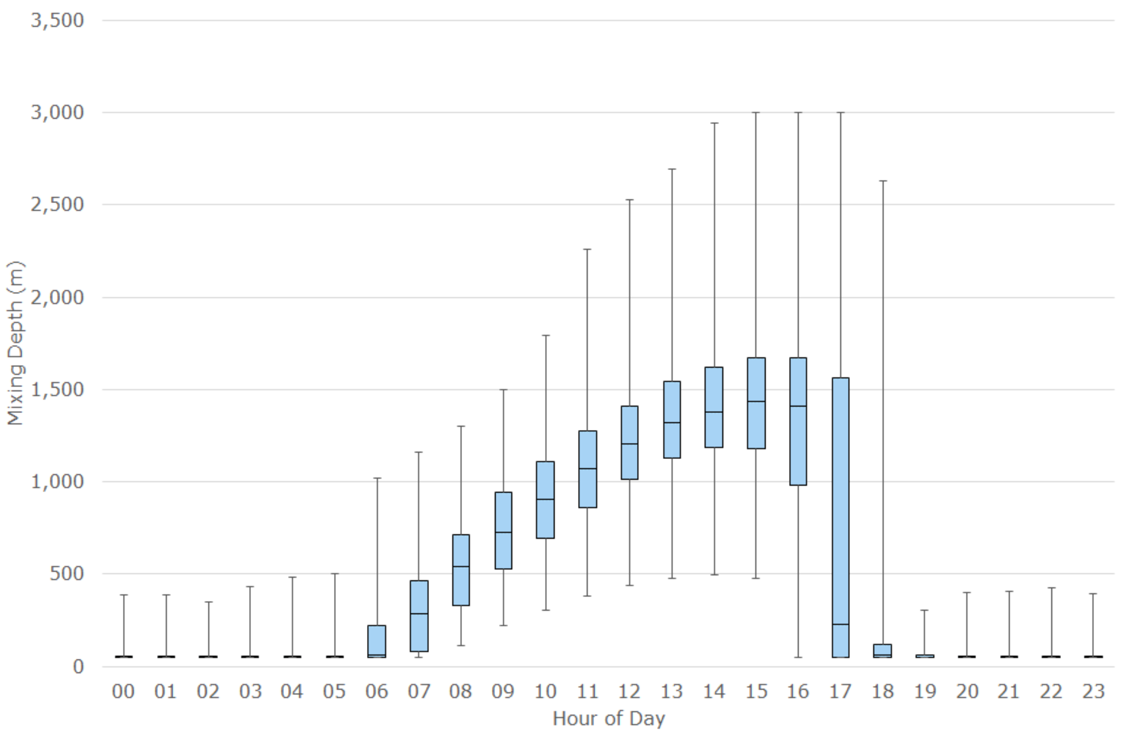
Figure 4-6: Comparisons of CALMET winds for the Genesis site with Prospect OEH

4.5 Atmospheric boundary layer heights

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Due to radiative flux divergence, nights are typically characterised by weak to no vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and hence lower dilution potentials.

CALMET generated mixing heights are extracted at site and the average boundary layer heights by hour of the day is shown in **Figure 4-7**. As seen in median and upper and lower quartiles, the highest boundary layer heights are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.



Lower, middle and upper box markers indicate 25th percentile, median and 75th percentile of CALMET-generated mixing height data respectively, while upper and lower whiskers indicate maximum and minimum values.

Figure 4-7: CALMET-generated diurnal variations in average boundary layer depth

4.6 Atmospheric stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible - typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4-8 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by CALMET. The diurnal profile at all locations illustrates that atmospheric instability increases during daylight hours as convective energy increases, while stable atmospheric conditions prevail during the night-time. The potential for atmospheric dispersion of emissions is therefore greatest during day time hours and lowest during evening through to early morning hours.

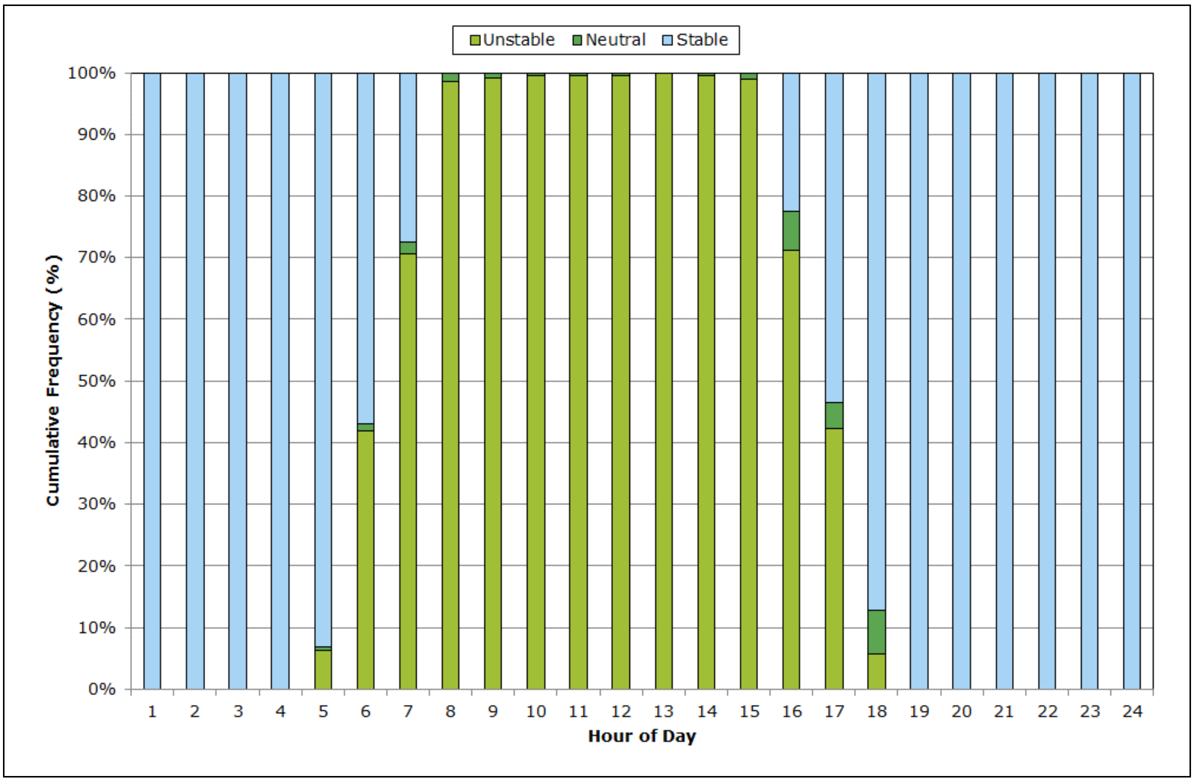


Figure 4-8: Diurnal variations in atmospheric stability derived from CALMET generated Monin-Obukhov length

5. EXISTING ENVIRONMENT

5.1 PM_{10} and $PM_{2.5}$

The Facility operates a BAM PM_{10} monitor at Minchinbury, which has been operational since mid-2012 and summary statistics for the modelling period (2016) are presented in **Table 5-1**. Reference is also made to the closest OEH sites at St Marys and Prospect (within 6 km of the site). Both OEH sites measure concentrations of PM_{10} and $PM_{2.5}$ (which is not measured by the Facility), although it is noted that $PM_{2.5}$ was only added as a parameter at St Marys in March 2016.

Annual mean PM_{10} concentrations across the three sites are 61% to 76% of the impact assessment criteria, while annual mean $PM_{2.5}$ concentrations for the region are 98%-108% of the impact assessment criteria (i.e. already at or above the impact assessment criteria). Elevated concentrations of $PM_{2.5}$ for the Western Sydney region are strongly influenced by vehicle emissions (cars, trucks and off-road equipment) and from wood heaters during winter months.

A timeseries plot of the 24-hour average concentrations in **Figure 5-1** shows the periods when the 24-hour average PM_{10} concentration exceeds 50 µg/m³ and in **Figure 5-2** when the 24-hour average $PM_{2.5}$ concentration exceeds 25 µg/m³. Exceedances of the 24-hour average criteria in Sydney are typically associated with periods of bushfire, hazard reduction and/or dust storms (NSW EPA, 2016).

Table 5-1: 2016 summary statistics (µg/m³) for PM_{10} and $PM_{2.5}$

Metric	Statistic	Genesis	St Marys	Prospect
PM_{10}	Annual mean	15.3	16.1	18.9
	Daily maximum	125.0*	100.2	110.1
	95th percentile	27.0	29.9	33.7
	90th percentile	23.7	26.4	29.5
	Number of exceedances	2*	3	4
$PM_{2.5}$	Annual mean	-	7.8	8.7
	Daily maximum	-	93.2	84.9*
	95th percentile	-	13.7	17.8
	90th percentile	-	11.4	14.0
	Number of exceedances	-	5	5*
Note: * Not based on a full year of observations so not a true daily maximum or number of exceedances				

5.2 TSP

TSP concentrations are not measured in the vicinity of the site, however historical measurements of TSP and PM_{10} in Sydney[2] indicate that PM_{10}/TSP ratios in urban areas typically range from 0.4 to 0.5. These ratios can be applied to the PM_{10} concentration data to derive an annual average TSP concentration.

5.3 Dust deposition

Dust deposition is measured at four locations on the site and results for the previous four years are summarised in **Table 5-2**. The measured dust deposition across all sites and years is 1.7 g/m²/month, which is consistent with background measurements seen across much of NSW (which is typically in the range of 1 g/m²/month to 2 g/m²/month).

[2] Reported in Quarterly Air Quality Monitoring Reports - http://www.environment.nsw.gov.au/aqms/datareports.htm#quarterlies

Table 5-2: Annual average dust deposition

Site	2016	2015	2014	2013	Average
North DDG	1.1	2.9	1.9	1.3	**1.6**
East DDG	1.5	2.9	1.4	2.0	**1.8**
South DDG	1.6	1.6	1.9	1.8	**1.7**
West DDG	2.1	1.8	2.4	1.6	**1.8**
Average	**1.2**	**1.6**	**2.3**	**1.9**	**1.7**

5.4 Adopted background for cumulative assessment

The baseline air quality adopted for cumulative assessment is summarised in **Table 5-3**. Annual average concentrations are generally based on the highest of the mean concentrations presented in **Table 5-1** (i.e. the Prospect monitoring site), however gaps in the daily data have been filled using both St Marys and the Facility's datasets. In the case of $PM_{2.5}$ (which isn't measured at the Facility and was only added at St Marys in March 2016) additional gaps in the daily data are estimated from the average $PM_{10}/PM_{2.5}$ ratio from the available data.

As previously described, background concentrations of $PM_{2.5}$ are already approaching or exceeding the impact assessment criteria and therefore assessment of impact will also be discussed in the context of the incremental increase from the proposal. For short term impacts, daily varying PM_{10} and $PM_{2.5}$ concentrations in 2016 are paired with modelling predictions for the same period.

Table 5-3: Adopted background for cumulative assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average	Daily varying
	Annual average	18.9 μg/m³
$PM_{2.5}$	24-hour average	Daily varying
	Annual average	8.6 μg/m³
TSP	Annual average	47.2μg/m³
Dust deposition	Annual average	2 g/m²/month

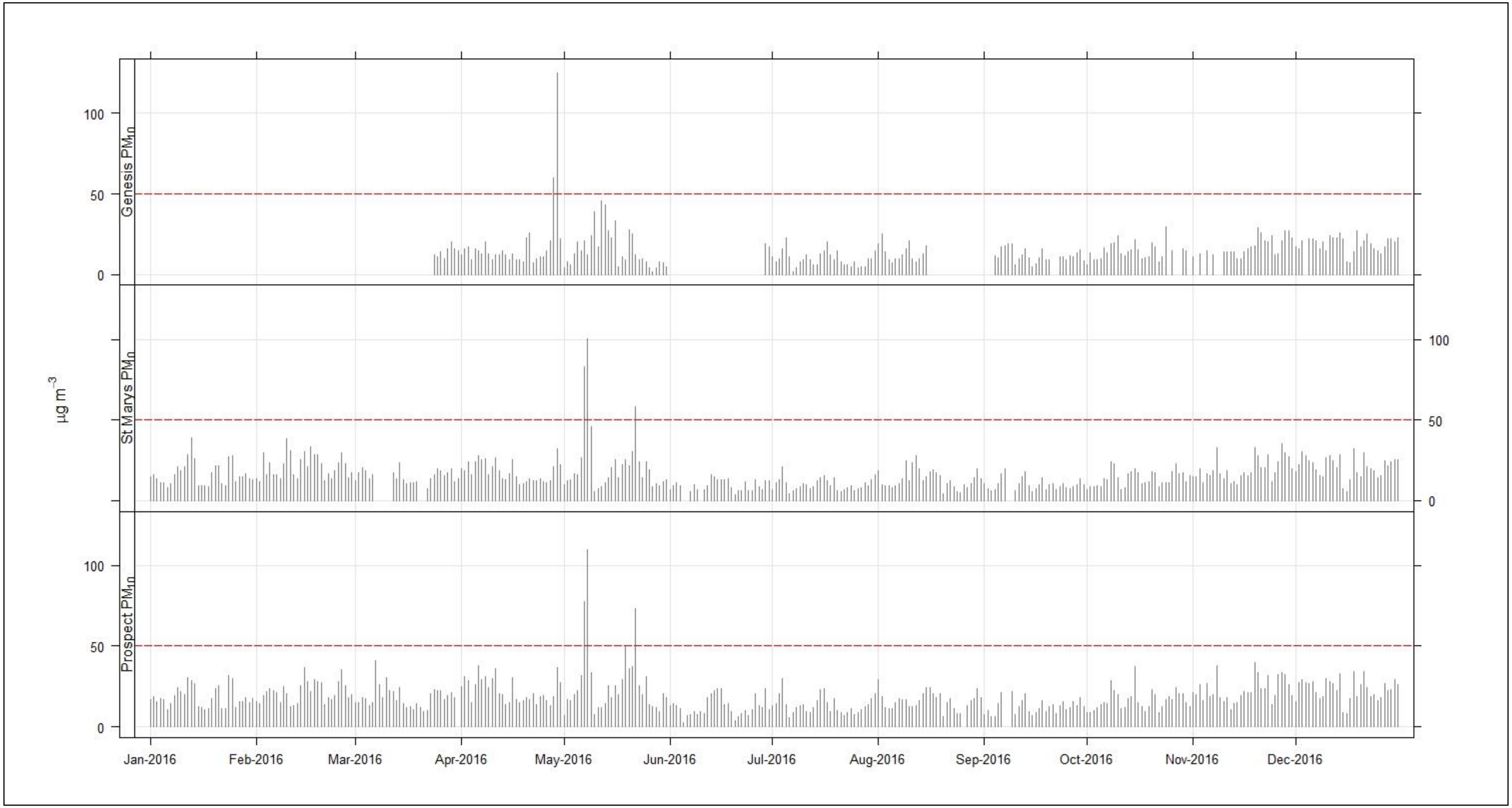


Figure 5-1: 24-hour average PM_{10} concentrations

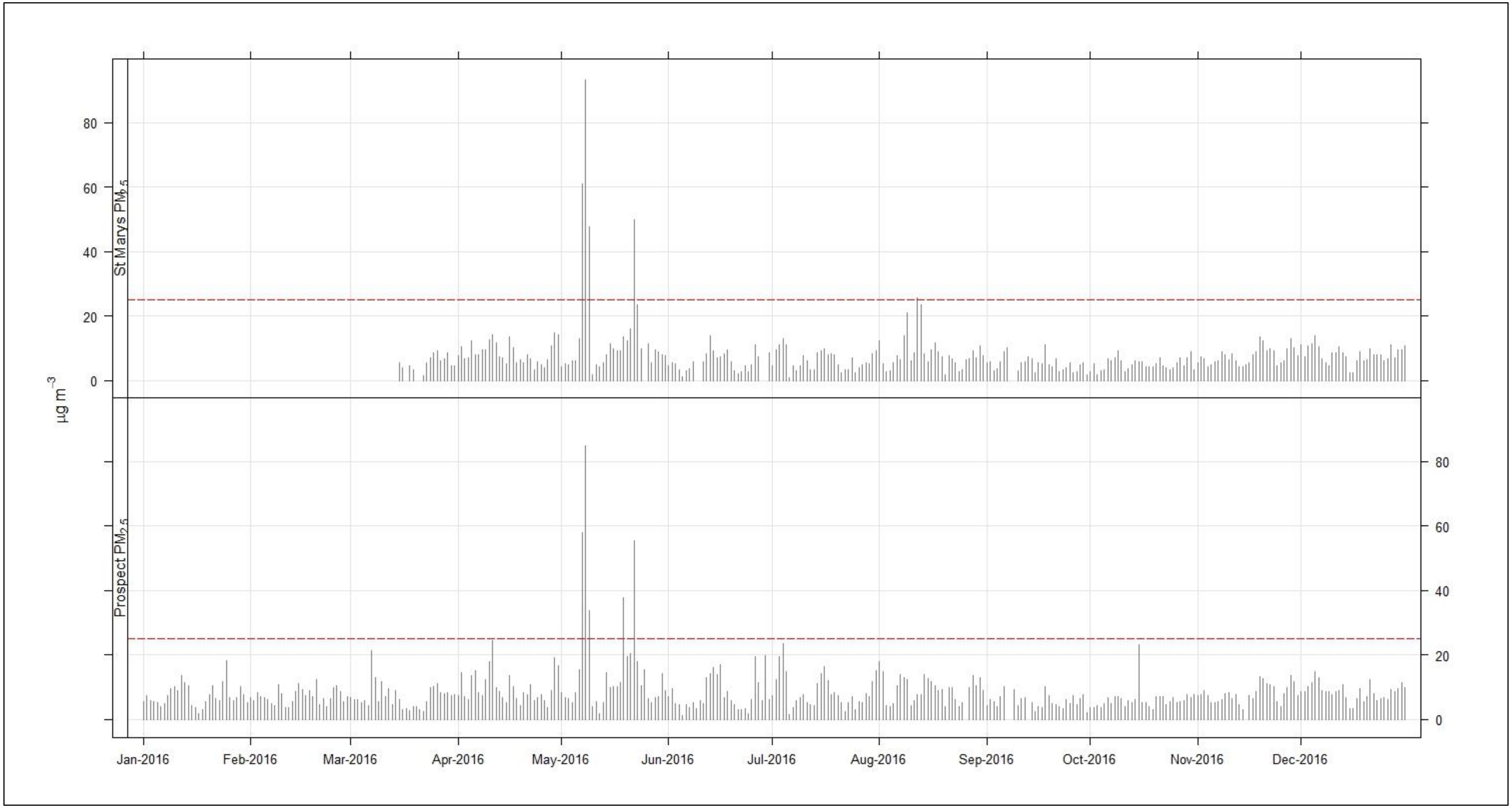


Figure 5-2: 24-hour average $PM_{2.5}$ concentrations

6. EMISSION INVENTORY

6.1 Dust emissions

Emission factors developed by the US EPA[3] have been applied to estimate the amount of dust produced by each activity (i.e. wheel generated dust, waste handling / processing and wind erosion). Emissions estimates have been developed for TSP, PM_{10} and $PM_{2.5}$, with the emission estimates for TSP also used to estimate dust deposition rates.

The extent to which the US EPA emissions factors account for the diesel exhaust component of each activity varies according to the emission factor and/or monitoring method which was used in deriving the emission factor. For hauling on paved surfaces, the exhaust component is not included whereas for material processing/handling, the emission factors may include some of the diesel exhaust component. To be conservative for this assessment, we have assumed that all emission factors do not include the exhaust component and emissions from diesel combustion are included as a separate emissions source.

Emissions are estimated based on a 50/50 split between the MPC and the landfill; that is, of the 2 Mtpa entering site, 1 Mtpa is processed through the MPC and 1 Mtpa enters the landfill. A summary of the annual TSP, PM_{10} and $PM_{2.5}$ emissions are presented in **Table 6-1**.

Further details on the emission inventory development, including the assumptions, input data and emission factors used, is provided in **Appendix 4**.

6.1.1 Existing dust controls

A number of existing and proposed dust controls are accounted for in the emissions estimates, as follows:

- Enclosure of material handling and processing and storage within the MPC shed.
- Misting sprays operated within the shed to dampen material as it is sorted and before being loaded to the hopper.
- The majority of travel routes onsite are sealed (exceptions are the haul route into the pit and within the segregated materials area).
- Water sprays on the mobile crusher and shredder.
- Fixed water sprays on product storage areas.
- Water truck operating on unsealed haul road into the pit, within the landfill and on the paved roads as needed.
- Speed limit of 40km/hr for unsealed haul road into the pit.
- Water cannon operating within the pit.
- Established earth bund along the northern boundary of the pit.
- A fixed water spray system operates on the access roadway.

Some of the dust controls listed above are incorporated into the emissions inventory for each relevant activity, based on control efficiencies reported in the literature. For example, all activities occurring within the shed are assigned a control efficiency of 40%. This is based on reported control efficiencies for material handling/transfer from enclosure or wind shielding, which range from 40% to 70% depending on roof/side wall wind shielding or full enclosure on all sides (Katestone, 2011). To provide a conservative (upper bound) estimate of emissions, we have adopted the lower of these reported control efficiencies. Also, to account for the mist sprays within the shed a control efficiency of 70% is assumed for waste sorting and loading the hopper (combination of 50% for watering and 40% for wind shielding).

[3]US EPA AP-42 Compilation of Air Pollutant Emission Factors (US EPA, 1998b; US EPA, 2004; US EPA, 2006).

Table 6-1: Particulate matter emissions for Modification 6 (kg/annum)

Activity	Controlled emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$
Waste trucks entering site - site access to MPC (paved)	2,483	477	115
Trucks unloading	92	44	7
Ex/FEL sorting waste	92	44	7
FEL loading hopper	64	30	5
Screening in MPC	154	52	4
Transfer points	387	183	28
Unloading to product storage	172	81	12
Rehandle to product storage (loading trucks)	172	81	12
Rehandle to product storage (hauling)	1,303	250	61
Mobile crusher - concrete/brick for roadbase product	306	138	26
Mobile screening - sand/soil	187	63	4
Shredding greenwaste	48	22	4
Loading product stockpiles	291	138	21
Loading product trucks	291	138	21
Product trucks leaving site - MPC to site access (paved)	1,078	207	50
Chute unload to landfill	9	4	0.6
Wheel generated dust - weighbridge to landfill (unpaved)	12,569	3,393	339
Trucks unloading	25	12	2
Dozer pushing waste at landfill	4,084	739	103
Excavator/loader at landfill	31	15	2
Wind erosion - landfill	1,488	744	112
Wind erosion - greenwaste storage bay	255	128	19
Wind erosion - soil storage area	701	351	53
Wind erosion - aggregate stockpile area	1,275	638	96
Diesel combustion - off-road	665	665	645
Diesel combustion - on-road trucks	151	151	139
Total	**28,373**	**8,784**	**1,884**

6.1.2 Accounting for peak day operations

The emissions presented in **Table 6-1** are estimated based on an annual production rate of 1,000,000,tpa for the MPC, which equates to an average daily processing rate of 2,740 tonnes per day (tpd) or 114 tonnes per hour (tph). When waste separation is optimal, the maximum processing rate is 150 tph; therefore to account for a theoretical worst-case day, the emissions from the MPC are increased by approximately 30% (i.e. 150/114). This, combined with a maximum of 1,000,000 tpa directed to landfill provides a worst-case assessment for peak day operations.

6.2 Odour emissions

The facility operates as a general solid waste (non-putrescible) landfill, and therefore odour emissions can be expected to be less significant when compared with a landfill which accepts putrescible waste (e.g. household waste, food waste, nappies, animal waste etc.). Recent odour audits for the current site found that no significant odour was detected beyond the site boundary (TOU, 2015; SEMA, 2017).

Notwithstanding, a proportion of the incoming waste is organic (wood waste, garden waste, paper and cardboard) and therefore has the potential to generate odour during decomposition. During normal operations the facility would aim to recover as much of this organic waste as possible, and therefore only a small volume of degradable waste would be disposed to landfill.

However, to address EPA's requirements, a worst-case scenario of 1 Mtpa directed to landfilled needs to be considered. Furthermore, although composting is not currently undertaken onsite, the facility is approved and licenced for this activity and therefore composting is included for a worst-case odour assessment.

The following odour sources are included in the model:

- Landfill (including active tip face, daily cover, intermediate cover and final cap).
- Greenwaste storage.
- Composting (including fresh and aged compost windrows).

One of the main challenges in accounting for an increase in odour emissions from landfilling at an increased rate, is how to appropriately scale existing odour emission data. The odour assessment for the 2008 EIS (HAS, 2008) did not have access to site specific monitoring data and instead used historical odour data from another landfill. After accounting for variations in emissions over time and across the landfill area, the historical emissions data were adjusted pro rata based on the reduced tonnages of organic waste landfilled at the Genesis facility. In other words, because most of the organic waste is recovered at modern landfills, the decomposition and resultant emissions would be much lower than for the historical monitoring data which was used.

An odour assessment undertaken as part of the Independent Environmental Audit in 2015 noted some limitations in this approach and suggested a better approach would be to adjust odour emission rates based on potential fugitive gas emissions (TOU, 2015). However, there are insufficient data available to take this approach and, regardless, for our worst-case scenario of 1 Mtpa landfilled, we have to assume that limited organic waste is recovered.

Site specific odour monitoring was completed onsite in 2013 for sources including the active tip face, the leachate sump/riser and the leachate treatment tanks. While these monitoring results are considered appropriate to derive emission rates for existing operations, no measurements were taken across the covered or capped areas of the landfill, although these areas of the landfill are expected to have low emissions potential. Furthermore, these measurements were taken while the MPC was operational and the organic waste volume may therefore not necessarily be representative of our worst-case scenario.

It is noted that subsequent odour assessments for the site in 2015 (TOU, 2015) and 2017 (SEMA, 2017) completed downwind odour surveys and did not measure odour sources directly. These reports, while useful in providing an indication of existing odour impact, cannot be used to derive odour emission rates for dispersion modelling.

To derive odour emission rates for a worst-case scenario, odour emission data for other putrescible waste landfills was reviewed, with a focus on sites where relatively recent odour monitoring was conducted. A summary of these data is provided in **Table 6-2**.

The approach taken for this assessment is to use the average specific odour emissions rate (SOER, expressed as OU.$m^3/m^2/s$) from the four putrescible waste landfills presented in **Table 6-2**. As shown, this provides a higher SOER than measurements taken at the existing facility and is generally higher than the emission rates used in the original EIS. To provide an additional level of conservatism, the source areas, across which these SOERs are applied, are scaled from the existing site layout according to the production increase.

Table 6-2: Review of odour emissions data and odour emission rates for modelling

Source	Specific Odour Emission Rate ($OU.m^3/m^2/s$)						
	Whytes Gully[1]	Spring Farm[2]	Woodlawn[3]	Lucas Heights[4]	SOER Average	Genesis site monitoring	Used in original EIS
Active tip face	1.115	0.424	0.7	*26-40 $OU.m^3/s$	**0.7**	0.4	
Daily cover	1.023	0.069		0.03	**0.4**		3.83
Intermediate cover	0.035	0.019	0.3	0.05	**0.1**		
Final cap		0.026			**0.03**		0.00051
Leachate storage	0.153	0.108	3.6	1.8	**1.4**	0.2	0.069
Greenwaste storage		1.279	*2.37 $OU.m^3/s$	4	**2.6**		
Compost windrow (fresh)		2.654	5.65	1.95	**3.3**		0.105
Compost windrow (aged/product)		0.18	0.83	0.34	**0.4**		

Note: * expressed as an OER ($OU.m^3/s$) and not included in the SOER average
[1] PAEHolmes, 2012
[2] Heggies, 2010
[3] GHD, 2015
[4] Pacific Environment, 2013

7. DISPERSION MODELLING RESULTS

7.1 PM10

The predicted ground level concentrations (GLCs) of PM_{10}at each receptor location are presented in **Table 7-1**. Results are presented for the Modification 6 increment alone, as well as cumulative which includes the addition of the existing background (described in **Section 5.4**).

The highest incremental annual average PM_{10} concentration at a residential receptor is 2.3 µg/m³ (R05 and R08). The highest incremental annual average PM_{10} concentration at a commercial receptor is 4.9 µg/m³ (effectively on the site boundary). With the addition of existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all receptor locations.

The highest incremental 24-hour average PM_{10} concentration at a residential receptor is 10.4 µg/m³ (R05) and 21.6 µg/m³ at a commercial receptor (R12). With the addition of existing background, the cumulative 24-hour average GLCs comply with the impact assessment criterion at all receptor locations.

Table 7-1: PM_{10} modelling predictions for Modification 6

Receptor ID	Receptor type	Modification 6 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
	Criteria	50 µg/m³	25 µg/m³	50 µg/m³	25 µg/m³
R01	Residential	7.7	1.3	44.1	20.2
R02		8.7	1.6	44.7	20.5
R03		9.1	1.9	43.2	20.8
R04		9.7	2.0	41.8	20.9
R05		10.4	2.3	41.8	21.2
R06		9.6	1.8	42.1	20.7
R07		10.1	2.2	41.8	21.1
R08		10.3	2.3	41.8	21.2
R09		1.7	0.3	42.4	19.2
R10		2.2	0.3	42.5	19.2
R11		2.4	0.4	42.2	19.3
R12	Commercial /industrial	21.6	4.9	49.2	23.8
R13		20.2	4.8	49.9	23.7
R14		11.6	2.8	43.5	21.7
R15		15.1	3.6	46.7	22.5
R16		19.3	4.8	46.2	23.7
R17		14.8	2.5	44.3	21.4

Note: [1]As described in **Section 5**, the background dataset contains four existing exceedances of the impact assessment criteria and the cumulative 24-hour average PM_{10} is therefore calculated using the 5thhighest background day (excluding the background days already at or over 50 µg/m³)

7.2 PM2.5

The predicted ground level concentrations (GLCs) of $PM_{2.5}$ at each sensitive receptor are presented in **Table 7-2**. Results are presented for the Modification 6 increment alone, as well as cumulative which includes the addition of existing background (described in **Section 5.4**).

The highest incremental annual average $PM_{2.5}$ concentration at a residential receptor is 0.6 µg/m³. The highest incremental annual average $PM_{2.5}$ concentration at a commercial receptor is 1.2 µg/m³ (effectively on the site boundary). With the addition of existing background, the cumulative annual average GLCs exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criterion.

The highest incremental 24-hour average $PM_{2.5}$ concentration at a residential receptor is 3.0 µg/m³ (R05). With the addition of existing background, the cumulative 24-hour average GLCs result in additional exceedances of the impact assessment criterion at a number of receptor locations (shown in bold). This is caused by a combination of elevated background with the additional dust emissions from the modification. It is noted that the background $PM_{2.5}$ concentration is already close to the impact assessment criterion (24.4 µg/m³).

Further analysis, showing the risk of additional exceedances above background, as a result of the modification, is presented below.

Table 7-2: $PM_{2.5}$ modelling predictions for Modification 6

Receptor ID	Receptor type	Modification 6 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
		25 µg/m³	8 µg/m³	25 µg/m³	8 µg/m³
R01	Residential	2.1	0.4	24.8	**9.0**
R02		2.4	0.5	24.8	**9.1**
R03		2.6	0.5	**25.1**	**9.1**
R04		2.8	0.6	**25.3**	**9.2**
R05		3.0	0.6	**25.4**	**9.2**
R06		2.6	0.5	**25.2**	**9.1**
R07		2.9	0.6	**25.3**	**9.2**
R08		2.9	0.6	**25.3**	**9.2**
R09		0.5	0.1	24.4	**8.7**
R10		0.6	0.1	24.4	**8.7**
R11		0.7	0.1	24.4	**8.7**
R12	Commercial /industrial	4.8	1.2	**26.5**	**9.8**
R13		4.1	1.1	**26.9**	**9.7**
R14		2.7	0.7	**26.2**	**9.3**
R15		3.3	0.9	**26.4**	**9.5**
R16		4.2	1.1	**26.8**	**9.7**
R17		3.8	0.7	**25.5**	**9.3**

Note: [1]As described in **Section 5**, the background dataset contains five existing exceedances of the impact assessment criteria and the cumulative 24-hour average $PM_{2.5}$ is therefore calculated using the 6th highest background day (excluding the background days already at or over 25 µg/m³)

In addition to the paired-in-time cumulative analysis presented above, to provide an analysis of the statistical likelihood of compliance with the impact assessment criterion, every predicted 24-hour average concentration (366 individual concentrations) has been paired with multiple years of measured 24-hour average concentrations from the NSW OEH Prospect and St Marys sites (a total of 1,007 measurements). Each combination of model prediction and recorded concentration (376,190 potential combinations) is combined, assuming that any background value from the data set could occur on any given day of the proposed operations.

For the receptors presented in **Table 7-2** with additional exceedance days (residential receptors R3 to R8 and commercial receptors R12 to R17), the number of cumulative 24-hour average $PM_{2.5}$ concentrations greater than 25 µg/m^3 is presented in **Figure 7-1**.

The analysis shows that for residential and commercial receptors, risk of any additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion does not increase significantly, above what is already caused by background (i.e. up to one additional day as a worst case).

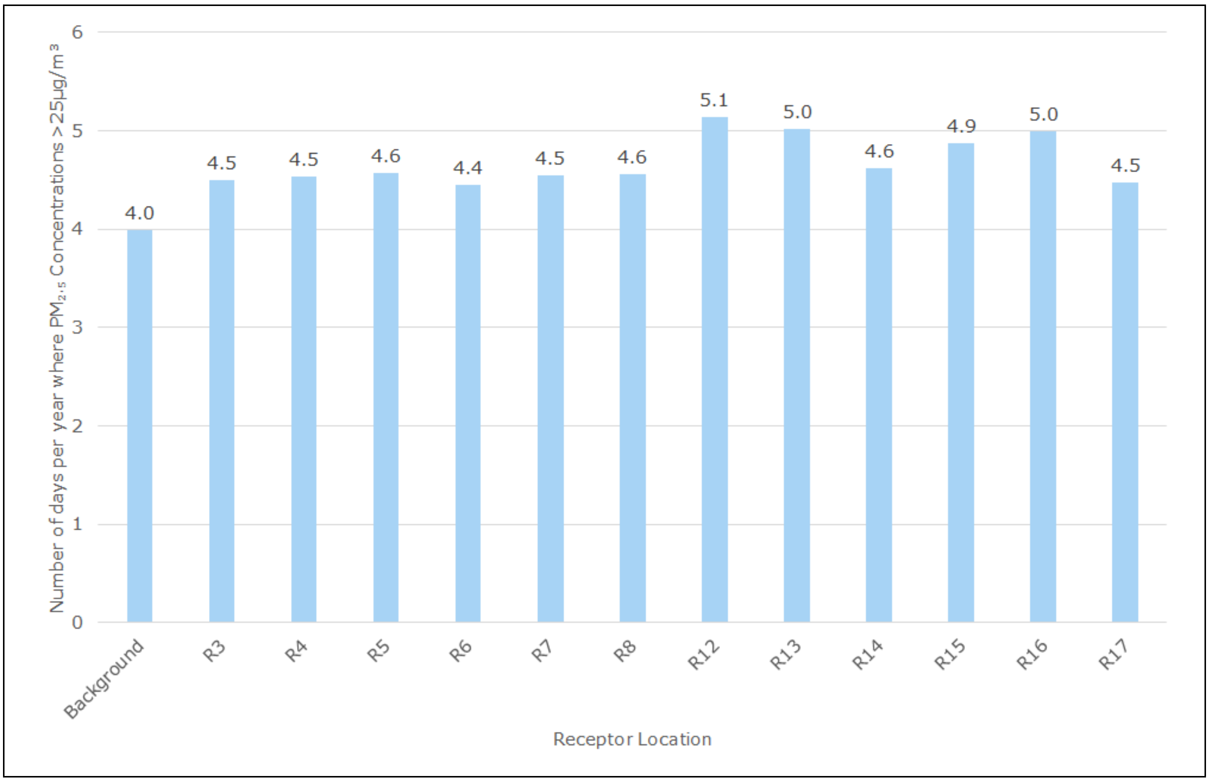


Figure 7-1: Frequency distribution of cumulative 24-hour average PM $_{2.5}$ concentration

7.3 TSP and Dust Deposition

The predicted ground level concentrations (GLCs) of TSP and dust deposition at each receptor are presented in **Table 7-3**. Results are presented for the Modification 6 increment alone, as well as cumulative which includes the addition of existing background (described in **Section 5.4**).

The incremental increase in annual average TSP is minor and with the addition existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all receptor locations. Similarly, the predicted dust deposition complies with both the incremental and cumulative impact assessment criteria at all receptor locations.

Table 7-3: TSP and dust deposition modelling predictions for Modification 6

Receptor ID	Receptor type	Modification 6 increment		Cumulative	
		TSP	Dust Depos	TSP	Dust Depos
		90 µg/m^3	2 g/m^2/month	90 µg/m^3	4 g/m^2/month
R01	Residential	2.0	0.1	49.2	2.1
R02		2.6	0.1	49.8	2.1
R03		3.0	0.1	50.2	2.1
R04		3.2	0.1	50.4	2.1
R05		3.6	0.2	50.8	2.2
R06		2.8	0.1	50.0	2.1
R07		3.4	0.1	50.6	2.1
R08		3.6	0.1	50.8	2.1
R09		0.4	0.0	47.6	2.0
R10		0.4	0.0	47.6	2.0
R11		0.4	0.0	47.6	2.0
R12	Commercial /industrial	9.9	0.5	57.1	2.5
R13		10.2	0.5	57.4	2.5
R14		5.0	0.3	52.2	2.3
R15		7.5	0.4	54.7	2.4
R16		12.3	0.7	59.5	2.7
R17		5.4	0.3	52.6	2.3

7.4 Odour

A theoretical worst-case odour scenario is modelled based on the potential for landfilling to occur up to the 1 Mtpa, in addition to greenwaste processing through the MPC (storage, processing and composting). It is noted that greenwaste processing is currently limited to shredding to produce various mulch products. However, as the facility is approved for composting, this is also included as an odour source in the modelling, nominally placed within the current greenwaste storage area.

The predicted ground level concentrations (GLCs) of odour for this worst-case scenario are presented in **Table 7-4**. All modelling predictions at residential receptors are below odour goal of 2 OU and therefore comply with the impact assessment criteria. Modelling predictions at commercial receptors are all less than 7 OU, which is considered an appropriate odour goal for this type of receptor.

Table 7-4: Predicted ground level concentration of odour (99th percentile, nose response average)

Receptor ID	Receptor type	Modification 6 increment
		Odour
		2 OU
R01	Residential	<1
R02		1
R03		1
R04		<2
R05		<2
R06		1
R07		<2
R08		1
R09		<1
R10		<1
R11		<1
R12	Commercial /industrial	2
R13		3
R14		2
R15		2
R16		3
R17		2

8. MANAGEMENT AND MONITORING

The principal fugitive dust emission sources during operation are:

- Movement of vehicles on travel routes and re-entrainment of dust from paved and unpaved surfaces.
- Material handling (trucks unloading, loading, screening, crushing, sorting).
- Wind erosion from exposed surfaces and stockpiles.
- Diesel vehicle exhaust from the trucks, front end loaders, excavators etc.

The existing and proposed dust controls include:

- Enclosure of material handling and processing and storage within the MPC shed.
- Misting sprays operated within the shed to dampen material as it is sorted and before being loaded to the hopper.
- The majority of travel routes onsite are sealed (exceptions are the haul route into the pit and within the segregated materials area).
- Water sprays on the mobile crusher and shredder.
- Fixed water sprays on product storage areas.
- Water truck operating on unsealed haul road into the pit, within the landfill and on the paved roads as needed.
- Speed limit of 40km/hr for unsealed haul road into the pit.
- Water cannon operating within the pit.
- Established earth bund along the northern boundary of the pit.
- A fixed water spray system operates on the access roadway.

The existing facility operates under an Operational Environmental Management Plan (OEMP) which outlines the roles, responsibilities and the tasks to be performed to ensure environmental impacts are minimised. The OEMP will be reviewed and updated, where required, for the modification.

Based on the modelling results presented in this report, the existing controls appear to be effective in preventing dust impacts in surrounding residential areas. This conclusion is supported by the existing monitoring data which demonstrate compliance with impact assessment criteria at the site boundary (dust deposition) and in the suburb of Minchinbury (PM_{10}).

There is a small risk of additional exceedances of the 24-hour average $PM_{2.5}$ concentrations at residential and commercial receptor locations (i.e. up to one additional day as a worst case). To better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary. The four existing boundary dust deposition monitoring sites remain appropriate for the modification.

9. CONCLUSION

Local air quality impacts are assessed using a Level 2 assessment approach in accordance with the Approved Methods. Emissions are estimated for all activities and dispersion modelling is used to predict ground level concentrations at surrounding sensitive receptors. Cumulative impacts are assessed by combining the contribution from the modification with the existing ambient baseline.

A worst-case emissions assessment is considered based on a 50/50 split between the MPC and landfill. Modelling a scenario with 1,000,000 tpa hauled to landfill provides a conservative worst-case assessment of impacts, as hauling along the unsealed access road to the pit is the largest potential source.

The predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all receptor locations. With the addition of existing background, there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion at any receptor location.

The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criteria. The cumulative 24-hour average $PM_{2.5}$ concentrations result in additional exceedances of the impact assessment criterion at residential and commercial receptor locations. It is noted that the background $PM_{2.5}$ concentration is already close to the impact assessment criterion (24.4 µg/m³). Furthermore, additional statistical analysis shows that the probability or risk of any additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion does not significantly increase, above what is already caused by background (i.e. up to one additional day as a worst case).

Cumulative annual average TSP concentrations comply with the impact assessment criterion at all receptor locations. Similarly, predicted dust deposition levels comply with both the incremental and cumulative impact assessment criteria at all receptor locations.

The worst case potential odour impact from landfilling at 1 Mtpa combined with greenwaste processing and composting, would not result in exceedances of the odour goal of 2 OU at any residential receptor.

To better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary.

10. REFERENCES

Australian Bureau of Statistics (2015). 9208.0 – Survey of Motor Vehicle Use, Australia, 12 months ended 31 October. Website: http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0/.

GHD (2015). Lucas Heights Resource Recovery Park Project. Air Quality Assessment. Prepared for SITA Australia. August 2015.

HAS (2008). Air Quality – Odour and Dust: Light Horse Business Centre Development Application‖, Holmes Air Sciences, April 2008.

Heggies (2010). Woodlawn Bioreactor Odour and Dust Impact Assessment. Woodlawn Expansion Project. Prepared for Veolia. 2 August 2010.

NEPC (1998). National Environmental Protection Measure for Ambient Air Quality. National Environmental Protection Council.

NEPC (2003). National Environmental Protection Measure (Ambient Air Quality) Measure, as amended, made under the National Environment Protection Act 1994. National Environmental Protection Council, 7 July 2003.

NEPC(2015). Variation to the National Environment Protection (Ambient Air Quality) Measure. National Environment Protection Act 1994. National Environmental Protection Council, 15 December 2015.

NSW EPA (2005). Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, August 2015.

NSW EPA(2012). Technical Report No. 6. Air Emissions Inventory for the Greater Metropolitan Region in New South Wales. 2008 Calendar Year. Off Road Mobile Emissions: Results.

NSW EPA (2016). Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, minor revisions November 2016, published January 2017.

NSW EPA (2016). NSW State of the Environment 2015. Chapter 8 Air Quality. http://www.epa.nsw.gov.au/resources/soe/150817-soe-8-air-quality.pdf

Oke T.T. (2003). Boundary Layer Climates, Second Edition, Routledge, London and New York, 435 pp.

Pacific Environment (2013). Spring Farm Advanced Resource Recovery Technology (ARRT) Facility – Air Quality and Odour Impact Assessment. Prepared for Cardno. 23 September 2013.

PAEHolmes (2012). Whytes Gully Landfill Extension Project. Prepared for Golder Associates. 30June 2012.

PEL (2015). Energy From Waste Facility – Air Quality and Greenhouse Gas Assessment. The Next Generation. Prepared by Pacific Environment Limited, 26 March 2015.

Stull R. B. (1997). An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, London.

TOU (2015). Genesis Xero Waste Facility. Field Ambient Odour Assessment and Review Study. Prepared for Cardno Limited. Eastern Creek/Minchinbury, NSW. Final Report. August 2015.

SEMA (2017). Field Ambient Odour Assessment – Site Boundary. Dial A Dump Industries Group. Genesis Xero Waste Facility. 24 February 2017. Report prepared for KMH Environmental.

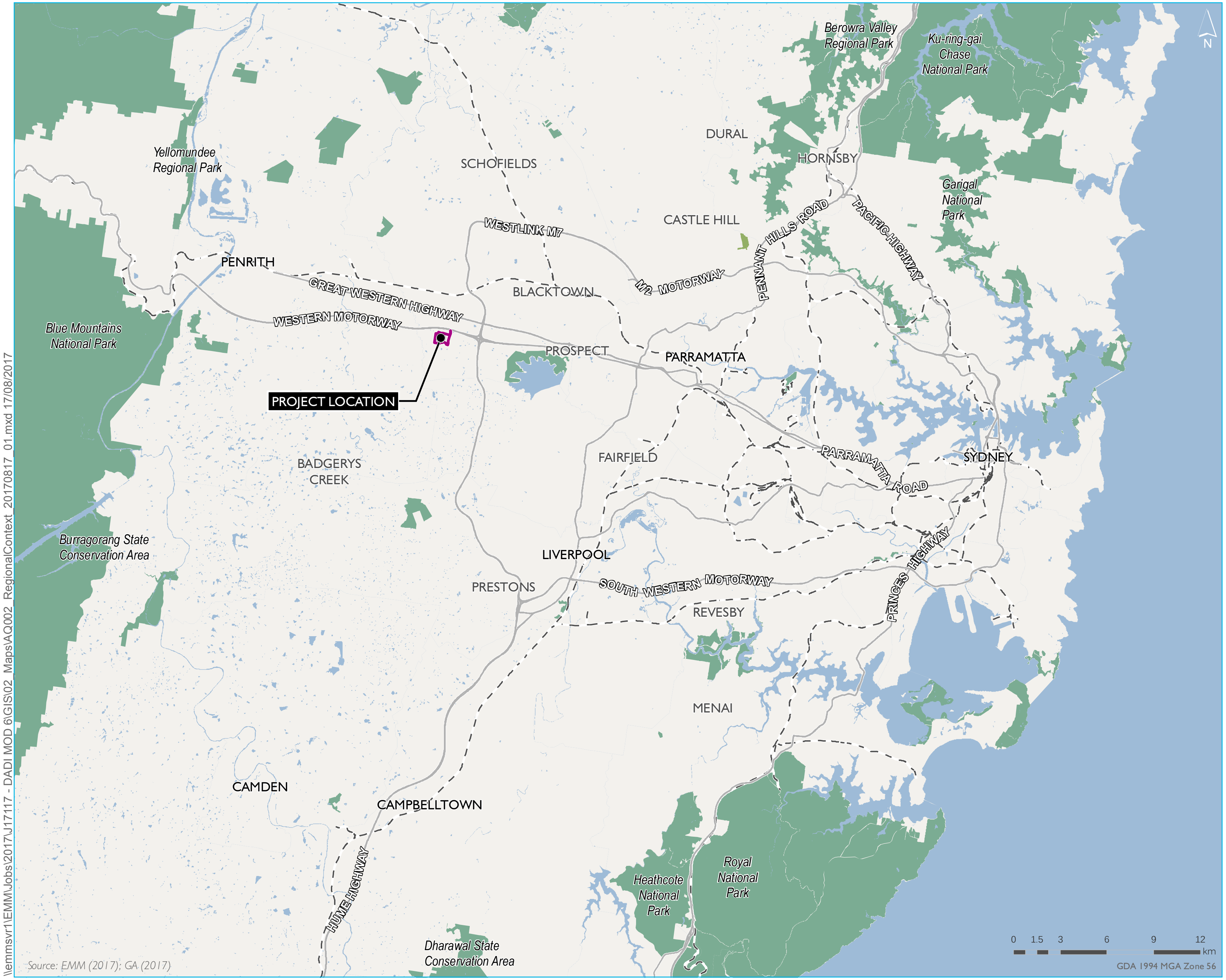
US EPA (1987). Update of fugitive dust emission factors in AP-42 Section 11.2, EPA Contract No. 68-02-3891, Midwest Research Institute, Kansas City, MO, July 1987.

US EPA(1998a). Emission Factor Documentation for AP-42. Section 13.2.2. Unpaved Roads. Final Report for U.S. United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Emission Factor and Inventory Group. MRI Project No. 4864. September 1998.

US EPA(1998b). AP-42 Emission Factor Database, Chapter 11.9 Western Surface Coal Mining, United States Environmental Protection Agency, 1998.

US EPA (2006). AP-42 Emission Factor Database, Chapter 13.2.5 Industrial Wind Erosion, United States Environmental Protection Agency, November 2006.

APPENDIX 1
FIGURES



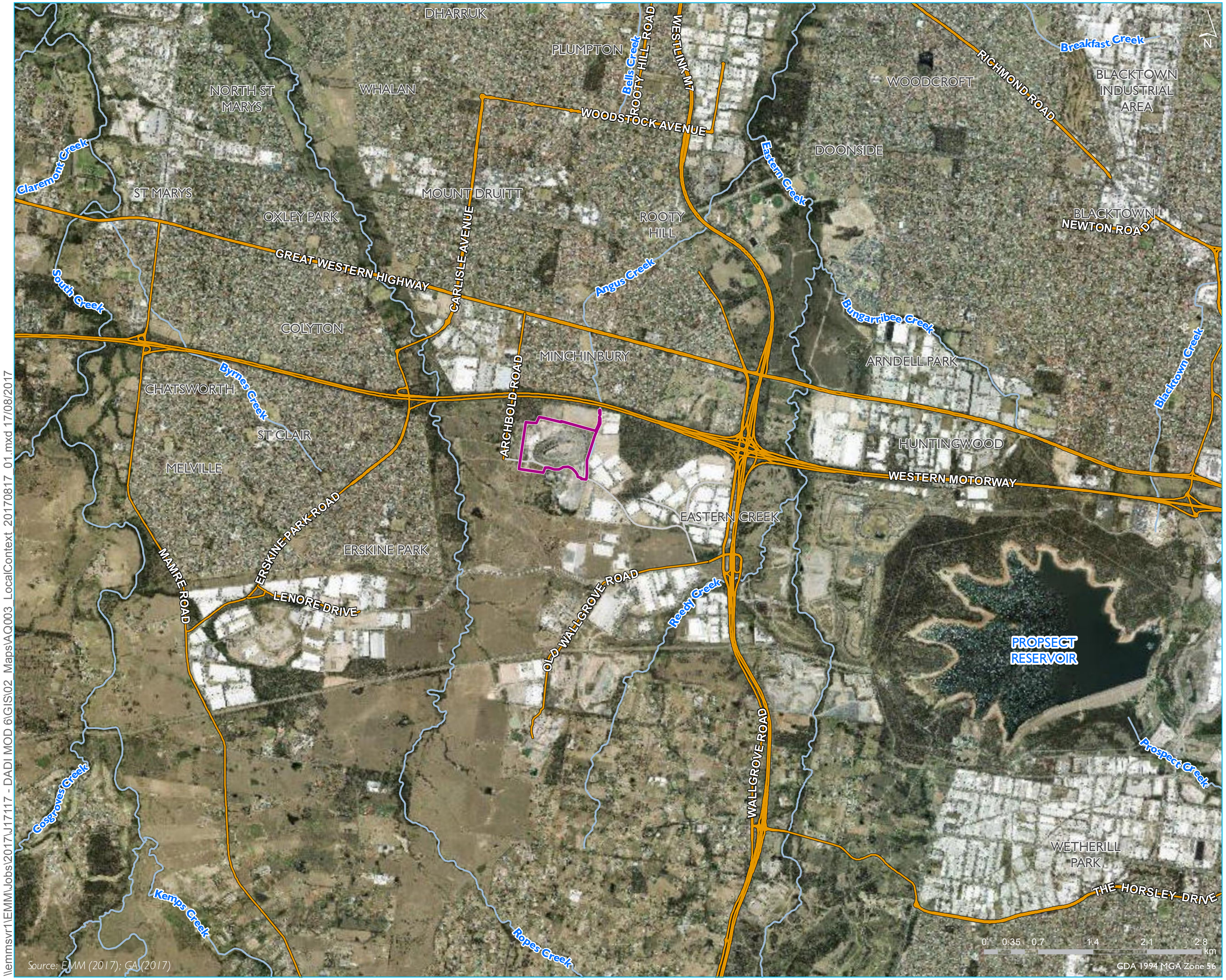
KEY

- Site location
- Main roads
- Waterbodies
- NPWS reserve
- State forest

Regional context

Genesis Zero Waste
Modification 6
Air quality impact assessment
Figure 1.1

EMM



KEY

- Site location
- Main road
- Local road
- Watercourse

Local context

Genesis Zero Waste
Modification 6
Air quality impact assessment
Figure 1.2

EMM

APPENDIX 2
MODEL SETTINGS

Table A2-1: TAPM settings	
Parameter	**Setting**
Model Version	TAPM v.4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25
Vertical grids / vertical extent	30 / 8000m (~400mb)
Centre of analysis	Lat 150.824997, long -33.7999992 Easting 298655, Northing 6257892S
Year of analysis	2016
Terrain and landuse	Terrain data using NASA SRTM3 database. Default TAPM values based on land-use and soils data sets from Geoscience Australia and the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC).
Assimilation sites	NSW OEH - St Marys BoM - Horsley Park Equestrian Centre, Badgerys Creek AWS, Penrith Lakes AWS, Bankstown Airport, Holsworthy Control Range, Sydney Olympic Park, Richmond RAAF and Camden Airport.

Table A2-2: CALMET settings	
Parameter	**Setting**
Grid domain	60 km x 60 km
Grid resolution	0.5 km
Number of grid points	120 x 120
Reference grid coordinate	268.900, 6228.200
Vertical grids / vertical extent	10 cell heights / 4,000m
Upper air meteorology	Prognostic 3D.dat extracted from TAPM at 1 km grid
Surface observations	NSW OEH - St Marys BoM - Horsley Park Equestrian Centre, Badgerys Creek AWS, Penrith Lakes AWS, Bankstown Airport, Holsworthy Control Range, Sydney Olympic Park, Richmond RAAF and Camden Airport.

Table A2-3: CALMET model options			
Flag	**Description**	**Recommended setting**	**Value used**
NOOBS	Meteorological data options	0,1,2	1 - combination of surface and prognostic data
ICLOUD	Cloud Data Options – Gridded Cloud Fields	4	4 -Gridded cloud cover from Prognostic relative humidity at all levels (MM5toGrads algorithm)
IEXTRP	Extrapolate surface wind observations to upper layers	-4	-4 - similarity theory used
IFRADJ	Compute Froude number adjustment effects	1	1 - applied
IKINE	Compute kinematic effects	0	0 - not computed
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations vs. upper air data	NZ * 0	NZ * 0 - layers in lower levels of model will have stronger weighting towards surface, higher levels will be have stronger weighting to upper air data
TERRAD	Radius of influence of terrain	No default (typically 5-15km)	5 km

Table A2-3: CALMET model options

Flag	Description	Recommended setting	Value used
NOOBS	Meteorological data options	0,1,2	1 - combination of surface and prognostic data
ICLOUD	Cloud Data Options – Gridded Cloud Fields	4	4 -Gridded cloud cover from Prognostic relative humidity at all levels (MM5toGrads algorithm)
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	10 km, 20km
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	R1 - 2 km, R2 – 5 km

Table A2-4: CALPUFF model options

Flag	Description	Value used	Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MWET	Wet Deposition	0	Not modelled
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Briggs plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion Coefficients	2	Based on micrometeorology
MPDF	Probability density function used for dispersion under convective conditions	1	Yes
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	1	ISC Method

APPENDIX 3
WIND ROSES

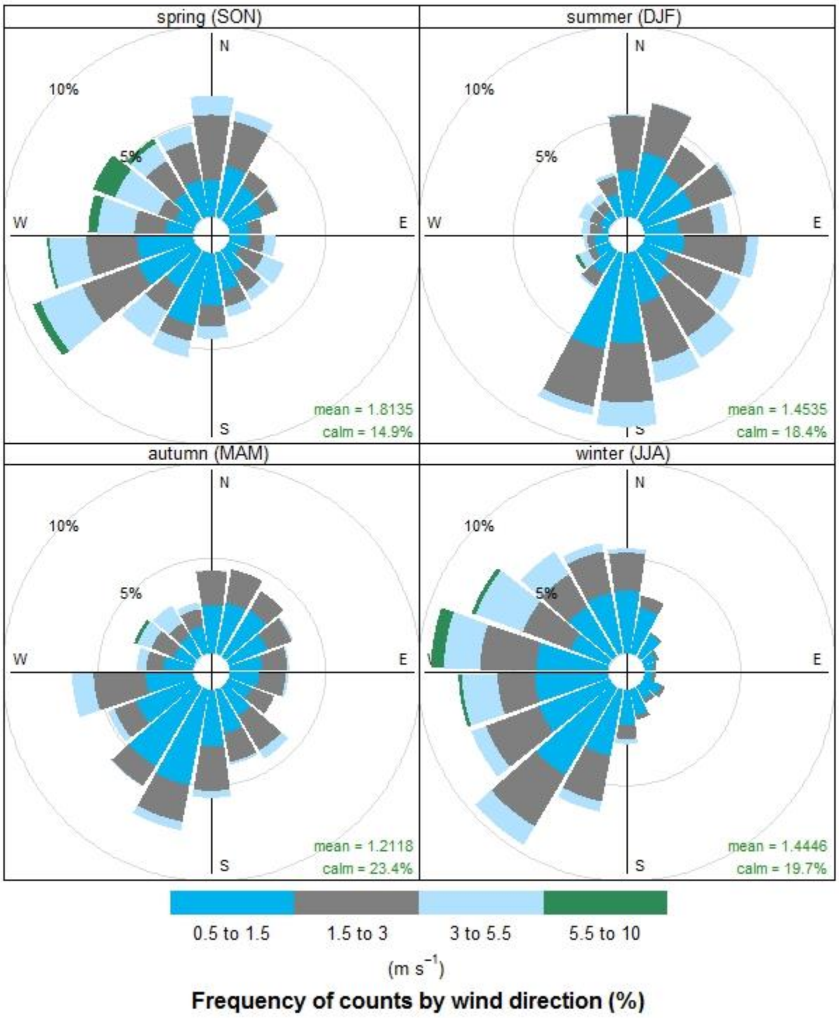


Figure A3-1: Seasonal wind rose

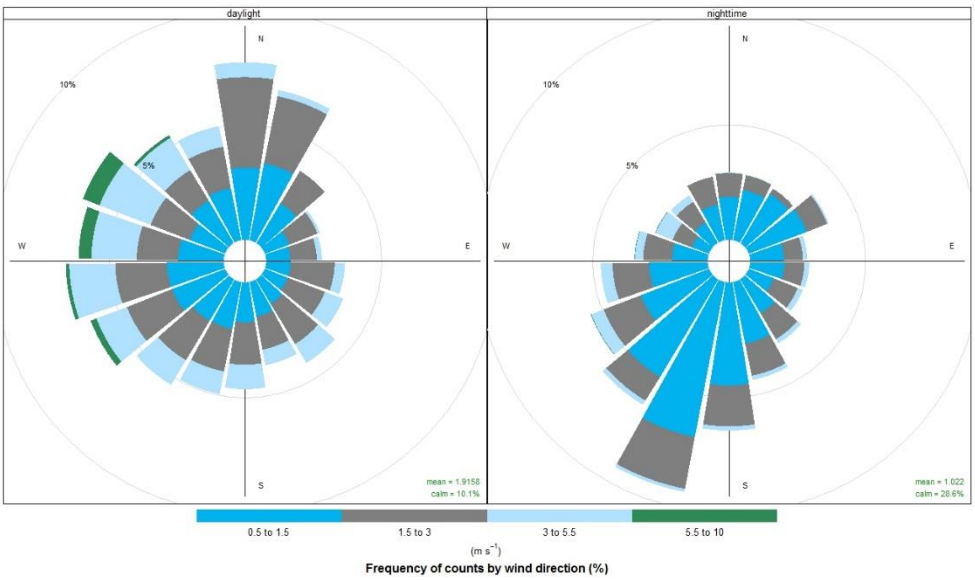


Figure A3-2: Diurnal wind rose

APPENDIX 4
EMISSIONS INVENTORY DEVELOPMENT

Dust emissions were estimated using US EPA AP-42 emission factors and predictive equations taken from the following chapters:

- Chapter 11.9 Western Surface Coal Mining.
- Chapter 13.2.2 Unpaved Roads.
- Chapter 13.2.1 Paved Roads
- Chapter 13.2.4 Aggregate Handling and Storage Piles.
- Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.
- Chapter 13.2.5 Industrial Wind Erosion.

The material properties listed in **Table A4-1** are used as input to the various emission factor equations listed in **Table A4-2** to derive site specific uncontrolled emission factors for each source.

Table A4-1: Material properties

Properties	Value	Source of Information
Silt loading of paved surface % silt content for unpaved roads	- 0.6 g/m2 - 7.4 g/m2 6.4%	AP42 13.2.1 Table 13.2.1-2 - for access road based on baseline for traffic less than 500 (average daily traffic) - for other internal road based on value for municipal solid waste landfills AP42 13.2.2 Table 13.2.2-1 based on value for municipal solid waste landfills
Return travel distances Site access to weighbridge/MPC Rehandle to product storage Product trucks leaving site In pit unsealed road	 2.1 km 0.5 km 2.4 km 2.0 km	Estimated from aerial photography
Average truck load	50 t	average for all trucks
Truck weight	45 t	Average of loaded and unloaded vehicle mass
Moisture content of raw material and product	2%	AP42 13.2.4 Table 13.2.4-1 – value for stone quarrying and processing – various limestone products
Areas for wind erosion Landfill Greenwaste storage Aggregate storage Soil storage area	 5.0 ha 0.6 ha 3.0 ha 1.7 ha	Estimated from aerial photography

Emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates. Fine particles (PM_{10} and $PM_{2.5}$) were estimated using the fraction specific equations or ratios for the different particle size fractions available within the literature (shown in **Table A4-2**). Emissions from onsite diesel consumption are estimated as follows:

- For on-road trucks, we have assumed a truck fuel consumption of 56.9 litres per 100 km (based on the ABS survey of motor vehicle use) and emission factors of 1.2 kg/kl and 1.1 kg/kl for PM_{10} and $PM_{2.5}$(based on NPI emission factor for heavy goods vehicle).
- For onsite equipment, (i.e. excavators, FELs, dozers, dump trucks, crushers, screens etc) a combined annual diesel consumption of 1007kL is assumed based on the reported consumption for NGERS reporting. US EPA Tier 2 emission factors (kg/kL) are assumed.

Table A4-2: Equations and emission factors

Inventory activity	Units	TSP emission factor/equation	PM_{10} emission factor/equation	$PM_{2.5}$ emission factor/equation	EF source
Material handling (loading trucks unloading trucks, loading screens etc)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP42 13.2.4
Wind erosion	kg/ha/yr	0.85×1000	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Hauling on sealed surfaces	g/VKT	$3.23\ x\ sL^{0.91} \times W^{1.02}$	$0.62\ x\ sL^{0.91} \times W^{1.02}$	$0.15\ x\ sL^{0.91} \times W^{1.02}$	AP43 13.2.1
Hauling on unsealed roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP42 13.2.2
Screening	kg/t	0.0125	0.0043	0.00043	AP42 11.19.2
Crushing	kg/t	0.0027	0.0012	0.0001	AP42 11.19.2
Dozers	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	AP42 11.9

Note: VKT = vehicle kilometre travelled; U = wind speed (m/s); M = moisture content (%); s = silt content (%); W = vehicle weight (t); S = speed (km/hr); ha = hectares, sL = silt loading

Activity	TSP Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Waste trucks entering site - site access to MPC (paved)	2,483	2,000,000	t/y	0.00414	kg/t	50	t/load	45	GVM (t) load/unload ave	2.1	km/return	0.1	kg/VKT	0.6	road surfa	70	water flushing
Trucks unloading at MPC	92	800,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Ex/FEL sorting waste	92	800,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
FEL loading hopper	64	560,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Screening in MPC	154	560,000	t/y	0.0011	kg/t											75	75% for enclosure plus controlled emission factor
Transfer points	387	560,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3	6	transfer points					85	75% for enclosure plus 50% for water sprays
Unloading to product storage	172	448,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (loading trucks)	172	448,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (hauling)	1,303	448,000	t/y	0.00969	kg/t	50	t/load	45	GVM (t) load/unload ave	0.5	km/return	1.0	kg/VKT	7.4	road surfa	70	water flushing
Mobile crusher - concrete/brick for roadbase product	306	510,000	t/y	0.0006	kg/t												Controlled emission factor for sprays and moisture content
Mobile screening - sand/soil	187	170,000	t/y	0.0011	kg/t												Controlled emission factor for sprays and moisture content
Shredding greenwaste	48	80,000	t/y	0.0006	kg/t												Controlled emission factor for sprays and moisture content
Loading product stockpiles	291	760,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Loading product trucks	291	760,000	t/y	0.0008	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Product trucks leaving site - MPC to site access (paved)	1,078	760,000	t/y	0.00473	kg/t	50	t/load	45	GVM (t) load/unload ave	2.4	km/return	0.1	kg/VKT	0.6	road surfa	70	water flushing
Chute unload to landfill	9	240,000	t/y	0.0001	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Wheel generated dust - weighbridge to landfill (unpaved)	12,569	1,000,000	t/y	0.128	kg/t	50	t/load	45	Vehicle gross mass (t)	2.0	km/return	3.1	kg/VKT	6	% silt cont	90	water cart 75% + 40km/h speed limit 44% + wind breaks (30%)
Trucks unloading	25	1,000,000	t/y	0.0001	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Dozer pushing waste at landfill	4,084	10,220	h/y	1.1	kg/h	10.9	moisture	7	silt content in %							65	Sprinklers + wind breaks (30%)
Excavator/loader at landfill	31	1,240,000	t/y	0.0001	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Wind erosion - landfill	1,488	5.0	ha	850	kg/ha/yr											65	Sprinklers + wind breaks (30%)
Wind erosion - greenwaste storage bay	255	0.6	ha	850	kg/ha/yr											50	Sprinklers
Wind erosion - soil storage area	701	1.7	ha	850	kg/ha/yr											50	Sprinklers
Wind erosion - aggregate stockpile area	1,275	3.0	ha	850	kg/ha/yr											50	Sprinklers
Diesel combustion - off-road	665																
Diesel combustion - on-road trucks	151																
Total	**28,373**																

Activity	PM10 Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Waste trucks entering site - site access to MPC (paved)	477	2,000,000	t/y	0.00079	kg/t	50	t/load	45	GVM (t) load/unload ave	2.1	km/returr	0.02	kg/VKT	0.6	road surfa	70	water flushing
Trucks unloading	44	800,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Ex/FEL sorting waste	44	800,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
FEL loading hopper	30	560,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Screening in MPC	52	560,000	t/y	0.0004	kg/t											75	75% for enclosure plus controlled emission factor
Transfer points	183	560,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3	6	transfer points					85	75% for enclosure plus 50% for water sprays
Unloading to product storage	81	448,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (loading trucks)	81	448,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (hauling)	250	448,000	t/y	0.00186	kg/t	50	t/load	45	GVM (t) load/unload ave	0.5	km/returr	0.2	kg/VKT	7.4	road surfa	70	water flushing
Mobile crusher - concrete/brick for roadbase product	138	510,000	t/y	0.0003	kg/t												Controlled emission factor for sprays and moisture content
Mobile screening - sand/soil	63	170,000	t/y	0.0004	kg/t												Controlled emission factor for sprays and moisture content
Shredding greenwaste	22	80,000	t/y	0.0003	kg/t												Controlled emission factor for sprays and moisture content
Loading product stockpiles	138	760,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Loading product trucks	138	760,000	t/y	0.0004	kg/t	2.0	moisture cor	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Product trucks leaving site - MPC to site access (paved)	207	760,000	t/y	0.00091	kg/t	50	t/load	45	GVM (t) load/unload ave	2.4	km/returr	0.02	kg/VKT	0.6	road surfa	70	water flushing
Chute unload to landfill	4	240,000	t/y	0.0000	kg/t	10.9	moisture cor	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Wheel generated dust - weighbridge to landfill (unpaved)	3,393	1,000,000	t/y	0.035	kg/t	50	t/load	45	Vehicle gross mass (t)	2.0	km/returr	0.8	kg/VKT	6	% silt cont	90	water cart 75% + 40km/h speed limit 44% + wind breaks (30%)
Trucks unloading	12	1,000,000	t/y	0.0000	kg/t	10.9	moisture cor	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Dozer pushing waste at landfill	739	10,220	h/y	0.2	kg/h	10.9	moisture cor	7	silt content in %							65	Sprinklers + wind breaks (30%)
Excavator/loader at landfill	15	1,240,000	t/y	0.0000	kg/t	10.9	moisture cor	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Wind erosion - landfill	744	5.0	ha	425	kg/ha/yr											65	Sprinklers + wind breaks (30%)
Wind erosion - greenwaste storage bay	128	0.6	ha	425	kg/ha/yr		15200	36480	207							50	Sprinklers
Wind erosion - soil storage area	351	1.7	ha	425	kg/ha/yr											50	Sprinklers
Wind erosion - aggregate stockpile area	638	3.0	ha	425	kg/ha/yr											50	Sprinklers
Diesel combustion - off-road	665																
Diesel combustion - on-road trucks	151																
Total	**8,784**																

Activity	PM2.5 Emission estimate (kg/year)	Intensity	Units	Emission Factor	Units	Variable 1		Variable 2		Variable 3		Variable 4		Variable 5		Control %	Control
Waste trucks entering site - site access to MPC (paved)	115	2,000,000	t/y	0.00019	kg/t	50	t/load	45	GVM (t) load/unload ave	2.1	km/retur	0.00	kg/VKT	0.6	road surfa	70	water flushing
Trucks unloading	7	800,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Ex/FEL sorting waste	7	800,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
FEL loading hopper	5	560,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							85	75% for enclosure plus 50% for water sprays
Screening in MPC	4	560,000	t/y	0.0000	kg/t											75	75% for enclosure plus controlled emission factor
Transfer points	28	560,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3	6	transfer points					85	75% for enclosure plus 50% for water sprays
Unloading to product storage	12	448,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (loading trucks)	12	448,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Rehandle to product storage (hauling)	61	448,000	t/y	0.00045	kg/t	50	t/load	45	GVM (t) load/unload ave	0.5	km/retur	0.05	kg/VKT	7.4	road surfa	70	water flushing
Mobile crusher - concrete/brick for roadbase product	26	510,000	t/y	0.0001	kg/t												Controlled emission factor for sprays and moisture content
Mobile screening - sand/soil	4	170,000	t/y	0.00003	kg/t												Controlled emission factor for sprays and moisture content
Shredding greenwaste	4	80,000	t/y	0.0001	kg/t												Controlled emission factor for sprays and moisture content
Loading product stockpiles	21	760,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Loading product trucks	21	760,000	t/y	0.0001	kg/t	2.0	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Product trucks leaving site - MPC to site access (paved)	50	760,000	t/y	0.00022	kg/t	50	t/load	45	GVM (t) load/unload ave	2.4	km/retur	0.00	kg/VKT	0.6	road surfa	70	water flushing
Chute unload to landfill	0.6	240,000	t/y	0.0000	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							50	Sprinklers
Wheel generated dust - weighbridge to landfill (unpaved)	339	1,000,000	t/y	0.003	kg/t	50	t/load	45	Vehicle gross mass (t)	2.0	km/retur	0.1	kg/VKT	6	% silt cont	90	water cart 75% + 40km/h speed limit 44% + wind breaks (30%)
Trucks unloading	2	1,000,000	t/y	0.0000	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Dozer pushing waste at landfill	103	10,220	h/y	0.03	kg/h	10.9	moisture	7	silt content in %							65	Sprinklers + wind breaks (30%)
Excavator/loader at landfill	2	1,240,000	t/y	0.0000	kg/t	10.9	moisture	0.6	(wind speed/2.2)^1.3							65	Sprinklers + wind breaks (30%)
Wind erosion - landfill	112	5.0	ha	64	kg/ha/yr											65	Sprinklers + wind breaks (30%)
Wind erosion - greenwaste storage bay	19	0.6	ha	64	kg/ha/yr											50	Sprinklers
Wind erosion - soil storage area	53	1.7	ha	64	kg/ha/yr											50	Sprinklers
Wind erosion - aggregate stockpile area	96	3.0	ha	64	kg/ha/yr											50	Sprinklers
Diesel combustion - off-road	645																
Diesel combustion - on-road trucks	139																
Total	**1,884**																

APPENDIX 5
CONTOUR PLOTS

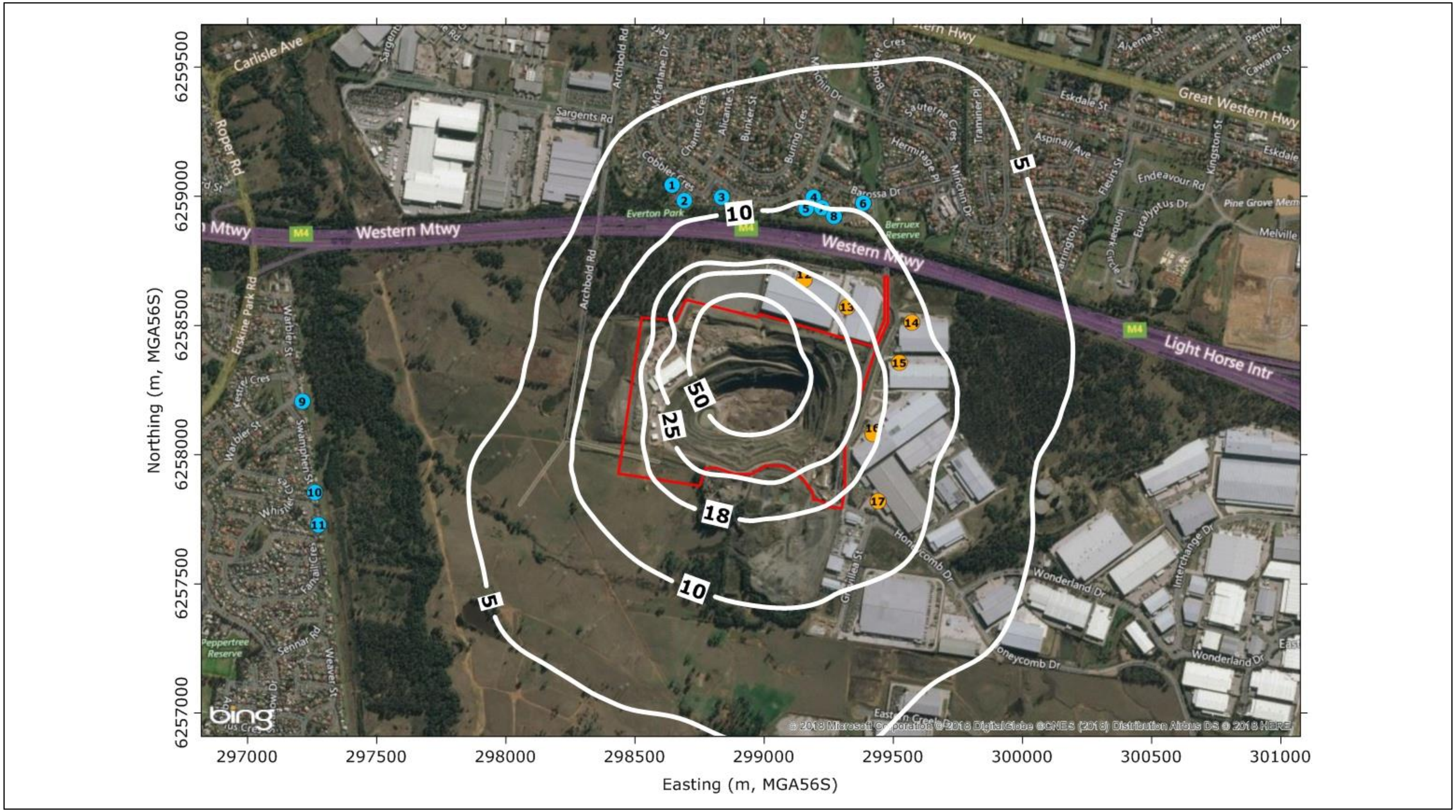


Figure A5-1: Predicted Project-only 24-hour average PM_{10} concentration ($\mu g/m^3$)

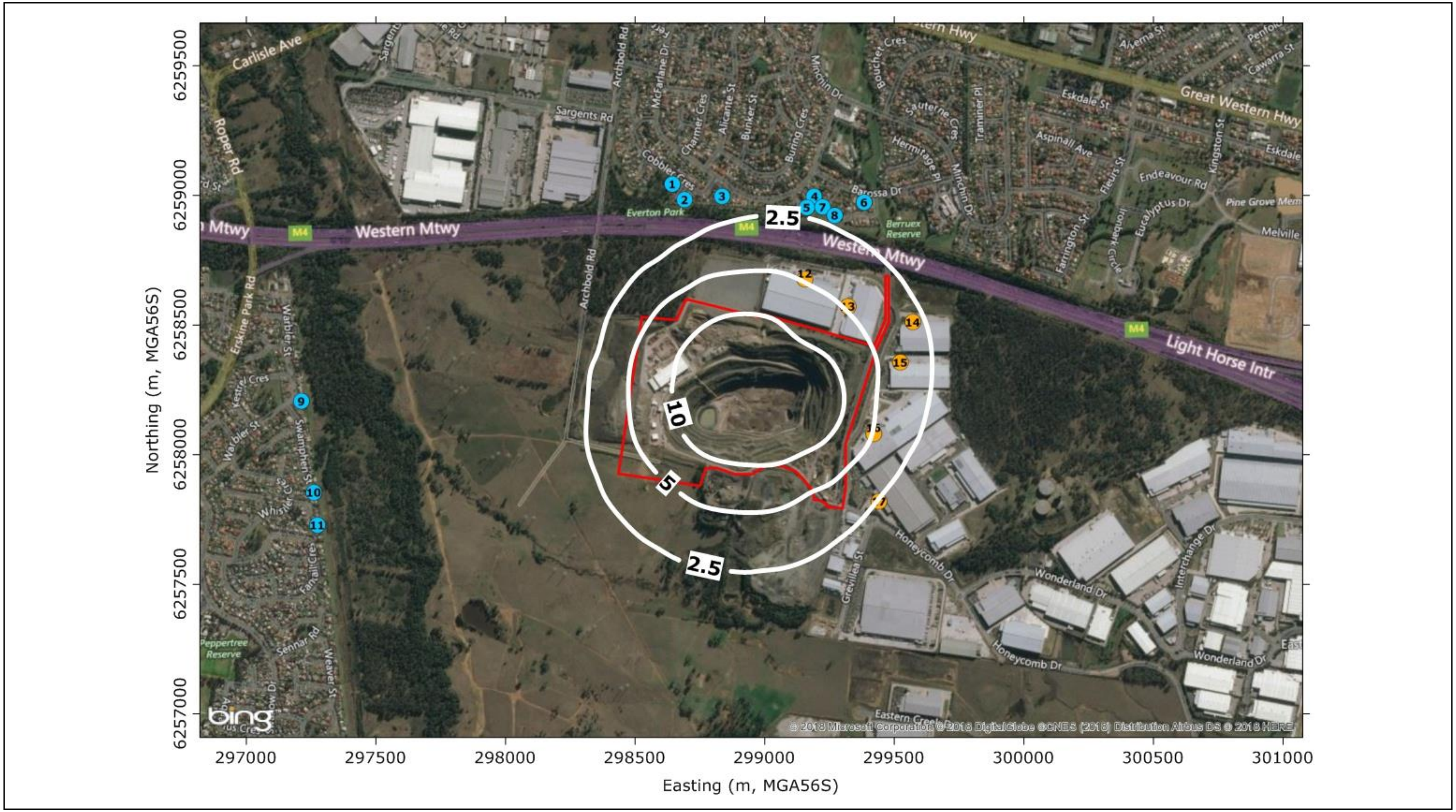


Figure A5-2: Predicted Project-only annual average PM_{10} concentration ($\mu g/m^3$)

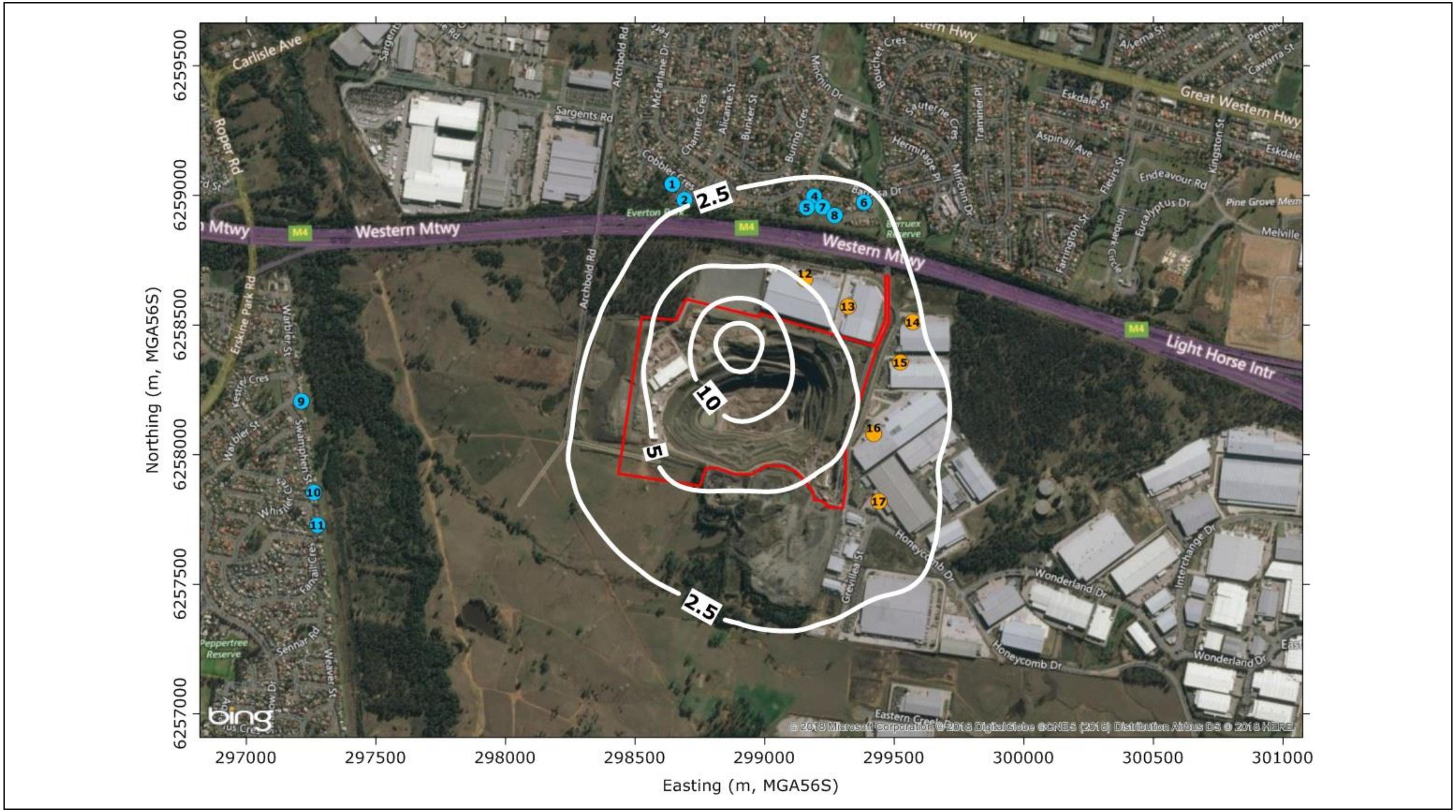


Figure A5-3: Predicted Project-only 24-hour average $PM_{2.5}$ concentration ($\mu g/m^3$)

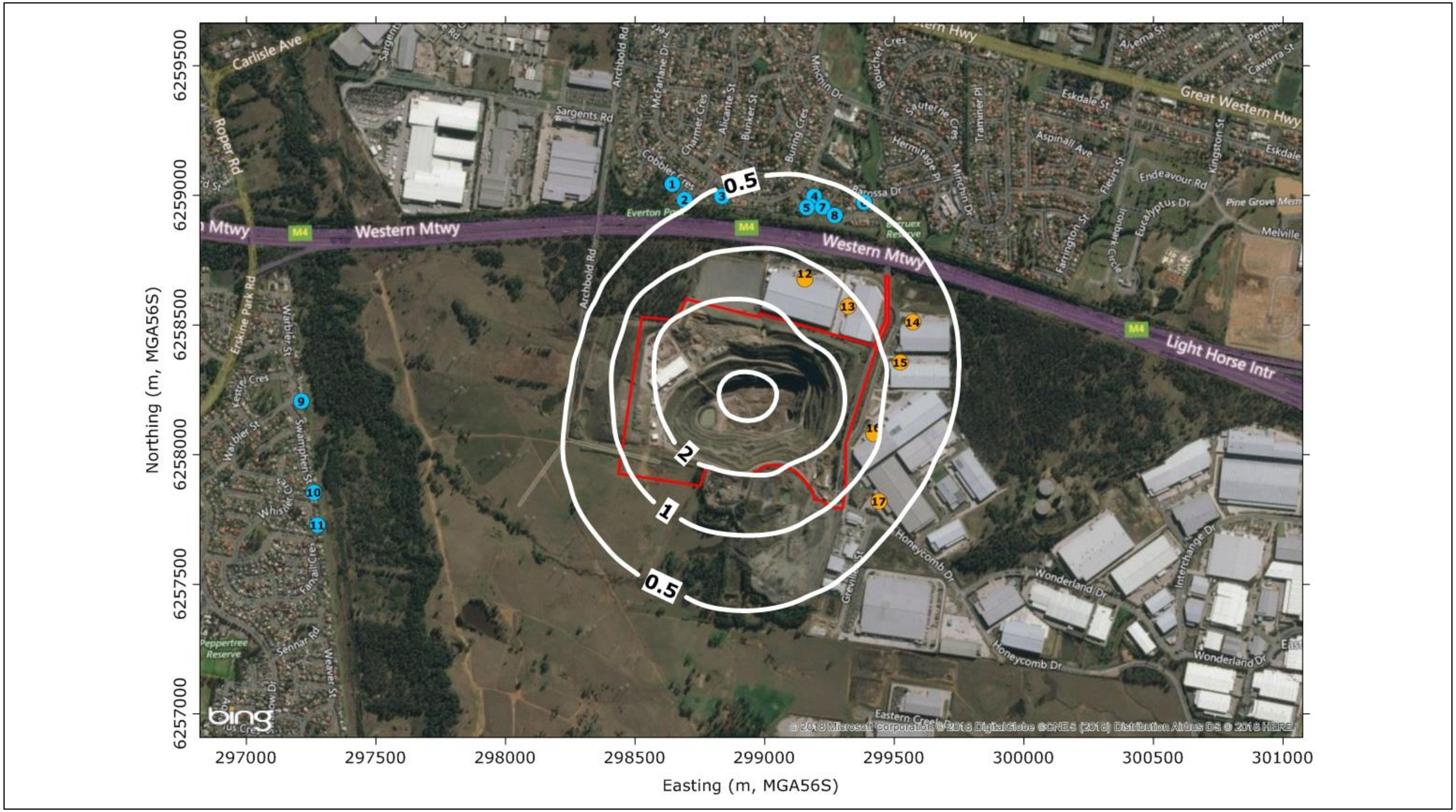


Figure A5-4: Predicted Project-only annual average $PM_{2.5}$ concentration ($\mu g/m^3$)

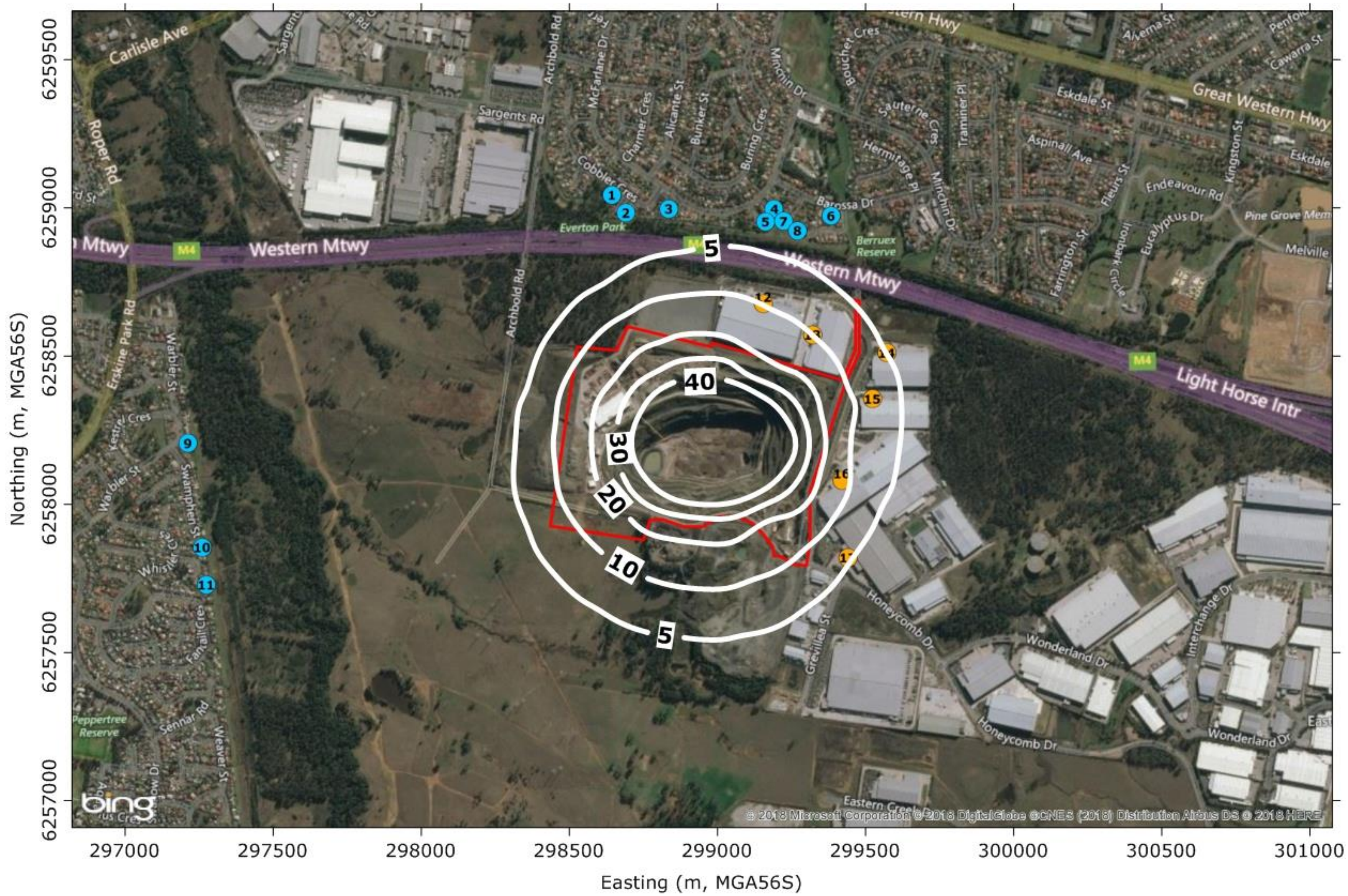


Figure A5-5: Predicted Project-only annual average TSP concentration (µg/m^3)

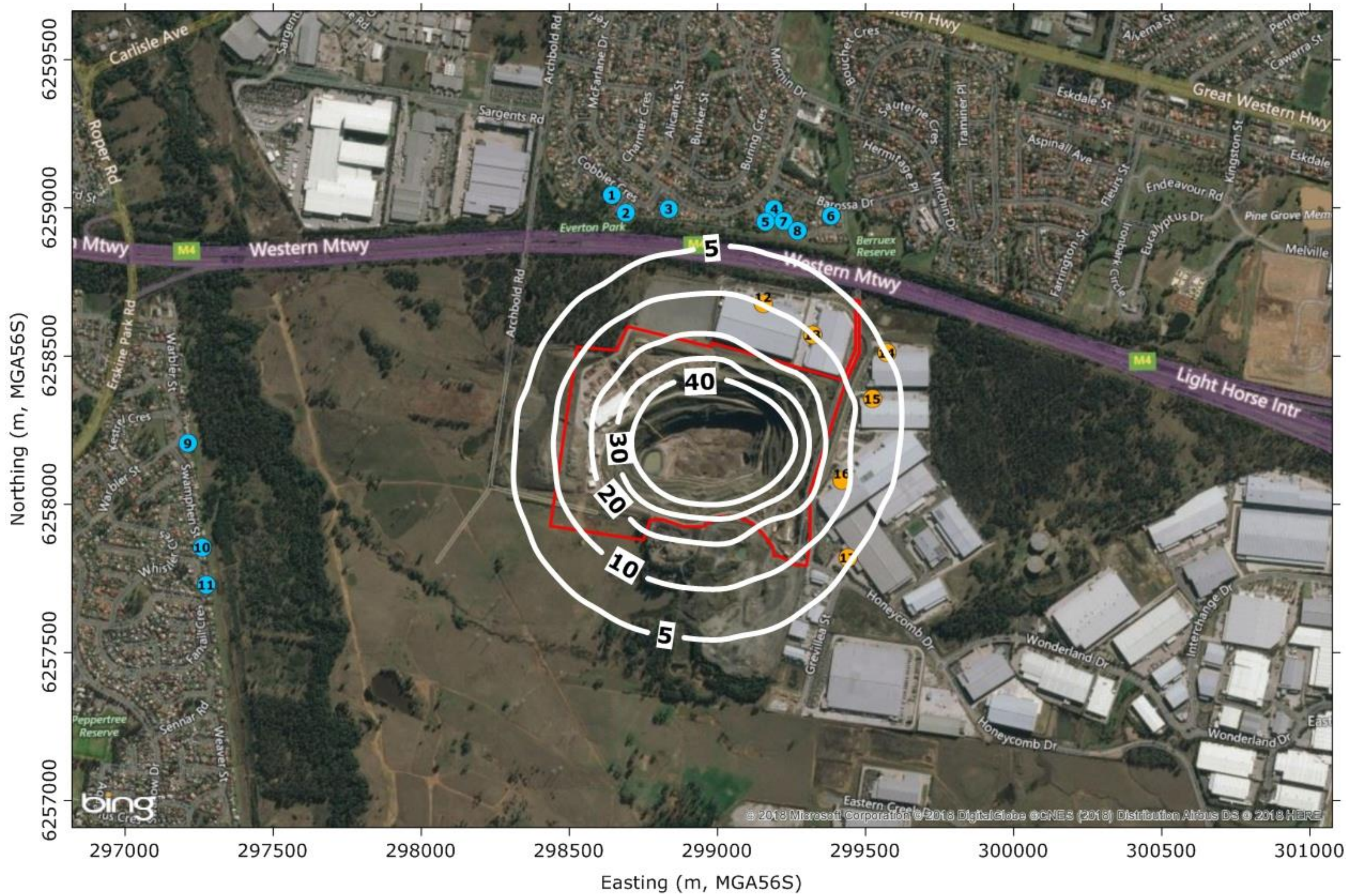


Figure A5-6: Predicted Project-only annual average dust deposition (g/m²/month)

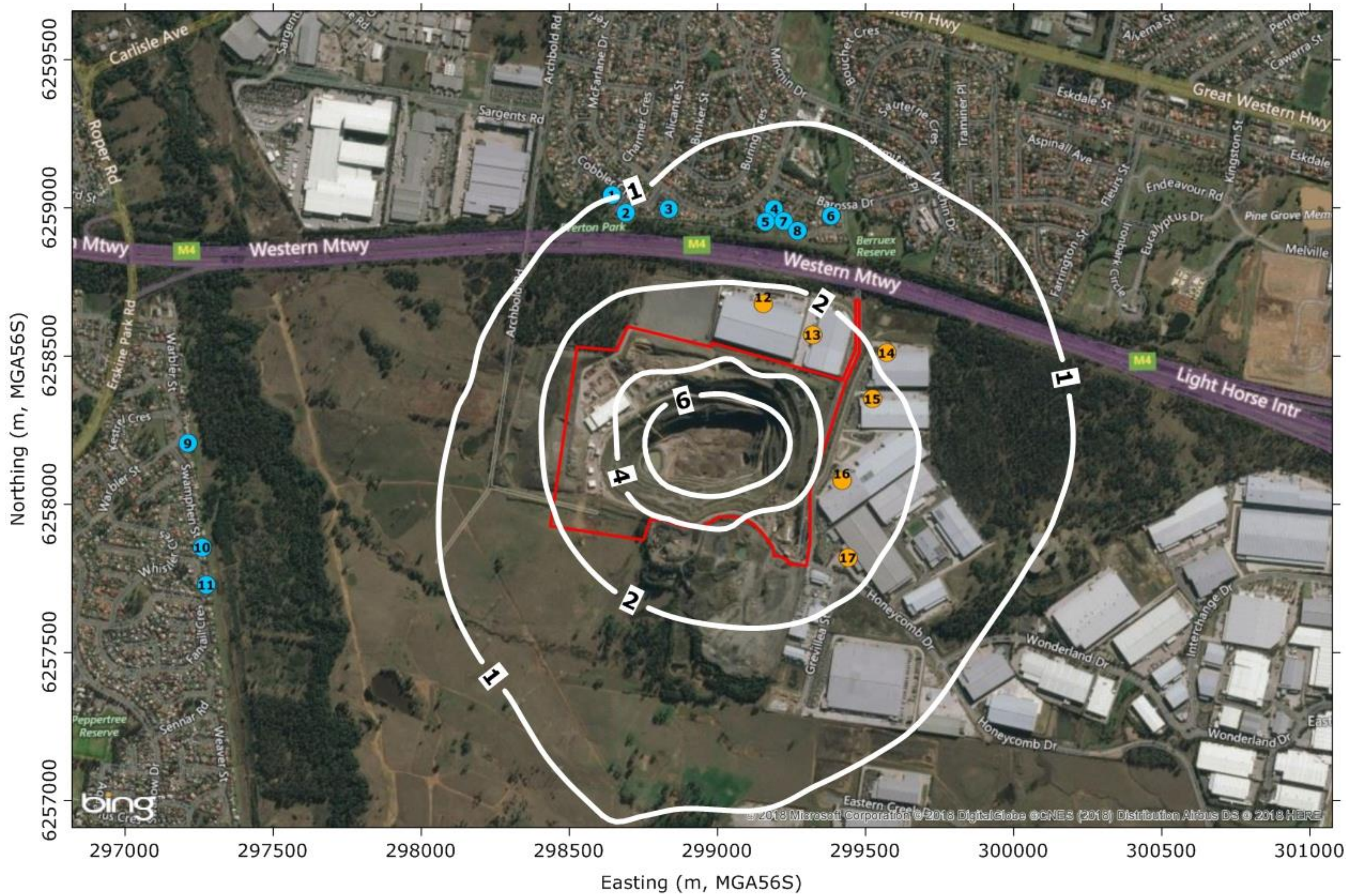


Figure A5-7: Predicted ground level concentration of odour (OU 99th percentile, nose response average)