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Air Quality Impact Assessment

Oakdale West Estate

Report Number 610.15617-R1

23 March 2017

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NSW 2000

Version: v1.1

Air Quality Impact Assessment

Oakdale West Estate

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
610.15617-R1	Final	23 March 2017	Varun Marwaha	K Lawrence	K Lawrence

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) was commissioned by Goodman Property Services (Australia) Pty Ltd (The Proponent) to perform an Air Quality Impact Assessment (AQIA) for the proposed staged development of a warehouse and distribution estate, at the Oakdale West Estate (hereafter 'the Development site') located in Erskine Park, NSW. The Development site is part of the Oakdale Industrial Estate, zoned under (1) General Industrial, under the Western Sydney Employment Area SEPP (2009).

1.1 Secretary's Environmental Assessment Requirements

This report has been prepared as part of the Environmental Impact Statement (EIS) for the development proposal. NSW Department of Planning and Environment (DPE) issued Secretary's Environmental Assessment Requirements (SEARs) for the staged development in November 2015. The aim of this report is to assess the potential impacts of the Development site on air quality and has been prepared in accordance with the guidelines discussed below. The report responds to the SEARs relevant to air quality, as shown in **Table 1**.

Table 1 Secretary's Environmental Assessment Requirements – Oakdale West Estate

Key Issue	Assessment Requirement	Addressed in Section
Air Quality and Odour	An assessment of the potential air quality impacts (particularly dust) of the development on surrounding receivers, including impacts from construction, operation and transport.	**Section 8**
	An assessment of the potential odour impacts.	**Section 2.5.2**
	Details of the proposed mitigation, management and monitoring measures.	**Section 1.1.1**

Source: SEARs for application number SSD 15_7348, November 2015

The SEARs require that the assessment be performed in accordance with relevant policies, guidelines and plans including:

- Protection of Environment Operations (Clean Air) Regulation (2010);
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005); and
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC 2006).

The development application for the Development site seeks consent for:

- A concept proposal for the warehouse and distribution estate comprised of 22 buildings, including a development master plan, development controls, landscape concept plan and biodiversity offsets; and
- Stage 1 development application including:
  - Staged bulk earthworks across the whole site;
  - Staged trunk infrastructure for the site;
  - Staged subdivision;
  - Landscaping and public domain works; and
  - Development comprising the construction and operation of three warehouse and distribution facilities in Precinct 1.

1.2 Outline of Assessment

The NSW Office of Environment and Heritage (OEH) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (DEC 2005) (hereafter the Approved Methods) outlines the requirements for conducting an AQIA, as follows (with identification of where each requirement has been met in this report):

- Description of local topographic features and sensitive receptor locations (**Section 2.3** and **Section 2.6** respectively).
- Establishment of air quality assessment criteria (**Section 3**).
- Description of existing air quality environment (**Section 4**).
- Analysis of climate and dispersion meteorology for the region (**Sections 6**).
- Compilation of a comprehensive emissions inventory for proposed operations (**Section 7**).
- Preparation of an air quality impact assessment report comprising the above.

Potential emissions to air from the proposed construction and operation of the Development site have been identified, and where appropriate emission rates have been estimated using relevant emission factors published in the literature. These emission rates have then been used in an air dispersion modelling study to assess the potential for any off-site air quality impacts in the surrounding area.

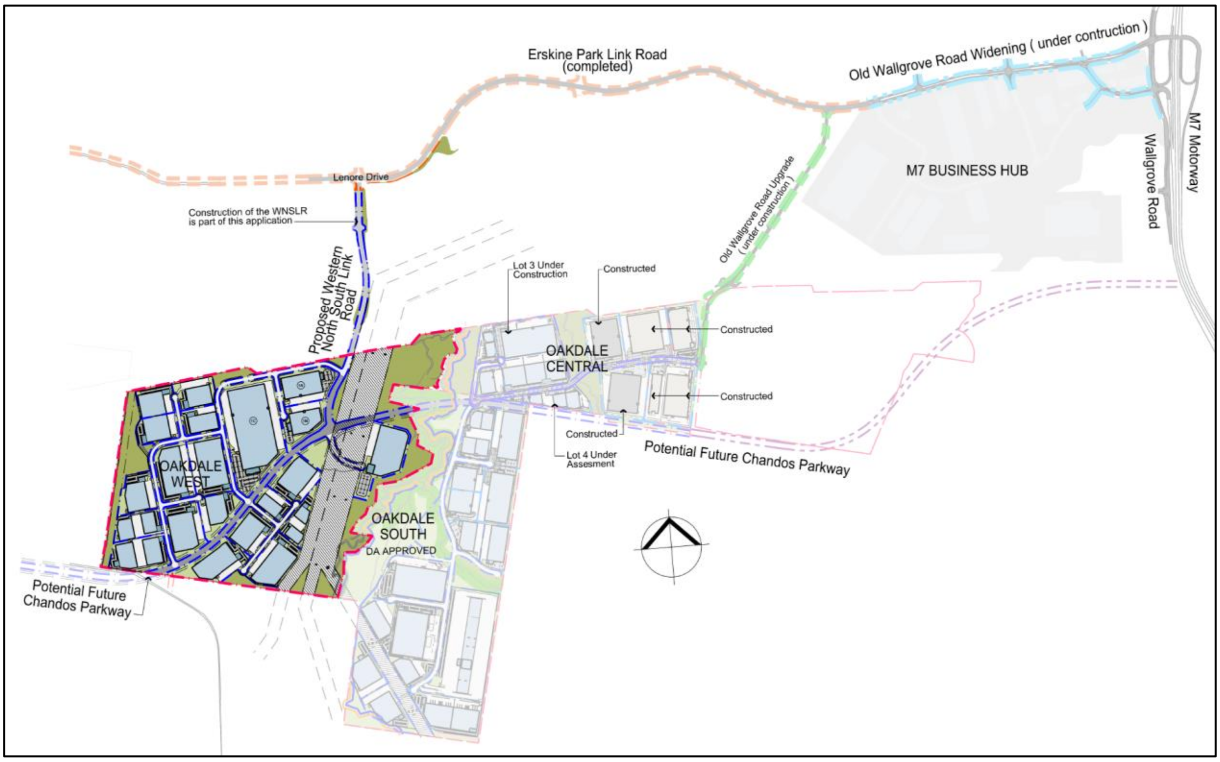
2 PROJECT OVERVIEW

2.1 Regional Setting

This report has been prepared to support an EIS and relates to the staged development of a warehouse and distribution estate comprising 22 buildings. The site is legally described as Lot 11 in DP 1178389.

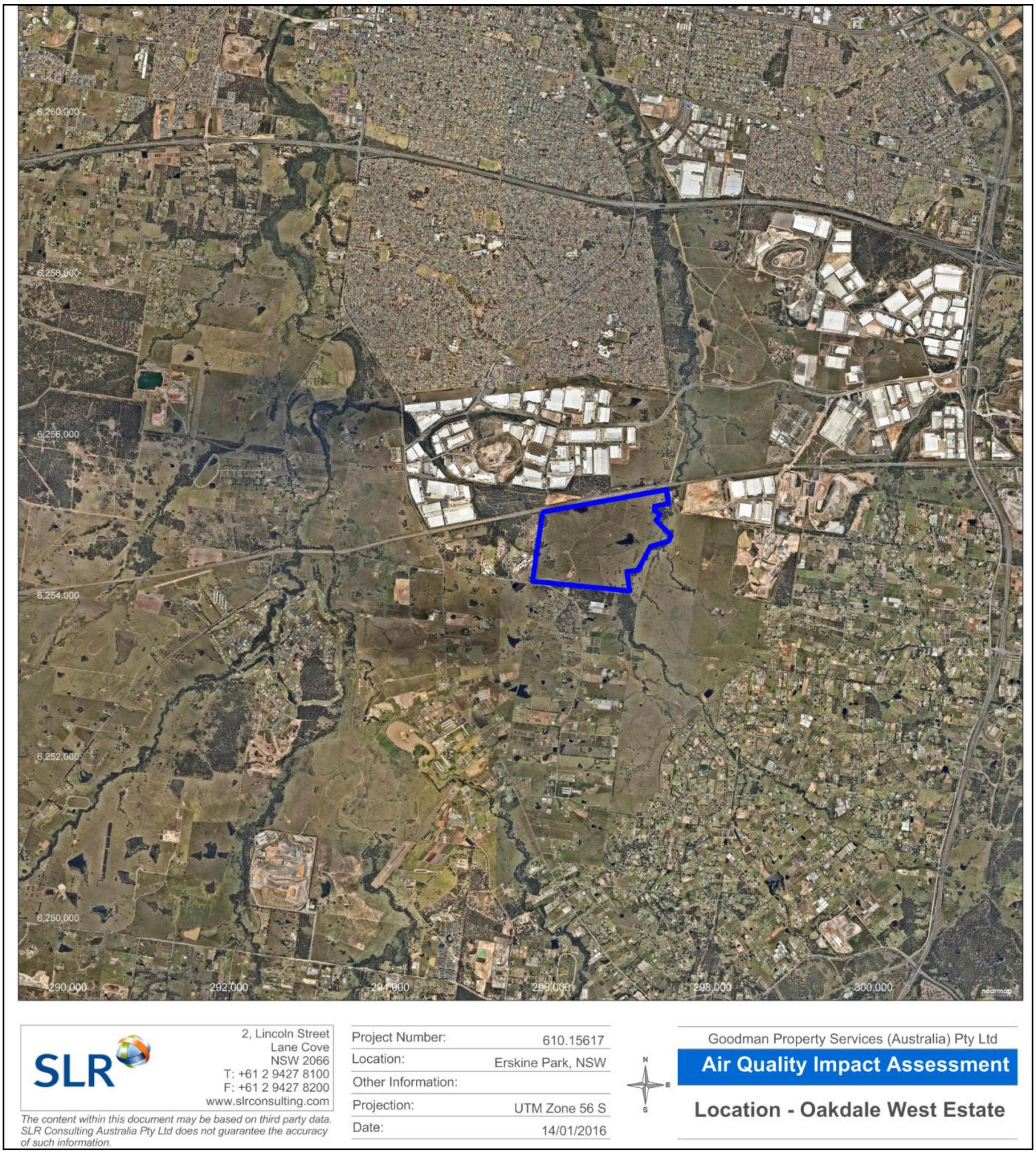
The Development site is surrounded by rural activities (grazing, market gardens etc) and rural residential houses to the south and west, industrial zone at Erskine Park to the north, and the Oakdale Central and Oakdale South Estates to the east. The main entrance to the Development Site is proposed to be via the future western north-south link road off Lenore drive. The site could also be accessed via the Old Wallgrove road through Oakdale Central Estate. The regional setting of the Development site is shown in **Figure 1** and **Figure 2**.

Figure 1 Regional Setting of the Oakdale West Estate



Source: SBA Architects, Cover Sheet/Location Plan; OAK MP 01 (K), 25 January 2017.

Figure 2 Regional Location of the Development Site – Oakdale West Estate

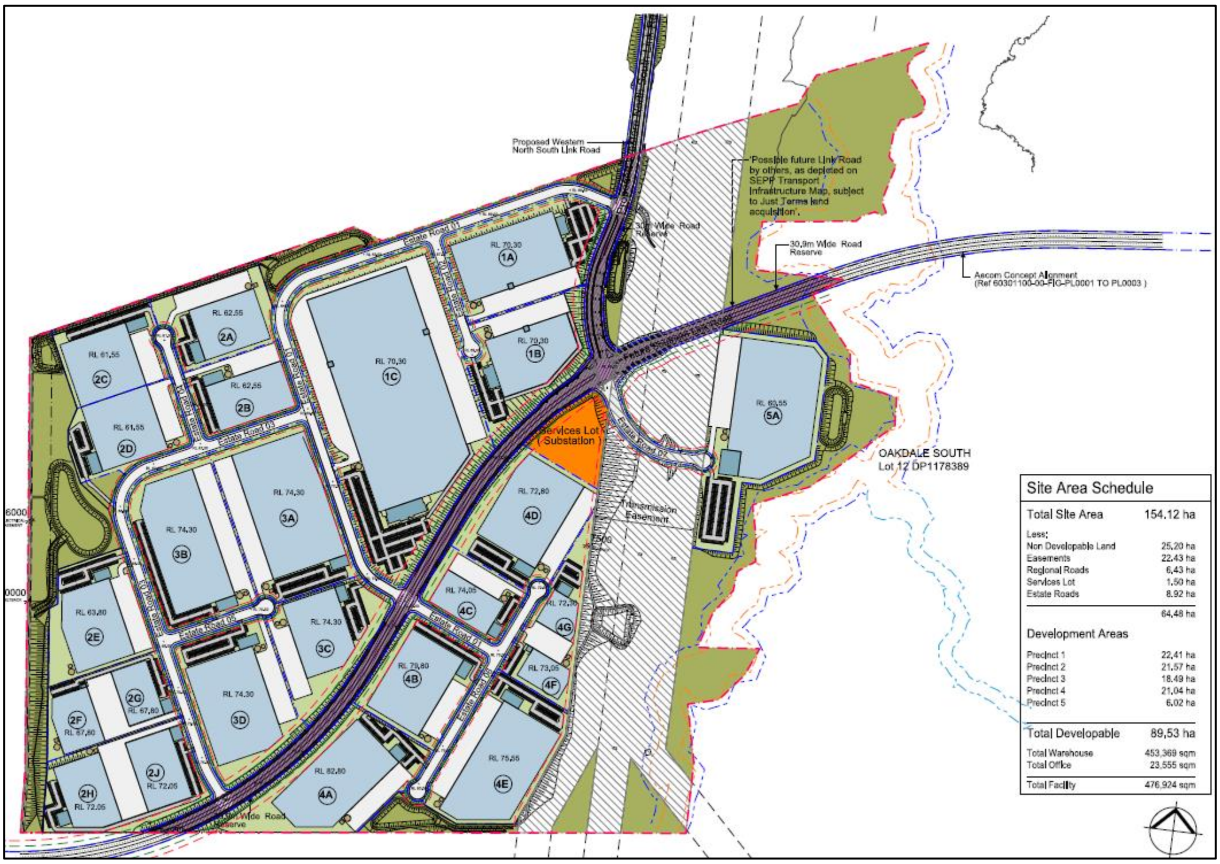


Source: 15117_OAK MP 01a_Cover Sheet; boundary of Oakdale West Estate shown in 'blue' colour

2.2 Local Setting

The development application is seeking to develop warehouse distribution centres within five precincts. A brief description of each precinct within the Development site is shown in **Figure 3** and outlined in **Table 2**.

Figure 3 Detailed Development Site Plan - Oakdale West Estate



Source: SBA Architects, SSDA Estate Masterplan – OAK MP 02 (X), 25 January 2017

Table 2 Oakdale West Estate – Precinct Development Description

Description	Area
Non developable land	25.20 ha
Easements	22.43 ha
Regional roads	6.43 ha
Services lot	1.50 ha
Estate roads	8.92 ha
Development areas	89.53 ha
Precinct 1	22.41 ha
Precinct 2	21.57 ha
Precinct 3	18.49 ha
Precinct 4	21.04 ha
Precinct 5	6.02 ha
Total Site Area	**154.12 ha**

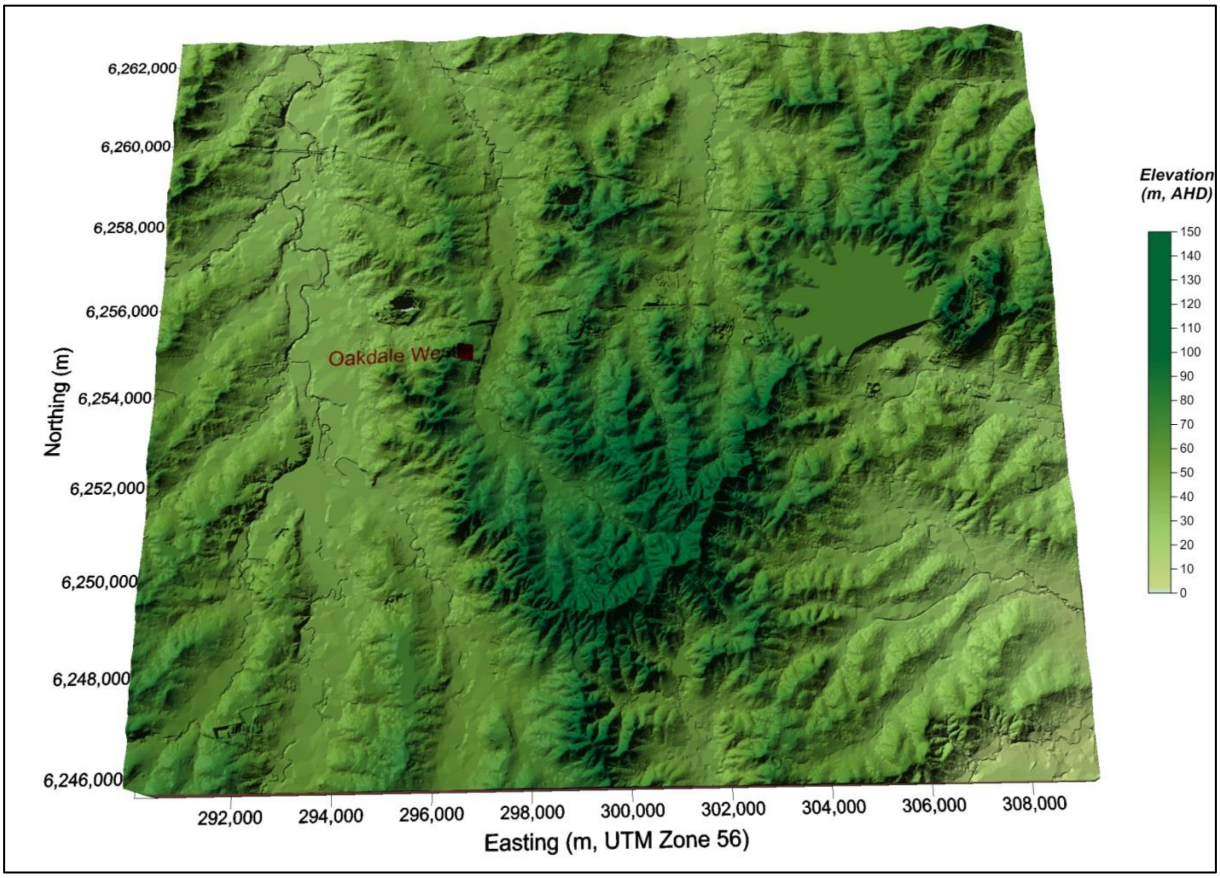
Source: SBA Architects, SSDA Estate Masterplan – OAK MP 02 (X), 25 January 2017

2.3 Local Topography

The topographical data used in this air quality impact assessment was sourced from the United States Geological Service's Shuttle Radar Topography Mission (STRTM) database that has recorded topography across Australia with a 3 arc second (~90 metre (m)) spacing.

Figure 4 illustrates the topography of the region surrounding the Development Site based on the SRTM data. The ground elevation ranges from approximately 5 – 100 m within 500 m of the site.

Figure 4 Topography Surrounding the Development Site



2.4 Proposed Development Activities

2.4.1 Construction Phase

The construction activities will include construction of buildings and associated infrastructure, such as sedimentation basins and estate roads across the entire Development site.

Specifically, this includes:

- Staged bulk earthworks across the whole site;
- Staged trunk infrastructure for the site;
- Staged subdivision;
- Landscaping and public domain works; and
- Construction of three warehouse and distribution facilities in Precinct 1.

2.4.2 Operational Activities

Operational activities that are anticipated to occur on the proposed Development site are receipt, storage and dispatch of products as part of the distribution centres' bulk warehousing and distribution services. These activities will involve:

- Unloading and loading of goods via trucks and shipping containers;
- Management of inventory in a racked and stacked environment;
- Order fulfilment including picking and packing of finished orders for customers;
- Loading of transport vehicles;
- Management of product returns;
- Inspection of goods for quality assurance purposes; and
- Product embellishment.

According to the RMS Guide to Traffic Generating Developments (RTA 2002), it is generally accepted that the AM and PM peaks would jointly represent about 20% (i.e. 10% each in the morning and evening peak) of the daily traffic generation with the remainder of the traffic volume averaged across a 22 hour period (if 24 hour operation).

From the advice provided by the proponent, it is assumed that heavy vehicle movements will represent approximately 10% of the total vehicle movements. This is consistent with the assessments prepared for other industrial estates within the Oakdale Industrial Estate (i.e. Oakdale Central and Oakdale South). The estimated activity data for the proposed operational phase are presented in **Table 3**.

Table 3 Operational Data - Oakdale West Estate

Variable	Data
Proposed hours of operation	24 hours/day, 7 days a week
Anticipated number of vehicle movements per day	14,000 vehicles per day (vpd)
Peak hourly traffic frequency	1,400 vph
Proportion of heavy vehicles in total vehicles	10%
Maximum on-site travel distances	3.75 km (based on estimated maximum distance travelled by vehicle in one trip)

Source: pers comm Andrew Johnson 14 January 2016

2.5 Identification of Atmospheric Pollutants

2.5.1 Construction

The main emissions to air during the construction phase will be emissions of particulate matter (dust), from clearing, excavation and material handling activities. Dust from the construction activities will be controlled using the best management practices outlined in **Section 1.1.1**.

2.5.2 Operations

During the operational phase, wheel-generated dust from vehicles travelling on sealed roads within the Development site and exhaust emissions from heavy vehicles travelling to, from and idling at the site are likely to be the main sources of emissions.

On this basis, the key pollutants for the operational phase have been identified as follows:

- particulate emissions (TSP, PM_{10} and $PM_{2.5}$) resulting from traffic movements on paved roads; and
- road traffic exhaust emissions, namely oxides of nitrogen (NO_X), carbon monoxide (CO), particulate matter (as TSP and PM_{10}), sulphur dioxide (SO_2), volatile organic compounds (VOCs) and lead (Pb).

There is also potential for odour to be emitted during the operational phase from the sewer systems within the Development site. However it has been notified the proponent that the sewer systems will be underground therefore it is considered to assume that the operations of the Development Site will not contribute any odour.

2.6 Sensitive Receptors

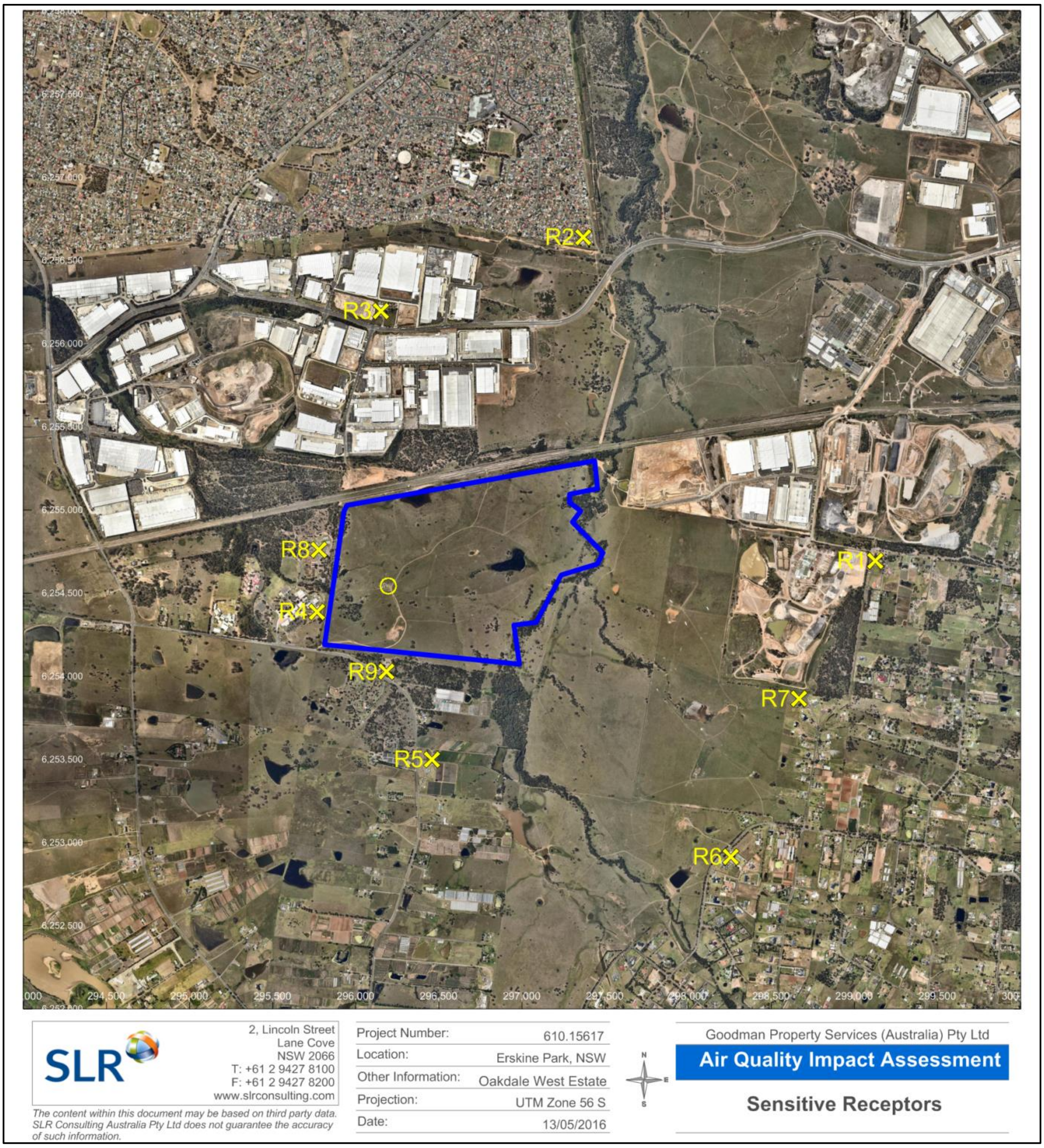
The closest residential areas are approximately 50 m to the west and south of the Development Site boundary. Surrounding sensitive receptors identified for this assessment are listed in **Table 4** and presented in **Figure 5**.

Table 4 List of Identified Sensitive Receptors

Receptor ID	Easting (km)	Northing (km)	Description
R1	299.124	6,254.696	315-321 Burley Road (Residential)
R2	297.367	6,256.640	Cetus Place (Residential)
R3	296.149	6,256.196	Ore Lane (Industrial)
R4	295.765	6,254.388	Emmaus Catholic College (Educational)
R5	296.458	6,253.501	Aldington Road (Agricultural - Farm)
R6	298.256	6,252.915	Capitol Hill Drive (Residential)
R7	298.665	6,253.864	41-43 Greenway Place (Residential)
R8	295.776	6,254.761	Emmaus Village
R9	296.183	6,254.027	Aldington Road (Residential)

It is noted that an existing residence has been identified within the boundary of the Development site, shown in **Figure 5** by 'O'. The proponent has advised that as part of the Oakdale West Project this residence will be demolished.

Figure 5 Locations of Identified Sensitive Receptors



Note: ‘O’ denotes an existing residential shed which will be demolished as part of the Oakdale West Project.

3 ADOPTED STANDARDS AND GUIDELINES

State air quality guidelines adopted by the NSW EPA are published in the Approved Methods.

The guidance provided in the Approved Methods has been consulted during the preparation of this assessment report. The Approved Methods lists the statutory methods that are to be used to assess the emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Project. The criteria listed in the Approved Methods are derived from a range of sources (including National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], World Health Organisation [WHO]). The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

3.1 Suspended Particulate Matter (as TSP, PM_{10} and $PM_{2.5}$)

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms “dust” and “particulates” are often used interchangeably. The term “ suspended particulate matter” refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP). The annual goal for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air ($\mu g/m^3$) (NHMRC, 1996).

The TSP goal was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

Emissions of particulate matter less than 10 µm and 2.5 µm in diameter (referred to as PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW EPA PM_{10} assessment goals set out in the Approved Methods are as follows:

- a 24-hour maximum of 50 $\mu g/m^3$; and
- an annual average of 30 $\mu g/m^3$.

The Approved Methods do not set any assessment goals for $PM_{2.5}$. In December 2000, the National Environment Protection Council (NEPC) initiated a review to determine whether a national ambient air quality criterion for $PM_{2.5}$ was required in Australia, and the feasibility of developing such a criterion. The review found that:

- there are health effects associated with these fine particles;
- the health effects observed overseas are supported by Australian studies; and
- fine particle standards have been set in Canada and the USA, and an interim criterion is proposed for New Zealand.

The review concluded that there was sufficient community concern regarding $PM_{2.5}$ to consider it an entity separate from PM_{10}. As such, in July 2003, a variation to the Ambient Air Quality NEPM was made to extend its coverage to $PM_{2.5}$, setting the following Interim Advisory Reporting Standards for $PM_{2.5}$ (NEPC, 2003):

- a 24-hour average concentration of 25 $\mu g/m^3$; and
- an annual average concentration of 8 $\mu g/m^3$.

It is noted that the NEPM Advisory Reporting Standards relating to $PM_{2.5}$ particles are reporting guidelines only at the present time and not intended to represent air quality criteria. A summary of the particulate guidelines is shown in **Table 5**.

Table 5 EPA Goals for Particulates

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m^3
PM_{10}	24 Hours Annual	50 µg/m^3 30 µg/m^3
$PM_{2.5}$	24 Hours Annual	25 µg/m^3 (interim advisory reporting standard only) 8 µg/m^3 (interim advisory reporting standard only)

Source: (NSW DEC, 2005), (NEPC, 2003)

3.1.1 Potential Changes to the Ambient Air Quality NEPM

On 29 April 2014, Environment Ministers signalled their intent to vary the Ambient Air Quality NEPM based on the latest scientific understanding of the health risks resulting from airborne particulate pollution. The variation to the Ambient Air Quality NEPM was the subject of consultation with the wider affected community until 10 October 2014 with the standards presented in **Table 6** have been proposed as a potential 'preferred option' (NEPC, 2014).

Table 6 Proposed Variation to the Ambient Air Quality NEPM

Metric	Averaging Period	Current Standard	Options for Standard	Allowed Exceedances
PM_{10}	Annual average	None	No standards with consideration of 20 µg/m^3	N/A
	24-hour mean	50 µg/m^3	50 µg/m^3, with consideration of 45 µg/m^3 and 40 µg/m^3	See note below
$PM_{2.5}$	Annual average	8 µg/m^3 (advisory)	8 µg/m^3	N/A
	24-hour mean	25 µg/m^3 (advisory)	25 µg/m^3	See note below

Source: (NEPC, 2014)

The four options for the form of the 24-hour standards and specifically the treatment of exceedances, for both PM_{10} and $PM_{2.5}$ are as follows:

- Business as usual option; a rule that allows a fixed number of exceedances of a PM standard in a given year, with no exclusion of data for exceptional events.
- A rule that allows a fixed number of exceedances of a PM standard in a given year, but with exclusion of data for exceptional events.
- A rule in which the 98th percentile PM concentration in a given year is compared with a standard, with no exclusion of data for exceptional events.
- A rule in which the 98th percentile PM concentration in a given year is compared with a standard, but with exclusion of data for exceptional events.

It has been identified by the NEPC that it is likely that jurisdictions will want to identify local issues that affect the form of the standards and therefore the options for this standard were left open for the consultation phase, which closed in October 2014.

3.2 Deposited Dust

The preceding section is concerned in large part with the health impacts of airborne particulate matter. Nuisance impacts need also to be considered, mainly in relation to deposited dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 grams per square metre per month (g/m^2/month).

Table 7 presents the impact assessment goals set out in the Approved Methods for dust deposition, showing the allowable increase in dust deposition level over the ambient (background) level to avoid dust nuisance.

Table 7 EPA Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2 g/m^2/month	4 g/m^2/month

Source: (NSW DEC, 2005)

3.3 Combustion-Related Pollutants

Emissions associated with road traffic and the combustion of automotive fuel (diesel, petrol, etc.) will include oxides of nitrogen (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2), volatile organic compounds (VOCs), lead (Pb) and particulates (TSP,PM_{10} and $PM_{2.5}$).

Oxides of Nitrogen (NO_X): Oxides of nitrogen (NO_X) is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry, NO_X generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2). NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. NO will be converted to NO_2 after leaving a vehicle exhaust in the presence of sunlight at a rate dependent on background ozone and VOC levels .

Carbon Monoxide (CO): CO is an odourless, colourless gas formed from the incomplete burning of fuels in motor vehicles. It can be a common pollutant at the roadside and highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road. CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow. The incomplete combustion of fuel in diesel powered vehicles can generate particulate in the form of black soot.

Sulphur Dioxide (SO_2): Vehicle exhausts can contain emissions of sulphur dioxide (SO_2) due to impurities in the fuel. It is noted that most of the vehicles in operation at the Oakdale West precinct are likely to be industrial vehicles (ie diesel-fuelled vehicles). The sulphur content in diesel fuel in Australia has significantly reduced over the years as shown in **Table 8**.

Table 8 The Environmental and Operability Standard in Australia – Diesel Fuel Quality Standard

Pollutant	National Standard	Date of Effect	Test Method
Sulphur Content of Fuel	10 ppm (max)	1 January 2009	ASTM D5453
	50 ppm (max)	1 January 2006	
	500 ppm (max)	31 December 2002	

Source: http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards/diesel, accessed on 19 June 2015.

Volatile Organic Compounds (VOCs): Volatile organic compounds (VOC) are emitted from the incomplete combustion of fuel. VOC emissions are reducing significantly due to the improved combustion processes offered by modern engines. The Approved Methods prescribe the air quality criterion for individual VOCs such as benzene, 1,3-butadiene etc. Generally for VOCs, the most stringent criteria of the individual VOCs (i.e. benzene) is used to assess the air quality exceedances of traffic-related VOCs.

Lead (Pb): On 15 March 2000, the Australian Government announced a phase-out of leaded petrol in Australia under the National Fuel Quality Standards Act 2000. On 1 January 2002, that phase-out was completed. The sale of leaded petrol in Australia is now prohibited, except in cases specifically authorised by the Minister.

Experience in performing assessments of the impact of combustion-related emissions has shown that the principal ‘indicator’ pollutants from fuel combustion are NO_2 and PM_{10} (and to a lesser extent CO) and the risk of non-compliance with the relevant criteria is typically associated with the short-term criteria rather than annual averages.

The NSW OEH has established ground level air quality impact assessment criteria for air pollutants to achieve appropriate environmental outcomes and to minimise associated risks to human health as published in the Approved Methods. A summary of the relevant impact assessment criteria for the pollutants discussed above is provided in **Table 9**.

Table 9 EPA Goals for Combustion-Related Pollutants

Pollutant	Averaging Period	Concentration		Source
Nitrogen dioxide (NO_2)	1 hour	12 pphm	246 µg/m^3	NEPC (1998)
	Annual	3 pphm	62 µg/m^3	NEPC (1998)
Carbon monoxide (CO)	15 minutes	87 ppm	100 mg/m^3	WHO (2000)
	1 hour	25 ppm	30 mg/m^3	WHO (2000)
	8 hours	9 ppm	10 mg/m^3	NEPC (1998)
Sulphur dioxide (SO_2)	10 minutes	25 pphm	712 µg/m^3	NHMRC (1996)
	1 hour	20 pphm	570 µg/m^3	NEPC (1998)
	24 hours	8 pphm	228 µg/m^3	NEPC (1998)
	Annual	2 pphm	60 µg/m^3	NEPC (1998)
Lead	Annual	-	0.5 µg/m^3	NEPC (1998)
Benzene	1 hour	0.009 ppm	29 µg/m^3	NEPC (1998)
TSP	Annual	90 µg/m^3		NEPC (1998)
PM_{10}	24 Hours Annual	50 µg/m^3 30 µg/m^3		NEPC (1998)
$PM_{2.5}$	24 Hours Annual	25 µg/m^3 (interim advisory reporting standard only) 8 µg/m^3 (interim advisory reporting standard only)		NEPC (1998)

3.4 Summary of Air Quality Criteria Adopted for this Assessment

The air quality criteria adopted for this assessment, which confirm to current EPA and Federal air quality criteria, are summarised in **Table 10**. All criteria are referenced as mass concentration.

The impact assessment criteria are required to be applied as follows:

- At the nearest existing or likely future off-site sensitive receptor.

- The incremental impact (predicted impacts due to the pollutant source alone) for each pollutant must be reported in units and averaging periods consistent with the impact assessment criteria.
- Background concentrations must be included using the procedures specified in Section 5 of the Approved Methods.
- Total impact (incremental impact plus background) must be reported as the 100th percentile (maximum) (or 99th percentile for odour) in concentration or deposition units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

Table 10 Summary of Air Quality Criteria – Oakdale West Project

Pollutant	Averaging Time	Goal (µg/m^3)	Source
Sulphur dioxide (SO_2)	10 minutes	712	NHMRC (1996)
	1 hour	570	NEPC (1998)
	24 hours	228	NEPC (1998)
	Annual	60	NEPC (1998)
Nitrogen dioxide (NO_2)	1 hour	246	NEPC (1998)
	Annual	62	NEPC (1998)
Lead	Annual	0.5	NEPC (1998)
Benzene	1 hour	0.009 ppm	29 µg/m^3
PM_{10}	24 hours	50	NEPC (1998)
	Annual	30	EPA (1998)
$PM_{2.5}$	24 hours	25	NEPC (2003)
	Annual	8	NEPC (2003)
TSP	Annual	90	NHMRC (1996)
		Goal (g/m^2/month)	
Deposited dust	Annual	2 (maximum increase in deposited dust level) 4 (maximum total deposited dust level)	NERDDC (1988)
		Goal (mg/m^3)	
Carbon monoxide (CO)	15 minutes	100	WHO (2000)
	1 hour	30	WHO (2000)
	8 hours	10	NEPC (1998)

Source: The Approved Methods, NSW DEC 2005, WHO 2005.

4 EXISTING AIR QUALITY

4.1 Available Air Quality Monitoring Data

Air quality monitoring is performed by the NSW OEH at four Air Quality Monitoring Stations (AQMS) within a 5 km radius of the Development Site. Details of these stations are provided in **Table 11**.

Table 11 Details of AQMS surrounding the Development Site

AQMS Name	Distance / Direction from Development Site	Location (km, Australian Map Grid, zone 56)		Parameters Measured	AQMS Commissioned
		Easting	Northing		
St Mary's Located off Mamre Rd	4.2 km / NW	293.2	6258.1	Ozone (O_3) NO, NO_2, NO_X Fine particles (by nephelometry) Fine particles (PM_{10} using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity	October 1992 -

Note: TEOM – Tapered Element Oscillating Microbalance

Available air quality monitoring data has been obtained for the closest AQMS for the years 2010 to 2014.

Table 12 Air Quality Monitoring Data – St Mary's 2010 to 2014

Pollutant	Averaging Time	Goal (µg/m^3)	St Mary's				
			2010	2011	2012	2013	2014
PM_{10}	24 hours	50	***52.1*** (***104%***)	***73.9*** (***148%***)	34.3 (69%)	***93.0*** (***186%***)	45.0 (90%)
	Annual	30	15.1 (50%)	14.7 (49%)	14.5 (48%)	15.6 (53%)	16.7 (56%)
NO_2	1 hour	246	73.8 (30%)	73.8 (30%)	88.2 (36%)	75.9 (31%)	30.8 (13%)
	Annual	62	12.3 (20%)	12.3 (20%)	10.3 (17%)	9.5 (15%)	7.9 (13%)

Note: All values are presented as µg/m^3. Values in exceedance of the stated criterion are highlighted in ***bold red***.

The 1-hour and 24-hour values shown are maximum concentrations recorded for each pollutant for the relevant averaging period in each year. Also shown is the percentage of the appropriate criterion represented by each measured value.

The data from the St Marys monitoring station has been adopted as background concertation for the cumulative assessment, as it is the closest located AQMS to the Development Site. Based on annual averages of PM_{10} and NO_2 for all five years it is appropriate to state that the air quality levels for all the years are consistent.

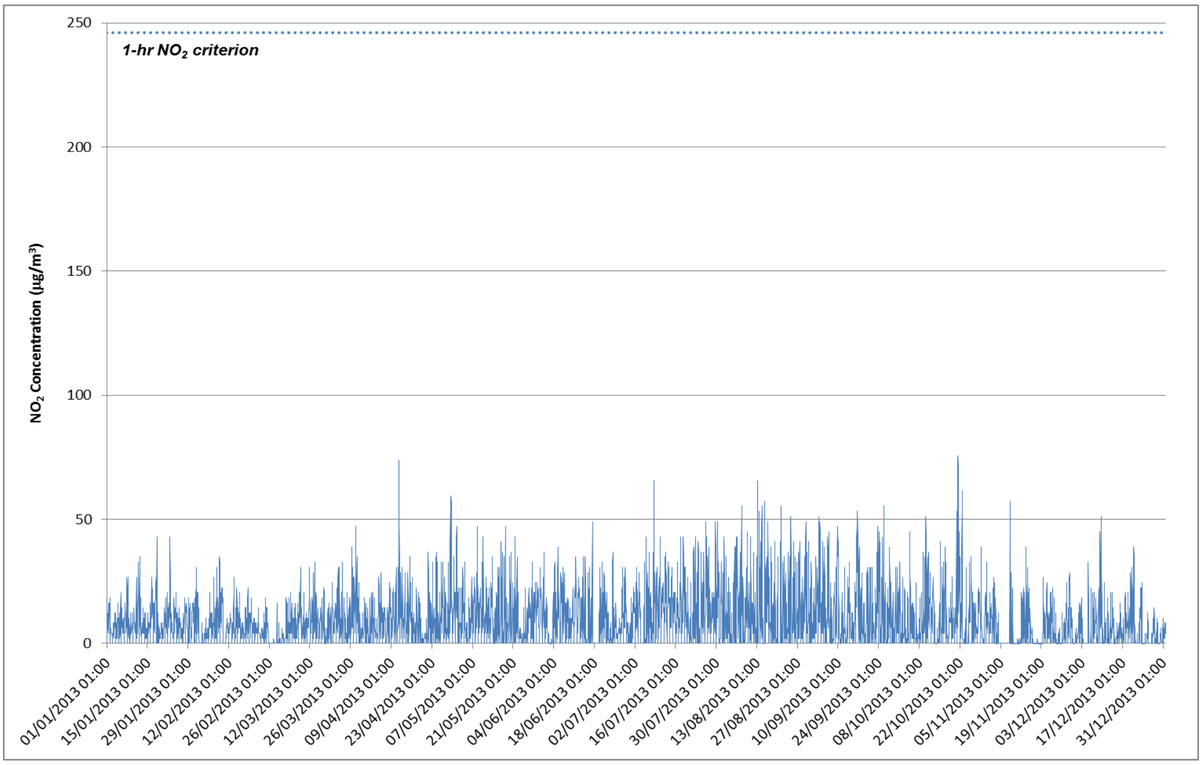
The year 2013 was adopted for the background pollutant concentration based on the same meteorological year selected for the assessment (see **Section 5.2.2**). This is consistent with the guidelines issued in the Approved Methods for contemporaneous assessment of the cumulative pollutant concentrations.

4.2 Nitrogen Dioxide (NO_2)

A summary of the concentrations of NO_2 measured by the St Mary's AQMS, which can be used as a marker species for combustion-related pollutants (NO_2, SO_2 and CO), is presented graphically in **Figure 6**.

The NO_2 monitoring data indicate that the 1-hour maximum criterion of 246 µg/m^3 is easily achieved at the St Mary's AQMS (4.2 km from the Development Site) with the maximum 1-hour NO_2 concentration measured during 2013 being 75.9 µg/m^3, representing 31% of the criterion. The annual average NO_2 concentration in 2013 was measured as 9.5 µg/m^3 which represents approximately 17% of the criterion of 62 µg/m^3.

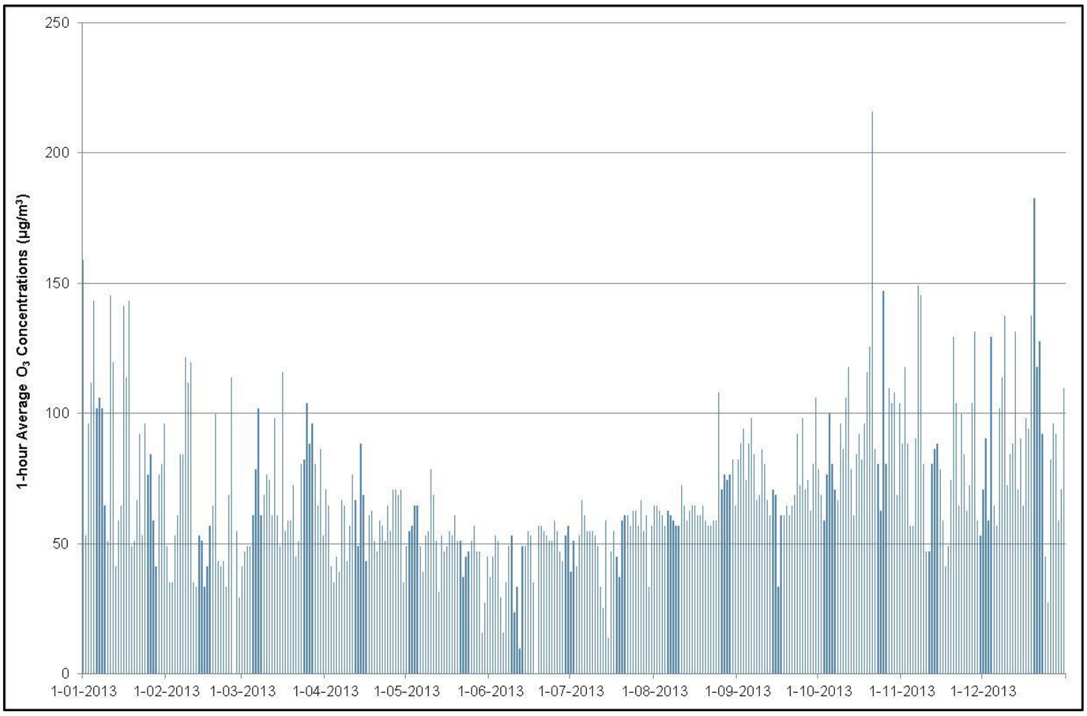
Figure 6 Measured 1 hour Average NO_2 Concentrations (St Marys AQMS, 2013)



4.3 Ozone (O_3)

For this assessment, the predicted NO_2 concentrations are calculated using the Ozone Limiting Method (OLM). This is in agreement with Method 2 for NO_2 assessment (Section 8.1.2) prescribed in the Approved Methods. The ozone measurements for the year 2013 recorded at St Marys AQMS is shown in **Figure 7**.

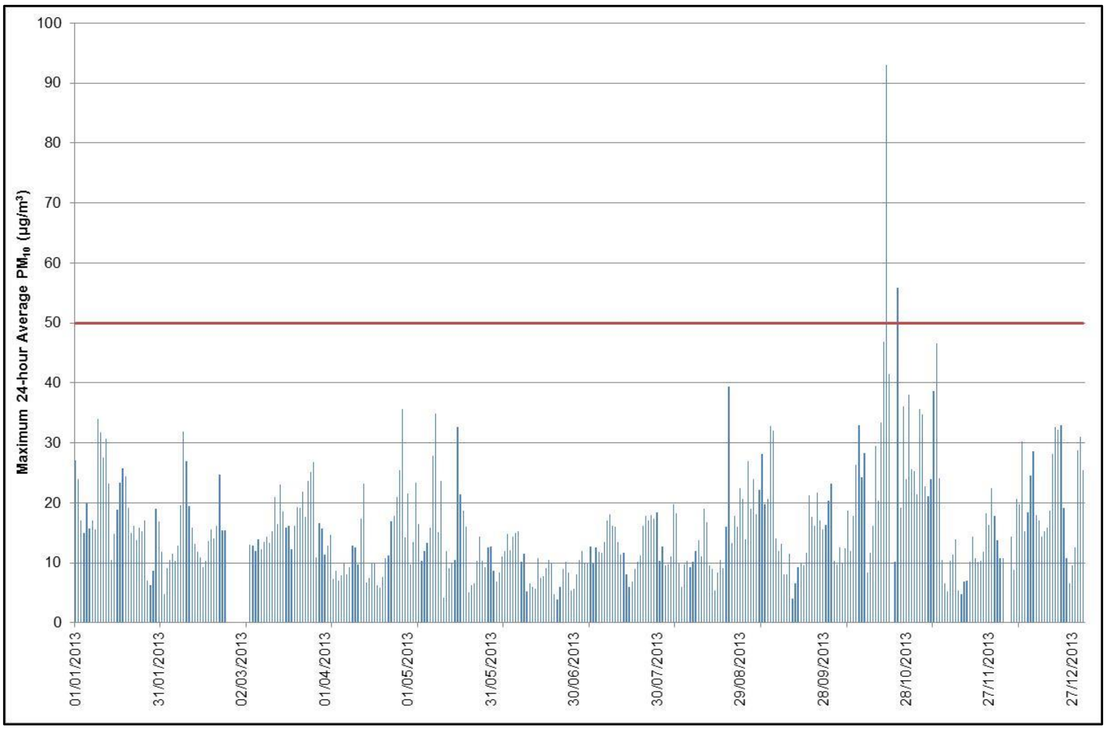
Figure 7 Measured 1-hour Average O_3 Concentrations (St Mary's AQMS - 2013)



4.4 Suspended Particulate (TSP, PM_{10} and $PM_{2.5}$)

A summary of the PM_{10} concentrations measured by the St Mary's AQMS, is presented graphically in **Figure 8**. It is noted that TSP and $PM_{2.5}$ concentrations are not monitored in the region.

Figure 8 Measured 24 hour Average PM_{10} Concentrations (St Mary's AQMS - 2013)



PM_{10} as measured at St Mary's,
See Table 13 for sources of the pollutant 'spikes'.

The monitoring data for PM_{10} indicate that exceedances of the short term (24-hour average) criteria for PM_{10} were experienced during 2013 at the St Mary's AQMS. The most significant exceedances for PM_{10} were observed during October 2013. A review of the NEPM compliance report for 2013 shows that these exceedances were attributable to the NSW bushfire emergency which extended into early November 2013 (refer to **Table 13**). A hazard reduction burn was identified as the cause of an exceedance recorded in August.

Table 13 Highest Ten PM_{10} and $PM_{2.5}$ Concentrations

Statistic	PM_{10} (µg/m^3)	Date	Comments from NEPM Compliance Report [1]
Maximum	93.0	21 October	Bushfire Emergency
2nd Highest	55.8	25 October	
3rd Highest	46.8	20 October	
4th Highest	46.5	8 November	
5th Highest	39.8	22 October	
6th Highest	39.3	25 August	Hazard Reduction Burn
7th Highest	38.6	7 November	N/A[2]
8th Highest	38.0	29 October	Bushfire Emergency
9th Highest	36.1	27 October	Bushfire Emergency
10th Highest	35.7	29 April	N/A[2]

1 Comments associated with nearby stations (St Mary's is not a NEPM Compliance AQMS)
2 No event can be clearly identified as causing the exceedance / elevated concentration

No data is available to characterise the existing air quality environment as it relates to TSP or $PM_{2.5}$. The annual average background TSP concentration has therefore been estimated using the annual average PM_{10} concentration (15.2 µg/m^3 with bushfire days removed) recorded at St Mary's in 2013, by applying a scaling factor. Identification of an appropriate scaling factor is challenging given the wide range of particulate sources in the local area (road traffic, waste management, industrial sources). A factor of 2 has been applied to the annual average PM_{10} concentration, which is considered to be a conservative estimate in the absence of site-specific TSP data.

$PM_{2.5}$ data are not measured at the St. Marys AQMS, therefore the modelling results for these indicators have been presented as incremental impacts only and a qualitative cumulative impact assessment has been included in this report.

4.5 Deposited Dust

No site-specific baseline dust deposition monitoring has been performed for the Oakdale West Estate. Dust deposition monitoring has been performed since 2010 for the adjacent Oakdale Central Project and data from this monitoring program has been reviewed to provide information on existing background dust deposition levels in the area and the impacts that may be anticipated during construction of the Oakdale West Project.

Gravimetric dust deposition monitoring using dust deposition gauges (DDGs) has been performed for the Oakdale Central Project at the following locations:

- "Northwest" DDG at the centre of the northern section of the Development site adjacent to the water pipe boundary.
- "Northeast" DDG at the north-eastern corner of the Development site adjacent to Old Wallgrove Road.
- "Southwest" DDG at the centre of the southern section of the Development site on the eastern side of the creek entrance.

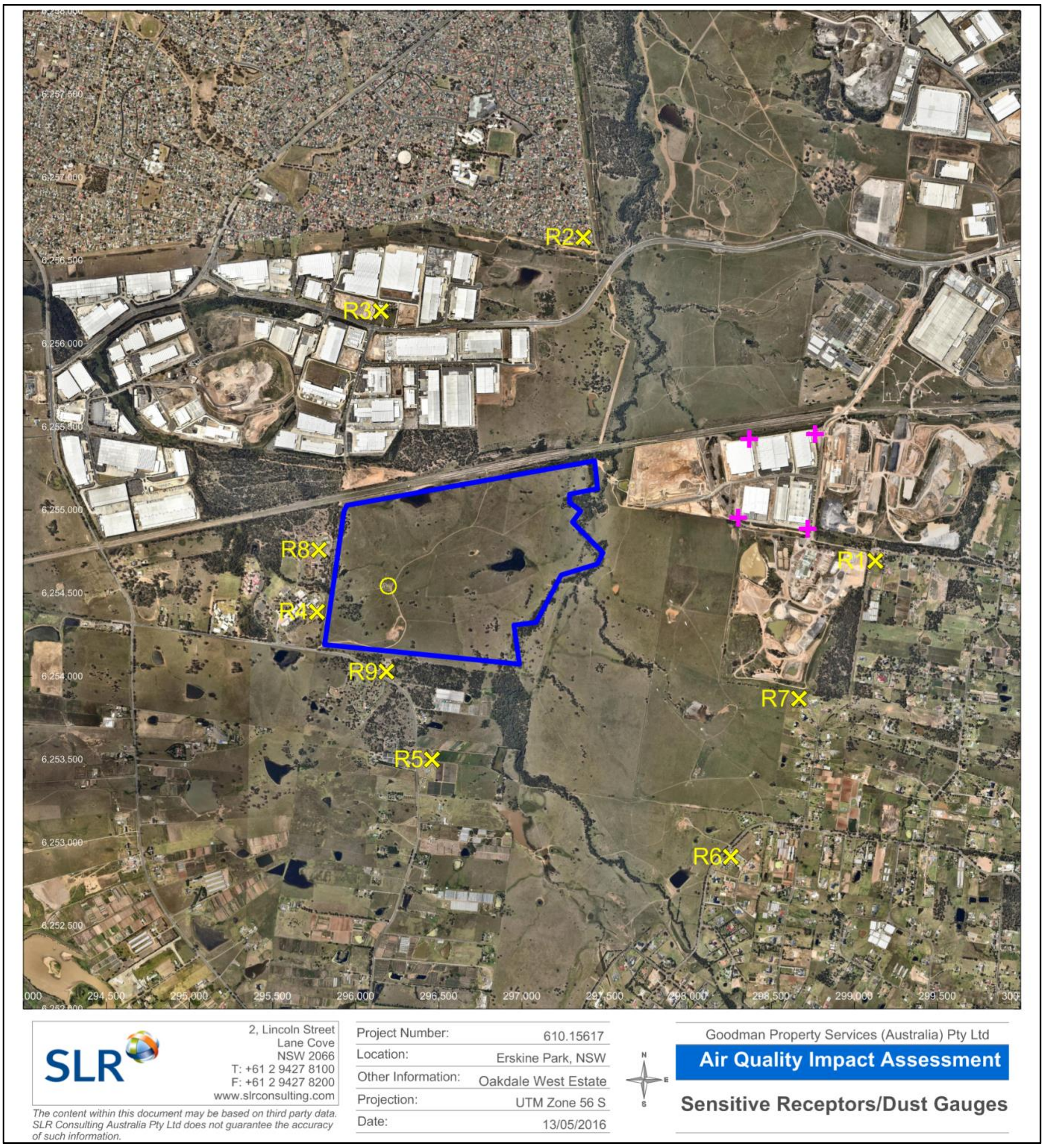
- "Southeast" DDG in the south-eastern corner of the Development site at the junction of Old Wallgrove Road.

Figure 9 illustrates the locations of the DDGs relative to the Oakdale West development site boundary (shown in blue).

The dust deposition monitoring results for the period 4 May 2010 to 6 November 2013 are shown in **Figure 10**. Dust sampling was performed in accordance with Australian Standard, AS 3580.10.1:2003, covering both construction and operational periods of the Oakdale Central Project as follows:

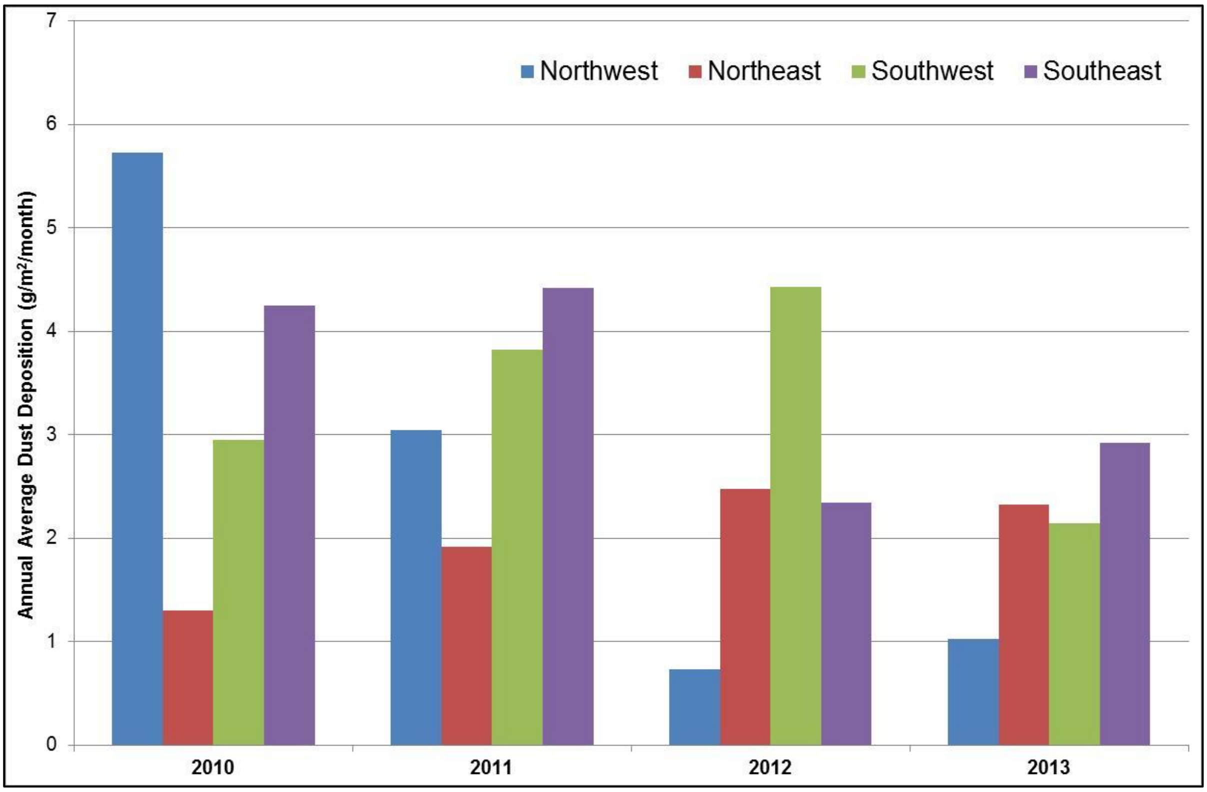
- No Oakdale Central Precinct (May 2010 - January 2013)
- Construction of Oakdale Central Precinct (January 2013 - current)
- Operation of Oakdale Central Precinct (January 2014 - current)

Figure 9 Dust Deposition Gauge Locations – Oakdale Central Monitoring Program



Note: Dust gauge locations showed using pink cross sign.

Figure 10 Deposited Dust Monitoring (4 May 2010 to 6 November 2013)



Note:
2010 refers to a period of 04/05/2010 to 7/01/2011 (8 data points)
2011 refers to a period of 7/01/2011 to 11/01/2012 (12 data points)
2012 refers to a period of 11/01/2012 to 15/01/2013 (12 data points)
2013 refers to a period of 15/01/2013 to 6/11/2013 (10 data points)

It is noted that generally, the annual average dust deposition has been decreasing over the years, even with the construction the Oakdale Central Precinct occurring since January 2013. The annual average dust deposition measured during 2013 was 2.1 g/m^2/month. This is well below the criterion of 4 g/m^2/month and indicates that the Oakdale Central Project construction activities have been effectively managed to prevent nuisance dust impacts.

Given the above, and noting that there were no complaints recorded in regards to dust nuisance impacts during the Oakdale Central Project construction phase, the dust emissions from construction of the Oakdale West Project are also expected to be able to be controlled so that off-site dust nuisance impacts do not occur. A risk-based assessment of the construction phase dust emissions is presented in **Section 8.1**.

4.6 Summary of Background Air Quality Data Assumed for Use in this Assessment

Table 14 provides a summary of the assumed background concentrations used in this report to evaluate the cumulative impacts due to the proposed operations of the Development Site.

Table 14 Adopted Background Pollutant Concentrations

Pollutant	Averaging Period	Assumed Background Concentration	Source
TSP	Annual	30.4 µg/m^3	Estimated from the annual average PM_{10} concentration using a factor of 2
PM_{10}	24 hours	Daily varying	St Mary's AQMS
	Annual	15.2 µg/m^3	St Mary's AQMS (without the bushfire days)
$PM_{2.5}$	24 hours	NA	N/A
	Annual	NA	N/A
NO_2	1-hour	75.9 µg/m^3	St Mary's AQMS
	Annual	9.5 µg/m^3	St Mary's AQMS

Note: [1] The dust concentration was monitored from 4 May 2010 to 6 November 2013.

5 IMPACT ASSESSMENT METHODOLOGY

5.1 Construction Phase

For this assessment, the *IAQM Guidance on the Assessment of Dust from Demolition and Construction (IAQM 2014)* developed in the United Kingdom by the Institute of Air Quality Management (IAQM) has been used to provide a qualitative assessment of fugitive dust emissions during the construction phase.

This methodology is further discussed in detail in **Section 5.1**.

5.2 Operational Phase

Emissions from the proposed operations at the Development Site identified as having the potential to impact upon the nearby residences have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system as described below.

5.2.1 Dispersion Modelling

For this assessment, dispersion modelling was conducted using the US EPA's CALPUFF (Version 6) modelling system, as recommended by the NSW EPA. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way.

CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further in **Section 5.2.2**. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period.

The primary output files from CALPUFF contain hourly concentrations or deposition values evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

5.2.2 Meteorological Modelling

Meteorological mechanisms govern the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading.

Pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Oke 1998).

To adequately characterise the dispersion meteorology of the study site, information is needed on the prevailing wind regime, mixing height and atmospheric stability and other parameters such as ambient temperature, rainfall and relative humidity.

Meteorological data collected over the period 2009-2013 at the nearest BOM station (Horsley Park [station number 67119]) were analysed to select a representative year for dispersion modelling. The analysis showed that data collected during the 2013 calendar year are in reasonably good agreement with long term averages compared to other years and was therefore selected for use in this assessment.

5.2.2.1 TAPM

In order to calculate all required meteorological parameters required by the dispersion modelling process, meteorological modelling using The Air Pollution Model (TAPM, v 4.0.4) has been performed. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain water and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

TAPM model may assimilate actual local wind observations so that they can optionally be included in a model solution. However, given that TAPM is known to under-predict calm wind conditions, the wind speed and direction observations obtained from the nearest BoM stations have also been used in the subsequent CALMET component of the modelling as described in **Table 15**. Observational meteorological data from the Horsley Park Equestrian Centre meteorological station, in conjunction with the cloud cover data from Bankstown Airport BOM station (Station # 66137), were used to generate a 1-year, hourly, site-representative meteorological file suitable for use in the CALPUFF model.

Table 15 Meteorological Parameters used for this Study (TAPM v 4.0.4)

Modelling Period	1 January 2013 to 31 December 2013
Centre of analysis	295,309 mE 6,255,681 mN (UTM Coordinates)
Number of grid points	40 × 40 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Data assimilation	Penrith Lakes AWS (Station # 67113) Badgery's Creek AWS (Station # 67108) Horsley Park Equestrian Centre AWS (Station # 67119) St Marys Air Quality Monitoring Station (St Marys AQMS)
Terrain	AUSLIG 9 second DEM

The three dimensional upper air data from TAPM output was used as input for the diagnostic meteorological model (CALMET).

5.2.2.2 CALMET

In the simplest terms, CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects the influences of local topography and current land uses.

CALMET modelling was conducted using the 'with Obs' CALMET approach. TAPM generated upper air data and available surface weather observations in the area were used to refine the wind field predetermined by TAPM data. Hourly surface meteorological data from the nearest BoM stations were incorporated in the CALMET modelling.

A horizontal grid spacing of 100 m was used to adequately represent the important local terrain features and land use. **Table 16** details the parameters used in the meteorological modelling.

Table 16 CALMET Configuration Used for this Study

Modelling Period	1 January 2013 to 31 December 2013
Centre of analysis	295,309 mE 6,255,681 mN (UTM Coordinates)
Meteorological grid domain (Meteorological grid resolution)	38 km x 38 km (1 km) 15 km x 15 km (0.3 km) 12 km x 12 km (0.1 km)
Vertical Resolution (Cell Heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1200 m, 2000 m, 3000 m, 4000 m)
Data Assimilation	Penrith Lakes AWS (Station # 67113) Badgery's Creek AWS (Station # 67108) Horsley Park Equestrian Centre AWS (Station # 67119) Bankstown Airport AWS (Station # 66137)* Holsworthy Aerodrome AWS (Station # 66161)* St Marys Air Quality Monitoring Station (St Marys AQMS) TAPM - upper air data (313,309 mE; 6,273,681 mN)

Note: *Holsworthy Aerodrome AWS and Bankstown Airport AWS were included to utilise cloud cover data

5.2.3 Accuracy of Modelling

Atmospheric dispersion models such as CALPUFF, Ausplume, AERMOD and even specialist models like DEGADIS, CALINE4 and SLAB all represent a simplification of the many complex processes involved in the dispersion of pollutants in the atmosphere. To obtain good quality results it is important that the most appropriate model is used and the quality of the input data (meteorological, terrain, source characteristics) is adequate.

The main sources of uncertainty in dispersion models, and their effects, are discussed below.

- **Oversimplification of physics:** This can lead to both under-prediction and over-prediction of ground level pollutant concentrations. Errors are greater in Gaussian plume models as they do not include the effects of non-steady-state meteorology (i.e., spatially- and temporally-varying meteorology).
- **Errors in emission rates:** Ground level concentrations are proportional to the pollutant emission rate. In addition, most modelling studies assume constant worst case emission levels or are based on the results of a small number of stack tests, however operations (and thus emissions) are often quite variable. Accurate measurement of emission rates and source parameters requires continuous monitoring.
- **Errors in source parameters:** Plume rise is affected by source dimensions, temperature and exit velocity. Inaccuracies in these values will contribute to errors in the predicted height of the plume centreline and thus ground level pollutant concentrations.
- **Errors in wind direction and wind speed**: Wind direction affects the direction of plume travel, while wind speed affects plume rise and dilution of plume. Errors in these parameters can result in errors in the predicted distance from the source of the plume impact, and magnitude of that impact. In addition, aloft wind directions commonly differ from surface wind directions. The preference to use rugged meteorological instruments to reduce maintenance requirements also means that light winds are often not well characterised.

- **Errors in mixing height:** If the plume elevation reaches 80% or more of the mixing height, more interaction will occur, and it becomes increasingly important to properly characterise the depth of the mixed layer as well as the strength of the upper air inversion.
- **Errors in temperature:** Ambient temperature affects plume buoyancy, so inaccuracies in the temperature data can result in potential errors in the predicted distance from the source of the plume impact, and magnitude of that impact.
- **Errors in stability estimates:** Gaussian plume models use estimates of stability class, and 3D models use explicit vertical profiles of temperature and wind (which are used directly or indirectly to estimate stability class for Gaussian models). In either case, errors in these parameters can cause either under-prediction or over-prediction of ground level concentrations. For example, if an error is made of one stability class, then the computed concentrations can be off by 50% or more.

The US EPA makes the following statement in its Modelling Guideline (US EPA, 2005) on the relative accuracy of models:

> *"Models are more reliable for estimating longer time-averaged concentrations than for estimating short-term concentrations at specific locations; and the models are reasonably reliable in estimating the magnitude of highest concentrations occurring sometime, somewhere within an area. For example, errors in highest estimated concentrations of ±10 to 40% are found to be typical, i.e., certainly well within the often quoted factor-of-two accuracy that has long been recognised for these models. However estimates of concentrations that occur at a specific time and site are poorly correlated with actually observed concentrations and are much less reliable."*

This study utilises the CALPUFF dispersion model in full 3D mode, incorporating 3D meteorological output from TAPM and CALMET. The meteorological dataset has been compiled using observations from nearby automatic weather stations and a five year period of meteorological data was reviewed to ensure that the year selected for use in the modelling is representative of long-term meteorological conditions.

5.2.4 Pollutants Assessed

As discussed previously, road traffic exhaust emissions are comprised of a large number of pollutants. In terms of this assessment, the focus has been upon a select number of key pollutants that are recognised as the key indicators of road traffic exhaust emissions; namely particulates (as TSP, PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2).

5.2.5 NO_X to NO_2 Conversion

For this assessment, the predicted NO_2 concentrations are calculated using the Ozone Limiting Method (OLM) and hourly varying background ozone data recorded at the St Marys AQMS. This is in agreement with Method 2 for NO_2 assessment (Section 8.1.2) prescribed in the Approved Methods (see **Section 4.3**).

6 METEOROLOGICAL DATA USED IN THIS ASSESSMENT

6.1.1 Wind Speed and Direction

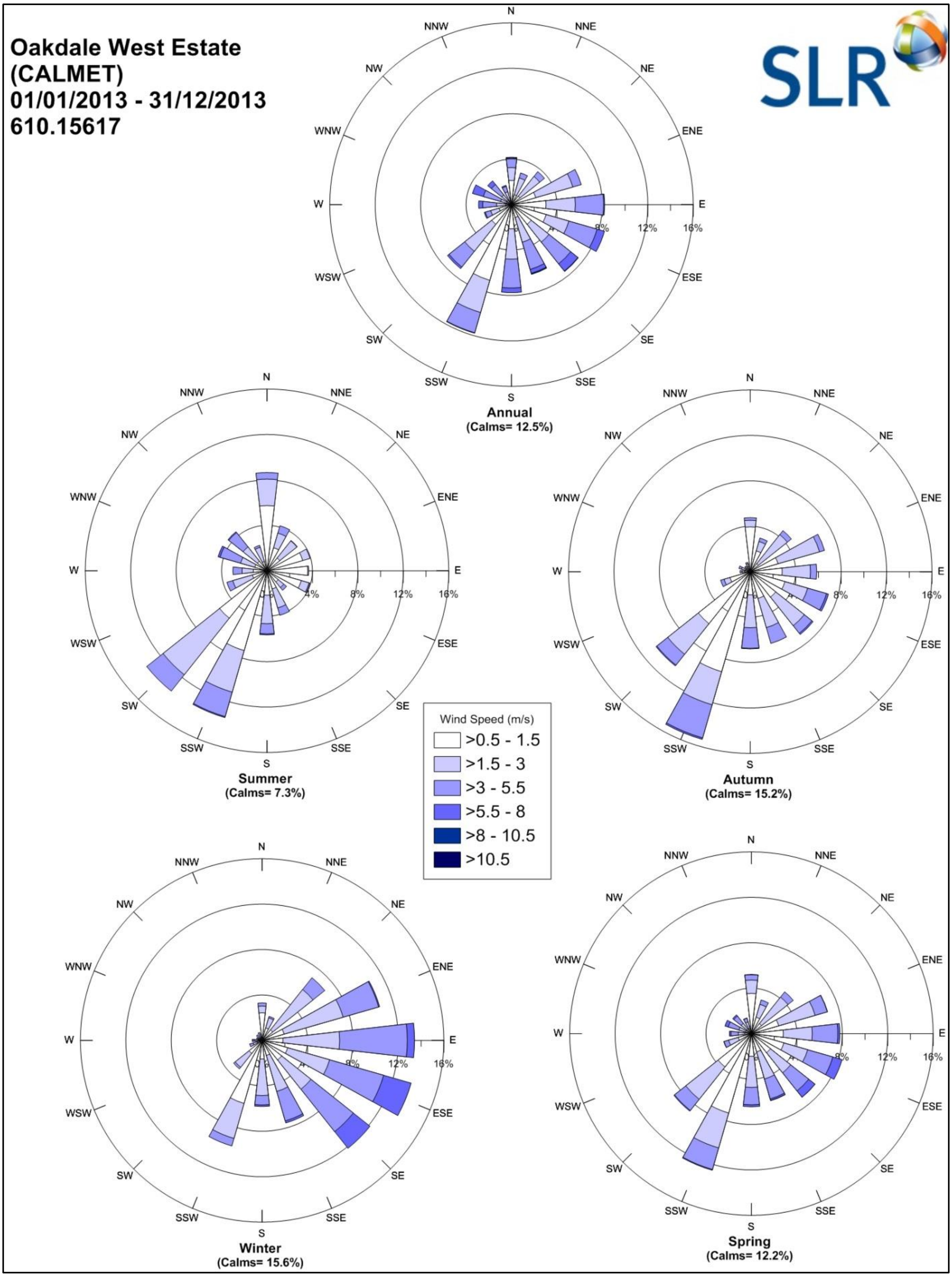
A summary of the annual wind behaviour predicted by CALMET at the Development Site is presented as wind roses in **Figure 11**.

Figure 11 indicates that winds experienced at the site are predominantly moderate to high (between 1.5 m/s and 8 m/s) with a small percentage of strong winds (>10.5 m/s). The predominant wind direction is seasonally dependent. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 1% of the time throughout the modelling period.

The seasonal wind roses indicate that typically:

- In summer, winds are light to moderate, predominantly from the northern and southwestern quadrants with very few winds from the southeast quadrant. Calm conditions were experienced approximately 7% of the time.
- In autumn, winds are light to moderate to high predominantly from the south southwest quadrants with very few winds from the north western quadrant. Calm conditions were experienced approximately 15% of the time.
- In winter, winds are moderate to high and are experienced predominantly from the southeast and northeast, with very few winds from the northwestern quadrant. Calm conditions were experienced approximately 15% of the time.
- In spring, winds are moderate to strong with high percentage of winds from the south southwestern, with very few winds from the northwestern quadrant. Calm conditions were experienced approximately 12% of the time.

Figure 11 Predicted Seasonal Wind Roses for the Oakdale West Estate (CALMET, 2013)



6.1.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorize the degree of atmospheric stability as follows:

- A = Extremely unstable conditions
- B = Moderately unstable conditions
- C = Slightly unstable conditions
- D = Neutral conditions
- E = Slightly stable conditions
- F = Moderately stable conditions

The meteorological conditions defining each Pasquill stability class are shown in **Table 17** .

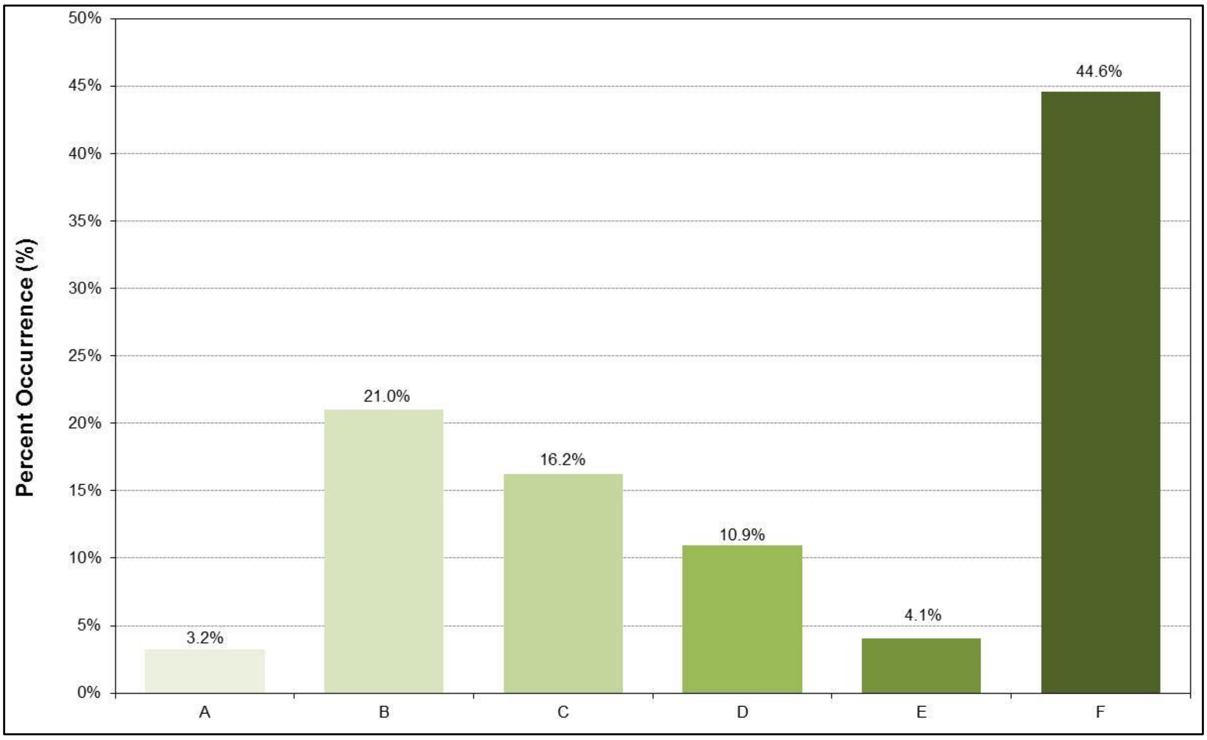
Table 17 Meteorological Conditions Defining Pasquill Stability Classes (Source: Pasquill, 1961)

Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

Notes:
[1] Strong insolation corresponds to sunny midday in midsummer in England; slight insolation to similar conditions in midwinter.
[2] Night refers to the period from 1 hour before sunset to 1 hour after sunrise.
[3] The neutral category D should also be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour preceding or following night as defined above.

The frequency of each stability class predicted by CALMET during the modelling period, extracted at the centre of the Development Site, is presented in **Figure 12**. The results indicate a high frequency of conditions typical to Stability Class F. Stability Class F is indicative of stable night time conditions, which will inhibit pollutant dispersion resulting in higher pollutant concentrations.

Figure 12 Predicted Stability Class Frequencies at the Oakdale West Estate (CALMET, 2013)



6.1.3 Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Development Site during the 2013 modelling period are illustrated in **Figure 13**.

As would be expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

6.1.4 Ambient Temperature

The modelled temperature variations as predicted at the Development Site during 2013 are illustrated in **Figure 14**. The maximum temperature (42.6°C) was predicted on 18 January 2013 and the minimum temperature (4.4°C) was predicted on 22 July 2013.

Figure 13 Predicted Mixing Heights at the Oakdale West Estate (CALMET, 2013)

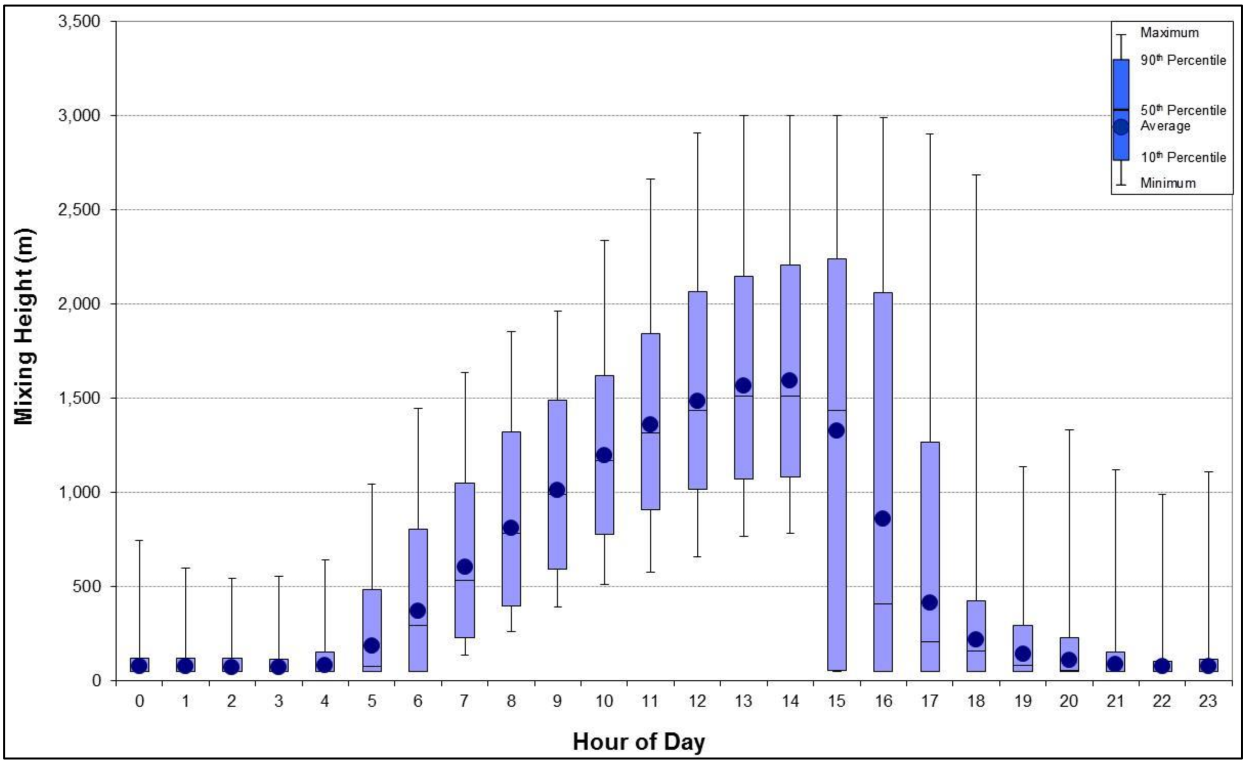
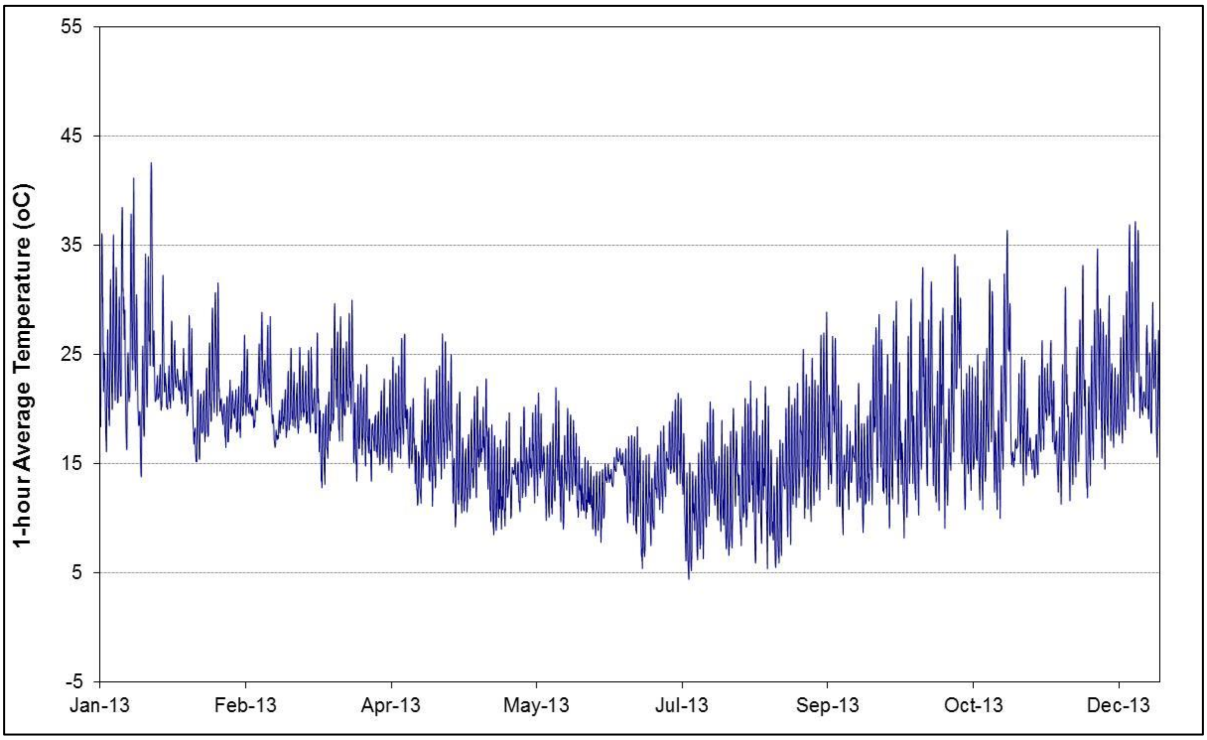


Figure 14 Predicted Temperatures at the Oakdale West Estate (CALMET, 2013)



7 EMISSION ESTIMATION

7.1 Construction Phase

Emissions from construction phase activities (principally dust) have been assessed using a qualitative assessment methodology, which targets the key sources of construction emissions for mitigation and control. The methodology for this is outlined in **Section 8.1**. As such, the quantification of emissions from the construction phase activities is not required.

7.2 Operational Phase

As stated in **Section 2.5.2**, wheel-generated dust from the on-site traffic movements and combustion emissions from road traffic exhaust emissions on-site have been identified as the main sources of potential emissions for the proposed operational phase.

Potential particulate emissions from the on-site traffic movements were estimated using emission factor equations sourced from the United States Environmental Protection Agency (US EPA) AP-42 Emission Factor Handbook (US EPA 2011). Potential NO_x and particulate emissions from idling trucks were sourced from US EPA documents on "*Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity*" (US EPA 2004).

The emission factors used in estimating potential emissions from the proposed operations are summarised in **Table 18** and the activity data assumed in the calculations are summarised in **Table 19**. The estimated total emission rates for the proposed operations are presented in **Table 20**.

Table 18 Emission Factors

Activity	Emission Factor Equation	Units	Source	Variables
Wheel generated dust	$EF_{TSP} = 3.23 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM10} = 0.62 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$ $EF_{PM2.5} = 0.15 \times (sL)^{0.91} \times (W \times 1.1023)^{1.02}$	g/VKT	US EPA (2011)	sL = road surface silt loading (0.06 g/m²) W = average weight of vehicles: 22.5 t for PUD's 62.5 t for B Doubles 42.5 t for Semi trailers
Idling combustion	$EF_{NOx} = 135$ $EF_{PM10} = 3.68$	g/hr	US EPA (2004)	

The use of idling emission factors is considered to be conservative compared to the use of in-motion emission factors for light commercial vehicles (90%) and diesel trucks (10%).

Based on the NPI Emission Estimation Technique Manual (EETM) for Combustion Engines, the NO_X emissions from diesel engines are 23 kg/m^3 for Heavy Goods Vehicles (HGV) and 17 kg/m^3 for Medium Goods Vehicles (MGV). Assuming that heavy trucks (HGVs) have an average mileage of 57.7 L/100 km and commercial vehicles (MGV) have an average mileage of 12 L/100 km (based on Survey of motor vehicle use in Australia, 12 months to June 2012, ABS 2015), the weighted average fuel consumption rate for the fleet is estimated to be 16.6 L/100 km. Based on the vehicles travelling at 30 km/h, the NO_X emissions are estimated to be approximately 114 g/h. This is lower than the idling truck fleet idling emission factor for NO_X emissions of 135 g/h adopted in this assessment.

Table 19 Activity Data Used for Emissions Estimation

Parameter	Value	Unit	Reference
Silt Loading	0.03	g/m^2	USEPA 2011 (ADT > 10,000)
Total number of vehicles	16,544	vpd	Oakdale West Network Flow Model (Ason Group, 13 May 2016)
Total distance	4.75	km	Based on estimated maximum distance travelled by vehicle in one trip
Total VKT	78,584	VKT/day	Based on Design Masterplan Link Road Option 1 (OAK MP 02 (H), 07 March 2016)
AM/PM peak hour number of vehicles	1,426	vph	Applicable 6AM to 7AM and 5PM to 6PM
Off peak hours number of vehicles	689	vph	Applicable to 7AM to 5PM and 7PM to 6AM

Table 20 Detailed Emissions Estimation

Wheel Generated Emissions	**Pickup and delivery vehicles (PUDs)**	**B Doubles**	**Semi-trailer**
Vehicle Weight (t)	*22.5*	*62.5*	*42.5*
Wheel generated dust Efs - TSP (g/VKT)	*3.5*	*10.0*	*6.7*
Wheel generated dust Efs - PM_{10} (g/VKT)	*0.7*	*1.9*	*1.3*
Wheel generated dust Efs - $PM_{2.5}$ (g/VKT)	*0.2*	*0.5*	*0.3*
Ratio of vehicles	*90%*	*5%*	*5%*
Wheel Generated Emissions - TSP (kg/day)	248.5	39.1	26.4
Wheel Generated Emissions - PM_{10} (kg/day)	47.7	7.5	5.1
Wheel Generated Emissions - $PM_{2.5}$ (kg/day)	11.5	1.8	1.2
Combustion Emissions	**Pickup and delivery vehicles (PUDs)**	**B Doubles**	**Semi-trailer**
Combustion (Onsite Idling EFs) - NO_X (g/h)	*135.0*	*135.0*	*135.0*
Combustion (Onsite Idling EFs) - PM_{10} (g/h)	*3.7*	*3.7*	*3.7*
Combustion (Onsite Idling EFs) - $PM_{2.5}$ (g/h)	*1.2*	*1.2*	*1.2*
Number of vehicles idling	*20*	*1*	*1*
Combustion Emissions - NO_X (kg/day)	64.8	3.2	3.2
Combustion Emissions - PM_{10} (kg/day)	1.8	0.1	0.1
Combustion Emissions - $PM_{2.5}$ (kg/day)	0.6	0.03	0.03
TOTAL EMISSIONS	**Pickup and delivery vehicles (PUDs)**	**B Doubles**	**Semi-trailer**
TSP (kg/day)	250.3	39.2	26.5
PM_{10} (kg/day)	49.5	7.6	5.2
$PM_{2.5}$ (kg/day)	12.1	1.8	1.3
NO_X (kg/day)	64.8	3.2	3.2

Note: Operational data such as the number of vehicles has been adopted from **Table 3**. It has been assumed that at least one vehicle is idling at each building (total of 22 buildings) within the Oakdale West Estate.

8 AIR QUALITY IMPACT ASSESSMENT

Impacts upon air quality in the area surrounding the Development site may be anticipated during both the construction and operational phases. The following sections present the findings of a qualitative risk-based assessment of dust emissions from the construction phase (**Section 8.1**) and a quantitative modelling-based assessment of air emissions from the operational activities (**Section 8.2**).

8.1 Construction Phase

The proposed construction works would involve:

- Demotion of all existing structures on the site (one building, see **Section 2.6**);
- Clearance of all vegetation on the site;
- Bulk earthworks across the site;
- Construction of multiple warehouse structures and distribution related facilities across the site;
- Construction of reticulated site services and site infrastructure, including on-site storm water detention structures;
- Construction of the internal access road that will be capable of accommodating both heavy and light vehicles; and
- Construction of lead-in services including electricity, sewer and potable water.

For this assessment, the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* (IAQM 2014) developed in the United Kingdom by the Institute of Air Quality Management (IAQM) has been used to provide a qualitative assessment method. The IAQM method uses a four-step process for assessing dust impacts from construction activities:

- **Step 1**: Screening based on distance to the nearest sensitive receptor; whereby the sensitivity to dust deposition and human health impacts of the identified sensitive receptors is determined.
- **Step 2**: Assess risk of dust effects from activities based on:
    a. the scale and nature of the works, which determines the potential dust emission magnitude; and
    b. the sensitivity of the area surrounding dust-generating activities.
- **Step 3**: Determine site-specific mitigation for remaining activities with greater than negligible effects.
- **Step 4**: Assess significance of remaining activities after management measures have been considered.

The assessment approach and findings are detailed in the following sections.

8.1.1 Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located more than 350 m from the boundary of the site, more than 50 m from the route used by construction vehicles on public roads and more than 500 m from the site entrance. This step is noted as having deliberately been chosen to be conservative, and will require assessments for most projects.

In the case of the proposed development site of Oakdale West Industrial Estate, sensitive receptors such as residential areas are located approximately 50 m from the site boundary and within 2 km of the site boundary.

8.1.2 Step 2a – Assessment of Scale and Nature of the Works

Step 2a of the assessment provides "dust emissions magnitudes" for each of four dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles). The magnitudes are: *Large*; *Medium*; or *Small*, with suggested definitions for each category as follows:

- **Demolition**
  - *Large:* Total building volume greater than 50,000 m^3, demolition activities greater than 20 m above ground, onsite crushing and screening activities or demolition of potentially dusty construction materials.
  - *Medium:* Total building volume between 20,000 m^3 and 50,000 m^3, demolition activities between 10 m and 20 m above ground or demolition of potentially dusty construction materials.
  - *Small:* Total building volume less than 10,000 m^3, demolition activities lower than 10 m above ground, demolition performed during wetter months or demolition of construction materials with low potential for dust release.
- **Earthworks**
  - *Large:* Total site area greater than 10,000 m^2, potentially dusty soil type (e.g., clay, which will be prone to suspension when dry to due small particle size), more than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8 m in height, total material moved more than 100,000 t.
  - *Medium:* Total site area 2,500 m^2 to 10,000 m^2, moderately dusty soil type (e.g., silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4 m to 8 m in height, total material moved 20,000 t to 100,000 t.
  - *Small:* Total site area less than 2,500 m^2, soil type with large grain size (e.g., sand), less than five heavy earth moving vehicles active at any one time, formation of bunds less than 4 m in height, total material moved less than 20,000 t, earthworks during wetter months.
- **Construction**
  - *Large:* Total building volume greater than 100,000 m^3, piling, on site concrete batching; sandblasting.
  - *Medium:* Total building volume 25,000 m^3 to 100,000 m^3, potentially dusty construction material (e.g., concrete), piling, on site concrete batching.
  - *Small:* Total building volume less than 25,000 m^3, construction material with low potential for dust release (e.g., metal cladding or timber).

In order to provide a conservative assessment of potential impacts, it has been assumed that if at least one of the parameters specified in the 'large' definition is satisfied, the works are classified as large, and so on.

The footprint of the site is approximately 154 ha and the Development site involves construction of twenty two new buildings (total volume of approximately 4.6 Mm^3). Demolition activities will predominantly be limited to removal of structures associated with the one old house within the site boundary (see **Section 2.6**).

Given this, the magnitude of dust emissions from each dust generating category have been categorised as shown in **Table 21**.

Table 21 Categorisation of Dust Emission Magnitude

Activity	Dust Emission Magnitude
Demolition	Small
Earthworks	Large
Construction	Large

8.1.3 Step 2b – Risk Assessment

Step 2b of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified sensitive receptors have to dust deposition and human health impacts.
- The proximity and number of those receptors.
- In the case of PM_{10}, the local background concentration.
- Other site-specific factors, such as whether there are natural shelters such as trees, to reduce the risk of wind-blown dust.

8.1.3.1 Receptor Sensitivity

Individual receptors are to be classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors have not been addressed in this assessment). The IAQM methodology provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in **Table 22**. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

Based on the criteria listed in **Table 22**, the sensitivity of the identified receptors in the study area (dwellings) is concluded to be of *high* for health impacts and *high* for dust soiling, based upon the following assumptions:

- The identified sensitive receptor locations are dwellings where members of the local community have the potential to be exposed to PM_{10} levels for eight hours (or more) in a day.
- In general, the local population could reasonably expect a high level of amenity (i.e. low annual average TSP concentrations and dust deposition rates) given the medium level vegetated nature of the area which would result in little natural wind-blown dust and low background dust levels.
- Given the location and nature of the receptors, the properties would not reasonably be expected to be significantly diminished in appearance, aesthetics or value by dust deposition.

Table 22 IAQM Guidance for Categorising Receptor Sensitivity

Value	High Sensitivity Receptor	Medium Sensitivity Receptor	Low Sensitivity Receptor
Dust soiling	Users can reasonably expect a high level of amenity; or The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. *Examples: dwellings, museums, medium and long term car parks and car showrooms.*	Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or The appearance, aesthetics or value of their property could be diminished by soiling; or The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. *Examples: parks and places of work.*	The enjoyment of amenity would not reasonably be expected; or Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. *Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*
Health effects	Locations where members of the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: residential properties, hospitals, schools and residential care homes.*	Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: office and shop workers, but will generally not include workers occupationally exposed to PM_{10}.*	Locations where human exposure is transient. *Examples: public footpaths, playing fields, parks and shopping street.*

8.1.3.2 Sensitivity of Surrounding Area

According to the IAQM methodology, the sensitivity of the identified individual receptors (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors. Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area and if relevant, the season during which the works will take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

Dust Soiling

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown **Table 23**.

Table 23 IAQM guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: Estimate the total number of receptors within the stated distance. Only the *highest level* of area sensitivity from the table needs to be considered.

Based on **Table 23**, the sensitivity of the surrounding area to dust soiling has been classified as *low* based on nine receptors being located approximately between 50 m and 2 km from site boundary.

Health Impacts

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table 24**. For high sensitivity receptors, the IAQM method takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account and is based on the air quality objectives for PM_{10} in the UK. As these objectives differ from the ambient air quality criteria adopted for use in this assessment (i.e. an annual average of 30 µg/m^3 for PM_{10}), the IAQM method has been adapted slightly.

Table 24 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Receptor sensitivity	Annual mean PM_{10} Concentration	Number of receptors [a,b]	Distance from the source (m)			
			<20	<50	<100	<350
High	>30 µg/m^3	>100	High	High	High	Low
		10-100	High	High	Medium	Low
		1-10	High	Medium	Low	Low
	26.3-30 µg/m^3	>100	High	High	Medium	Low
		10-100	High	Medium	Low	Low
		1-10	High	Medium	Low	Low
	22.5-26.3 µg/m^3	>100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	<22.5 µg/m^3	>100	Medium	Low	Low	Low
		10-100	Low	Low	Low	Low
		1-10	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low
	-	1-10	Medium	Low	Low	Low
Low	-	>1	Low	Low	Low	Low

[a] Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m), noting that only the highest level of area sensitivity from the table needs to be considered.

[b] In the case of high sensitivity receptors with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

[c] The estimated background annual average PM_{10} concentration is taken from monitoring data as outlined within **Table 14**.

This approach is consistent with the IAQM guidance, which notes that in using the tables to define the *sensitivity of an area*, professional judgement may be used to determine alternative sensitivity categories, taking into account the following factors:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area, and if relevant the season during which the works will take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in this document.

Using **Table 24**, the sensitivity of the surrounding area to health effects has been classified as *low* based on the sensitivity classifications for a background annual average PM_{10} concentration of 16.7 µg/m^3 (which is the highest annual average PM_{10} concentration recorded at the St Marys AQMS over the period 2010 – 2014, as discussed in **Section 4.1**) and the expectation that there would be 1-10 receptors located approximately between 50 m and 2 km from site boundary.

A summary of the sensitivity of the areas surrounding the proposed development site has been determined as shown in **Table 25**.

Table 25 Assessment of Sensitivity of Areas Surrounding Key Construction Activities

Value	Area	Sensitivity of receptors	Number of receptors	Distance from source	Sensitivity of the surrounding area
Dust soiling	Areas to the north of Development site (receptors R2-R3)	High	1-10	~1.5 km from Development site boundary	Low
	Areas to the west of the site (receptor R4, R8)	High	1-10	~50 m from Development site boundary	Low
	Areas to the south of the site (receptor R5, R9)	High	1-10	Between 50 m and 1 km from Development site boundary	Low
	Areas to the east of the Development site (receptors R1, R6-R7)	High	10-100	~2 km from Development site boundary	Low
Human Health	Areas to the north of Development site (receptors R2-R3)	High	1-10	~1.5 km from Development site boundary	Low
	Areas to the west of the site (receptor R4, R8)	High	1-10	~50 m from Development site boundary	Low
	Areas to the south of the site (receptor R5, R9)	High	1-10	Between 50 m and 1 km from Development site boundary	Low
	Areas to the east of the Development site (receptors R1, R6-R7)	High	10-100	~2 km from Development site boundary	Low

8.1.4 Risk Assessment

The dust emission magnitude from Step 2a (**Table 21**) and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table 26** to determine the risk category with no mitigation applied.

Table 26 Risk category from Demolition, Earthworks and Construction Activities

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	High Risk[1]	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

[1] For Earthworks and Construction Activities, this category is 'Medium Risk'.

A preliminary risk assessment (i.e. no application of mitigation measures) has been performed for each element of the construction works using the tables presented in the preceding sections. The resultant risk ratings are presented below in **Table 27**.

The results indicate that there is a _negligible_ risk of adverse air quality impacts during the demolition works and _medium_ risk of adverse air quality impacts occurring at the identified offsite receptor locations in the event that no mitigation is applied during the earthworks and construction works.

Table 27 Risk of Air Quality Impacts from Demolition, Earthworks and Construction

Location	Impact	Sensitivity of Area	Dust Emission Magnitude			Preliminary Risk		
			Demolition	Earthworks	Construction	Demolition	Earthworks	Construction
Areas to the north of Development site (receptors R2-R3)	Dust Soiling	Low	Small	Large	Large	Negligible	Medium	Medium
	Human Health	Low	Small	Large	Large	Negligible	Medium	Medium
Areas to the west of the site (receptor R4, R8)	Dust Soiling	Low	Small	Large	Large	Negligible	Medium	Medium
	Human Health	Low	Small	Large	Large	Negligible	Medium	Medium
Areas to the south of the site (receptor R5, R9)	Dust Soiling	Low	Small	Large	Large	Negligible	Medium	Medium
	Human Health	Low	Small	Large	Large	Negligible	Medium	Medium
Areas to the east of the Development site (receptors R1, R6-R7)	Dust Soiling	Low	Small	Large	Large	Negligible	Medium	Medium
	Human Health	Low	Small	Large	Large	Negligible	Medium	Medium

A low level risk rating does not preclude the requirement for suitable mitigation measures to be implemented during the construction phase. The following section provides a range of appropriate mitigation measures that should be applied during the works to ensure that all risks are minimised where ever practicable.

8.1.5 Step 3 - Site-Specific Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high risk site. **Table 28** lists the relevant mitigation measures recommended as *highly recommended* (H) or *desirable* (D) by the IAQM methodology for a medium risk site. Not all these measures will be practical or relevant to the proposed Development site, hence a detailed review of the recommendations should be performed once the details of the construction phase are available (e.g. list of construction equipment, quantities of soils to be handled on site, etc) and the most appropriate measures adopted.

Table 28 Site-Specific Management Measures Recommended by the IAQM

1	**Communications**	
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	H
1.2	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H
1.3	Display the head or regional office contact information.	H
1.4	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority.	H
2	**Site Management**	
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H
2.2	Make the complaints log available to the Local Authority when requested.	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H
3	**Monitoring**	
3.1	Perform daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the Local Authority when requested. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100 m of the site boundary.	D
3.2	Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the Local Authority when requested.	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H
3.4	Agree dust deposition, dust flux, or real-time PM_{10} continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.	H
4	**Preparing and Maintaining the Site**	
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	H
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	H
4.4	Avoid site runoff of water or mud.	H

4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	H
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion.	H
5	**Operating Vehicle/Machinery and Sustainable Travel**	
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable.	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles.	H
5.3	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	H
5.4	Impose and signpost a maximum-speed-limit of 25 km/hr on surfaced and 15 km/hr on unsurfaced haul roads and work areas.	D
5.5	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	H
5.6	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing).	D
6	**Operations**	
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate.	H
6.3	Use enclosed chutes and conveyors and covered skips.	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	H
7	**Waste Management**	
7.1	Avoid bonfires and burning of waste materials.	H
8	**Demolition**	
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H
8.2	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H
8.3	Bag and remove any biological debris or damp down such material before demolition.	H
9	**Construction**	
9.1	Avoid scratching or roughening of concrete surfaces, where possible.	D
9.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	D
10	**Trackout**	
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D
10.2	Avoid dry sweeping of large areas.	D
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
10.4	Record all inspections of haul routes and any subsequent action in a site log book.	D
10.5	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D

H = Highly recommended; D = Desirable

8.1.6 Step 4 – Residual Impacts

Following Step 3, the residual impact is then determined after management measures are then considered.

A reappraisal of the predicted unmitigated air quality impacts on sensitive receptors has been performed to demonstrate the opportunity for minimising risks associated with the use of mitigation strategies. These are termed "residual impacts". The results of the reappraisal are presented below in **Table 29**.

Table 29 Residual Risk of Air Quality Impacts from Demolition, Earthworks and Construction

Sensitivity of Area	Risk Including Mitigation		
	Demolition	Earthworks	Construction
Low	Negligible Risk	Low Risk	Low Risk

The mitigated dust deposition and human health impacts of proposed earthworks and construction activities is anticipated to be *low*.

A detailed CEMP should be constructed and implemented prior to construction works, and should include contingency plans and response procedures (eg proactive response procedures, non-compliance and continued non-compliance response procedures, complaints handling procedures) and suitable reporting and performance monitoring procedures.

Also, it is noted that there have been no complaints in regards to dust during the construction works for other similar sites such as Oakdale Central industrial precinct. Considering that the development site is proposed by the same proponent (Goodman Pty Ltd) and the dust deposition monitoring indicating that the dust deposition rates have been reducing, it is appropriate to assume that the dust impacts during the construction will be managed by implementing the best management practices.

8.2 Operational Phase

Dispersion modelling predictions of TSP, PM_{10}, $PM_{2.5}$ and NO_2 at the residences/properties nominated in **Section 2.6** are presented in **Section 8.2.1** to **Section 8.2.4**. Pollutant isopleth plots are also provided in the respective sections which show the maximum predicted incremental (Project operations only) concentrations and deposition rates of the pollutants assessed.

As discussed in **Section 4** a detailed assessment of the background concentrations in the area surrounding the Development site has been performed. Within this results section, where applicable, the predicted contribution from Project activities has been added to the background dataset in order to provide information on the cumulative impact of Project activities on the air quality within the local area.

8.2.1 Particulates (as TSP)

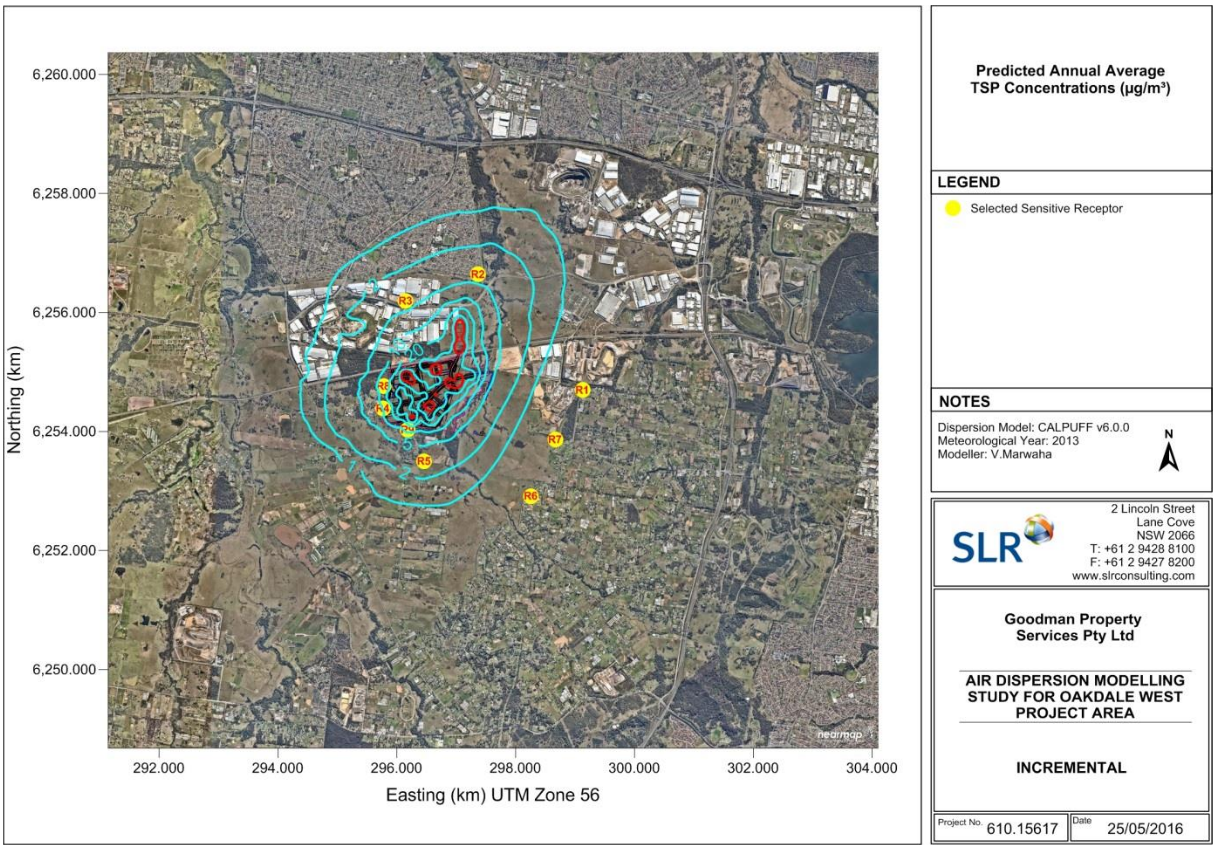
Table 30 presents the incremental and cumulative annual average TSP concentrations predicted at surrounding representative sensitive receptors. It can be observed from **Table 30** that the predicted cumulative annual average TSP concentrations at all receptors are below the relevant OEH guideline (<50% of the criterion). The main source of TSP emissions estimated for the site is wheel-generated dust. These estimates are expected to be very conservative over-estimates of actual emission rates given the low silt content expected on the roads and low vehicle speeds that would occur within the distribution centre. Actual impacts from the Development site are therefore expected to be significantly lower than the predicted concentrations presented in this assessment.

Contour plots of the predicted incremental annual average TSP concentrations are presented in **Figure 15**.

Table 30 Predicted Annual Average TSP Concentrations at Sensitive Receptors

Receptor ID	Incremental Impact (µg/m^3)	Cumulative Impact (µg/m^3)
R1	0.3	30.7
R2	4.0	34.4
R3	3.9	34.3
R4	10.3	40.8
R5	3.0	33.4
R6	0.4	30.8
R7	0.4	30.8
R8	13.8	44.2
R9	12.1	42.5
Criterion		**90 (cumulative)**

Figure 15 Predicted Incremental Annual Average TSP Concentrations - Operation



8.2.2 Particulates (as PM_{10})

To assess the maximum cumulative 24-hour average PM_{10} concentrations at each of the identified sensitive receptors, a contemporaneous analysis was performed following the Approved Methods. At each receptor, each individual incremental prediction was added to the corresponding day's measured background concentration at the St Marys AQMS site to predict the cumulative 24-hour average PM_{10} impacts.

Table 31 presents a summary of the contemporaneous analysis at each receptor listed in **Section 2.6**. It can be observed from **Table 31** that the incremental and cumulative 24-hour average PM_{10} concentrations predicted at each surrounding sensitive receptor as a result of operational emissions are below the relevant OEH guideline. Therefore it is concluded that the proposed operation is unlikely to cause any additional exceedences of the guideline at these locations.

Table 31 Summary of 24-Hour PM_{10} Cumulative Impact Analysis - Operation

Receptor ID	Date of Highest Cumulative	PM_{10} 24-Hour Average Concentrations (µg/m³)			Date of Highest Increment	PM_{10} 24-Hour Average Concentrations (µg/m³)		
		Background	Increment	Highest Cumulative		Background	Highest Increment	Total Impact
R1	07/11/2013	38.6	<0.1	<38.7	24/06/2013	3.8	1.5	5.4
R2	29/10/2013	38.0	2.0	40.0	03/04/2013	14.7	6.5	21.2
R3	07/11/2013	38.6	1.7	40.3	28/06/2013	8.3	4.9	13.2
R4	07/11/2013	38.6	5.8	44.4	28/07/2013	18.0	14.6	32.6
R5	07/11/2013	38.6	1.3	39.9	15/07/2013	16.0	8.9	24.9
R6	07/11/2013	38.6	<0.1	<38.7	13/08/2013	10.5	1.5	12.0
R7	07/11/2013	38.6	<0.1	<38.7	14/06/2013	6.5	2.1	8.7
	07/11/2013	38.6	9.2	47.8	16/07/2013	13.5	15.7	29.1
	09/09/2013	32.8	11.2	44.0	15/07/2013	16.0	22.9	38.9
Criterion				**50**				**50**

Note: Background PM_{10} data recorded is likely to be biased by the controlled burning in Blue Mountain region (see **Section 4**) and has been excluded from this study.

Figure 16 Maximum Predicted Incremental 24-Hour Average PM_{10} Concentrations - Operation

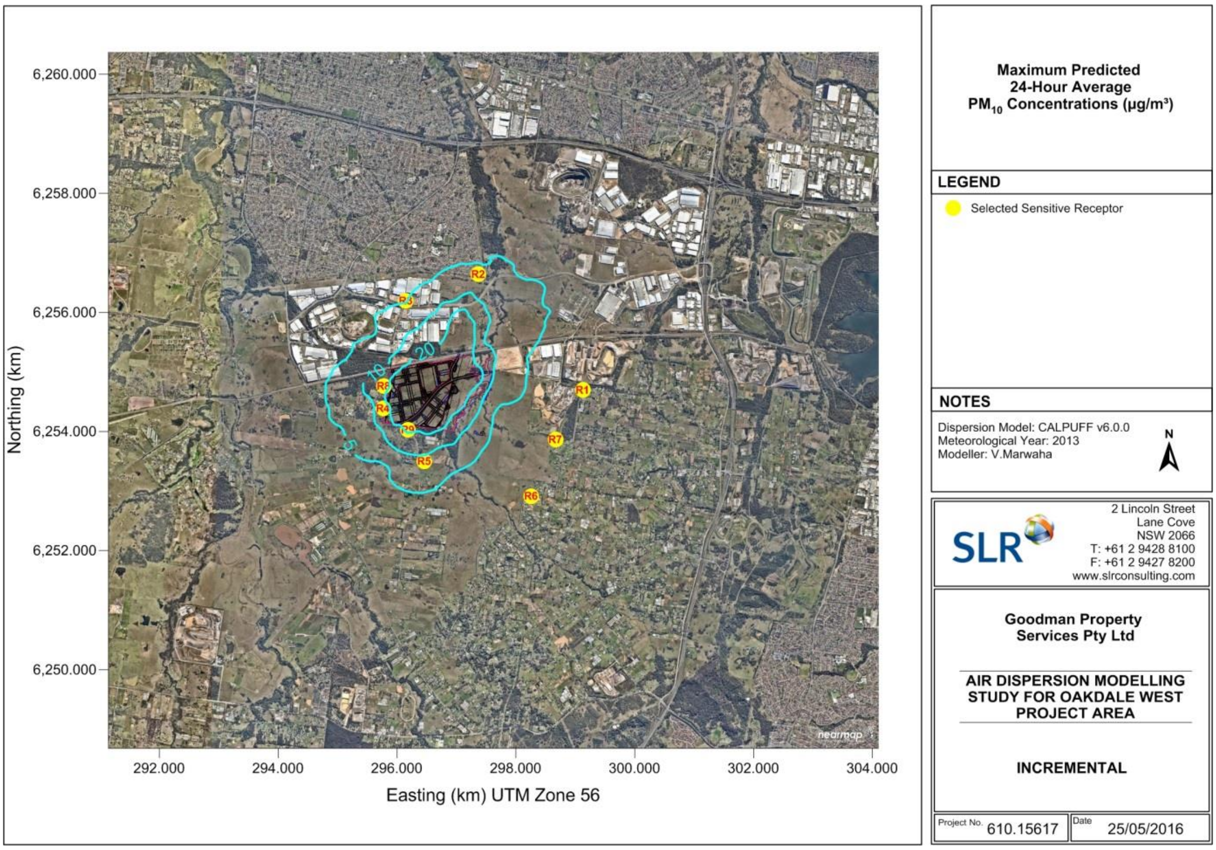


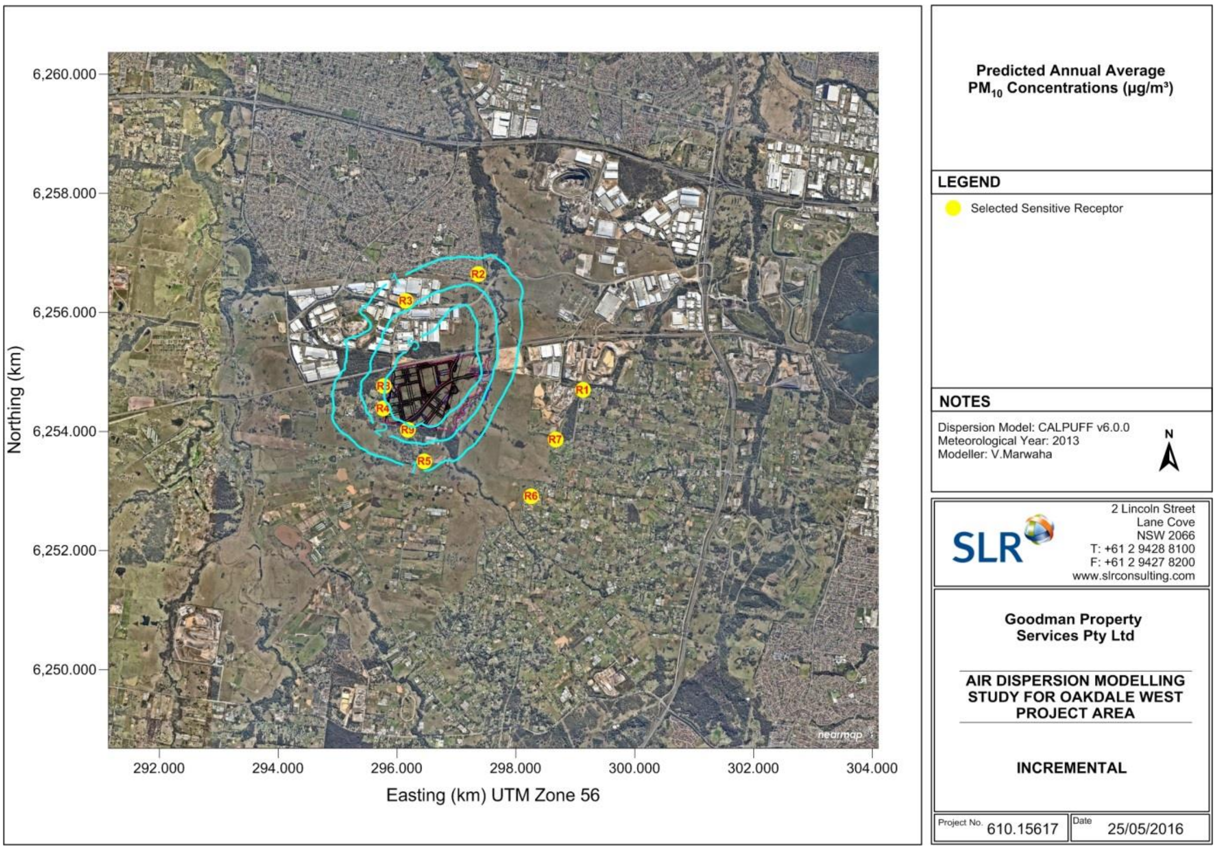
Table 32 presents a summary of the incremental and cumulative annual average PM_{10} concentrations predicted at each identified sensitive receptor location. It can be observed from **Table 32** that the incremental annual average PM_{10} impacts predicted as a result of the proposed operations are minimal and that the cumulative annual average PM_{10} concentrations predicted at all surrounding sensitive receptor locations are well below the relevant OEH guideline.

Table 32 Predicted Maximum Annual Average PM_{10} Concentrations at Sensitive Receptors - Operation

Receptor ID	**Annual Average PM_{10} Concentrations ($\mu g/m^3$)**	
	Incremental Impact	**Cumulative Impact**
R1	0.1	15.4
R2	1.5	16.7
R3	1.6	16.8
R4	3.5	18.7
R5	1.2	16.4
R6	0.2	15.4
R7	0.2	15.4
R8	4.6	19.8
R9	3.8	19.0
Assessment Criterion	**-**	**30**

Contour plots of the maximum 24-hour and annual average incremental PM_{10} concentrations are presented in **Figure 16** and **Figure 17**.

Figure 17 Predicted Incremental Annual Average PM_{10} Concentrations - Operation



8.2.3 Particulates (as $PM_{2.5}$)

Table 33 shows the predicted incremental impacts for 24-hour and annual average $PM_{2.5}$ concentrations at each receptor identified in **Section 2.6**. The maximum 24-hour average and annual average incremental $PM_{2.5}$ concentrations are presented as contour plots in **Figure 18** and **Figure 19**.

It can be observed from **Table 33** that the predicted incremental 24-hour and annual average $PM_{2.5}$ concentrations at all receptors are minimal (<20%) compared to the relevant ambient air quality guideline. Considering the relatively small predicted incremental contribution from the proposed operations, it can be concluded that the proposed operational activities are unlikely to cause any exceedences of relevant 24-hour or annual average $PM_{2.5}$ criteria at any surrounding sensitive receptor locations.

Table 33 Maximum Predicted 24-Hour and Annual Average $PM_{2.5}$ Concentrations - Operation

Receptor ID	Incremental Impacts Predicted at Sensitive Receptors	
	24 Hour Average (µg/m³)	Annual Average (µg/m³)
R1	0.4	<0.1
R2	1.7	0.4
R3	1.3	0.4
R4	3.9	0.9
R5	2.4	0.3
R6	0.4	<0.1
R7	0.6	0.1
R8	4.2	1.2
R9	6.0	1.0
Assessment Criteria	**25 (cumulative)**	**8 (cumulative)**

Figure 18 Maximum Predicted Incremental 24-Hour Average $PM_{2.5}$ Concentrations - Operation

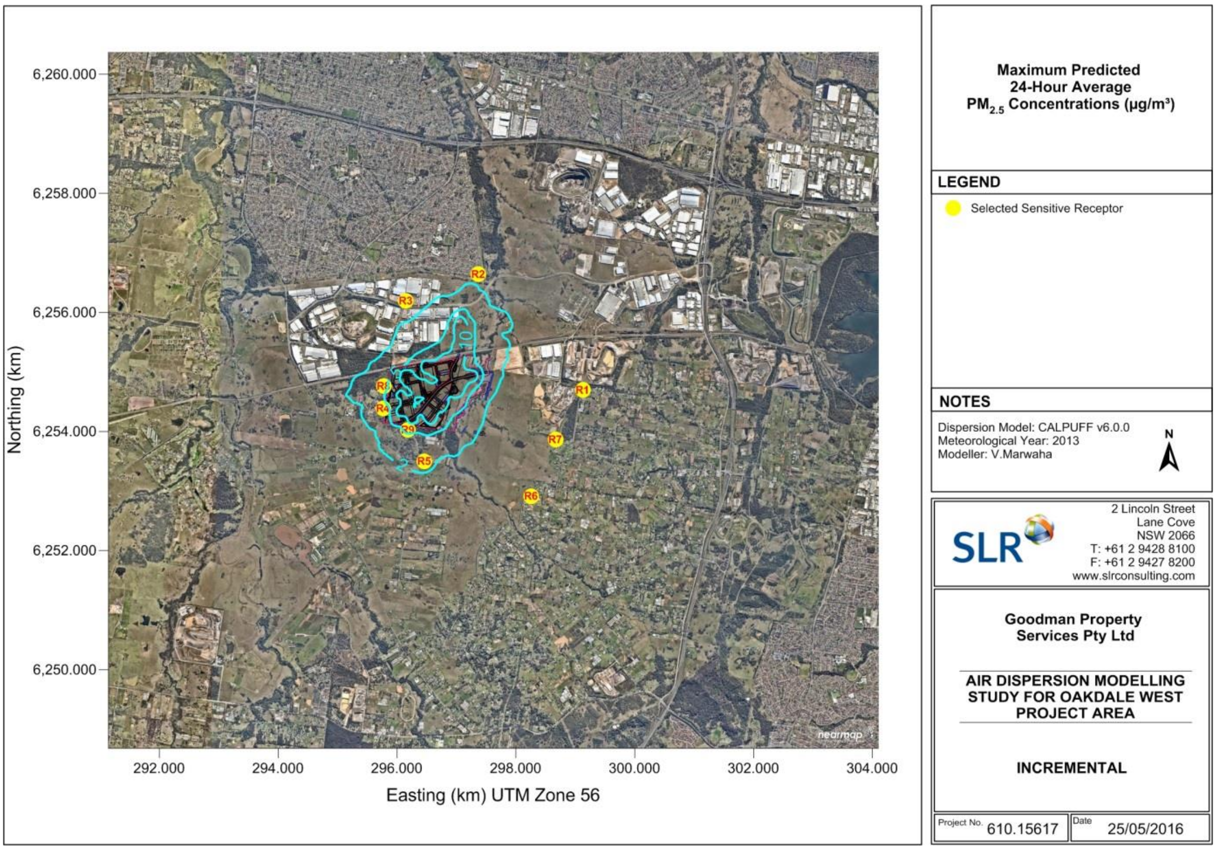
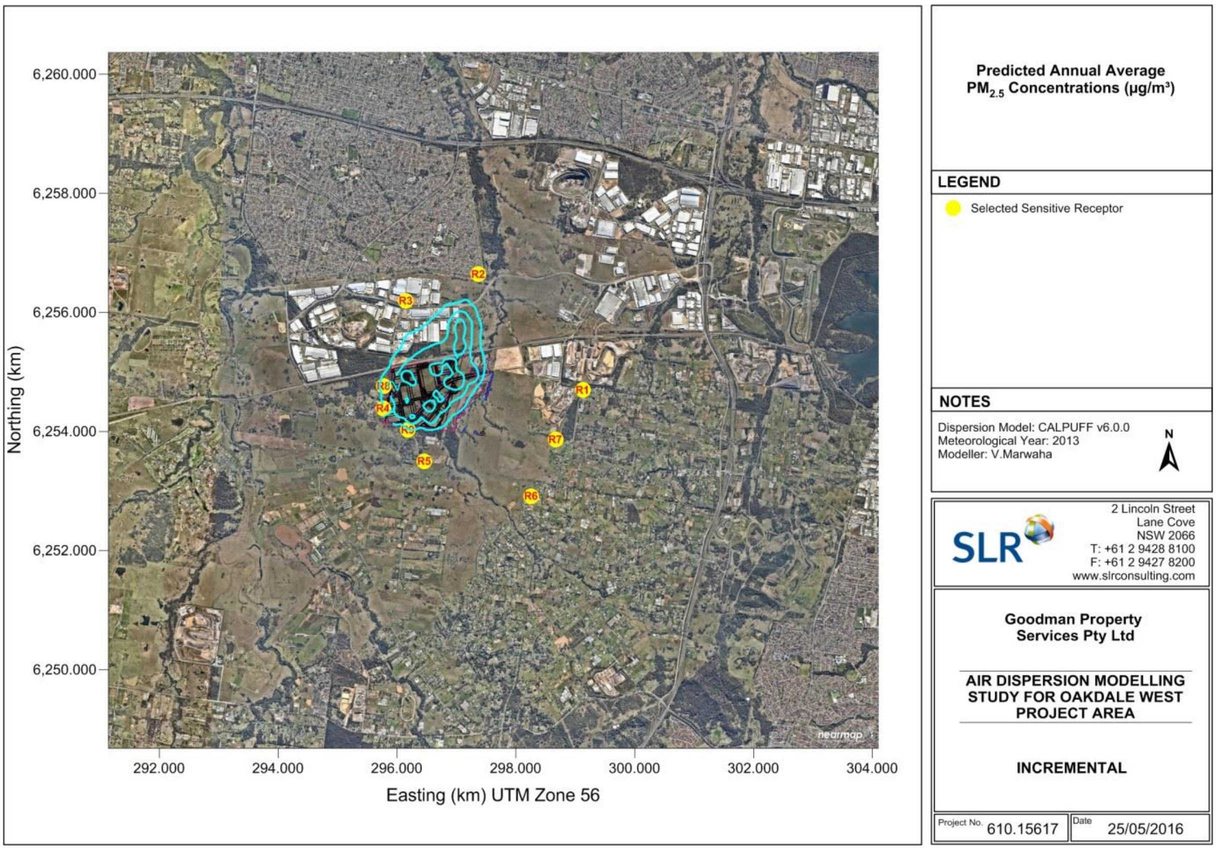


Figure 19 Predicted Incremental Annual Average $PM_{2.5}$ Concentrations - Operation



8.2.4 Nitrogen Dioxide (NO_2)

Table 34 presents the incremental and cumulative 1-hour and annual average NO_2 concentrations predicted at each receptor identified in **Section 2.6**. The NO_2 concentrations are estimated using the predicted NO_X concentrations and the OLM method, as prescribed by the Approved Methods. The ozone concentrations are discussed in detail in **Section 4.3**. The results presented in **Table 34** show that the predicted cumulative 1-hour and annual average NO_2 concentrations are well below the relevant OEH criteria at all receptors.

Table 34 Predicted Maximum 1-Hour and Annual Average NO_2 Concentrations at Sensitive Receptors

ID	1-Hour Averages		Annual Averages	
	Incremental Impact (µg/m³)	Cumulative Impact (µg/m³)	Incremental Impact (µg/m³)	Cumulative Impact (µg/m³)
R1	23.3	75.9	0.2	9.7
R2	34.8	75.9	2.0	10.9
R3	31.1	79.9	2.2	11.1
R4	88.4	80.1	4.7	12.1
R5	56.5	81.4	1.6	10.6
R6	18.9	75.9	0.2	9.7
R7	21.9	75.9	0.3	9.7
R8	75.5	83.7	6.1	12.7
R9	158.8	91.6	5.0	12.0
Criteria		**246**		**62**

The maximum predicted 1-hour and annual average incremental NO_X concentrations are presented as contour plots in **Figure 20** and **Figure 21**. It is noted that the due to the incapacity of the dispersion model to incorporate OLM calculations, only incremental NO_X concentrations are presented in the contour plots.

Figure 20 Maximum Predicted Incremental 1-Hour Average NO_X Concentrations - Operation

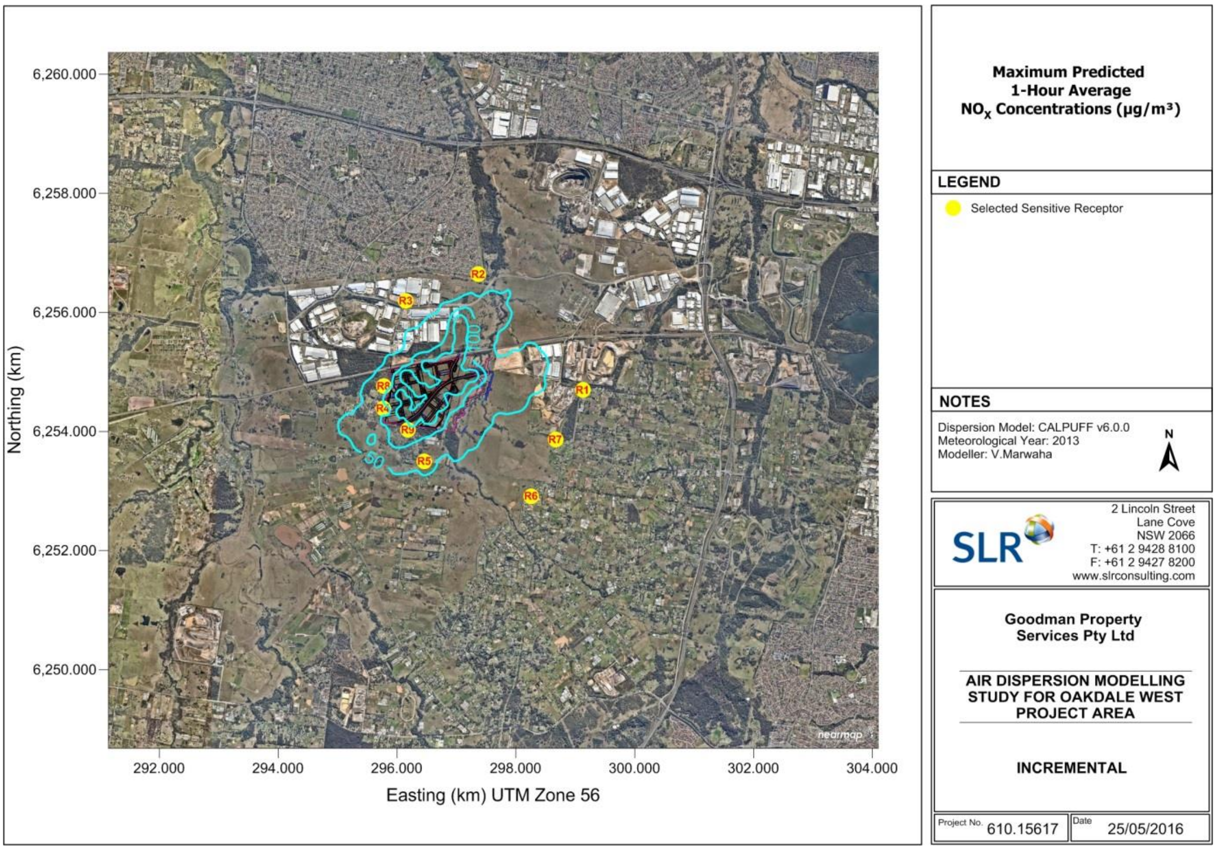
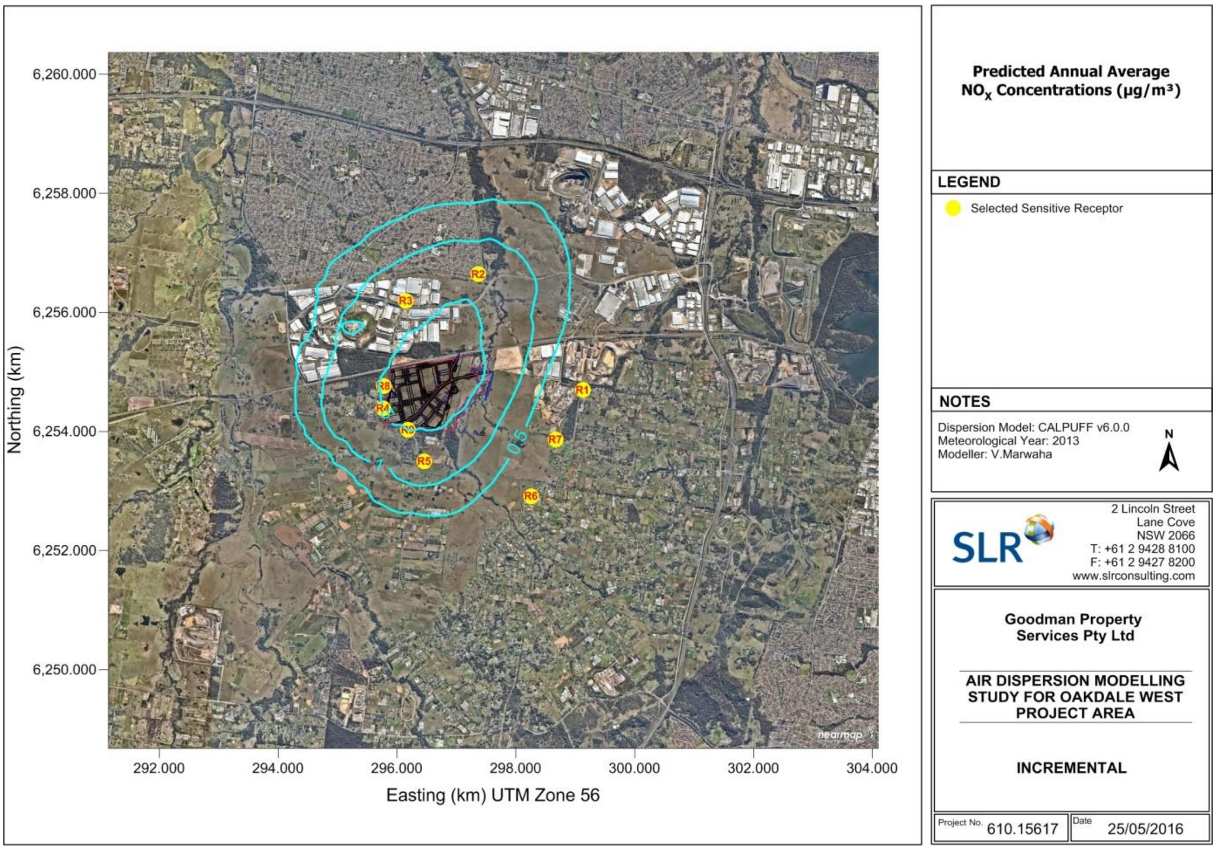


Figure 21 Predicted Incremental Annual Average NO_X Concentrations - Operation



9 CONCLUSIONS

SLR Consulting Australia Pty Ltd (SLR Consulting) has conducted an Air Quality Impact Assessment (AQIA) at the request of Goodman Property Services (Aust) Pty Ltd in preparing the development application for Oakdale West Estate, NSW.

The potential dust-generating and fuel combustion activities for the proposed future operations have been identified and potential emissions from these activities were estimated based on available Project information and emission factors from the literature. These estimated emissions from the proposed operations have then been assessed through a combination of qualitative and quantitative techniques (construction and operation respectively).

For the construction assessment, a range of control measures to minimise fugitive dust emissions have been outlined for inclusion in the Construction Environmental Management Plan (CEMP) for the project. These measures will be adopted to minimise the dust missions during construction as part of the CEMP.

For the operational assessment, the predicted results indicate that the proposed operational activities would comply with all relevant OEH ambient air quality criteria at all representative surrounding sensitive receptors. The predicted $PM_{2.5}$ concentrations could not be assessed against the relevant cumulative criterion as no background $PM_{2.5}$ concentrations are recorded by the St Marys AQMS.

It is noted that the predicted impacts are based on worst case operational activity data and the use of conservative emission factors from the literature to estimate the emissions. As a result, all predictions in the assessment should be viewed as conservatively high, with levels expected to be lower during normal operation of the facility.

It is concluded that air emissions due to the construction and operation of the Oakdale West Estate associated with the increase in vehicles servicing the development (eg deliveries and despatch during operation) are not anticipated to represent a constraint for operation of the site.

10 REFERENCES

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