Air Quality and Greenhouse Gas Assessment

Appendix I

Appendix I — Air Quality and Greenhouse Gas Assessment

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KURRI KURRI BATTERY RECYCLING FACILITY
AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

RAMBOLL ENVIRON

KURRI KURRI BATTERY RECYCLING FACILITY
AIR QUALITY AND GREENHOUSE GAS ASSESSMENT

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

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EXECUTIVE SUMMARY

Pymore Recyclers International Pty Ltd (the proponent) propose to develop and operate a used lead-acid battery (ULAB) recycling facility (the project) at 129 Mitchell Avenue, Kurri Kurri (the site), approximately 40 km northwest of Newcastle.

Ramboll Environ Australia Pty Ltd (Ramboll Environ) was commissioned by EMM Consulting Pty Ltd (EMM) on behalf of the proponent to undertake an air quality and greenhouse gas (GHG) assessment for the project.

Emissions of PM_{10}, $PM_{2.5}$, lead, NO_2, SO_2 and individual air toxics associated with peak proposed operations were accounted for through information provided by the proponent and publically available emission estimation techniques. Atmospheric dispersion modelling predictions of air pollution emissions for proposed operations were undertaken using the AERMOD dispersion model.

Cumulative impacts were accounted for through the modelling of emissions from the neighbouring Weston Aluminium facility and existing ambient air quality based on monitoring data from the NSW OEH Beresfield monitoring station.

The results of the dispersion modelling conducted indicated that the operation of the project is highly unlikely to result in exceedances of the applicable NSW Environment Protection Authority's (EPA) assessment criteria for any of the assessed pollutants at any of the surrounding sensitive receptors.

Annual GHG emissions (all scopes) represent approximately 0.009% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

1. INTRODUCTION

This air quality and greenhouse gas assessment has been prepared by Ramboll Environ Australia Pty Ltd (Ramboll Environ) for Pymore Recyclers International Pty Ltd's (the proponent) proposed used lead-acid battery (ULAB) recycling facility (the project) at 129 Mitchell Avenue, Kurri Kurri (the site).

The site is in the Cessnock local government area (LGA), approximately 40 km northwest of Newcastle (**Figure 1-1**). The site will occupy part (approximately 3.4 ha) of the lot on which the Weston Aluminium Dross Recycling Plant (the aluminium plant) is located, within Lots 796 and 797, DP 39877 (**Figure 1-2**).

The project would recycle approximately 60,000 tonnes per annum (tpa) of ULABs. The ULAB recycling plant would have four main processes – crushing, screening and separation; desulphurisation; crystallisation; and lead extraction. The entire process converts a ULAB into materials which are recycled for use in new products. Lead and plastics recovered are used in the production of new batteries. Sodium sulphate crystals, a by-product of ULAB recycling, can be readily used in other industries.

The project has been designated as State Significant Development (SSD) which requires development consent under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). A development application for SSD is required to be accompanied by an environmental impact statement (EIS). This air quality and greenhouse gas assessment forms part of the EIS for the project.

1.1 Study objectives

The first objective of the study is to identify the potential air quality related impacts associated with the project, prepared in accordance with the Department of Planning and Environment (DPE) Secretary's Environmental Assessment Requirements (SEARs). **Table 1-1** provides a summary of the SEARs for air quality and where the requirement has been addressed in this report.

The second objective is to identify potential greenhouse gas (GHG) related impacts of the project.

General requirements from the NSW Environment Protection Authority (EPA) were also provided as part of the SEARs. The EPA's general requirements for air quality are addressed by following the assessment requirements outlined in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ("the Approved Methods for Modelling"), (NSW EPA, 2005).

Cessnock City Council were also invited by DPE to provide comment and, in relation to air emissions, provided a recommendation for ambient air quality monitoring sites and local exhaust ventilation monitoring.

Table 1-1: Summary of SEARs for air quality	
Requirement	**How requirement is addressed**
Air quality and odour, including: a quantitative assessment of potential air quality and odour impacts of the proposed development including impacts on any surrounding receivers. The assessment must consider impacts from the construction and operation, and include:	This report is prepared in accordance with the Approved Methods.
• details of the air emission inputs and outputs	**Section 6**
• identification of all pollutants of concern	**Section 3.1**
• a quantitative assessment of all potential impacts using dispersion modelling, including adequate justification and validation (where appropriate) of all model inputs and outputs;	**Section 8**
• a cumulative assessment of all existing and proposed emission sources; and	**Section 8.3**
• details of the proposed management and monitoring measures	**Section 9**

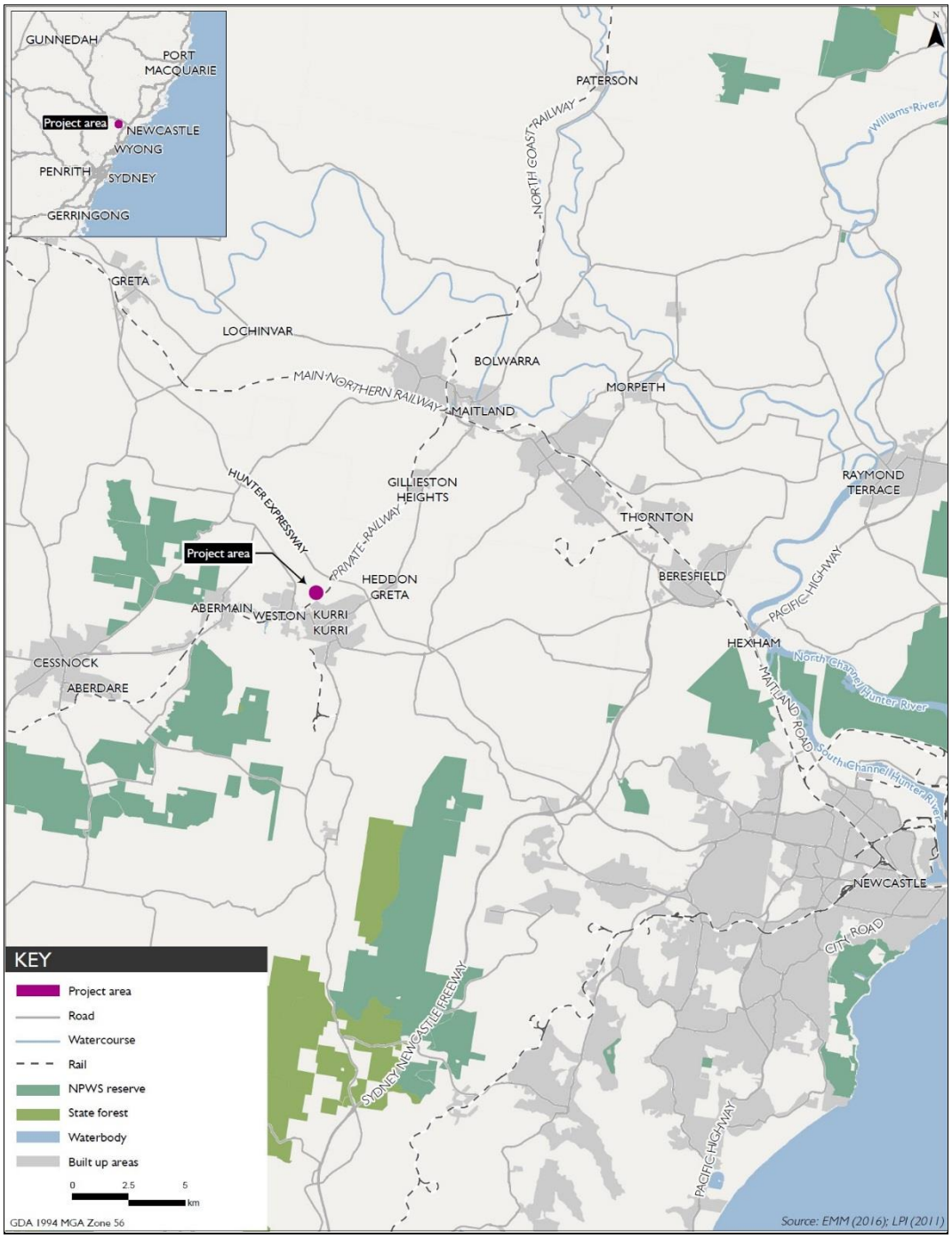


Figure 1-1: Site Location

Source: EMM (2016)

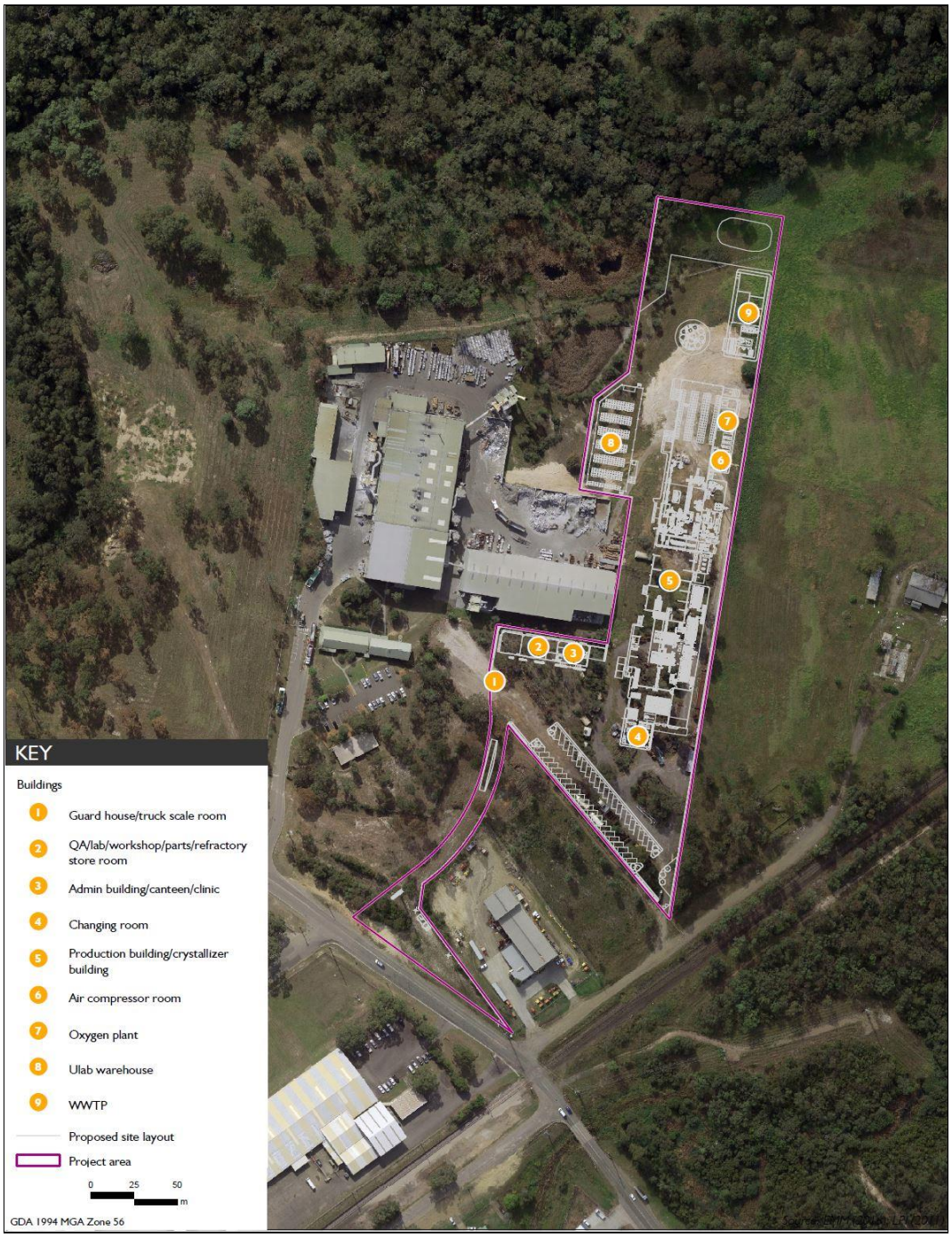


Figure 1-2: Proposed Site Layout

Source: EMM (2016)

2. PROJECT DESCRIPTION AND LOCAL SETTING

2.1 Project description

2.1.1 Recycling technology

The technology used for the project will be supplied by Engitec Technologies S.p.A (Engitec). Engitec has developed the CX Integrated System, which uses a combination of hydrometallurgical and pyrometallurgical process for the recovery of lead and associated by-products. This technology is used in over 60 plants worldwide to treat ULABs and is used in the Renewed Metal Technologies plant in Wagga Wagga.

2.1.2 Used lead-acid battery recycling process

The ULAB recycling plant would have four main processes – crushing, screening and separation; desulphurisation; crystallisation; and lead paste processing – which are described further below. The entire recycling process converts a ULAB into materials which are recycled for use in new products. Lead and plastics recovered are used in the production of new batteries. Sodium sulphate crystals are a by-product of ULAB recycling which are readily used in other industries. A process flow chart for the project is presented in **Figure 2-1**.

2.1.3 Crushing, screening and separation

The ULABs are sent through an automatic de-palletiser, into a vibrating feed hopper, and transported on a belt conveyor into a crushing mill. To protect the crusher a metal detector is installed to remove iron and other unwanted metallic objects while the batteries are still on the belt conveyor. The batteries are crushed to 50 – 80 mm in size. The crushing mill is fully enclosed in an acoustic chamber to mitigate noise as well as prevent dust emissions.

The crushed materials pass through a screen and are wetted down with high pressure water sprayers using recycled water. This rotating screen separates the solid and liquid components of the batteries. These materials include:

- lead metals such as battery posts (or poles) and battery plates (called grids);
- crushed polypropylene plastic from the battery casing and cover; and
- a slurry solution composed mainly of lead pastes from the battery plates and the electrolyte in the battery.

The solid components (lead metals and plastics) go through a further hydrodynamic separation process using controlled flow of recycled water which naturally separates the materials due to their differences in density. The solid metals are collected and fed into the rotary furnace, while the plastics (polypropylene) are washed, grinded, cleaned and sent to battery production facilities where they are pelletized and reused as battery casings and covers.

2.1.4 Desulphurisation and crystallisation

The slurry solution of lead sulphates, lead oxides and sulphuric acid goes through a desulphurisation process which effectively removes the sulphur from lead sulphates and sulphuric acid. This is an important step in minimising sulphur (sulphur dioxide and sulphur trioxide) emissions by eventually converting them to a solid form instead of gases emitted from the furnace. Removal of the sulphur prior to feeding the material to the furnace significantly improves process efficiency.

Desulphurization involves mixing the slurry with soda ash to produce sodium sulphate. The resulting solution is further processed in a filter press which separates the desulphurised lead paste from the sodium sulphate solution.

The liquid sodium sulphate is processed further through crystallization which removes water, purifies, and converts the solution to sodium sulphate crystals. Sodium sulphate crystals are packed and sold commercially to glass and detergent manufacturers.

2.1.5 Lead paste processing

A furnace is used to melt the lead metals and lead oxide from the lead paste, subjecting them to high temperatures to recover the lead and produce lead bullion.

Desulphurised lead paste is fed into a rotary furnace, mixed with the solid metals and some fluxing agents, and processed under high temperatures into lead bullion. The rotary furnace will be completely enclosed to prevent release of fugitive emissions. Dust and smoke suction chambers and closed ducting systems convey the dust and smoke to a series of filters inside a filter bag house to ensure that air emissions are clean and free from lead particulates. The lead bullion is sent to battery production facilities for production of new batteries.

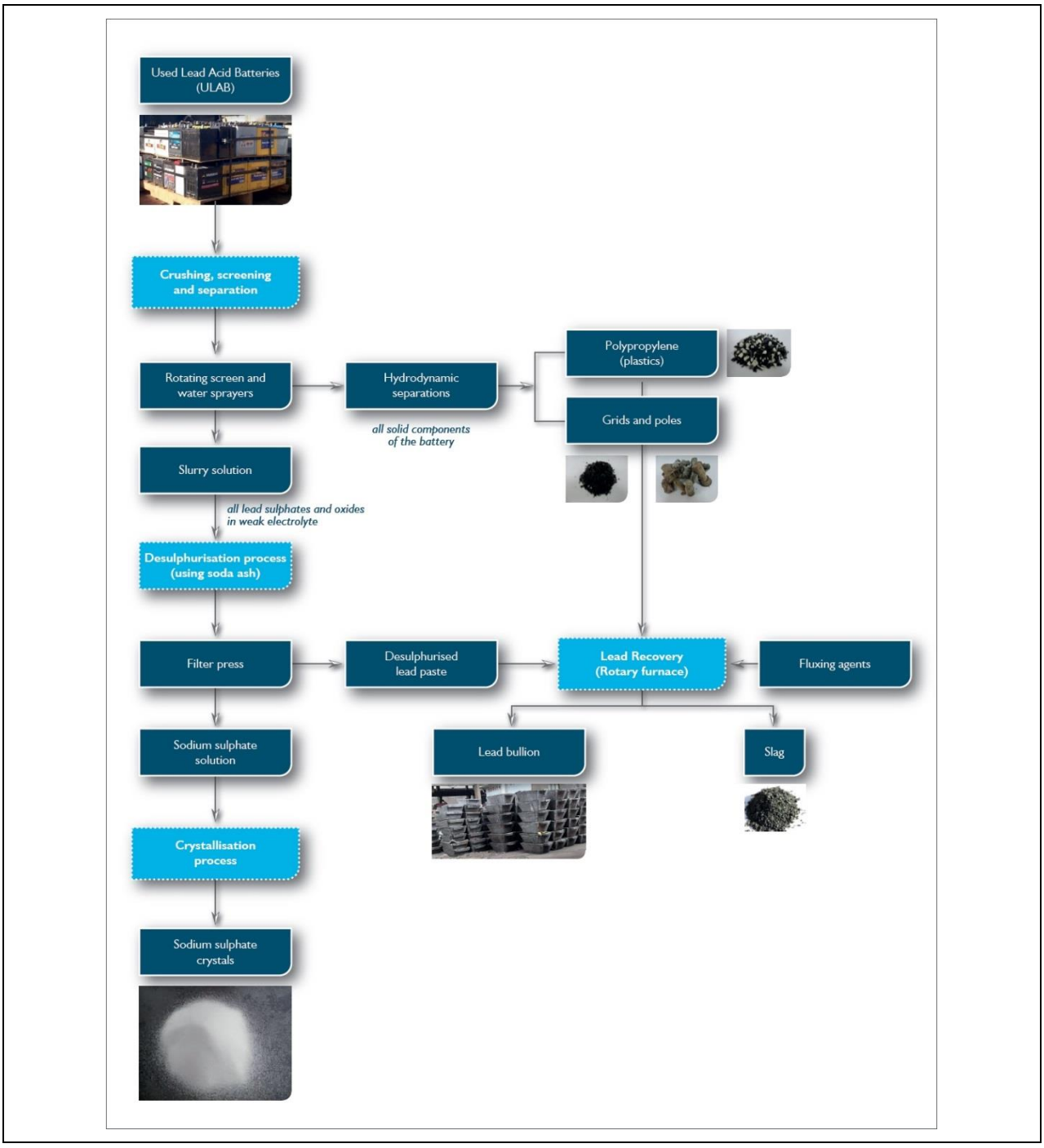


Figure 2-1: Project process flow chart

Source: EMM (2016)

2.2 Surrounding land use and receptor locations

The site currently comprises undeveloped land used for the storage of unused industrial equipment for the aluminium plant.

Surrounding land uses are primarily industrial, including the aluminium plant, a waste water treatment facility 750 m to the east, and the Hydro Aluminium Kurri Kurri Smelter 1.3 km to the north. The residential areas of Kurri Kurri and Weston are approximately 650 m to the south-east and 1,000 m to the west of the site, respectively. The Hunter Expressway is approximately 550 m to the north-east. Swamp Creek borders the site to the north.

The site is zoned IN3 Heavy Industrial under the *Cessnock Local Environmental Plan 2011* (Cessnock LEP).

The surrounding area comprises a mixture of industrial and residential receptors, of which a range have been selected as representative receptor locations for assessment purposes. The selected receptor locations are presented in **Table 2-1** and illustrated in **Figure 2-2**.

Table 2-1: Sensitive receptor locations surrounding the site

Receptor ID	Location (m, MGA56S)		Elevation (m, AHD)	Receptor Type
	Easting	Northing		
1	357732	6369938	21	Residence
2	358192	6370061	25	Residence
3	358700	6369027	36	Residence
4	358291	6368809	41	High school
5	358569	6368620	30	Park
6	357797	6368638	27	Residence
7	358145	6368075	51	Child care centre
8	357903	6368028	51	Church
9	357753	6367795	56	Medical centre
10	357512	6368444	24	Park
11	357466	6368791	20	Residence
12	356252	6367155	55	Nursing home
13	357332	6369037	22	Industrial
14	357263	6368947	21	Industrial
15	356682	6367981	28	Aquatic centre
16	356128	6367153	61	Hospital
17	356459	6368394	24	Park
18	357175	6369036	22	Industrial
19	355966	6368848	27	Primary school
20	356317	6368932	20	Residence
21	356984	6369083	19	Industrial
22	356369	6369236	18	Residence
23	356585	6369476	23	Residence
24	357320	6369268	16	Industrial
25	357057	6369952	22	Residence

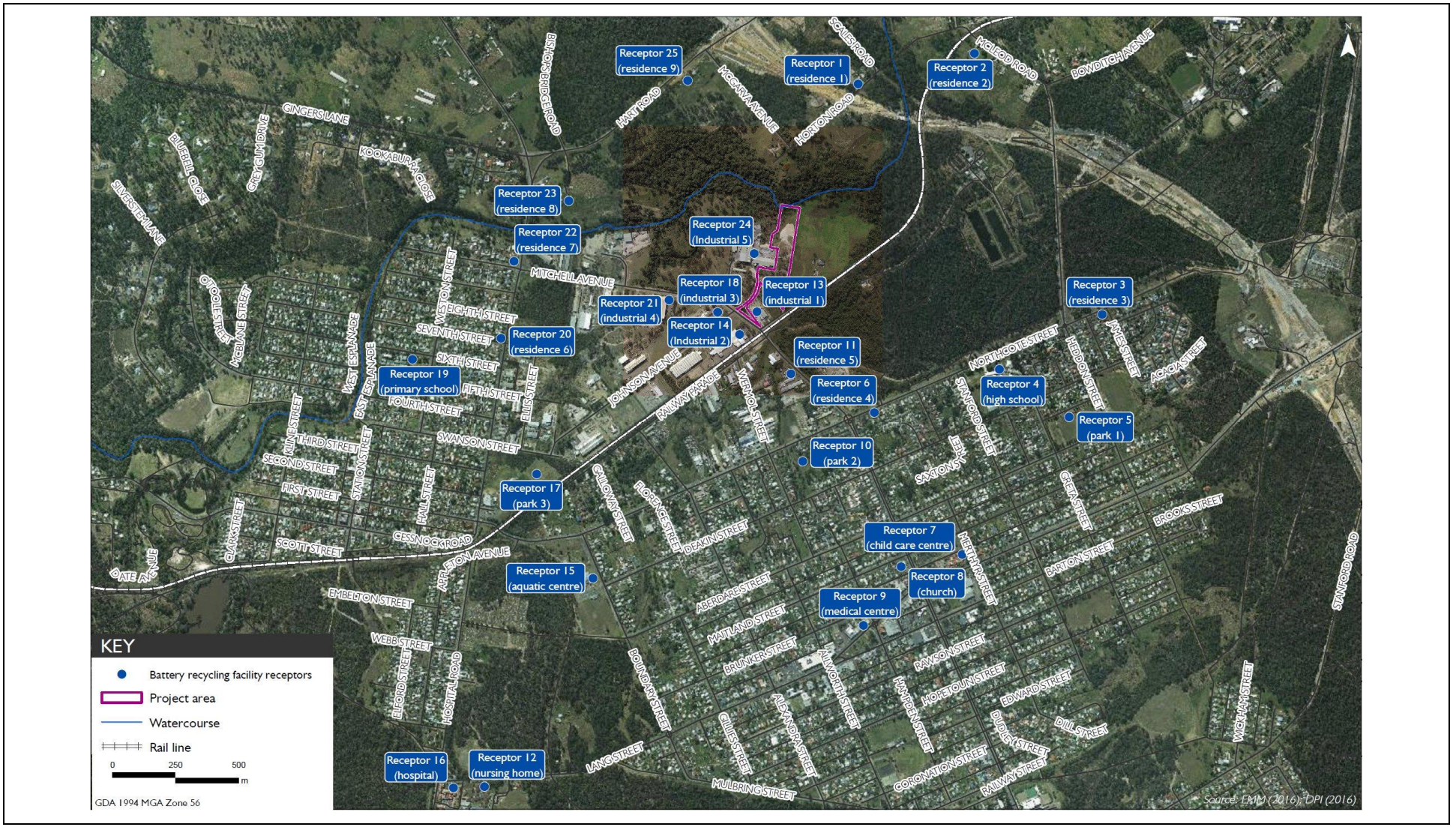


Figure 2-2: Surrounding sensitive receptor locations

Source: EMM (2016)

3. ASSESSMENT APPROACH

3.1 Ambient air quality assessment criteria

The project must demonstrate compliance with the impact assessment criteria outlined in the Approved Methods for Modelling (NSW EPA, 2005). The impact assessment criteria are designed to maintain ambient air quality that allows for the protection of human health and well-being. Based on information provided by the proponent, the following pollutants have been identified, quantified and assessed for the project:

- Particulate matter (PM) with an equivalent aerodynamic diameter of less than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$);
- Nuisance dust (or dust deposition);
- Lead;
- Nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Sulphur trioxide / sulphuric acid (SO_3 / H_2SO_4)
- Volatile organic compounds (VOCs), specifically benzene, toluene, xylenes, ethylbenzene and formaldehyde;
- Arsenic;
- Dioxins and furans.

Relevant ambient air quality criteria applicable to the project are presented **Table 3-1**. The Approved Methods for Modelling specifies that the impact assessment criteria for 'criteria pollutants[1]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be presented, requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For individual air toxics (arsenic, H_2SO_4, dioxins and furans and individual VOCs), the Approved Methods for Modelling specifies that the impact assessment criteria is applicable to the maximum predicted incremental (project-only) concentration at or beyond site boundary.

The impact assessment criteria for PM_{10} is prescribed in the Approved Methods for Modelling, however $PM_{2.5}$ is not included. Reference is therefore made to the $PM_{2.5}$ reporting standards issued by the National Environmental Protection Council (NEPC) (NEPC, 2003). The National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) $PM_{2.5}$ reporting standards were first published as advisory goals in 2003 for the purpose of supporting the monitoring and evaluation of ambient $PM_{2.5}$ concentrations ahead of the setting ambient air quality standards for this pollutant. The AAQ NEPM was varied in December 2015 to adopt these 'advisory reporting standards' as formal standards for $PM_{2.5}$ (NEPC, 2015).

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

Table 3-1: Impact assessment criteria for the project

Pollutant	Averaging Period	Concentration (µg/m³)	Reference
PM_{10}	24 hours	50	NSW EPA(1)
	Annual	30	NSW EPA(1)
$PM_{2.5}$	24 hours	25	NEPM(2)
	Annual	8	NEPM(2)
NO_2	1 hour	246	NSW EPA(1)
	Annual	62	NSW EPA(1)
SO_2	10 minute	712	NSW EPA(1)
	1 hour	570	NSW EPA(1)
	24 hours	228	NSW EPA(1)
	Annual	60	NSW EPA(1)
Lead	Annual	0.5	NSW EPA(1)
Arsenic	99.9th percentile 1-hour (3)	0.09	NSW EPA(1)
H_2SO_4	99.9th percentile 1-hour (3)	18	NSW EPA(1)
Dioxins and furans	99.9th percentile 1-hour (3)	2.0 x 10^{-9}	NSW EPA(1)
Benzene	99.9th percentile 1-hour (3)	29	NSW EPA(1)
Toluene	99.9th percentile 1-hour (3)	360	NSW EPA(1)
Xylenes	99.9th percentile 1-hour (3)	190	NSW EPA(1)
Formaldehyde	99.9th percentile 1-hour (3)	20	NSW EPA(1)
Ethylbenzene	99.9th percentile 1-hour (3)	8,000	NSW EPA(1)

Note 1: NSW EPA, 2005 *Approved Methods for Modelling*

Note 2: NEPC, 2015, *National Environment Protection (Ambient Air Quality) Measure,* as amended

Note 3: Criteria applicable maximum-predicted incremental concentration at or beyond site boundary

The NSW EPA impact assessment goals for dust deposition are given in **Table 3-2** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided.

Table 3-2: Impact assessment criteria for 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

3.2 POEO (Clean Air) Regulation

The statutory framework for managing air emissions in NSW is provided in the NSW *Protection of the Environment Operations Act 1997* (POEO Act)[2] and the primary regulations for air quality are made under the POEO Act are:

- NSW *Protection of the Environment Operations (Clean Air) Regulation 2010*[3].
- NSW *Protection of the Environment Operations (General) Regulation 2009*[4].

The project will comply with the POEO regulations as follows:

- As a scheduled activity under the POEO regulations, the project will operate under an environment protection licence (EPL) issued by the NSW EPA and will be operated to comply with requirements including emission limits, monitoring and pollution reduction programmes (PRPs).
- Best management practice (BMP) is a guiding principle in the POEO Act, and requires that all necessary practicable means are used to prevent or minimise air pollution in NSW. The applicable air pollution control measures for the project are outlined in **Section 9**.
- The proponent will manage all aspects of its operations to ensure that offensive odour does not cause 'harm to' or involve 'interfering unreasonably' with the comfort or repose of any person outside the premises.

The POEO (Clean Air) Regulation limits, or "standards of concentration" relevant to the project are summarised in **Table 3-3**.

[2] http://www.legislation.nsw.gov.au/maintop/view/inforce/act+156+1997+cd+0+N
[3] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N
[4] http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+211+2009+cd+0+N

Table 3-3: In-stack standards of concentration applicable to the project			
Pollutant	**Limit**	**Activity or plant**	**Industry group**
Solid particles (total)	50 mg/m^3	Any activity or plant (except crushing, grinding, separating or materials handling)	Non-ferrous metals: secondary production
			General standards of concentration
NO_x (as NO_2 equivalent)	300 mg/m^3	Any activity or plant	Non-ferrous metals: secondary production
	350 mg/m^3		General standards of concentration
Type 1 & Type 2 substances	1 mg/m^3	Any smelting or refining process	Non-ferrous metals: secondary production
		Any activity or plant	General standards of concentration
Sulfuric acid mist (H_2SO_4) / sulfur trioxide (SO_3), as SO_3	100 mg/m^3	Any activity or plant	General standards of concentration
Dioxins or furans	0.1 ng/m^3	Any smelting or refining process	Non-ferrous metals: secondary production
		Any activity or plant	General standards of concentration
VOCs	40 mg/m^3 or 125 mg/m^3 CO	Any smelting or refining process	Non-ferrous metals: secondary production
		Any activity or plant involving combustion	General standards of concentration
Smoke	Ringelmann 1 or 20% opacity	Any smelting or refining process	Non-ferrous metals: secondary production

Note: Type 1 and 2 substances include antimony, arsenic, cadmium, lead, mercury, beryllium, chromium, cobalt, manganese, nickel, selenium, tin, vanadium.

4. CLIMATE AND DISPERSION METEOROLOGY

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere.

In the absence of onsite meteorological monitoring data, a combination of local area observational data and meteorological modelling techniques were used. Details regarding the approach to meteorological modelling are presented in **Section 4.1**.

The following data were used in the meteorological analysis:

- 1-hour average meteorological data and historical climate data from the Bureau of Meterology (BoM) Automatic Weather Station (AWS) at Cessnock Airport (Station Number 061260) and Williamtown RAAF Airport (Station Number 061078) located 13 km west and 33 km east of the site respectively.

4.1 Meteorological modelling

Section 4.1 of the Approved Methods for Modelling specifies that meteorological data representative of a site can be used in the absence of suitable on-site observations. Data should cover a period of at least one year with a percentage completeness of at least 90%. Site representative data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model The Air Pollution Model (TAPM).

As stated, hourly average meteorological data from the BoM Cessnock Airport and Williamtown RAAF AWSs were obtained in the absence of onsite monitoring at the site. Data from the Cessnock Airport AWS was used as the primary resource, with observations from the Williamtown RAAF AWS adopted for cloud cover observations.

To supplement these meteorological observation datasets, the CSIRO meteorological model TAPM was used to generate parameters not routinely measured, specifically the vertical temperature profile.

TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling (NSW EPA, 2005), with the following refinements:

- Modelling to 300 m grid cell resolution (beyond 1 km resolution specified).
- Inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data).

The TAPM vertical temperature profile for every hour was adjusted by first substituting the predicted 10 m above ground temperature with hourly recorded temperature at 10 m (sourced from the Cessnock Airport AWS). The difference between the TAPM predicted temperature and the measured 10 m temperature was applied to the entire predicted vertical temperature profile. This modified vertical profile was used in combination with the ambient air temperature throughout the day to calculate convective mixing heights between sunrise and sunset.

4.2 Prevailing wind regime

A wind rose showing wind speed and direction data recorded at the Cessnock Airport AWS is presented in **Figure 4-1**. The annual recorded wind pattern is dominated by defined northwest and southeast to southwest airflow. Highest wind speeds recorded at the location are most frequently experienced from the northwest. The average recorded wind speed for 2015 was 3.3 m/s, with a frequency of calm conditions (wind speeds less than 0.5 m/s) in the order of 13 % of the time.

Additional inter-annual, seasonal and diurnal wind roses for the Cessnock Airport AWS are provided in **Appendix 1**.

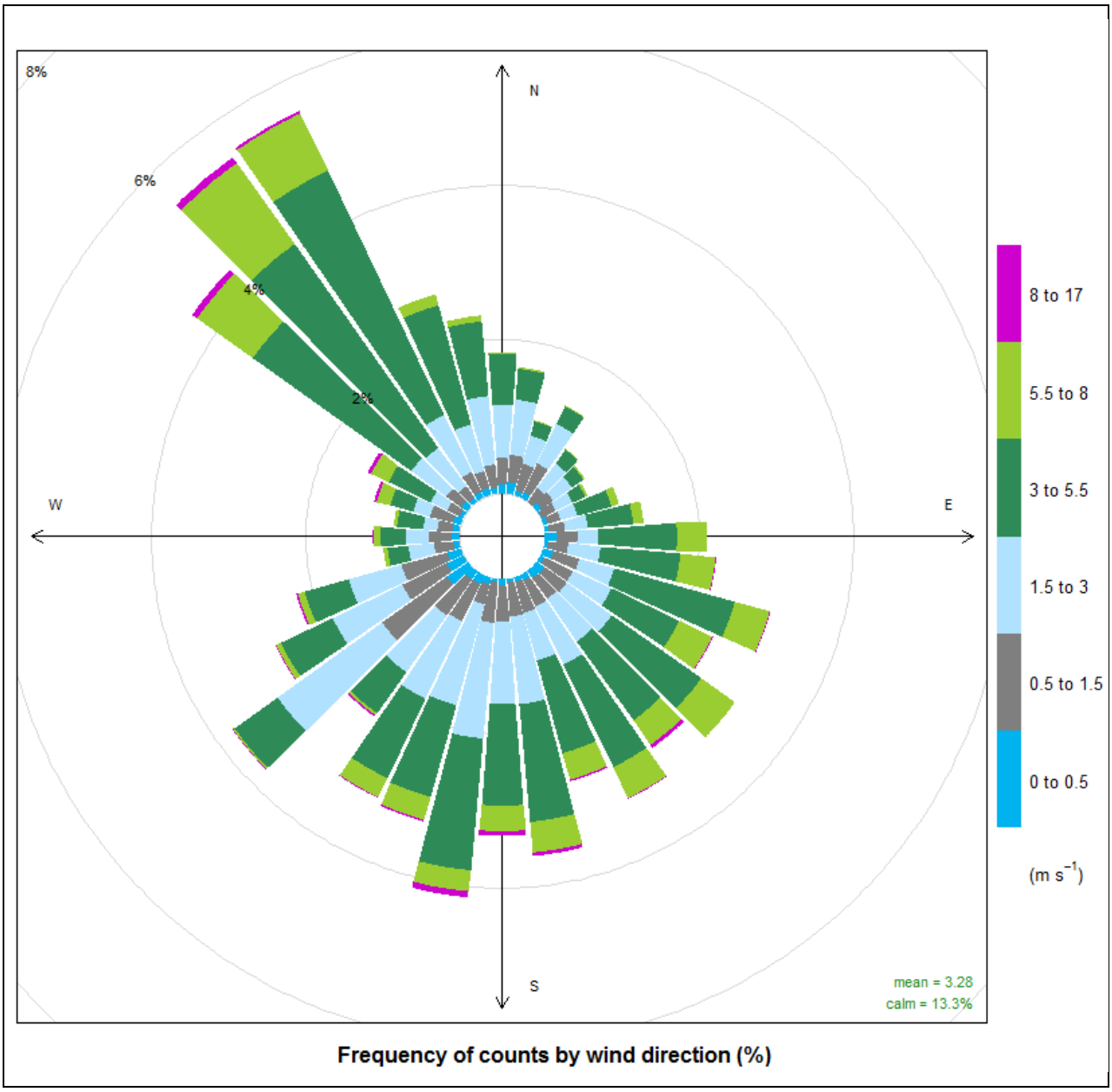


Figure 4-1: Annual Average Wind Rose – Cessnock Airport AWS – 2015

Seasonal and diurnal (dividing the day into night and day) wind roses for the meteorological dataset are presented within **Appendix 1**. Pronounced seasonal variation is evident in the data recorded at the Cessnock Airport AWS. The southwest component is most defined during the summer months, while the northwest component increases during autumn and is dominant during the winter months. Spring experiences a mixture of northwest and southeast winds. Autumn and winter are also notable for the frequency of southwest winds that are recorded. Wind speed is greatest during summer and spring, while the incidence of calms is greatest during the autumn months.

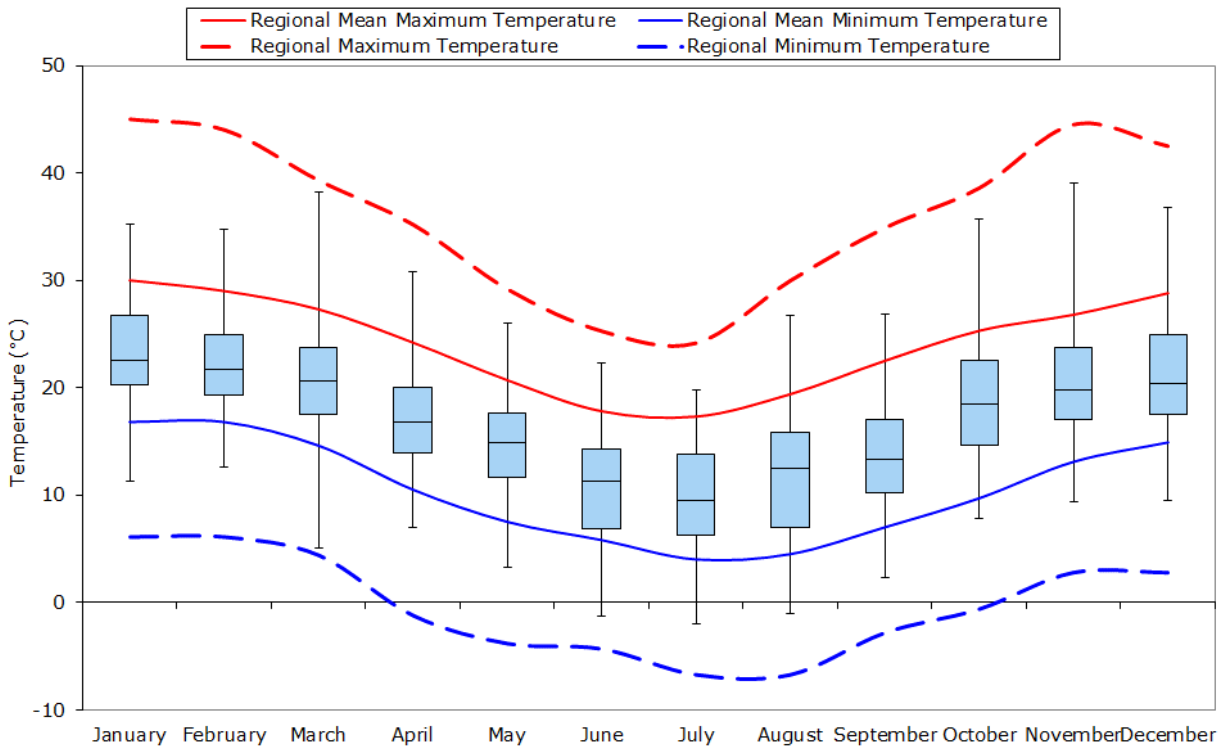
Diurnal variation is also evident at the Cessnock Airport AWS. Wind speeds are greatest during the daylight periods, with wind patterns recorded along the northwest-southeast directional axis. Wind speeds are notably lower during the night and early morning hours, with the southwest component the dominant wind direction.

4.3 Ambient temperature

Monthly mean minimum temperatures are in the range of 4°C to 17°C, with monthly mean maxima of 17°C to 30°C, based on the long-term average record. Peaks occur during summer months with the highest temperatures typically being recorded between November and February. The lowest temperatures are usually experienced between May and August.

The 2015 Cessnock Airport AWS temperature dataset has been compared with long term trends recorded at the AWS to determine the representativeness of the dataset.

Figure 4-2 presents the monthly variation in recorded temperature during 2015 compared with the recorded station mean, minimum and maximum temperatures. There is good agreement between temperatures recorded during 2015 and the recorded historical trends, indicating that the dataset is representative of conditions likely to be experienced in the region.



Note: 2015 data from Cessnock Airport are illustrated by the 'box and whisker' indicators. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values. Maximum and minimum temperatures from long-term measurements at Cessnock Airport are depicted as line graphs.

Figure 4-2: Temperature Comparison between Cessnock Airport AWS 2015 dataset and Historical Averages (1995-2016) – Cessnock Airport AWS

4.4 Atmospheric stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10 % of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4-3 illustrates the seasonal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET based on the Cessnock Airport AWS dataset. The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

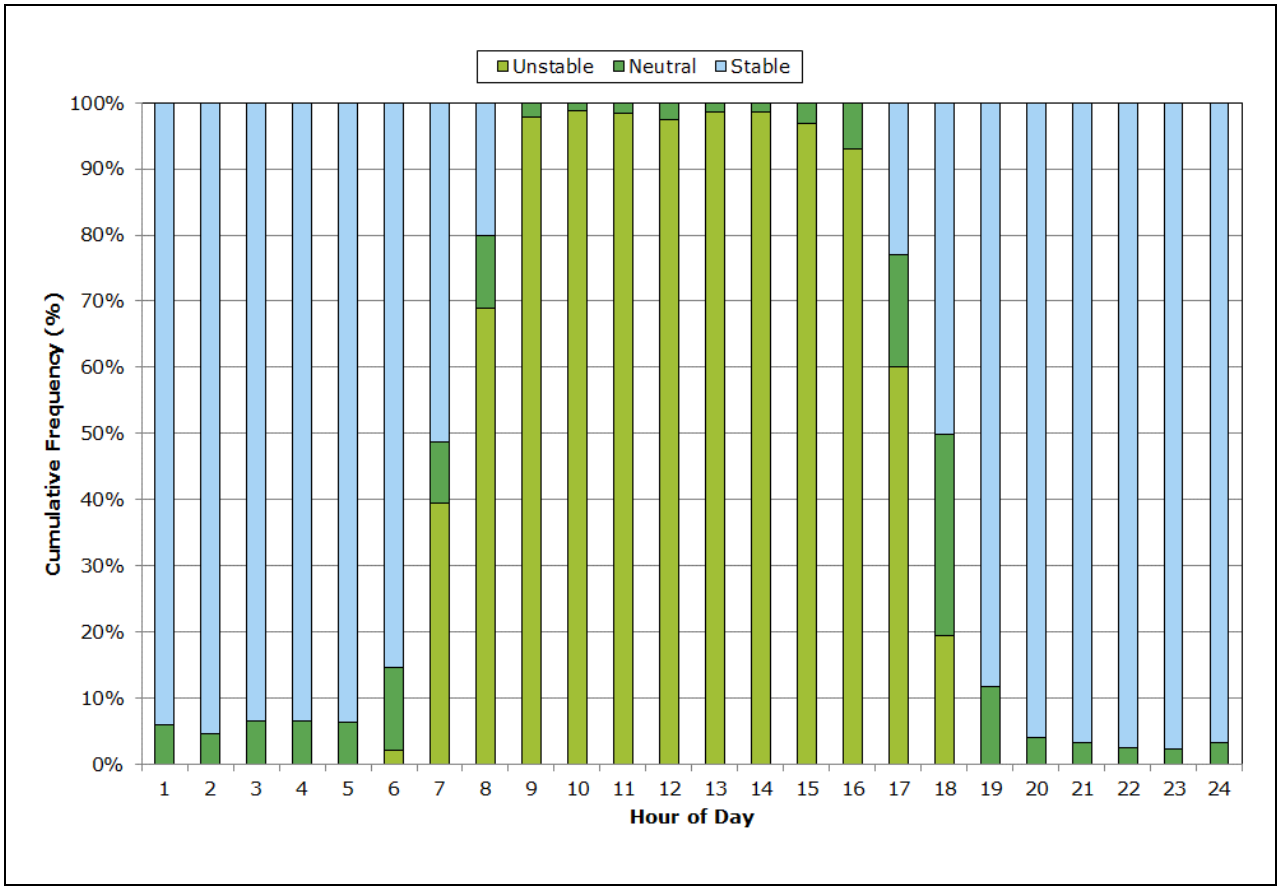
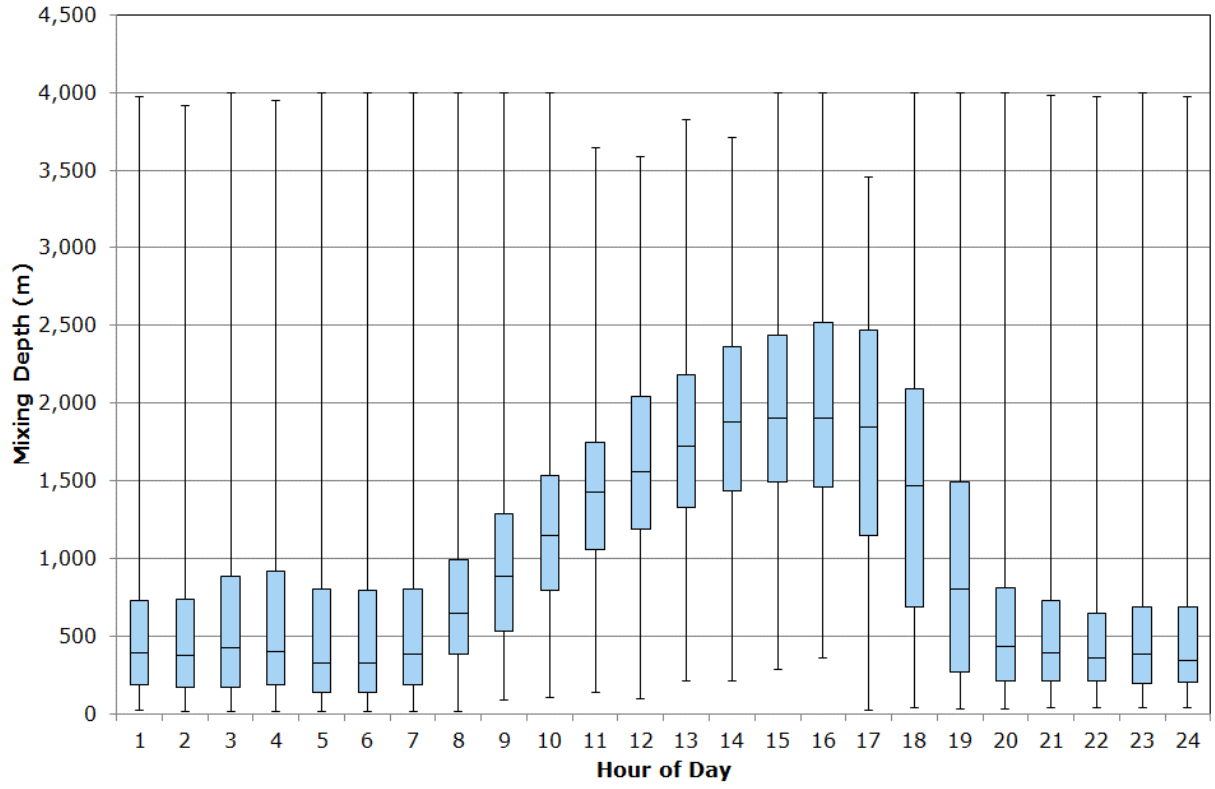


Figure 4-3: AERMET-Calculated Diurnal Variation in Atmospheric Stability– Cessnock Airport AWS 2015 dataset

4.5 Mixing depth

Hourly-varying atmospheric boundary layer depths were generated by AERMET, the meteorological processor for the AERMOD dispersion model (see **Section 7.1** for further information), using a combination of surface observations from the Cessnock Airport BoM AWS, sunrise and sunset times and adjusted TAPM predicted- upper air temperature profile.

The variation in average boundary layer depth by hour of the day is illustrated in **Figure 4-4**. It can be seen that greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.



Note: Boxes indicate 25th, Median and 75th percentile of AERMET-calculated mixing height data while upper and lower whiskers indicate maximum and minimum values.

Figure 4-4: AERMET-Calculated Diurnal Variation in Atmospheric Mixing Depth – Cessnock Airport 2015 dataset

5. EXISTING AIR QUALITY ENVIRONMENT

5.1 Existing sources of atmospheric emissions

The National Pollutant Inventory (NPI) database identifies one reporting source of air emissions in the local area, being the aluminium plant, immediately adjacent to the site.

Emissions from the aluminium plant have the potential to cause direct cumulative impacts with emissions from the project. The aluminium plant has seven individual point emission sources. Emissions data has been provided by Weston Aluminium (WA) for the inclusion in cumulative modelling of PM_{10}, $PM_{2.5}$, lead, NO_2 and SO_2. The emissions data provided by WA is presented in **Appendix 2**.

There are a number of other NPI sources within 10 km of the site, including hard rock quarrying, open cut coal mining, animal by-product rendering, construction industry product manufacturing and chemical manufacturing facilities. In addition, the surrounding local industrial zones contain smaller industrial emission sources such as metals fabrication, material recycling facilities, concrete batching plants and scrap metal recycling facilities. Emissions from these facilities are not quantitatively assessed as part of the cumulative modelling scenario. These existing operations are assumed to be accounted for in the consideration of baseline or background air quality described in **Section 5.2**.

Hydro Aluminium are seeking approval for the demolition and remediation of the former Kurri Kurri Aluminium Smelter, located approximately 1.2km north of the site. While the proposed demolition and remediation activities have the potential to generate air pollutant emissions, the results presented within the air quality assessment completed for that proposal (Ramboll Environ, 2016) indicate that associated impacts in the surrounding area would be minor and cumulative impacts with potential emissions from the site are unlikely.

Finally, it is considered that the following sources also contribute to air pollution emissions in the vicinity of the proposed project:

- Dust entrainment and tyre and break wear due to vehicle movements along public roads;
- Petrol and diesel emission from vehicle movements along public roads;
- Wind generated dust from exposed areas within the surrounding region;
- Seasonal emissions from household wood burning fires;
- Sea salts contained in sea breezes.

More remote sources which contribute episodically to suspended air quality levels in the region include dust storms and bushfires.

In summary, the emissions of PM_{10}, $PM_{2.5}$, lead, NO_2 and SO_2 from the aluminium plant emission sources are combined with site-only increment model predictions (**Section 8**) and background air quality to assess cumulative impacts at surrounding receptor locations.

5.2 Background air pollutant concentrations

Ambient air pollutant concentrations are recorded by the NSW OEH at a number of monitoring stations across the lower Hunter region. The closest monitoring station to the site is located at Beresfield, approximately 17 km to the east. Concentrations of PM_{10}, $PM_{2.5}$, NO_2 and SO_2 recorded during 2015 at the NSW OEH Beresfield monitoring station were reviewed. To provide a conservative worst case assessment of cumulative PM_{10} and $PM_{2.5}$ impacts, the maximum recorded concentrations throughout 2015 were adopted for background. For NO_2 and SO_2, daily maximum and average concentrations recorded throughout 2015 were paired in time with hourly predicted concentrations.

For PM_{10} and $PM_{2.5}$ concentrations, exceedance of the respective 24-hour average assessment criterion were recorded at the Beresfield station on two and one occasions respectively. These exceedances were attributable to bushfire events in NSW (NSW OEH, 2016). Therefore the third highest PM_{10} concentration and the second highest $PM_{2.5}$ concentration were adopted for cumulative assessment purposes.

In the case of NO_2, concentrations have been derived through the application of the ozone limiting method (OLM), using maximum daily concentrations of NO_2. Further discussion on the OLM is presented in **Section 7.5**.

There are no dust deposition or lead monitoring data available suitable to quantify baseline levels at the site. In the case of dust deposition, modelling has focussed on the incremental contribution from proposed operational emissions only. This is suitable for assessment against the NSW EPA incremental criterion of 2g/m^2/month, expressed as an annual average. Ambient concentrations of lead are assumed to be negligible for the purpose of this assessment.

A summary of the adopted ambient air quality concentrations based on the NSW OEH Beresfield data for 2015 is presented in **Table 5-1**.

Table 5-1: Adopted ambient air quality concentrations – NSW OEH Beresfield monitoring data - 2015

Pollutant	Averaging period	Concentration (µg/m³)
PM_{10}	24-hour	43.3
	Annual	18.8
$PM_{2.5}$	24-hour	20.2
	Annual	7.3
NO_2	1-hour	Hourly-varying (max 92.1)
	Annual	35.8
SO_2	1-hour	Hourly-varying (max 214.8)
	24-hour	Daily-varying (max 21.0)
	Annual	3.0
Lead	Annual	Negligible

6. EMISSION ESTIMATION

Process emissions occurring within the project buildings will be ducted to pollution control equipment (wet scrubber and bag house), prior to venting to atmosphere via five individual point sources. Stack parameters, including emission concentrations, exit temperature, exit velocity, release height and stack diameter, were provided by the proponent for configuration in the dispersion modelling conducted. Emission are derived based on stack testing data from identical facilities operating the Engitec CX system. The pollution control equipment for each release point is described in **Section 9**.

In addition to process emissions occurring within the project buildings, emissions associated with the transportation of raw material to and product material from site have also been quantified. These emissions include fugitive PM emissions from vehicles moving along paved road surfaces and diesel fuel combustion emissions.

6.1 Process emissions

Stack emission parameters from the five proposed emissions release points are presented in **Table 6-1**. The emission rates (in grams per second) are derived from the expected in-stack concentrations provided by the proponent based on similar operational facilities. Particulate matter concentrations were divided into PM_{10} and $PM_{2.5}$ size fractions through the application of the US-EPA (1995) generalised particle size distribution profiles for *melting, smelting and refining* (C-720 and C-720A), *mechanically generated* (C-530) and *calcining* (U-421/PK-420).

Four of the stacks, C-720, C-720A, PK-520 and U-421/PK-420, involve the combustion of natural gas. To conservatively account for by-products of natural gas combustion, the annual natural gas combustion rate by source has been combined with published emissions factors for natural gas combustion (<=30MW wall fired, Table 21 of NPI, 2011) to quantify emissions of assorted pollutants. To convert estimated VOC emission rates into individual VOC species, the US-EPA emissions profile *1001 Internal Combustion Engine - Natural Gas* (US-EPA, 2016) has been adopted.

The heat required to boil the sodium sulphate solution is provided by the same vapour generated in the crystallizer, adiabatically recompressed by the compressor K-401 and fed to the heat exchanger E-402, where condensation takes place. The operation of the natural gas boiler associated with stack PK-520 is to supply live steam (from boiler PK-520) in order to prime the thermodynamic cycle (recompression of the vapour) and compensate the heat losses. As the sequencing of the natural gas boiler is unknown at the time of reporting, this assessment has assumed continuous operation of the natural gas boiler and emissions from stack PK-520. This approach is considered highly conservative.

Emissions of arsenic from the project have been quantified based on the estimated arsenic content of the lead slag of 0.2%. This percentage has been applied to the estimated particulate matter emission rate to conservatively estimate arsenic emissions.

Table 6-1: Stack emission parameters – proposed project					
Source ID	C-720	C-720A	C-530	PK-520	U-421/PK-420
Description	Process gas captured in KL-710; and Sanitary air captured Slag Room and Preparation Area	Process gases captured in K-710a	Sanitary Air at CX Section	Steam Boiler (1,000kg/h)	Sodium sulphate drying and conveying air
Easting	357455	357448	357465	357455	357463
Northing	6369217	6369175	6369289	6369262	6369280
Exit velocity (m/s)	20.4	18	15	15	16
Exit diameter (m)	1.5	1.0	0.8	0.35	0.3
Flow (Nm^3/h)	130,000	50,000	16,000	1,000	4,000
Stack Height (m)	20	20	15	18.6	15
Exit Temperature (deg C)	55	80	25	180	100
Natural Gas Consumption (GJ/year)	36,040	36,040	N/A	19,770	10,874
In-stack concentration (mg/Nm^3)[1]					
PM	<1	<2.5	<5	-	<5
Lead	<0.2	<0.5	<0.5	-	-
NO_x	<80	<200	-	<150	-
SO_2	<50	<125	-	-	-
SO_3	<0.7	<2	-	-	-
Dioxins and furans	<0.04	<0.1	-	-	-

Note: Emission concentrations converted to actual conditions accounting for stack exit temperature. Emission concentrations represent upper bound estimates of actual emission concentrations.

Table 6-2: Stack emission rates – proposed project					
Source ID	**C-720**	**C-720A**	**C-530**	**PK-520**	**U-421/PK-420**
Emission rates (g/s)					
PM_{10}	4.84E-02	4.99E-02	2.43E-02	2.75E-03	9.10E-03
$PM_{2.5}$	4.06E-02	4.18E-02	7.13E-03	2.75E-03	4.09E-03
Lead	8.68E-03	8.98E-03	2.43E-03	1.85E-07	1.02E-07
NO_x	3.54E+00	3.66E+00	-	1.06E-01	2.04E-02
SO_2	2.17E+00	2.25E+00	-	4.09E-04	2.25E-04
SO_3	3.04E-02	3.59E-02	-	-	-
Dioxins and furans	1.74E-09	1.80E-09	-	1.84E-12	1.01E-12
Arsenic	3.38E-07	3.38E-07	4.85E-05	1.85E-07	1.02E-07
VOCs	3.73E-03	3.73E-03	-	2.04E-03	1.12E-03
Benzene	4.10E-06	4.10E-06	-	2.25E-06	1.24E-06
Toluene	1.49E-06	1.49E-06	-	8.18E-07	4.50E-07
Xylene	7.45E-07	7.45E-07	-	4.09E-07	2.25E-07
Formaldehyde	3.02E-05	3.02E-05	-	1.66E-05	9.11E-06
Ethylbenzene	3.73E-07	3.73E-07	-	2.04E-07	1.12E-07

Note: Emission rates include process emissions and natural gas combustion emissions

6.2 Vehicle movements

The fugitive emissions from the movement of trucks across paved roads at the site were quantified using the emission factor equations documented within AP42 Chapter 13.2.2 -"Paved Roads" (US-EPA 2011) and using the following assumptions:

- Delivery of materials to site – 2,400 trucks per year, maximum of 14 trucks per day;
- Dispatch of material from site – 1,480 trucks per year, maximum of six trucks per day;
- Total road length of 800 m;
- Default silt loading of 0.2 g/m^2 (US-EPA, 2011); and
- Truck weight of 30 tonnes.

Diesel combustion emissions from delivery and dispatch trucks were estimated using the following:

- PM, NO_x and VOC Emission factors for 1996 ADR70/00 for articulated trucks as presented in the NSW EPA 2008 emissions inventory (EPA, 2012) in gram/vehicle kilometres travelled;
- Annual onsite vehicle kilometres travelled for dispatch and delivery trucks of 3,640km/year.

To convert estimated VOC emission rates into individual VOC species, the US-EPA emissions profile *8775 - Diesel Exhaust Emissions from 2007 Model Year Heavy-Duty Diesel Engines with Controls* (US-EPA, 2016) has been adopted.

Table 6-3: Truck movement emissions – fugitive dust and diesel combustion

Site	Emission rate (g/s)
PM_{10}	6.70E-04
$PM_{2.5}$	2.03E-04
NO_x	3.83E-03
VOC	2.23E-04
Benzene	1.36E-06
Toluene	2.77E-06
Xylene	3.78E-06
Formaldehyde	2.24E-05
Ethylbenzene	7.03E-07

6.3 Annual emissions

Assuming continual operations of all emission sources quantified above, the annual air pollutant emissions from the project are presented in **Table 6-4**.

Table 6-4: Total site annual emissions

Site	Annual emissions (kg/annum)
PM_{10}	4,259.1
$PM_{2.5}$	3,045.3
NO_x	231,079.2
SO_2	139,257.4
SO_3	2,090.2
Lead	633.3
Dioxins and furans	0.00011
Arsenic	1.56
Benzene	0.41
Toluene	0.22
Xylene	0.19
Formaldehyde	3.42
Ethylbenzene	0.06

6.4 Other emission sources

In addition to the sources quantified above, the operation of the project will also involve the operation of two forklifts and a front end loader within the project buildings, unloading of soda ash from trucks to an elevated silo, a wastewater treatment plant and an onsite laboratory.

Emissions from the forklifts and front end loader will largely be contained within the project buildings (assorted material handling and truck loading operations) and therefore are accounted for in the stack emissions of ducted internal air.

The unloading of soda ash, estimated to be approximately 5,200 tpa, to an elevated silo will occur under vacuum with minimal potential for fugitive emissions.

The proposed onsite waste water treatment plant is completely enclosed with metal cladding on the exterior walls and steel framework. Emissions to ambient air are considered minimal. Emissions from the proposed laboratory are likely to be infrequent and minimal relative to the proposed project and have not been quantified in this assessment.

6.5 Odour emissions

On the basis of other similar operational facilities (e.g. Wagga Wagga), the proponent considers that odour emissions from processes occurring within the buildings to ambient air are unlikely. All potentially odourous processes are connected to a dedicated scrubber system to prevent any kind of fugitive emission from internal reactors and tanks to ambient air.

7. MODELLING ASSESSMENT METHODOLOGY

7.1 Dispersion model selection and application

The atmospheric dispersion modelling completed within this assessment used the AMS/US-EPA regulatory model (AERMOD) (US-EPA, 2004). AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

Predicted concentrations were calculated for a regular Cartesian receptor grid covering a 4 km by 4 km computational domain centred over the site, with a grid resolution of 100 m applied. Additionally, concentrations were predicted at the representative receptor locations listed in **Table 2-1**.

Simulations were undertaken for the 12 month period of 2015 using the AERMET-generated file based largely on the Cessnock Airport AWS meteorological monitoring dataset as input (see **Section 4** for description of input meteorology).

The methodology and results of the emissions inventory developed for this study are presented in **Section 6**.

7.2 Presentation of model results

Dispersion simulations were undertaken to predict the concentrations of PM_{10}, $PM_{2.5}$, NO_2, SO_2, lead, individual air toxics and dust deposition. Incremental project-related concentrations and deposition rates occurring due to the proposed operations were predicted. Model results are expressed as the maximum predicted concentration for each averaging period at the selected assessment locations over the 2015 modelling period.

The results are presented in the following formats:

- Tabulated results of concentrations and dust deposition rates at the selected assessment locations are presented and discussed in **Section 8**.
- Isopleth plots, illustrating spatial variations in project-only incremental PM_{10}, $PM_{2.5}$, lead, NO_2 and SO_2 concentrations are provided in **Appendix 3**. Isopleth plots of the maximum 1-hour and 24-hour average concentrations presented in **Appendix 3** do not represent the dispersion pattern on any individual hour or day, but rather illustrate the maximum daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2015 modelling period.

7.3 Cumulative impacts assessment

Cumulative impacts in the environment surrounding the project have been assessed in the following way:

- For each hour of the modelling period, predicted incremental concentrations from the proposed site operations and neighbouring aluminium plant emission sources have been paired in time at each sensitive receptor location;
- For all pollutants, with the exception of NO_2, the adopted ambient concentrations presented in **Table 5-1** were paired with the corresponding maximum predicted combined project-aluminium plant concentrations at each receptor location.
- For NO_2 concentrations, cumulative impacts were assessed through the OLM approach described in **Section 7.5**.

7.4 Building wake effects

Plumes trapped in building wakes can either be recirculated in the cavity region immediately downwind of a building or subjected to plume downwash and enhanced horizontal or vertical spreading due to the turbulent zone that exists further downwind. Buildings generate downwind wake effects up to 5 times the lesser of the building

height or projected building width. For stacks with heights less than approximately 2.5 times the building height located within this zone, dispersion of emissions may be affected by building wake effects.

AERMOD accounts for building wake effects through the implementation of the BPIP PRIME model. Building wake effects were considered in this assessment for the proposed structures associated with the project and the existing structures at the adjacent aluminium plant.

7.5 Modelling of NO_x emissions

Oxides of nitrogen (NO_x) emissions from the project are primarily emitted as nitrous oxide (NO) with some NO_2. The transformation in the atmosphere of NO to NO_2 was accounted for using the US-EPA's Ozone Limiting Method (OLM) which requires ambient ozone data, as per the Approved Methods for Modelling (NSW EPA, 2005). In applying the OLM method, the maximum one hour NO_2 and O_3 concentrations recorded on each day during 2015 at the NSW OEH Beresfield station were applied.

The equation used to calculate NO_2 concentrations from predicted NO_X concentrations is as follows:

$$[NO_2]_{TOTAL} = \{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\} + [NO_2]_{BKGD}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of NO_2 as $\mu g/m^3$.

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level NO_X concentrations as $\mu g/m^3$.

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – maximum one hour concentration for each day of 2015 at OEH Beresfield as $\mu g/m^3$.

46/48 = the molecular weight of NO_2 divided by the molecular weight of O_3.

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – maximum one hour concentration for each day of 2015 OEH Beresfield as $\mu g/m^3$.

The US-EPA's OLM assumes that all of the available O_3 in the atmosphere will react with NO until either all of the O_3, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. Furthermore, the method assumes that the complete mixing of the plume NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the plume reaches the ground level receiver of the maximum ground level NO_X concentration.

In addition to the conservatism of the OLM approach, the use of the maximum one-hour average NO_2 and O_3 concentrations for each day of the 2015 Beresfield dataset across all hours of the corresponding day is considered conservative for the conversion of NO_2 from NO_x concentrations.

Consequently, concentrations of the NO_2 reported within this assessment should be viewed as highly conservative, providing an upper bound estimate of potential NO_2 concentrations.

8. ASSESSMENT RESULTS

8.1 Estimated in-stack concentrations

A comparison between the proponent's estimated in-stack concentrations and the standards of concentration prescribed by the POEO (Clean Air) Regulation demonstrates that all emission sources would comply with the relevant limits, as shown in **Table 8-1**.

Table 8-1: Comparison with in-stack standards of concentration

Pollutant	Stack	Estimated in-stack concentration (mg/m^3)	Limit (mg/m^3)
PM	C-720	1	50
	C-720A	2.5	
	C-530	5	
	PK-520	-	
	U-421/PK-420	5	
Pb	C-720	0.2	1
	C-720A	0.5	
	C-530	0.5	
	PK-520	-	
	U-421/PK-420	-	
NOx	C-720	80	300
	C-720A	200	
	C-530	-	
	PK-520	150	
	U-421/PK-420	-	
SO_3	C-720	0.7	100
	C-720A	2	
	C-530	-	
	PK-520	-	
	U-421/PK-420	-	
Dioxins or furans	C-720	0.04	0.1
	C-720A	0.1	
	C-530	-	
	PK-520	-	
	U-421/PK-420	-	

8.2 Incremental (site-only) ground level concentrations

Predicted project-only incremental concentrations and deposition rates at each of the representative assessment locations are presented in **Table 8-2** (PM_{10}, $PM_{2.5}$, lead and dust deposition), **Table 8-3** (NO_2 and SO_2) and **Table 8-4** (individual air toxics).

It can be seen from these tables of results that the predicted project-only incremental concentrations and deposition rates are below applicable impact assessment criteria and goals. It is noted that the impact assessment criteria and goals for PM_{10}, $PM_{2.5}$, lead, NO_2 and SO_2 are applicable to cumulative concentrations. Cumulative impacts have been addressed in **Section 8.3**.

Isopleth contour plots of project-only incremental concentrations of PM_{10}, $PM_{2.5}$, lead, NO_2 and SO_2 are presented in **Appendix 3**.

Table 8-2: Predicted project-only increment impacts – PM_{10}, $PM_{2.5}$, lead and dust deposition

Receptor ID	PM_{10}		$PM_{2.5}$		Lead	Dust deposition
	24-hour	Annual	24-hour	Annual	Annual	Annual
Unit	µg/m³					g/m²/month
Criteria	50	30	25	8	0.5	2
1	0.4	0.1	0.3	0.1	<0.1	<0.1
2	0.3	<0.1	0.2	<0.1	<0.1	<0.1
3	0.1	<0.1	0.1	<0.1	<0.1	<0.1
4	0.2	<0.1	0.1	<0.1	<0.1	<0.1
5	0.1	<0.1	0.1	<0.1	<0.1	<0.1
6	0.4	0.1	0.3	0.1	<0.1	<0.1
7	0.1	<0.1	0.1	<0.1	<0.1	<0.1
8	0.1	<0.1	0.1	<0.1	<0.1	<0.1
9	0.1	<0.1	0.1	<0.1	<0.1	<0.1
10	0.2	<0.1	0.1	<0.1	<0.1	<0.1
11	0.5	0.1	0.3	0.1	<0.1	<0.1
12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
13	0.7	0.2	0.5	0.1	<0.1	<0.1
14	0.4	0.1	0.3	0.1	<0.1	<0.1
15	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
18	0.4	0.1	0.3	0.1	<0.1	<0.1
19	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
21	0.2	0.1	0.2	<0.1	<0.1	<0.1
22	0.1	<0.1	0.1	<0.1	<0.1	<0.1
23	0.2	<0.1	0.2	<0.1	<0.1	<0.1
24	2.1	0.5	1.5	0.3	0.1	0.1
25	0.5	0.1	0.3	<0.1	<0.1	<0.1

Table 8-3: Predicted project-only increment impacts – NO_2 and SO_2

Receptor ID	NO_2		SO_2			
	1-hour	Annual	10-minute	1-hour	24-hour	Annual
Unit	µg/m³					
Criteria	246	62	712	570	228	60
1	105.3	3.1	102.5	71.7	11.4	1.7
2	68.1	1.6	75.9	53.1	7.2	0.9
3	40.6	0.5	33.5	23.4	3.5	0.3
4	65.6	1.2	71.8	50.1	5.8	0.7
5	32.4	0.8	29.9	20.9	3.6	0.4
6	87.2	4.1	84.5	59.1	14.1	2.3
7	38.8	1.3	37.1	26.0	4.7	0.7
8	47.0	1.0	44.7	31.2	3.6	0.5
9	28.2	0.7	26.8	18.7	2.5	0.4
10	50.4	1.6	48.4	33.8	6.8	0.9
11	88.0	4.3	94.2	65.8	15.1	2.5
12	17.9	0.2	17.1	12.0	1.0	0.1
13	148.7	5.7	281.2	196.5	23.3	4.0
14	101.9	3.9	230.2	160.9	12.2	2.4
15	28.4	0.3	26.0	18.2	1.2	0.2
16	17.8	0.2	17.0	11.9	0.9	0.1
17	25.6	0.4	23.6	16.5	1.0	0.2
18	145.7	3.9	242.4	169.4	13.0	2.3
19	21.3	0.3	18.6	13.0	0.9	0.2
20	25.7	0.5	23.0	16.1	1.5	0.3
21	97.6	2.7	180.6	126.2	9.5	1.5
22	42.6	0.9	54.6	38.1	2.8	0.5
23	79.1	1.8	127.6	89.2	7.5	1.0
24	168.5	14.6	318.0	222.3	72.1	14.5
25	122.3	3.0	118.7	82.9	13.4	1.7

Table 8-4: Predicted project-only increment impacts – individual air toxics

Receptor ID	H_2SO_4	Dioxin and Furans	Arsenic	Benzene	Toluene	Xylenes	Formalde-hyde	Ethylben-zene
	99.9th Percentile 1-hour average							
Unit	µg/m³							
Criteria	18	2.0e-6	0.09	29	360	190	20	8,000
1	1.1	4.2E-08	0.002	0.0001	0.0001	0.0001	0.0012	<0.0001
2	0.8	3.3E-08	0.001	0.0001	<0.0001	<0.0001	0.0008	<0.0001
3	0.4	1.6E-08	0.001	0.0001	<0.0001	<0.0001	0.0006	<0.0001
4	0.8	3.0E-08	0.001	0.0001	0.0001	0.0001	0.0011	<0.0001
5	0.3	1.3E-08	0.001	0.0001	<0.0001	<0.0001	0.0005	<0.0001
6	0.9	3.0E-08	0.001	0.0001	0.0001	<0.0001	0.0011	<0.0001
7	0.4	1.2E-08	0.001	0.0001	<0.0001	<0.0001	0.0006	<0.0001
8	0.5	1.3E-08	0.001	0.0001	<0.0001	<0.0001	0.0007	<0.0001
9	0.3	1.1E-08	0.001	0.0001	<0.0001	<0.0001	0.0005	<0.0001
10	0.5	2.1E-08	0.001	0.0001	<0.0001	<0.0001	0.0006	<0.0001
11	1.1	4.4E-08	0.002	0.0002	0.0001	0.0001	0.0015	<0.0001
12	0.2	5.8E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001
13	3.0	1.2E-07	0.003	0.0005	0.0005	0.0007	0.0051	0.0001
14	2.4	9.2E-08	0.002	0.0004	0.0002	0.0002	0.0032	<0.0001
15	0.3	8.0E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001
16	0.2	5.7E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001
17	0.2	8.5E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001
18	2.5	6.2E-08	0.002	0.0003	0.0002	0.0002	0.0027	<0.0001
19	0.2	7.4E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001
20	0.2	8.6E-09	<0.001	<0.0001	<0.0001	<0.0001	0.0003	<0.0001
21	1.9	3.4E-08	0.001	0.0002	0.0001	0.0001	0.0011	<0.0001
22	0.6	1.4E-08	0.001	<0.0001	<0.0001	<0.0001	0.0004	<0.0001
23	1.4	3.3E-08	0.002	0.0001	0.0001	<0.0001	0.0009	<0.0001
24	3.4	1.5E-07	0.007	0.0005	0.0004	0.0005	0.0046	0.0001
25	1.3	5.1E-08	0.002	0.0002	0.0001	0.0001	0.0014	<0.0001
Site Boundary Maximum	7.9	3.76E-07	0.083	0.0024	0.0012	0.0017	0.0184	0.0003

8.3 Cumulative ground level concentrations

Predicted cumulative concentrations and deposition rates, combining project increment, aluminium plant predicted increment and existing ambient background (as per **Section 5.2**) at each of the representative assessment locations are presented in **Table 8-5** (PM_{10}, $PM_{2.5}$, lead and dust deposition) and **Table 8-6** (NO_2 and SO_2).

It can be seen from these tables of results that the project-related cumulative concentrations and deposition rates are below applicable are below the applicable NSW EPA assessment criterion and NEPM reporting goals at all surrounding assessment locations.

The potential for cumulative impacts above the applicable criteria in the surrounding environment is therefore considered low.

Table 8-5: Predicted cumulative impacts – PM_{10}, $PM_{2.5}$, lead and dust deposition

Receptor ID	PM_{10}		$PM_{2.5}$		Lead	Dust deposition
	24-hour	Annual	24-hour	Annual	Annual	Annual
Unit	µg/m³					g/m²/month
Criteria	50	30	25	8	0.5	2
1	44.4	19.0	20.6	7.4	<0.1	<0.1
2	43.7	18.9	20.2	7.3	<0.1	<0.1
3	43.6	18.8	20.2	7.3	<0.1	<0.1
4	43.7	18.9	20.2	7.3	<0.1	<0.1
5	43.6	18.8	20.2	7.3	<0.1	<0.1
6	44.3	19.0	20.2	7.4	<0.1	0.1
7	43.7	18.9	20.2	7.3	<0.1	<0.1
8	43.6	18.8	20.2	7.3	<0.1	<0.1
9	43.5	18.8	20.2	7.3	<0.1	<0.1
10	43.8	18.9	20.2	7.3	<0.1	<0.1
11	44.4	19.0	20.2	7.4	<0.1	0.1
12	43.4	18.8	20.2	7.3	<0.1	<0.1
13	44.4	19.1	20.4	7.4	<0.1	0.1
14	44.1	19.0	20.3	7.4	<0.1	0.1
15	43.5	18.8	20.2	7.3	<0.1	<0.1
16	43.4	18.8	20.2	7.3	<0.1	<0.1
17	43.4	18.8	20.2	7.3	<0.1	<0.1
18	44.1	19.0	20.3	7.4	<0.1	0.1
19	43.4	18.8	20.2	7.3	<0.1	<0.1
20	43.4	18.8	20.2	7.3	<0.1	<0.1
21	43.8	18.9	20.2	7.3	<0.1	<0.1
22	43.6	18.8	20.2	7.3	<0.1	<0.1
23	43.9	18.9	20.2	7.3	<0.1	<0.1
24	45.8	19.8	20.4	7.7	0.1	0.3
25	44.2	18.9	20.2	7.4	<0.1	<0.1

Table 8-6: Predicted cumulative impacts – NO_2 and SO_2

Receptor ID	NO_2		SO_2			
	1-hour	Annual	10-minute	1-hour	24-hour	Annual
Unit	µg/m³					
Criteria	246	62	712	570	228	60
1	141.1	38.8	310.5	217.0	21.3	5.0
2	110.3	37.0	346.6	242.2	22.5	4.1
3	109.8	35.9	310.5	217.0	21.1	3.5
4	111.8	36.9	315.9	220.7	21.4	3.9
5	99.7	36.4	311.4	217.6	21.3	3.7
6	139.4	40.5	354.8	247.9	25.3	5.6
7	99.3	37.0	326.2	228.0	22.3	3.9
8	108.5	36.6	333.6	233.1	23.0	3.8
9	124.8	36.2	318.4	222.5	22.4	3.6
10	145.1	37.4	329.9	230.5	23.9	4.1
11	153.6	40.7	367.9	257.1	30.3	5.8
12	96.3	35.5	308.3	215.4	21.0	3.3
13	221.1	42.7	328.2	229.4	24.9	7.6
14	170.0	40.1	318.1	222.3	22.7	5.8
15	98.9	35.7	309.0	216.0	21.1	3.4
16	96.2	35.5	308.2	215.4	21.0	3.3
17	99.8	35.7	308.9	215.9	21.1	3.4
18	208.1	40.1	313.2	218.9	21.9	5.7
19	98.7	35.7	309.1	216.0	21.1	3.4
20	100.5	36.0	308.7	215.7	21.1	3.5
21	127.7	38.6	310.1	216.7	21.4	4.8
22	101.1	36.5	308.5	215.6	21.1	3.7
23	140.9	37.7	308.7	215.7	21.1	4.3
24	213.6	56.3	344.3	240.6	73.9	20.8
25	216.3	39.0	336.3	235.0	21.9	5.0

9. MITIGATION AND MONITORING

9.1 Pollution control equipment

The proposed pollution control equipment consists of bag houses for dust control and wet scrubbing for acid gas / mist removal. The dust control measures are as follows:

- The crushing mill and associated conveyors are fully controlled to prevent dust emissions. The crushed materials pass through a screen and are wetted down with high pressure water sprayers using recycled water.
- The charge preparation building will be completely closed and under strong negative pressure. Dusty air is draw off in a closed duct system and carried to the to the sanitary air bag house filtration system (PK-721).
- Process fume from the rotary furnace are sucked into the bag house system (PK-720). Ambient air from the furnace feeding area will be injected to the settling chamber before passing to the PK-720 bag house.
- Flue dust collected from the bag house filters will be mixed with the lead paste for recycling into the rotary furnace.
- The sodium sulphate crystals silo is equipped with a bag house for de-dusting prior to discharge (during filling).

Polluted air, containing acid mist, is collected from the following points:

- Batteries vibrating feeding
- Sound proofing cabin of mill
- Paste settler
- Battery conveyor terminal hood
- Components separator
- Separators dewatering system
- Grid rotary classifier
- Reaction tank
- Lead paste filter press
- Purification tank
- Polishing filter
- Crystallizer feed tank

This air is collected and ducted to a packed tower scrubber (FL-530) for removal of acid gas and mist.

9.2 Air quality monitoring

As a scheduled activity under the POEO regulations, the project will operate under an EPL. The EPL will prescribe limits for each discharge point and the stack monitoring requirements will be described, including the monitoring method, pollutants and frequency.

Ambient air quality monitoring requirements will also be outlined in the EPL, however based on the modelling predictions presented in this report, ambient monitoring may not be required. The predicted ground level concentrations for all key pollutants from the project are low and comply with the relevant impact assessment criteria, provided the project can demonstrate compliance with the in-stack concentration presented in this report.

10. GREENHOUSE GAS ASSESSMENT

10.1 Introduction

The estimation of GHG emissions for the project is based on the Australian Government Department of the Environment and Energy (DoEE) National Greenhouse Accounts Factors (NGAF) workbook (DoEE, 2016). The methodologies in the NGAF workbook follow a simplified approach, generally equivalent to the "Method 1" approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE, 2014). The Technical Guidelines are used for the purpose of reporting under the Commonwealth *National Greenhouse and Energy Reporting Act 2007* (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DoE, 2015). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the upstream use of products and services or the downstream extraction and production of raw materials.

Scope 3 is an optional reporting category (Bhatia et al, 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels (relating to extraction and transport) and purchased electricity (relating to transmission and distribution loses), making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

10.2 Emission sources

The GHG emissions sources included in this assessment are listed in **Table 10-1**, representing the most significant sources associated with the project.

Other minor sources of GHG emissions, such as those generated by employee travel and waste disposal are anticipated to be negligible in comparison and have not been considered in this assessment.

Table 10-1: Scope 1, 2 and 3 emission sources

Scope 1	Scope 2	Scope 3
Direct emissions from fuel combustion (natural gas and diesel) by onsite plant and equipment.	Indirect emissions associated with the consumption of purchased electricity	Indirect upstream emissions from the extraction, production and transport of diesel and gas fuel.
		Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network.
		Upstream and downstream emissions generated from raw material delivery and product transportation in non-company owned trucks

10.3 Emission estimates

GHG emissions are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and Scope 1, 2 and 3 emission factors (EF) for natural gas, diesel, and electricity use in NSW (DoEE, 2016).

Activity data for the emission estimates are presented in **Table 10-2** based on the following assumptions:

- Annual electricity usage (kWh) has been estimated based on an intensity factor provided by the client and expressed as "*kWh per tonne of crude led produced by the system*". It is noted that the estimate provided by the proponent is for the Engitec CX processing system and does not include power requirements for ventilation, extraction, lighting, services, workshop etc.
- The annual gas consumption rate is derived from an hourly consumption rate of 14,267 MJ/hr, and assumed for all operational hours (24 hours a day, 300 days of the year).
- On-site diesel consumption for the front end loader is estimated based on an assumed fuel consumption of 10 litres per hour. The front end loader is assumed to be operational for 70% of the time, for all operational hours (24 hours a day, 300 days of the year).
- On-site diesel consumption for lifts trucks is estimated based on an assumed fuel consumption of 3 L/hr Two lift trucks are assumed to be operational for 70% of the time, for all operational hours (24 hours a day, 300 days of the year).
- An estimate of diesel consumption for transportation has been made based on the NSW average fuel consumption rate for articulated trucks of 0.6 L/km (ABS, 2015[5]). For raw material delivery and product trucks an average trip distance of 50 km is assumed and multiplied by the daily truck movements to derive the daily vehicle kilometres travelled (VKT). For other miscellaneous truck movements, such as waste collection, an average travel distance of 30 km is assumed to derive the daily VKT.

Table 10-2: Estimated activity data for GHG emission estimates

Lead production (tonnes)	Electricity (kWh)	Natural Gas (GJ)	Diesel consumption (kL) - onsite	Diesel consumption (kL) – transport
18,000	4,410,000	102,724	81	382

The estimated annual GHG emissions for each source are presented in **Table 10-3**. Annual emissions (all scopes) represent approximately 0.009% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014[6].

Table 10-3: Estimated GHG emissions (tonnes CO2-e)

Scope 1			Scope 2	Scope 3				
Diesel (onsite)	Natural gas	Total	Electricity	Diesel (onsite)	Natural gas	Electricity	Diesel (transport)	Total
216	5,293	5,510	3,704	11	1,397	529	1,094	3,031

[5] http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

[6] http://ageis.climatechange.gov.au/

11. CONCLUSIONS

Ramboll Environ was commissioned to undertake an air quality and GHG assessment for the project.

Emissions of PM_{10}, $PM_{2.5}$, lead, NO_2, SO_2 and individual air toxics associated with peak proposed operations were accounted for through information provided by the proponent and publicly available emission estimation techniques. Atmospheric dispersion modelling predictions of air pollution emissions for proposed operations were undertaken using the AERMOD dispersion model.

Cumulative impacts were accounted for through the modelling of emissions from the neighbouring aluminium facility and existing ambient air quality based on monitoring data from the NSW OEH Beresfield monitoring station.

The results of the dispersion modelling conducted indicated that the operation of the proposed project is highly unlikely to result in exceedances of the applicable NSW EPA assessment criteria for any of the assessed pollutants at any of the surrounding sensitive receptors.

Annual GHG emissions (all scopes) represent approximately 0.009% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2014.

12. REFERENCES

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13. GLOSSARY OF ACRONYMS AND SYMBOLS

Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AHD	Australian Height Datum
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CO_2-e	Carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DoE	Department of Environment
DPE	Department of Planning and Environment
EIS	Environmental impact statement
EPA	Environmental Protection Authority
EMM	EMM Consulting Pty Limited
H_2SO_4	Sulphuric acid
µg	Microgram (g x 10-6)
µm	Micrometre or micron (metre x 10-6)
m^3	Cubic metre
NGAF	National Greenhouse Accounts Factors
NO_2	Nitrogen Dioxide
NPI	National Pollutant Inventory
OEH	NSW Office of Environment and Heritage
POEO	Protection of the Environment
PM_{10}	Particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 microns in aerodynamic diameter
Ramboll Environ	Ramboll Environ Australia Pty Ltd
SEARs	Secretary's Environmental Assessment Requirements
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
SSD	State Significant Development
TAPM	"The Air Pollution Model"
The project	Proposed used lead-acid battery recycling facility
The Proponent	Pymore Recyclers International Pty Ltd
The site	129 Mitchell Avenue, Kurri Kurri
ULAB	Used lead-acid battery
US-EPA	United States Environmental Protection Agency
VKT	Vehicle Kilometres Travelled

APPENDIX 1
WIND ROSES

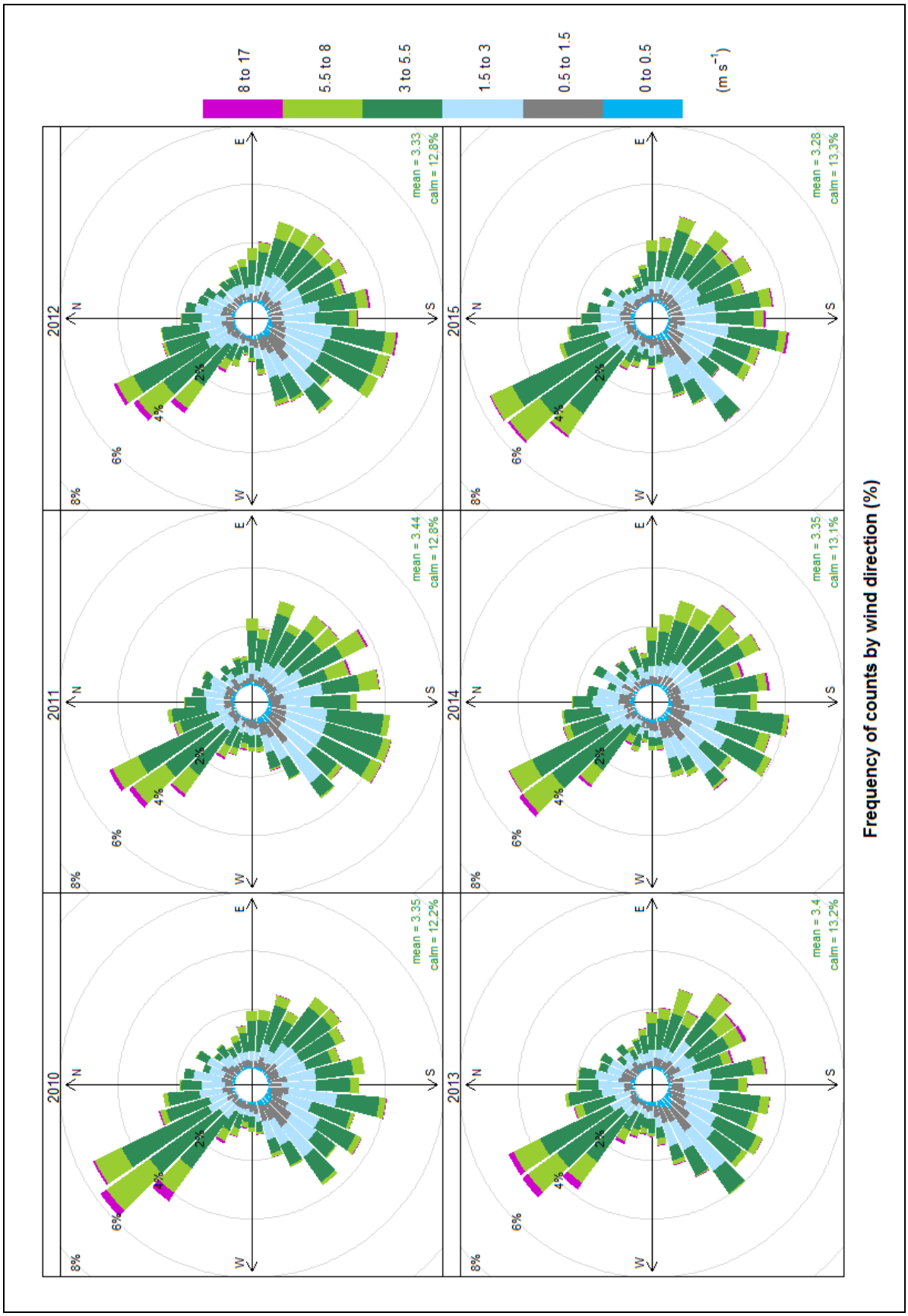

Figure A1.1 Annual Wind Roses – Cessnock Airport BoM AWS – 2010 - 2015

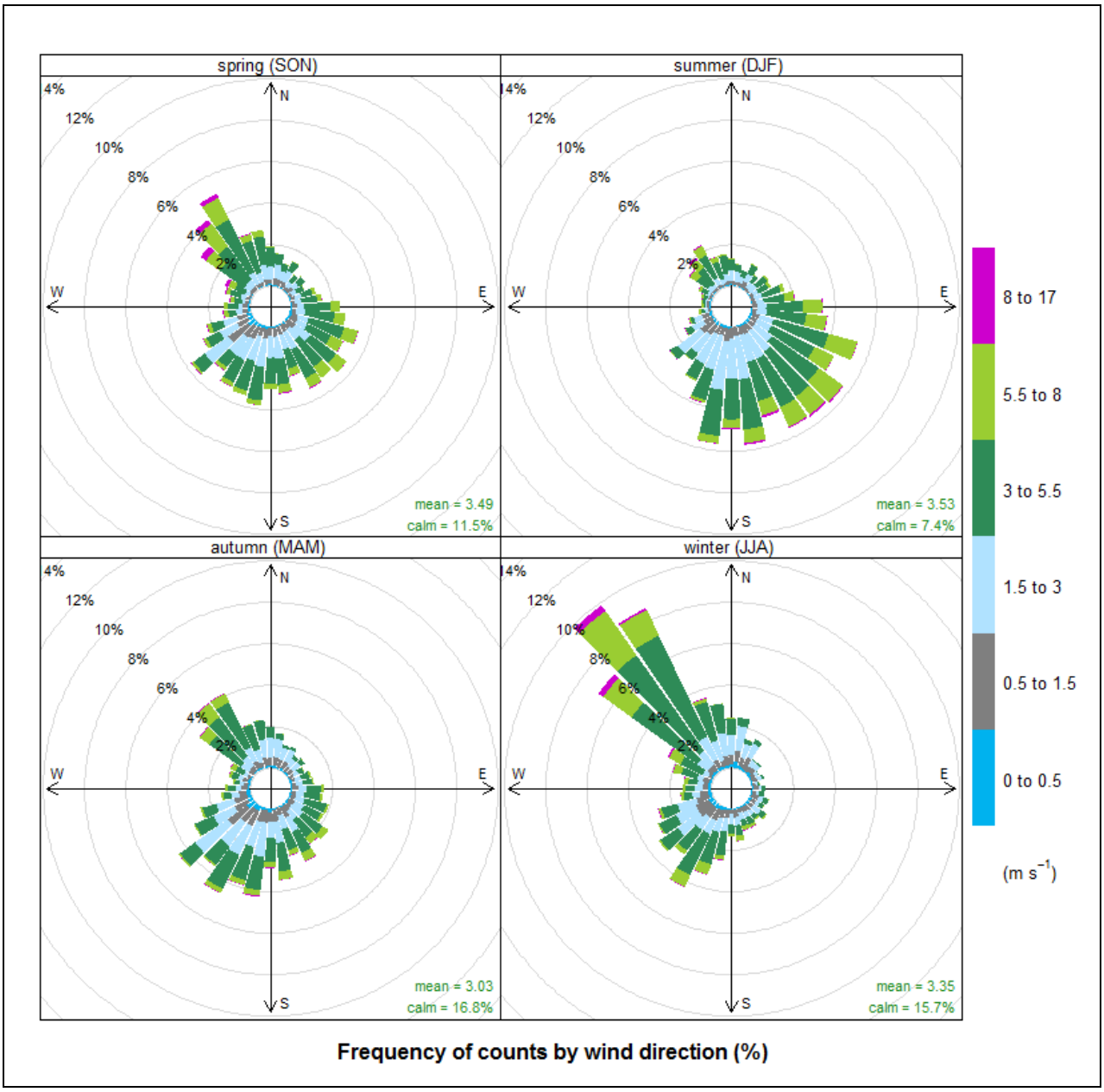

Figure A1.2 - 2015 Seasonal Wind Roses – Cessnock Airport BoM AWS – 2010

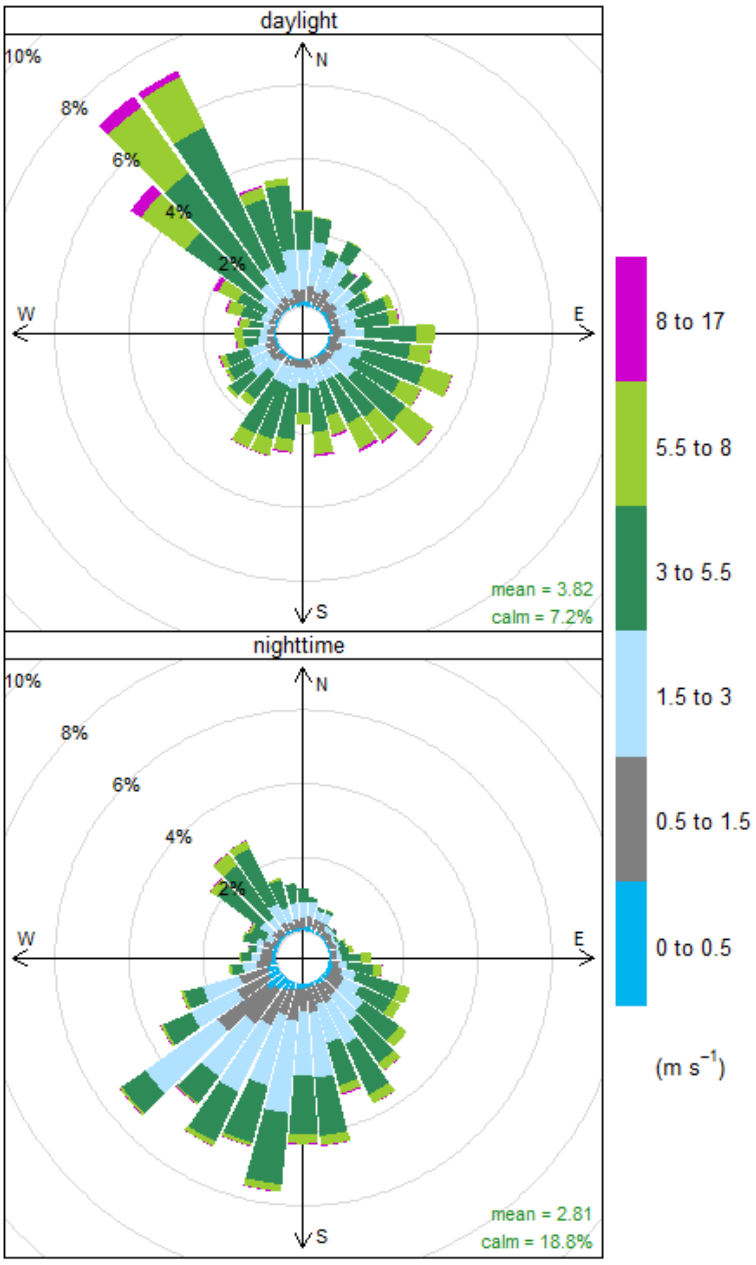

Figure A1.3 Diurnal Wind Roses – Cessnock Airport BoM AWS – 2010 - 2015

APPENDIX 2
WESTON ALUMINIUM STACK SOURCES

In order to incorporate emissions from the adjacent Weston Aluminium (WA) facility, stack emissions data and source characteristics were provided to the proponent by WA. The adopted stack configurations are provided in **Table A2.1** and emission rates in **Table A2.2**. These emission sources were incorporated into the AERMOD dispersion model configured for the project to predicted cumulative air quality impacts.

Table A2.1 – Weston Aluminium stack characteristics

Stack ID	Height AGL (m)	Diameter (m)	Exit Velocity (m/s)	Temperature (K)	Easting (m, MGA56)	Northing (m, MGA56)
Stack 1	15	1.7	26.0	349.3	357265	6369322
Stack 2	15	1.3	22.9	302.4	357310	6369262
Stack 3	15	1.0	23.9	305.2	357310	6369272
Stack 4	15	1.4	31.8	312.4	357314	6369296
Stack 5	30	1.5	18.8	423.2	357347	6369347
Stack 6	18	0.6	21.9	557.6	357302	6369325
Stack 7	15	1.5	35.1	301.4	357325	6369226

Table A2.1 – Weston Aluminium stack characteristics

Pollutant emission rate (g/s)	Stack 1	Stack 2	Stack 3	Stack 4	Stack 5	Stack 6	Stack 7
PM_{10}	0.0134	0.0029	0.0037	0.0146	0.3084	0.001	0.0644
$PM_{2.5}$	0.00201	0.000435	0.000555	0.00219	0.0429	0.00015	0.00966
SO_2	0.134	0	0	0	0.0333	0.0421	0.1967
NO_x	0.2769	0	0	0	4.2891	0.102	0.0718
Lead	0.00043	0	0	0	0.0016	0	0

APPENDIX 3
INCREMENTAL ISOPLETH PLOTS

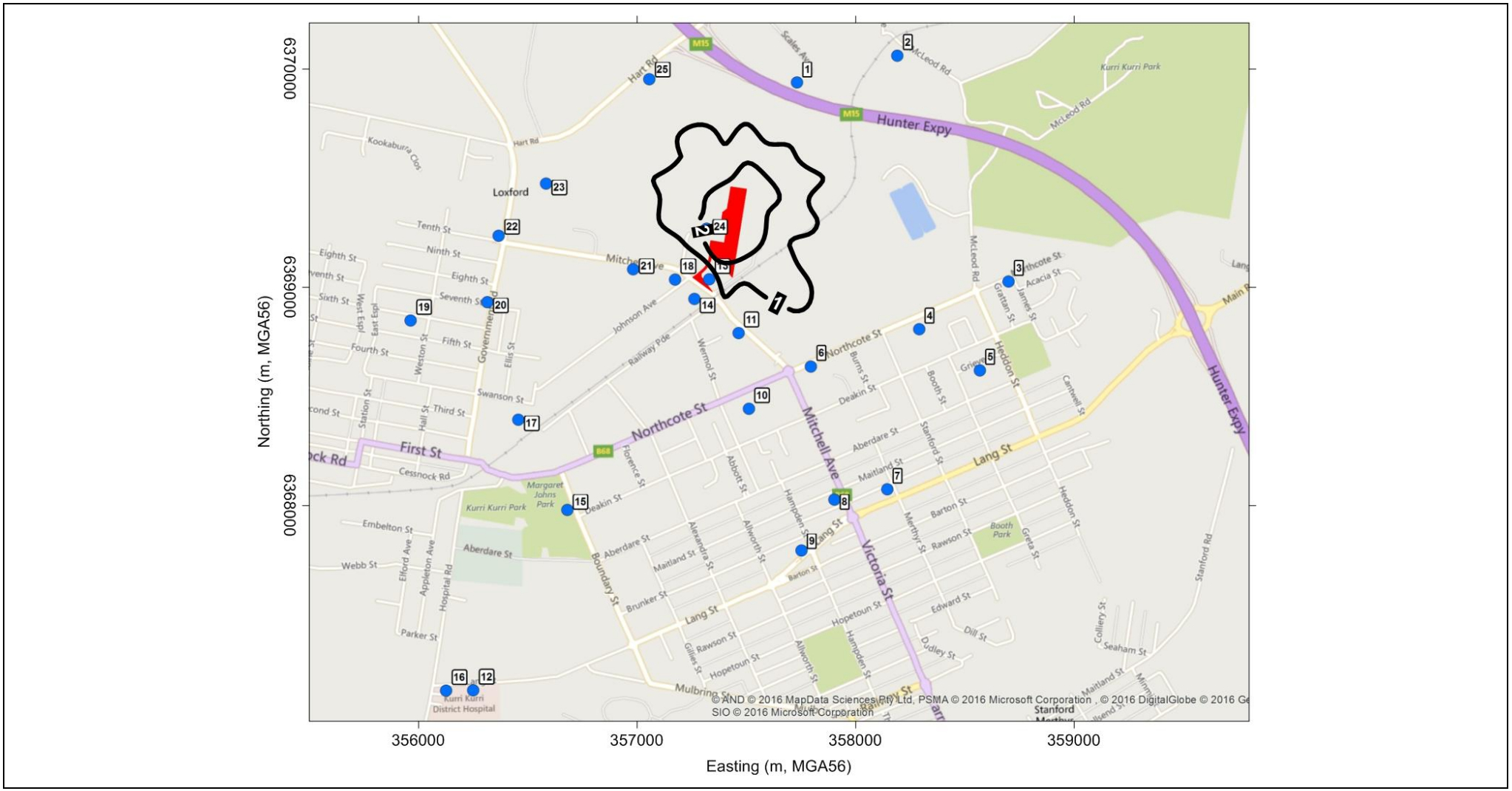

Figure A3.1 Predicted Incremental Maximum 24-hour Average PM_{10} Concentrations (µg/m³)

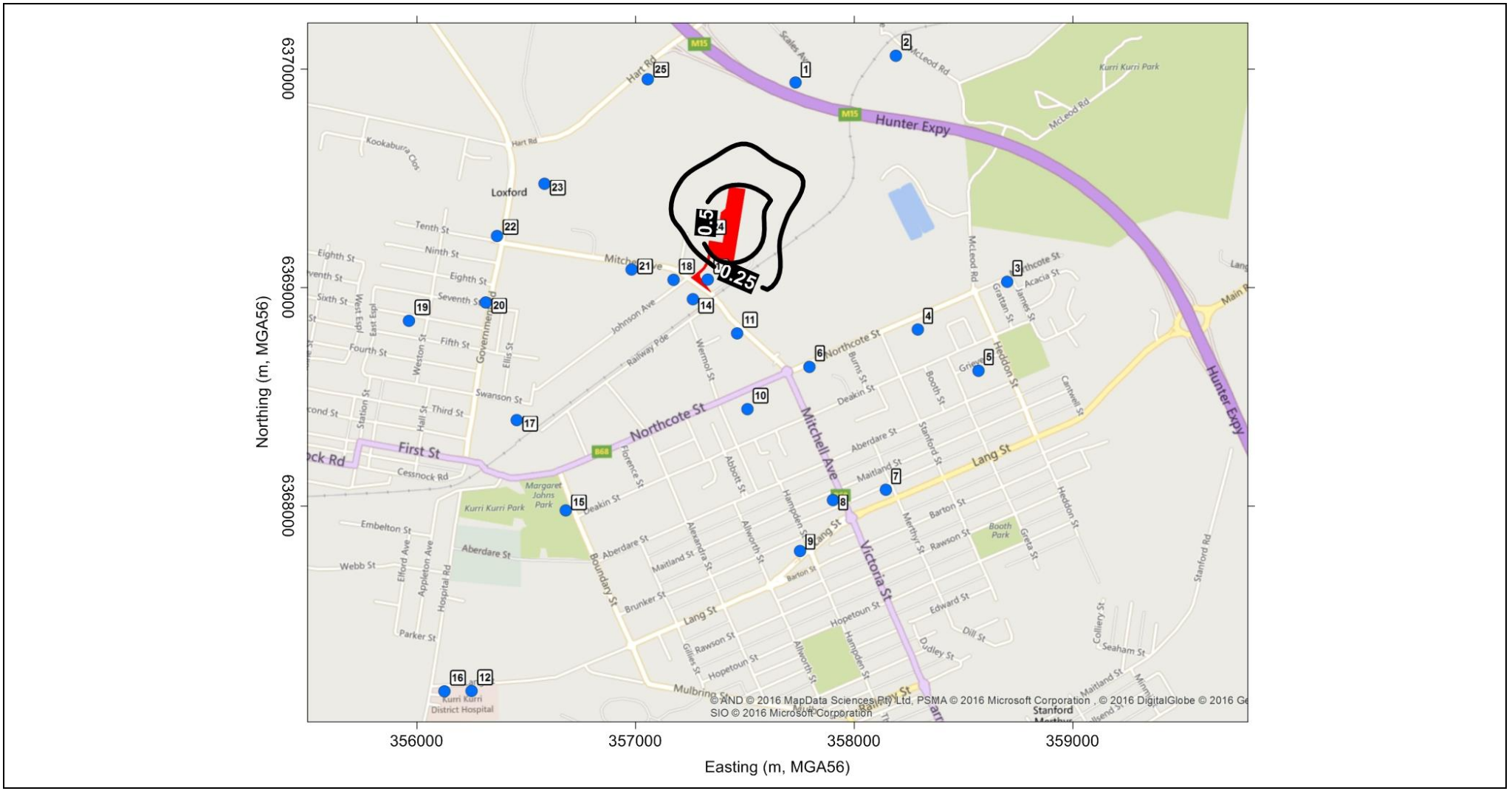

Figure A3.2 Predicted Incremental Annual Average PM_{10} Concentrations (µg/m³)

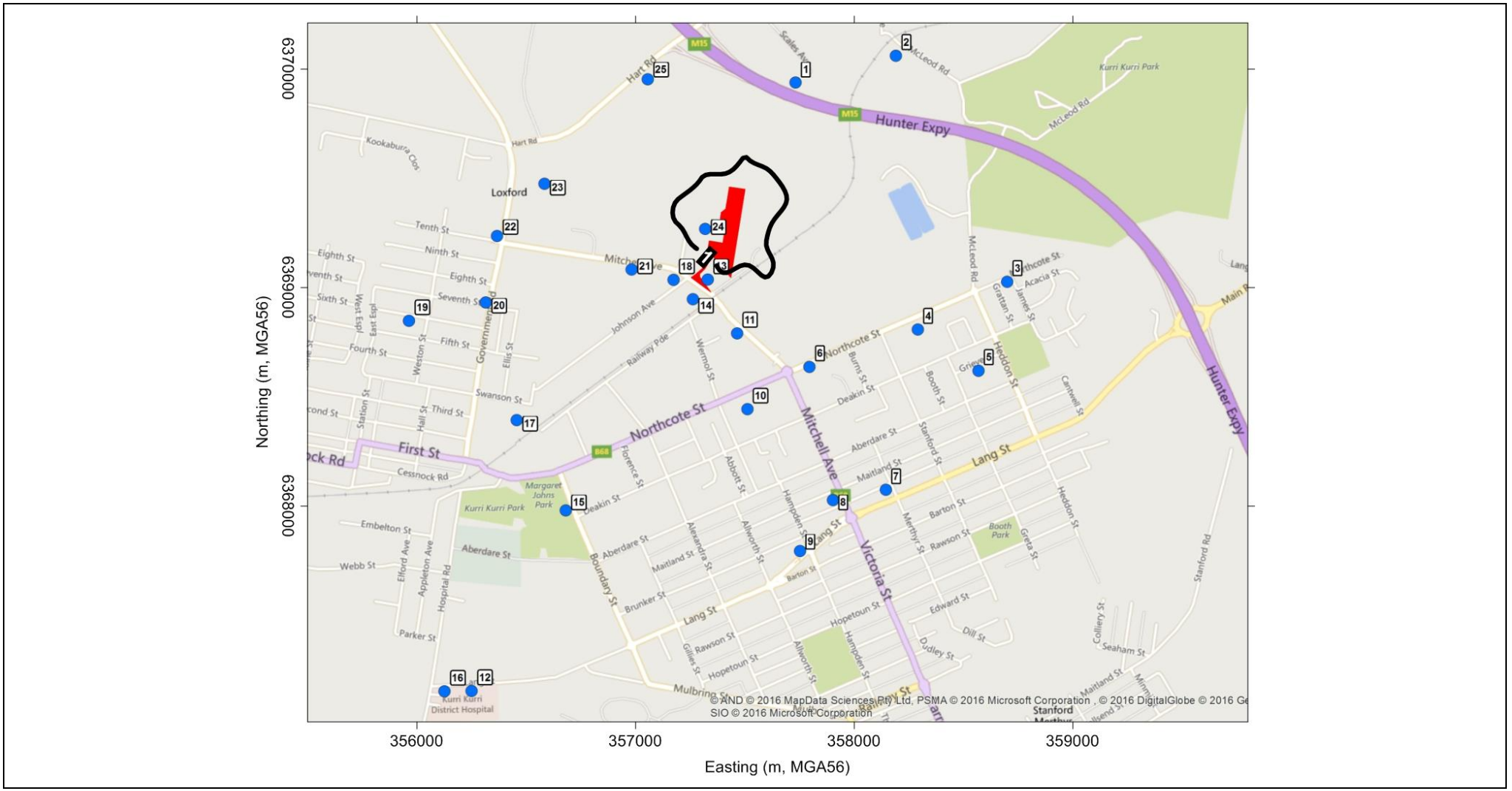

Figure A3.3 Predicted Incremental Maximum 24-hour Average $PM_{2.5}$ Concentrations (µg/m³)

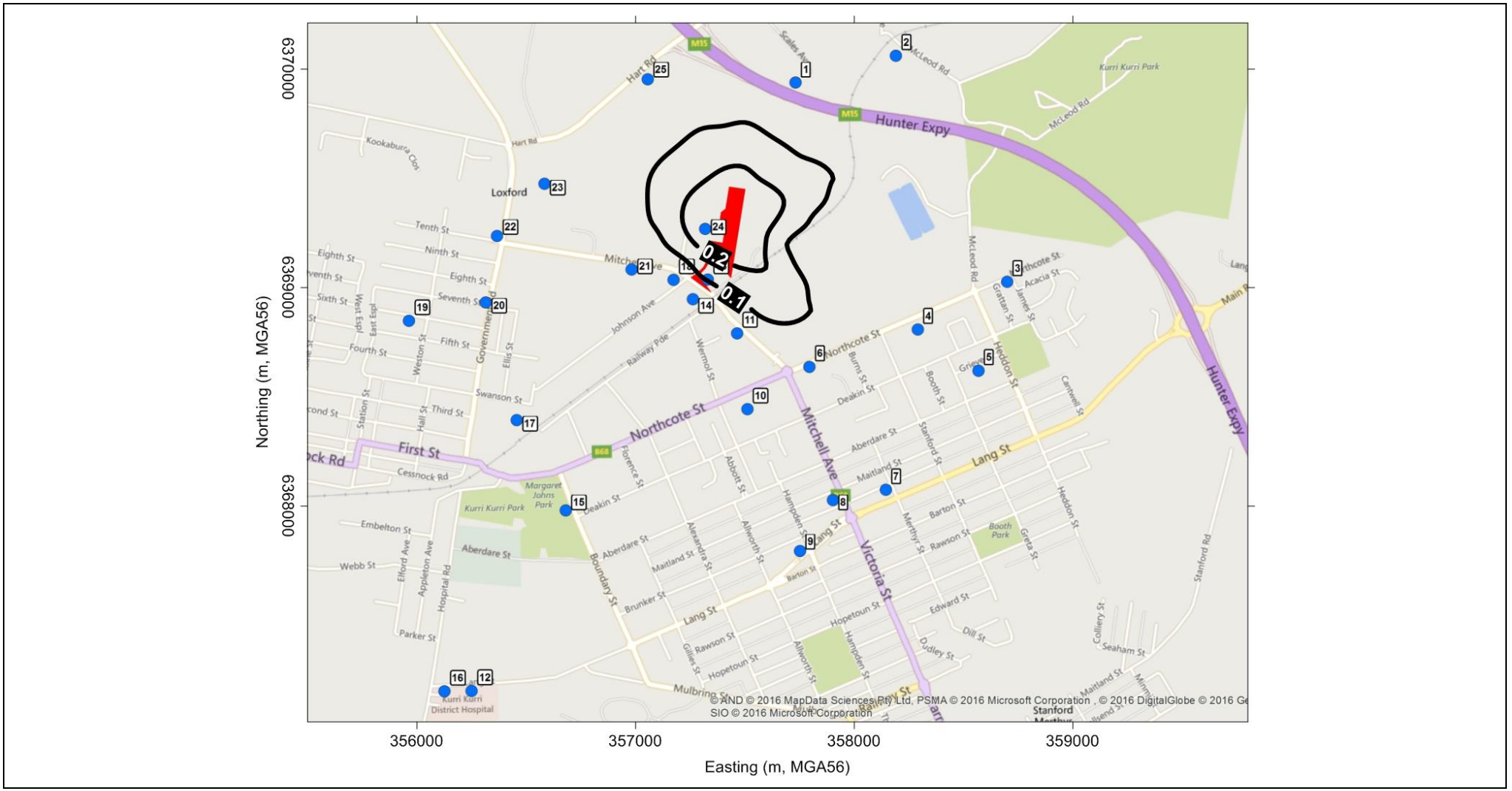

Figure A3.4 Predicted Incremental Annual Average $PM_{2.5}$ Concentrations (µg/m³)

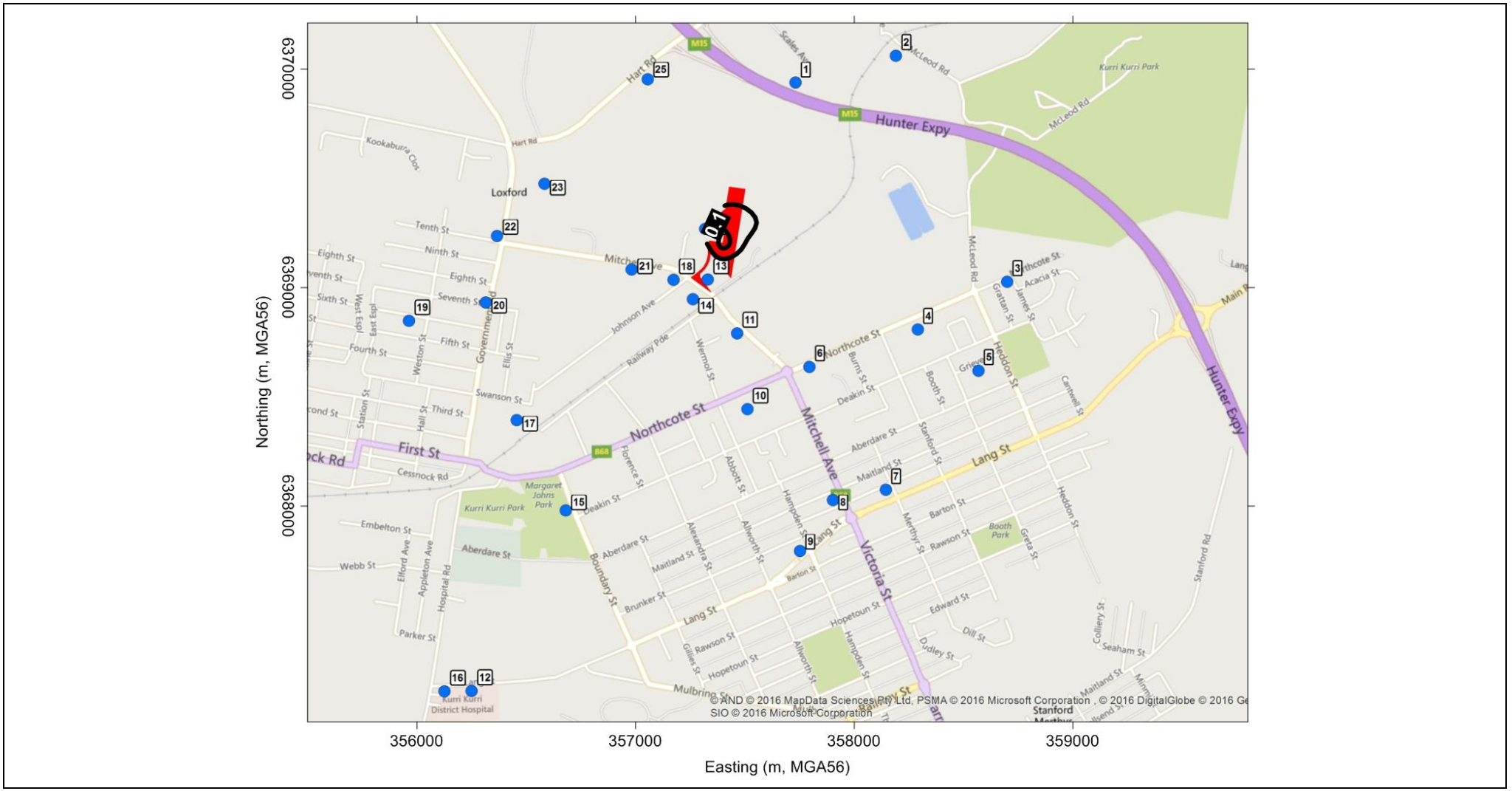

Figure A3.5 Predicted Incremental Annual Average Lead Concentrations (µg/m³)

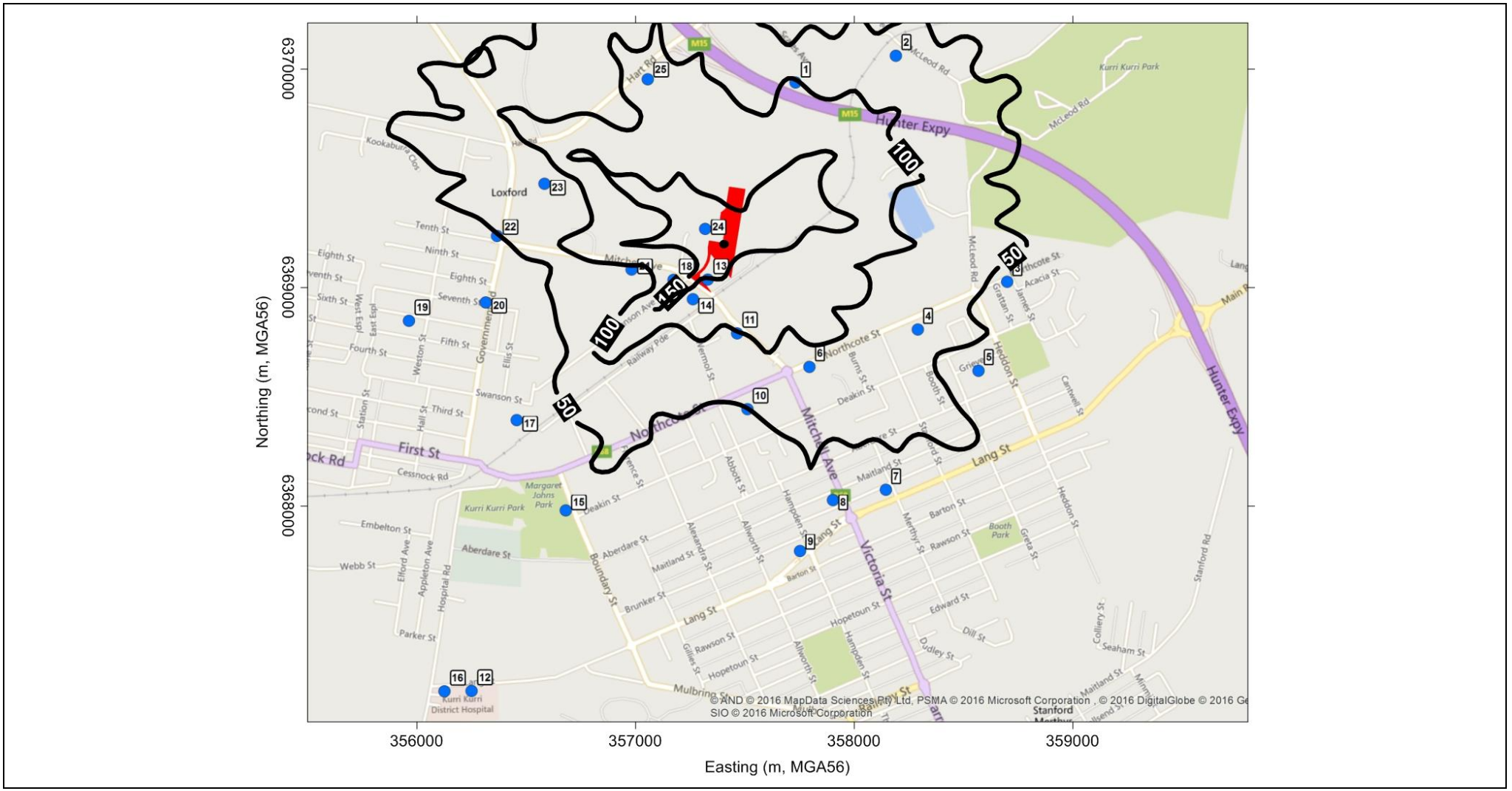

Figure A3.6 Predicted Incremental 1-hour Average NO_2 Concentrations (µg/m³)

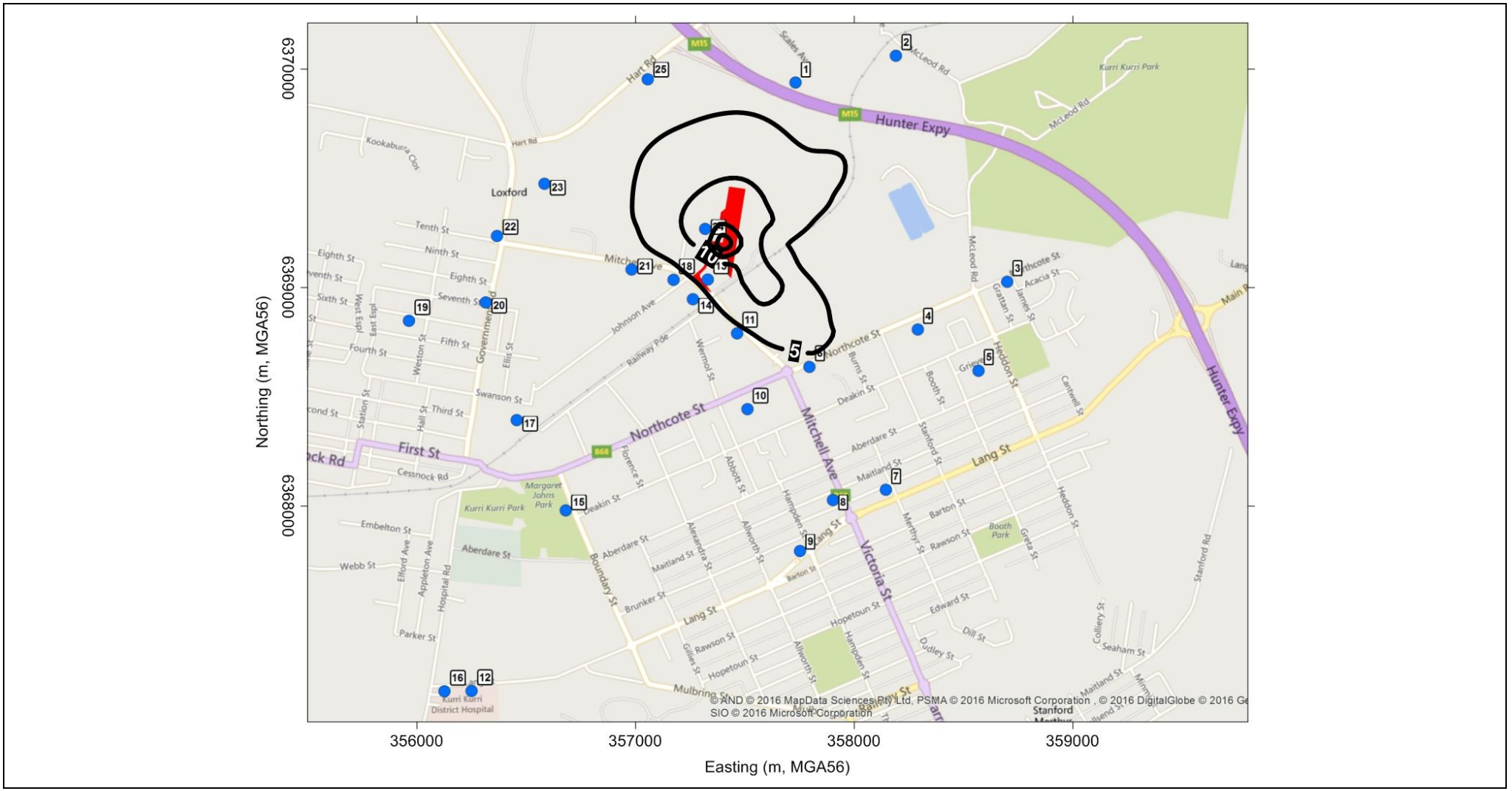

Figure A3.7 Predicted Incremental Annual Average NO_2 Concentrations (µg/m³)

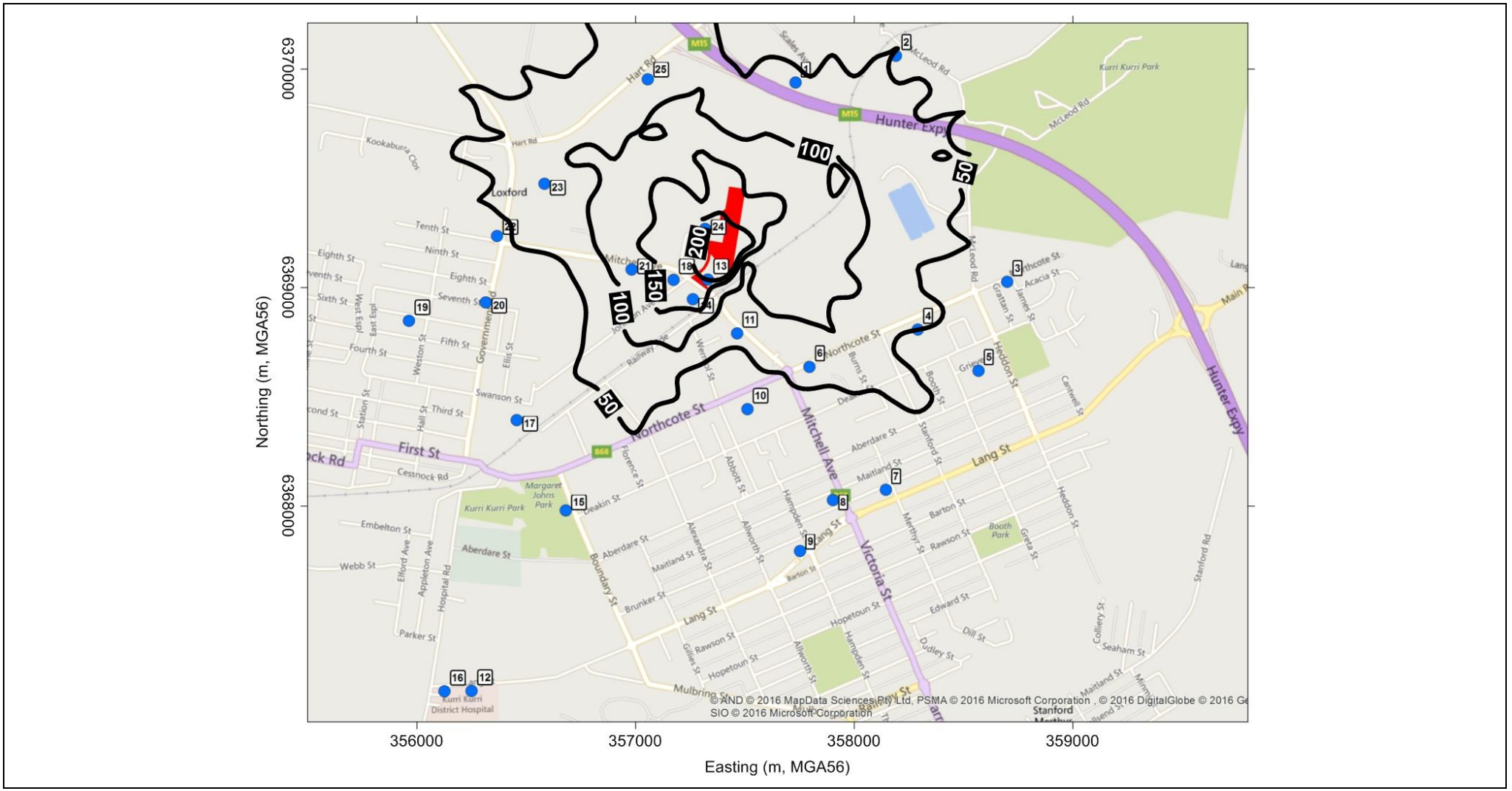

Figure A3.8 Predicted Incremental 1-hour Average SO_2 Concentrations (µg/m³)

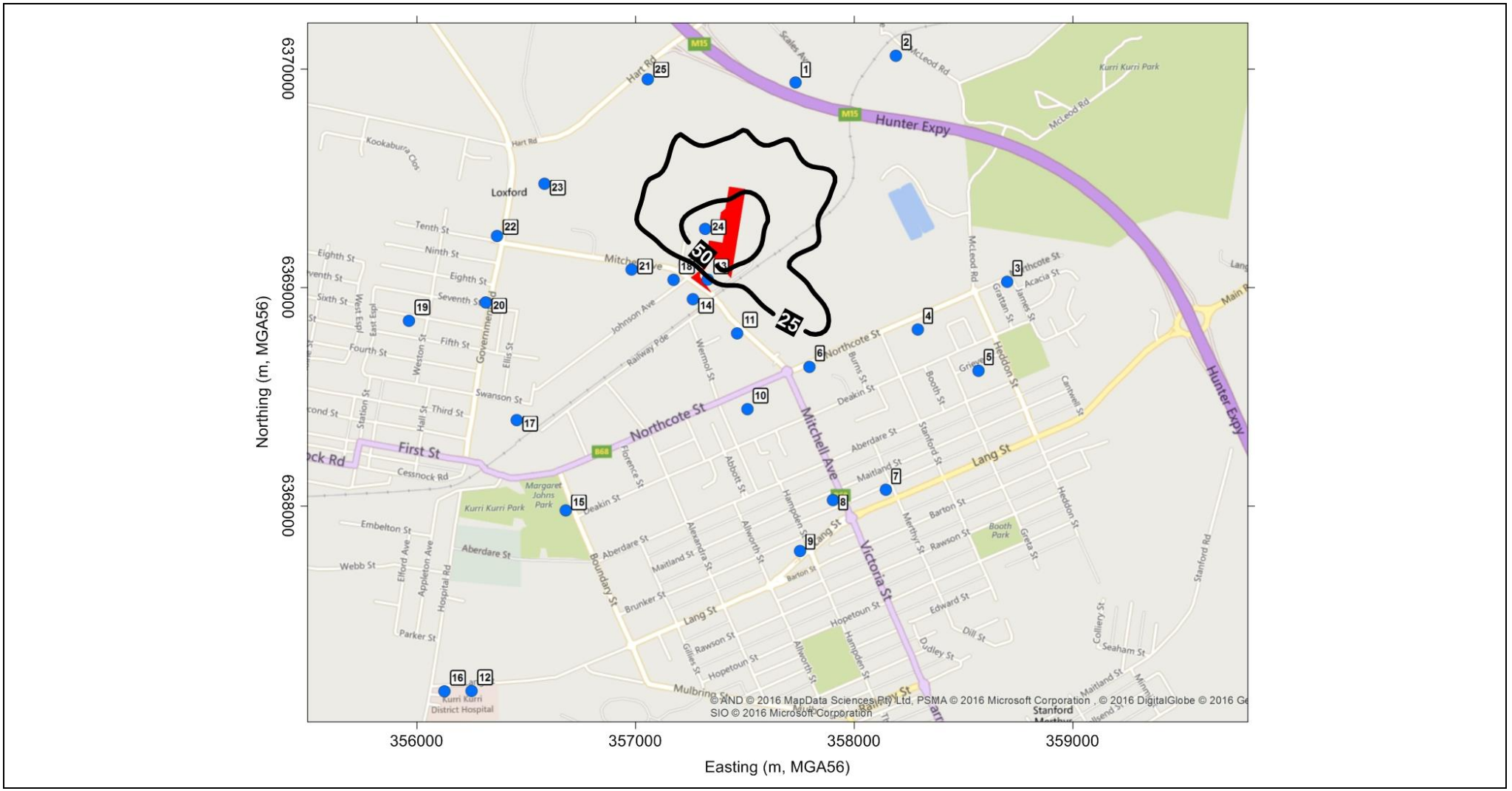

Figure A3.9 Predicted Incremental 24-hour Average SO_2 Concentrations (µg/m³)

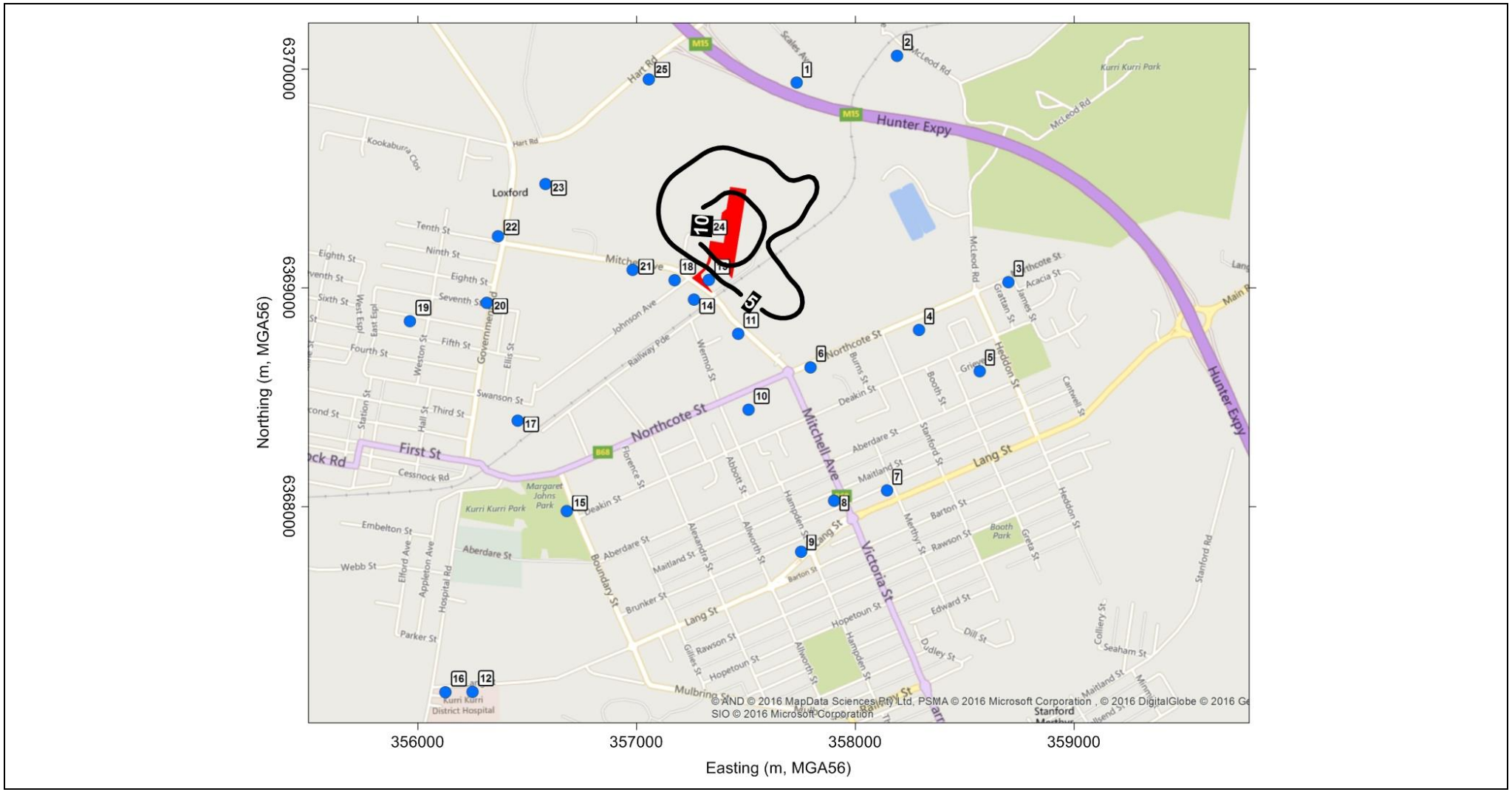

Figure A3.10 Predicted Incremental Annual Average SO_2 Concentrations (µg/m³)