27 July 2018

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HB&B Property Pty Ltd
Level 3, Building 1 South,
75 O'Riordan St
Alexandria, NSW 2015

Attention: Craig Sims

Dear Craig

Lot 7 585-649 Mamre Road
Air Quality Cover Letter

In 2016, SLR Consulting Australia Pty Ltd (SLR) prepared an Air Quality Impact Assessment (AQIA) (610.15775-R1) for a proposed warehouse and logistics hub at 585 – 649 Mamre Road, Orchard Hills, NSW. SLR has now been commissioned by HB&B Property Pty Ltd on behalf of Snackbrand, to prepare a covering letter for the AQIA, which is to be submitted as part of a development application for a warehouse and distribution facility on Lot 7 585 – 649 Mamre Road. This letter provides additional comment and context regarding the potential air quality impacts associated with the construction and operation of the proposed Snackbrand warehouse and distribution facility, within the context of the 585 – 649 Mamre Road development site and existing surrounding operations.

1 Overview of the Previous Assessment - AQIA 2016

The AQIA assessed emissions to air from the proposed construction activities and future operations of Lots 7, 8A and 8B through a combination of qualitative and quantitative techniques.

For the construction phase, a qualitative risk-based assessment of potential impacts was performed based on the scale and nature of the works proposed. Based on the results of this assessment, a range of control measures to minimise fugitive dust emissions were outlined for inclusion in the Construction Environmental Management Plan (CEMP) for the project to minimise dust emissions during construction.

For the operational assessment, potential dust-generating and fuel combustion activities associated with the proposed future operations were identified and potential emissions from these activities were estimated based on available information and emission factors from the literature.

2 Qualitative Assessment of Impacts to Air Quality from Construction

The AQIA included a qualitative assessment of the risk of adverse impacts on local air quality from construction using the Institute of Air Quality Management (IAQM) approach. This risk assessment covered the entire Stage 1 development site, ie Lots 1-9.

Details of the site areas considered in the AQIA include:

- a total site footprint of approximately 45 ha (449,800 m^2); and

- a Stage 1 development footprint of approximately 13.5 ha (135,430 m^2).

No demolition work was proposed as part of the proposed Stage 1 development but the following works were anticipated:

- clear approximately 449,800 m^2 of the site to a nominal 0.5 m depth;
- establish hard standing on approximately 60% of the total site;
- construct a steel framed building covering approximately 80,050 m^2 to an assumed height of 12 m above ground level (AGL) (equating to 960,600 m^3 in building volume); and
- assume an access route around the site during construction works of up to 2.0 km in total length.

Based upon the assumptions outlined above, the dust emission magnitudes were estimated according to the IAQM methodology and are reproduced from the AQIA (Table 19, page 41) in **Table 1**.

Table 1 Categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Demolition	N/A
Earthworks	Large
Construction	Large
Trackout	Large

The proposed development of Lot 7 by Snackbrands includes a warehouse and distribution facility of approximately 31,550 m^2. This is considerably smaller than the building area assessed in the AQIA (80,050 m^2), however this area does not include all the buildings proposed on the other lots that make up the Stage 1 development site. The dust emission magnitudes shown in **Table 1** were categorised as large, which correlates to a 'total building volume greater than 100,000 m^3'. This would effectively account for any additional building volumes being constructed at the same time as the Snackbrands development.

The dust emission magnitudes shown in **Table 1** were used to assess the likely risk of off-site air quality impacts. The results indicated that there was a low risk of adverse dust soiling impacts occurring at the off-site receptor locations, even if no mitigation measures were to be applied to control emissions from earthworks, construction and trackout. The risk of adverse human health impacts was also concluded to be low.

For almost all construction activity, the IAQM method notes that the aim should be to prevent significant effects on receptors using effective mitigation, and experience shows that this is normally possible. Given the limited duration of the earthwork activities, the lack of demolition activities, and the expectation that water would be readily available for dust suppression when required, residual impacts associated with fugitive dust emissions from the proposed Stage 1 development (including Lot 7) were concluded to be 'not significant'.

Consequently, given that the findings of this assessment were inclusive of impacts to air quality from construction of Lot 7 and also address any impacts to air quality from the construction of all nine (9) lots concurrently, the potential off-site impacts from the construction of the Snackbrand warehouse and distribution facility are also expected to be 'not significant'.

To minimise the risk of any off-site impacts however, the air quality management measures recommended in the AQIA should be implemented during the works.

3 Quantitative Assessment of Impacts to Air Quality from Operation

The AQIA includes a quantitative assessment of impacts to air quality from operational activities using the air dispersion model CALPUFF. The assessment of impacts on local air quality from operational activities was undertaken for Lots 7, 8A and 8B. Operational activities on Lots 2-6 and Lot 9 (a bio-retention basin will be constructed on Lot 1) will also have potential to impact on local air quality. Emissions from the operation of these facilities were not included in the AQIA, as these sites were not operating at the time of assessment or no information was available on the proposed activities, and hence they:

- did not form part of the emissions inventory; and/or
- did not form part of the background air quality data used (presented in Section 4 of report 610.15775-R01).

In the AQIA, modelling of emissions from Lot 7, 8A and 8B indicated that the proposed operational activities would comply with all relevant OEH ambient air quality criteria at all representative surrounding sensitive receptors, except where existing background pollutant levels were elevated (ie $PM_{2.5}$). These predicted impacts were based on worst case operational activity data at Lots 7, 8A and 8B and the use of conservative emission factors from the literature.

The following sections outline how emissions of pollutants from the remaining lots may affect the conclusions presented in the AQIA, based on the traffic volumes that were used in the emission estimates and the level of conservatism inherent to the model.

3.1 Previous Assessment – AQIA 2016

3.1.1 Vehicle Activity Data

Details of the activity data used to estimate emissions from vehicles in the AQIA are outlined in **Table 2**. This shows that 2,139 vehicles per day were modelled, travelling 2.0 km each.

Table 2 Activity Data Used for Emissions Estimation for Lots 7, 8A and 8B

Parameter	Value	Unit	Reference
Total distance	2.0	km	estimated distance travelled by vehicle in one trip
AM/PM peak hour number of vehicles	214	vph	peak hourly traffic flow is approximately 10% of the daily flow in urban areas
Total number of vehicles (conservatively assumed in model)	2,139	vpd	per comms Luke Wilson 09/03/2016
Total VKT	4,278	VKT/day	average daily traffic and maximum distance travelled
Proportion of PUD vehicles	70	%	calculated
Proportion of heavy vehicles	30	%	estimated conservatively from similar assessments (10-25%)
Number of loading bays	41	-	from site layout 4648_MP-001[B].pdf

3.1.2 Modelling Conservatism

The modelling presented in the AQIA is very conservative, as:

- The 2,139 vehicles modelled per day were assumed to travel 2 km each, which is essentially traversing the whole Stage 1 development site (4,278 vehicle kilometres travelled). If each of those vehicles only travelled 1 km, which is a more realistic estimation, then the modelling has been effectively undertaken for 4,278 vehicles per day.
- 30% of the vehicles have been assumed to be heavy vehicles (ie B-Doubles or semi-trailers weighing 62.5 tonnes), with the remaining 70% assumed to be pick-up and delivery vehicles weighing 22.5 tonnes. The definition of 70% of the vehicles as pick-up and delivery vehicles would over-estimate the emissions of wheel generated dust as a proportion of these would be passenger cars.
- All 41 loading docks have been modelled as occupied with idling B-doubles or semi-trailers every hour of the day on Lots 7, 8A and 8B. While this does not represent all the loading docks across the entire site, it is still a conservative assumption that 41 loading docks will be occupied for the whole hour, every hour of the day.
- In the modelling undertaken for the AQIA, the initial plume is concentrated as all the emissions sources (ie vehicles) have been defined on Lot 7, 8A and 8B. Therefore, dispersion at the nearest sensitive receptors will be more conservative than if the sources had been spread across all the lots.

3.1.3 Modelling Results

- The predicted cumulative annual average TSP concentrations at all receptors were well below the relevant OEH guideline (<47% of the criterion).
- The cumulative annual average PM_{10} concentrations predicted at all surrounding sensitive receptor locations were also below the relevant OEH guideline.
- The predicted incremental 24-hour average PM_{10} concentrations at all receptors were minor, at <17% of the relevant ambient air quality guideline. The cumulative 24-hour average PM_{10} concentrations predicted at each sensitive receptor were also well below the relevant OEH guideline.
- The predicted incremental annual average $PM_{2.5}$ concentrations at all receptors were minor (<5%) compared to the relevant ambient air quality guideline. However, the background contribution to $PM_{2.5}$ annual average is significant. A review of regional ambient monitoring data for $PM_{2.5}$ showed that the annual average criterion was exceeded during 2013 at the Liverpool AQMS. A significant contributor to this exceedance was the NSW bushfire emergency which extended from October into early November 2013. The incremental contribution to annual average $PM_{2.5}$ concentrations predicted at the sensitive receptors indicates that under normal conditions, the proposed Development would not be expected to cause an exceedance of the annual average $PM_{2.5}$ criterion.
- The predicted incremental 24-hour average $PM_{2.5}$ concentrations at all receptors were minor (<10%) compared to the relevant ambient air quality guideline. The cumulative 24-hour average $PM_{2.5}$ concentrations predicted at all surrounding sensitive receptor locations were below the relevant OEH guideline.
- The NO_2 concentrations were estimated using the predicted NO_X concentrations and the OLM method (based on background ozone data), as prescribed by the Approved Methods. These results showed:
    - The predicted cumulative annual average NO_2 concentrations were well below the relevant OEH criteria at all receptors.

- The predicted cumulative maximum 1-hour average NO_2 concentrations were below the relevant OEH criteria at all receptors, except for receptors 1-4. However a detailed contemporaneous analysis for receptor 1 showed that the incremental and cumulative 1-hour average NO_2 concentrations predicted were below the relevant OEH guideline. Therefore, the proposed operation is unlikely to cause any exceedances of the guideline at receptor 1. Given receptor 1 was predicted to be the most impacted receptor, the proposed operation, it can be concluded that the development is also unlikely to cause any exceedances of the guideline at receptors 2, 3 or 4.

3.2 Estimated Vehicle Numbers for the Snackbrand Warehouse and Logistics Hub

3.2.1 Estimated Vehicle Numbers for Lot 7

RMS Technical Direction 04a gives the following traffic generation rates for the Erskine Park Industrial Area, which are considered to be representative of the proposed development:

- 0.134 trips per 100 m^2 GFA (total building, warehouse and office) during the morning peak hour;
- 0.139 trips per 100 m^2 GFA during the evening peak hour; and
- 1.892 trips per 100 m^2 GFA per day.

For Snackbrand's warehouse and distribution facility on Lot 7, the application of the above rates will result in:

- 41 vehicles/hour during the AM peak hour;
- 42 vehicles/hour during the PM peak hour; and
- 572 vehicles per day.

3.2.2 Estimated Vehicle Numbers for Lot 8A & 8B

Table 3 presents estimated vehicle numbers for Lot 8A & 8B based on the proposed building areas from the Traffic Impact Assessment for Lot 8A - First Estate, Mamre West Precinct, prepared by ASON Group (July 2018). However, it is unclear if these building areas reflect the design that received approval and proceeded to the build stage (noting that the building area in this report for Lot 7 is incorrect).

Table 3 Building Area and Estimated Vehicle Numbers for Lot 8A & 8B

Building	Building Area (m^2)	AM Peak (vehicles/hr)	PM Peak (vehicles/hr)	Daily Trips (vehicles/day)
Warehouse 8A	11,400	15	16	216
Warehouse 8B	9,400	13	13	178
			Total	**394**

3.2.3 Estimated Vehicle Numbers as a Percentage of those Modelled

For Snackbrand's warehouse and distribution facility on Lot 7, 572 vehicles per day are estimated. An additional 394 vehicles per day are estimated to traverse Lot 8A and 8B.

The estimated vehicles per day traversing Snackbrand's site represents 27% of the vehicles modelled in the AQIA. In total, 966 vehicles per day are estimated to traverse Lot 7, 8A and 8B, which represents 45% of the vehicles modelled in the AQIA.

3.3 Conclusion

In March 2016, SLR submitted an AQIA that assessed emissions to air from the proposed construction activities and future operations of Lots 7, 8A and 8B, 585-649 Mamre Rd through a combination of qualitative and quantitative techniques.

The results of the qualitative assessment were inclusive of adverse impacts to air quality from construction of Lot 7 and conservatively, address any impacts to air quality from the construction of all nine (9) lots concurrently. Therefore, adverse impacts to air quality from construction activities outlined in the qualitative assessment in the AQIA can be relied on to address impacts of construction from Snackbrand's Lot 7 site design.

The predicted modelling results for the operational activities (namely traffic emissions) presented in the AQIA can be expected to adequately address impacts to air quality from operational activities occurring Snackbrand's warehouse and distribution facility on Lot 7 as their estimated vehicle activity represents only 27% of the vehicles modelled in the AQIA, and hence would contribute only 27% of the predicted concentrations.

The operational activities at the remaining seven (7) lots at 585 – 649 Mamre Rd may also be adequately addressed by the predicted modelling results outlined in the AQIA due to the conservatism in the modelling, which includes:

- An additional 1,173 vehicles per day in the modelling (55% of 2,139 vehicles modelled in the AQIA), which could account for traffic volumes to Lots 2-6 and Lots 8-9.
- The vehicle kilometres travelled on site assumed was 2 km per vehicle, and 4,278 vehicle kilometres travelled in total. This is likely to be highly conservative, and provides a large buffer on actual vehicle numbers (If vehicles only travel 1 km on-site, this represents an additional 3,312 vehicles that have been included in the modelling).
- 100% of vehicles on-site have been assumed to weigh at least 22.5 tonnes, with 30% of the total vehicles defined as heavy vehicles weighing 62.5 tonnes. This is highly conservative when calculating wheel-generated dust as a proportion of the total vehicles would be passenger cars.
- 41 loading docks have been modelled as occupied. While this does not represent all the loading docks across the entire site, it is still a conservative assumption that 41 loading docks will be occupied for the whole hour, every hour of the day.
- In the modelling undertaken for the AQIA, the initial plume is concentrated as all the emission sources (ie vehicles) have been defined on Lot 7, 8A and 8B. Therefore, dispersion at the nearest sensitive receptors will be more conservative than if the sources had been spread across all the lots.

We trust this letter meets your immediate requirements. However, should you require additional information or clarification please do not hesitate to contact me.

Yours sincerely

ARadford

ALISON RADFORD
Associate - Air Quality

Checked/ Authorised by: KL

585 - 649 Mamre Road Orchard Hills

Air Quality and Odour Assessment

Report Number 610.15775-R1

15 March 2016

ALTIS Property Partners
Level 14
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Sydney NSW 2000

Version: Revision 0

585 - 649 Mamre Road Orchard Hills

Air Quality and Odour Assessment

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Executive Summary

SLR Consulting Australia Pty Ltd (SLR Consulting) has conducted an Air Quality Impact Assessment (AQIA) at the request of ALTIS Property Partners Pty Ltd (ALTIS Property Partners) as part of preparing a development application for a proposed warehouse and logistics hub at 585 – 649 Mamre Road, Orchard Hills, NSW.

Emissions to air from the proposed construction activities and future operations have been assessed through a combination of qualitative and quantitative techniques.

For the construction phase, a qualitative risk-based assessment of potential impacts was performed based on the scale and nature of the works proposed. Based on the results of this 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 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 information and emission factors from the literature. Modelling of these emissions to predict maximum off-site pollutant concentrations indicates that the proposed operational activities would comply with all relevant OEH ambient air quality criteria at all representative surrounding sensitive receptors, even when existing background pollutant levels are considered.

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. 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.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been commissioned by ALTIS Property Partners Pty Ltd (ALTIS Property Partners) to perform an Air Quality and Odour Impact Assessment (AQIA) for the development of a proposed warehouse and logistics hub located at 585 – 649 Mamre Road, Orchard Hills NSW (hereafter 'the Development site').

1.1 Secretary's Environmental Assessment Requirements

NSW Department of Planning and Environment (DPE) issued Secretary's Environmental Assessment Requirements (SEARs) for State Significant Development (SSD) 7173 on 24 September 2015. **Table 1** below identifies the SEARs relevant to Air Quality and Odour issues. The Air Quality and Odour issues have been addressed in the relevant sections of this report.

Table 1 Secretary's Environmental Assessment Requirements – SSD 7173

Key Issue	Assessment Requirement	Addressed in Section
Air Quality and Odour	The assessment must include:	
	An assessment of the potential air quality impacts (particularly dust) of the development on surrounding receivers, including impacts from construction, operation and transport	**Section 6.1** **Section 6.2**
	An assessment of the potential odour impacts	**Section 3.1**
	Details of the proposed management and monitoring measures	**Section 7**

Source: NSW Department of Planning and Environment Major Projects Portal (http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=7173).

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

Air Quality

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

Odour

- *Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW* (NSW DEC, 2006);
- *Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW* (NSW DEC, 2006)*; and*
- *Protection of Environment Operations (Clean Air) Regulation* (NSW Parliament, 2010).

This assessment addresses the key issues raised within the SEARs and is performed in accordance with the relevant policies and guidelines.

1.2 Outline of Assessment

The NSW Environment Protection Authority (EPA) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (NSW DEC, 2005) (hereafter the Approved Methods) outline the requirements for conducting an AQIA, as follows (with identification of where each requirement has been met):

- Description of local topographic features and sensitive receptor locations (**Section 2.3** and **Section 2.2** 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 (**Section 5.2**).
- Compilation of a comprehensive emissions inventory for proposed operations (**Section 5.2.3**).
- Preparation of an air quality impact assessment report comprising the above.

Potential emissions to air from the proposed operation 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 DEVELOPMENT OVERVIEW

The Development site is located at 585 - 649 Mamre Road in Orchard Hills, NSW and covers an area of approximately 48 hectares (ha). The site is currently agricultural / grazing land. The Development site is located approximately 40 kilometres (km) west of Sydney Central Business District (CBD), in the local government area of the City of Penrith and is part of the Greater Western Sydney region.

The Development site is located immediately to the west of the Erskine Park Industrial Precinct. The adjacent Erskine Business Park includes:

- Liebherr Aus.
- Chep (Pallet Supplier)
- Visy (Packaging)
- P&G (Cosmetics)
- Bunzl Brands and Operations
- Linfox
- Ubeeco (Packaging)
- Worksense
- CSR Limited
- Transpacific
- Woolworths
- Cleanaway
- Stramit Building Products
- Alvaro Transport
- Capral Limited
- Silk Logistics Group
- Ubeeco (Waste Management Services)

Adjacent land uses include rural lands to the west, rural and undeveloped agricultural land to the north, and agricultural / grazing land to the south. South Creek is located approximately 300 metres (m) west of the site. The nearest residential premises are located to the north and northwest. A description of the identified sensitive receptors is provided in **Section 2.2**. The location of the Development site is shown in **Figure 1**.

Figure 1 Location of the Development Site

2.1 Proposed Development

Consent is sought to develop the site for the purposes of a warehouse and logistics hub. The concept plan establishes the road layout, allotments and building pads as well as built form and infrastructure relating to the warehouse and logistics development.

The Development site will ultimately comprise approximately nine industrial lots that will be prepared and released to the market. Development structures are expected to include warehouses, industrial sheds and freight handling facilities.

Use of the facility will be for warehousing and distribution on a 24 hour, 7 day basis, consistent with surrounding operations.

The layout of the proposed Development is presented in **Figure 2**.

2.1.1 Construction

The construction phase of the Development will consist of three main stages:

- Bulk earthworks to form level building pads, batters and earth retaining walls.
- Building and construction of new roads, pavements and services.
- Integrated building fit-out and commissioning.

Bulk earthworks and road construction will be completed in a staged manner. The establishment of building pads will provide flexibility for the design of future facilities as consent for the building footprints (other than the Stage 1 Development) is not sought under this application.

The existing topography is relatively flat and low-lying, varying from a reduced level of RL 38 m in the south-east to RL 32 m in the north-west (ie a slight grade of about 1°). According to plans, filling up to 2 m high will be required to create level pads for development and to provide a minimum 0.5 m freeboard for potential flooding from South Creek.

The staged development will allow building and other structural works to commence in conjunction with importation and placement of the required fill. Vehicles bringing fill would enter the site via a site entrance on Mamre Road.

Approximately 400 construction-related jobs would be created by the Development.

Figure 2 Proposed Development Layout

2.1.2 Operation

Proposed internal roadways can accommodate two lanes of future truck movements up to B-double heavy vehicles. The Stage 1 Development includes 357 car parking spaces and docks for up to approximately 41 heavy vehicles (assumed to be mostly B-Doubles). A number of vehicles may enter the site and be stationary for a period of time whilst parked (staff vehicles) or unloading/loading (B-Doubles, PUDs, and others including semi-trailers). It is proposed that 2,139 total daily vehicle movements will be generated by the Stage 1 Development. It has been assumed that heavy vehicles will make up 30% of these vehicles.

Details of each of the Development particulars are provided in **Table 2**.

Table 2 Development Particulars

Structure	Area (m^2)
Stage 1 Site Area	135,430
Stage 1 Warehouse – Lot 7	36,370
Stage 1 Warehouse – Lot 8A	18,170
Stage 1 Warehouse – Lot 8B	19,120
Office	6,390
Total Stage 1 Building Area	**80,050**
Total Site Area	**449,800**

2.2 Sensitive Receptors

The Development site is largely surrounded by existing rural residential lands, with industrial development to the immediate east. High density urban development is located approximately 1 km to the north (St Clair) with a number of low density residential developments between 70 m and 550 m from the Development boundary. The residence (R1) 70 m to the north is due to be acquired however it has been left in this assessment for conservatism. The Development is also in close proximity to an approved 80 place childcare centre (R2, currently under construction). Surrounding sensitive receptors identified for this assessment are listed in **Table 3** and presented in **Figure 3**. The predicted impacts at these receptors will be representative of the concentrations experienced in the wider area.

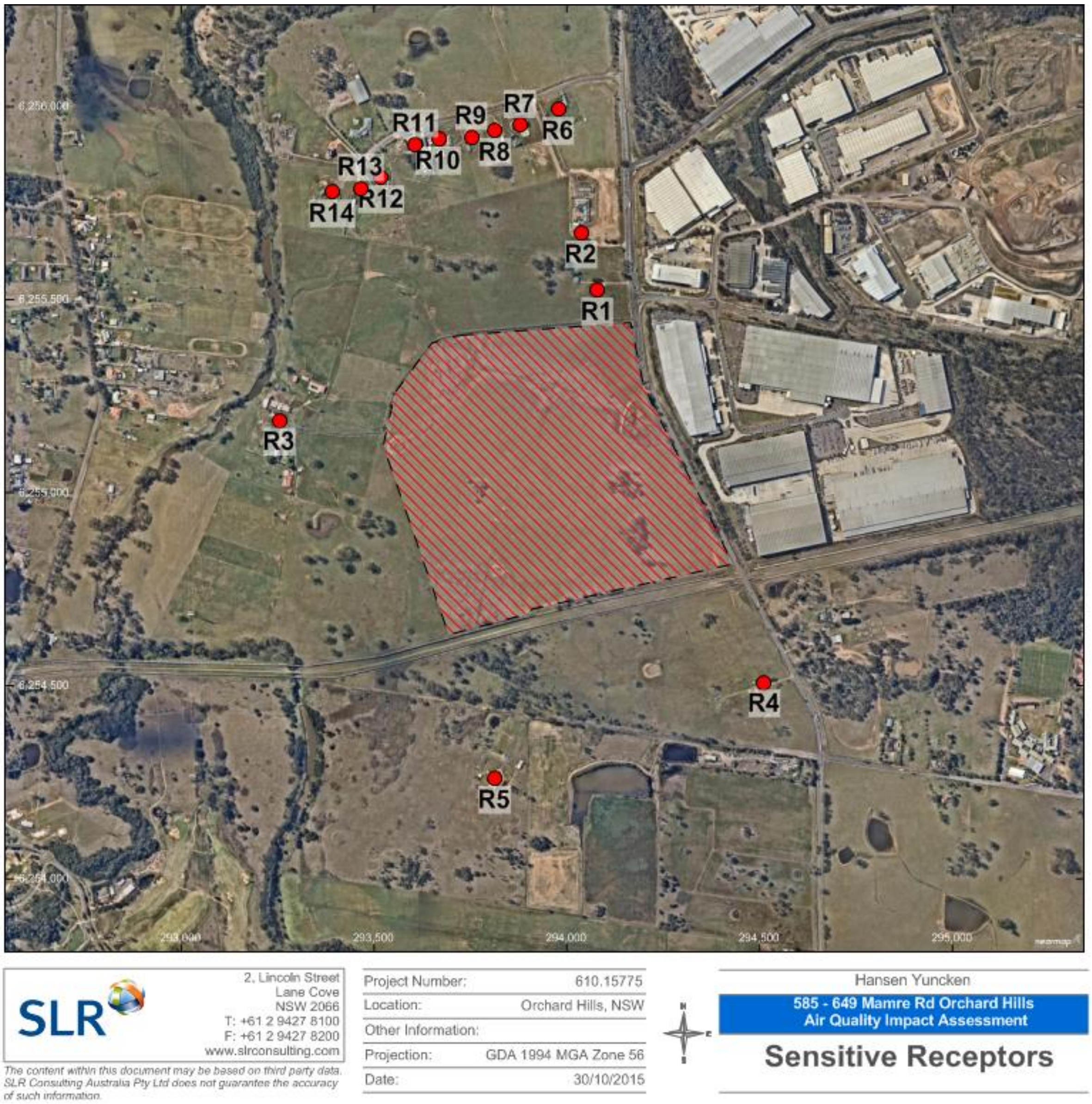
Table 3 List of Identified Sensitive Receptors

Receptor ID	Easting (m)	Northing (m)	Description	Distance / Direction from Site Boundary
R1	294,079	6,255,524	573-577 Mamre Road, Orchard Hills, NSW 2748[2]	70 m / N
R2	294,037	6,255,671	539-571 Mamre Road, Orchard Hills, NSW 2748	240 m / N
R3	293,255	6,255,187	579-649 Mamre Road, Orchard Hills, NSW 2748	280 m / W
R4	294,512	6,254,509	657-703 Mamre Road, Kemps Creek, NSW 2178	300 m / S
R5	293,813	6,254,259	707A Mamre Road, Kemps Creek, NSW 2178	375 m / S
R6	293,977	6,255,992	1-19 Mandalong Close, Orchard Hills, NSW 2748	550 m / N
R7	293,878	6,255,952	25 Mandalong Close, Orchard Hills, NSW 2748	510 m / N
R8	293,814	6,255,937	33-41 Mandalong Close, Orchard Hills, NSW 2748[1]	510 m / N
R9	293,752	6,255,921	33-41 Mandalong Close, Orchard Hills, NSW 2748[1]	500 m / N
R10	293,667	6,255,915	43 Mandalong Close, Orchard Hills, NSW 2748	495 m / N
R11	293,607	6,255,902	53-63 Mandalong Close, Orchard Hills, NSW 2748	500 m / N
R12	293,519	6,255,815	65 Mandalong Close, Orchard Hills, NSW 2748[1]	440 m / NNW
R13	293,466	6,255,788	65 Mandalong Close, Orchard Hills, NSW 2748[1]	430 m / NNW
R14	293,392	6,255,778	75-77 Mandalong Close, Orchard Hills, NSW 2748	450 m / NW

Notes:

1. Two dwellings on same property
2. Proposed to be acquired

Figure 3 Locations of Identified Sensitive Receptors

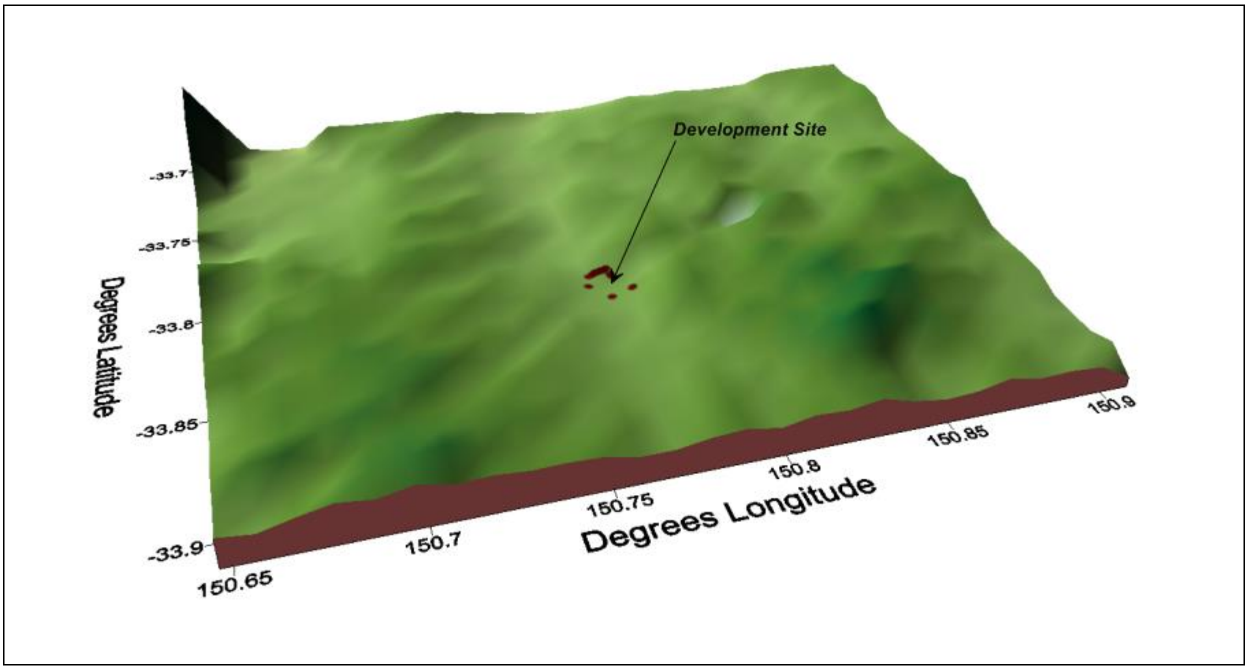


2.3 Local Topography

Figure 4 illustrates the topography of the region surrounding the Development site. The topographical data used in the modelling assessment was sourced from the United States Geological Service's Shuttle Radar Topography Mission database that has recorded topography across Australia with a 3 arc second (approximately 90 m) spacing.

The topography of the area surrounding the site is characterised by gently undulating terrain, with an approximate range of 30 m to 40 m, Australian Height Datum (AHD).

Figure 4 Local Topographical Features



Note: Receptors shown in red for context

3 ADOPTED STANDARDS AND GUIDELINES

3.1 Pollutants of Interest

Potential emissions to air during the construction phase will be emissions of particulate matter (dust as TSP, PM_{10} and $PM_{2.5}$), from clearing, excavation and material handling activities. Dust from the construction activities will be controlled using the best management practices outlined in **Section 7**. Emissions of combustion related pollutants (oxides of nitrogen [NO_X], carbon monoxide [CO], particulate matter, sulphur dioxide [SO_2] and volatile organic compounds [VOCs]) will also be emitted as a result of diesel combustion in construction vehicles.

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

State air quality guidelines adopted by the NSW EPA relating to these pollutants are published in the Approved Methods.

It is not anticipated that odour would be emitted in any significant quantity by the Development during construction works. A Phase 1 Contamination Assessment performed by Coffey (Coffey Environments, 2014) indicates that given the site history (predominantly grazing with no previous development) and observations made during the assessment, there is a low potential for contamination of the subsurface of the site. It is therefore anticipated that any invasive ground works would not result in the emission of odour and it is not considered further within this assessment. No odour is anticipated to be emitted from the Development during operation.

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 outlines the impact assessment criteria relevant to the Development. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC and WHO) and are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

3.2 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 “particulate matter” refers to a category of airborne particles, typically less than 50 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 (µg/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 µg/m^3; and

- an annual average of 30 µg/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 µg/m^3; and
- an annual average concentration of 8 µg/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.

The National Clean Air Agreement (NCAA) was endorsed by Commonwealth, state and territory Environment Ministers on 15 December 2015. Ministers agreed to strengthen national ambient air quality reporting standards for airborne fine particles as follows:

For PM_{10}:

- a 24-hour average concentration of 50 µg/m^3 (unchanged from the Approved Methods); and
- an annual average of 25 µg/m^3 (compared to a value of 30 µg/m^3 in the Approved Methods).

For $PM_{2.5}$:

- a 24-hour average concentration of 25 µg/m^3; and
- an annual average concentration of 8 µg/m^3.

All jurisdictions have agreed to implement strengthened standards for particles, as well as move to even tighter standards for annual average and 24-hour $PM_{2.5}$ in 2025. As these standards have not yet been adopted by NSW EPA, this assessment is based on the current assessment goals set out in the Approved Methods.

A summary of the particulate guidelines is shown in **Table 4**.

Table 4 EPA Criteria for Particulates

Pollutant	Averaging Time	Criteria
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)

3.2.1 Particulates (as 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 5 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 5 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 particulate matter, NO_x, CO, SO_2, and VOCs.

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 and is therefore not considered within this assessment.

3.3.1 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 soon after leaving a vehicle exhaust.

3.3.2 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.

3.3.3 Sulphur Dioxide (SO_2)

Vehicle exhausts can contain emissions of sulphur dioxide (SO_2) due to impurities in the fuel. The sulphur content in diesel fuel has significantly reduced over the years and a timeline of the sulphur content in diesel fuels in Australia is shown in **Table 6**.

Table 6 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-Jan-09	ASTM D5453
	50 ppm (max)	1-Jan-06	
	500 ppm (max)	31-Dec-02	

Source: http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards/diesel, accessed on 29 October 2015.

3.3.4 Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOC) may be emitted as a result of 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 potential for air quality exceedance of VOCs.

3.3.5 Summary of Combustion-Related Pollutants

The NSW EPA 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 is provided in **Table 7**.

Table 7 NSW 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)

Source: (NSW DEC, 2005)

3.4 Summary of Air Quality Criteria Adopted for this Assessment

Experience in performing assessments of the impact of combustion-related emissions determines 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 the annual averages. Therefore, short-term NO_2 concentrations are used as an indicator of combustion related pollutant impacts within this assessment.

The air quality goals adopted for this assessment, which conform to current NSW EPA and Federal air quality criteria, are summarised in **Table 8**. 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 100^{th} percentile (maximum) (or 99^{th} percentile for odour) in concentration or deposition units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

Table 8 Air Quality Criteria Adopted for this Assessment

Pollutant	Averaging Period	Criteria (µg/m^3)	Source
Nitrogen dioxide (NO_2)	1 hour	246	NEPC (1998)
	Annual	62	NEPC (1998)
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)
		Criteria (g/m^2/month)	
Deposited dust	Annual	2 (maximum increase in deposited dust level) 4 (maximum total deposited dust level)	NERDDC (1988)

4 EXISTING AIR QUALITY ENVIRONMENT

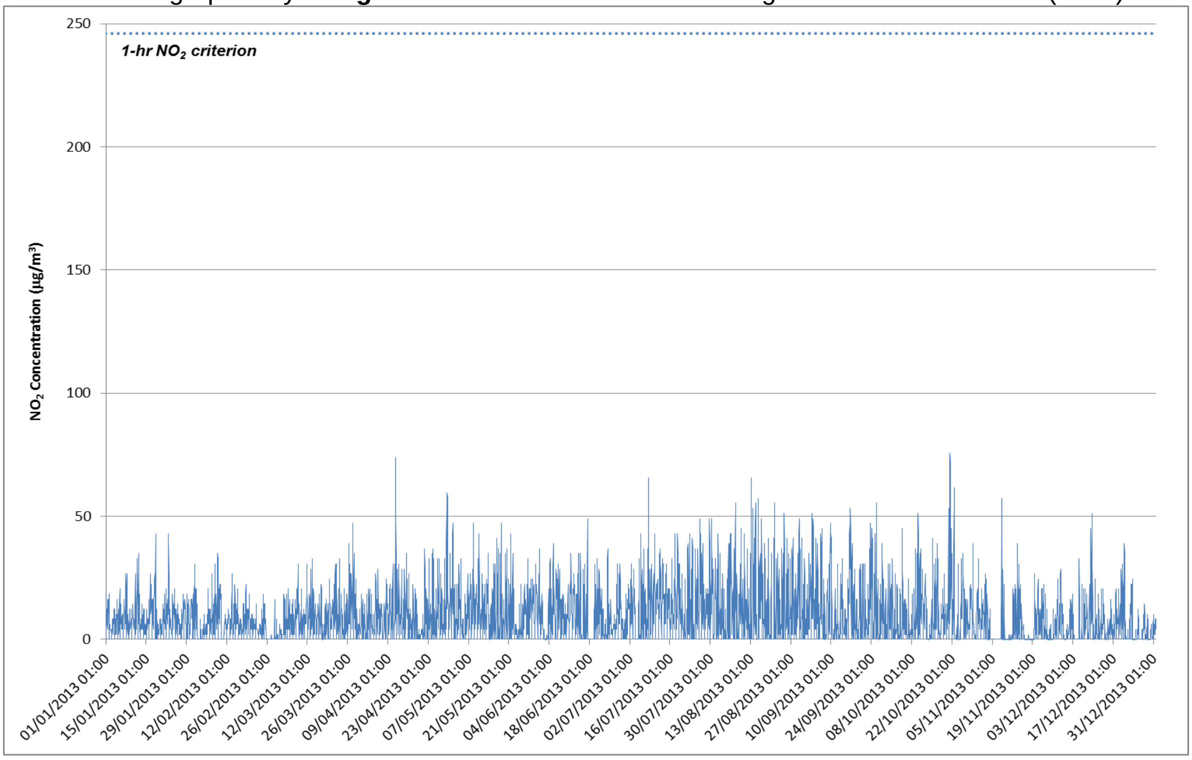
Air quality monitoring is performed by the NSW OEH at four Air Quality Monitoring Station (AQMS) located in a radius of approximately 20 km of the Development site. Details of the monitoring performed at these AQMS are provided in **Table 9**.

Table 9 Details of AQMS surrounding the Development Site

AQMS Name	Distance / Direction from Project Site	Location (km, Australian Map Grid, zone 56)		Parameters Measured	AQMS Commissioned
		Easting	Northing		
St Mary's Located off Mamre Rd	2.8 km / N	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 -
Bringelly Located on Ramsay Rd	10.2 km / S	293.0	6244.5	O_3 NO, NO_2, NO_X SO_2 Fine particles (by nephelometry) Fine particles (PM_{10} using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity Solar radiation	October 1992 -
Prospect Located in William Lawson Park, Myrtle Street	12.4 km / ENE	306.9	6258.7	O_3 NO, NO_2, NO_X CO Fine particles (by nephelometry) Fine particles (PM_{10} using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity Solar radiation	February 2007 -
Liverpool Located off Rose St.	17.0 km / SW	306.4	6243.3	O3 NO, NO2, NO_X CO Fine particles (by nephelometry) Fine particles (PM_{10} and $PM_{2.5}$ using a TEOM) Wind speed, wind direction and sigma theta) Ambient temperature Relative humidity Solar radiation	1990

Note: TEOM – Tapered Element Oscillating Microbalance

The following sections describe the available air quality monitoring data. The measured concentrations of NO_2, which is examined as a marker species for combustion related pollutants (NO_2, SO_2 and CO), O_3 and PM_{10} at the St Mary's AQMS and $PM_{2.5}$ at the Liverpool AQMS are presented in **Table 10** and graphically in **Figure 5** Measured 1 hour Average NO2 Concentrations (2013)



Note: NO2 as measured at St Mary's

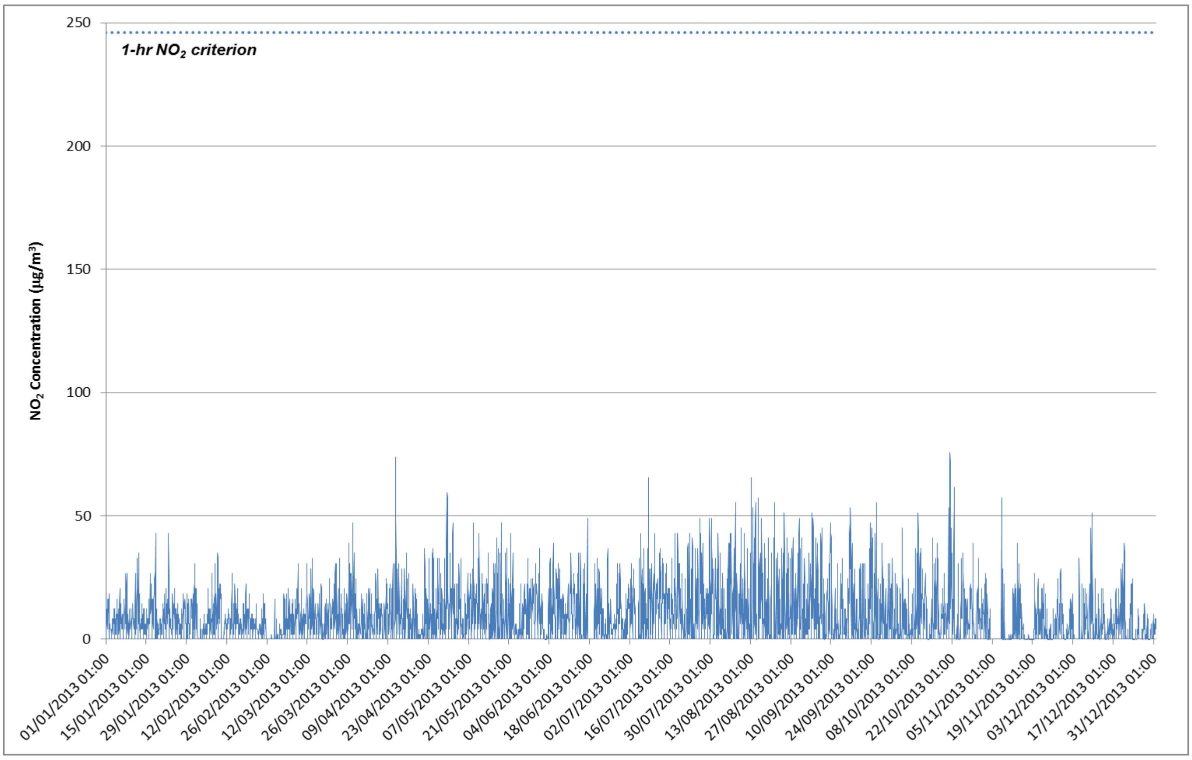
Figure 6 (24 hour PM_{10} and $PM_{2.5}$), Error! Reference source not found., (hourly average NO_2) and **Figure 7** (hourly O_3).

The monitoring data for NO_2 indicate that the 1 hour maximum criterion of 246 µg/m^3 is easily achieved at the St Mary's AQMS (2.8 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 15% of the criterion of 62 µg/m^3. Review of the NEPM compliance report for 2013 also indicates that SO_2 and CO concentrations across all AQMS in NSW were substantially below the relevant criteria.

Table 10 Summary of Air Quality Monitoring Data (2013)

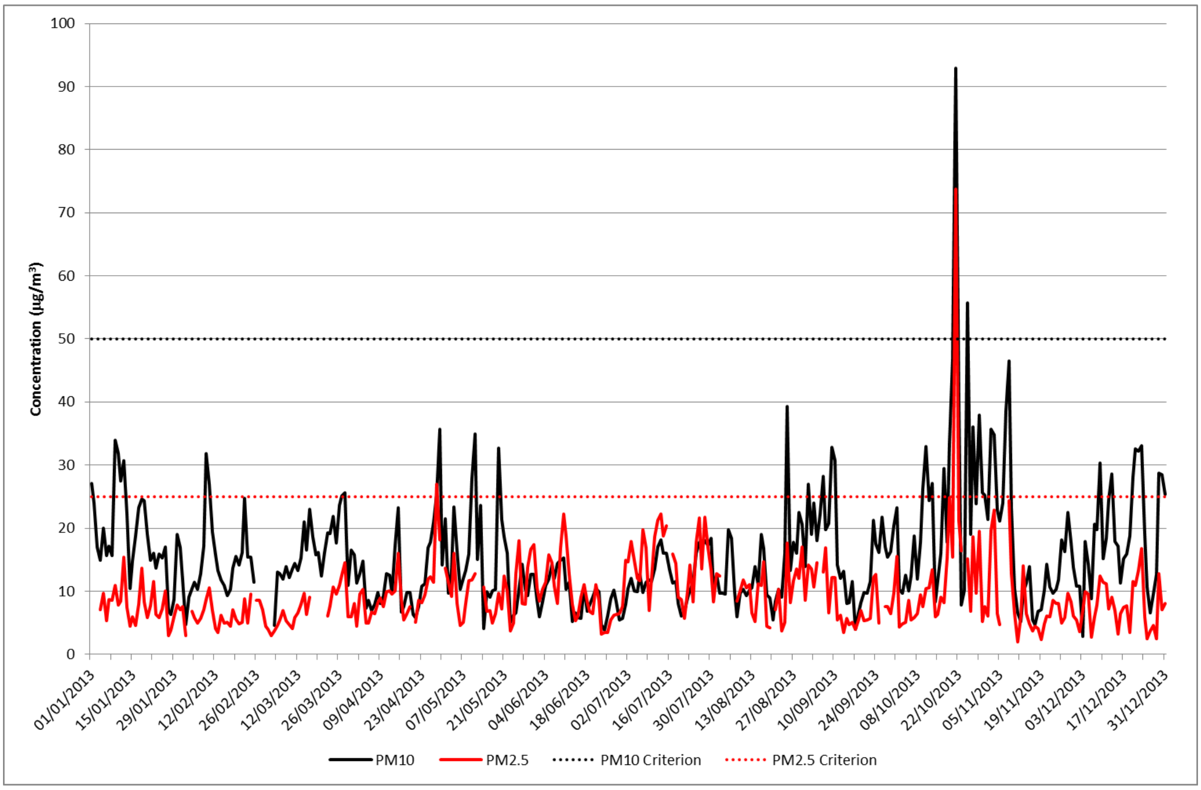
Pollutant	**NO_2**	**PM_{10}**	**$PM_{2.5}$**	**O_3**
AQMS	**St Mary's**	**St Mary's**	**Liverpool**	**St Mary's**
Units	**µg/m^3**	**µg/m^3**	**µg/m^3**	**µg/m^3**
Averaging Period	**1 hour**	**24 hour**	**24 hour**	**1 hour**
Criterion	**246**	**50**	**25**	**-**
Maximum	75.9	93.0	73.8	216
Averaging Period	**Annual**	**Annual**	**Annual**	**Annual**
Criterion	**62**	**30**	**8**	**-**
Mean	9.5	15.6	9.4	69

Figure 5 Measured 1 hour Average NO_2 Concentrations (2013)



Note: NO_2 as measured at St Mary's

Figure 6 Measured 24 hour Average PM_{10} and $PM_{2.5}$ Concentrations (2013)



Note: PM_{10} as measured at St Mary's, $PM_{2.5}$ as measured at Liverpool
See Table 11 for sources of the pollutant 'spikes'.

The monitoring data for PM_{10} and $PM_{2.5}$ indicate that exceedances of the relevant short term criteria (for PM_{10} and $PM_{2.5}$) and annual average criterion (for $PM_{2.5}$) were recorded during 2013 at the St Mary's and Liverpool AQMS. Exceedances for both PM_{10} and $PM_{2.5}$ were recorded during October 2013. Review of the NEPM compliance report for 2013 indicates that the exceedances were generally attributable to the NSW bushfire emergency which extended into early November 2013 (**Table 11**).

Table 11 Highest Ten PM_{10} and $PM_{2.5}$ Concentrations

Statistic	PM_{10} Conc^{n} (µg/m^3)	Date	Comments from NEPM Compliance Report [1]	$PM_{2.5}$ Conc^{n} (µg/m^3)	Date	Comments from NEPM Compliance Report
Maximum	93.0	21 October		73.8	21 October	Bushfire Emergency
2nd Highest	55.8	25 October		27.0	28 April	N/A[2]
3rd Highest	46.8	20 October	Bushfire Emergency	24.8	19 October	
4th Highest	46.5	8 November		24.3	8 November	Bushfire Emergency
5th Highest	39.8	22 October		22.9	3 November	
6th Highest	39.3	25 August	Hazard Reduction Burn	22.2	10 June	N/A[2]
7th Highest	38.6	7 November	N/A[2]	22.2	13 July	N/A[2]
8th Highest	38.0	29 October	Bushfire Emergency	21.8	28 July	N/A[2]
9th Highest	36.1	27 October	Bushfire Emergency	21.6	26 July	N/A[2]
10th Highest	35.7	29 April	N/A[2]	21.3	12 July	N/A[2]

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

Concentrations of TSP are not measured at the St Mary's AQMS. As PM_{10} represents a fraction of the broader particulate concentration, relationships between TSP and PM_{10} as measured at four sites in the Newcastle area between 2000 and 2011 (NSW OEH, 2012) and in the Illawarra region between 1996 and 2004 have been examined and are presented in **Appendix A**. This analysis indicates that the annual average TSP concentration is approximately 2.4 times the annual average PM_{10} concentration (ie PM_{10} represents 41% of total TSP). This multiplier has been applied to the annual average PM_{10} concentration measured at St Mary's in 2013 to estimate the annual average TSP concentration at this location.

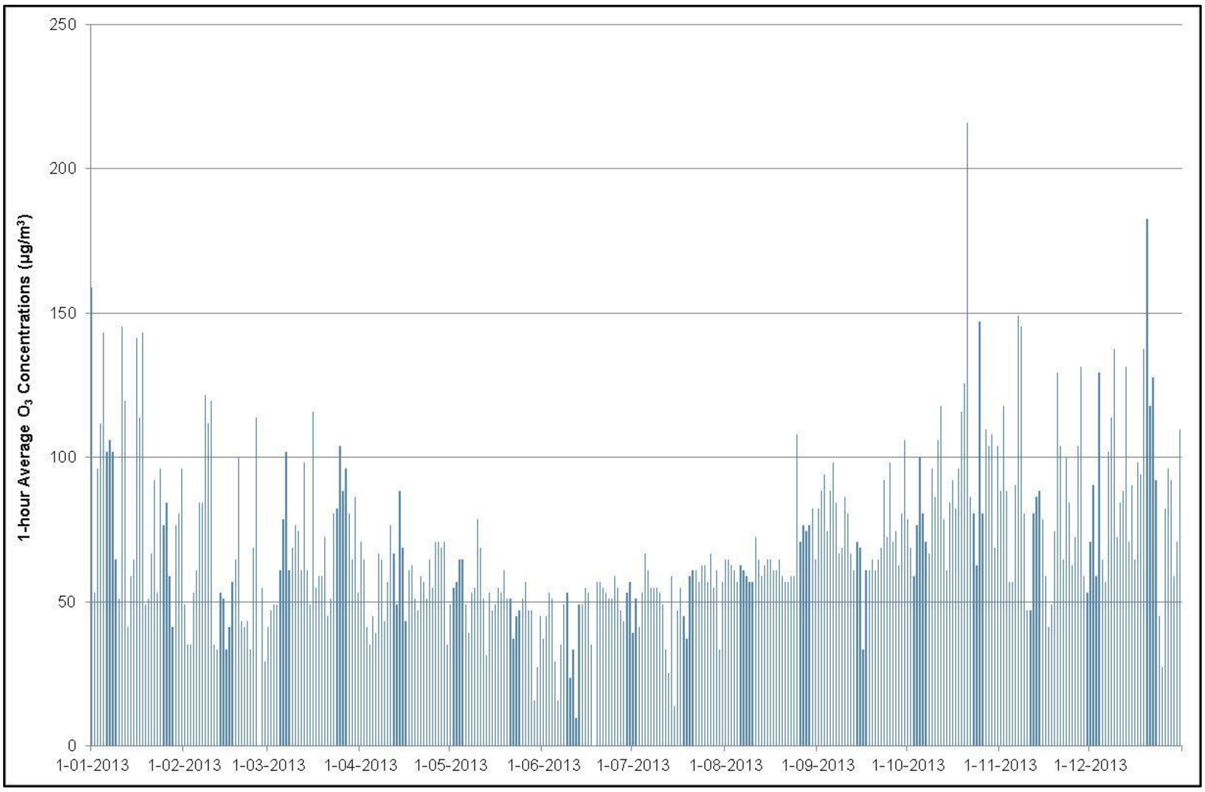
Although many of the TSP/PM_{10} data have been measured in areas in which the sources of particulate matter may not be identical to those surrounding the Development site, the broad relationship is considered to be appropriate for use within this assessment. It is noted that the conclusions of this assessment as they relate to the annual average TSP concentration are not dependent on highly accurate calculation of the existing background TSP concentration experienced in the area.

As is the case with TSP, there is no dust deposition data available in close proximity to the Development site for use in this study. Therefore, the assumed background level of deposited dust defaults to 2 g/m^2/month, as outlined in the Approved Methods (NSW DEC, 2005).

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

An annual maximum 1-hourly average ozone concentration of 216 µg/m^3 from St Mary's AQMS in 2013 was used to calculate the conversion of 1-hour average concentrations of NO_X to NO_2 using the OLM method. An annual average ozone concentration of 69 µg/m^3 from St Mary's AQMS in 2013 was used to calculate the conversion of annual average concentrations of NO_X to NO_2 using the OLM method. Using a conservative and fixed ozone concentration allowed for contour plots of the predicted NO_2 concentrations to be produced.

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



4.1 Summary of Background Air Quality for Assessment Purposes

Table 12 provides a summary of the assumed background concentrations used in this report to evaluate the cumulative impacts of the proposed Development.

Table 12 Adopted Background Pollutant Concentrations

Pollutant	Averaging Period	Maximum Concentration	Source
NO_2	1 hour	75.9 µg/m^3	St Mary's AQMS
	Annual	9.5 µg/m^3	
TSP	Annual	37.7 µg/m^3	Estimated based on a PM_{10}:TSP ratio of 0.41
PM_{10}	24 hours	38.6 µg/m^3	St Mary's AQMS –highest measured concentration not due to bushfire
	Annual	15.6 µg/m^3	St Mary's AQMS
$PM_{2.5}$	24 hours	22.2 µg/m^3	Liverpool AQMS – Highest concentration which is not an exceedance nor due to bushfire
	Annual	9.4 µg/m^3	Liverpool AQMS
Dust Deposition	Annual	2 g/m^2/month	(NSW OEH, 2005)

5 IMPACT ASSESSMENT METHODOLOGY

5.1 Construction Phase Impact Assessment

In general, construction works, such as vegetation clearance, bulk earthworks and construction of the pad and warehouse/distribution buildings have the potential to generate fugitive dust emissions. These emissions have the potential to result in elevated TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates in the vicinity of the works.

Where diesel-powered mobile machinery and vehicles are being used, localised elevations in ambient concentrations of combustion-related pollutants would also be anticipated, but fugitive dust emissions generally have the greatest potential to give rise to downwind air quality impacts.

Modelling of dust from construction projects is generally not considered appropriate, as emission rates can vary significantly depending on a combination of the construction activity and prevailing meteorological conditions (ie rainfall and wind speed), which cannot be reliably predicted. The following sections therefore describe the methods used to perform a qualitative assessment of the potential risks to air quality associated with dust from Development-related construction activities.

5.1.1 Construction Dust Risk Assessment Method

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 (see **Appendix B** for the full methodology). 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.

5.2 Operational Phase Impact Assessment

The assessment of emissions from the operational phase of the development has been assessed quantitatively through the use of dispersion modelling techniques.

5.2.1 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, 1988). 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 2010-2014 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. A summary of the long-term meteorology is presented in **Appendix C** of this report.

5.2.2 Dispersion Modelling

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. 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 5.2.4** and **Section 5.2.5**. 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.

The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as AUSPLUME) is its ability to handle calm wind speeds (<0.5 m/s) and the effects of complicated terrain on plume dispersion. Steady state models assume that meteorology is unchanged by topography over the modelling domain and may result in significant over or under estimation of air quality impacts.

5.2.3 Emissions Estimation

Emissions of pollutants identified in **Section 3.1** resulting from the operation of the Development were estimated based on the following assumptions:

- During the operational phase, vehicles (B-Doubles and PUDs) are likely to stay idle during the loading/unloading operations and emissions from onsite vehicle movements are likely to be minimal compared to that from long-duration idling, however, they have still been assessed.

Potential emissions associated with the combustion of fuel onsite during the operational phase of the project were estimated using emission factors sourced from:

- Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy Duty Trucks (US EPA Office of Transport and Air Quality, 2008), EPA420-F-08-025.

It is understood that the total number of onsite vehicles and number of vehicles in each category (PUDs and B-Double) will vary during operational hours.

The emission factors used in estimating potential emissions from the proposed operations are summarised in **Table 13** and the activity data assumed in the calculations are summarised in **Table 14**. The estimated total emission rates for the proposed operations are presented in **Table 15**.

Table 13 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 vehicles, - 62.5 t for B Doubles
Idling combustion	$EF_{NOx} = 135$ $EF_{PM10} = 3.68$	g/hr	US EPA (2004)	

Table 14 Activity Data Used for Emissions Estimation

Parameter	Value	Unit	Reference
Silt loading	0.06	g/m^2	USEPA 2011
Total distance	2.0	km	Based on estimated maximum distance travelled by vehicle in one trip
AM/PM peak hour number of vehicles	214	vph	The peak hourly traffic flow is approximately 10% of the daily flow in urban areas
Total number of vehicles (conservatively assumed in model)	2,139	vpd	(per comms Luke Wilson 09/03/2016)
Total VKT	4,278	VKT/day	Based on average daily traffic and maximum distance travelled
Proportion of PUD vehicles	70	%	calculated
Proportion of heavy vehicles	30	%	Estimated conservatively from similar assessments (10-25%)
Number of loading bays	41	-	From site layout 4648_MP-001[B].pdf

Table 15 Detailed Emissions Estimation

Wheel Generated Emissions	PUD Vehicles	B Doubles
Vehicle Weight (t)	22.5	62.5
Wheel generated dust EFs - TSP (g/VKT)	6.6	18.7
Wheel generated dust EFs - PM_{10} (g/VKT)	1.3	3.6
Wheel generated dust EFs - $PM_{2.5}$ (g/VKT)	0.3	0.9
Ratio of vehicles	0.7	0.3
Wheel Generated Emissions - TSP (kg/h)	0.82	1.00
Wheel Generated Emissions - PM_{10} (kg/h)	0.16	0.19
Wheel Generated Emissions - $PM_{2.5}$ (kg/h)	0.04	0.05
Combustion Emissions	**PUD Vehicles**	**B Doubles**
Combustion (Onsite Idling EFs) - NO_X (g/h)	135.0	135.0
Combustion (Onsite Idling EFs) - PM_{10} (g/h)	3.7	3.7
Combustion (Onsite Idling EFs) - $PM_{2.5}$ (g/h)	1.2	1.2
Number of vehicles idling[1]	-	41
Combustion Emissions - NO_X (kg/h)	-	5.54
Combustion Emissions - PM_{10} (kg/h)	-	0.15
Combustion Emissions - $PM_{2.5}$ (kg/h)	-	0.05
TOTAL EMISSIONS	**All Vehicles[2]**	
TSP (kg/h/source)	0.036	
PM_{10} (kg/h/source)	0.009	
$PM_{2.5}$ (kg/h/source)	0.003	
NO_X (kg/h/source)	0.135	

Note:
1. It has been assumed that there is a B-Double idling in every loading bay each hour.
2. Emission rates have been applied as continuous emission rates for every hour of the year in the model.

5.2.4 Meteorological Modelling - 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 **Section 5.2.5** below.

Table 16 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)
Terrain	AUSLIG 9 second DEM

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

5.2.5 Meteorological Modelling - 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 17 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)* TAPM - upper air data (313,309 mE; 6,273,681 mN)

Note: *Holsworthy Aerodrome AWS was included to utilise cloud cover data

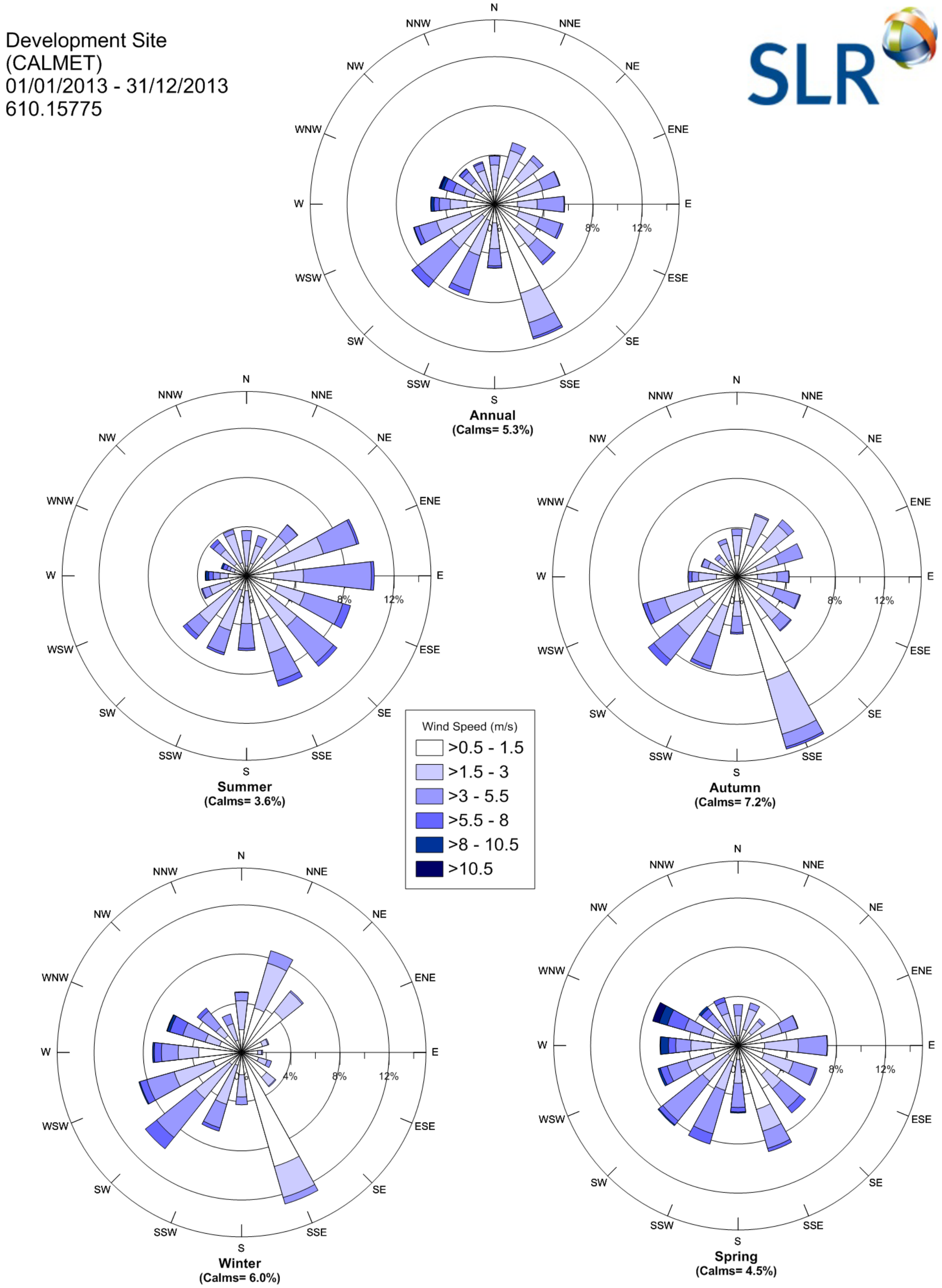
5.2.6 Meteorological Data Used in Modelling – Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET at the Development site is presented as wind roses in **Figure 8**. **Figure 8** indicates that winds experienced at the site are predominantly moderate (between 1.5 m/s and 5.5 m/s) with a small percentage of strong winds (>10.5 m/s) and wind direction is seasonally dependent. Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur approximately 5.3% of the time throughout the modelling period.

The seasonal wind roses indicate that typically:

- In summer, winds are moderate to strong predominantly from between the east-northeast and south-southeast, with very few winds from the northwest quadrant.
- In autumn, winds are light predominantly from the south-southeast with also a significant contribution of winds from the southwest quadrant.
- In winter, predominant wind directions are similar to autumn but with a greater contribution of lighter winds from the north-northeast.
- In spring, moderate to strong winds occur from the west northwest with winds from the southeast and southwest quadrants also dominant.

Figure 8 Predicted Seasonal Wind Roses for the Development Site (CALMET predictions, 2013)



5.2.7 Meteorological Data Used in Modelling – 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 18** .

Table 18 Meteorological Conditions Defining Pasquill Stability Classes (Source: Pasquill, 1961)

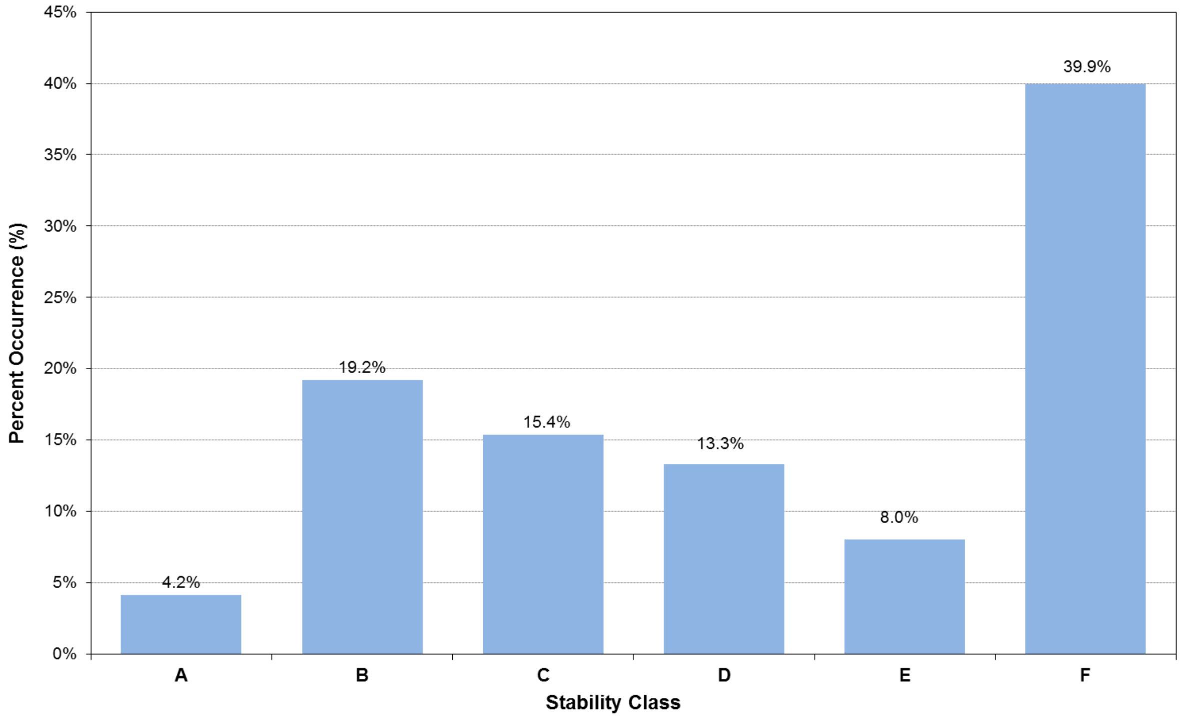
Surface wind speed (m/s)	Daytime insolation			Night-time conditions	
	Strong	Moderate	Slight	Thin overcast or > 4/8 low cloud	<= 4/8 cloudiness
< 2	A	A - B	B	E	F
2 - 3	A - B	B	C	E	F
3 - 5	B	B - C	C	D	E
5 - 6	C	C - D	D	D	D
> 6	C	D	D	D	D

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 9**. 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 9 Predicted Stability Class Frequencies at the Development Site (CALMET predictions, 2013)

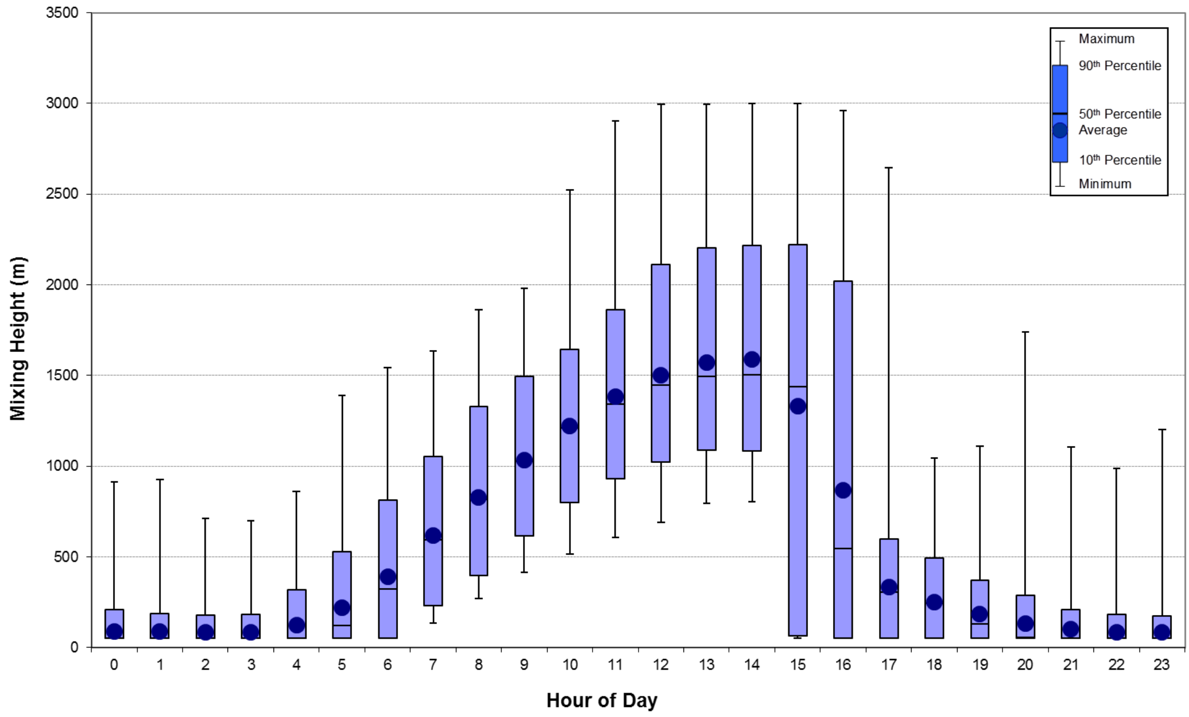


5.2.8 Meteorological Data Used in Modelling – Mixing Heights

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Development site during the 2013 modelling period are illustrated in **Figure 10**.

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.

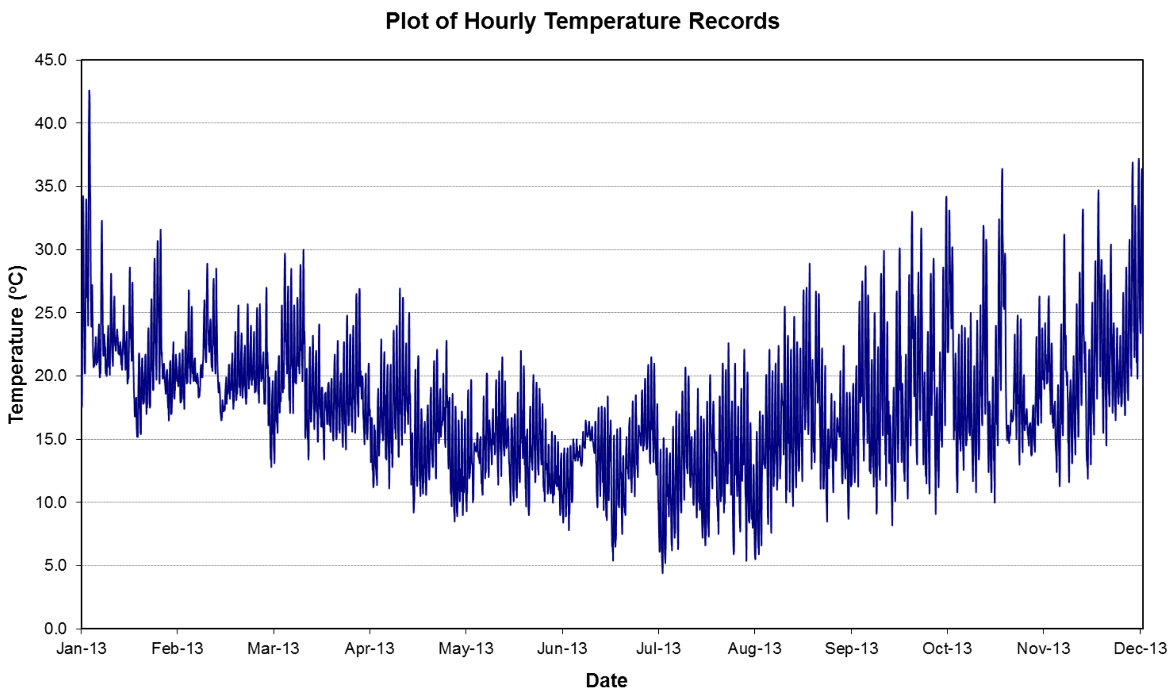
Figure 10 Predicted Mixing Heights at the Development Site (CALMET predictions, 2013)



5.2.9 Meteorological Data Used in Modelling – Temperature

The modelled temperature variations as predicted at the Development site during 2013 are illustrated in **Figure 11**. The maximum temperature (42.6°C) was predicted on 18 January and the minimum temperature (4.4°C) was predicted on 22 July.

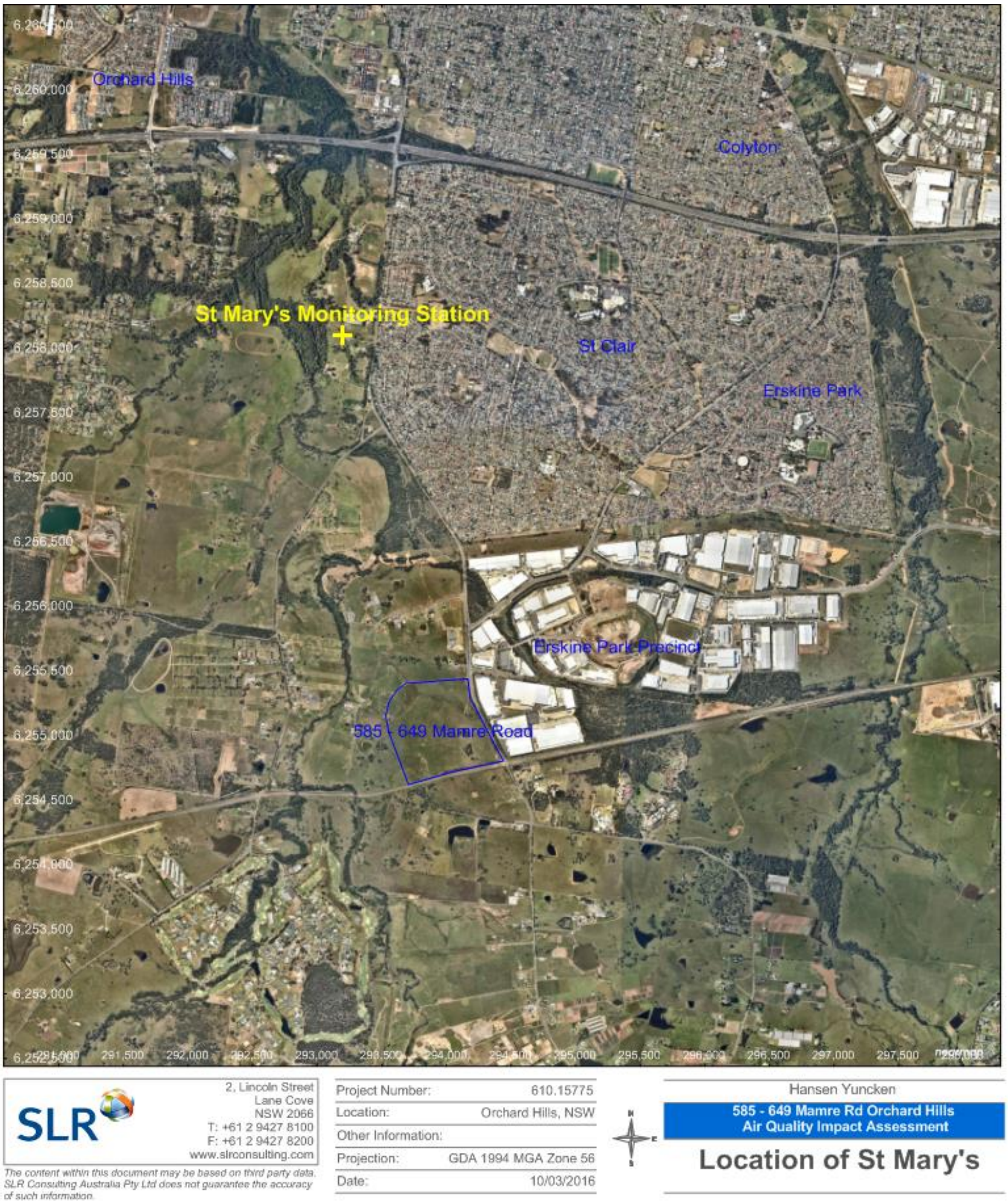
Figure 11 Predicted Temperatures at the Development Site (CALMET predictions, 2013)



5.2.10 Meteorological Data Used in Modelling – Data Validation

As discussed in **Section 4**, NSW OEH operates air quality network across various locations in NSW. The nearest such station is located at Mamre Road in St Mary's (~3 km from the Development site). It is noted that meteorological data (wind speed, wind direction, sigma theta and ambient temperature) are also monitored at St Marys monitoring station. The location of the St Marys monitoring station is shown in **Figure 12**.

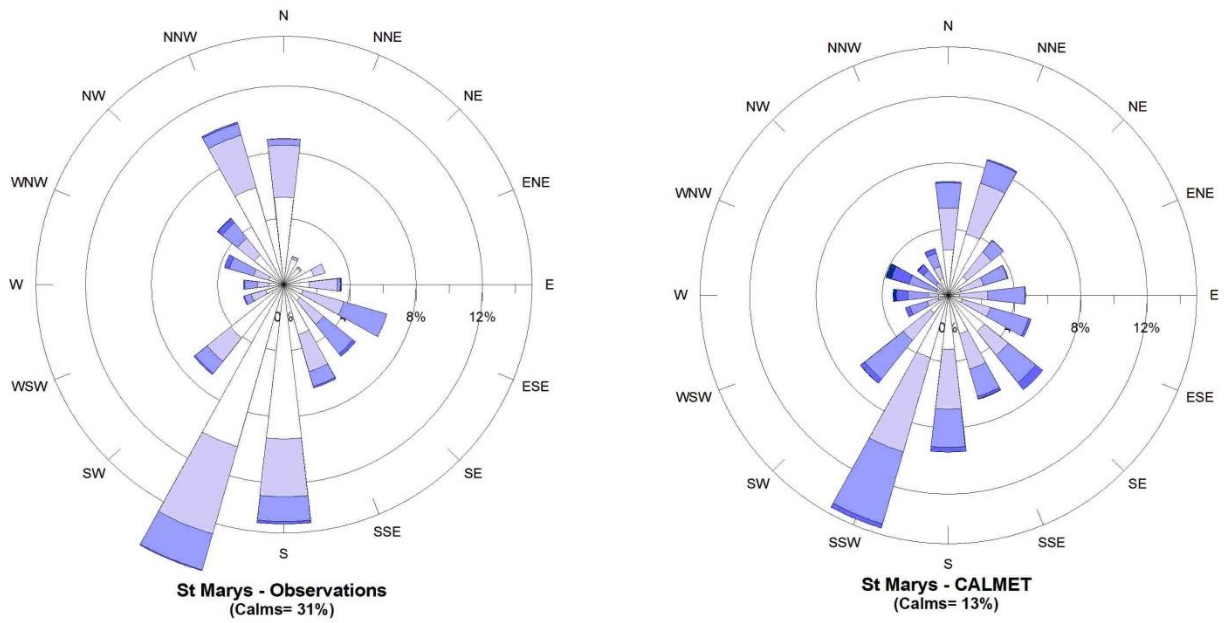
Figure 12 Location of the St Marys Monitoring Station



Source: Nearmaps (2014)

In the absence of any site specific meteorological data, the meteorological data from St Marys monitoring station has been used to validate the meteorological modelling approach. A summary of the comparison between modelled meteorological data and observed meteorological data at St Marys monitoring station is presented as wind roses and is shown in **Figure 13**.

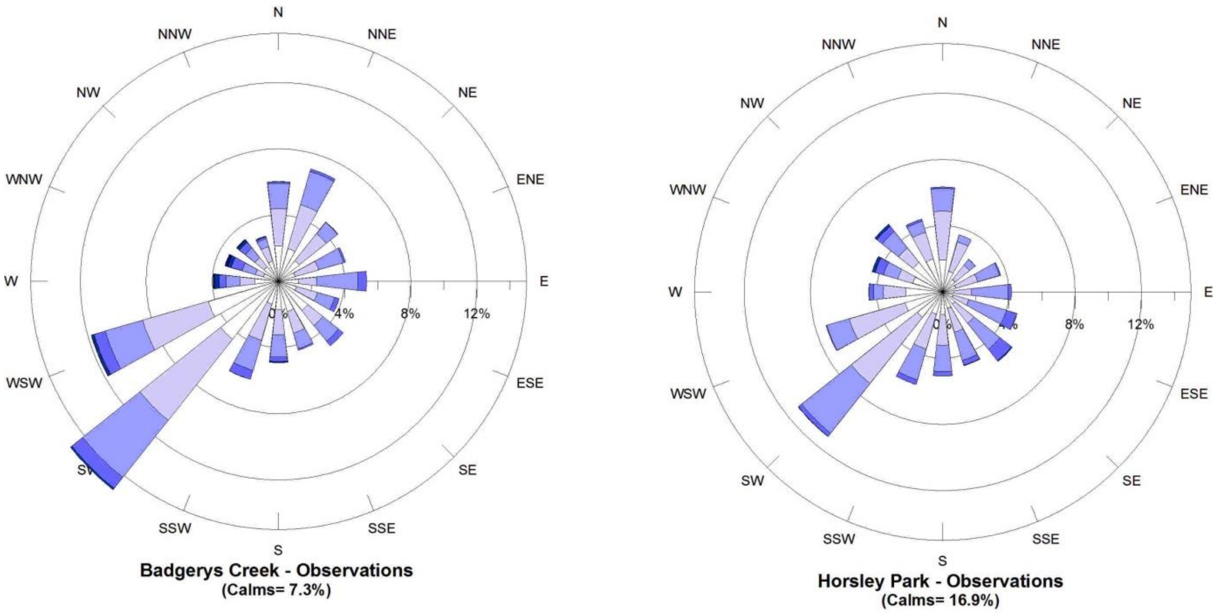
Figure 13 Comparison of Wind Roses at St Marys Monitoring Station – Observed Vs CALMET



It is noted that the observed meteorological data compares well with the modelled meteorological data at St Marys monitoring station, with the exception of winds from north northeast direction and significantly higher calm conditions (31% compared to 13%) for observed data.

It is considered appropriate to analyse the monitored meteorological data in a regional context to analyse the north northeast component of winds. The nearest BoM stations are located at Horsley Park AWS and Badgerys Creek AWS. The observed meteorological data at Badgerys Creek AWS and Horsley Park AWS is shown in **Figure 14**.

Figure 14 Observed Meteorological Data Monitored at Badgerys Creek and Horsley Park (2013)



It is noted from the observed meteorological data at Badgerys Creek AWS and Horsley Park AWS that there is a consistent northeast and southwest wind component in the region, which has been predicted by the CALMET meteorological modelling at the St Marys monitoring station.

It is concluded from the above analysis that at the St Marys monitoring station, the low percentage of winds from the north northeast direction and higher percentage of calm conditions is likely to be caused be the obstruction (large building) present to the northeast of the St Marys monitoring station (shown in **Figure 12**).

5.3 Background Air Quality Data Used for Cumulative Impact Assessment

As described in **Section 4**, the existing air quality of the area surrounding the Development site has been characterised using measurements collected at the Liverpool and St Mary's AQMS in 2013. Although the data in **Table 10** represents the maximum concentrations measured (for comparison with the criteria), in some instances time series data has been used in this assessment to allow contemporaneous hour by hour assessment of predicted plus background concentrations. The resulting time series of cumulative concentrations have then been analysed to determine the compliance status against each criterion.

5.3.1 NO_X to NO_2 Conversion

For NO_2, predictions are made using emission rates of NO_X (refer **Section 5.2.3**) with corresponding impacts assessed at sensitive receptors. A conservative assumption can be made that all NO_X emitted will be converted to NO_2 with the background NO_2 concentration added to allow comparison with the cumulative NO_2 criterion. However, this method is highly simplistic and conservative with the Approved Methods providing for more detailed assessment. Method 2, which assumes the NO to NO_2 conversion is limited by the ambient ozone (O_3) concentration (OLM), has been adopted as per Section 8.1.2 of the Approved Methods.

NO_X emissions from combustion sources are principally comprised of nitric oxide (NO) with low concentrations of nitrogen dioxide (NO_2). Once emitted into the atmosphere, the NO is oxidised to NO_2, predominantly (although not exclusively) through reaction with O_3.

The OLM assumes that all the available O_3 in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. The approach assumes that the atmospheric reaction is instant. In reality the reaction takes place over a number of hours. The level 2 assessment of the OLM has been adopted in this assessment, which uses contemporaneous predicted and background concentrations (O_3 and NO_2 from the St Marys AQMS).

The OLM is presented below:

$$[NO_2]total = \{0.1 \times [NO_x]pred\} + MIN\left\{(0.9) \times [NO_x]pred \ or \ \left(\frac{46}{48}\right) \times [O_3]bkgd\right\} + [NO_2]bkgd$$

Where:

$[NO_2]total$ = the predicted concentration of NO_2 in µg/m^3
$[NO_x]pred$ = the dispersion model prediction of the ground level concentration of NO_X in µg/m^3
MIN = the minimum of the two quantities within the braces
$[O_3]bkgd$ = the background ambient O_3 concentration in µg/m^3
$\left(\frac{46}{48}\right)$ = the molecular weight of NO_2 divided by the molecular weight of O_3
$[NO_2]bkgd$ = the background ambient NO_2 concentration in µg/m^3

6 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 outline in detail the results of the assessment for both the construction and operational phases of the Development.

6.1 Impacts during Development Construction

6.1.1 Step 1 – Screening Based on Separation Distance

In the case of the proposed Development, sensitive receptors are noted to be located between 70 m (R1) and 550 m (R6) from the Development boundary. Given that the majority of receptors are located within 500 m of the site entrance, with some being with within 350 m of the site boundary, further assessment is required.

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

The footprint of the total site is approximately 45 ha (449,800 m^2) with the Stage 1 development planned to occupy approximately 13.5 ha (135,430 m^2). Although the Development involves no demolition work, the following works are required:

- ground clearance of the site (449,800 m^2 in area to a nominal 0.5 m depth);
- the establishment of hard standing on approximately 60% of the total site (for the Stage 1 development); and
- the construction of a steel framed building covering approximately 80,050 m^2 to an assumed height of 12 m above ground level (AGL) (equating to 960,600 m^3 in building volume).

The assumed access route around the site during construction works may be up to 2.0 km in total length.

Based upon the above assumptions, the dust emission magnitudes are as presented in **Table 19**.

Table 19 Categorisation of dust emission magnitude

Activity	Dust Emission Magnitude
Demolition	N/A
Earthworks	Large
Construction	Large
Trackout	Large

6.1.3 Step 2b – Risk Assessment

Receptor Sensitivity

Based on the criteria listed in **Section 3.4**, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, as the receptors are dwellings where people may be reasonably expected to be present continuously as part of the normal pattern of land use.

Sensitivity of an Area

Using the classifications shown in **Section 3.4**, the sensitivity of the surrounding area to health effects has been classified as 'low', and the sensitivity of the area to dust soiling is classified as '*low*'. This categorisation has been made taking into account the distances between receptors and the Development, the annual mean background PM_{10} concentration of 15.6 µg/m^3 (refer **Table 10**) and the low number of receptors present.

Risk Assessment

Given the sensitivity of the identified individual receptors is classified as '*high*' for dust soiling 'health effects, the sensitivity of the general area as '*low'* for dust soiling and health effects and the dust emission magnitudes for the various construction phase activities as shown in **Table 19**, the resulting risk of air quality impacts is as presented in **Table 20**. The results indicate that there is a low risk of adverse dust soiling impacts occurring at the off-site receptor locations if no mitigation measures were to be applied to control emissions from earthworks, construction and trackout. The risk of adverse human health impacts is also designated as low.

Table 20 Risk of Air Quality Impacts from Construction Activities - Earthworks

Impact	Sensitivity of Area	Dust Emission Magnitude				Preliminary Risk			
		Demolition	Earthworks	Construction	Trackout	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Low	N/A	Large	Large	Large	N/A	Low	Low	Low
Human Health	Low					N/A	Low	Low	Low

6.1.4 Step 3 – Site Specific Mitigation

Table 21 lists the relevant mitigation measures recommended as *highly recommended* (H) or *desirable* (D) by the IAQM methodology for a development shown to have a low risk of adverse impacts. Not all these measures would be practical or relevant to the proposed Development, 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 excavated/handled on site, etc) and the most appropriate measures adopted.

Table 21 Site-Specific Management Measures Recommended by the IAQM

1	**Communications**	
1.1	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
1.2	Display the head or regional office contact information.	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Local Authority.	D
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 asked.	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 asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100 m of 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 asked.	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
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.	D
4.4	Avoid site runoff of water or mud.	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D
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
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.	D
7	**Waste Management**	
7.1	Avoid bonfires and burning of waste materials.	H
8	**Construction**	
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D
8.2	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
9	**Trackout**	
9.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D
9.2	Avoid dry sweeping of large areas.	D

9.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D
9.4	Record all inspections of haul routes and any subsequent action in a site log book.	D
9.5	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

6.1.5 Step 4 – Residual Impacts

For almost all construction activity, the IAQM Methods notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible. Given the limited duration of the Development earthworks activities, the lack of demolition activities, and the expectation that water would be readily available for dust suppression when required, residual impacts associated with fugitive dust emissions from the proposed Development are anticipated to be ‘not significant’.

6.2 Impacts during Development Operation

Dispersion modelling predictions at the residences/properties nominated in **Section 2.3** are presented in **Section 6.2.1** to **Section 6.2.4** for the operational phase of the Development. Pollutant isopleth plots are also provided in the respective sections which show the maximum predicted incremental (Development only) concentrations and deposition rates of the pollutants assessed.

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

6.2.1 Particulates (as TSP)

Table 22 presents the incremental and cumulative annual average TSP concentrations predicted at surrounding representative sensitive receptors. It can be observed from **Table 22** that the predicted cumulative annual average TSP concentrations at all receptors are lower than to the relevant OEH guideline (<47% of the criterion).

Contour plots of the predicted incremental annual average TSP concentrations are presented in **Figure 11**.

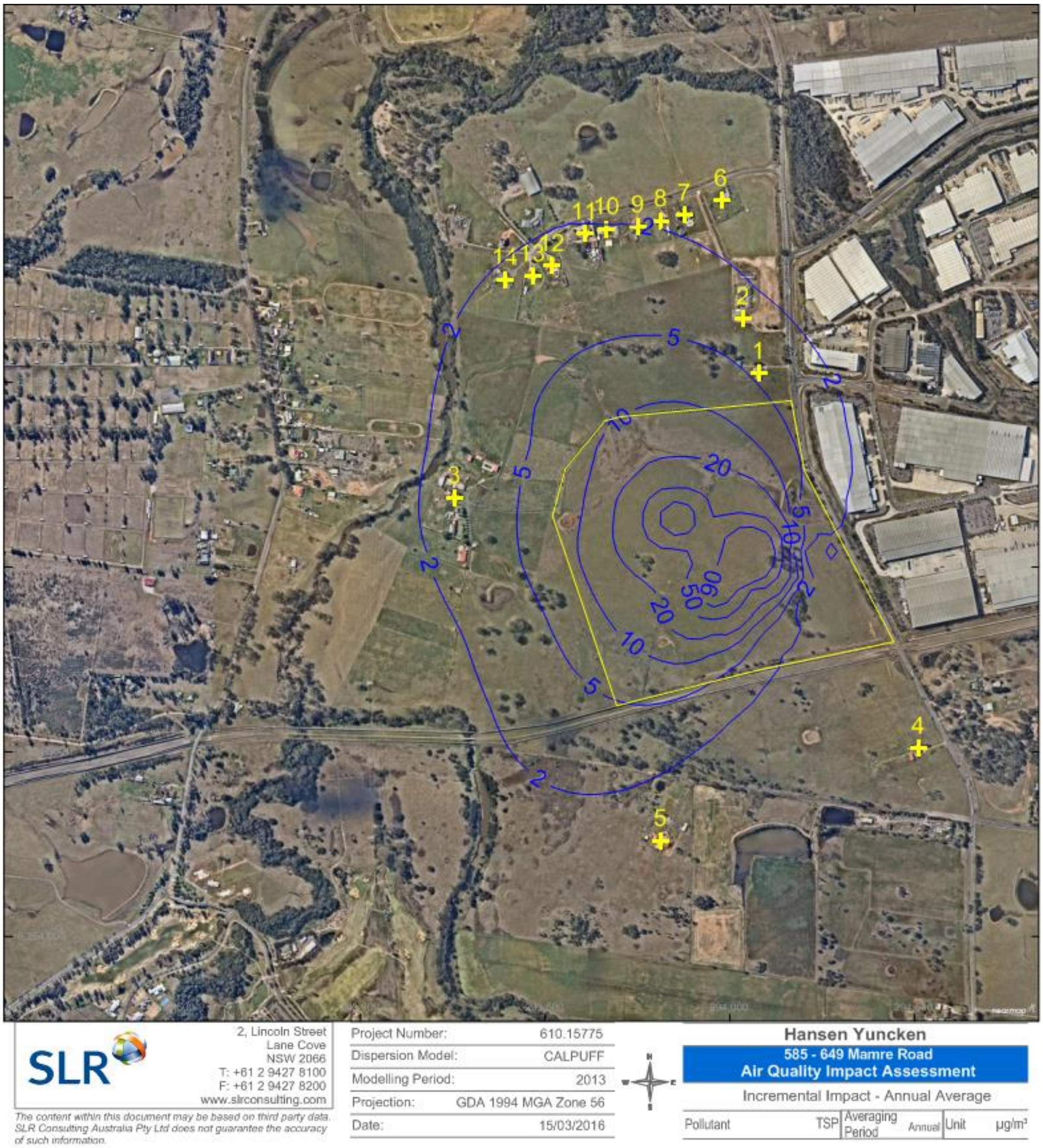
Table 22 Predicted Annual Average TSP Concentrations at Sensitive Receptors - Operation

Receptor ID	Incremental Impact (µg/m^3)	Assumed Background (µg/m^3)[1]	Cumulative Impact (µg/m^3)
R1	4.4	37.7	42.1
R2	2.8	37.7	40.5
R3	2.8	37.7	40.5
R4	0.3	37.7	38.0
R5	1.0	37.7	38.7
R6	1.4	37.7	39.1
R7	1.7	37.7	39.4
R8	1.9	37.7	39.6
R9	2.0	37.7	39.7
R10	2.1	37.7	39.8

Receptor ID	Incremental Impact (µg/m³)	Assumed Background (µg/m³)[1]	Cumulative Impact (µg/m³)
R11	2.2	37.7	39.9
R12	2.5	37.7	40.2
R13	2.5	37.7	40.2
R14	2.2	37.7	39.9
Criterion	**-**	**-**	**90**

Note 1: Refer **Section 4.1**

Figure 15 Predicted Annual Average TSP Concentrations



6.2.2 Particulates (as PM_{10})

Table 23 presents incremental and cumulative maximum 24-hour average PM_{10} concentration at each receptor listed in **Section 2.2**. The incremental and cumulative 24-hour average PM_{10} concentrations predicted at each sensitive receptor are well below the relevant OEH guideline and the proposed operation is unlikely to cause any exceedances of the guideline at these locations.

It can be observed that the predicted incremental 24-hour average PM_{10} concentrations at all receptors are minor (<17%) compared to the relevant ambient air quality guideline. The proposed operational activities are unlikely to cause any additional exceedances above background air quality concentrations of the 24-hour PM_{10} criterion at the sensitive receptor locations.

Table 23 Predicted Maximum 24-Hour Average PM_{10} Concentrations at Sensitive Receptors

Receptor ID	Maximum 24-hour Average PM_{10} Concentrations (µg/m^3)		
	Incremental Impact	**Background**	**Cumulative Impact**
R1	8.5	38.6	47.1
R2	6.0	38.6	44.6
R3	3.9	38.6	42.5
R4	2.0	38.6	40.6
R5	3.0	38.6	41.6
R6	3.3	38.6	41.9
R7	3.3	38.6	41.9
R8	3.4	38.6	42.0
R9	3.5	38.6	42.1
R10	3.4	38.6	42.0
R11	3.4	38.6	42.0
R12	3.4	38.6	42.0
R13	3.2	38.6	41.8
R14	2.9	38.6	41.5
Criterion			**50**

Table 24 presents a summary of the incremental and cumulative annual average PM_{10} concentrations predicted at each identified sensitive receptor location. 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 24 Predicted Maximum Annual Average PM_{10} Concentrations at Sensitive Receptors

Receptor ID	Annual Average PM_{10} Concentrations ($\mu g/m^3$)		
	Incremental Impact	**Background**	**Cumulative Impact**
R1	1.5	15.6	17.1
R2	1.0	15.6	16.6
R3	1.1	15.6	16.7
R4	0.1	15.6	15.7
R5	0.4	15.6	16.0
R6	0.6	15.6	16.2
R7	0.7	15.6	16.3
R8	0.8	15.6	16.4
R9	0.8	15.6	16.4
R10	0.8	15.6	16.4
R11	0.9	15.6	16.5
R12	1.0	15.6	16.6
R13	1.0	15.6	16.6
R14	0.9	15.6	16.5
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 16 Predicted Maximum 24 Hour Average PM_{10} Concentrations

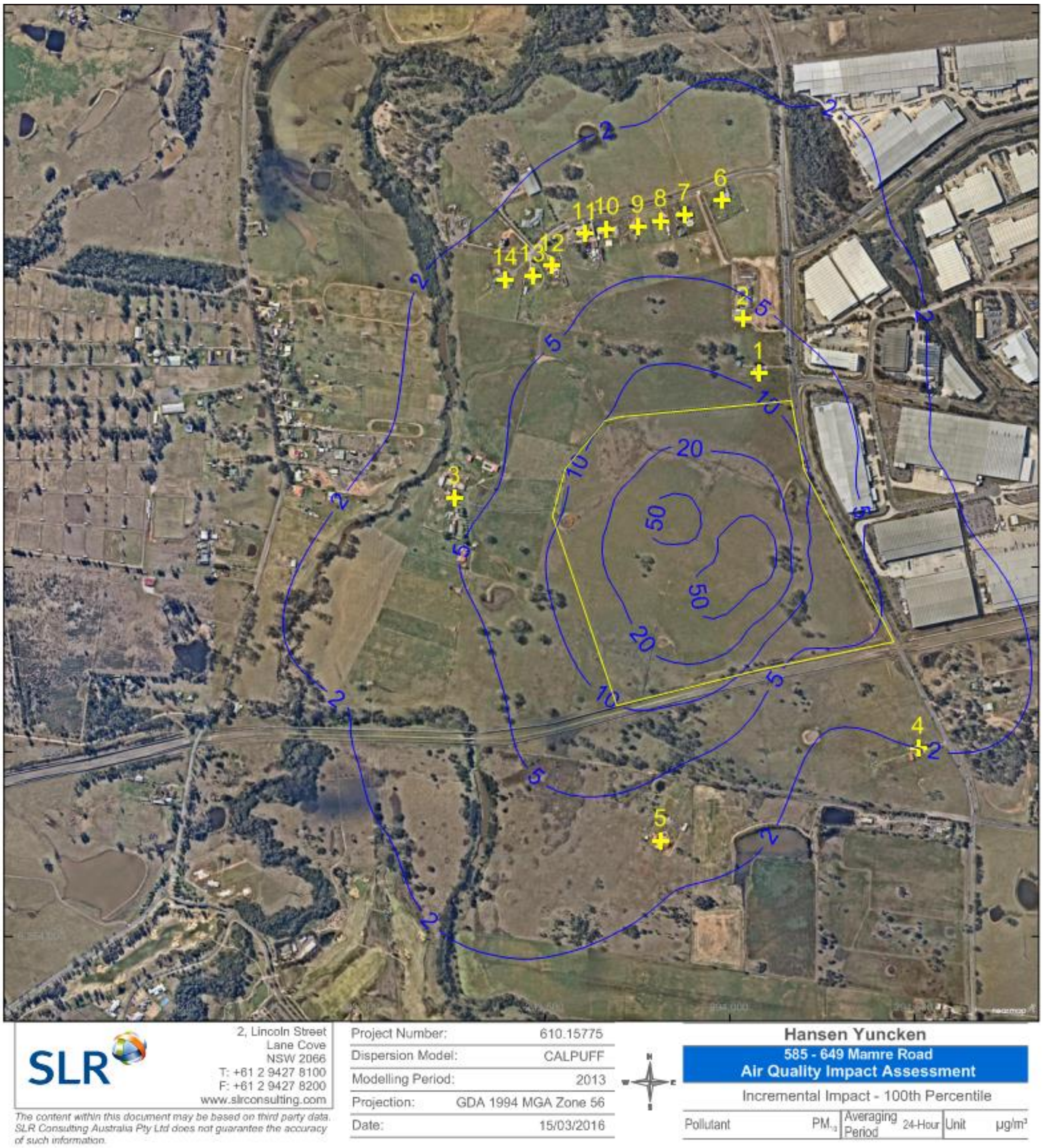
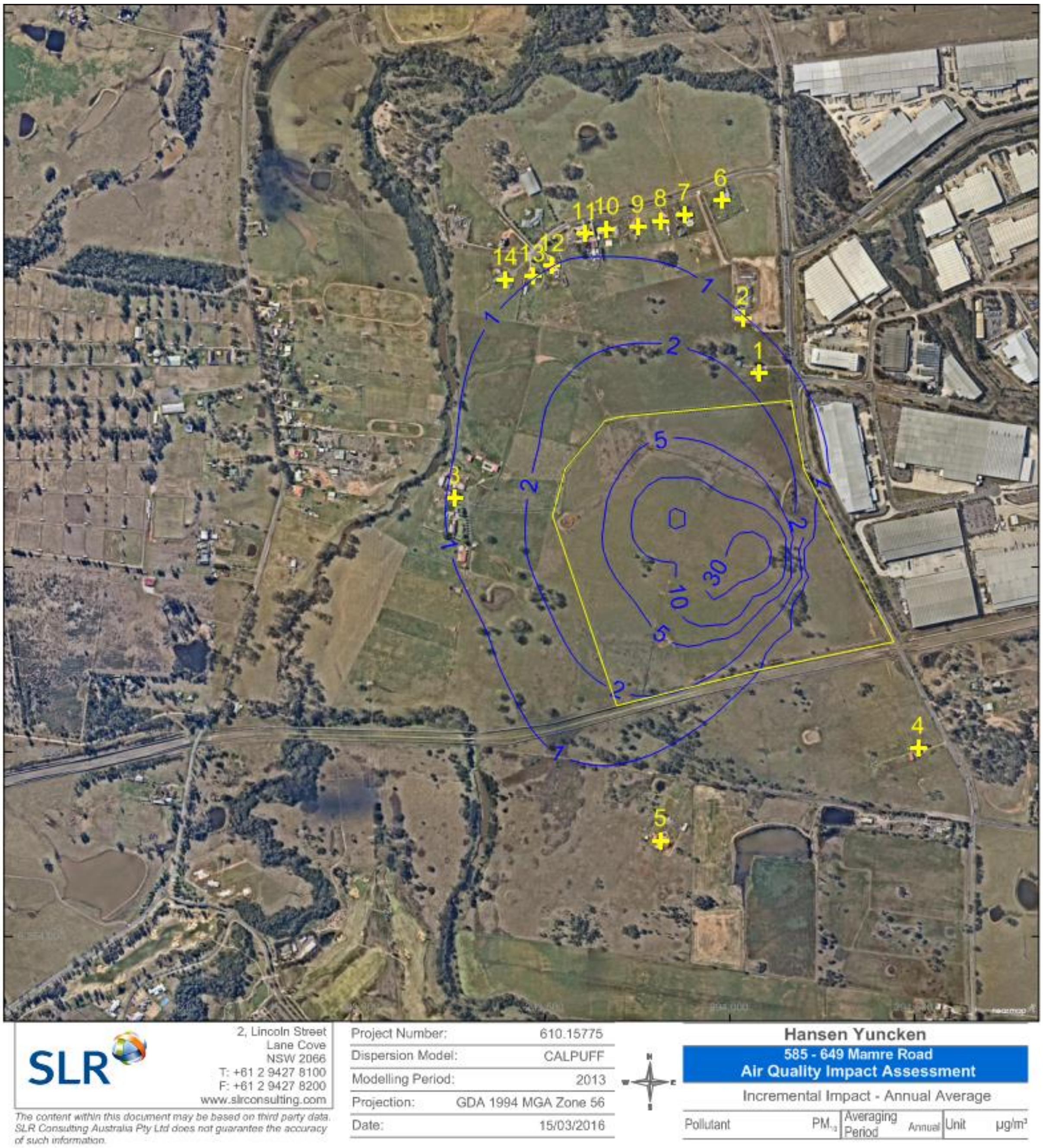


Figure 17 Predicted Annual Average PM_{10} Concentrations



6.2.3 Particulates (as $PM_{2.5}$)

Table 25 and **Table 26** show the predicted incremental impacts for 24-hour and annual average $PM_{2.5}$ concentrations at each receptor identified in **Section 2.2**. The maximum 24-hour and annual average incremental $PM_{2.5}$ concentration contour plots are presented in **Figure 18** and **Figure 19**.

The predicted incremental 24-hour and annual average $PM_{2.5}$ concentrations at all receptors are minor (<10% and <5% respectively) compared to the relevant ambient air quality guideline. Considering the relatively small predicted incremental contribution, it can be concluded that the proposed operational activities are unlikely to cause any additional exceedances above background air quality concentrations of the 24-hour or annual average $PM_{2.5}$ criteria at the sensitive receptor locations.

It is noted that the monitoring data for $PM_{2.5}$ indicate that the annual average criterion was exceeded during 2013 at the Liverpool AQMS. A significant contributor to this exceedance was the NSW bushfire emergency which extended from October into early November 2013. The incremental contribution to annual average $PM_{2.5}$ concentrations predicted at the sensitive receptors indicates that under normal conditions, the proposed Development would not be expected to cause an exceedance of the annual average $PM_{2.5}$ criterion.

Table 25 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations at Sensitive Receptors

Receptor ID	**Maximum 24-hour Average PM_{10} Concentrations (µg/m^3)**		
	Incremental Impact	**Background**	**Cumulative Impact**
R1	2.4	22.2	24.6
R2	1.7	22.2	23.9
R3	1.1	22.2	23.3
R4	0.6	22.2	22.8
R5	0.8	22.2	23.0
R6	0.9	22.2	23.1
R7	0.9	22.2	23.1
R8	1.0	22.2	23.2
R9	1.0	22.2	23.2
R10	1.0	22.2	23.2
R11	1.0	22.2	23.2
R12	1.0	22.2	23.2
R13	0.9	22.2	23.1
R14	0.8	22.2	23.0
Criterion			**25**

Table 26 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations at Sensitive Receptors

Receptor ID	Annual Average $PM_{2.5}$ Concentrations (µg/m^3)		
	Incremental Impact	**Background**	**Cumulative Impact**
R1	0.4	9.4	9.8
R2	0.3	9.4	9.7
R3	0.3	9.4	9.7
R4	<0.1	9.4	<9.5
R5	0.1	9.4	9.5
R6	0.2	9.4	9.6
R7	0.2	9.4	9.6
R8	0.2	9.4	9.6
R9	0.2	9.4	9.6
R10	0.2	9.4	9.6
R11	0.2	9.4	9.6
R12	0.3	9.4	9.7
R13	0.3	9.4	9.7
R14	0.3	9.4	9.7
Criterion	**-**	**-**	**8**

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

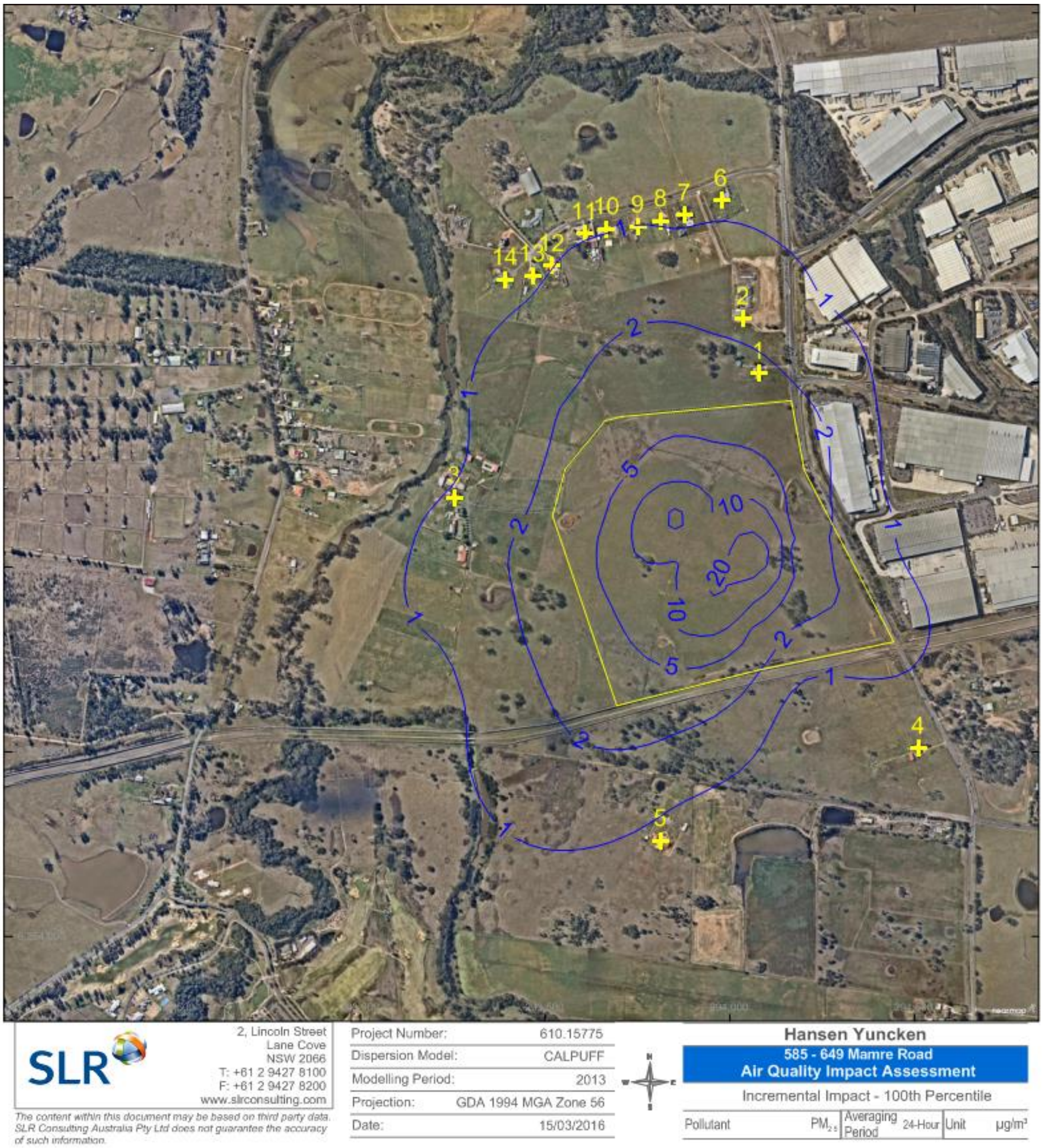
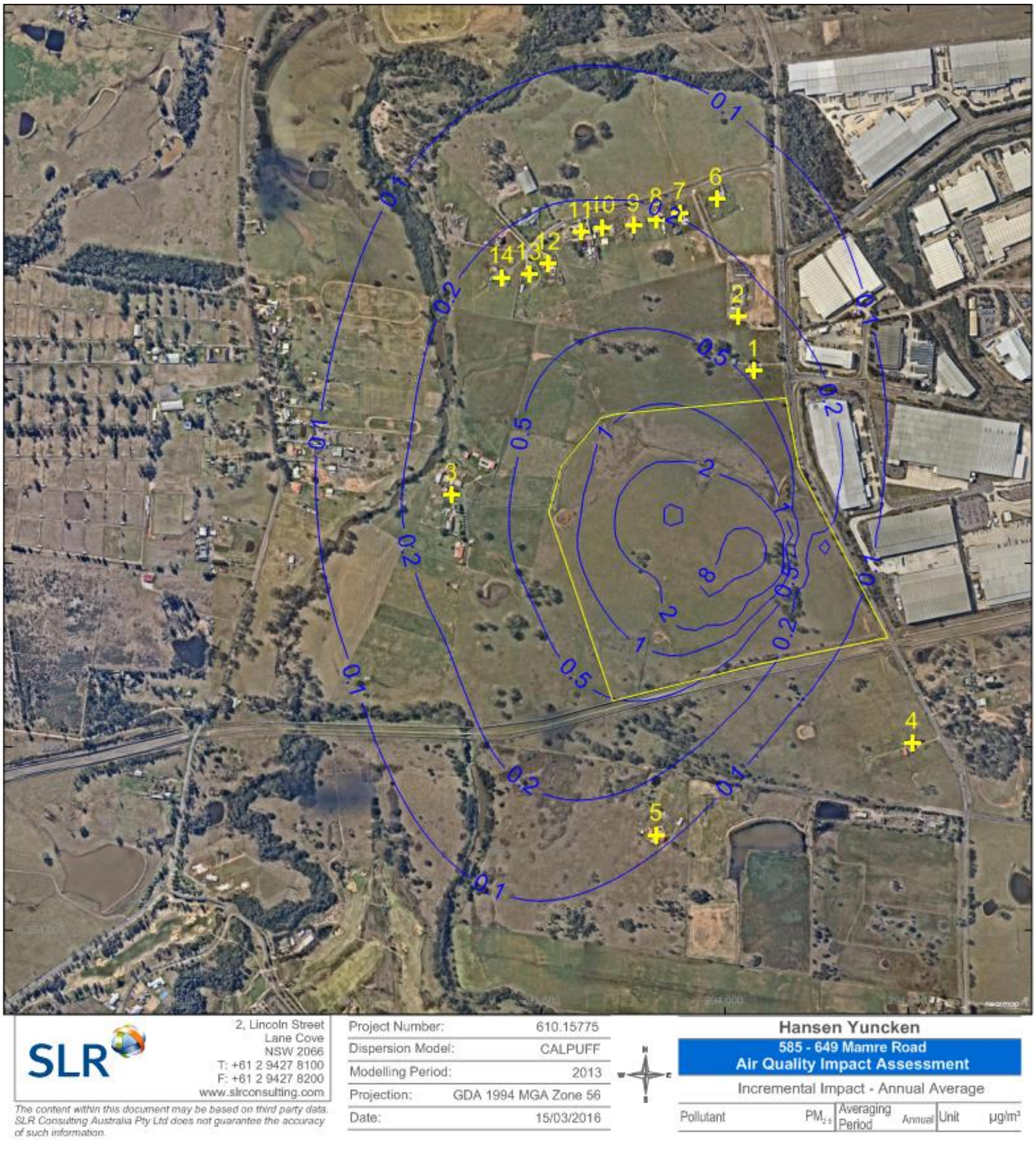


Figure 19 Predicted Annual Average $PM_{2.5}$ Concentrations



6.2.4 Nitrogen Dioxide (NO_2)

Table 27 presents the incremental and cumulative 1-hour and annual average NO_2 concentrations predicted at each receptor identified in **Section 2.2**. The NO_2 concentrations have been estimated using the predicted NO_X concentrations and the OLM method (based on background ozone data), as prescribed by the Approved Methods. The ozone concentrations are discussed in detail in **Section** 4. The results presented in **Table 29** show that the predicted cumulative annual average NO_2 concentrations are well below the relevant OEH criteria at all receptors.

The results presented in **Table 27** show that the predicted cumulative maximum 1-hour average NO_2 concentrations are below the relevant OEH criteria at all receptors except at receptors 1-4. It is worth noting that three factors add to the conservatism associated with this cumulative impact:

1. the assessment is based on the assumption that vehicles are idling at all 41 bays simultaneously,
2. the background concentration of NO_2 represents the maximum 1-hour average concentration recorded for NO_2 in 2013; and
3. the incremental impact has been calculated using the OLM, which effectively takes the maximum 1-hour average NOx concentration predicted at the receptor and adds the maximum 1-hour average concentration recorded for NO_2 in 2013.

In addition sensitive receptor R1 is proposed to be purchased prior to the development occurring.

Given the conservative assumptions outlined above, it is expected that during normal operations the NO_2 concentrations will be below those listed in **Table 27**. The cumulative impact outlined in **Table 27** represents the absolute worst case.

Table 27 Predicted Maximum 1-Hour Average NO_2 Concentrations at Sensitive Receptors

ID	1-Hour Average NO_2 Concentrations[1] ($\mu g/m^3$)		
	Incremental Impact	**Background**	**Cumulative Impact**
R1	237	75.9	**313**
R2	209	75.9	**285**
R3	178	75.9	**254**
R4	175	75.9	**251**
R5	150	75.9	226
R6	117	75.9	193
R7	126	75.9	202
R8	134	75.9	210
R9	138	75.9	213
R10	132	75.9	208
R11	145	75.9	221
R12	148	75.9	224
R13	143	75.9	219
R14	143	75.9	219
Criteria			**246**

Notes:

1. An annual maximum 1-hourly average ozone concentration of 216 $\mu g/m^3$ from St Mary's AQMS in 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.

To further investigate the predicted exceedances, a contemporaneous analysis was performed following the Approved Methods to assess the maximum cumulative 1-hour average NO_2 concentrations at receptor 1 (the most impacted receptor). At receptor 1, each individual incremental prediction was added to the corresponding hour's maximum daily 1-hour average background concentration measured at the St Marys AQMS to predict the cumulative 1-hour average NO_2 impacts. This analysis matches up the hourly predictions with background data from the same time period (both NO_2 background concentrations and the background O_3 concentrations used in the OLM method).

Table 28 presents a summary of the contemporaneous analysis at receptor 1. It can be observed from **Table 28** that the incremental and cumulative 1-hour average NO_2 concentrations predicted at receptor 1 as a result of operational emissions are below the relevant OEH guideline. Therefore, in reality the proposed operation is unlikely to cause any exceedances of the guideline at receptor 1. Given receptor 1 is the most impacted receptor, the proposed operation is also unlikely to cause any exceedances of the guideline at receptors 2, 3 or 4.

Table 28 Summary of 1-Hour NO_2 Cumulative Impact Analysis – Receptor 1

Date of Highest Background	NO_2 1-Hour Average Concentrations (µg/m³)			Date of Highest Increment	NO_2 1-Hour Average Concentrations (µg/m³)		
	Highest Background[1]	Increment[2]	Total		Background[1]	Highest Increment[2]	Total
21/10/13	75.9	<0.1	<76.0	01/01/13	16.4	172	188
11/04/13	73.8	<0.1	<74.9	01/01/13	16.4	143	159
21/10/13	71.8	<0.1	<71.9	22/12/13	0.0	142	142
08/07/13	65.6	0.4	66.0	22/12/13	0.0	137	137
13/08/13	65.6	<0.1	<65.7	25/10/13	4.1	134	138
22/10/13	61.5	<0.1	<61.6	21/12/13	0.0	134	134
29/04/13	59.5	<0.1	<59.6	10/02/13	0.0	130	130
15/08/13	57.4	<0.1	<57.5	02/11/13	8.2	124	132
29/04/13	57.4	<0.1	<57.5	25/10/13	4.1	124	128
08/11/13	57.4	<0.1	<57.5	21/12/13	0.0	119	119
Criterion			**246**				**246**

Note:
1. The NO_2 background concentrations are the 1-hour average from St Mary's AQMS.
2. The O_3 background concentrations used in calculating the conversion of NO_X to NO_2 are the daily maximum 1-hour average from St Mary's AQMS.

Table 29 Predicted Annual Average NO_2 Concentrations at Sensitive Receptors

ID	Annual Average NO_2 Concentrations[1] (µg/m³)		
	Incremental Impact	Background	Cumulative Impact
R1	16.2	10.3	26.5
R2	11.0	10.3	21.3
R3	11.3	10.3	21.6
R4	1.2	10.3	11.5
R5	4.2	10.3	14.5
R6	5.9	10.3	16.2
R7	7.2	10.3	17.5
R8	7.9	10.3	18.2
R9	8.5	10.3	18.8
R10	8.6	10.3	18.9
R11	9.0	10.3	19.3
R12	10.4	10.3	20.7
R13	10.3	10.3	20.6
R14	9.3	10.3	19.6
Criteria			**62**

Notes:

1. An annual average ozone concentration of 69 µg/m³ from St Mary's AQMS in 2013 was used to calculate the conversion of NO_X to NO_2 using the OLM method.

The maximum predicted 1-hour and annual average incremental NO_2 concentrations are presented as contour plots in **Figure 20** and **Figure 21**.

Figure 20 Maximum Predicted Incremental 1-Hour Average NO_2 Concentrations

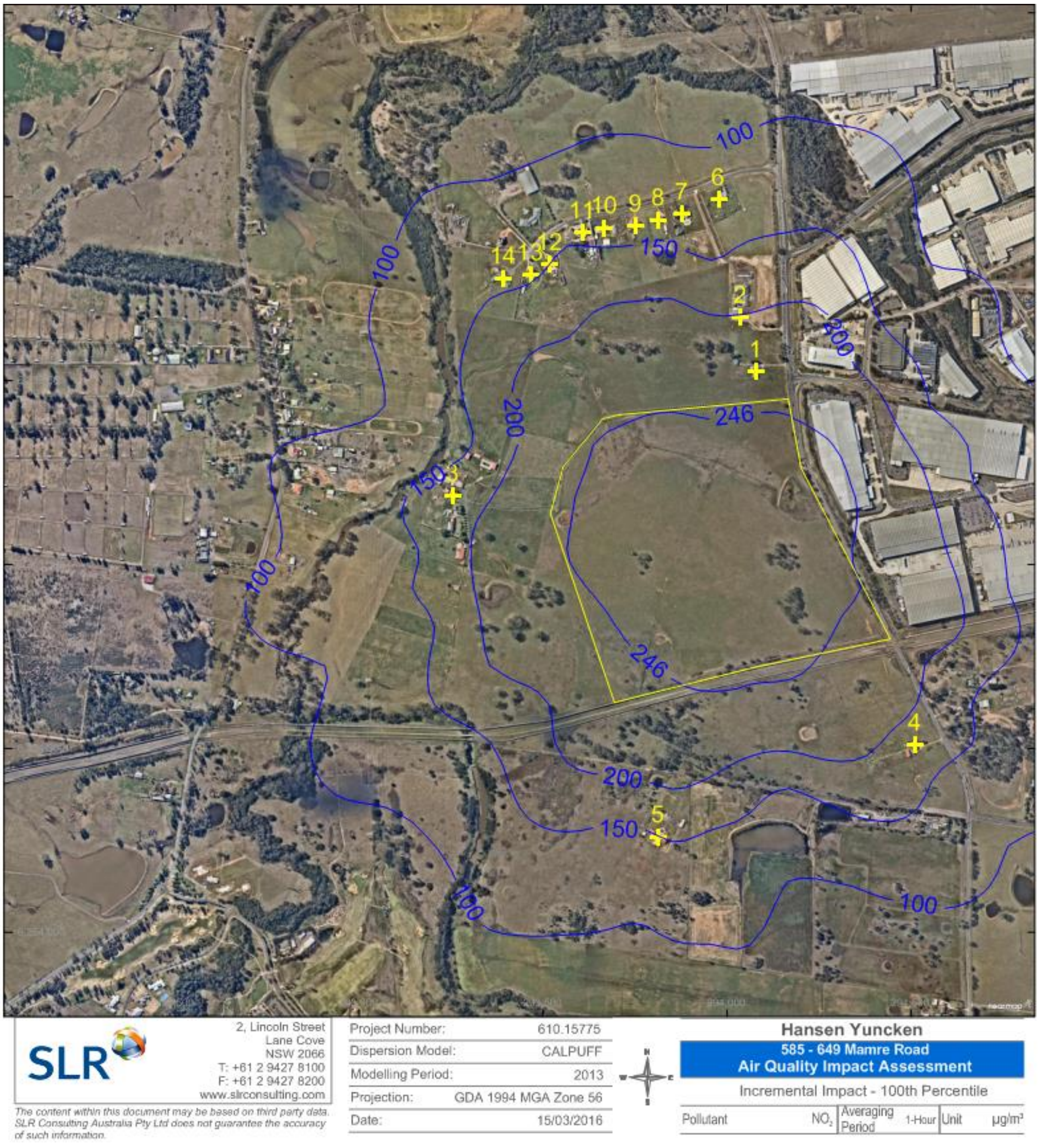
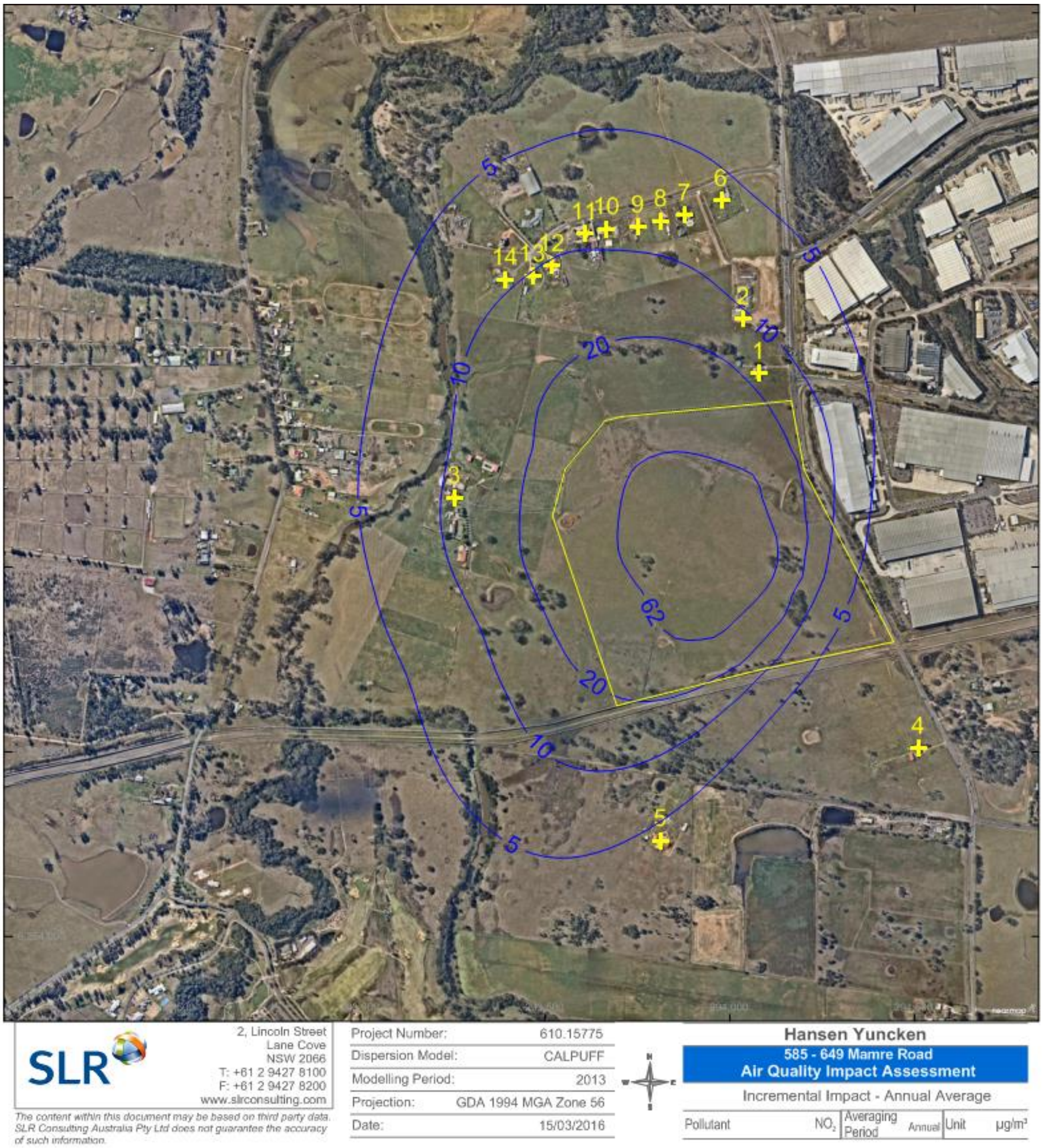


Figure 21 Predicted Incremental Annual Average NO_2 Concentration



7 MITIGATION, MANAGEMENT AND MONITORING

The results of the impact assessment indicate that all pollutants are anticipated to meet the required goals both during Development construction and operation.

The impact assessment indicates that air quality impacts would not constrain either the construction or operation of the Development. However, as required by the SEARS (refer **Section 1.1**), details of the proposed management and monitoring measures to be implemented at the Development site are required to be outlined. The following sections outline a number of measures which would be employed during both construction and operation.

7.1 Construction

A detailed Construction Environment Management Plan (CEMP) is proposed to be developed and implemented prior to construction works (as part of the SSD application), and will 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.

The following outlines a number of measures which will be considered for inclusion within the CEMP.

7.1.1 Nuisance Dust Control Measures

Ambient dust emissions from wheel-generated dust, excavation and rehabilitation, demolition, clearing and grading, truck loading and unloading, and wind erosion areas would be the primary focus of dust control during construction works at the Development site. Typically, emissions from these processes can be minimised through the implementation of water spraying, particularly during periods of heavy on-site activity.

Dust mitigation measures that may be implemented during the construction phase have been included in **Table 21**.

7.1.2 Plant and Machinery

Control measures relating to plant and machinery that may be utilised during the construction phase include:

- Ensuring vehicles and machinery are maintained in accordance with manufacturer’s specifications.
- Minimising truck queuing and unnecessary trips through logistical planning of materials delivery and work practices.
- Ensure all vehicles switch off engines when stationary so that there are no idling vehicles.
- Fixed plant should be located as far from local receptors as practicable.

7.1.3 Fuel Storage Areas

The storage of fuels should be performed in accordance with the relevant Australian Standards. The Australian Institute of Petroleum’s document, *Guidance for the Safe Above Ground Fuel Storage on Farms and Industrial Sites* (AIP GL12-2003), provides a succinct summary of the above requirements and a checklist to appraise whether the fuel storage facility is deigned and operated in compliance with the relevant Australian Standards. The Australian Capital Territory (ACT) Government has also produced a guidance document entitled *Environmental guidelines for service station sites and hydrocarbon storage* (2011), which provides further clarification and advice concerning environmental monitoring around fuel storage facilities.

Control measures that may be implemented during the construction phase will be referenced from the above Australian Standard, and will include:

- Storage areas for all liquids should be appropriately bunded.
- Spill kits including absorbing materials should be provided nearby handling and storage areas.
- Where possible, the delivery of liquid fuels should utilise reciprocal feeds, so that tank vapours are displaced into the delivery vehicle rather than being emitted to the atmosphere as a fugitive emission.
- Empty containers should be managed and disposed of in appropriate manner.

7.1.4 Site Management

Air emissions associated with all construction activities should also be managed through compliance with the CEMP. The CEMP would be implemented so that:

- The works are conducted in a manner that minimises the generation of air emissions.
- The effectiveness of the controls being implemented is monitored.
- Additional measures are implemented where required.
- Construction contractors should also undertake daily environmental inspections of their works and worksite. The daily environmental inspection reports should include the below observations, with remedial or corrective actions noted (as appropriate).
- Any remedial or corrective actions should be reported to the Site Manager as soon as is practicable. Inspections may include, but not be limited to:
    - Visual inspection of dust generation.
    - Ensure roads leaving the site are free of soil, and prevention of soil tracking onto the road network.
    - Inspection of the erosion and sediment controls.
    - Inspection of the waste storage areas.
    - Inspection of any rehabilitated areas (where relevant).
    - Ensure all hazardous goods, including fuel and oil, are adequately stored or bunded.
    - Ensure spill kits are appropriately located and stocked.

7.1.5 Complaints Handling

An effective complaints logging system should be maintained by Council and the Construction Contractor to monitor complaints, to effectively manage any requests for information or respond to any public concerns in relation to the proposed redevelopment activities throughout the construction phase, and to ensure identified incidents are dealt with through investigation and implementation of corrective treatments.

7.1.6 Air Quality Monitoring

During construction works, no air quality monitoring is considered to be necessary given the findings of the risk assessment presented within this assessment. However, suspended particulate monitoring on the boundary in closest proximity to the receptors may be performed to assist in dust management and to confirm the mitigation measures are being effectively implemented.

7.2 Operation

7.2.1 Vehicle Operation

Control measures relating to vehicles that may be utilised during the operational phase include:

- Ensuring vehicles are maintained in accordance with manufacturer's specifications.
- Minimising truck queuing and unnecessary trips through logistical planning of materials delivery and work practices.
- Ensure all vehicles switch off engines when stationary so that there are no idling vehicles.

7.2.2 Complaints Handling

The complaints logging system maintained during construction works would be continued during operation.

7.2.3 Air Quality Monitoring

During operation, no air quality monitoring is considered to be necessary, given the results of this assessment.

8 CONCLUSIONS

SLR Consulting Australia Pty Ltd (SLR Consulting) has conducted an Air Quality Impact Assessment (AQIA) at the request of ALTIS Property Partners Pty Ltd (ALTIS Property Partners) as part of preparing a development application for a proposed warehouse and logistics hub at 585 – 649 Mamre Road, Orchard Hills, NSW.

Emissions to air from the proposed construction activities and future operations have been assessed through a combination of qualitative and quantitative techniques.

For the construction phase, a qualitative risk-based assessment of potential impacts was performed based on the scale and nature of the works proposed. Based on the results of this 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 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 information and emission factors from the literature. Modelling of these emissions to predict maximum off-site pollutant concentrations indicates that the proposed operational activities would comply with all relevant OEH ambient air quality criteria at all representative surrounding sensitive receptors, even when existing background pollutant levels are considered.

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. 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.

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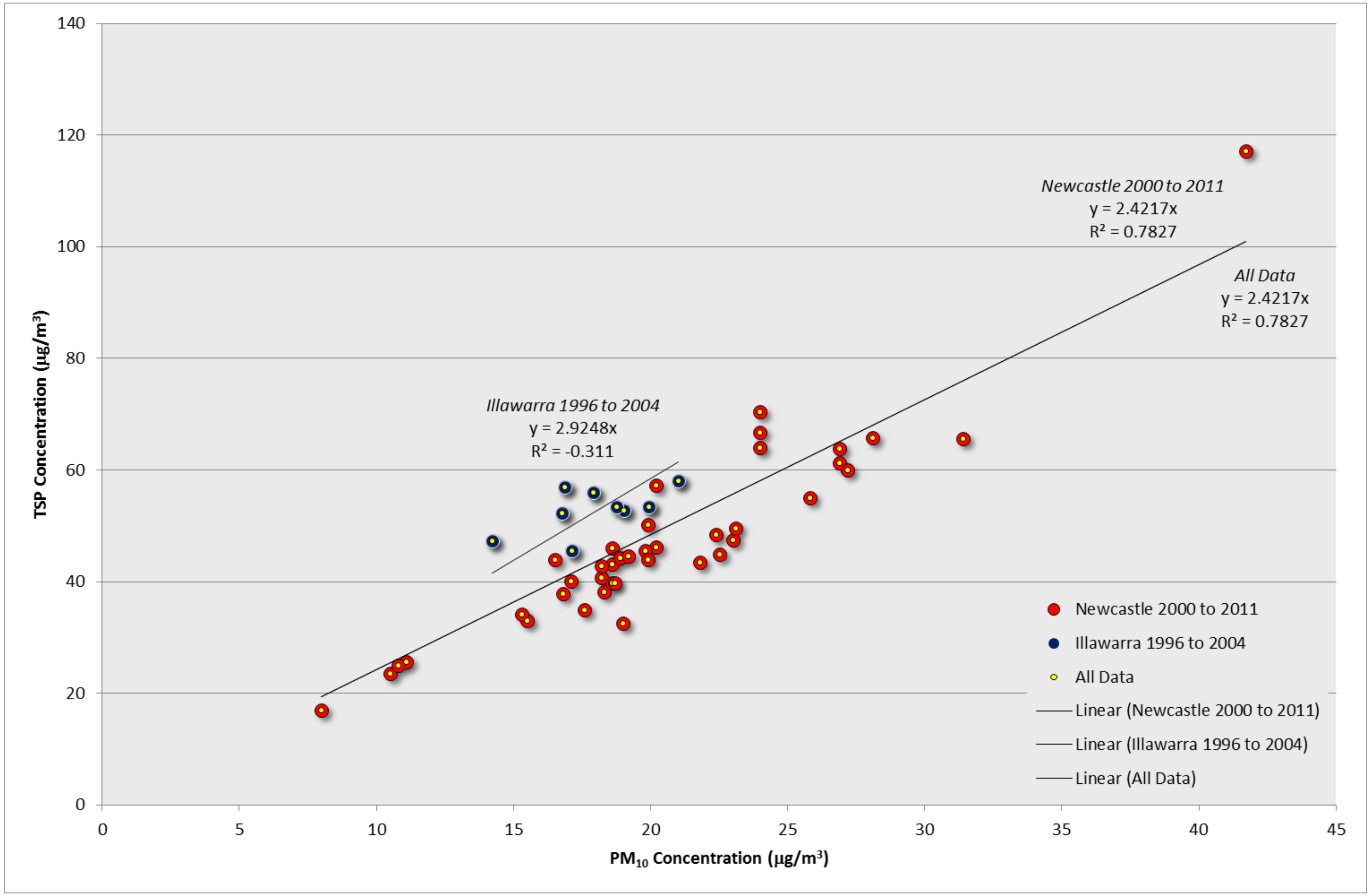
ANALYSIS OF TSP AND PM_{10} DATA

Figure A1 Analysis of PM_{10} and TSP HVAS Data, Newcastle Region (2000 to 2011) and Illawarra Region (1996 to 2004)



Newcastle: Mayfield, Steel River Estate, Stockton, Fern Bay and Fullerton Road, Stockton. Illawarra: Albion Park, Kembla Grange, Warrawong, Wollongong, Port Kembla.

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.

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. The definitions given in the IAQM guidance for earthworks, construction activities and track-out, which are most relevant to this Development, are as follows:

- Earthworks:
  - ***Large***: Total site area greater than 10,000 m^2, potentially dusty soil type (eg clay, which will be prone to suspension when dry due to 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 (eg 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 (eg 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 (eg concrete), piling, on site concrete batching.
  - ***Small***: Total building volume less than 25,000 m^3, construction material with low potential for dust release (eg metal cladding or timber).
- Track-out:
  - ***Large***: More than 50 heavy vehicle movements per day, surface materials with a high potential for dust generation, greater than 100 m of unpaved road length.
  - ***Medium***: Between 10 and 50 heavy vehicle movements per day, surface materials with a moderate potential for dust generation, between 50 m and 100 m of unpaved road length.
  - ***Small***: Less than 10 heavy vehicle movements per day, surface materials with a low potential for dust generation, less than 50 m of unpaved road length.

Note: No demolition of existing structures will be performed as part of this Development.

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.

Step 2b – Assessment of the Sensitivity of the Area

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; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Individual receptors are classified as having *high*, *medium* or *low* sensitivity to dust deposition and human health impacts (ecological receptors are not addressed using this approach). The IAQM method provides guidance on the sensitivity of different receptor types to dust soiling and health effects as summarised in **Table 30** (IAQM, 2014). It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

Based on the criteria listed in **Table 30**, the sensitivity of the identified receptors in this study is concluded to be *high* for health impacts and *high* for dust soiling, based upon the following assumptions:

- The identified sensitive receptor locations are dwellings where 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.
- 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 highly vegetated nature of the area which would result in little natural wind-blown dust and low background dust levels.

Table 30 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 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 PM10.*	Locations where human exposure is transient. *Examples: Public footpaths, playing fields, parks and shopping street.*

According to the IAQM methods, 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, and 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;
- the duration of the potential impact (as a receptor may be willing to accept elevated dust levels for a known short duration, or may become more sensitive or less sensitive (acclimatised) over time for long-term impacts); and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in **Table 31**. The sensitivity of the area should be derived for each of activity relevant to the project (ie construction and earthworks).

Table 31 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. For example, if there are 7 high sensitivity receptors < 20m of the source and 95 high sensitivity receptors between 20 and 50 m, then the total of number of receptors < 50 m is 102. The sensitivity of the area in this case would be high.

A modified version of the IAQM guidance for assessing the *sensitivity of an area* to health impacts is shown in **Table 32**. For high sensitivity receptors, the IAQM methods 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 (ie an annual average of 20 µg/m^3 for PM_{10}) the IAQM method has been modified slightly.

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; and
- any known specific receptor sensitivities which go beyond the classifications given in this document.

Given the above, for the purposes of this study, all receptors have been classified based on the sensitivity classifications for a background annual average PM_{10} concentration of 15.6 µg/m^3, as outlined in **Section 4.1**.

Table 32 IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Receptor sensitivity	Annual mean PM_{10} conc	Number of receptors [a,b]	Distance from the source (m)			
			<20	<50	<100	<350
High	15-22.5 µg/m^3	>100	High	Medium	Low	Low
		10-100	High	Medium	Low	Low
		1-10	Medium	Low	Low	Low
	<15 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

Notes: (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 **Section 4**.

The dust emission magnitude from Step 2a and the receptor sensitivity from Step 2b are then used in the matrices shown in **Table 33** (earthworks and construction) and **Table 34** (track-out) to determine the risk category with no mitigation applied.

Table 33 Risk Category from Earthworks and Construction Activities

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

Table 34 Risk Category from Track-out Activities

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

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.

Step 4 – Residual Impacts

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

LONG TERM METEOROLOGY

Multi-Year Meteorology (2009-2013)