MOOREBANK
INTERMODAL
COMPANY

Moorebank Intermodal Terminal Project
Environmental Impact Statement

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PARSONS
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Technical Paper 8
Regional Air Quality Impact Assessment

Technical Paper 8 – Regional Air Quality Impact Assessment

Contents of the EIS

Contents

VOLUME 1A – MAIN VOLUME

VOLUME 1B – MAIN VOLUME

VOLUME 2 – APPENDICES

VOLUME 3

VOLUME 4

VOLUME 5A

VOLUME 5B

Technical Paper 5	Environment Site Assessment (Phase 2) – Appendices C-F

VOLUME 6

Technical Paper 6	Surface Water Assessment
Technical Paper 7	Local Air Quality Impact Assessment
Technical Paper 8	Regional Air Quality Impact Assessment
Technical Paper 9	Greenhouse Gas Assessment

VOLUME 7

Technical Paper 10	Aboriginal Heritage Impact Assessment

VOLUME 8

Technical Paper 11	European Heritage Impact Assessment
Technical Paper 12	Visual Impact Assessment

VOLUME 9

Technical Paper 13	Light Spill Impact Assessment
Technical Paper 14	Social Impact Assessment
Technical Paper 15	Human Health Risk Assessment
Technical Paper 16	Health Impact Assessment

REGIONAL AIR QUALITY ASSESSMENT

INTERMODAL TERMINAL, MOOREBANK

Parsons Brinckerhoff

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Job Number 12030074

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REGIONAL AIR QUALITY ASSESSMENT

INTERMODAL TERMINAL, MOOREBANK

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TABLE OF CONTENTS

LIST OF APPENDICES

APPENDIX A - Results
APPENDIX B - CALMET/CALPUFF Input Variables

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Parsons Brinkerhoff on behalf of Moorebank Intermodal Company (MIC). It provides an assessment of potential regional air quality impacts from the proposed establishment of an intermodal freight terminal at Moorebank, NSW. This report supports the Environmental Impact Statement for the proposed Moorebank Intermodal Terminal on the Moorebank Defence site.

The assessment methodology provided in the NSW Office of Environment and Heritage (OEH)[1] document "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" **NSW DEC (2005**) was adopted in preparing the assessment. The report assesses the potential air quality impacts from the proposed development and includes the following:

- A brief background to the project and description of the proposed operations;
- A review of the existing environment surrounding the project site;
- A description of the emission estimation technique and modelling methodology;
- Presentation and analysis of the predicted results; and,
- A discussion of the potential air quality impacts as a result of the proposed operations.

A separate assessment of local air quality has been prepared by Environ.

2 PROJECT SETTING AND DESCRIPTION

2.1 The Moorebank Intermodal Terminal Project

The Moorebank Intermodal Terminal (IMT) Project (the Project) primary function is to be a transfer point in the logistics chain for shipping containers and to handle both international import/export (IMEX) cargo, and domestic interstate and intrastate (regional) cargo. The key aims of the Project are to increase Sydney's rail freight mode share including: promoting the movement of container freight by rail between Port Botany and western and south-western Sydney; and reducing road freight on Sydney's congested road network. The Project proponent is MIC, a Government Business Enterprise set up to facilitate the development of the Project.

When completed, the Moorebank IMT Project would include:

- an IMEX freight terminal to service 'port shuttle' train services between Port Botany and the Project;
- an interstate freight terminal to service freight trains travelling to and from regional and interstate destinations; and
- warehousing facilities to provide an interface between the IMT and commercial users of the facilities such as freight forwarders, logistics facilities and retail distribution centres.

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[1] The NSW EPA exists as a legal entity operated within the Office of Environment and Heritage (OEH) which was formed in April 2011. Subsequently parts of the OEH became part of the EPA. The OEH was previously known as the Department of Environment, Climate Change and Water (DECCW), the Department of Environment and Climate Change (DECC), and previously the Department of Environment and Conservation (DEC). The terms NSW EPA, OEH, DECCW, DECC and DEC are interchangeable in this report. The NSW EPA and OEH are presently part of the newly formed NSW Department of Planning and Environment.

2.2 The Project Site

The Project is situated on land in the Sydney suburb of Moorebank, NSW (refer **Figure 2-1**). The Project Site is approximately 220 hectares (ha) in area, and is located within a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Department of Defence (Defence) land. The Project would provide connectivity to Port Botany by rail, and would connect to major regional and interstate roads and highways via the M5 and M7 Motorways.

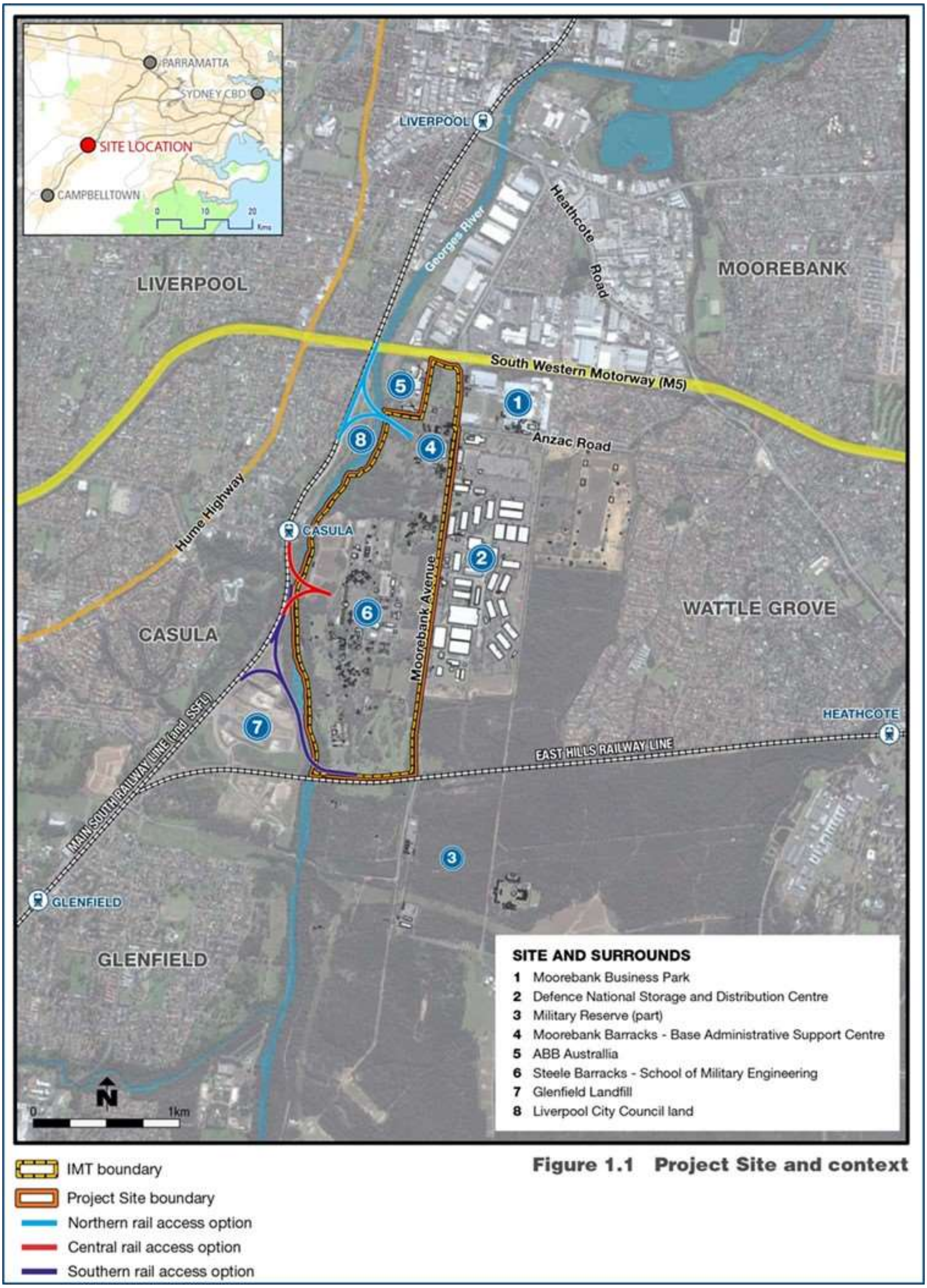


Figure 2-1 Project site and local context

2.3 Project delivery

The Project would be developed generally in accordance with a concept master plan developed for the Project Site. This proposes a staged approach for delivery (construction and operation) of the Project. The Project design has only been developed to a concept level at this stage and would be subject to further detailed design processes and planning approval (see **Section 2.4**).

Development of the Moorebank IMT would occur in three primary stages, as outlined in **Table 2-1**.

Table 2-1: IMT development schedule

Project stage	Project component	Indicative delivery schedule
Early works	**Early works** The key activities included within this phase include: - Site and soil remediation; - Building demolition; - Service disconnection; - Establishment of construction access and services; and - Conservation area establishment.	2015
Phase A	**Construction of initial IMEX terminal and warehousing** The development would involve the construction of IMEX freight terminal facilities to cater for a 'port shuttle' service between Port Botany and Moorebank and associated warehousing, including: - Construction of 0.5 million TEU per annum IMEX facility; - Construction of 100,000 m² warehousing; - Construction of the northbound rail connection from the SSFL to the IMT site for IMEX operations; and - Construction of some supporting infrastructure for the wider Project	2015-2018
Phase B	**Operation of initial IMEX terminal and warehousing, construction of additional capacity** The development would involve operation of the initial IMEX terminal and associated warehousing and progressive development of additional IMEX freight terminal facilities to increase IMT capacity to a maximum 1.05 million TEUs per annum. Additional warehousing would also be constructed. Activity includes: - Operation of 0.5 million TEU per annum IMEX facility; - Operation of 100,000 m² warehousing; - Construction of additional 0.55 million TEU per annum IMEX facility; and - Construction of additional 150,000 m² warehousing	2018-2025
Phase C	**Operation of IMEX terminal and warehousing, construction of interstate terminal and additional warehousing** The development would involve operation of the IMEX terminal at maximum capacity, operation of warehousing at close to full build, and construction of interstate terminal and additional warehousing. Activity includes: - Operation of IMEX facilities at 1.05 million TEU per annum; - Operation of 250,000 m² warehousing;	2025-2030

Project stage	**Project component**	**Indicative delivery schedule**
	• Construction of interstate terminal facilities for a capacity of 500,000 TEU per annum; • Construction of additional 50,000 m² warehousing; and • Construction of the southbound rail connection from the SSF to the IMT site for interstate operations and some arrival storage tracks from 1800 m trains	

Three separate rail access options are included as part of the proposal concept as detailed in the EIS and shown in **Figure 2-2**. These options are designed to maintain flexibility for future developers and operators of the Project.

Figure 2-2: Rail access options and layouts

2.4 Planning and assessment process

The Project is subject to both Commonwealth and NSW State Government approvals, and this Environmental Impact Statement (EIS) has been prepared to support applications for both approvals (EPBC number 2011/6086 and SSD-5066). The Project is a 'controlled action' under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Therefore, MIC is seeking approval for the construction and operation of the Project from the (Commonwealth) Department of the Environment (DoE) under Part 9 of the EPBC Act.

Under the (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act), MIC is seeking a staged development approval for the Project as State significant development (SSD). At this stage, MIC is seeking Stage 1 SSD development approval for the proposal concept (as described in EIS) from NSW Planning and Infrastructure (NSW P&I) under Part 4, Division 4.1 of the EP&A Act (hereafter referred to as the Stage 1 SSD development approval). The Stage 1 SSD development approval application also includes a package of 'early works' that comprises remediation, clean-up and demolition or relocation of existing buildings, and establishment of a conservation area. This EIS is seeking approval for these early works without the need for any further approvals. Subject to Stage 1 SSD development approval being received, the Project (with the exclusion of the early works) will be subject to further development applications and environmental assessment under the EP&A Act (hereafter referred to as the Stage 2 SSD development approvals).

2.5 Environmental impact assessment requirements

This Technical Paper has been prepared by Todoroski Air Sciences to address environmental impact assessment requirements of both the Commonwealth Government under the EPBC Act (the "Final EIS Guidelines"); and the NSW Government under the EP&A Act ("the Secretary for the NSW Department of Planning and Environment's (NSW DP&E's) Environmental Assessment Requirements (NSW SEARs)").

Specifically this Technical Paper addresses the requirements outlined in the **Table 1.2**.

Table 1.2 EIS requirements addressed within this Technical Paper

Requirement
EPBC Act – Final EIS Guidelines
Analyse and describe the changes to the local and regional air drainage basin as a result of construction and operational phases of the action. The analysis must consider diurnal and seasonal variations in air pollution levels and the influence of short term weather phenomena. The analysis must provide results for the following: hydrocarbons, suspended particulate matter, carbon monoxide, oxides of nitrogen, sulfur (sulfur) dioxide, ozone, reactive organic compounds, lead and air toxics.
Secretary for the NSW DP&E's Environmental Assessment Requirements (SEARs)
Air Quality – including but not limited to: ○ a quantitative assessment of worst-case predicted emission of air pollutants, including an assessment of potential air pollution sources (including identifying locomotive standards), dust deposition, total suspended particulates, PM$_{10,}$ PM$_{2.5}$ and atmospheric pollutants of concern for local and regional air quality;

- consideration of relevant weather characteristics, seasonal variations and topographic features that may affect the dispersion of atmospheric pollutants;
- identify impacts of the pollutants on human health, including cumulative impacts from background air pollution; and
- taking into account the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC 2005) and the *National Environmental Protection Measures for Ambient Air Quality* (National Protection Council)

This technical paper does not examine Scope 1 Greenhouse Gas emissions, and assesses impacts on human health by comparison to NSW EPA's impact assessment criteria.

Whilst detailed later in the report, the potential effects of the Project on regional Ozone levels were considered in the context of the Project resulting in a net decrease on NO_X emissions and no net change in VOC emissions. NO_X and VOC are the emissions of the project that may be associated with effect on ozone, and given the change (decrease) was small, it became apparent that there would not be any potential for Ozone impacts of any consequence to arise and this issue was not considered further in the detailed modelling.

The Early works phase would involve various activities related to the site establishment and the construction of new infrastructure which would include activities with the potential to generate air emissions.

The potential air impacts due to these activities is difficult to accurately quantify due to the short sporadic periods of dust generating activity that may occur over the construction time frame. The sources are considered temporary in nature and would be confined to the construction period which is expected to occur for approximately 6 months.

Air emissions generated from the construction process are unlikely to be significant at a regional level given the nature of the activities and that appropriate operational and physical mitigation measures would be utilised. In light of this such activities not been assessed further in this regional air quality assessment. The potential effects are however examined in the local air quality impact assessment.

3 AIR QUALITY CRITERIA

3.1 Preamble

The main source of atmospheric pollutants generated as a result of this Project on a regional scale would be from the change in use of motor vehicles, but specifically heavy diesel trucks. Emissions from motor vehicles include a number of pollutants that are known to be potentially harmful to the well-being of humans. The main pollutants of concern are carbon monoxide, nitrogen oxides, various volatile organic compounds and particulate matter. Each of these pollutants has the capacity to adversely affect health if the concentration is too great over a particular exposure period. The following sections outline each of these pollutants and the potential effects they can have on humans as well as the relevant impact assessment criteria adopted in this assessment.

3.1.1 Carbon monoxide (CO)

CO enters the bloodstream and reduces oxygen delivery to the body's organs and tissues, and prolonged exposure at high levels can impair health. CO is an odourless gas formed from the partial oxidation of carbon-containing compounds, commonly generated as a result of incomplete or inefficient combustion of fuels. CO in the atmosphere is relatively unstable and reacts with oxygen to form carbon dioxide and ozone.

3.1.2 Oxides of nitrogen (NO_x)

NOx is a generic term for a range of nitrogen and oxygen compounds. Of these compounds nitrogen dioxide (NO_2) is considered harmful to health. NO_2 can irritate the lungs and lower resistance to respiratory infections such as influenza.

NO_2 belongs to a family of reactive gases called nitrogen oxides (NOx). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power stations and industrial boilers, **USEPA (2011)**.

3.1.3 Volatile Organic Compounds (VOC)

VOC is a term given to various organic chemical components, several of which are considered air toxics. These are reactive organics that have a small role in photochemical smog formation and are readily oxidised by ozone.

- 1,3 butadiene
- Acetaldehyde
- Benzene
- Formaldehyde
- Isomers of xylene
- Polycyclic aromatic hydrocarbons
- Toluene

3.1.4 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

The TSP is defined further into two sub-components. They are PM_{10} particles, particulate matter with aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with aerodynamic diameters of 2.5µm or less.

The majority of the particles generated in the PM_{10} and TSP size range arise from abrasion or crushing of material and disturbance of dusty material. The majority of fine particulates in 2.5µm size range are generated through combustion processes. Fine particulates can be more harmful to human health as the particles have the ability to penetrate deep into the human respiratory system and generally include acidic and carcinogenic substances produced in the combustion process.

3.2 Impact assessment criteria

Table 3-1 summarises the air quality goals that are relevant to this study as outlined in the NSW EPA document "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" **NSW DEC, (2005)**. The impact assessment criteria refer to the total pollutant load in the environment and not just the assessed project. Consideration of existing background levels needs to be made when using these goals to assess potential impacts.

Table 3-1: Ambient air quality impact assessment criteria

Pollutant	Averaging period	Goal	Source
Nitrogen dioxide	1 hour	246 µg/m³	NEPC 1998
	1 hour	200 µg/m³	OEH long term goal
	Annual	62 µg/m³	NEPC 1998
Carbon monoxide	15 minute	100 mg/m³	WHO 2000
	1 hour	30 mg/m³	WHO 2000
	8 hour	10 mg/m³	NEPC 1998
PM_{10}	24 hour	50 µg/m³	NEPC 1998
	Annual	30 µg/m³	EPA 1998
Lead	Annual	0.5 µg/m³	NEPC 1998
Toluene	1 hour	360 µg/m³	DEC 2005
Xylene	1 hour	190 µg/m³	DEC 2005
Benzene	1 hour	29 µg/m³	DEC 2005
1,3-butadiene	1 hour	40 µg/m³	DEC 2005
Formaldehyde	1 hour	20 µg/m³	DEC 2005
Acetaldehyde	1 hour	42 µg/m³	DEC 2005
PAH (as benzo(a)pyrene)	1 hour	0.4 µg/m³	DEC 2005

Source: **NSW DEC, 2005**

The above goals (for the criteria pollutants) are numerically the same as the corresponding Commonwealth NEPM goals, but are more stringent as no automatic allowance for any exceedance is permitted. The NSW impact assessment criteria are generally applied to individual projects and although this assessment is for a specific project it is focussed on assessing regional air quality and is therefore more amenable to the use of the Commonwealth NEPM goals. Nevertheless, the more stringent NSW criteria have been adopted for criteria pollutants.

The NEPM air toxics investigation levels include additional goals for longer averaging periods than the NSW impact assessment criteria, as shown in **Table 3-2**. These goals have also been adopted in this assessment.

Table 3-2: NEPM air toxics investigation levels

Pollutant	Averaging period	Goal
Benzene	Annual	0.003 ppm
Formaldehyde	24 hour	0.04 ppm
Toluene	24 hour	1 ppm
	Annual	0.1 ppm
Xylene	24 hour	0.25 ppm
	Annual	0.2 ppm
PAH	Annual	0.3 ng/m

Source: **NEPM Air Toxics, 1998**

4 REGIONAL AIR QUALITY

4.1 Introduction

The main sources of air pollution in the wider area of the Sydney basin would include emissions from major industries, commercial operations, motor vehicle exhaust and domestic activities such as wood heaters. This section summarises and reviews the current state of regional ambient air quality and monitoring data collected from a number of ambient monitoring programs in the Sydney Basin.

4.2 State of the environment

The Australian State of the Environment Report **SOE (2011)** provides a national assessment of the state of Australia's environment. It provides a comprehensive review of the state and trends of the environment.

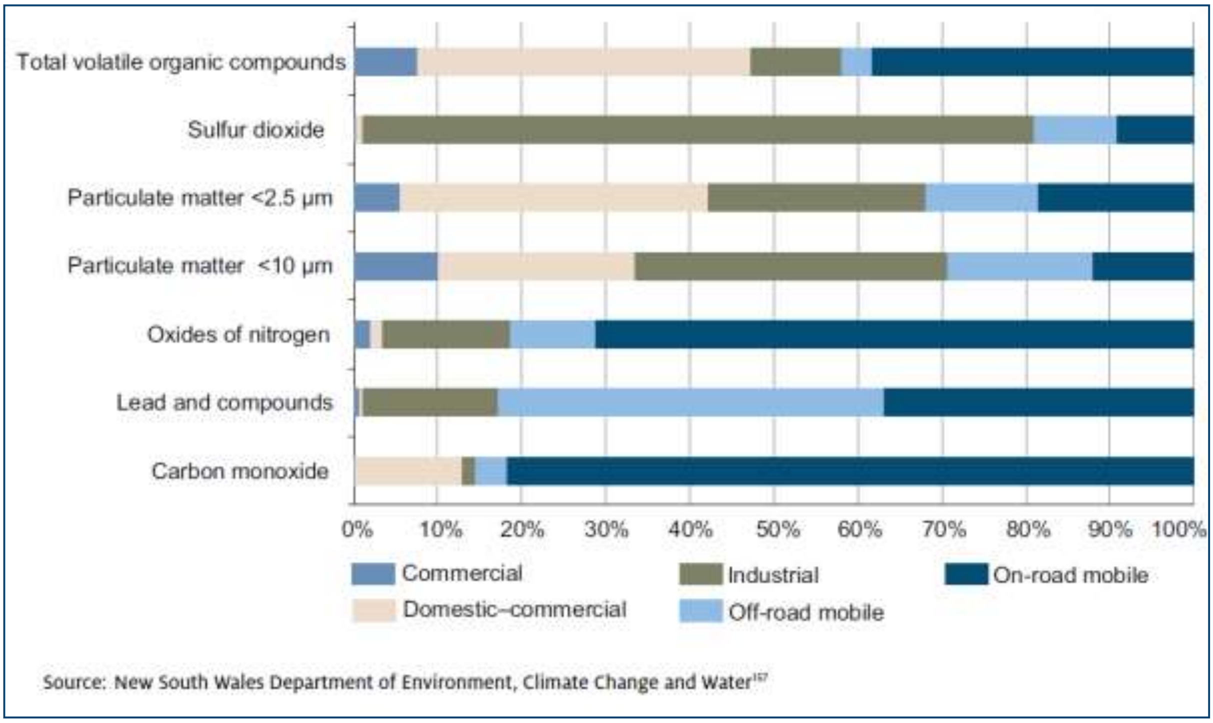
It is noted in the most recent 2011 report that the national health-based standards for ambient air quality are:

> *"...rarely exceeded for prolonged periods, and very high levels of pollution are usually associated with short-lived extreme events such as bushfires and dust storms that generate very high levels of particulate pollution."*

> *"Levels of CO, NO2, SO2 and Pb* [lead] *in urban air have decreased over the past two decades, but ozone and particulate levels have not. Prospects of achieving reductions in levels of these two pollutants will be influenced by a number of factors, most notably vehicle technology, extent of ongoing low-density suburban development and availability of reliable public transport, and the impact of climate change on urban air sheds."*

4.3 Motor vehicle emission sources

Motor vehicles are one of the most significant sources of pollutants in the major cities of Australia. In Sydney, on-road mobile sources account for around 80% of carbon monoxide emissions, 70% of oxides of nitrogen emissions and almost 40% of total volatile organic compound emissions (see **Figure 4-1**).



Source: **SOE, 2011**

Figure 4-1: Proportion of total estimated annual anthropogenic emissions from each anthropogenic source type in the Sydney region

The size of the Australian motor vehicle fleet has continually increased, and this trend is likely to continue. From 2005 to 2010, motor vehicle registrations increased by 15.4% (averaging 2.9% annually); the bulk of this growth was in passenger vehicles, which make up 76% of the total Australian fleet. The vehicle kilometres travelled per vehicle has also increased at a rate of 6.8% between 2003 and 2007.

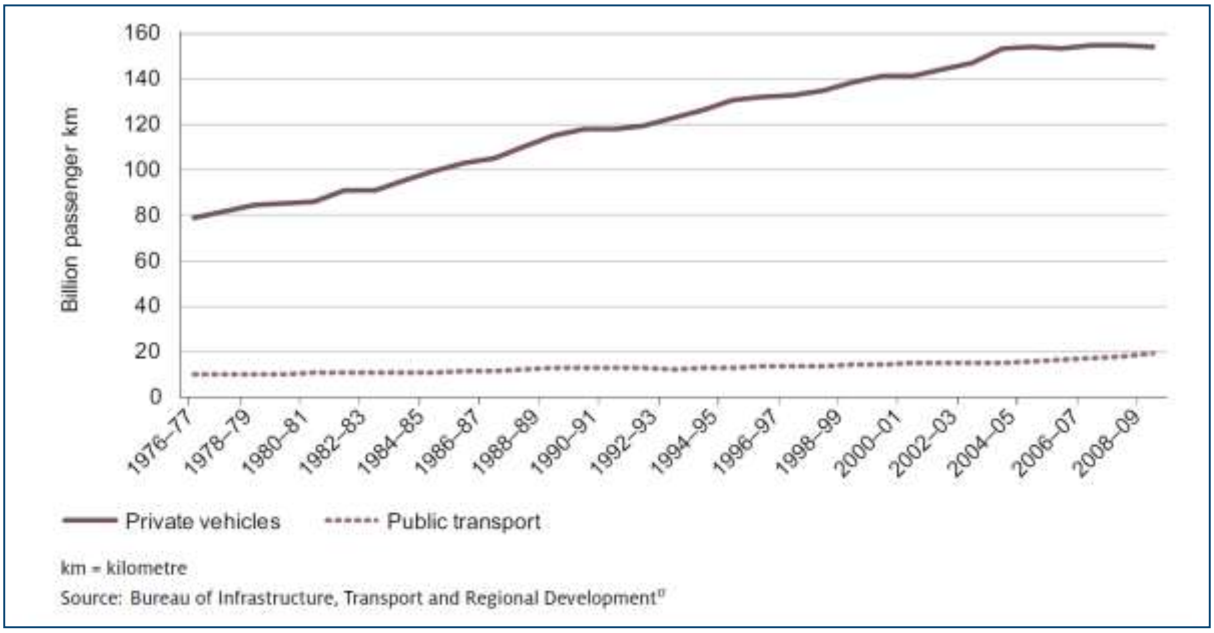
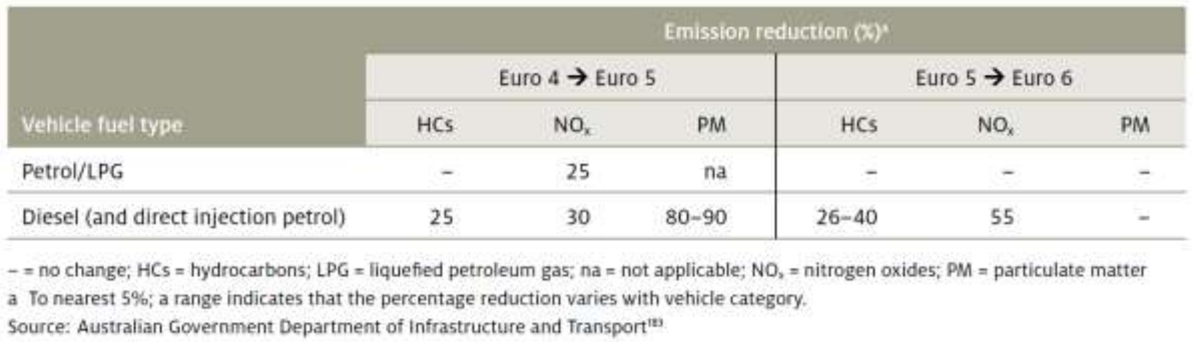


Figure 4-2: Passenger kilometres travelled in capital cities

Figure 4-2 shows that total passenger kilometres travelled has almost doubled over the past 40 years.

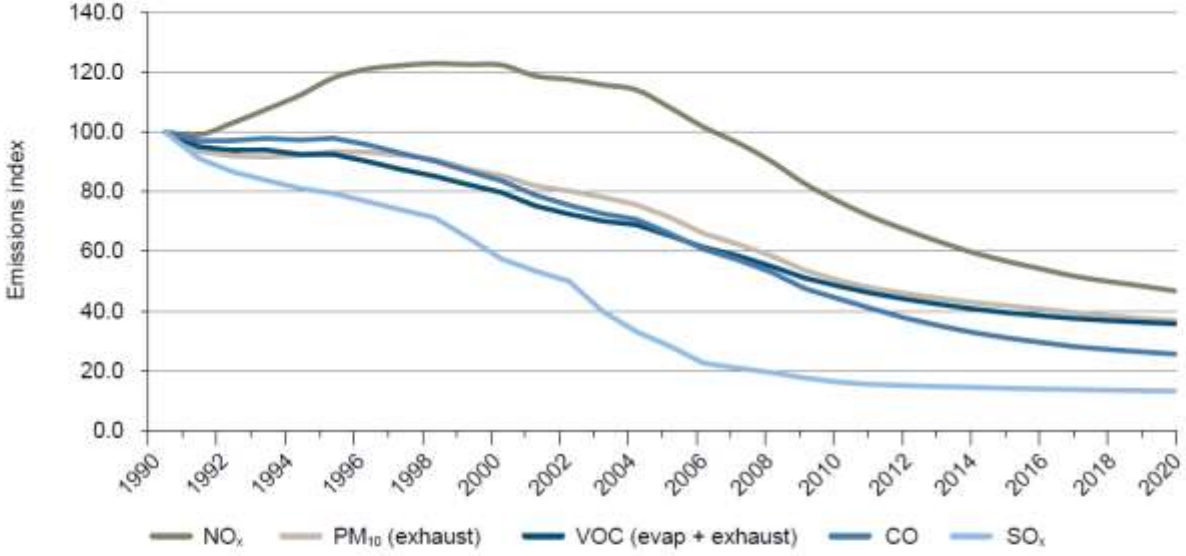
In the past, several emission limits and standards have been introduced to reduce the total emissions of the motor vehicle fleet in Australia. Euro 5 emission standards are scheduled to apply for all new-model light vehicles by November 2013, with existing models to comply by November 2016. Euro 6 emissions standards will also be introduced for light vehicles in 2017 and 2018. **Figure 4-3** shows that these newer standards are expected to significantly decrease NOx and particulate matter emissions through the use of catalytic particle filters and NOx absorbers.



	Emission reduction (%)[a]					
	Euro 4 → Euro 5			Euro 5 → Euro 6		
Vehicle fuel type	HCs	NO_x	PM	HCs	NO_x	PM
Petrol/LPG	–	25	na	–	–	–
Diesel (and direct injection petrol)	25	30	80–90	26–40	55	–

– = no change; HCs = hydrocarbons; LPG = liquefied petroleum gas; na = not applicable; NO_x = nitrogen oxides; PM = particulate matter
a To nearest 5%; a range indicates that the percentage reduction varies with vehicle category.
Source: Australian Government Department of Infrastructure and Transport[183]

Figure 4-3: Emissions reduction from adoption of Euro 5 and Euro 6 light vehicle standards



CO = carbon monoxide; NO_x = nitrogen oxides; PM_{10} = particulate matter smaller than 10 micrometres; SO_x = sulfur oxides; VOC (evap + exhaust) = volatile organic compounds from evaporative and exhaust emissions
Source: Bureau of Infrastructure, Transport and Regional Economics;[180] D Cosgrove, Principal Research Scientist, Bureau of Infrastructure, Transport and Regional Economics, pers. comm., May 2011

Figure 4-4: Base-case projected growth in major pollutant emissions from motor vehicles for Australian metropolitan areas, 1990-2020 (index with 1990 = 100)

Figure 4-4 shows the projected growth in major pollutant emission from motor vehicles for Australian metropolitan areas. The overall trend is a reduction in all major pollutants from motor vehicles due to the implementation of tighter emission-control standards.

> *"Although the size of the Australian vehicle fleet is continuing to grow (as are the distances travelled), emissions are expected to continue to decline over the next decade as a result of tighter national fuel standards and the mandating of improved emission-control technologies under the Motor Vehicle Standards Act 1989."*

The threat, however is that the combination of increasing vehicle numbers, distance travelled and congestion (which leads to more exhaust and evaporative emissions) may in future cancel out gains in technology, resulting in increased impacts on health and reduced amenity. For example, data show diesel registered vehicles increasing from 10.1% of the fleet to 13.8% between 2005 and 2010. Whilst this primarily relates to increasing numbers of diesel passenger vehicles, these figures represent an increase of 57.4% over the five years.

In Europe, the steady trend in roadside nitrogen dioxide levels, despite the falling trend in nitrogen oxide levels has been attributed to passenger diesel catalyst technology that whilst lowering total nitrogen oxide emissions increases the fraction of nitrogen dioxide. This may foreshadow a similar trend in Australia if the proportion of diesel passenger vehicles in the fleet continues to grow at a fast rate.

In this regard, timely actions to introduce motor vehicle emissions standards and potentially in-service maintenance requirements for pollution controls may play an important role in achieving the projected emissions trends.

4.4 NSW state of the environment

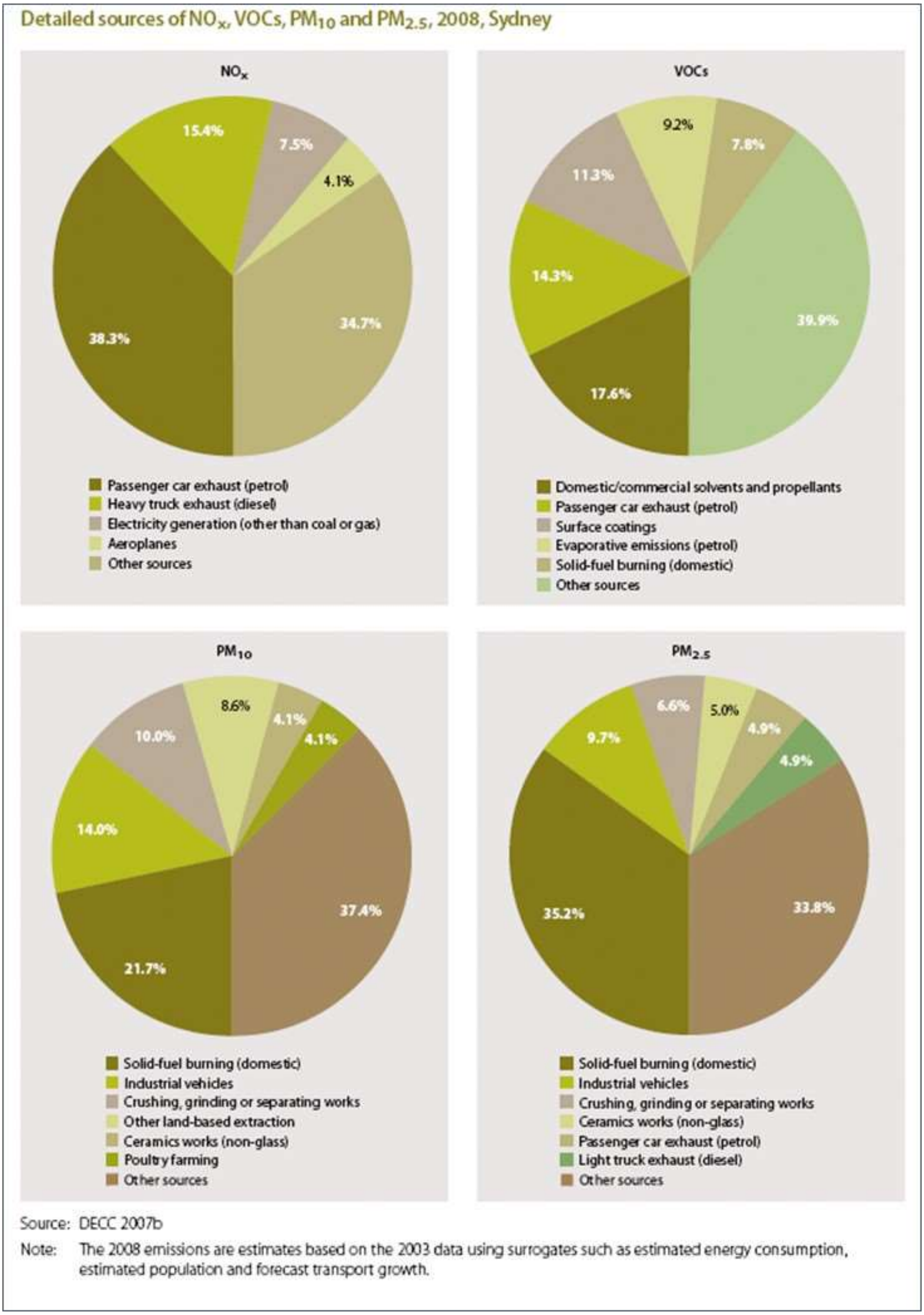
The NSW State of the Environment Report, 2009 **SOE (2009)** provides further detail on air quality in the Sydney Region.

Figure 4-5 presents a more detailed breakdown of air pollutant sources in Sydney. Petrol passenger motor vehicles are the largest source of NO_x emissions, contributing 38% of the total, while heavy duty diesel vehicles are the second largest single source at 15%.

The largest single source of VOC emissions in Sydney (over 17%) is solvents and propellants used in aerosol products by the domestic and commercial sector. Petrol passenger motor vehicles are almost as significant, contributing 14% of total VOC emissions.

Other significant sources of VOCs are surface coatings and evaporative emissions from petrol.

Domestic solid-fuel burning is the largest single source of PM_{10} and $PM_{2.5}$ emissions.



Source: DECC 2007b

Note: The 2008 emissions are estimates based on the 2003 data using surrogates such as estimated energy consumption, estimated population and forecast transport growth.

Figure 4-5: Additional detail on air emissions sources in Sydney

4.5 NSW EPA air emission inventory

Since the State of the Environment report **SOE (2009)**, NSW EPA has released an air emissions inventory **EPA (2012)** which provides a detailed estimate of the sources of emissions in the greater metropolitan region, encompassing Sydney.

The **EPA (2012)** methodology and approach to emissions estimation was used as a basis for calculations in this assessment. Further details are provided in the results section.

4.6 NSW EPA Ambient Monitoring

As part of the NSW Government air quality management plan, ambient monitoring is conducted by the NSW EPA. Substances in air may impair human health as well as the health of plants and animals and reduce visibility. Urban air pollution arises from emissions from motor vehicles, major industry, commercial operations and domestic activities.

The location of the current NSW EPA monitoring network is presented in **Figure 4-6**.

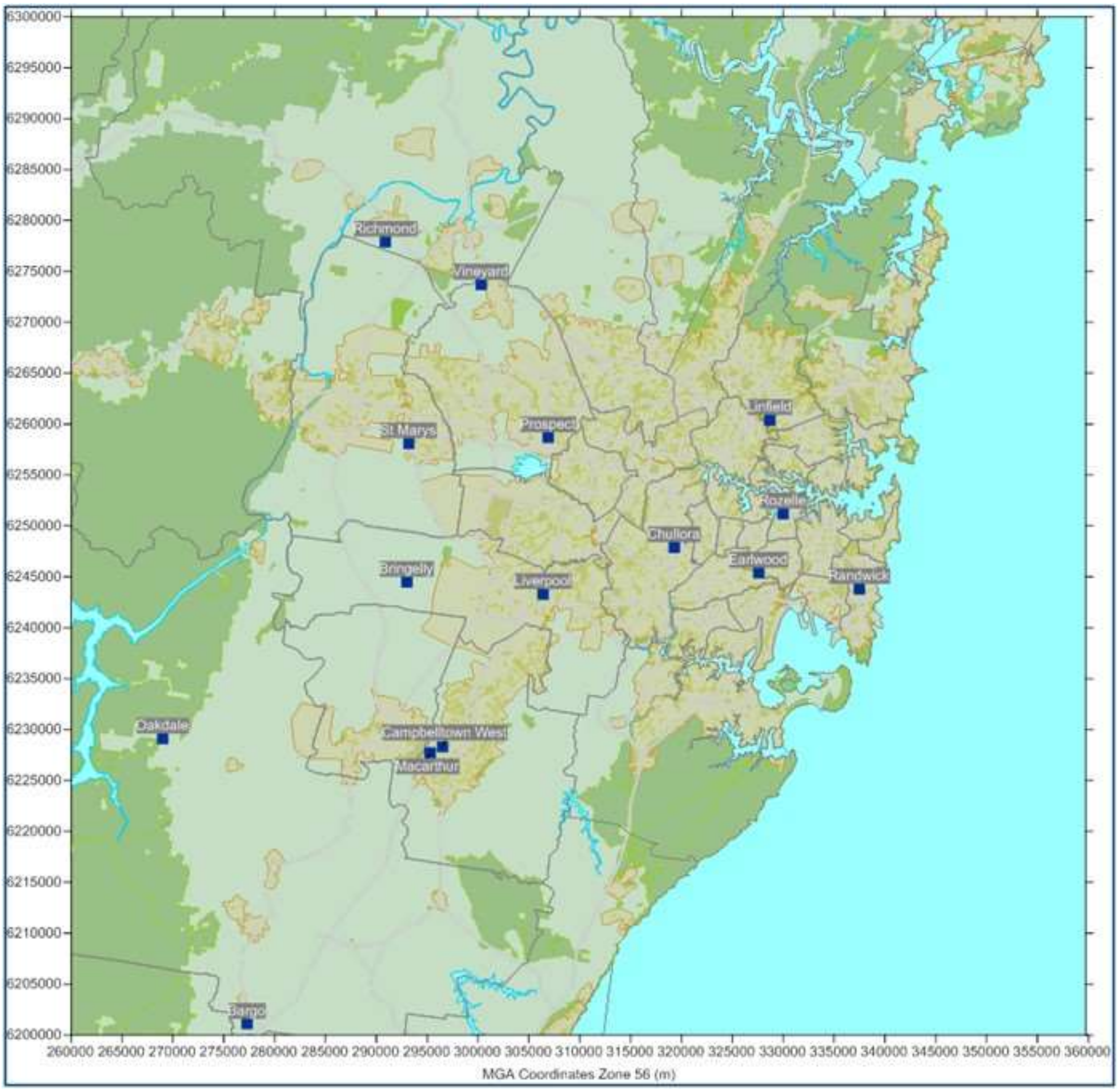


Figure 4-6: Location of NSW EPA monitoring sites

A summary of the annual average measured PM_{10} levels between 2005 and 2013 from the NSW EPA monitoring stations is presented in **Figure 4-7**.

The trend in annual average PM_{10} concentrations since 2005 be seen from **Figure 4-7**. It should be noted that during 2009, widespread regional dust storms occurred which contributed significantly to the annual average levels. The figure also shows that annual average PM_{10} levels are below criteria at all monitoring sites, and that generally the monitoring sites show a similar trend relative to the other sites. This indicates that the monitoring locations are representative of the trends in air quality that may affect the wider population (i.e. not at hot spots) and are thus suitable for NEPM compliance monitoring.

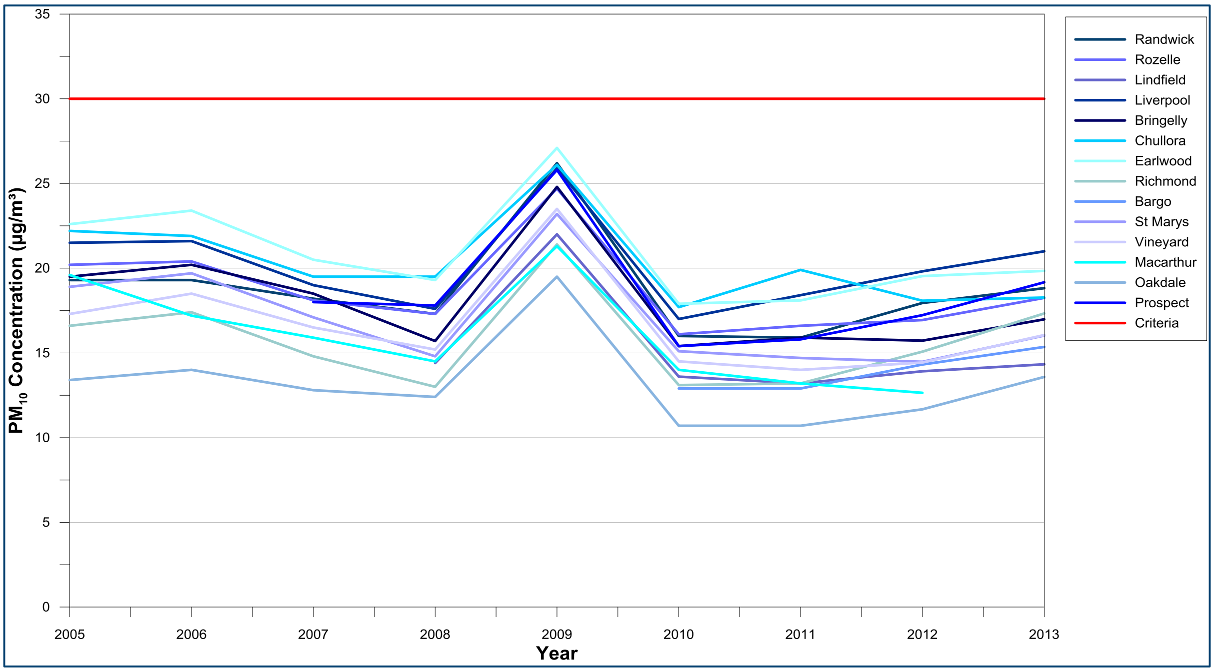


Figure 4-7: Annual average PM_{10} concentrations at NSW EPA monitoring sites

A summary of the annual average $PM_{2.5}$ levels between 2005 and 2013 from the NSW EPA monitoring stations is presented in **Figure 4-8**.

Figure 4-8 presents a similar trend to the annual average PM_{10} levels over time. There are presently no criteria for $PM_{2.5}$ in NSW, however there is a NEPM advisory reporting standard of 8µg/m^3 annual average. The reporting standard level was essentially breached in 2006, 2009, 2012 and 2013. It is noted that widespread bushfire events occurring in late 2013 would have attributed to the elevated annual average levels.

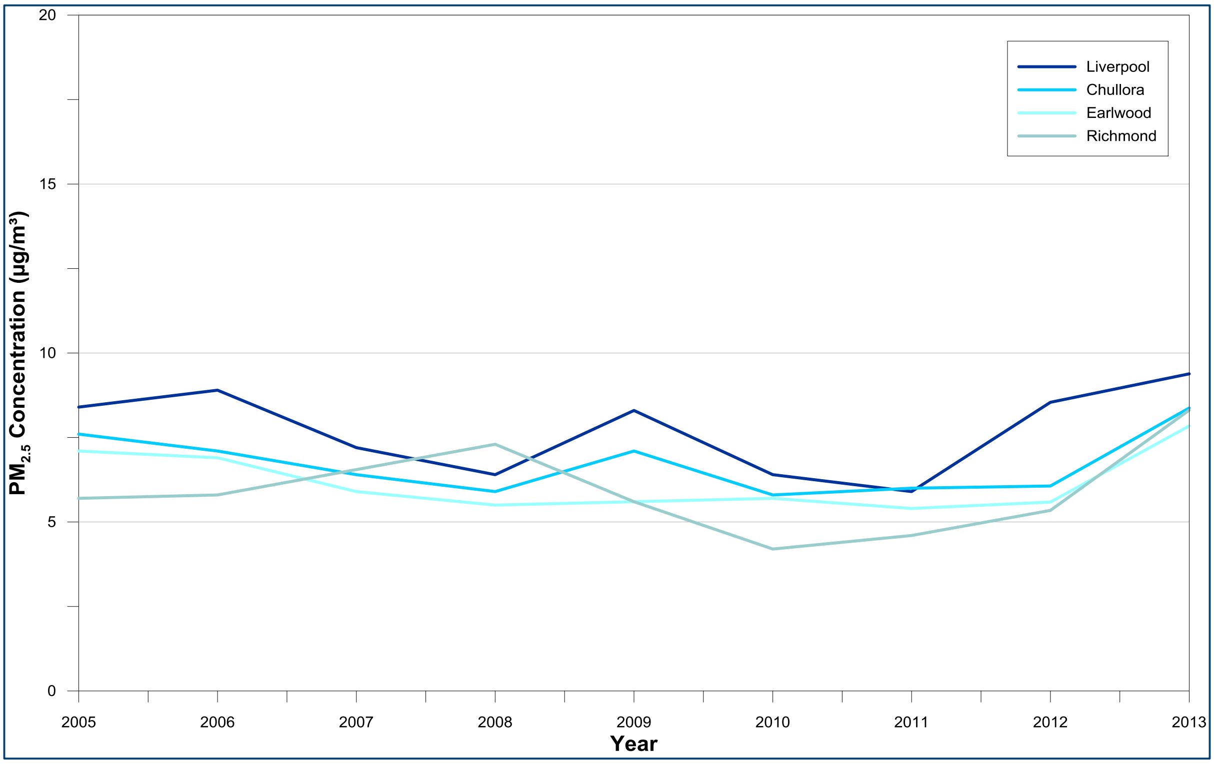


Figure 4-8: Annual average PM$_{2.5}$ concentrations at NSW EPA monitoring sites

A summary of the annual average NO_2 levels between 2005 and 2013 from the NSW EPA monitoring stations is presented in **Figure 4-9**. The figure shows a falling trend in NO_x levels and the at measured levels were below criteria at all monitoring sites

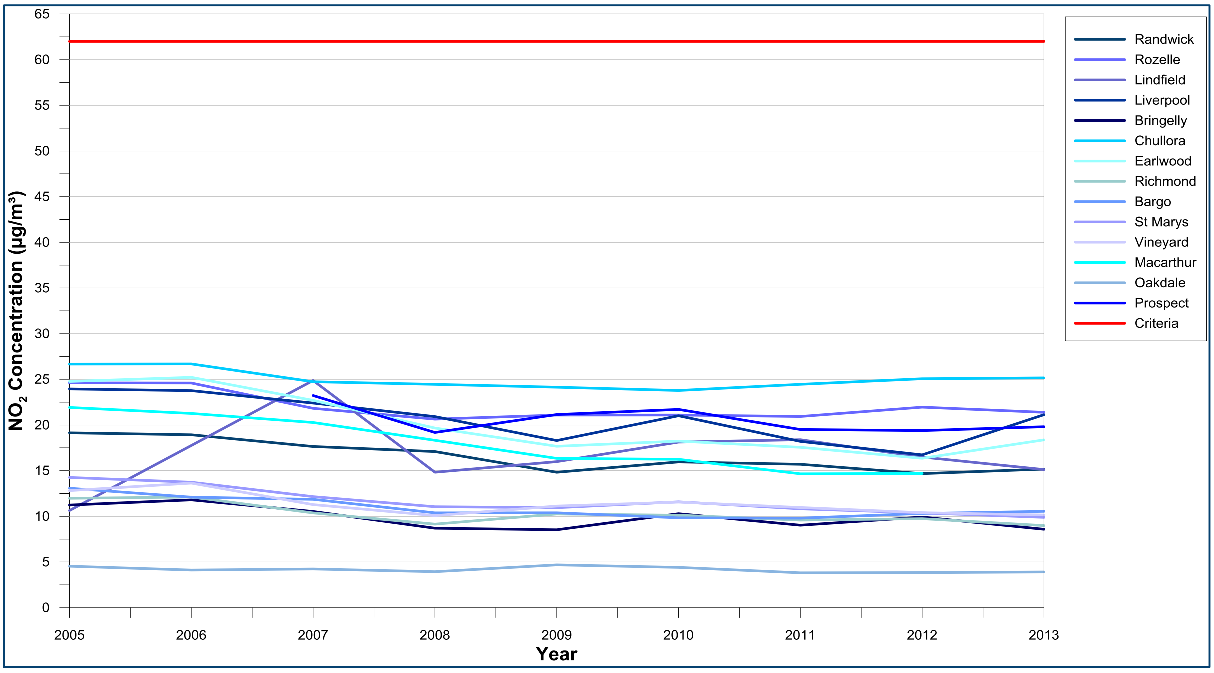


Figure 4-9: Annual average NO_2 concentrations at NSW EPA monitoring sites

5 ASSSESSMENT APPROACH

The focus of this assessment is on the potential change in heavy truck traffic and rail traffic as a result of the Project. The change only occurs in the spatial position of where the trucks are dispatched i.e. some containers that would have been dispatched by truck from Port Botany would be despatched from Moorebank after arriving there by rail.

As there is no tangible change in container traffic leaving Sydney, only the change in the spatial position of the container transport activity within the Sydney Basin needs to be considered. This was done on a suburb and local government area basis.

In regard to determining the container road transport case, the first step was to identify the destination of inbound containers from Port Botany and from the proposed terminal, for the case with the Project and the case without the Project.

The next step was to identify the total distance travelled by heavy diesel vehicles associated with container transport for the case with and without the Project. The distance or vehicle kilometres travelled (VKT) is the basis for calculating the emissions that would be produced. These emissions were then compared with the total emissions in the individual local areas and the regional air shed to see what effect the project would have.

A qualitative assessment of the change in traffic numbers and quantitative assessment using air dispersion modelling was conducted. This was done for the worst case, year 2031 scenario which has the largest change relative to the existing situation.

The estimated total number of interstate trains that the Project would handle at full capacity is 4 trains per day **Deloitte (2013)** which equates to approximately 30 trains per week. These trains would traverse three lines, the northern line towards Newcastle, the western line towards Lithgow and the southern line from Liverpool. The Deloitte projections indicate that approximately two of these trains would traverse on the Southern line, and one each daily on the Northern and Western lines.

In comparison, there would be approximately 20 trains daily traversing the rail line between Botany and the Project location at Moorebank.

Both the local and interstate train movements have been included explicitly in the modelling, along with the shift in heavy vehicle traffic along major roads for the 2031 scenario.

5.1 Traffic numbers and VKT

The estimated traffic distribution for the Sydney region during 2031 is detailed in the Strategic Transport Modelling Report, **PB (2012a)**. The traffic simulation included two scenarios one with and the other without the Project in operation in 2031.

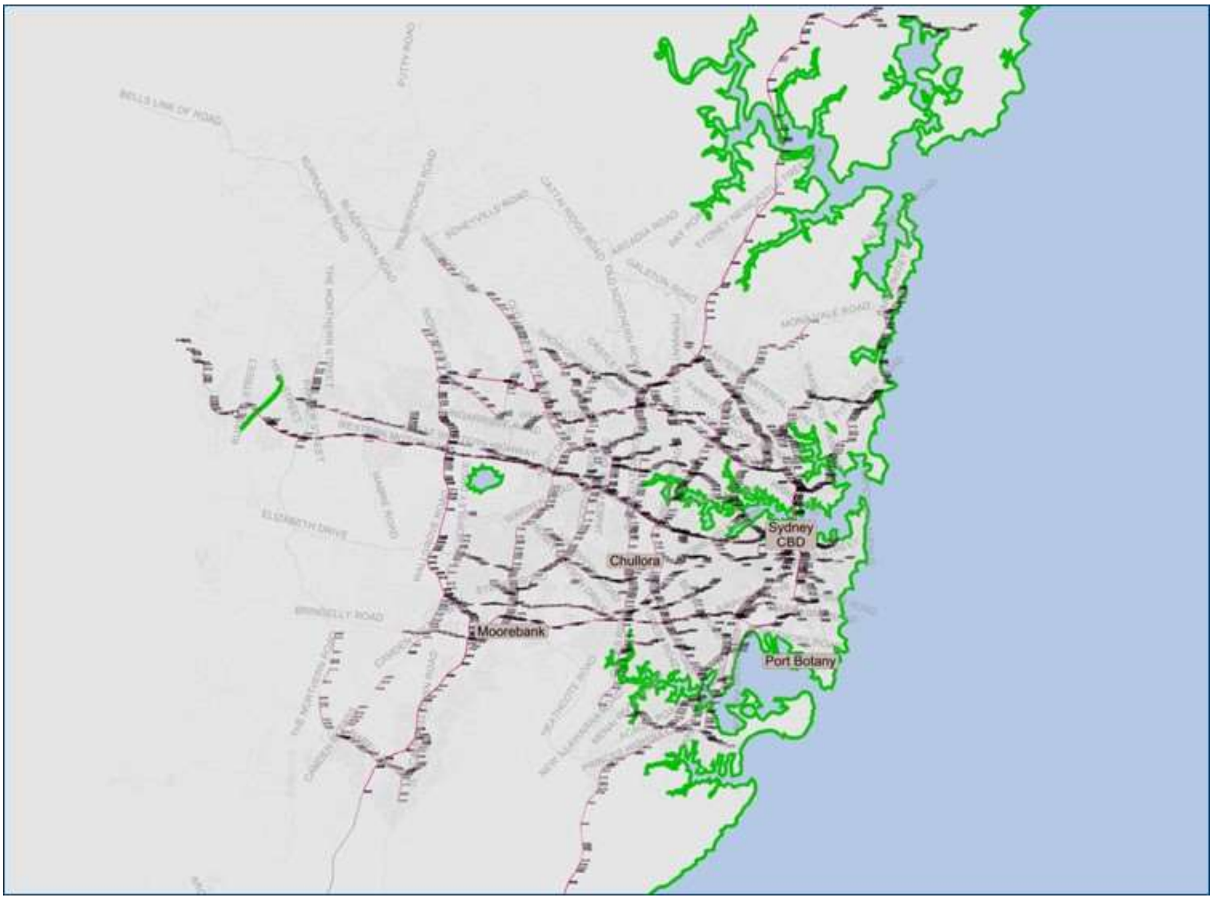
To assess the regional influence of the Project, we have focused on assessing all Sydney road sections that would carry Annual Average Daily Traffic numbers (AADT) of 20,000 or greater. This has been done as these roads would be traversed by the heavy diesel trucks associated with the project for the majority of the distance that the trucks would travel. Also, in terms of impact assessment, the areas nearest such roads would generally be more affected by traffic pollutants than say the smaller suburban roads.

Traffic data for each road section included traffic volume data split between various vehicle fleet types and the distance between each node.

The traffic numbers and node distances were used to calculate the VKT travelled on each road section.

Each node and road segment used in the calculations is shown in **Figure 5-1.**

Data from **EPA (2012)** were available for each Local Government Area (LGA) for motor vehicle emissions. The LGA's are shown in **Figure 5-2**.



Source: **PB, 2012a**

Figure 5-1: Road segments and nodes modelled

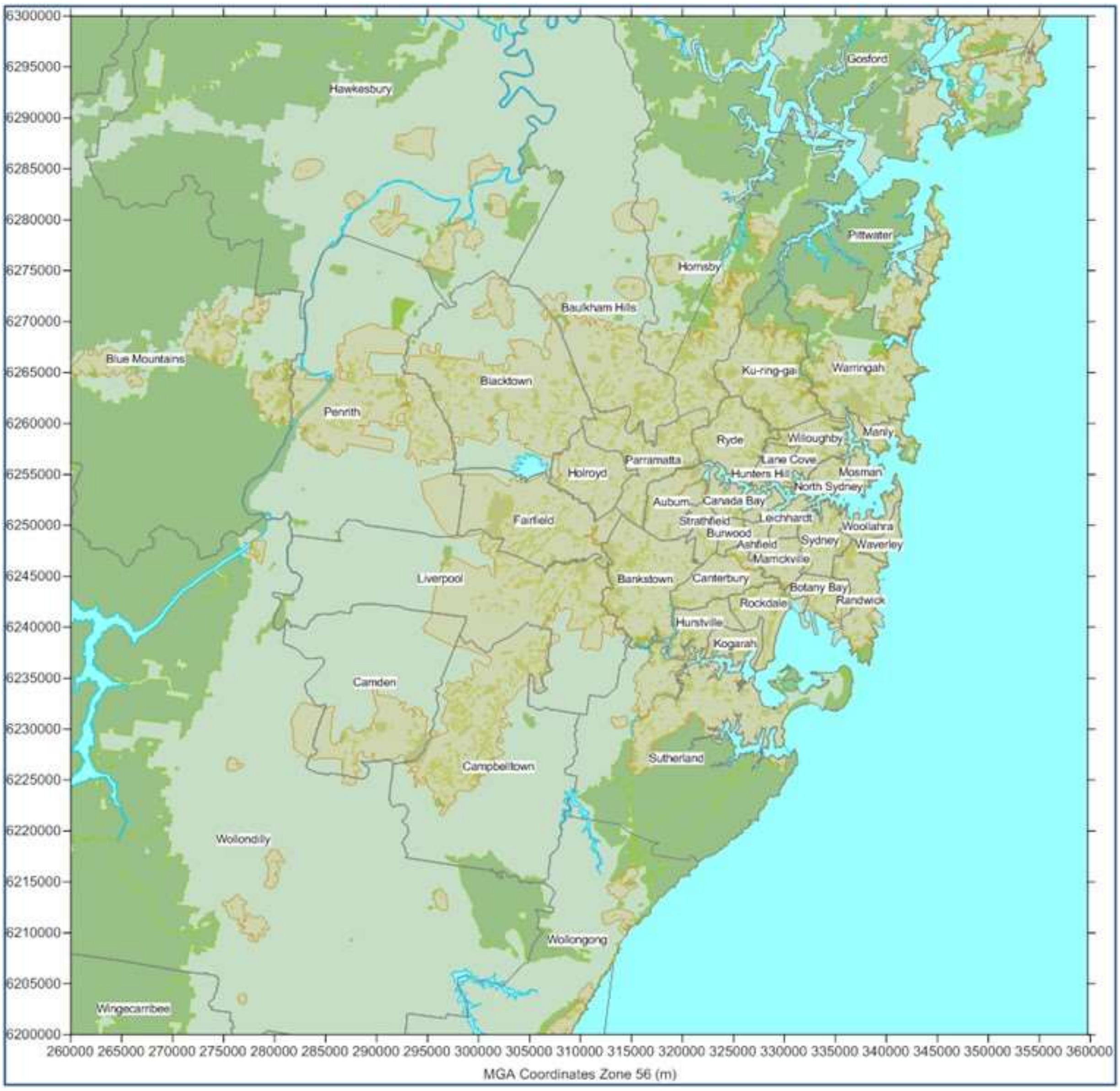


Figure 5-2: Local government areas in the modelling domain

5.2 Emission Estimation

5.2.1 Traffic emissions

Potential traffic emissions estimates have been calculated using the methodology presented in the NSW EPA document *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales 2008 Calendar Year On-Road Mobile Emissions* (2008 inventory) **EPA (2012)**.

The estimated articulated truck fleet profile (see **Table 5-1**) was used as a multiplier in the emissions estimation calculations. New truck emissions in future years are likely to be lower than truck emissions at present due to tightening vehicle emission standards. When calculating the fleet profile for 2031 however, to remain conservative in regard to future vehicle emission standards we have assumed that vehicles manufactured after 2011 would comply with the latest 2011 vehicle emissions standards. This is likely to overestimate emissions, as some improvement in vehicle emission standards might reasonably be expected by 2031. The resulting fleet profile used in the calculations is shown in **Table 5-1**.

Table 5-1: Estimated articulated trucks fleet profile - 2031

Year of Manufacture	Articulated Trucks
2031	0.0791
2030	0.0774
2029	0.0750
2028	0.0713
2027	0.0674
2026	0.0638
2025	0.0603
2024	0.0565
2023	0.0517
2022	0.0466
2021	0.0457
2020	0.0412
2019	0.0369
2018	0.0326
2017	0.0285
2016	0.0282
2015	0.0243
2014	0.0208
2013	0.0179
2012	0.0148
2011	0.0092
2010	0.0077
2009	0.0064
2008	0.0066
2007	0.0054
2006	0.0044
2005	0.0039
2004	0.0036
2003	0.0028
2002	0.0017
2001	0.0010
2000	0.0010

Year of Manufacture	Articulated Trucks
1999	0.0010
1998	0.0010
1997	0.0043

Source: **EPA**, **2012**

Table 5-2 summarises the base exhaust emission factors applied per each emission age class in the calculations.

Table 5-2: Base exhaust emission factors for articulated trucks (g/km)

Emission Age Class	ADR	NOx	VOC	CO	Exhaust PM_{10}
1996	ADR70/00	16.592	0.967	4.921	0.584
2003	ADR80/00	14.331	0.862	7.402	0.399
2008	ADR80/02	9.225	0.045	0.490	0.073
2011	ADR80/03	5.383	0.045	0.0496	0.074

Source: **EPA**, **2012**

The emission estimations calculated above were then considered for each road segment, for each hour of the day. A daily profile for each pollutant was applied at each of the node points to account for the diurnal variation in traffic (see **Table 5-3**).

Table 5-3: Daily profile for exhaust emissions from heavy duty vehicles

Hour	VOC	CO	NOx	PM
0	0.00903	0.00981	0.01103	0.00898
1	0.00813	0.0089	0.00987	0.00823
2	0.00868	0.00944	0.01027	0.00904
3	0.0117	0.01274	0.01384	0.01221
4	0.01838	0.01992	0.02148	0.01928
5	0.03533	0.03723	0.0385	0.03837
6	0.05721	0.05782	0.05677	0.06204
7	0.07841	0.0769	0.07284	0.07215
8	0.08723	0.08426	0.07788	0.07698
9	0.07558	0.07515	0.07383	0.07693
10	0.0723	0.07311	0.07259	0.07562
11	0.07253	0.07316	0.07221	0.07541
12	0.06894	0.06968	0.06925	0.07221
13	0.06796	0.06847	0.06787	0.07097
14	0.06741	0.06714	0.06563	0.06944
15	0.05955	0.05782	0.05654	0.05758
16	0.05196	0.04964	0.04932	0.04938
17	0.04311	0.0405	0.04107	0.03951
18	0.03339	0.03208	0.03387	0.03275
19	0.02122	0.0214	0.0234	0.02146
20	0.01576	0.01632	0.01832	0.01578
21	0.01345	0.01412	0.01599	0.01333
22	0.01206	0.01287	0.01451	0.01189
23	0.01068	0.01152	0.01311	0.01044

Source: **EPA**, **2012**

For each hour, for each road segment, a speciation profile for VOC and PM for heavy duty diesel vehicles was applied, as outlined in **Table 5-4**. This profile was used to estimate the fractions of the various VOC compounds, PAH and metals that comprise the total VOC and PM_{10} emissions.

Table 5-4: Diesel vehicle speciation data for selected compounds

Substance	Diesel Vehicles	
	Mass fraction (% VOC)	Mass fraction (% PM10)
1,3 butadiene	0.402828	
Acetaldehyde	3.813449	
Benzene	1.066778	
Formaldehyde	9.857486	
Isomers of xylene	0.38359	
Lead & compounds		0.017854
Particulate matter (PM2.5)		97
Polycyclic aromatic hydrocarbons	1.65302	5.45131313
Toluene	0.46912	
Total suspended particulate		101

Source: **EPA**, **2012**

It is noted that the areas where there would be any significant change in emissions, (Port Botany and Moorebank), are relatively flat and that the trucks would predominantly use the main motorway, freeway and arterial roads in these areas. Therefore, other relatively minor adjustment factors such as speed and road type adjustments have been omitted from the emission estimation.

The calculated emissions were then used as inputs to calculate emissions per local government region, as shown in **Section 7.1** and as inputs to air dispersion modelling, as described in **Section 6** and presented in **Section 7.2** and **Appendix A**.

5.2.2 Locomotive emissions

Locomotive emissions were calculated using **USEPA (2009)** and **ERG (2011)** emission factors using generally the same assumptions as **EPA (2012)**.

The fleet distribution for locomotives that was adopted in this assessment was obtained from the local air quality impact assessment and is shown in **Table 5-5**. As the Tier 1 and 2 emission factors are similar, the resultant emissions calculations would not be greatly sensitive to changes in the fleet distribution provided that the majority of the fleet in 2031 operated locomotive engines that attain Tier 1 or Tier 2 standards of emissions performance.

Table 5-5: Assumed locomotive fleet distribution 2031

% of locomotives	Pre Tier 0	Tier 0	Tier 1	Tier 2
2031	0%	0%	50%	50%

The number of trains delivering containers each week from Port Botany was determined to be 137, as advised by PB. It was assumed that the trains traverse the rail corridor between Port Botany and Moorebank, a return distance of approximately 75km at an assumed average speed of 60km/hr. This results in approximately 8,905 hours of train travel per annum that is associated with the Project. (Note that at any receptor near the rail line the annual period of time that a train associated with the project is present would be a small fraction of that amount.) Power per locomotive was assumed to be approximately 1050kW@649rpm on average for container delivery. Based on these values the fuel consumption was taken to be 227 kg/h per locomotive on average.

For conservatism, two locomotives are assigned to each train travelling between Port Botany and Moorebank and four locomotives are assigned to each train travelling on the interstate lines. In reality fewer locomotives would be required per train, thus the assessment will overestimate train impacts.

The calculated emissions are shown in **Table 5-6**.

Table 5-6: Locomotive container transport - calculated emissions

Substance	Emissions (tonnes per annum)
Carbon monoxide	32.28
Oxides of nitrogen	146.88
Particulate matter (PM10)	3.53
Particulate matter (PM2.5)	3.42
Total volatile organic compounds	5.30
1,3 Butadiene	1.69E-02
Acetaldehyde	9.75E-02
Benzene	1.34E-02
Formaldehyde	2.25E-01
Isomers of Xylene	2.54E-02
Lead and compounds	2.97E-04
Toluene	1.69E-02
PAH	9.53E-06

The emissions were modelled similarly to the traffic modelling, using the **EPA (2012)** diurnal profile shown in **Table 5-7**, which indicates limited freight rail activity during the morning and afternoon commuter peaks.

Table 5-7: Locomotive activity - diurnal profile

Hour	Week day and weekend proportion (%)	Hour	Week day and weekend proportion (%)
1	8.16	13	4.21
2	8.34	14	4.05
3	8.37	15	3.43
4	8.35	16	0.36
5	7.91	17	0.31
6	1.38	18	0.27
7	0.95	19	0.72
8	0.28	20	5.46
9	0.04	21	6.7
10	0.69	22	7.1
11	4.12	23	7.1
12	3.9	24	7.81

6 DISPERSION MODELLING APPROACH

6.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach combined with the emission estimates for the assessed scenarios.

6.2 Modelling methodology

Modelling was undertaken using a combination of the CALPUFF Modelling System and TAPM. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a three-dimensional gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the three dimensional meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for three-dimensional simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

6.2.1 Meteorological modelling

The TAPM model was applied to the available data to generate a three dimensional upper air data file for use in CALMET. The centre of analysis for the TAPM modelling used is 33deg52.5min south and 150deg57min east. The simulation involved four nesting grids of 30km, 10km, 3km and 1km with 35 vertical grid levels.

Observed surface wind field data from monitoring sites have been included in the model to generate a more representative 3D wind field for the modelled area. The grid domain was run on a 100 x 100km area with a 1km grid resolution. The available meteorological data for the 2011 calendar year from 11 surrounding meteorological monitoring sites were included in this run.

Figure 6-1 presents the location of each of these sites and **Table 6-1** outlines the parameters used from each station. Further detail regarding the CALMET input variables are presented in **Appendix B**.

Local land use and detailed topographical information including proposed mine topography for each modelled year was included to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas, as shown in **Figure 6-2**.

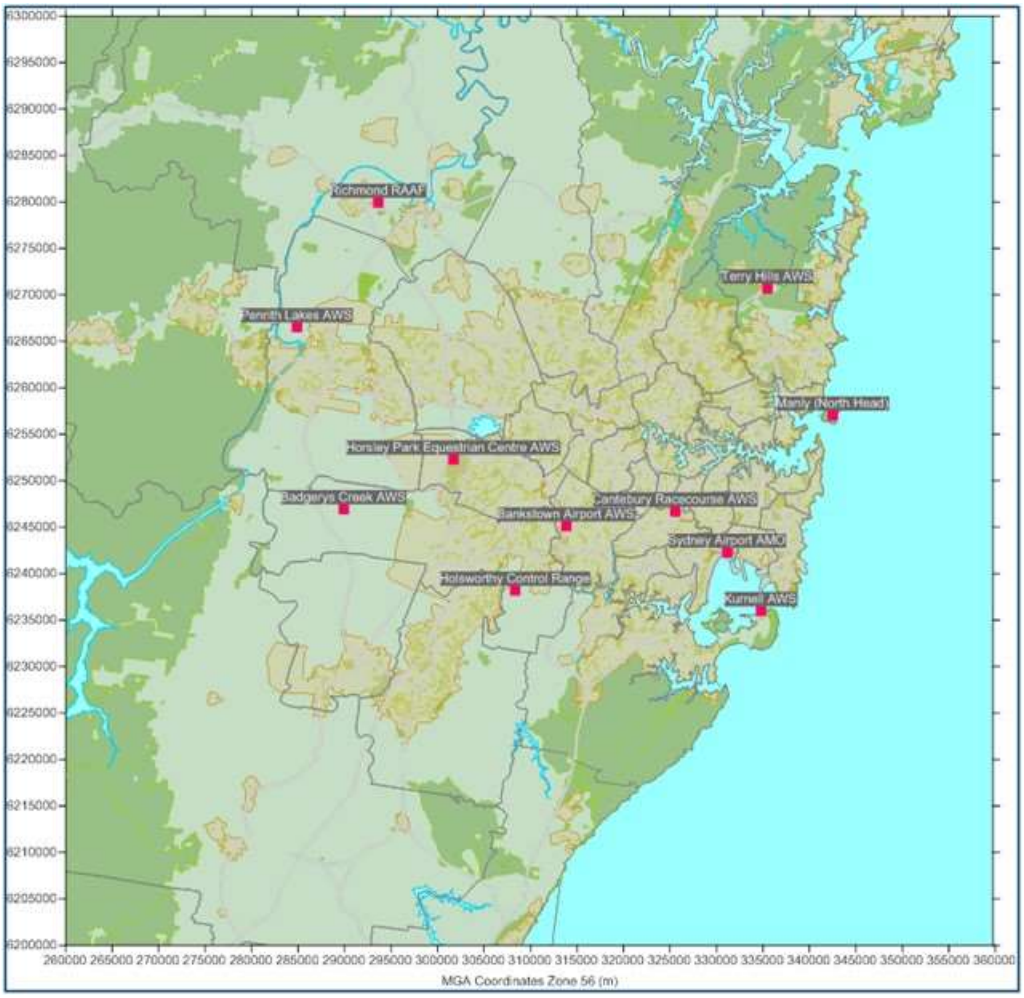


Figure 6-1: Surface observation station locations

Table 6-1: Surface observation station parameters

Weather station	Parameters
Sydney Airport AMO (BoM) (Station No. 066037)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Richmond RAAF (BoM) (Station No. 067105)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Bankstown Airport AWS (BoM) (Station No. 066137)	Wind speed, wind direction, temperature, humidity, sea level pressure, cloud height, cloud amount.
Terry Hills AWS (BoM) (Station No. 066059)	Wind speed, wind direction, temperature, humidity.
Penrith Lakes AWS (BoM) (Station No. 067113)	Wind speed, wind direction, temperature, humidity.
Horsley Park Equestrian Centre AWS (BoM) (Station No. 067119)	Wind speed, wind direction, temperature, humidity.
Badgerys Creek AWS (BoM) (Station No. 067108)	Wind speed, wind direction, temperature, humidity, sea level pressure.
Canterbury Racecourse AWS (BoM) (Station No. 066194)	Wind speed, wind direction, temperature, humidity.
Holsworthy Control Range (BoM) (Station No. 067117)	Wind speed, wind direction, temperature, humidity.
Kurnell AWS (BoM) (Station No. 066043)	Wind speed, wind direction.
Manly (North Head) (BoM) (Station No. 066197)	Wind speed, wind direction.

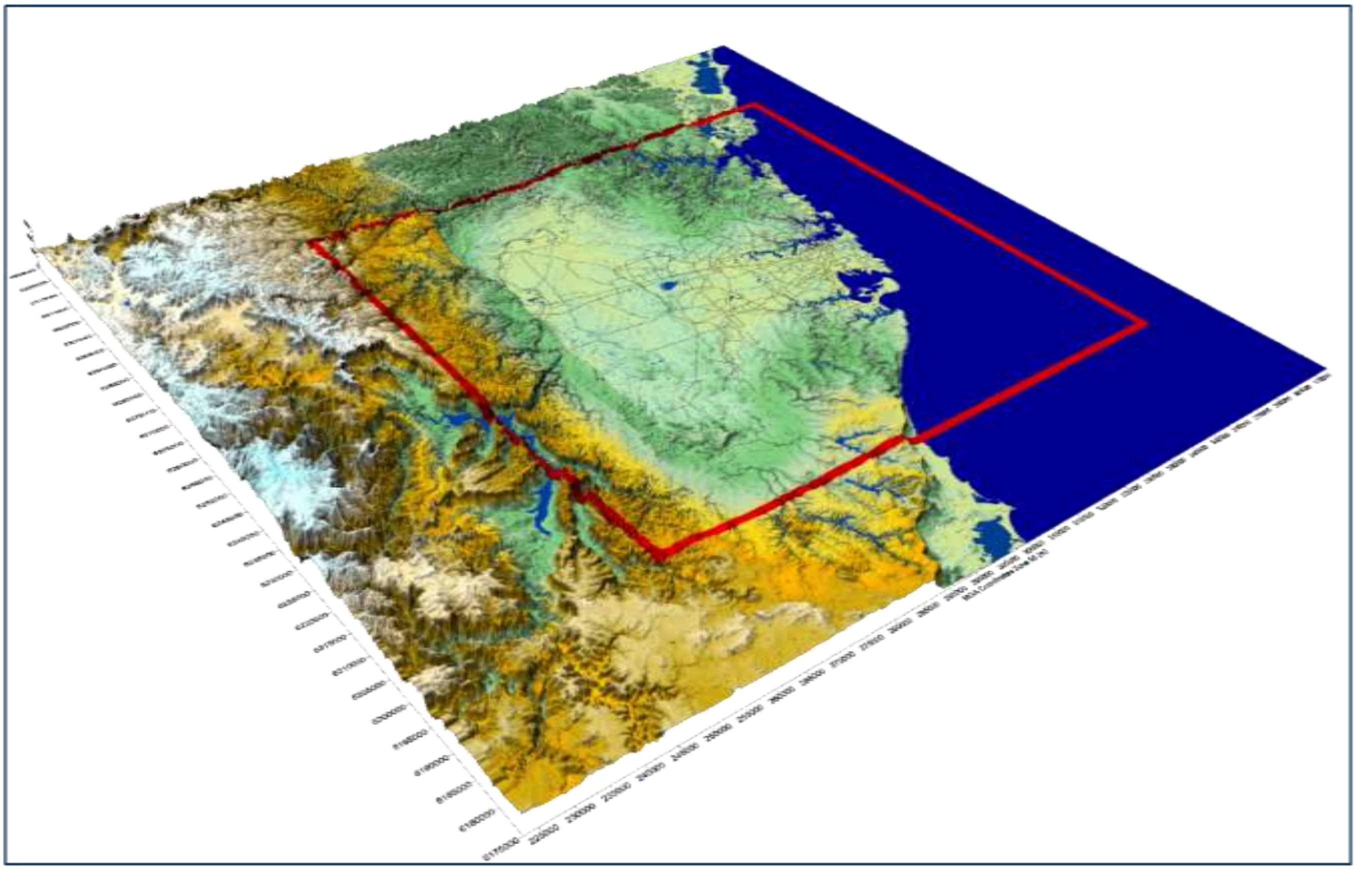


Figure 6-2: Terrain showing modelling domain (Sydney GMR boundary (EPA, 2012))

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-3** and **Figure 6-4**.

Figure 6-3 presents the annual and seasonal windroses from the CALMET data. On an annual basis, winds from the west-southwest and southwest are most frequent with a lesser proportion of winds from the west and south-southeast. During summer, winds from the southeast quadrant are predominant and range from the southwest and east-northeast. The autumn and winter seasons have relatively similar wind distributions to the annual distribution with winds from the west-southwest dominating. In spring, west-southwest and southwest winds dominate the wind distribution with fewer portions of winds from all other sectors. Overall the windroses reflect the typical wind distributions patterns that would be expected in the area.

Figure 6-4 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.

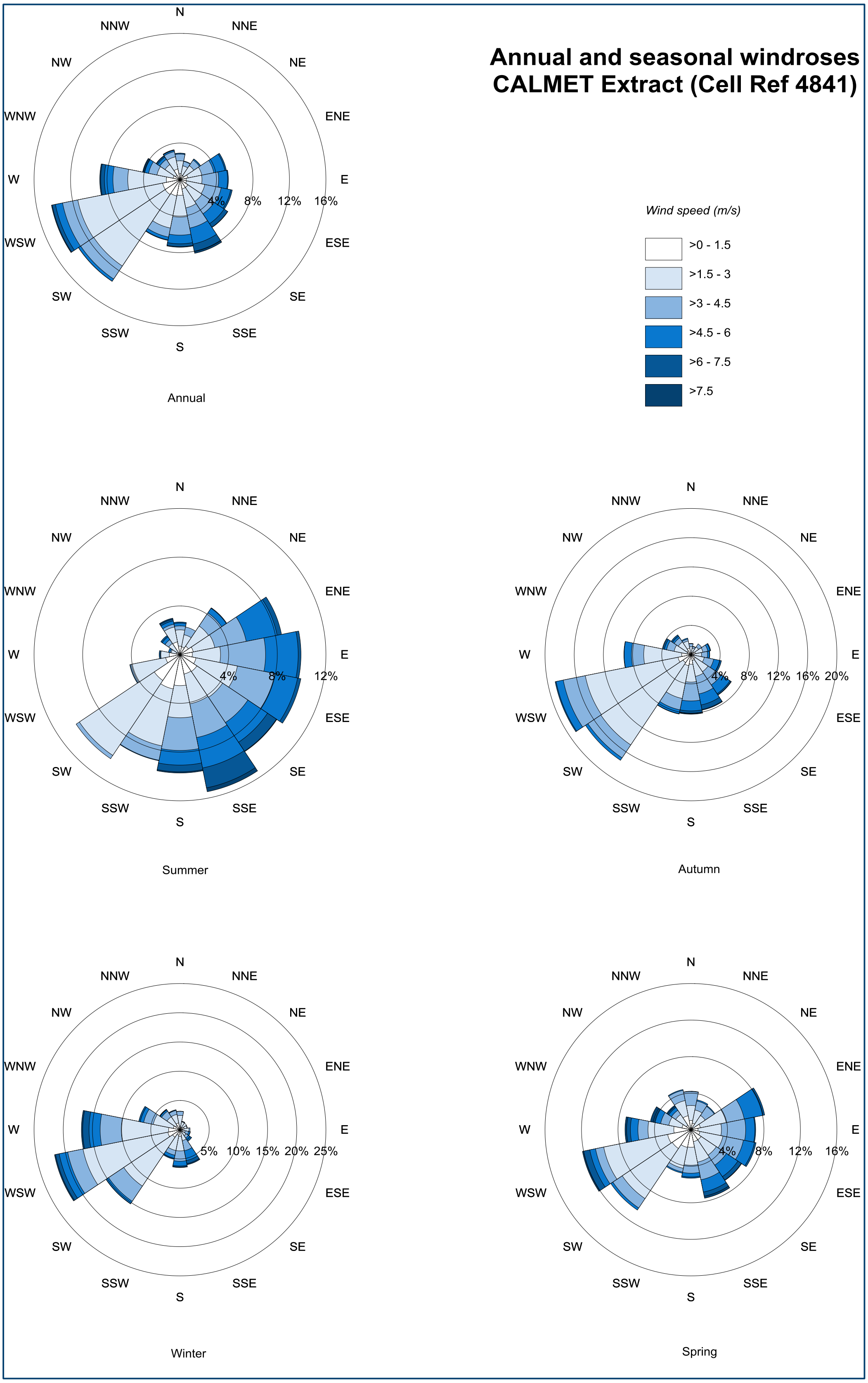


Figure 6-3: Windroses from CALMET extract (Cell Ref 4841)

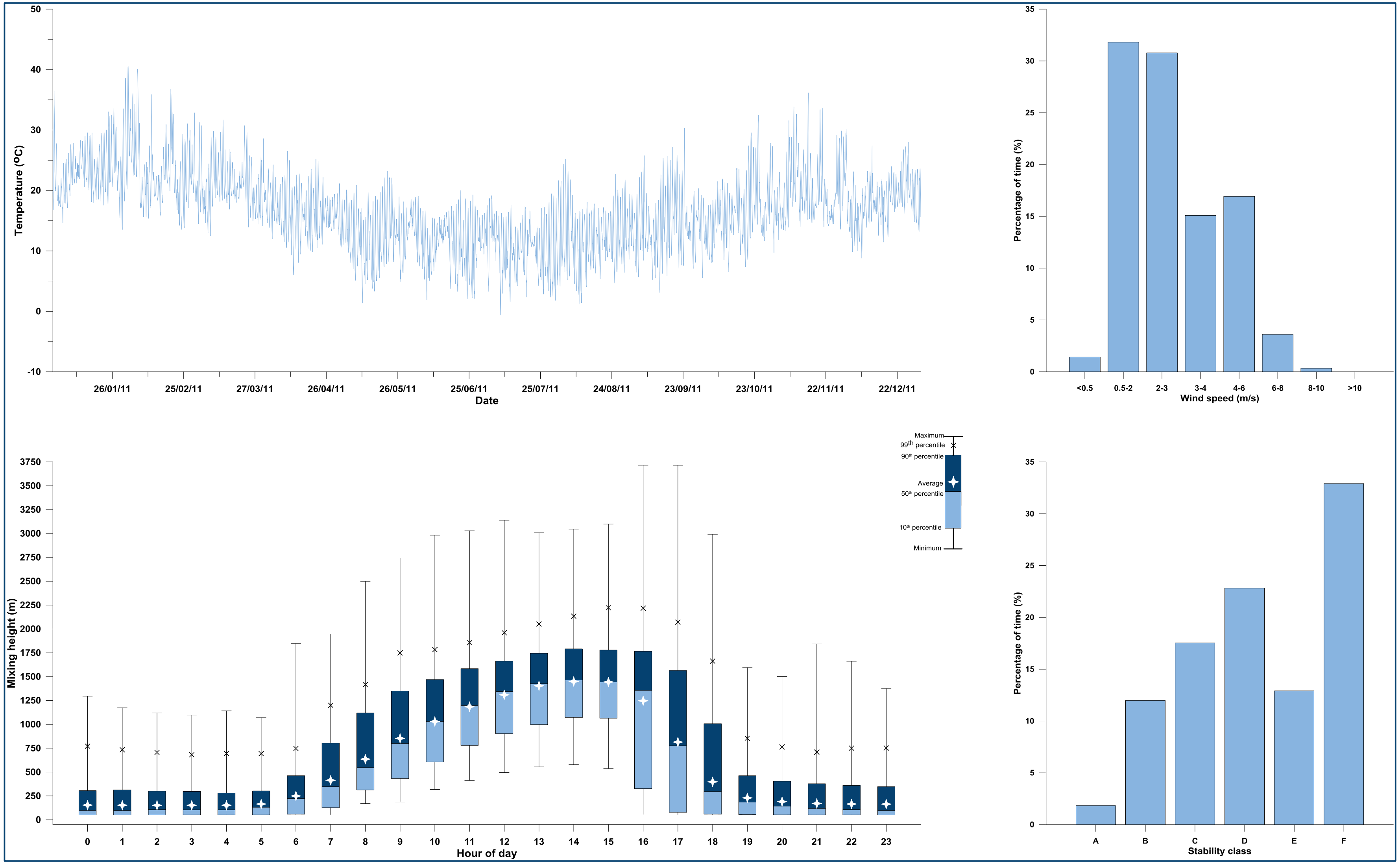


Figure 6-4: Meteorological analysis of CALMET extract (Cell Ref 4841)

6.2.2 Dispersion modelling

CALPUFF modelling utilised the traffic numbers and emission estimations as described in **Section 4**. Each of the traffic nodes was represented by a series of volume sources, (see **Figure 6-5**), which were included in the model via an hourly varying emission file. Rail emissions were modelled in a similar fashion. Each of the various rail access options to the Project site were modelled, however only the option with greatest impacts is presented, as the other rail access options would have less impact.

The results shown in **Section 7.1** indicate that the project would generally reduce emissions of key traffic pollutants at most locations across the basin with only a small increase in emissions in the vicinity of the Project. Whilst the percentage change in emissions would be greater in the vicinity of the project, the net total quantity of emissions would be lower, and overall, only negligible increases in total emissions may arise in the air shed. It was thus considered that detailed photochemical modelling would not reasonably show the effects of the small changes that may arise and would not be warranted in this situation.

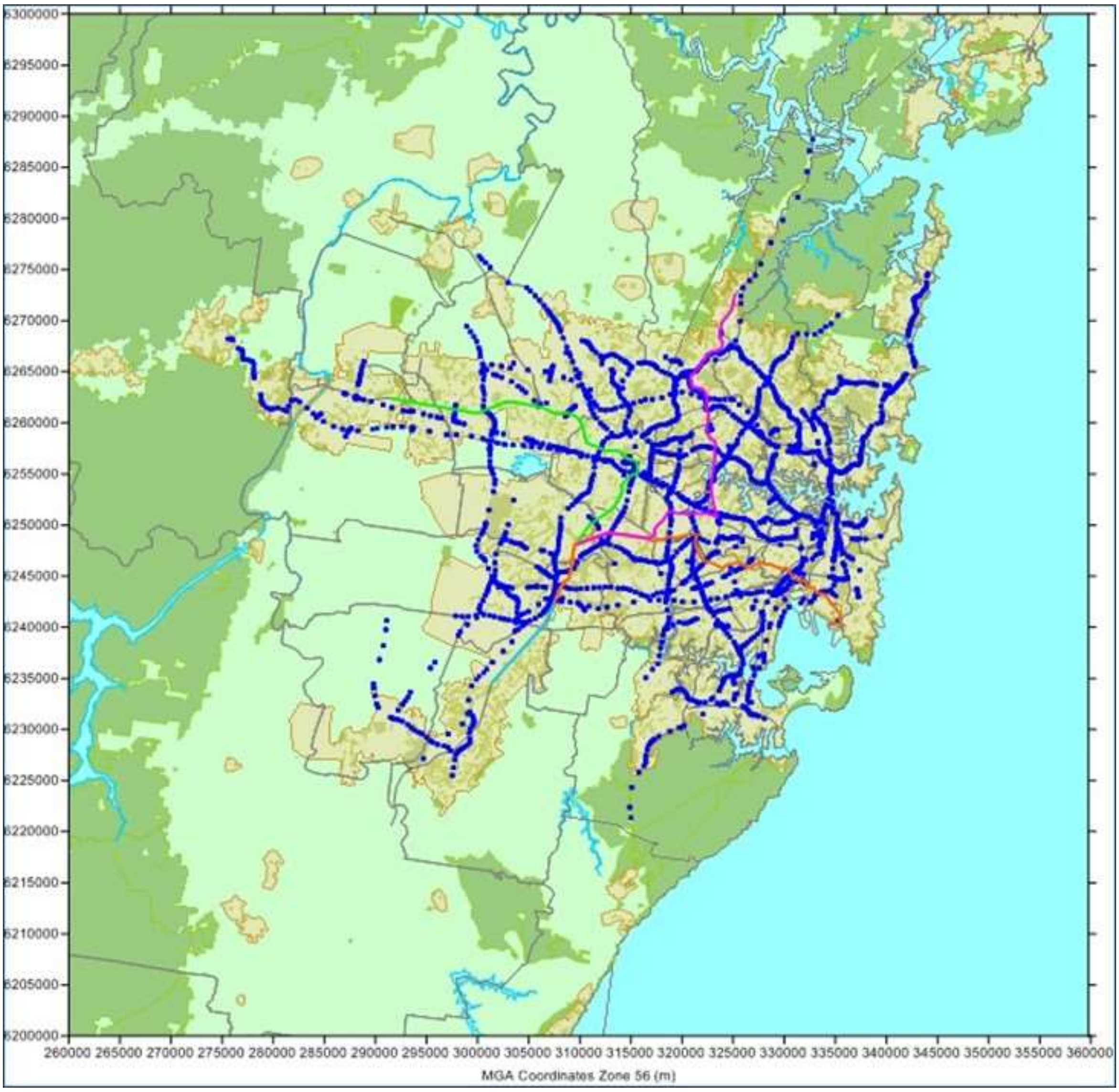


Figure 6-5: Modelled source locations (traffic - dark blue, rail - other colours)

7 RESULTS AND ANALYSIS

A summary of the results showing the change in emissions due to the project is presented for the whole Sydney basin in **Table 7-1** and **Table 7-2**.

Table 7-1 shows the total emissions in the Sydney basin per **EPA (2012)**, and also the corresponding heavy duty diesel (HDD) vehicle emissions associated with transport of containers due to the Project. The result is consistent with the predicted net reduction in VKT for container transport.

Table 7-1: Summary of results - traffic emissions

Substance	Sydney Region (EPA 2012) (tonnes/year)			Project (2031) (tonnes/year)		Change due to Project (Percent increase)		
	Total Sydney	Motor vehicles	Heavy duty diesel	With Project HDD	Without Project HDD	Grand Total	Motor vehicles	Heavy duty diesel
Carbon monoxide	246,692	123,712	4,081	335.1	346.5	0.00%	-0.01%	-0.28%
Oxides of nitrogen	74,722	45,392	14,423	2837.7	2934.6	-0.13%	-0.21%	-0.67%
Particulate matter (PM_{10})	20,443	2,110	592	42.2	43.7	-0.01%	-0.07%	-0.24%
Particulate matter ($PM_{2.5}$)	11,728	1,553	574	41.0	42.4	-0.01%	-0.09%	-0.24%
Total volatile organic compounds	131,356	23,512	866	34.9	36.1	0.00%	-0.01%	-0.14%
1,3 Butadiene		142	3.49	0.1	0.1		0.00%	-0.14%
Acetaldehyde		101	33	1.3	1.4		-0.05%	-0.14%
Benzene		624	9.23	0.4	0.4		0.00%	-0.14%
Formaldehyde		266	85.3	3.4	3.6		-0.04%	-0.14%
Isomers of Xylene		979	3.32	0.1	0.1		0.00%	-0.14%
Lead and compounds		2.82	0.106	0.01	0.01		-0.01%	-0.24%
Toluene		1,315	4.06	0.2	0.2		0.00%	-0.14%
TSP		2,737	598	42.7	44.1		-0.05%	-0.24%
PAH			23.3	2.9	3.0			-0.42%

The results show that the Project would have a small effect in reducing emissions from heavy duty diesel vehicles across the Sydney Basin. The largest effect is predicted to be a 0.13% decrease in NO_x emissions.

However, the project would result in some additional rail traffic and thus locomotive emissions need to be considered. The emissions from locomotives are added to the total emissions arising from the project, and are shown in the column labelled "With Project (HDD+loco)" in **Table 7-2**.

Table 7-2: Summary of results - total emissions (traffic and rail)

Substance	Sydney Region (EPA 2012) (tonnes/year)			Project (2031) (tonnes/year)		Change due to Project (Percent increase)		
	Total Sydney	Motor vehicles and locomotives	Heavy duty diesel and locomotives	With Project (HDD + loco)	Without Project HDD	Total Sydney	Motor vehicles and locomotives	Heavy duty diesel and locomotives
Carbon monoxide	246,692	123,728	4,097	351.3	346.5	0.00%	0.00%	0.12%
Oxides of nitrogen	74,722	45,466	14,497	2911.5	2934.6	-0.03%	-0.05%	-0.16%
Particulate matter (PM_{10})	20,443	2,112	594	44.0	43.7	0.00%	0.01%	0.05%
Particulate matter ($PM_{2.5}$)	11,728	1,555	576	42.7	42.4	0.00%	0.02%	0.06%
Total volatile organic compounds	131,356	23,515	869	37.6	36.1	0.00%	0.01%	0.17%
1,3 Butadiene		142	3	0.1	0.1		0.01%	0.24%
Acetaldehyde		101	33	1.3	1.4		-0.05%	-0.15%
Benzene		624	9	0.4	0.4		0.00%	0.07%
Formaldehyde		266	85	3.5	3.6		-0.03%	-0.10%
Isomers of Xylene		979	3	0.1	0.1		0.00%	0.38%
Lead and compounds		3	0	0.0	0.01		0.01%	0.14%
Toluene		1,315	4	0.2	0.2		0.00%	0.21%
TSP		2,739	600	44.5	44.1		0.01%	0.06%
PAH			23	2.9	3			-0.43%

The table indicates that the project would have no discernable effect on emissions in Sydney.

The largest calculated change is a reduction of 0.03% in NOx emissions in Sydney.

The largest calculated change in emissions from only heavy duty diesel and locomotive sources ranges from a reduction of 0.43% to an increase of 0.38% for individual pollutants. This represents a small change in a subpart of all of the emissions sources in Sydney.

7.1 Calculated changes due to the Project

7.1.1 Traffic numbers

Figure 7-1 illustrates the small regional effect of the Project on heavy vehicle traffic. The figure shows the small percentage change in traffic numbers attributable to the Project in 2031, the full scale operational year.

The yellow orange and red colours show a small percentage increase in traffic on roads near the Project site and the dark green, blue and purple colours show the small decrease in traffic numbers on the road network.

Traffic numbers are directly linked to traffic emissions, and a similar trend in emissions would be expected, however there are two important points to consider.

Firstly there are significantly differences in the levels of traffic across the network and on particular road sections and thus a small change in traffic numbers in locations with little traffic may result in a large percentage difference but have little effect in regard to compliance with criteria levels. Conversely, the same numbers of traffic introduced into a high traffic location may not result in any significant change in the number of vehicles, and may raise potentially more elevated pollution levels slightly higher.

In this regard, it also needs to be noted that the majority of the decreases in traffic numbers would occur in areas that are more likely to experience congested traffic conditions for prolonged periods, where emissions per vehicle are higher. Also, the increases in traffic numbers are predicted to occur in areas that are less congested, for less time, and where the emissions per vehicle would be lower. The data available to this study however does not allow detailed calculations to be made in this regard, and it has been assumed that the same level of emissions would occur across the roads modelled.

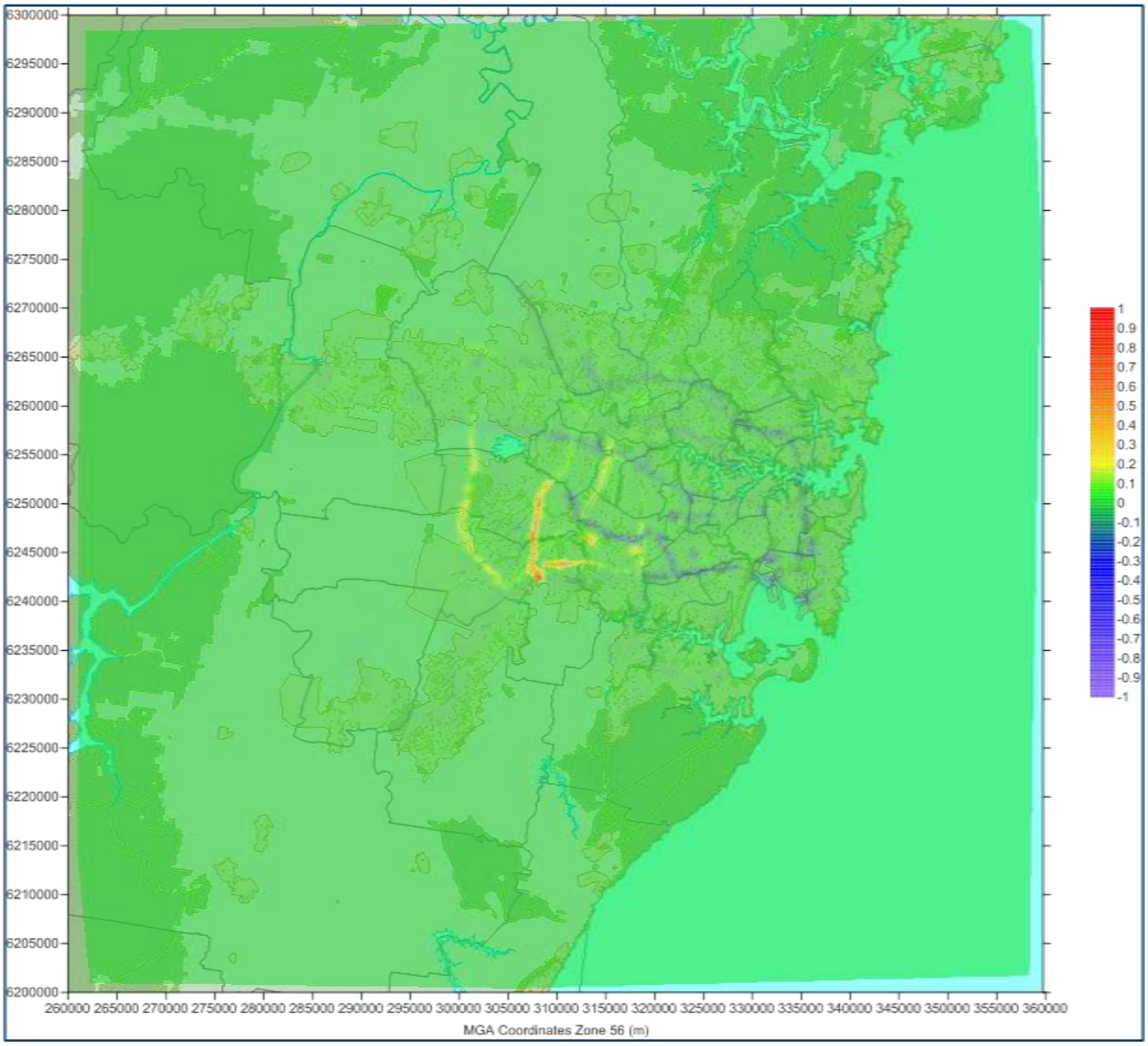


Figure 7-1: Relative increase in traffic numbers due to the Project (%)

7.1.2 Vehicle kilometres travelled

The total VKT travelled on 20,000 AADT roads in Sydney shows no significant change due to the Project in any LGA, as shown in **Figure 7-2**.

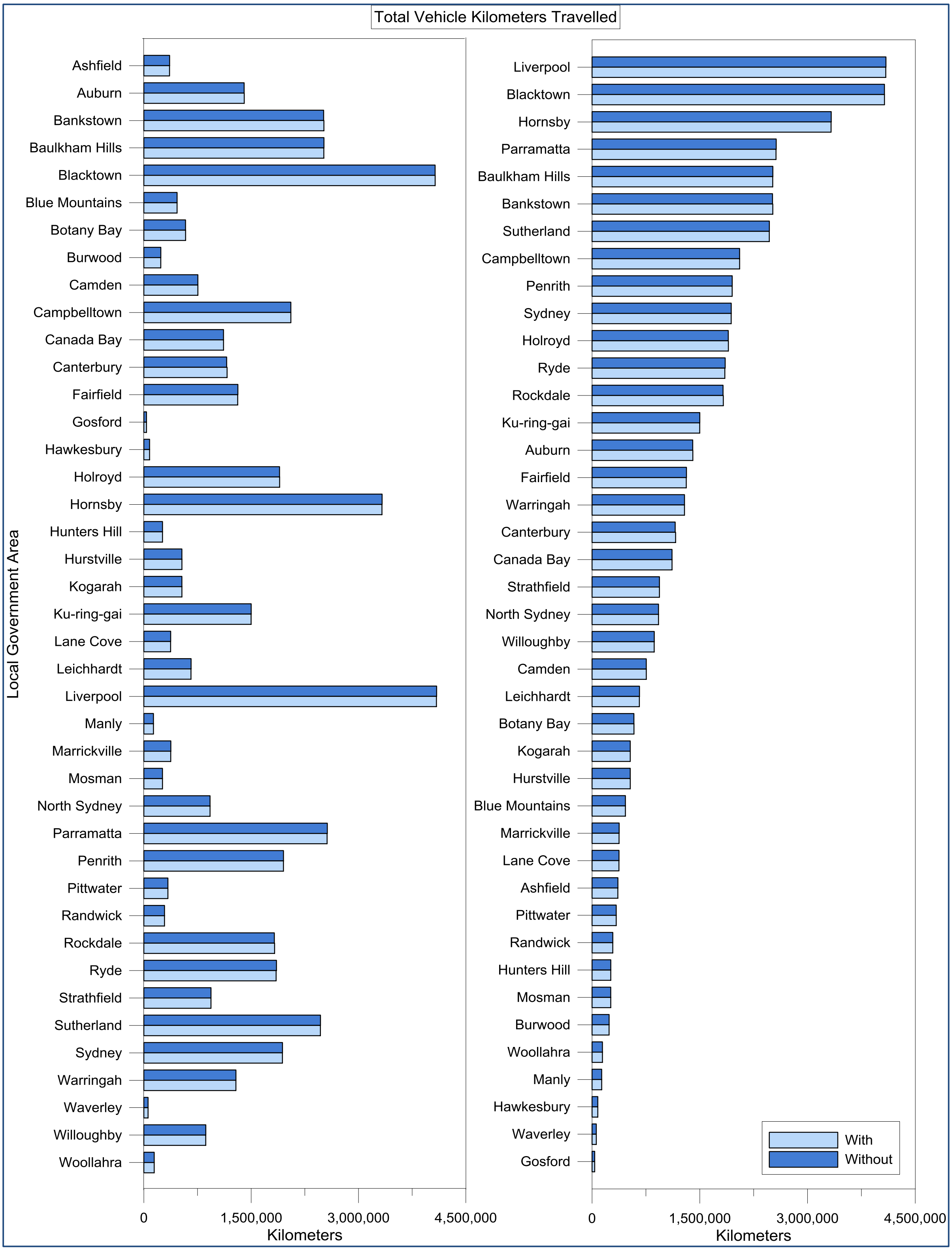


Figure 7-2: Total VKT on 20,000 AADT roads in Sydney

To enable the small changes to be presented, the percentage change in VKT for only heavy diesel vehicles associated with container transport is shown in **Figure 7-3**.

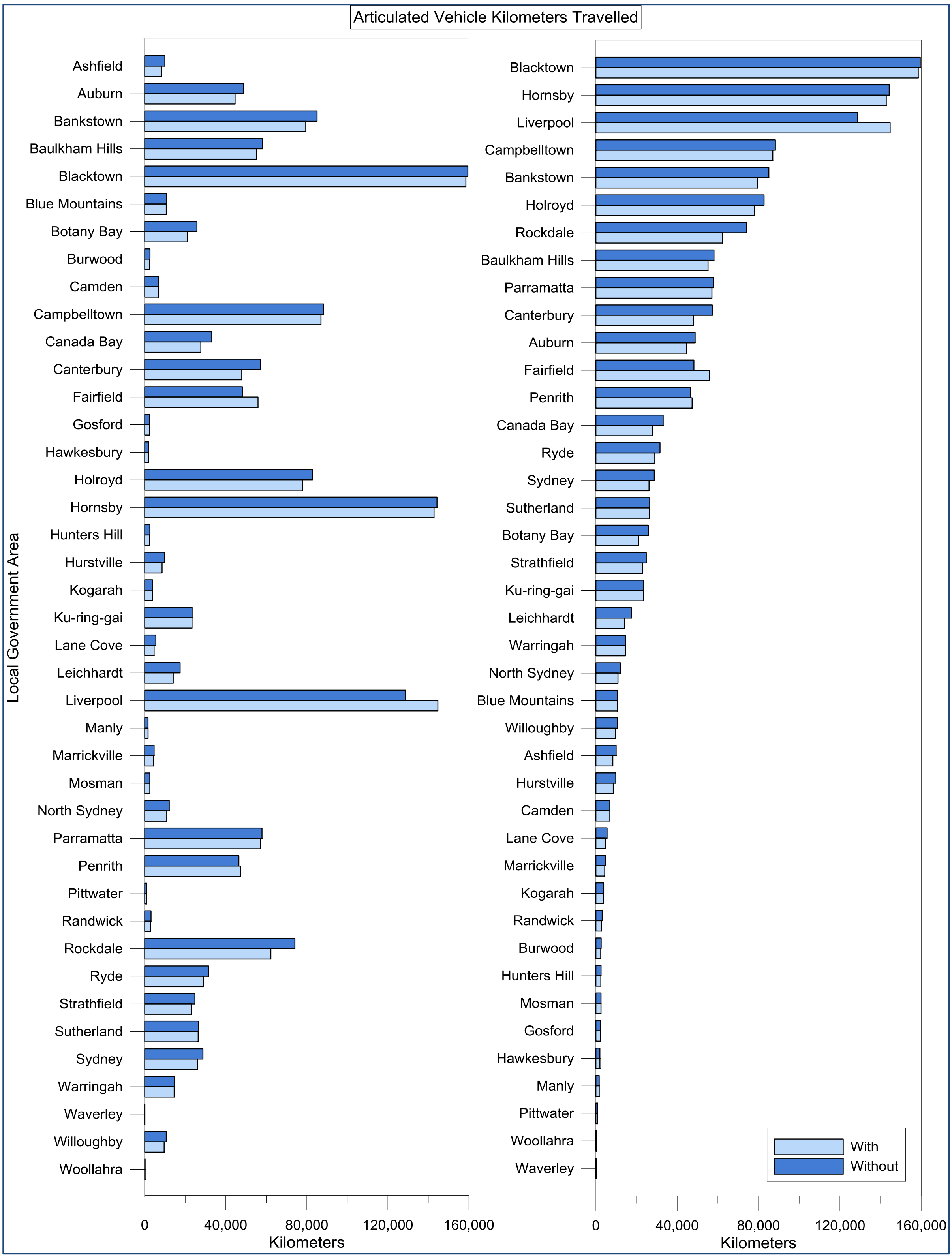


Figure 7-3: Heavy vehicle VKT associated with container transport in Sydney

This figure shows that with the project there would be decreases in VKT in most LGA's, notably Bankstown and Hornsby, which have the highest existing heavy vehicle VKT levels of the various LGA's. As might be expected there is an increase in VKT in the Liverpool and Fairfield LGA near the Project in 2031.

The total VKT per annum associated with container transport in Sydney is reduced from approximately 4,882,000 VKT/day without the Project down to approximately 4,815,000 VKT/day with the Project, and represents a reduction of approximately 1.4% or 24,455,000 kilometres per annum of heavy diesel truck activity, **(PB 2012a)**.

As emissions are largely proportional to VKT, the rates of emissions in each LGA would follow a similar pattern, as detailed below. It needs to be noted that closer to the Sydney city centre, the LGA areas are smaller, and so distances travelled are also smaller, which multiplied by with the number of container deliveries in that LGA is the factor influencing in the trends shown.

7.1.3 Emissions

The total emissions from heavy vehicles associated with container transport for the with and without the scenarios, per LGA by is shown in **Figure 7-4** for PM_{10} emissions.

The figure shows a similar trend to the results for VKT. The results show that a change in emissions is only discernible when one examines the change in emissions only from heavy diesel vehicles, as outlined in .In reality it will not be possible to separate these emissions from all traffic emissions and no discernible change would be likely to arise at the LGA level.

A similar figure for each pollutant is shown in **Appendix A**. The figures are very similar for each pollutant and show essentially the same trend as shown for PM_{10}.

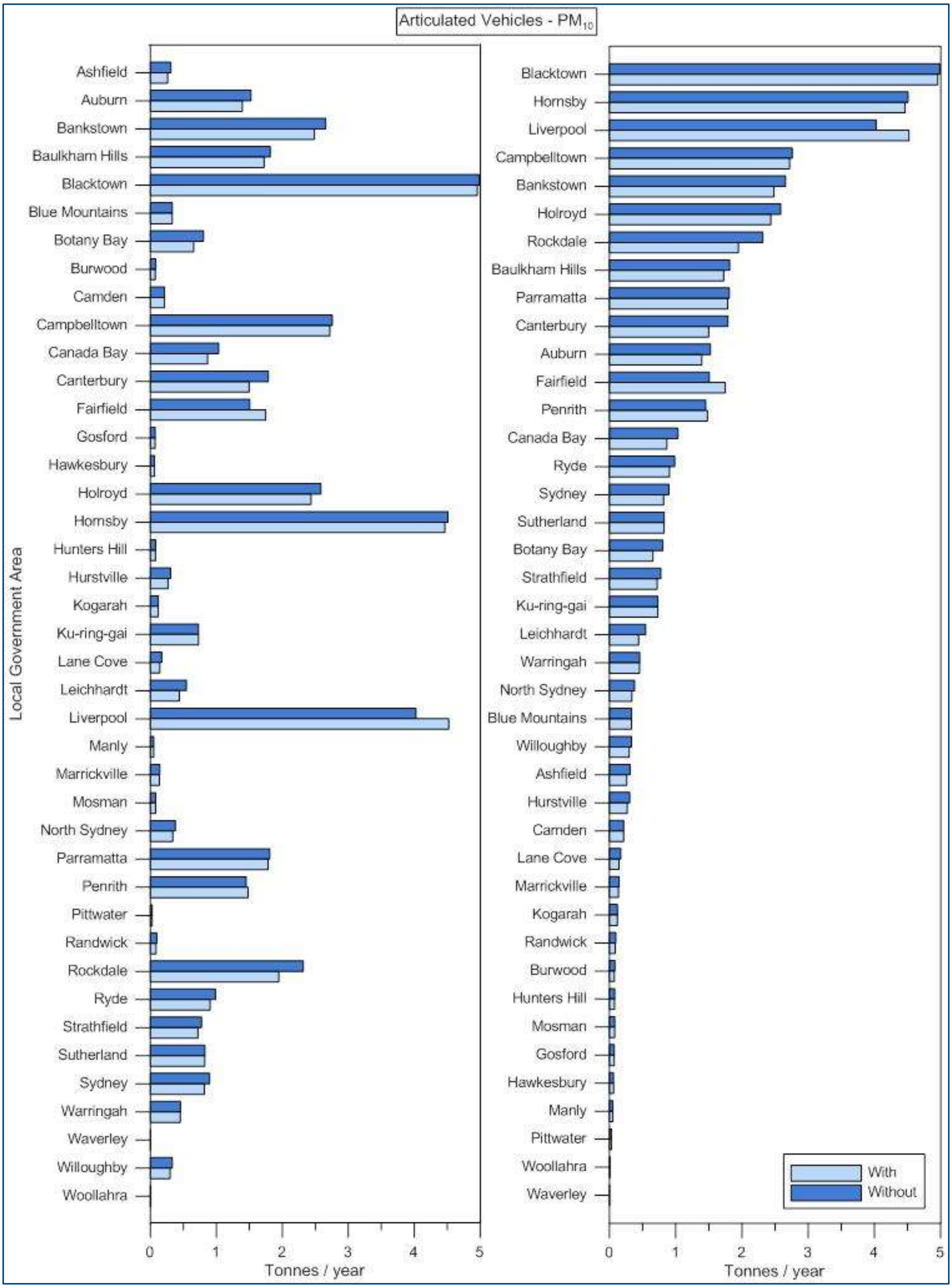


Figure 7-4: PM_{10} emissions associated with container transport by road in Sydney

Figure 7-5 and **Figure 7-6** show the effect of the project on NO_x emissions across the various LGA's. NO_x has been chosen for these figures as it is the pollutant that is most affected by the Project (but note that the Project results in only a 0.13% change in total NO_x emissions).

Figure 7-5 shows the levels of NO_x emissions per LGA without the Project, and **Figure 7-6** shows the levels of NO_x emissions with the Project.

The figures show that there is no discernible change in the total emissions in each LGA.

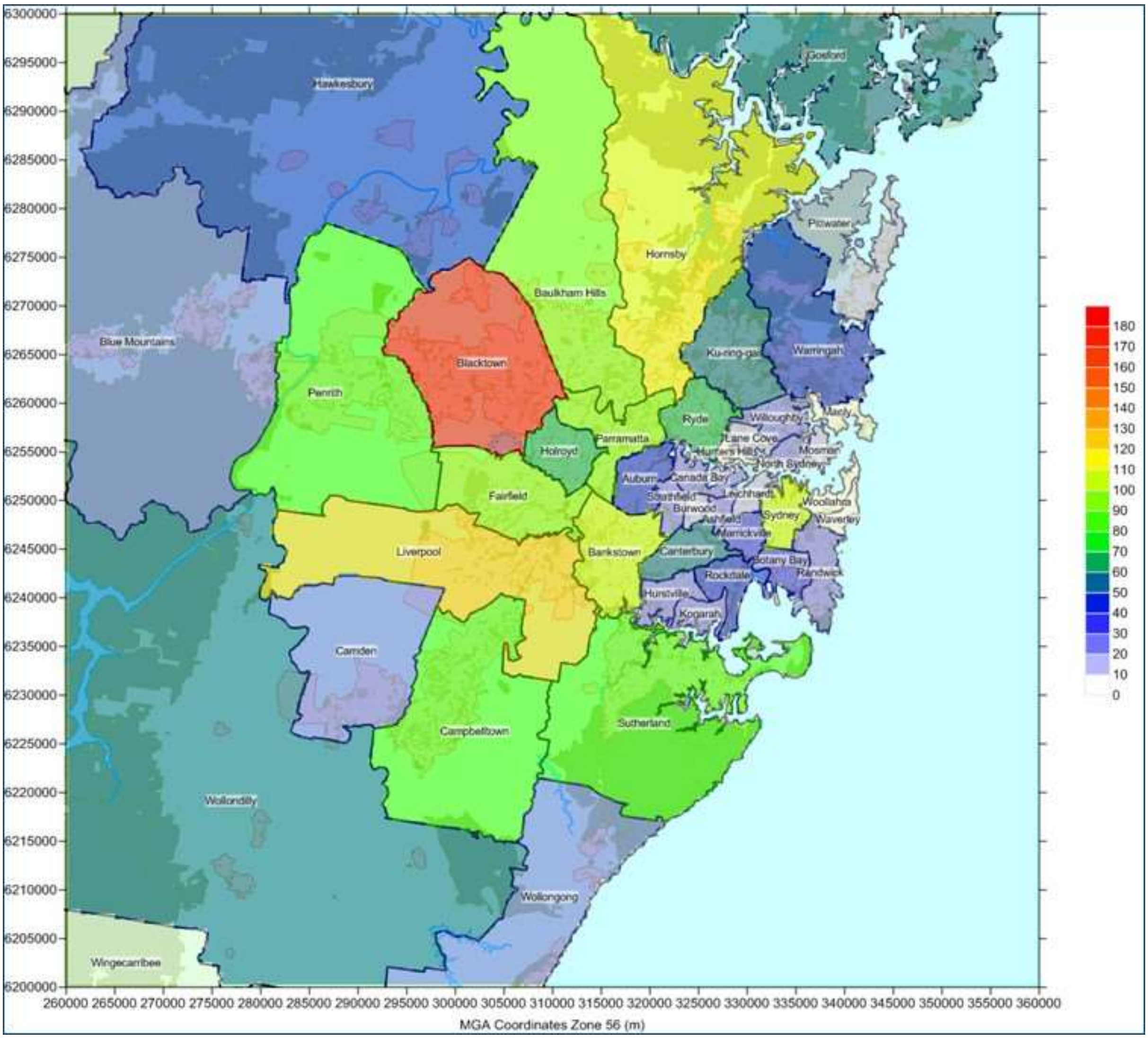


Figure 7-5: PM_{10} On-Road mobile emissions per LGA with Project emissions, tonnes per annum

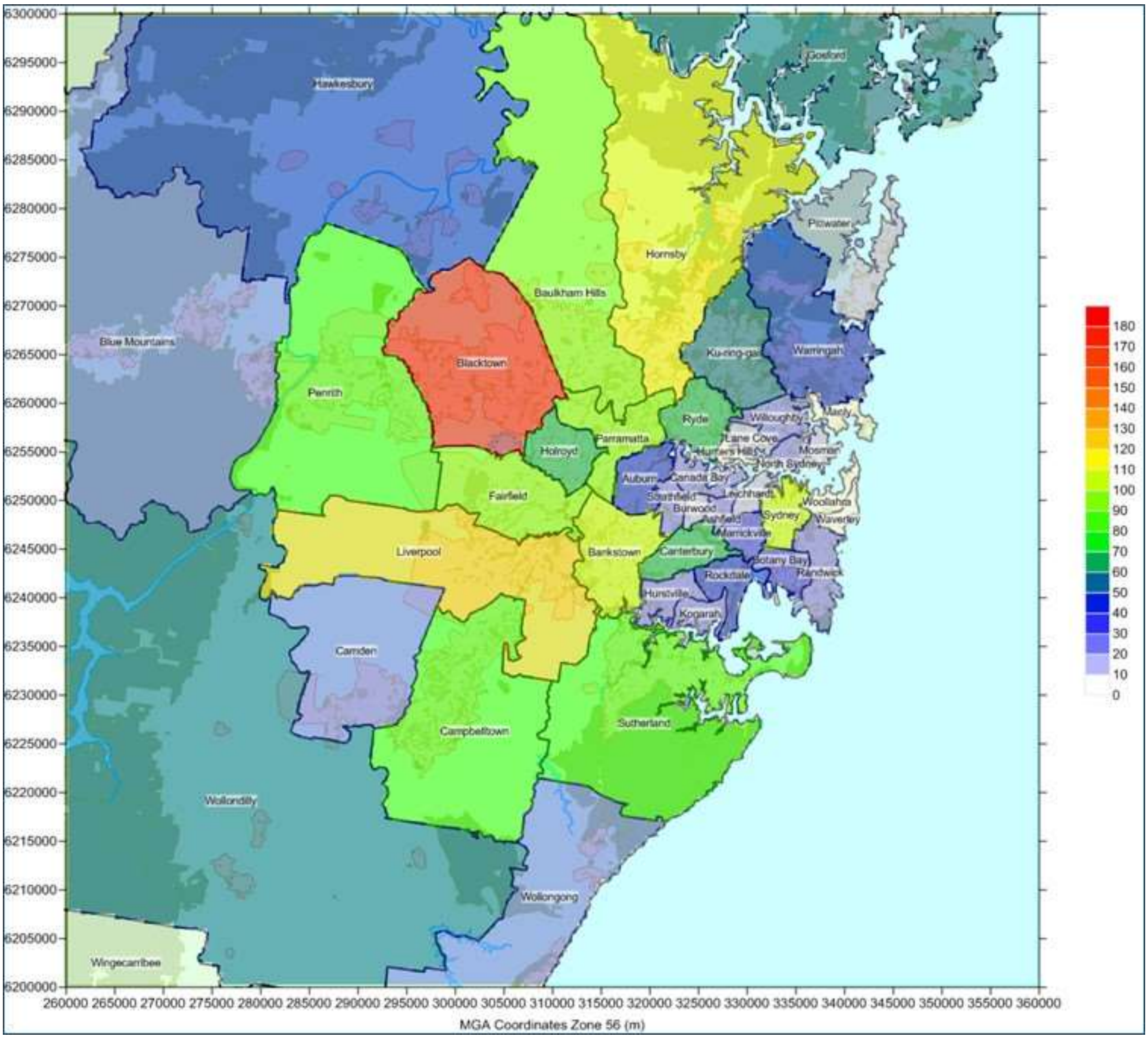


Figure 7-6: PM_{10} On-Road mobile emissions per LGA without Project emissions, tonnes per annum

As there is no discernible change in emissions per LGA, finer scale examination of the distribution of potential impact was conducted using air dispersion modelling, as outlined below.

7.2 Air dispersion modelling results

Three scenarios were modelled, including heavy duty diesel emissions from traffic with and without the Project, and also emissions from locomotives and heavy duty diesel emissions from traffic with the Project.

Emissions were predicted spatially across the region to produce impact assessment contours, and also at EPA NEPM monitoring sites for comparison to measured data.

7.2.1 Predicted impact at NEPM monitoring sites in the Sydney Region

The NSW EPA operates a number of monitoring sites across the Sydney basin. The sites operate per the national NEPM requirements for the purpose of monitoring the potential exposure of the population to pollutants. These sites are specifically positioned to provide an indicator of the air quality that the majority of the Sydney population would be exposed to.

To assess the potential effects of the Project on the population of Sydney, predictions of the additional impact that the Project could have were made at each of the EPA monitoring stations.

The results are presented in **Table 7-3** alongside the measured data in 2011 and the additional impact that would arise in 2031 both with and without the project. It can be seen that the Project would have no tangible effect on the population exposure to pollutants across Sydney.

Table 7-3: Modelling predictions at NSW EPA (NEPM) monitoring sites

Measured 2011 levels and additional future impact due to the project															
		Bargo	Bringelly	Chullora	Earlwood	Lindfield	Liverpool	Macarthur	Oakdale	Prospect	Randwick	Richmond	Rozelle	St Marys	Vineyard
Max NO_2 1-hr ave. (µg/m³)	Measured	86.5	54.5	95.9	86.5	75.2	86.5	84.6	50.8	73.3	99.6	54.5	94	67.7	69.6
	Additional impact, in 2031, Without	0.01	0.13	0.26	0.15	0.22	0.26	0.23	0.02	0.29	0.18	0.08	0.27	0.13	0.12
	Additional impact, in 2031 With	0.01	0.14	0.27	0.17	0.21	0.37	0.23	0.02	0.27	0.17	0.08	0.27	0.12	0.13
	Change due to Project (%)	0.00	0.02	0.00	0.03	-0.01	0.13	0.00	0.00	-0.02	-0.01	0.00	0.00	0.00	0.01
NO_2 Ann. ave. (µg/m³)	Measured	8.7	9	24.5	17.4	18.4	18.2	14.6	3.4	19.5	14	9.6	20.9	10.8	11
	Additional impact, in 2031, Without	0.00	0.03	0.10	0.05	0.06	0.09	0.07	0.00	0.11	0.02	0.01	0.07	0.03	0.03
	Additional impact, in 2031 With	0.00	0.01	0.05	0.02	0.02	0.05	0.03	0.00	0.04	0.01	0.01	0.03	0.01	0.01
	Change due to Project (%)	-0.01	-0.16	-0.21	-0.14	-0.21	-0.22	-0.28	-0.06	-0.33	-0.09	-0.08	-0.20	-0.19	-0.19
Max PM_{10} 24-hr ave. (µg/m³)	Measured	89.7	86	65.2	124.9	35.7	68.8	38.1	54.7	41.5	40.1	46.2	39.4	73.9	32.7
	Additional impact, in 2031, Without	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	Additional impact, in 2031 With	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	Change due to Project (%)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PM_{10} Ann. ave. (µg/m³)	Measured	12.9	15.9	19.8	18	13.3	18.1	13.2	10.7	15.8	16	13.2	16.6	14.7	14
	Additional impact, in 2031, Without	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Additional impact, in 2031 With	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Change due to Project (%)	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Max CO 1-hr ave. (mg/m³)	Measured	ND	ND	1.73	ND	ND	2.76	1.27	ND	1.96	ND	ND	1.61	ND	ND
	Additional impact, in 2031, Without	0.01	0.08	0.16	0.09	0.13	0.15	0.14	0.01	0.17	0.1	0.05	0.16	0.07	0.07
	Additional impact, in 2031 With	0.01	0.08	0.19	0.13	0.13	0.35	0.14	0.01	0.16	0.15	0.05	0.18	0.07	0.08
	Change due to Project (%)	-	-	1.90	-	-	7.21	0.55	-	-0.52	-	-	1.25	-	-

7.2.2 Predicted impact spatially across the Sydney Region

Estimated air pollutant levels with and without the Project are shown in the figures in the appendices.

It is important to note that for clarity, the concentration scale in each figure may differ, hence care needs to be taken when making any comparisons between the figures.

The key findings of the study are presented below, using NO_2 and PM_{10} levels to illustrate the trends that may occur as a result of the Project. A generally similar trend would occur for the other pollutants related to the Project. It is notable that the interstate rail effects are not discernable in the modelling results, largely as there are very few trains traversing a significant length of line.

Figure 7-7 shows that the effect of the Project is to increase 1-hour average NO_2 emissions in the vicinity of the project, but to decrease NO_2 emissions along major roads and the eastern half of the corridor between Port Botany and Moorebank.

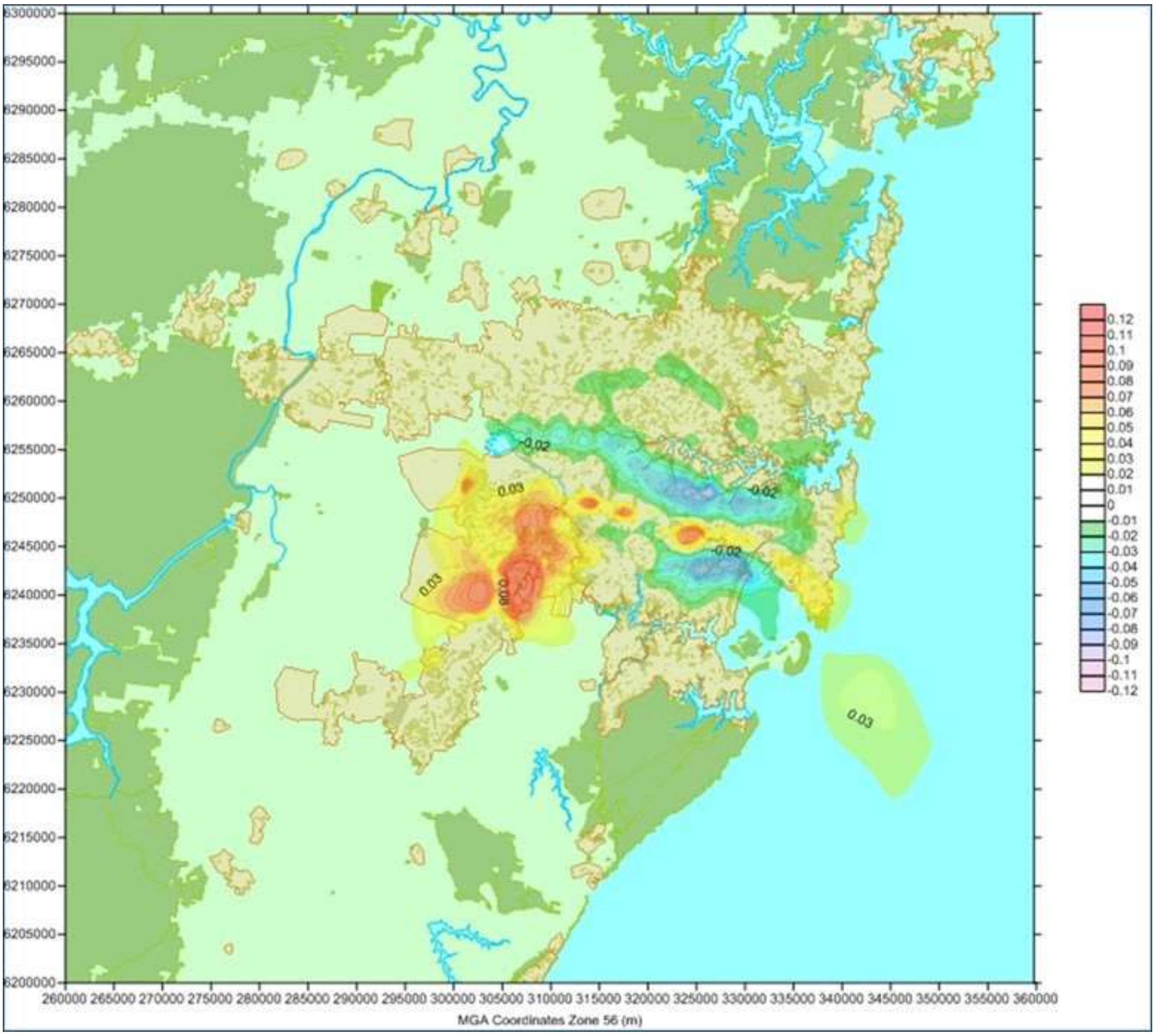


Figure 7-7: Change in NO_2 1-hour average levels due to the Project ($\mu g/m^3$)

The results shown in **Figure 7-7** indicate that the change in 1-hour NO_2 levels is small, ranging from approximately -0.1 to 0.1 µg/m^3, or – 0.04% to 0.04% of the criteria of 246µg/m^3.

Figure 7-8 and **Figure 7-9** show that the effect of the Project is to increase PM_{10} emissions by a small amount in the vicinity of the project site and along the rail corridor and to decrease emissions along main traffic corridors, such as the M4.

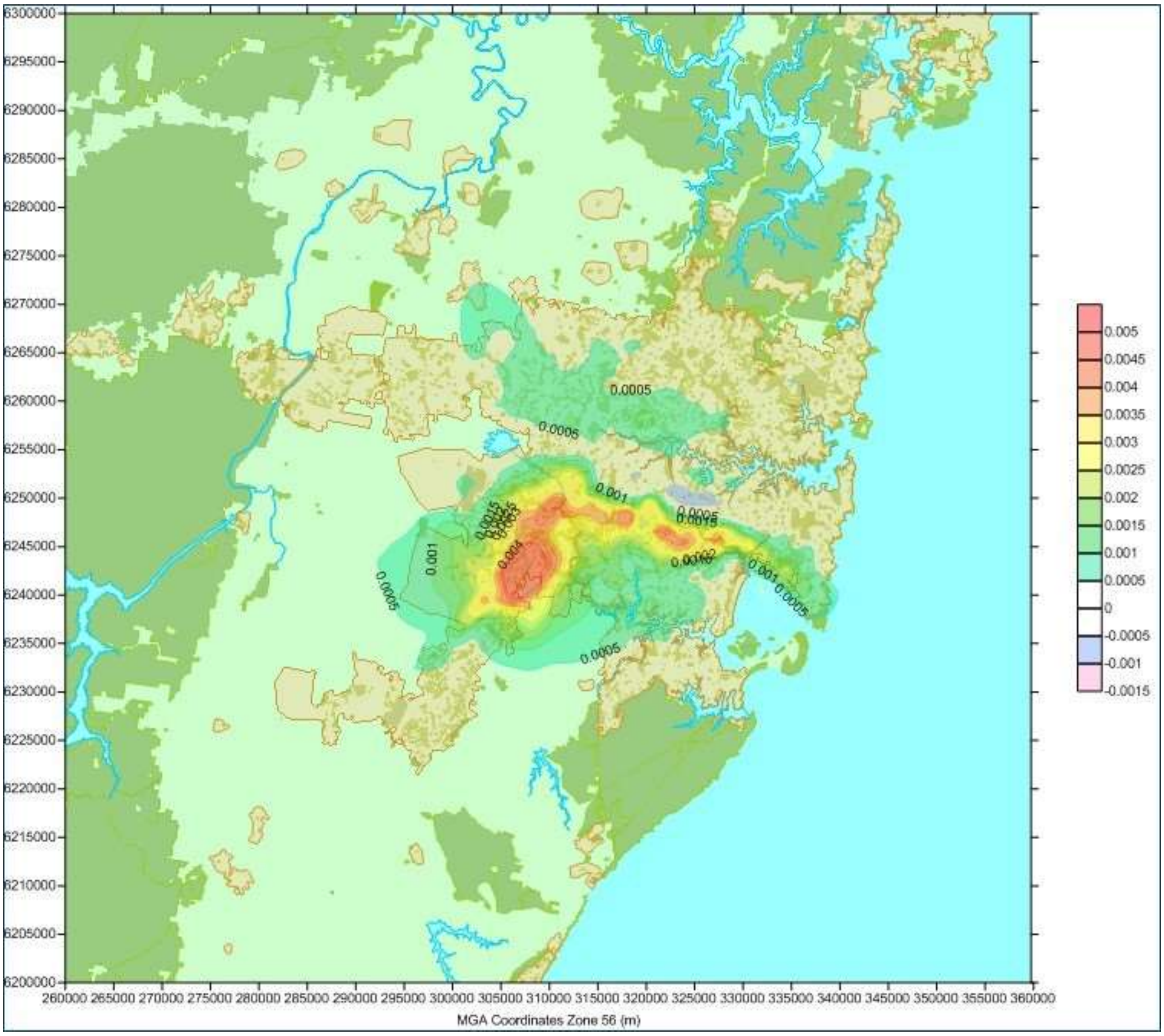


Figure 7-8: Change in PM_{10} 24-hour average levels due to the Project (µg/m^3)

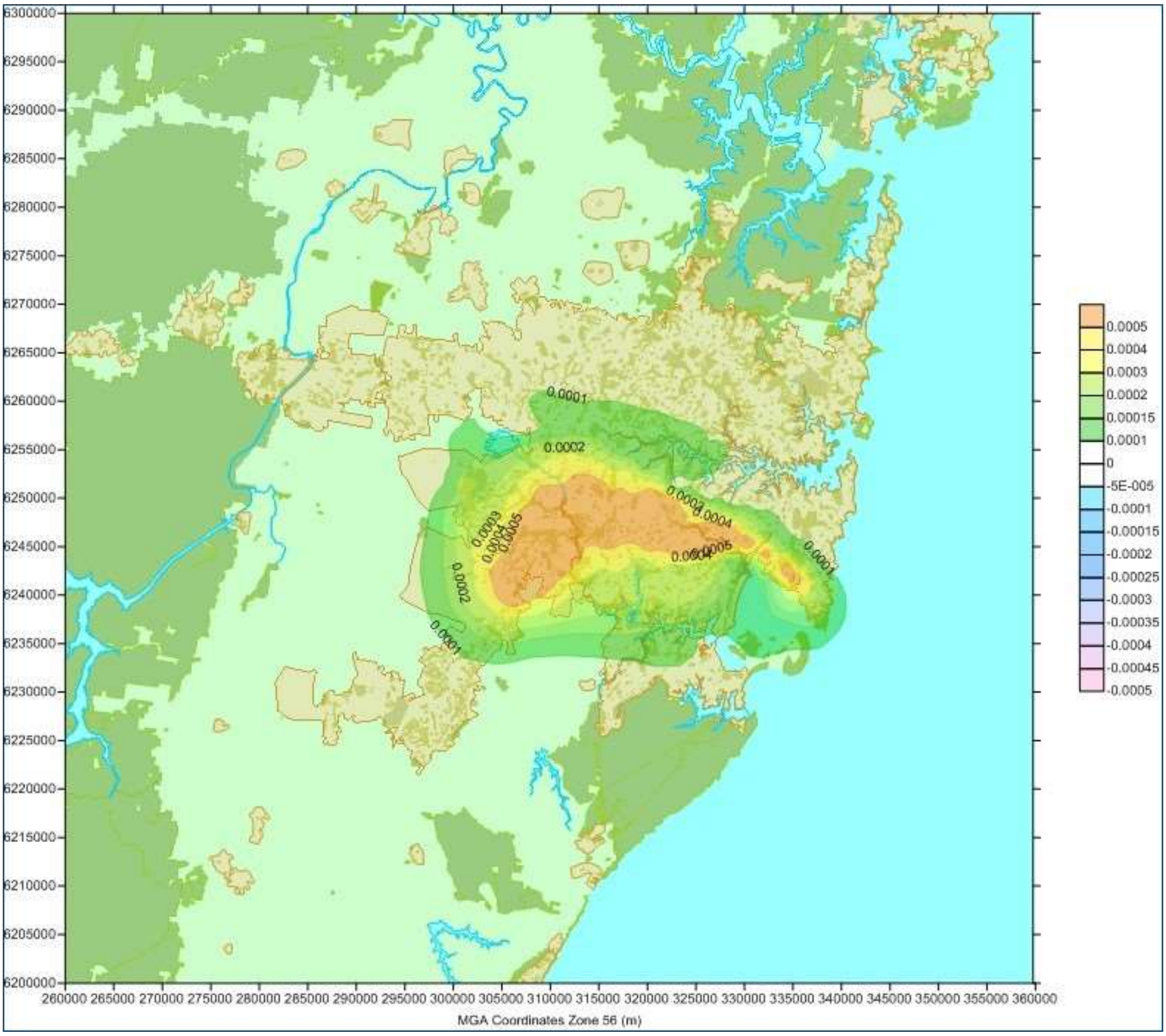


Figure 7-9: Change in PM_{10} annual average levels due to the Project ($\mu g/m^3$)

The results shown in **Figure 7-8** and **Figure 7-9** indicate that the predicted change in PM_{10} emissions is small and are consistent with the small predicted change at the various NEPM monitoring locations.

The Project intends to transfer heavy duty diesel traffic from Sydney roads to rail. The effect of this is to decrease truck emissions along major roads, increase truck emissions near the Project and increase locomotive emissions along the rail line connecting Port Botany and Moorebank, as shown in **Figure 7-7** to **Figure 7-9**.

The results indicate that the level of change at a regional level is small and insignificant, and is confined to the area near the Project, major roads and the rail corridor. The level of impact is significantly smaller across the wider region and is therefore also insignificant.

To examine the relative differences across the region arising from a shift from road to rail transport it was necessary to consider the rail and road emissions separately, and in context with the total results.

Figure 7-10 to **Figure 7-12**, (without the locomotive emissions included) have been presented to illustrate the effect of the project on heavy duty diesel traffic emissions across the region.

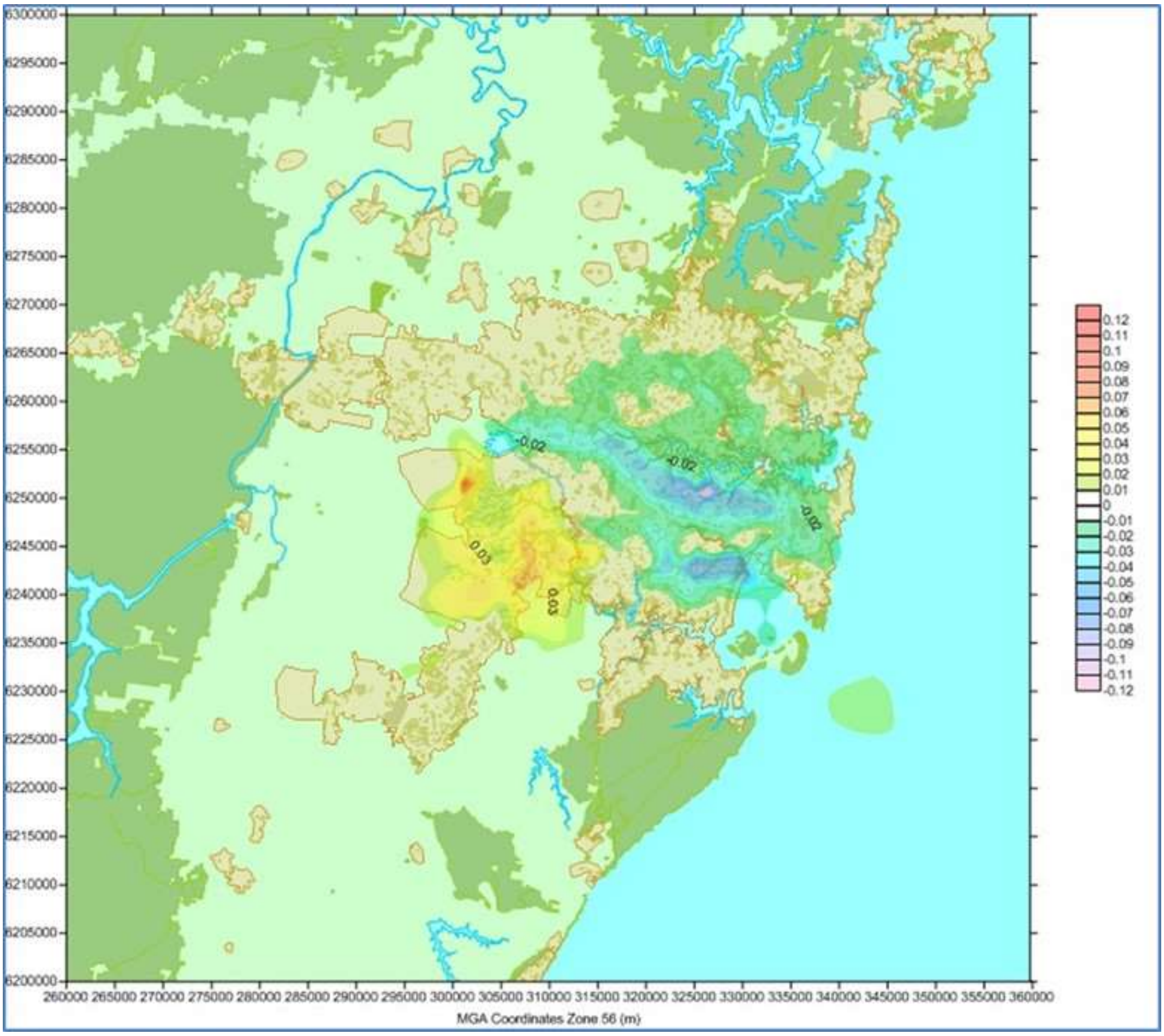


Figure 7-10: Change in NO_2 1-hour average traffic emissions due to the Project (µg/m^3)

There is a small difference between **Figure 7-10** and **Figure 7-7** at the Project site and along the rail corridor, indicating that regional NO_2 emissions are more influenced by traffic, rather than locomotive effects. This can also be seen by considering the small change in levels along the rail corridor due to locomotives which shown in **Figure 7-13**.

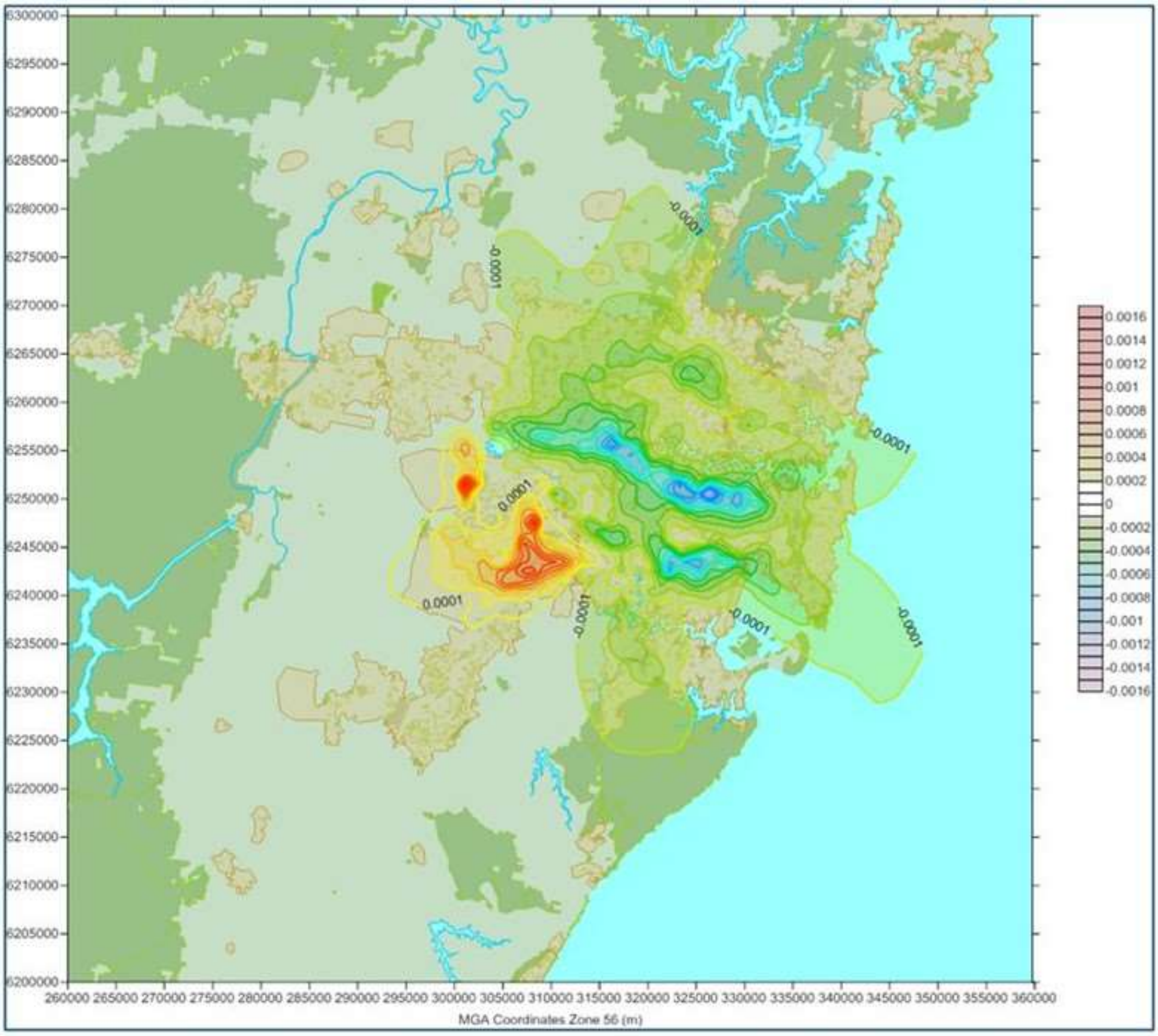


Figure 7-11: Change in PM_{10} 24-hour average traffic emissions due to the Project (µg/m^3)

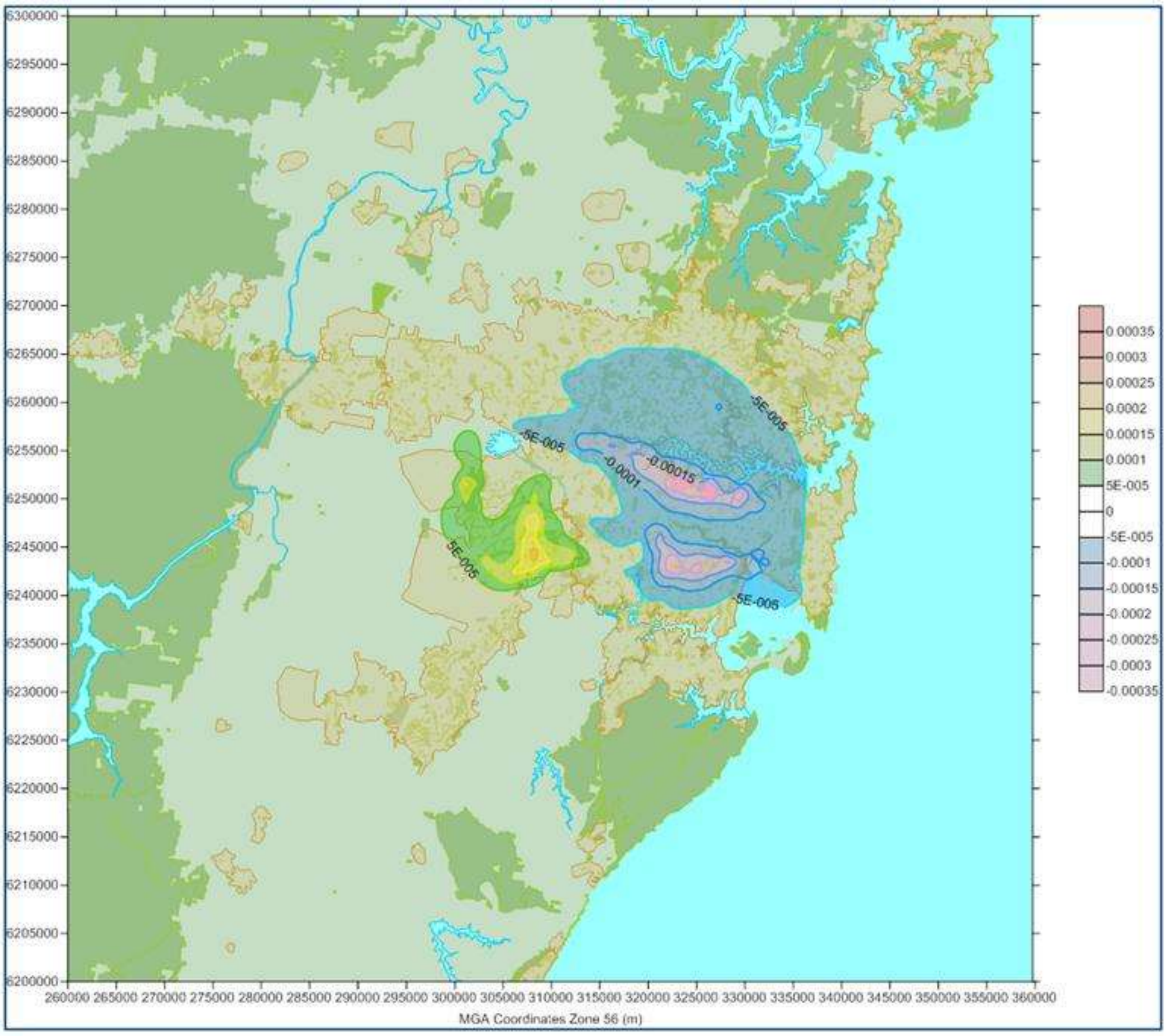


Figure 7-12: Change in PM_{10} annual average heavy duty diesel traffic emissions due to the Project (µg/m^3)

The modelling results presented in **Figure 7-11** and **Figure 7-12** indicate that there would be a net decrease in heavy duty diesel traffic emissions in an area to the west of Port Botany, generally around the M5 Motorway, and also in the area from Strathfield to Prospect generally around the M4 Motorway.

The results also indicate an increase in heavy duty diesel emissions in an area around the Project site at Moorebank, stretching north, east and west along major roads, and also an area north west of the Project site, generally along the M7 Motorway, south of the M4 Motorway.

A similar trend arises for all other heavy duty diesel traffic pollutants, as illustrated in **Appendix A**.

Figure 7-13 to **Figure 7-15**, without the traffic emissions have been presented to illustrate the effect of the project on locomotive emissions across the region.

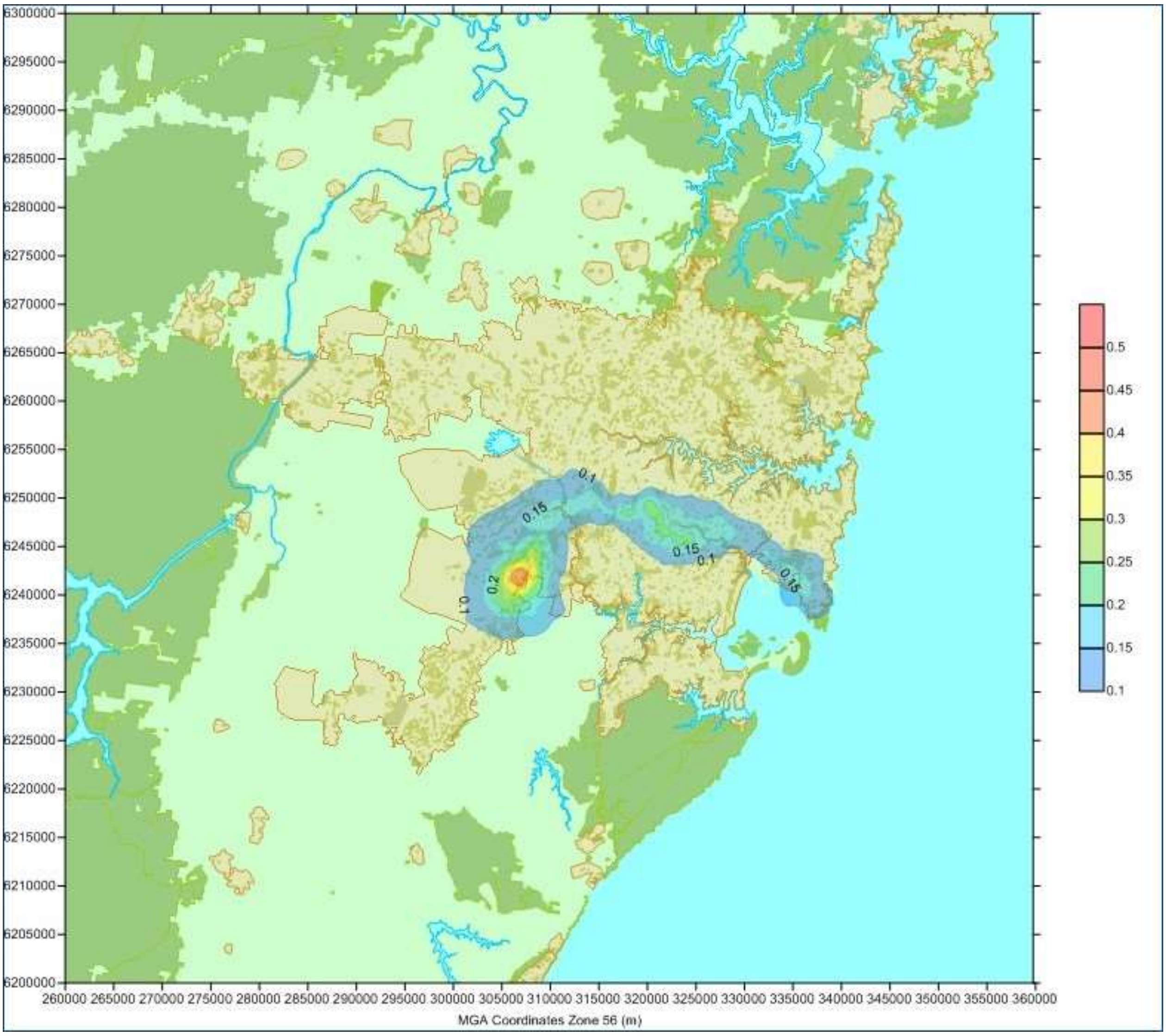


Figure 7-13: Change in NO_2 1-hour average locomotive emissions due to the Project (µg/m³)

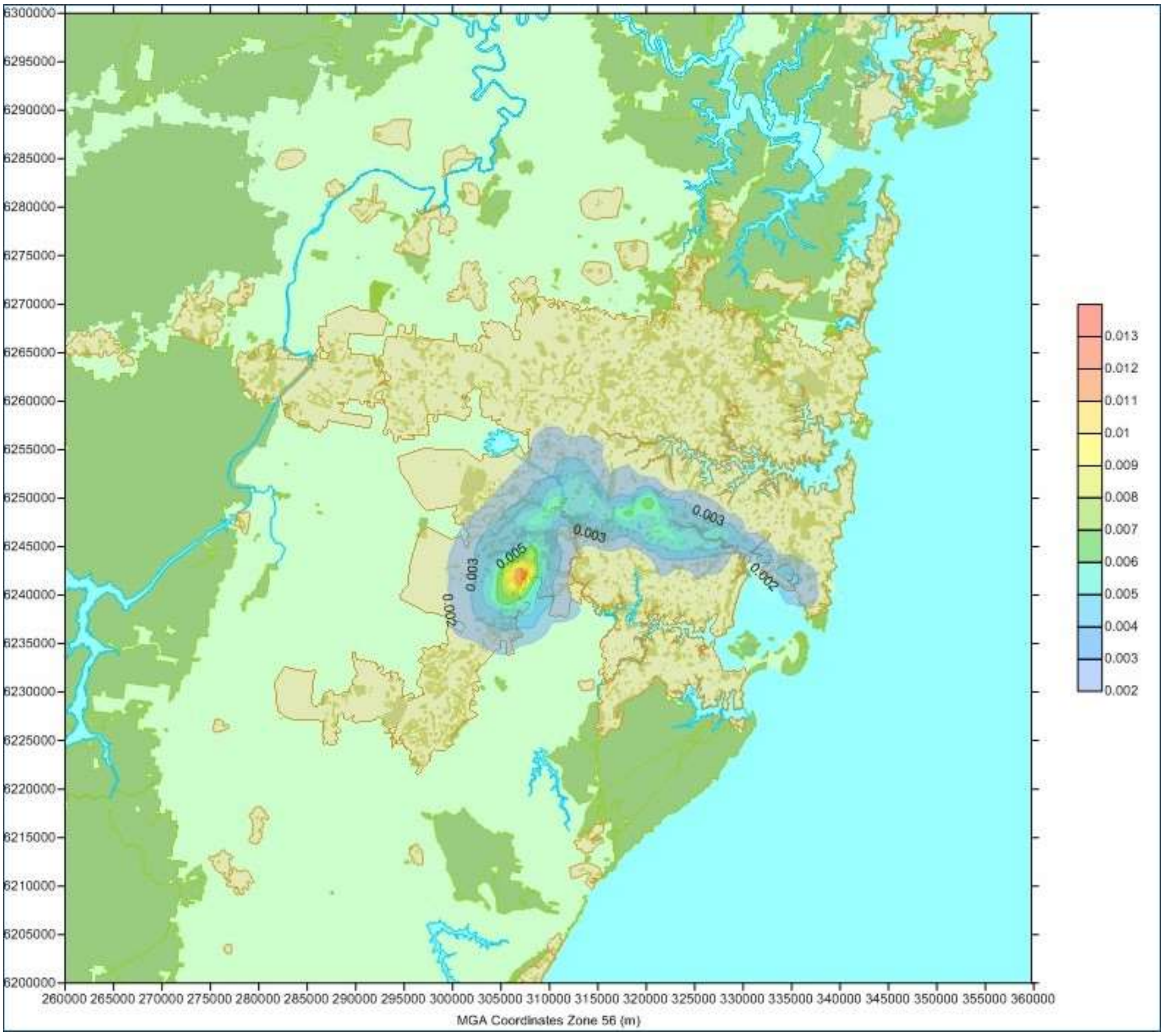


Figure 7-14: Change in PM_{10} 24-hour average locomotive emissions due to the Project (µg/m³)

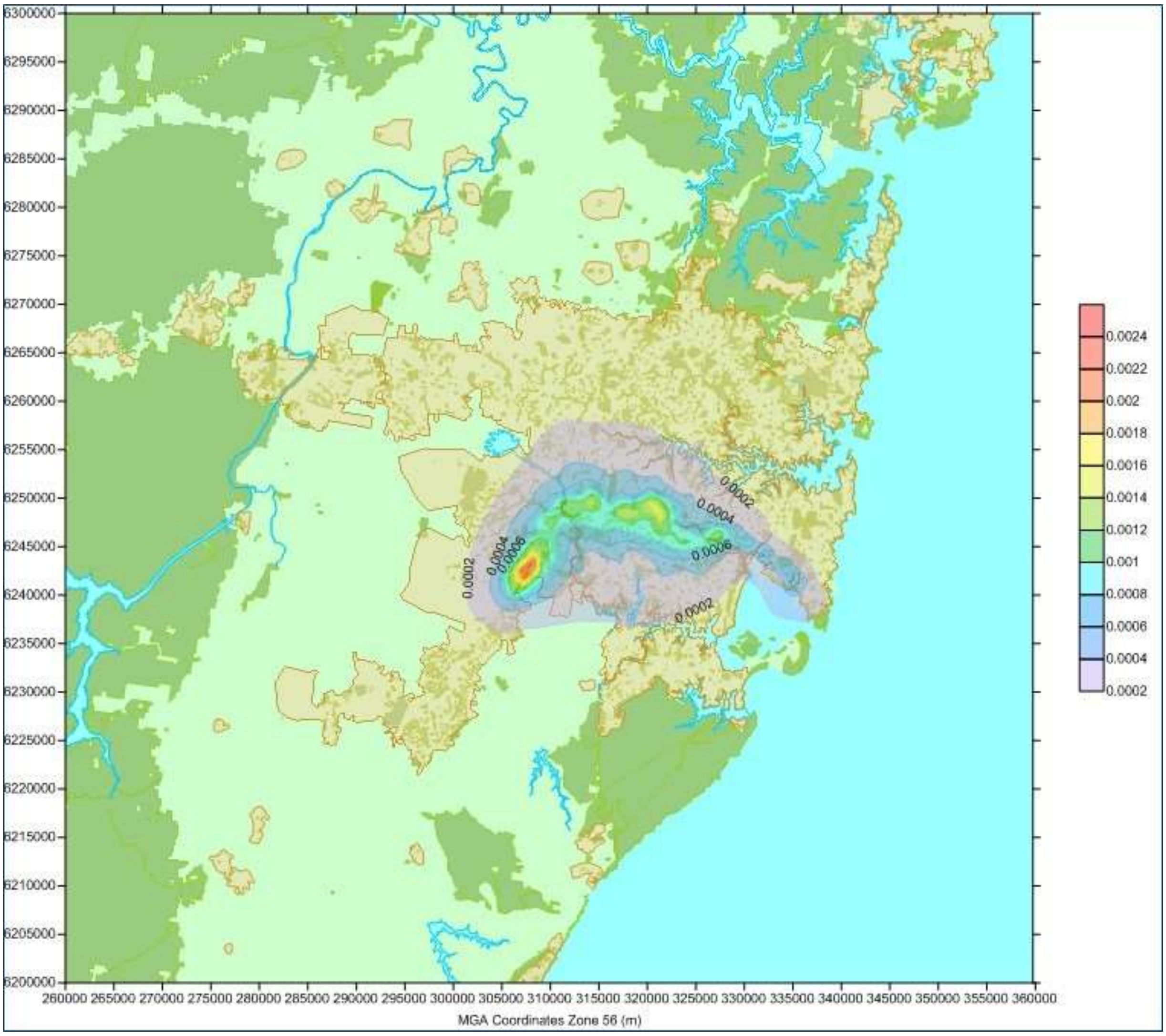


Figure 7-15: Change in PM_{10} annual average locomotive emissions due to the Project ($\mu g/m^3$)

A comparison between the figures for traffic and locomotive emissions shows that generally, the changes due to the Project arise mainly due to changes in heavy vehicle traffic rather than locomotive traffic.

The largest change in predicted impacts due to the Project is small, for example typically the maximum change in annual average PM_{10} is less than 0.003µg/m^3, (or 0.01% of the criteria of 30 µg/m^3 criteria).

The average level of impact across the region is small and can be reasonably considered to be insignificant.

The area along the eastern half of the corridor between Port Botany and Moorebank shows a decrease in traffic emissions and an increase in rail emissions, with the net effect resulting in an overall decrease in 1-hour average NO_2 emissions (approx. -0.1µg/m^3, or -0.04% of the criteria of 246µg/m^3) and a slight increase in annual average PM_{10} emissions (approx. 0.0004, or 0.0013% of the criteria of 30µg/m^3).

Whilst the actual change in emissions is small and can be reasonably considered to be insignificant, it is noted that for toxic pollutants any exposure should be minimised. In this regard, as for NO_2 and PM_{10}, the results are mixed, with some increases and some decreases in emissions. This is due to the relative difference in such emissions from locomotives and heavy duty diesel trucks. The extent of the area that would experience a change in emissions (i.e. the population exposure) is relevant in this regard.

8 DISCUSSION

The project has been assessed using conservative assumptions that tend to overestimate locomotive emissions. Regardless, the results show that the project would have a negligible effect on air emissions across the Sydney basin when it reaches full operation in 2031.

The largest calculated effect is predicted to be a 0.03% decrease in NO_x emissions released into the Sydney air shed, and there is no net predicted increase in other pollutant emissions that are quantified for the whole of the Sydney region, as shown in **Table 7-2**.

The change in emissions due to the project arises due to a reduction of approximately 25 million kilometres per annum travelled by heavy diesel trucks on Sydney roads, and an increase of approximately 20 trains per day travelling between Port Botany and Moorebank.

The main regional effect on air quality due to the Project is small and arises from a decrease in emissions from heavy diesel vehicles in most LGAs and an increase in locomotive emissions between Port Botany and Moorebank. There is also an increase in emissions from heavy diesel vehicles in the general area of the Project. It is notable that the interstate rail effects are not discernable in the modelling results, largely as there are very few trains traversing a significant length of line.

Table 7-3 shows the predicted maximum air quality pollutant levels due to the Project in 2031 at the NSW EPA NEPM monitoring sites. The analysis in **Figure 4-7** to **Figure 4-9** shows that the Sydney NEPM monitoring sites all display a similar trend over time and are therefore considered to represent the underlying levels of pollutants in Sydney. The results in **Table 7-3** are thus representative of the underlying baseline exposure level of the population.

The results show that the operation of the Project would have a negligible effect on the air quality levels that the Sydney Population would be exposed to, relative to the measured levels of air pollutants. The greatest change at a NEPM monitoring location is predicted to occur at the Prospect monitor and the Liverpool monitor, with a decrease in the NO_2 annual average levels measured in 2011 of 0.33% and 0.22% respectively. The maximum increase in potential impacts occurs at the Liverpool and Earlwood monitoring stations, with an increase in the NO_2 1-hour average levels measured in 2011 of 0.13% and 0.03% respectively. Notably, there is zero predicted change in PM_{10} levels at every NEPM monitoring station apart from Liverpool, where a 0.01% increase is predicted. These changes in maximum predicted impacts are insignificant in relation to population exposure.

The effect of the project spatially across the Sydney region is illustrated in the figures in **Appendix A** and also in more detail in **Figure 7-7** to **Figure 7-15**.

The effect of the Project on traffic emissions alone was examined, as shown in **Figure 7-11** and **Figure 7-12**. The results indicate that there would be a net decrease in traffic emissions to the west of Port Botany around the M5 Motorway, and around the M4 Motorway between Strathfield and Prospect, and a minor decrease around the M2 Motorway. The results also indicate an increase around the Project site at Moorebank, stretching north, east and west along major roads, and along the M7 Motorway, south of the M4 Motorway.

The results indicate an increase in emissions along the western section of the transport corridor between Port Botany and Moorebank, but a decrease in emissions along the eastern section. This arises as the increase in rail emissions along this corridor is offset by the reduction in heavy duty diesel emission along the eastern portion of the corridor. However the net change is small. For example, the maximum net increase in 24-hour PM_{10} levels along the corridor, as shown in **Figure 7-9** is approximately 0.003 $\mu g/m^3$, (or 0.01% of the criteria of $30\mu g/m^3$ criteria). This level of change is small, and is confined to the area near the rail corridor and the Project site. The average level of impact is significantly smaller across the region and can also be reasonably considered as insignificant.

The results indicate that the effect of the Project on pollutant concentrations in the ambient air at a regional level is negligible, and that generally, whilst some areas may have a small increase in emissions other areas would experience a decrease in emissions. Overall, the indication is that the Project would not result in any significant change in regional air quality.

9 CONCLUSIONS

It can be concluded that the predicted impacts of the project on regional air quality in Sydney are insignificant.

There is no observable effect in the results due to additional interstate trains, and the project is predicted to slightly increase impacts along roads near Moorebank and the western part of the corridor from Port Botany to Moorebank, and to decrease emissions along the eastern part of this corridor, together with a decrease in emissions around most major roads such as the M5, M4 and M2 Motorways..

However the most significant finding is that the maximum change in emissions due to the Project on a regional level is small and is unlikely to be discernible in comparison to pollutant levels that would occur with or without the Project.

On this basis it is concluded that the project would have no significant effect on the regional air quality in Sydney.

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Appendix A

Results

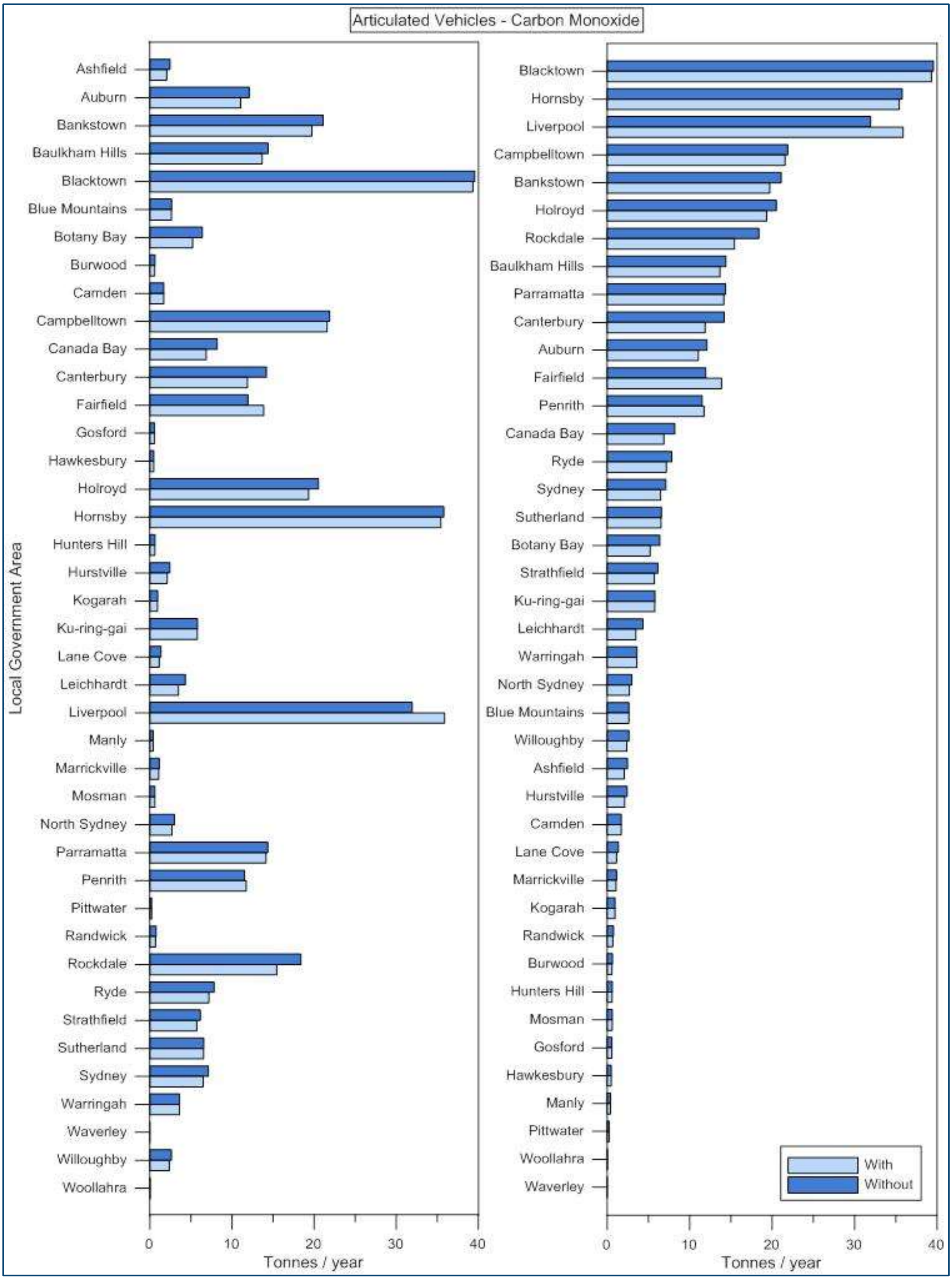

Figure A-1: CO emissions associated with container transport by road in Sydney

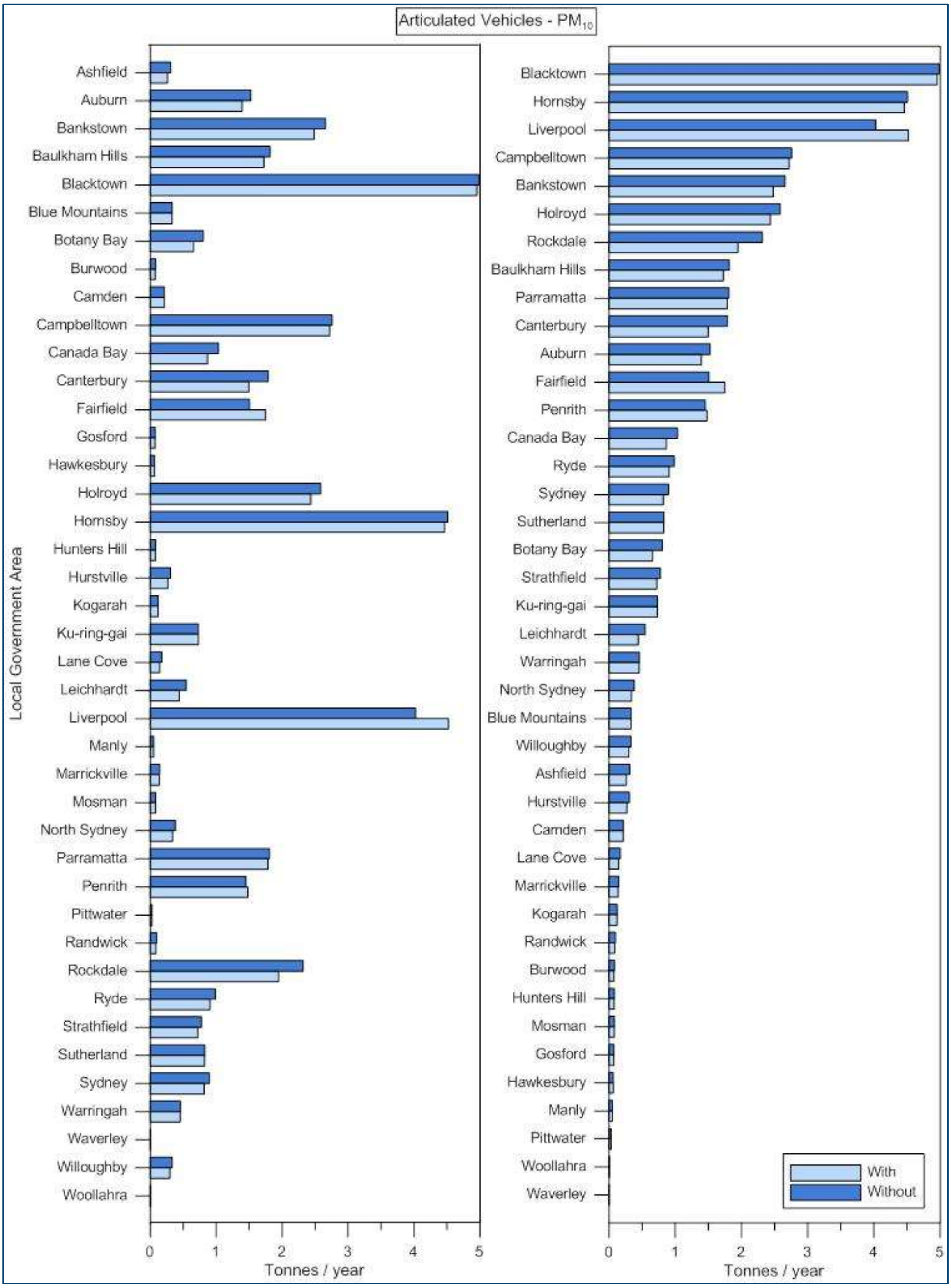

Figure A-2: PM$_{10}$ emissions associated with container transport by road in Sydney

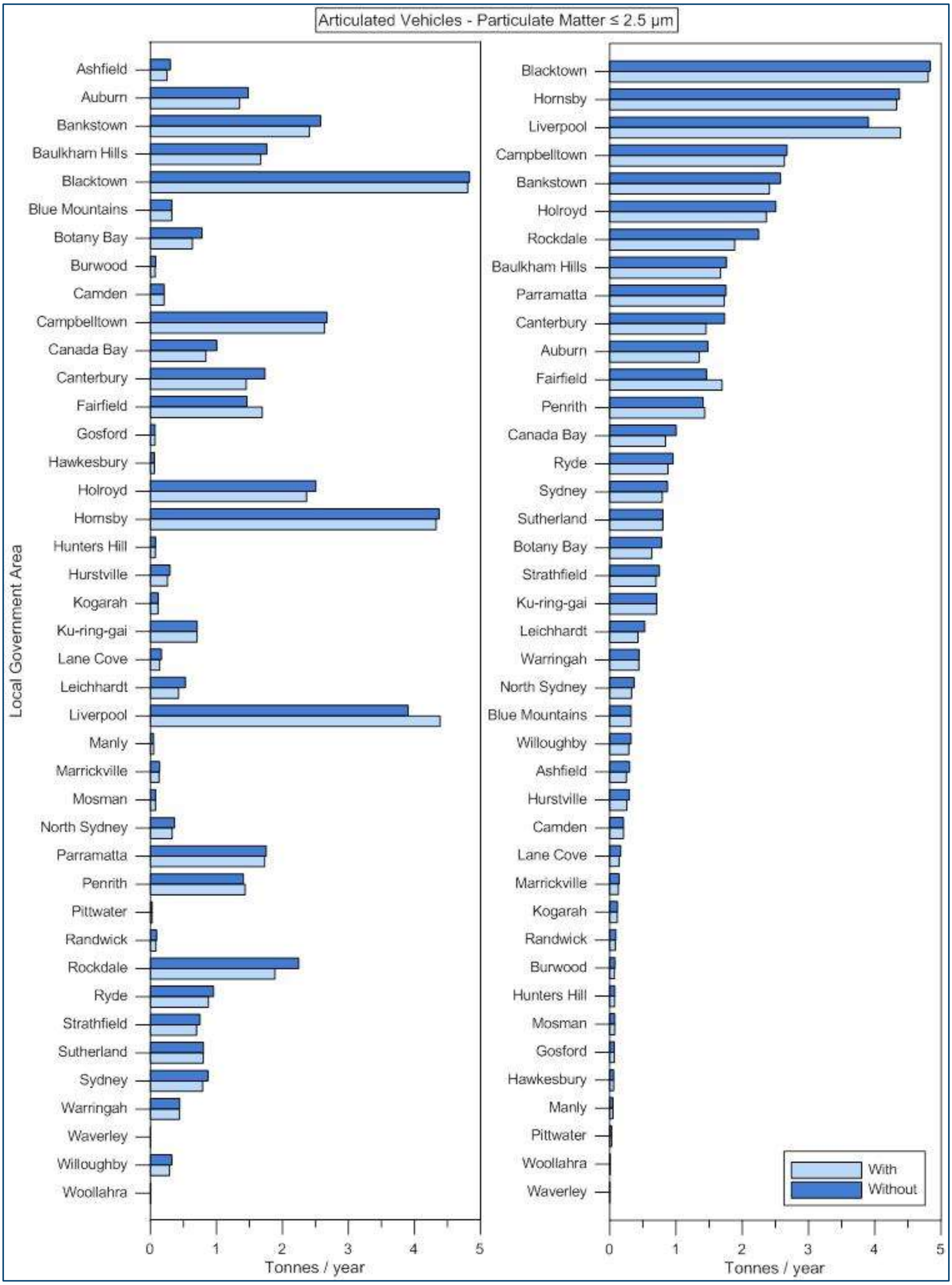

Figure A-3: PM25 emissions associated with container transport by road in Sydney

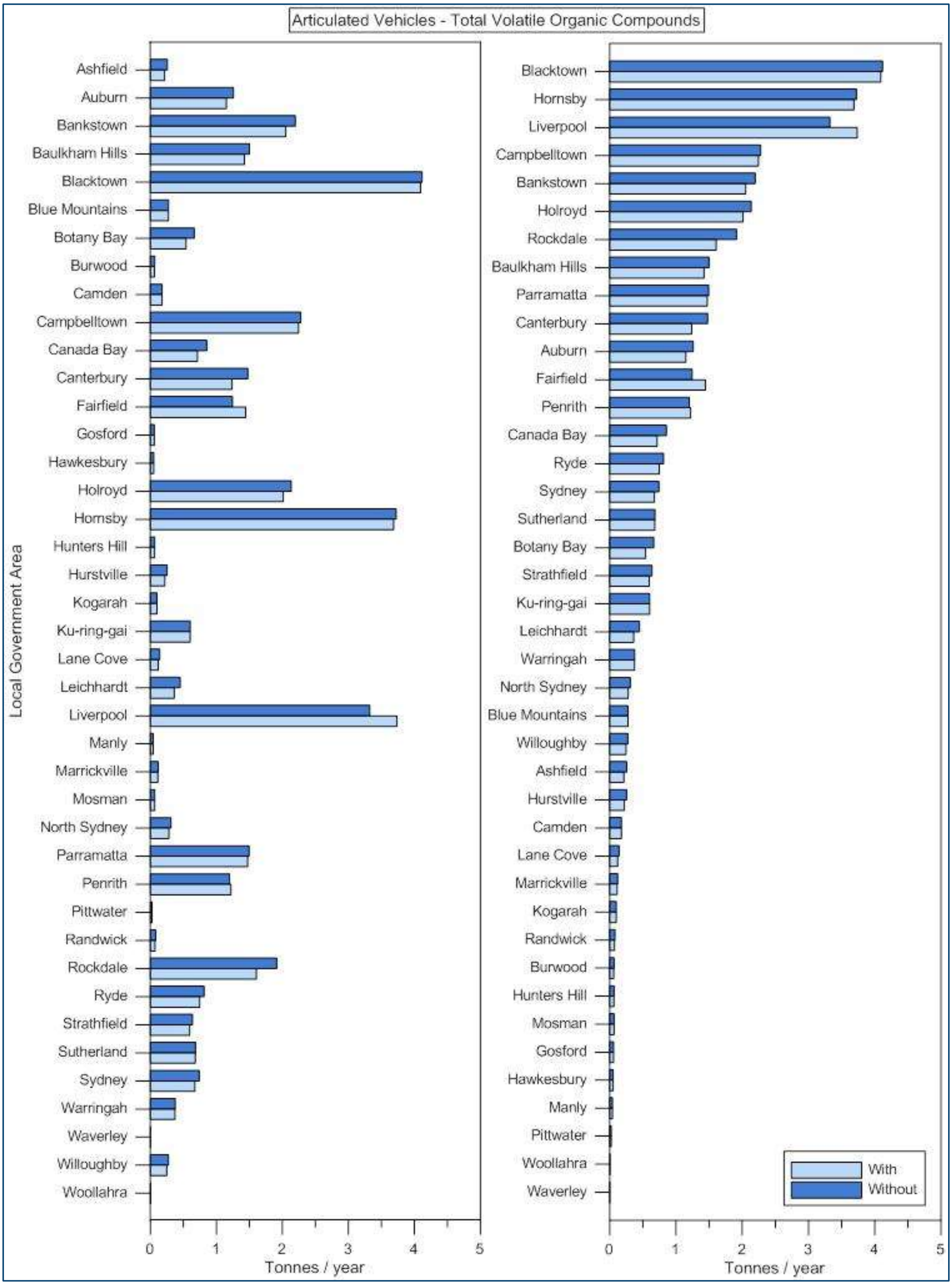

Figure A-4: VOC emissions associated with container transport by road in Sydney

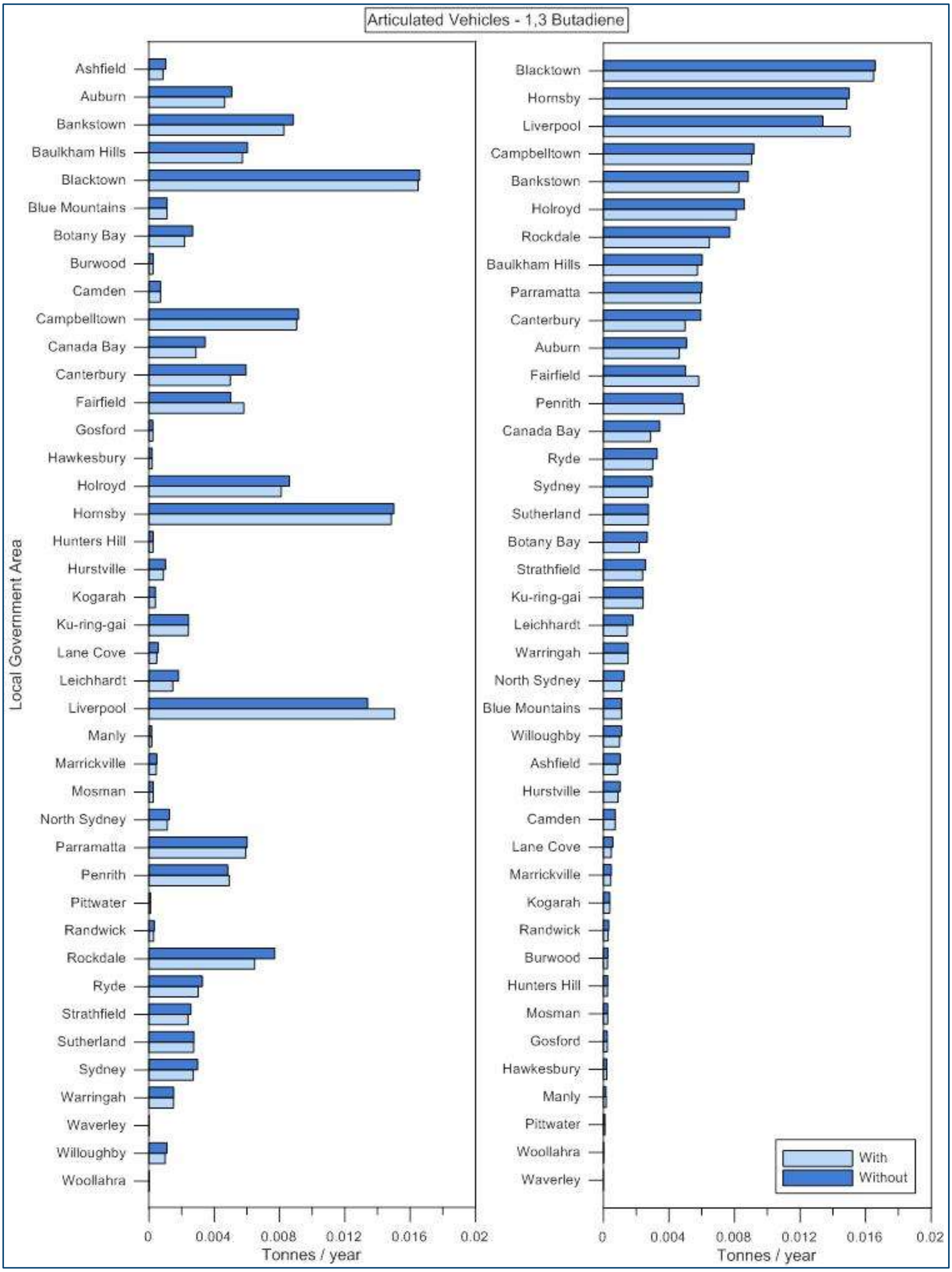

Figure A-5: 1,3 Butadiene emissions associated with container transport by road in Sydney

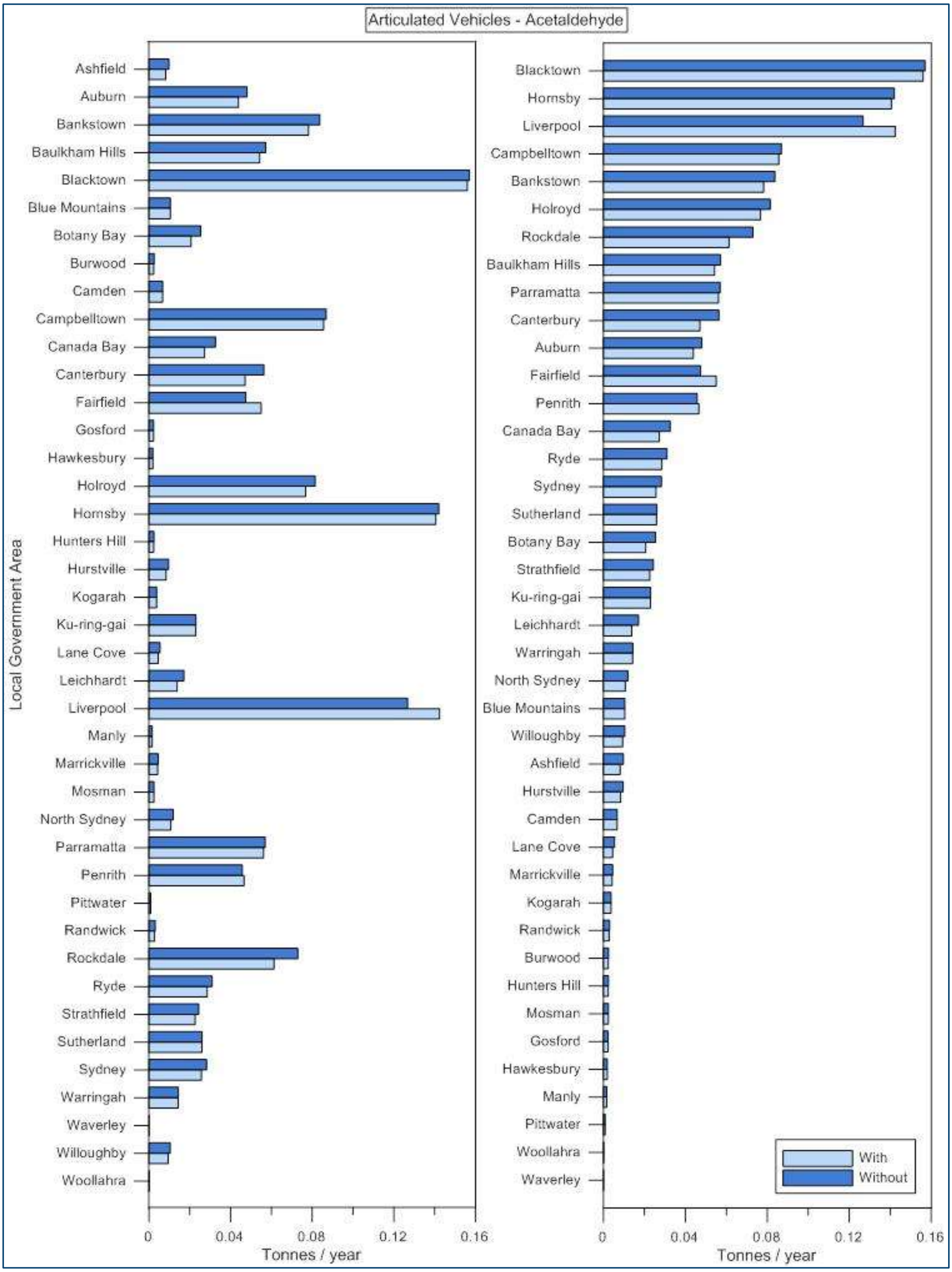

Figure A-6: Acetaldehyde emissions associated with container transport by road in Sydney

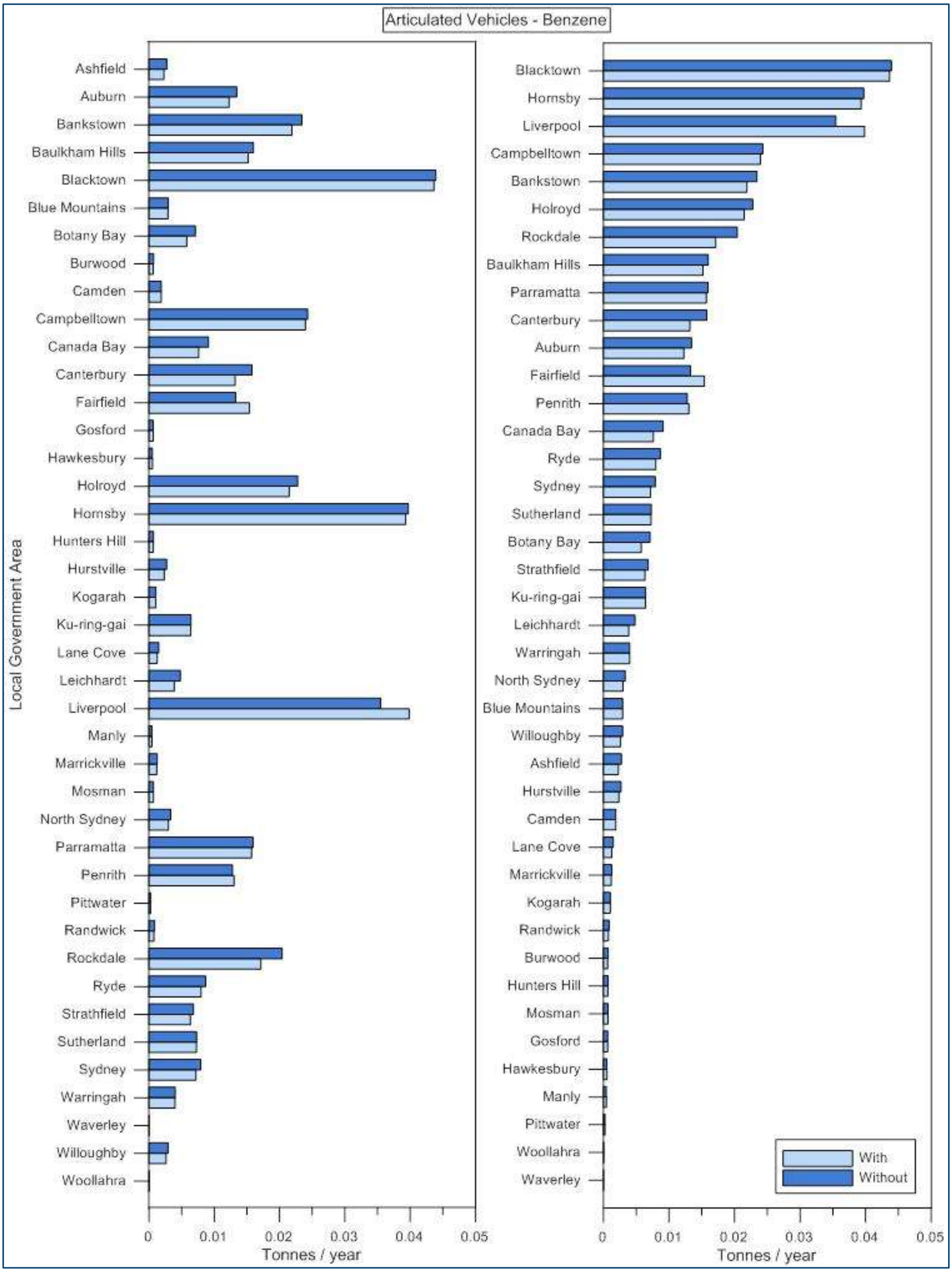

Figure A-7: Benzene emissions associated with container transport by road in Sydney

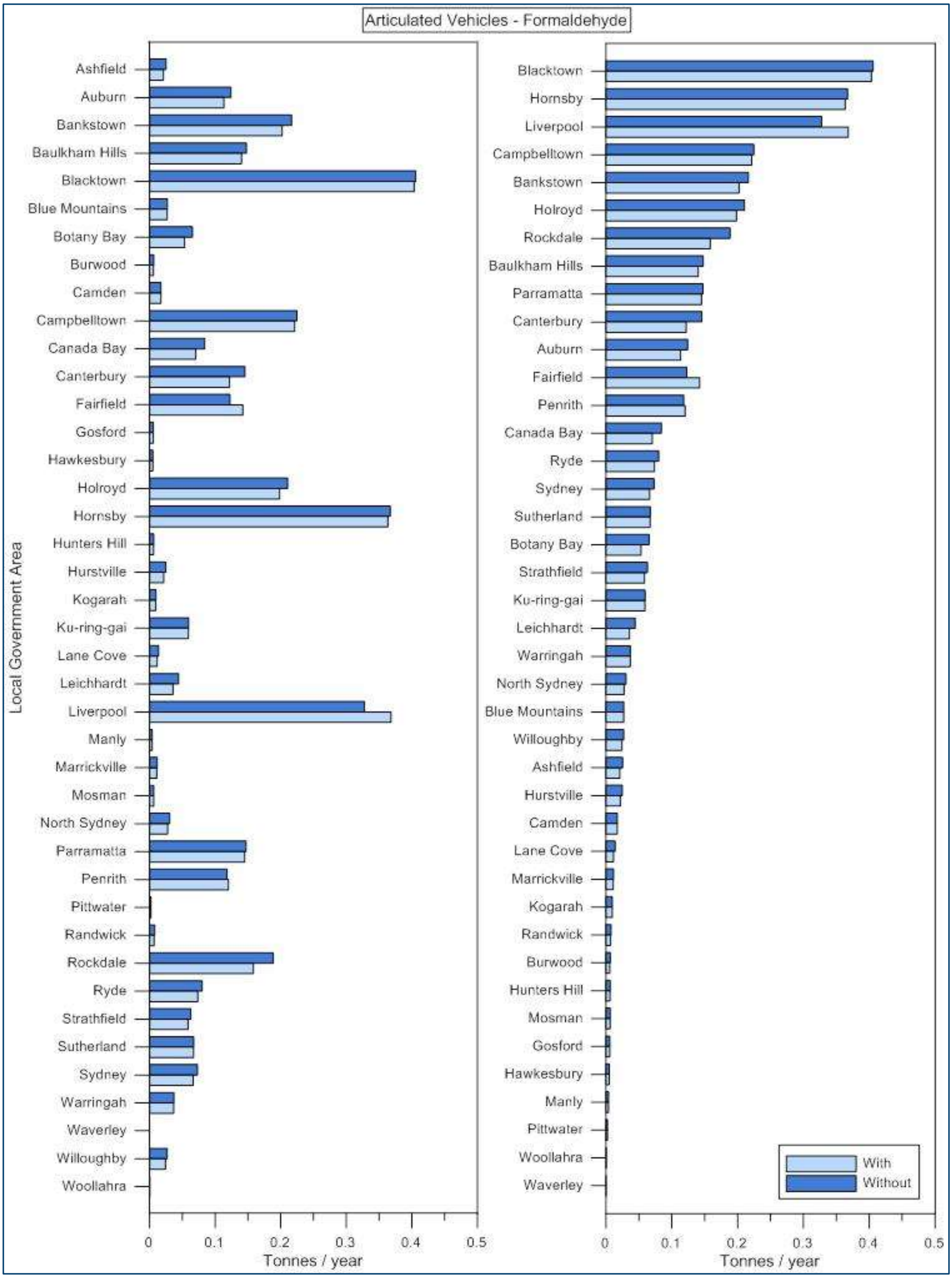

Figure A-8: Formaldehyde emissions associated with container transport by road in Sydney

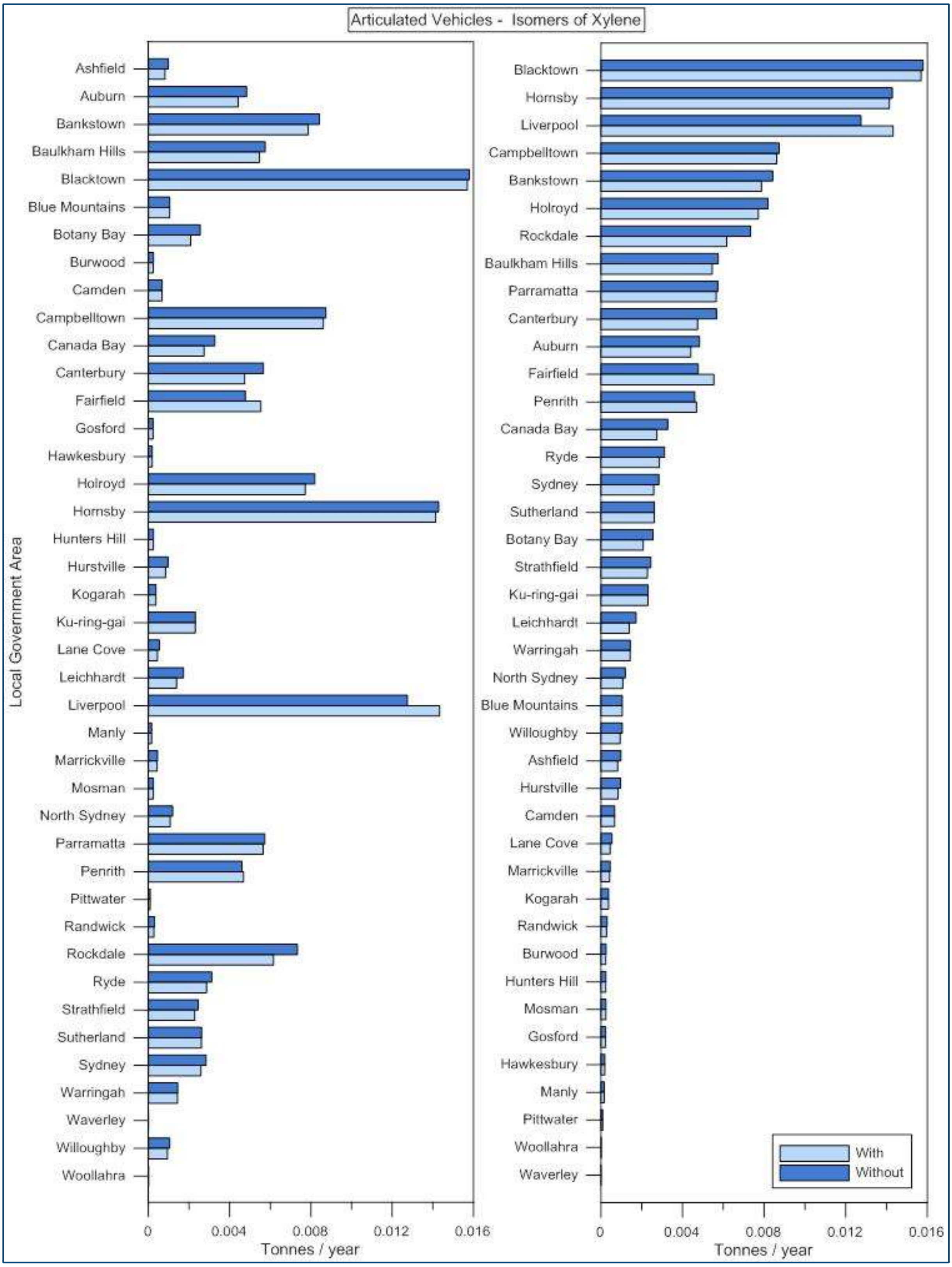

Figure A-9: Isomers of xylene emissions associated with container transport by road in Sydney

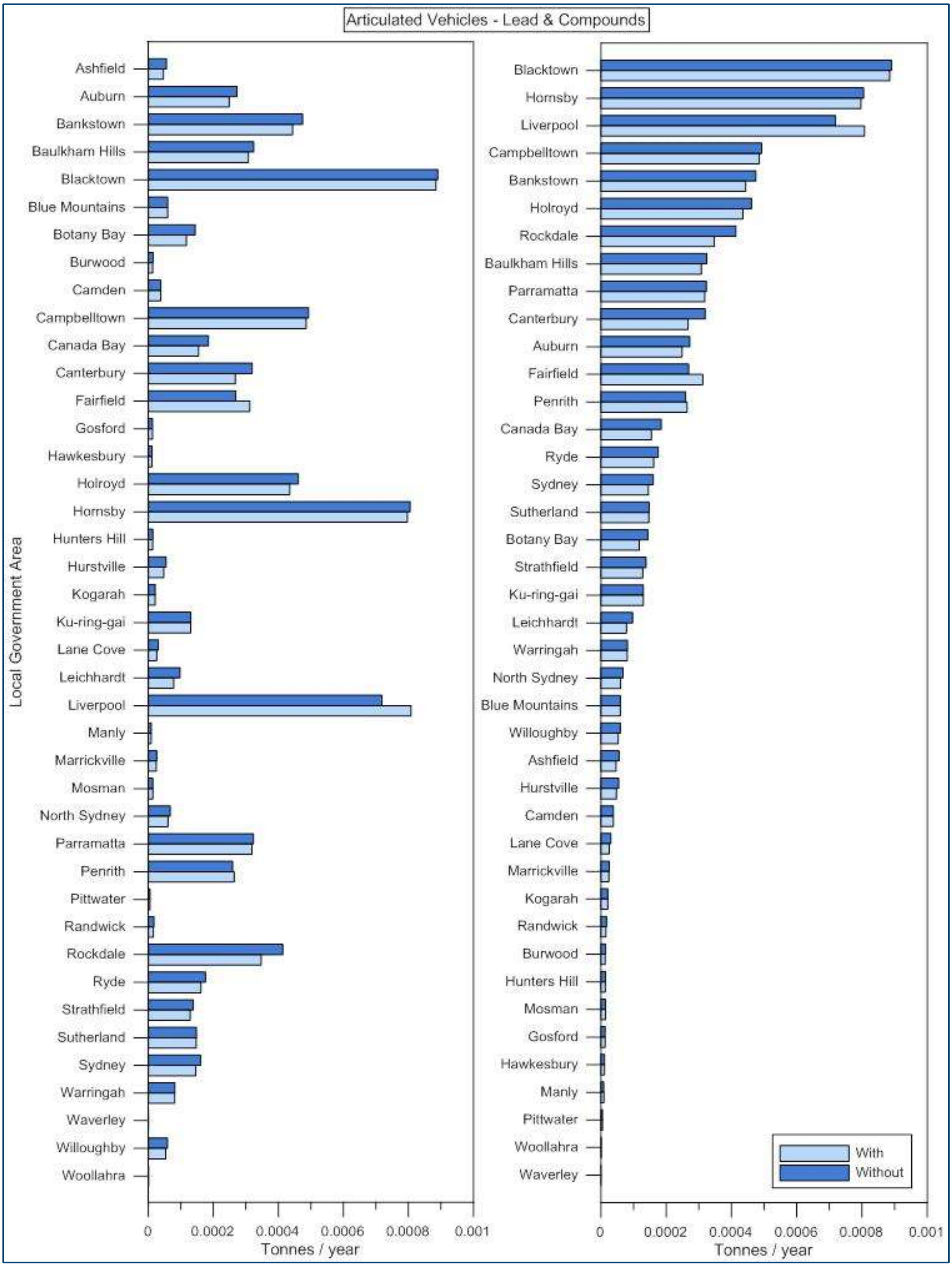

Figure A-10: Lead & compounds emissions associated with container transport by road in Sydney

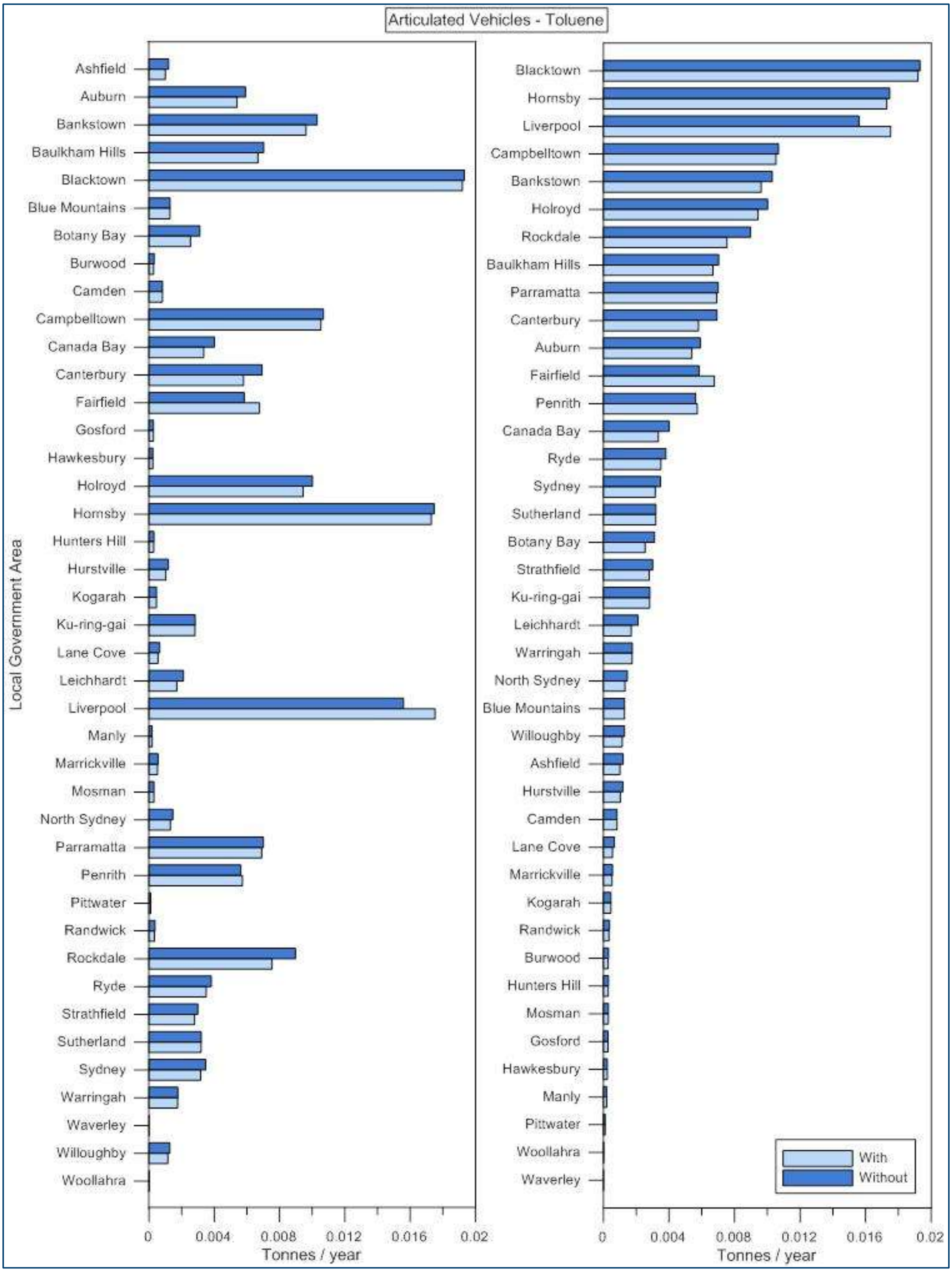

Figure A-11: Toluene emissions associated with container transport by road in Sydney

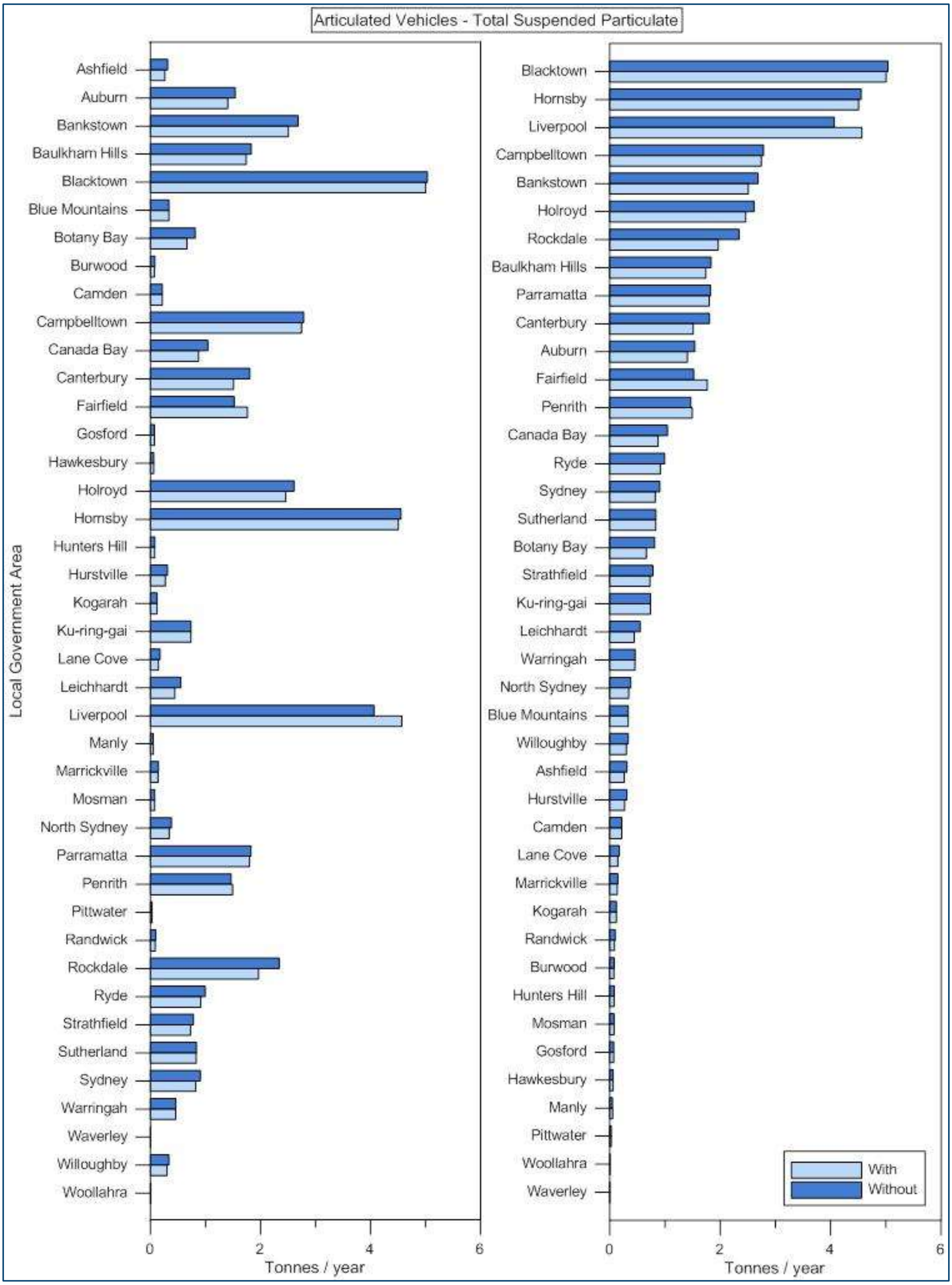

Figure A-12: TSP emissions associated with container transport by road in Sydney

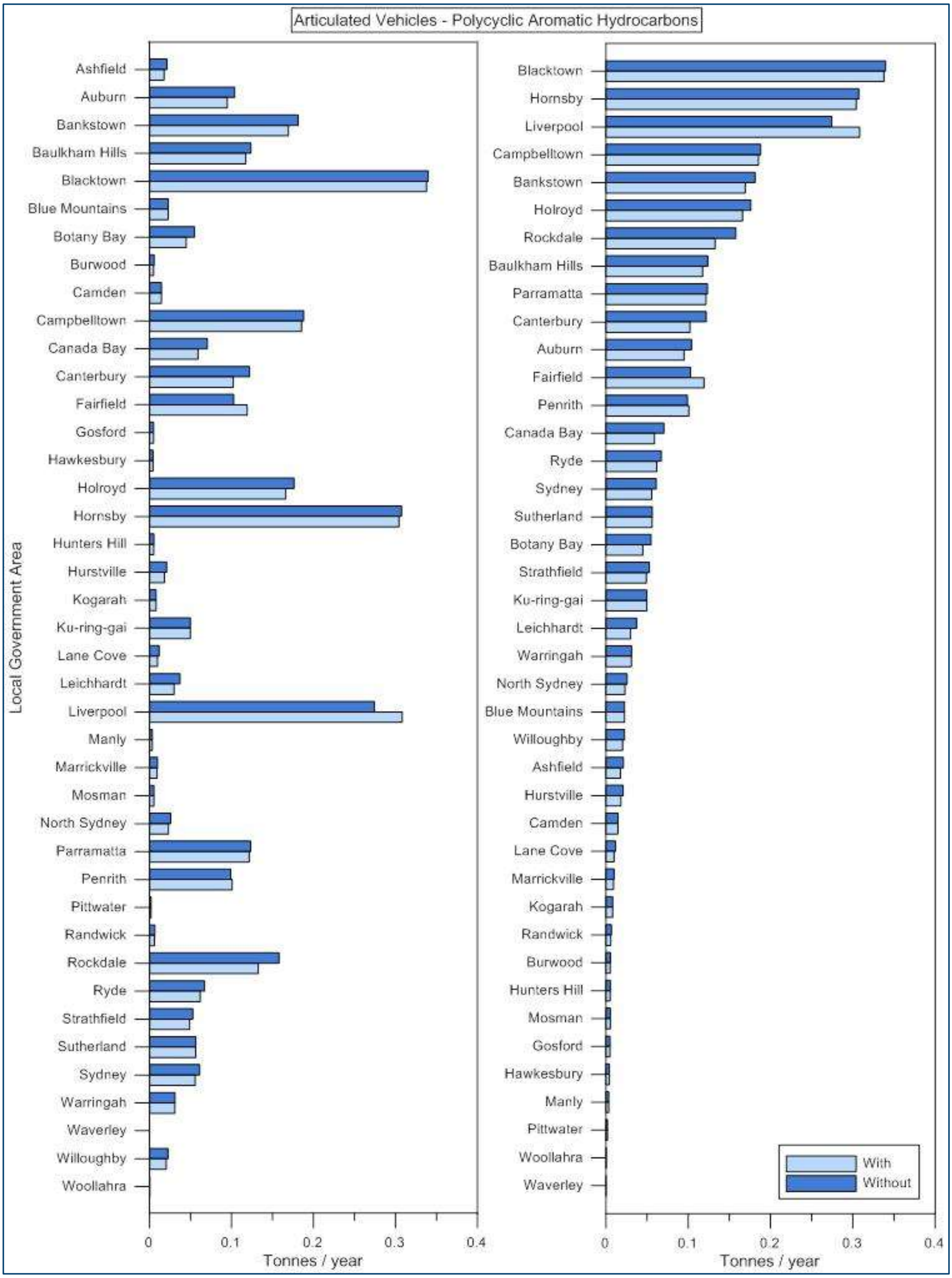

Figure A-13: PAH emissions associated with container transport by road in Sydney

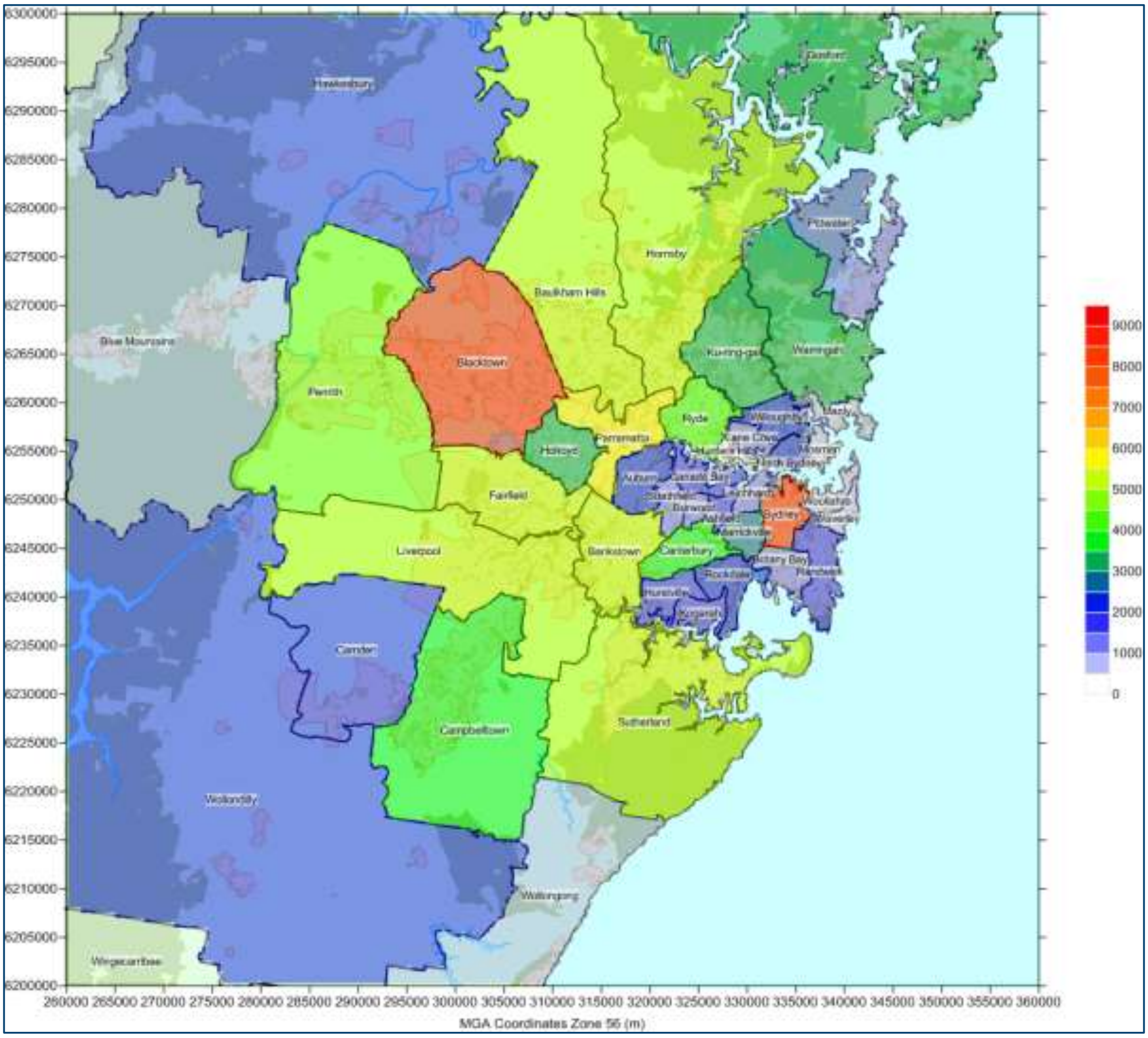

Figure A-14: CO On-Road mobile emissions per LGA with Project emissions, tonnes per annum

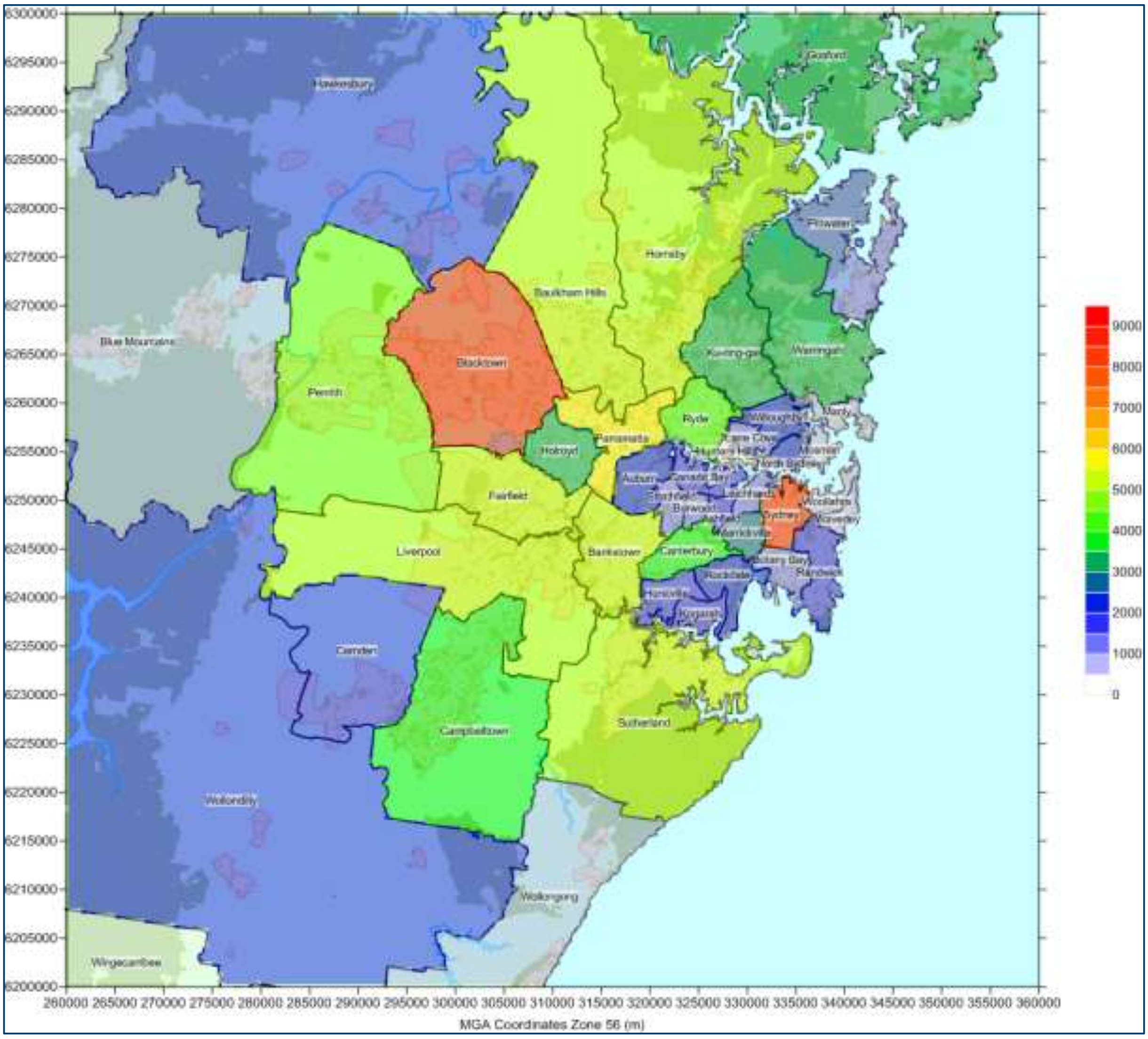

Figure A-15: CO On-Road mobile emissions per LGA without Project emissions, tonnes per annum

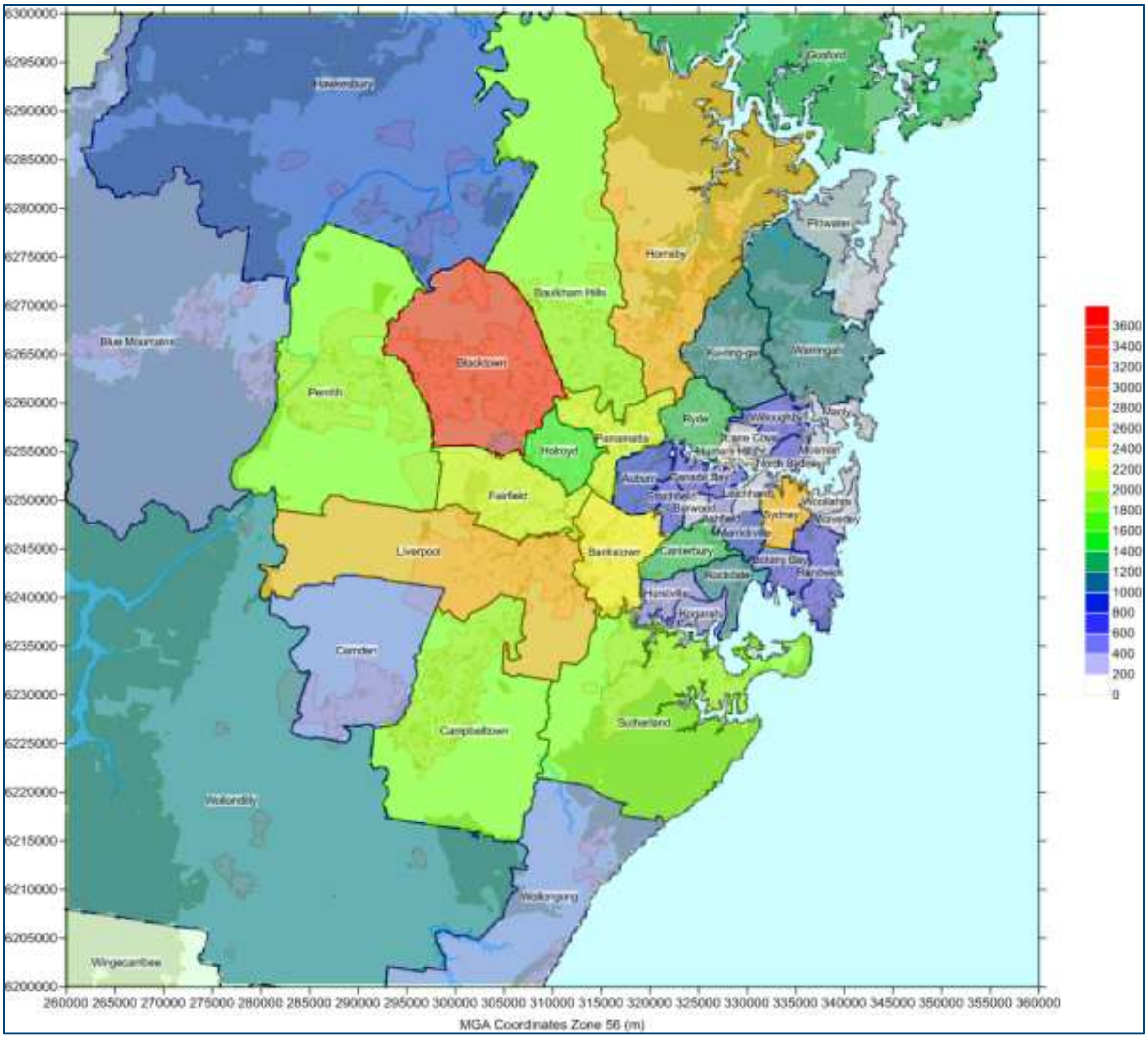

Figure A-16: NO_X On-Road mobile emissions per LGA with Project emissions, tonnes per annum

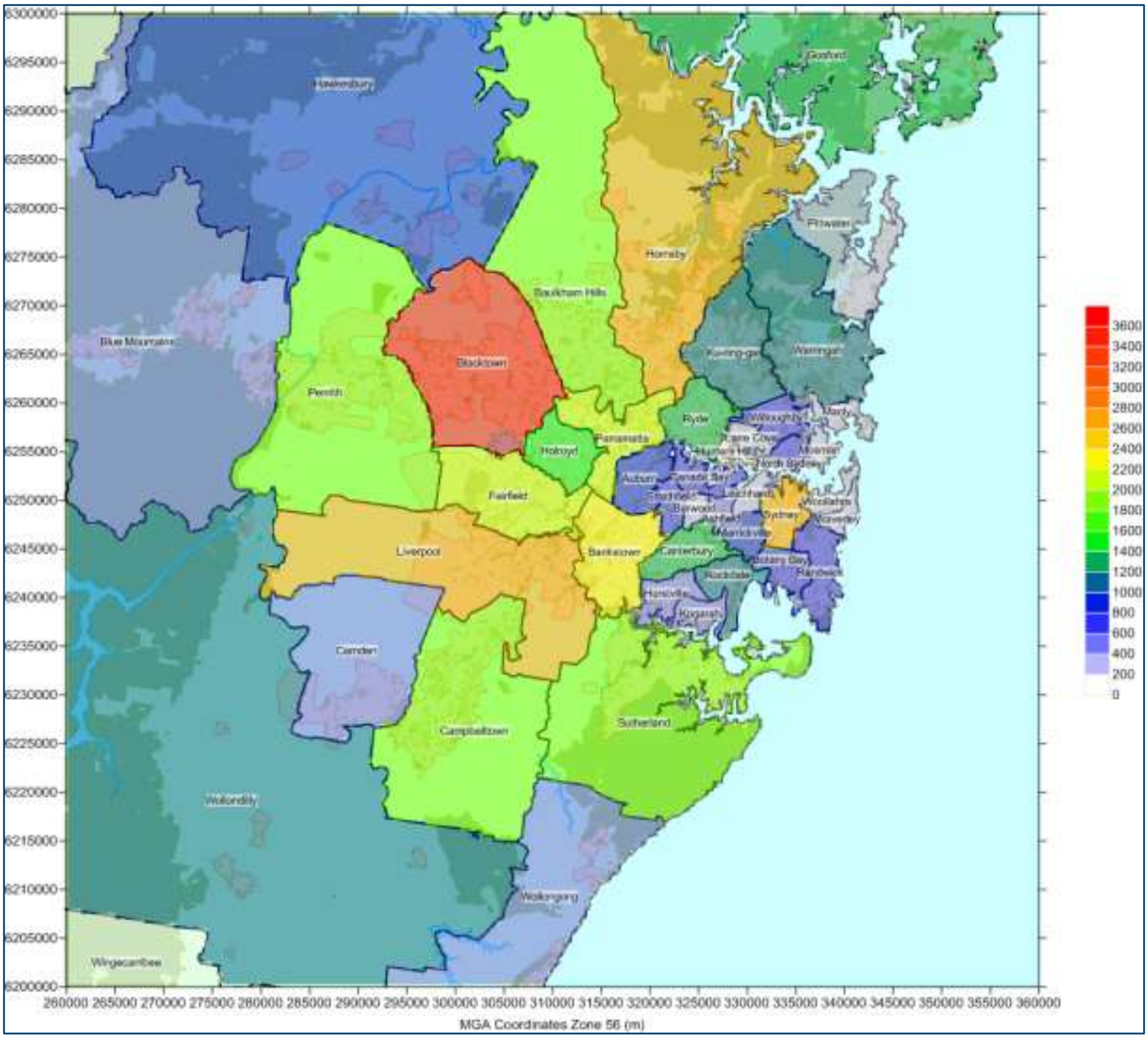

Figure A-17: NO_X On-Road mobile emissions per LGA without Project emissions, tonnes per annum

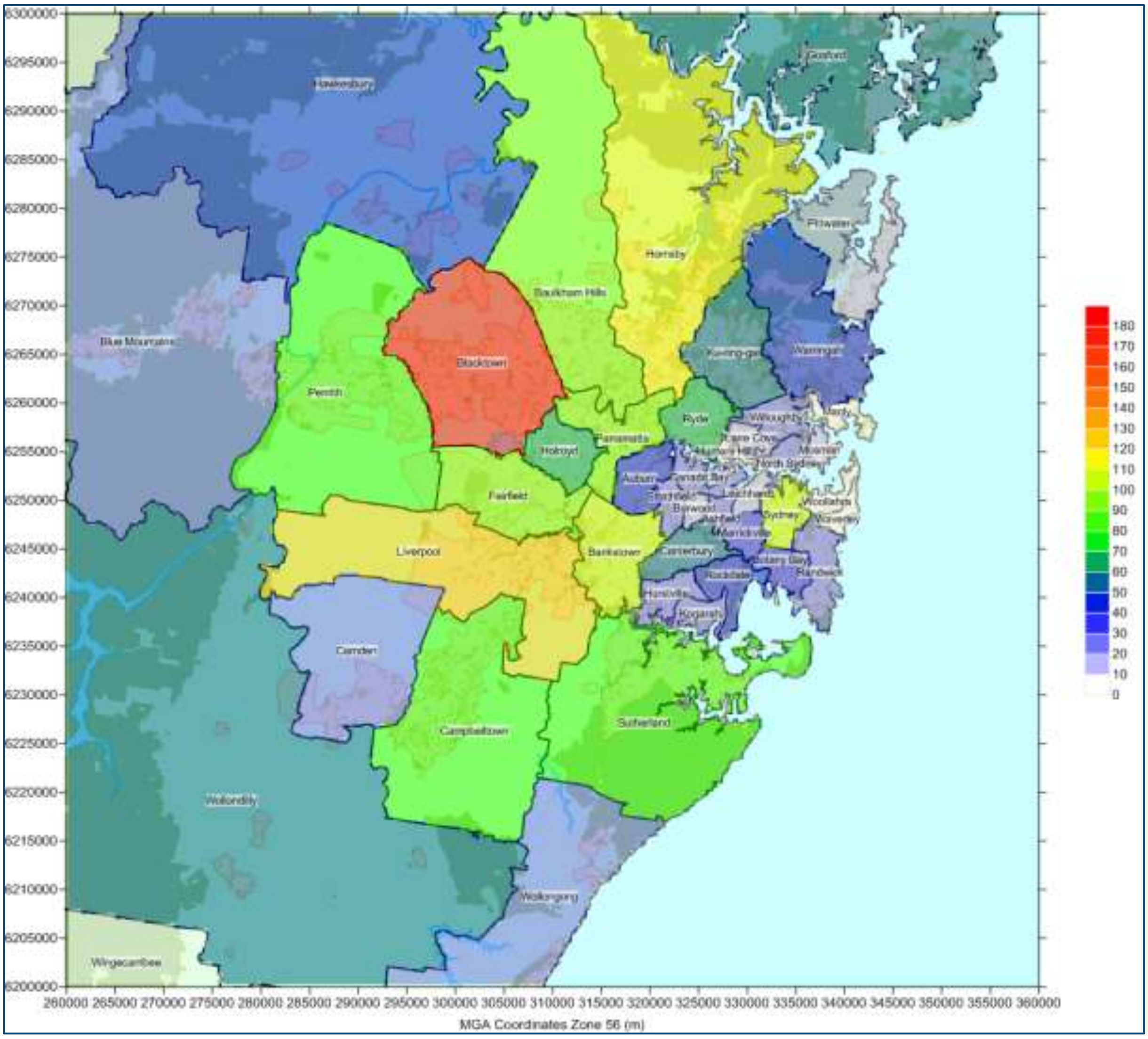

Figure A-18: PM$_{10}$ On-Road mobile emissions per LGA with Project emissions, tonnes per annum

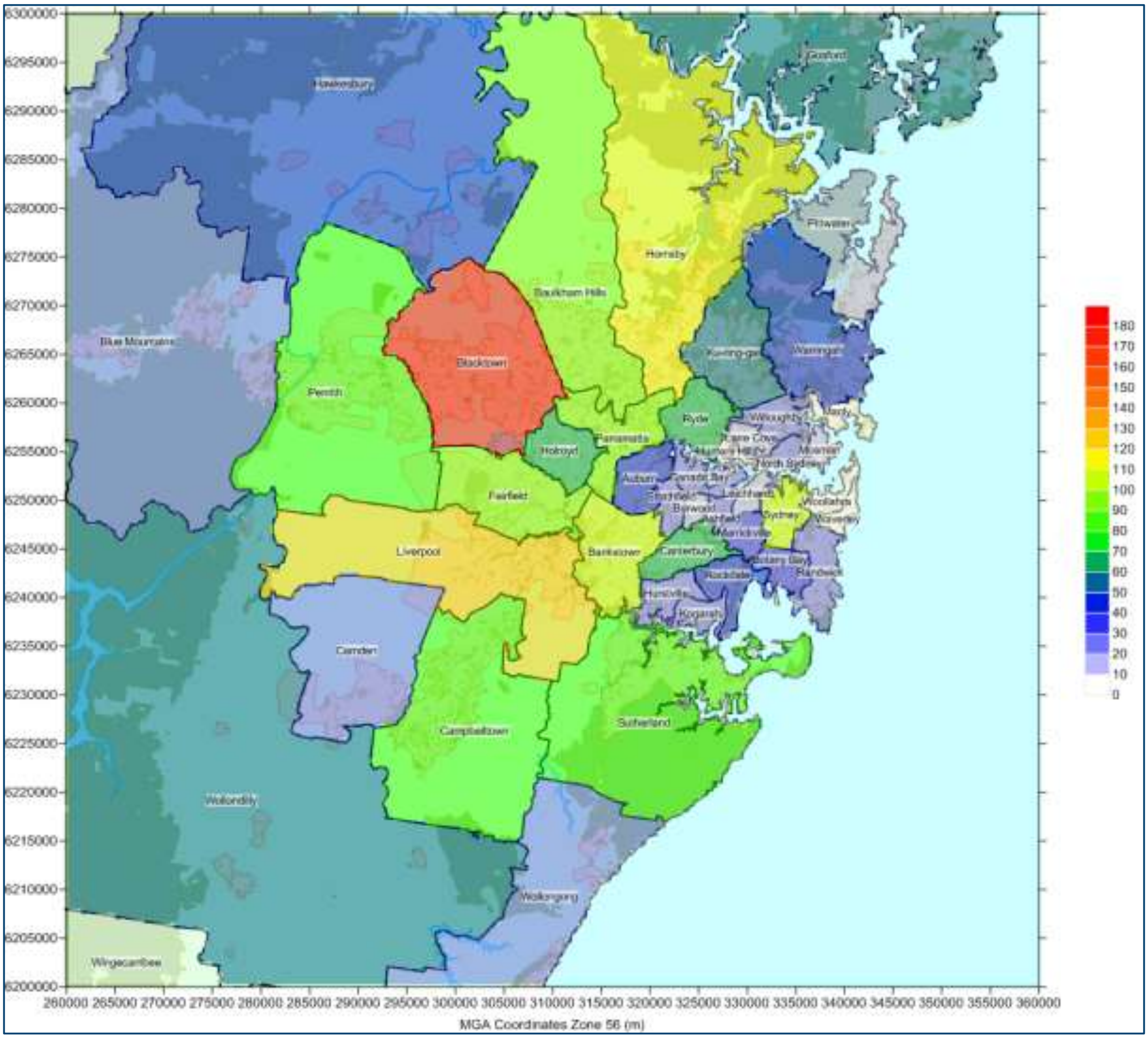

Figure A-19: PM$_{10}$ On-Road mobile emissions per LGA without Project emissions, tonnes per annum

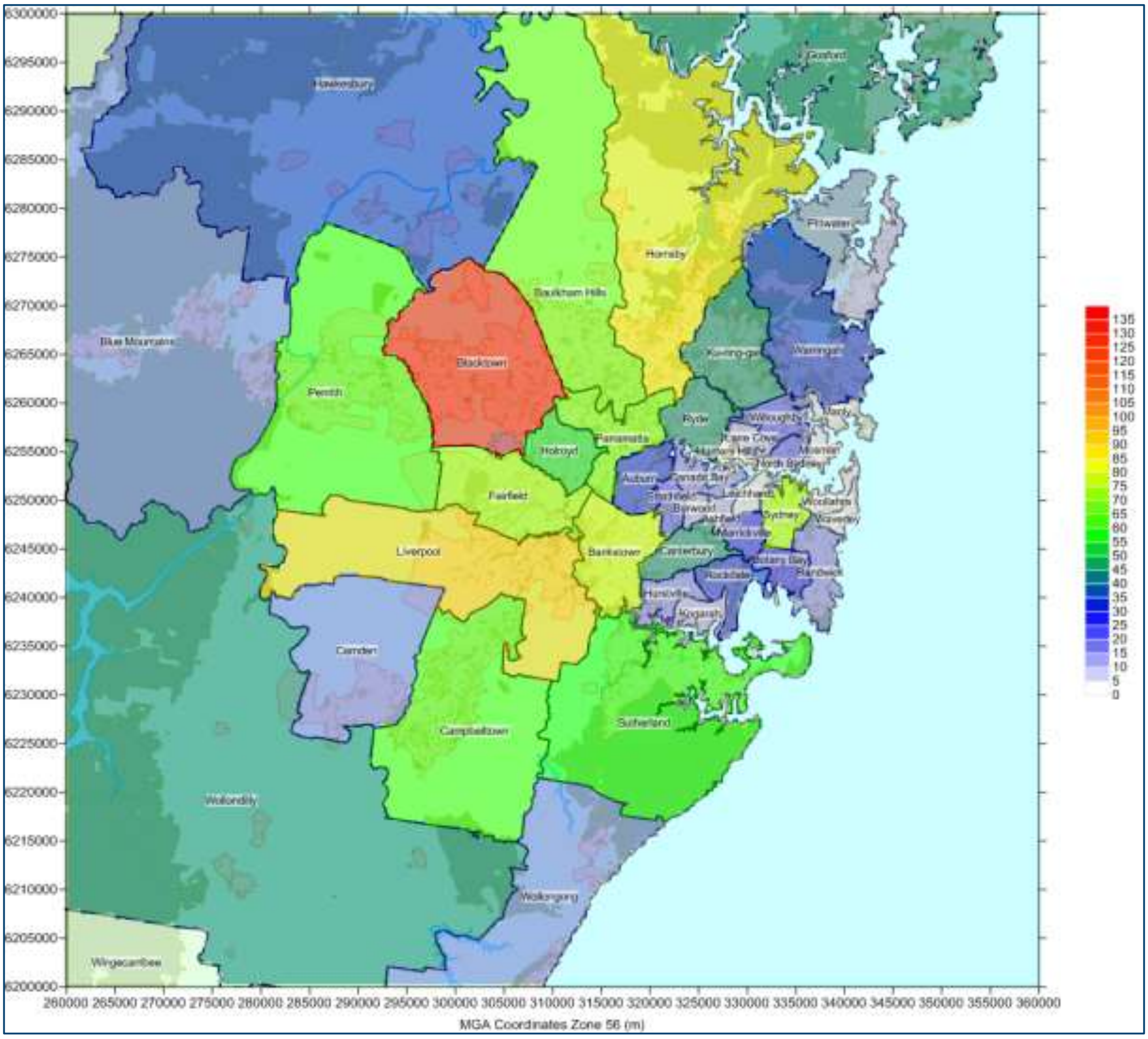

Figure A-20: PM$_{2.5}$ On-Road mobile emissions per LGA with Project emissions, tonnes per annum

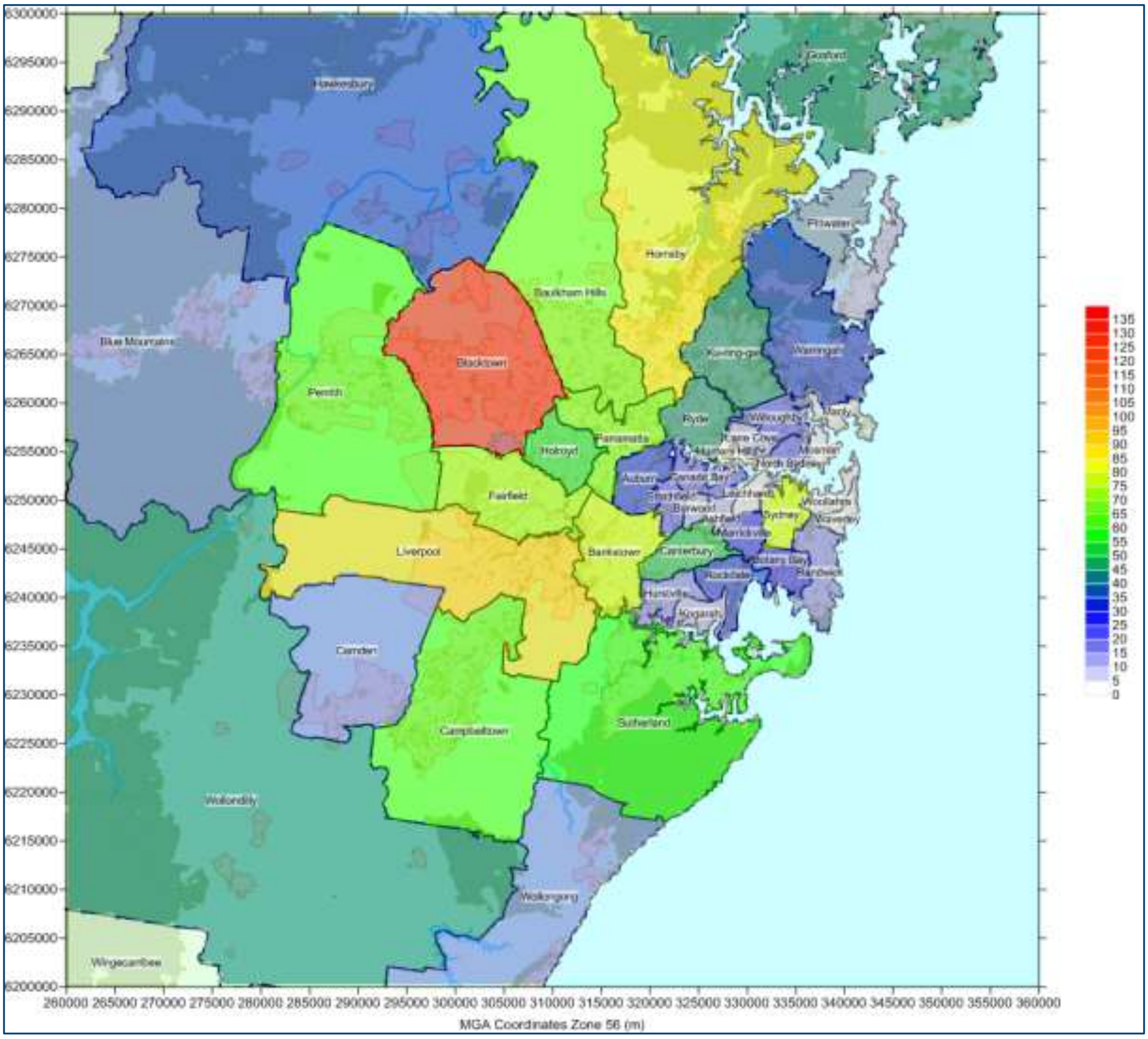

Figure A-21: PM$_{2.5}$ On-Road mobile emissions per LGA without Project emissions, tonnes per annum

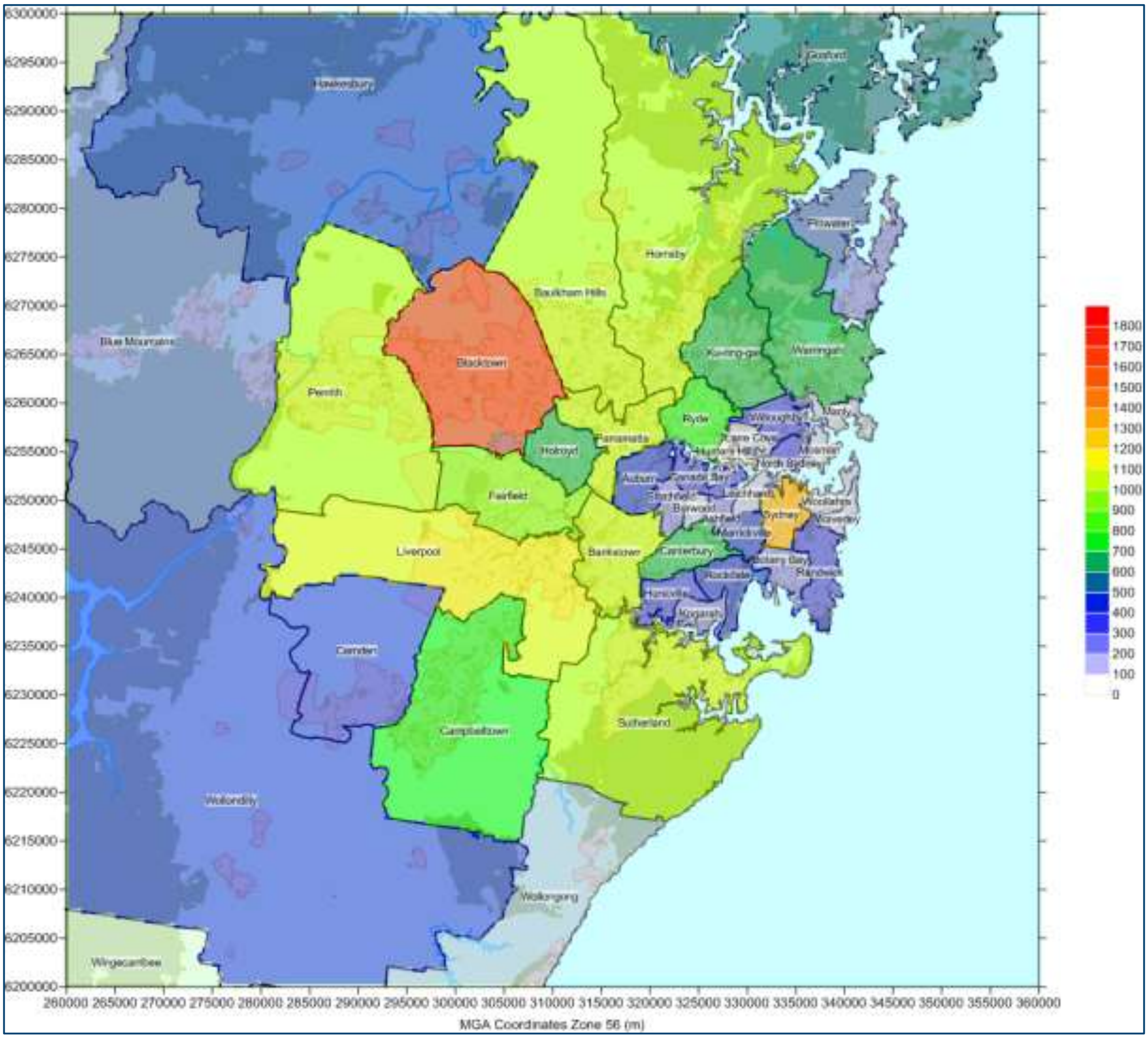

Figure A-22: VOC On-Road mobile emissions per LGA with Project emissions, tonnes per annum

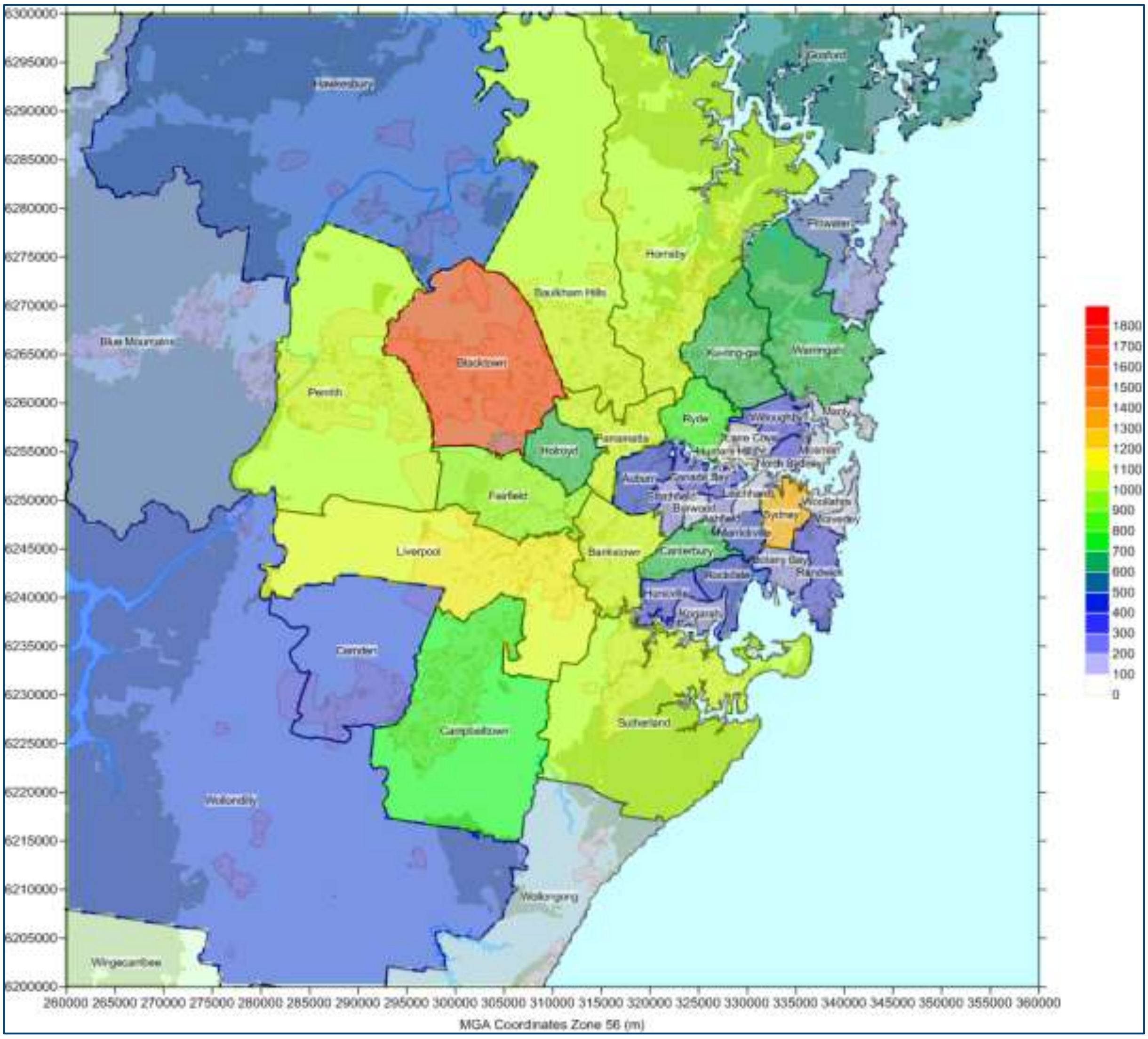

Figure A-23: VOC On-Road mobile emissions per LGA without Project emissions, tonnes per annum

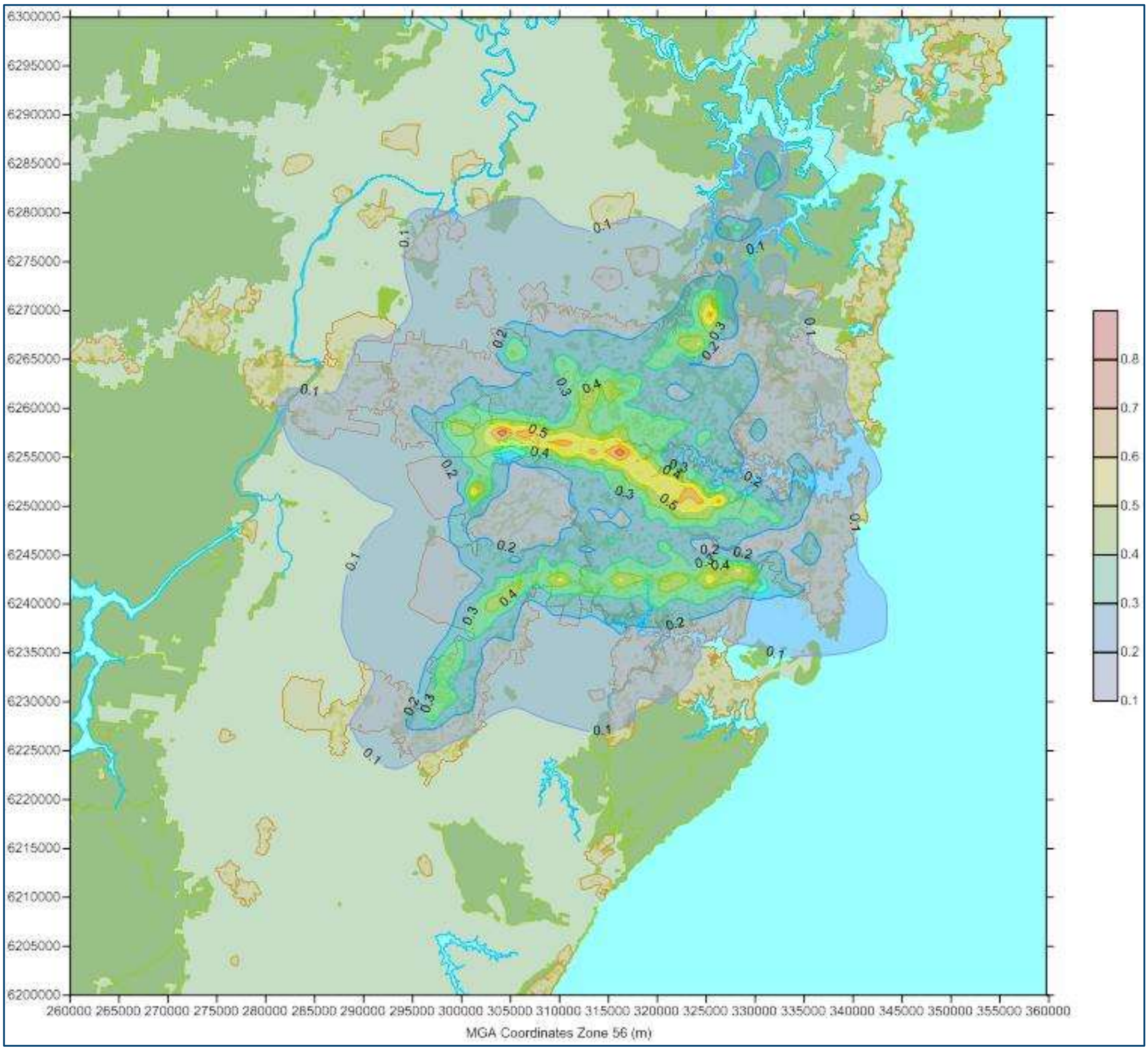

Figure A-24: NO$_2$ 1-hour average emissions without the Project (µg/m^3)

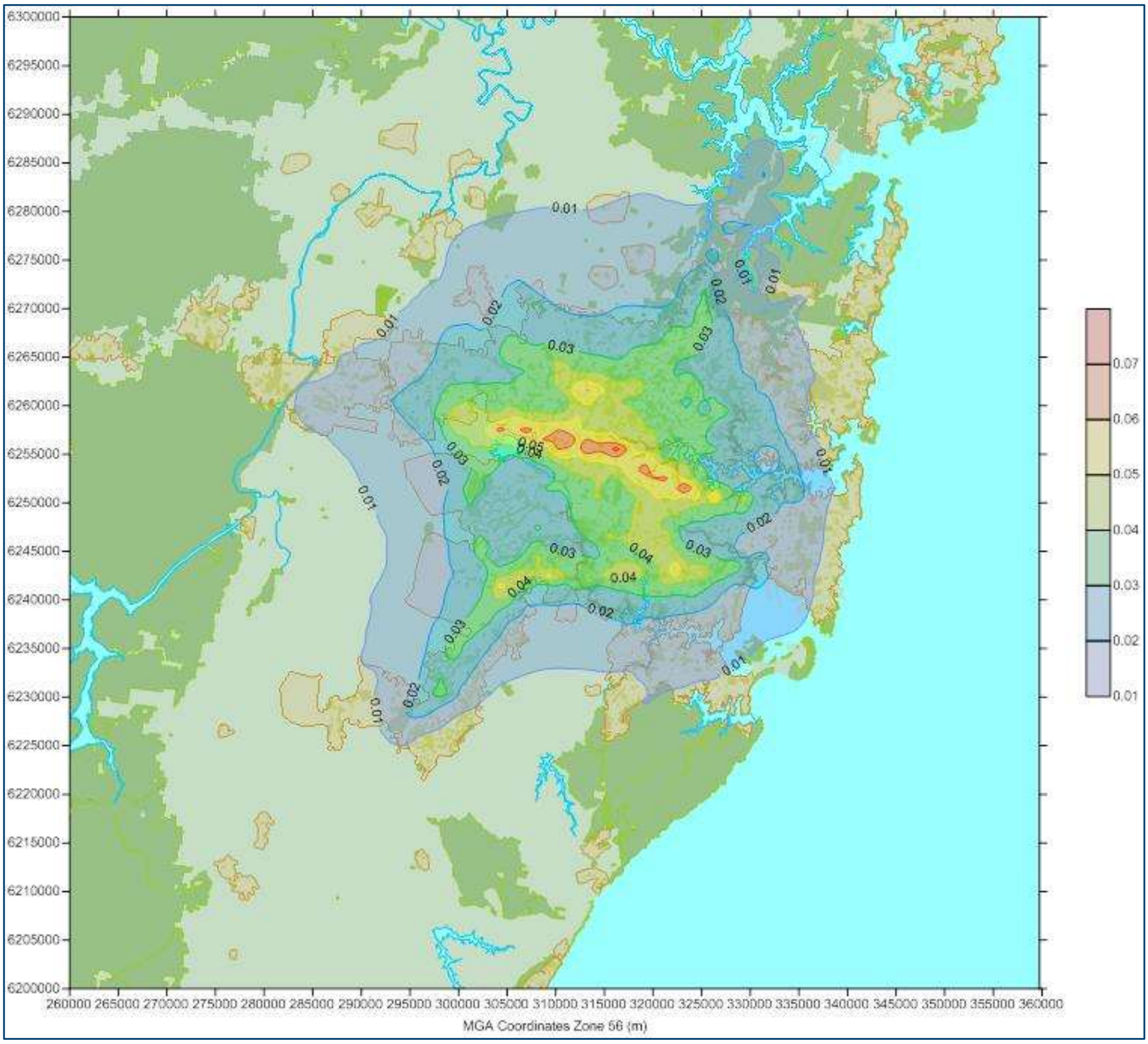

Figure A-25: NO_2 annual average emissions without the Project (µg/m^3)

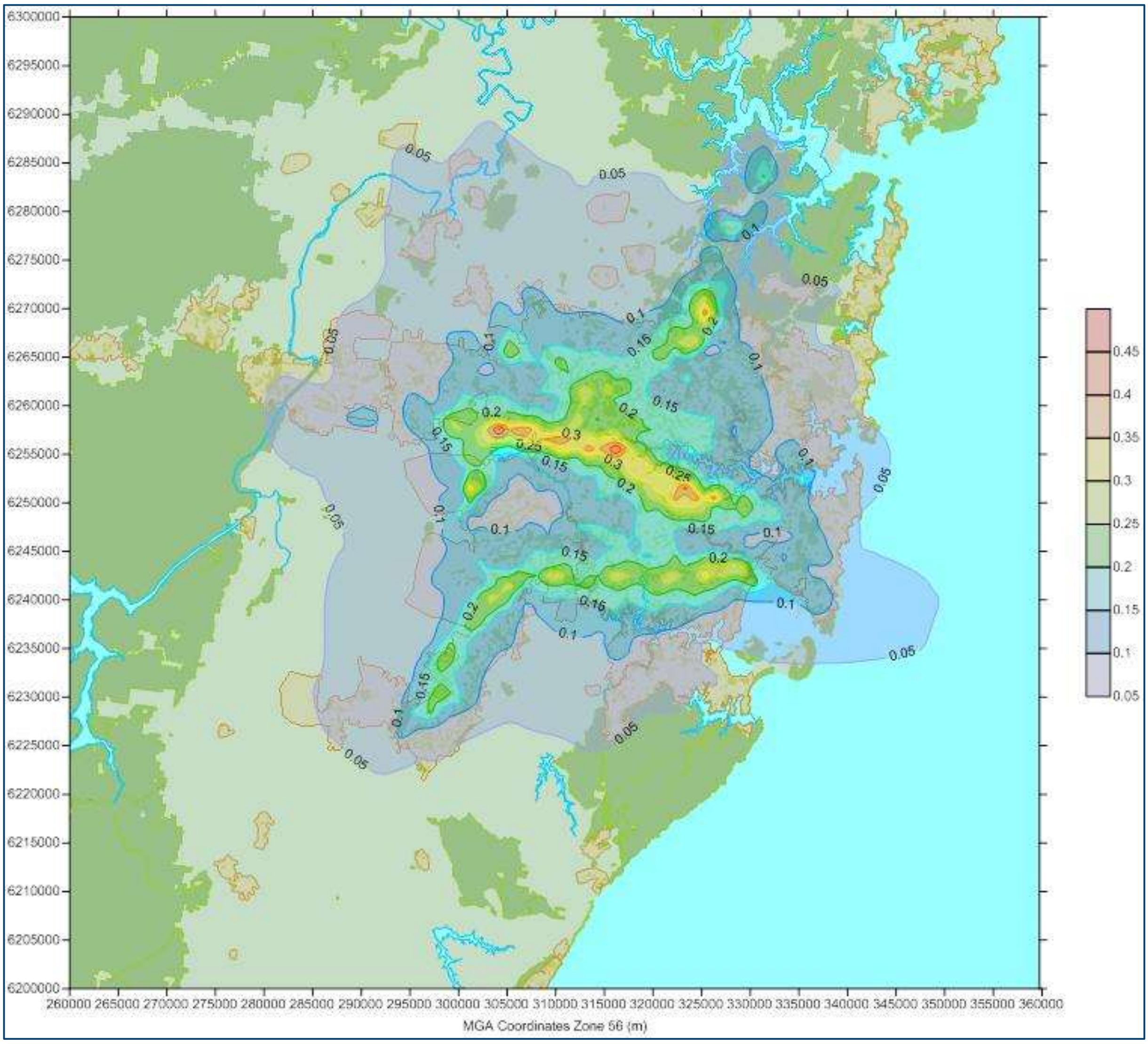

Figure A-26: CO 1-hour average emissions without the Project (µg/m³)

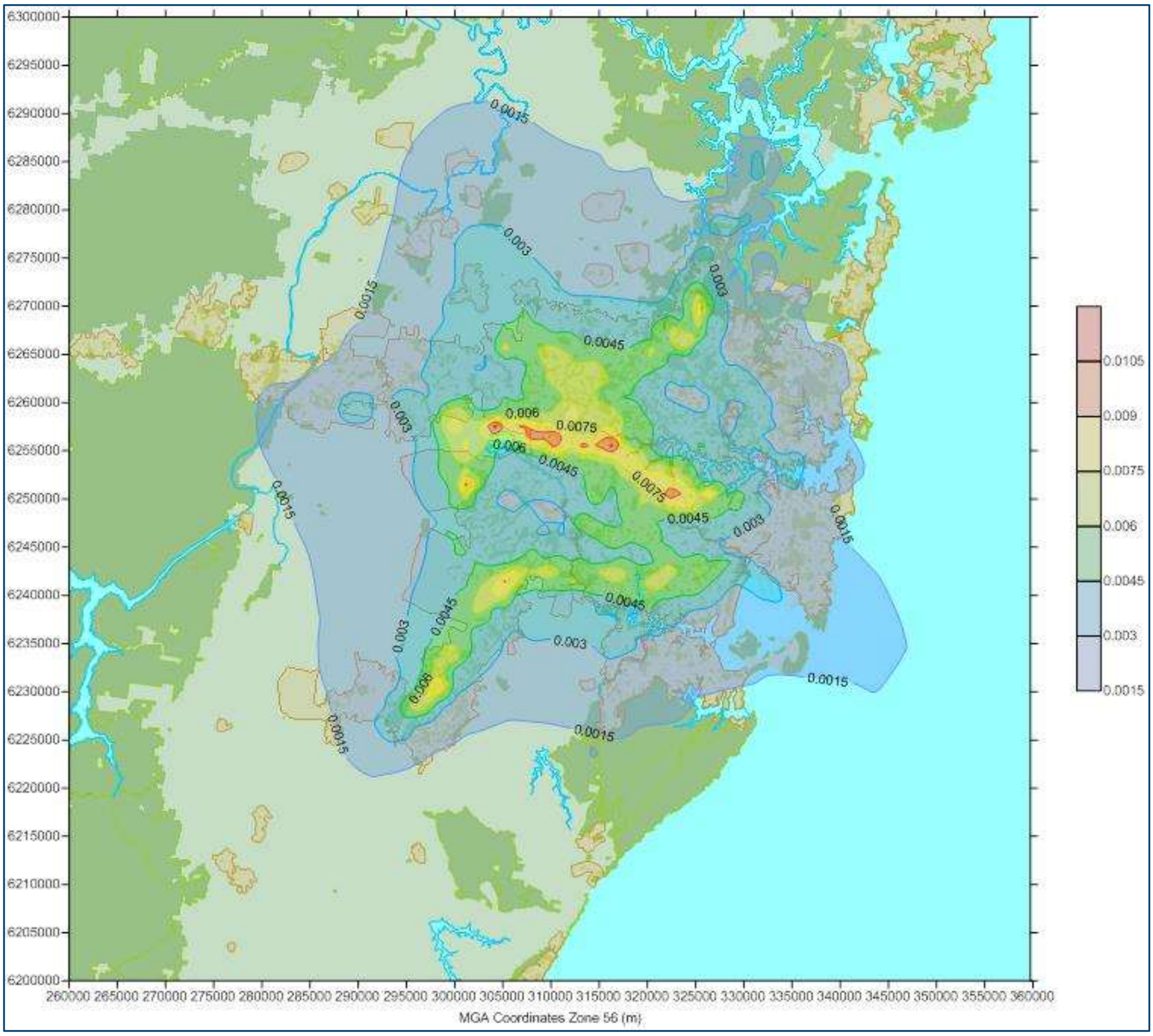

Figure A-27: PM$_{10}$ 24-hour average emissions without the Project (μg/m^3)

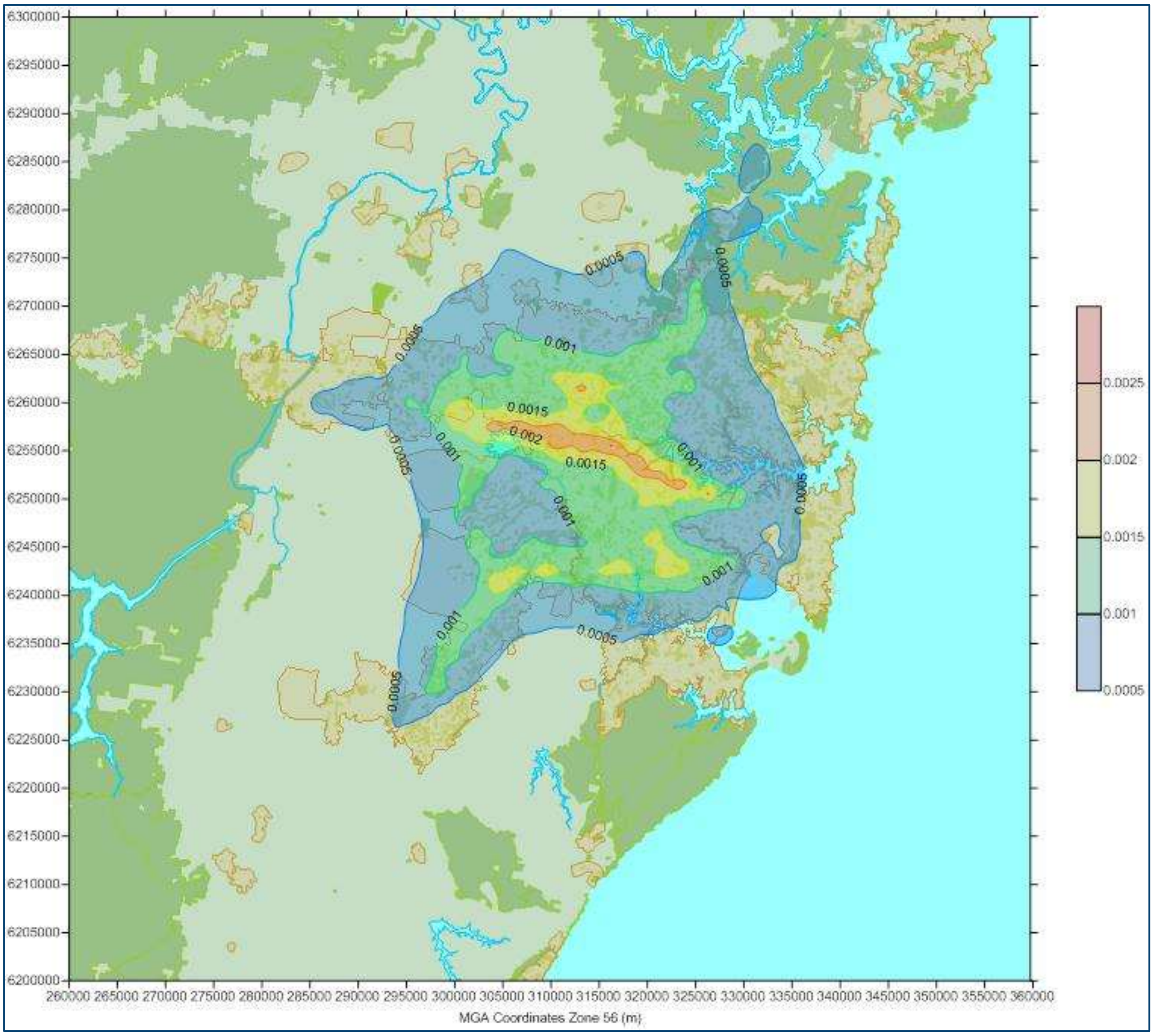

Figure A-28: PM10 annual average emissions without the Project (μg/m³)

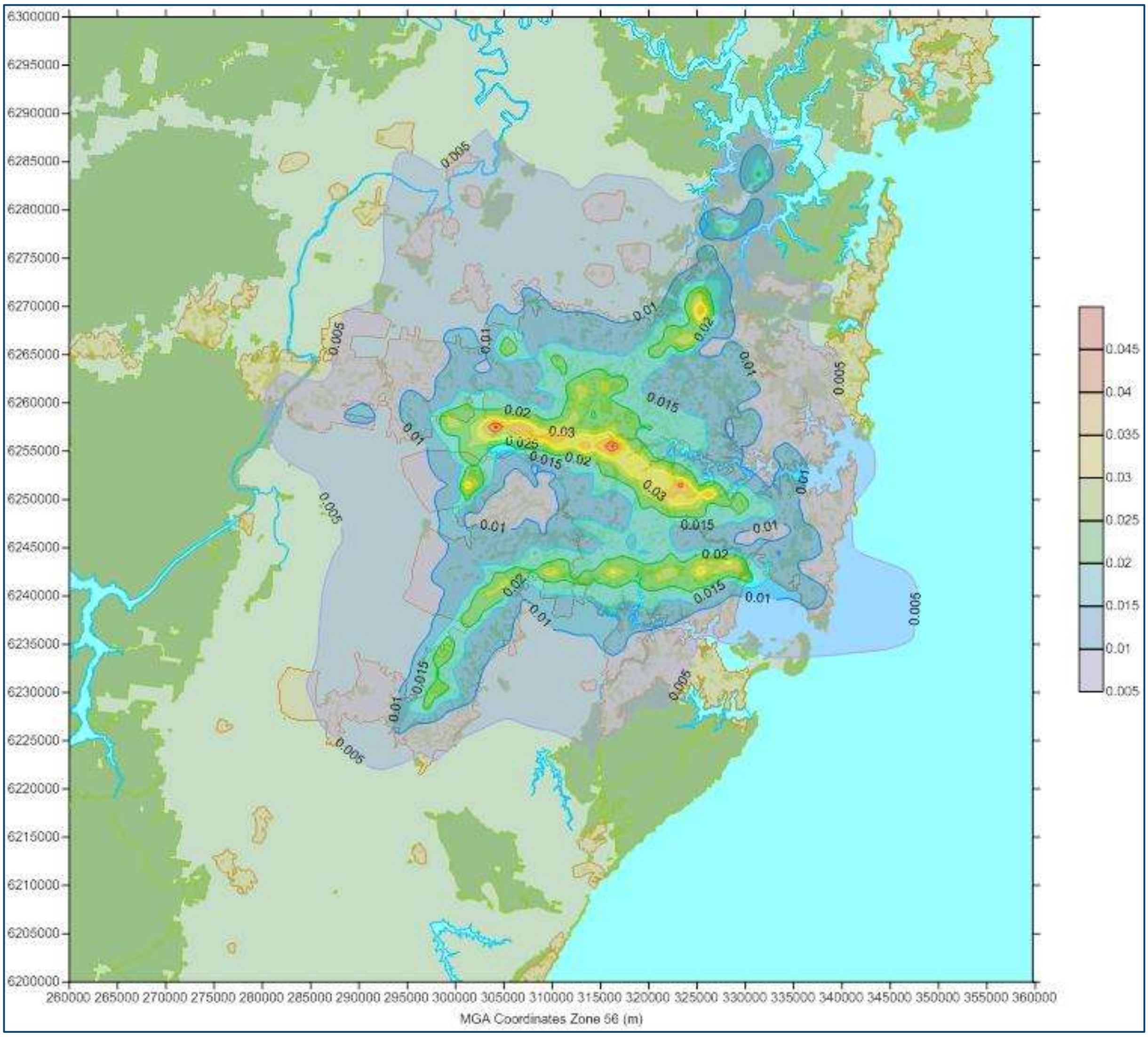

Figure A-29: VOC 1-hour average emissions without the Project (µg/m³)

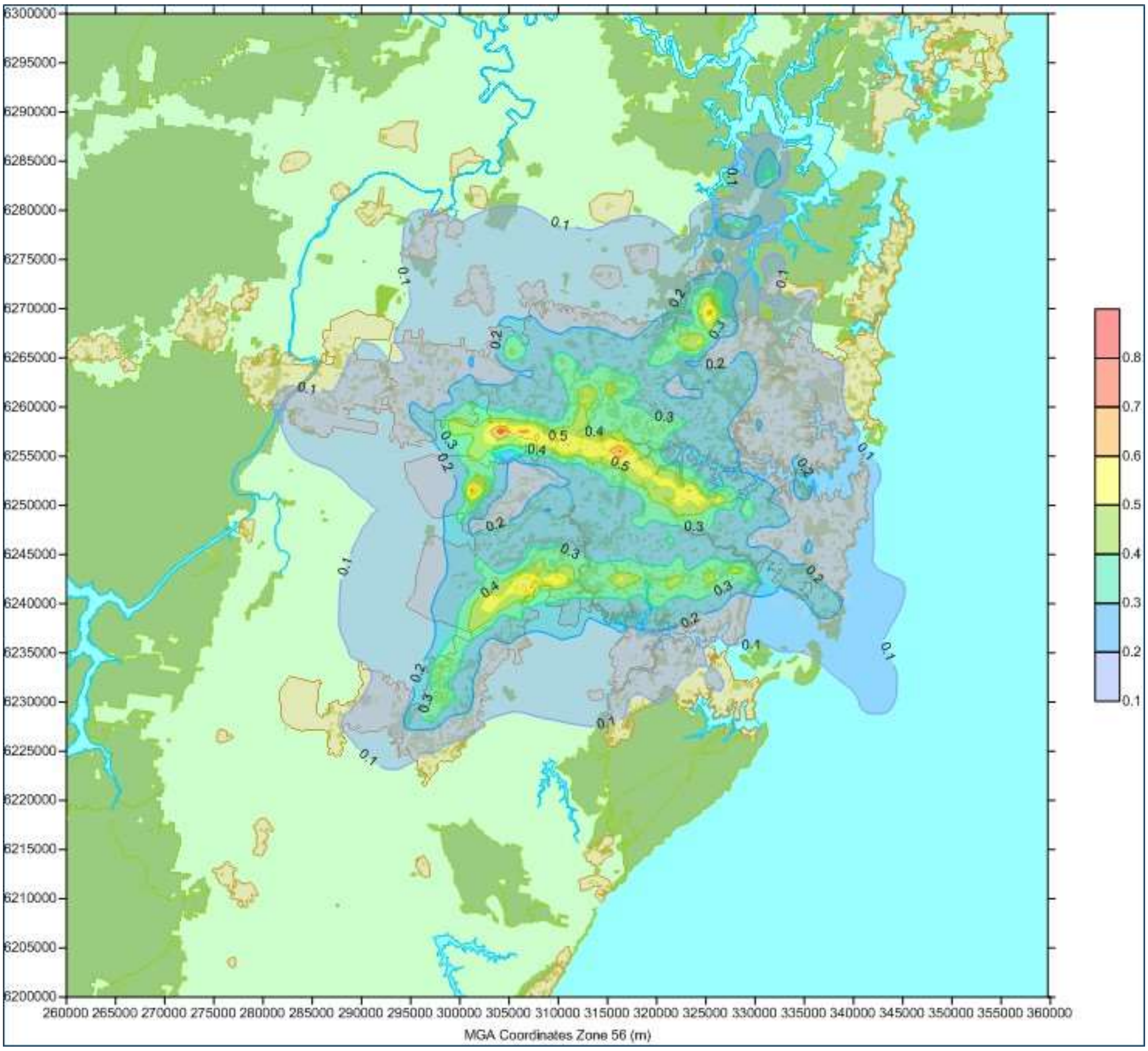

Figure A-30: NO$_2$ 1-hour average emissions with the Project (µg/m^3)

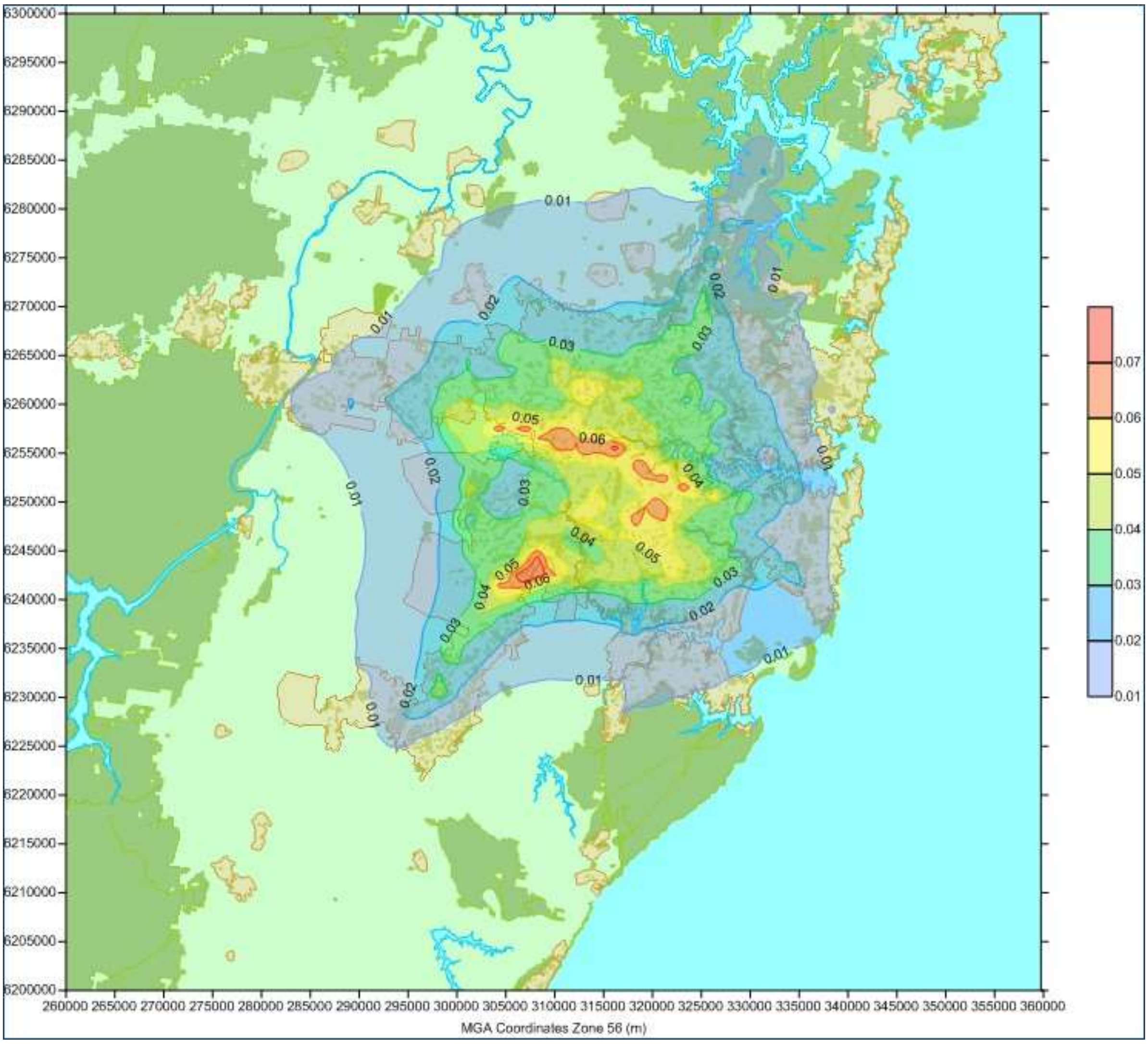

Figure A-31: NO$_2$ annual average emissions with the Project (µg/m^3)

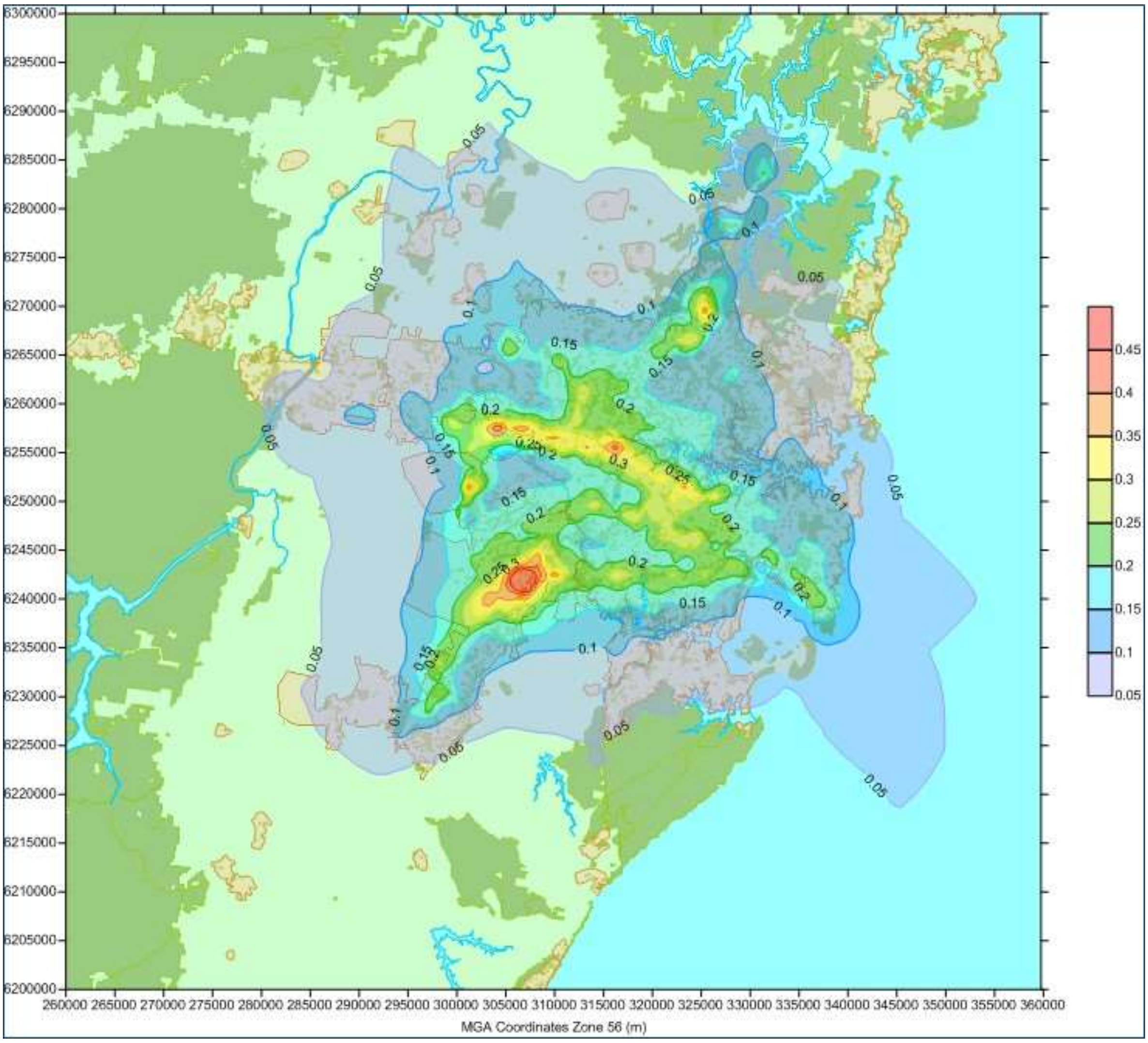

Figure A-32: CO 1-hour average emissions with the Project (µg/m³)

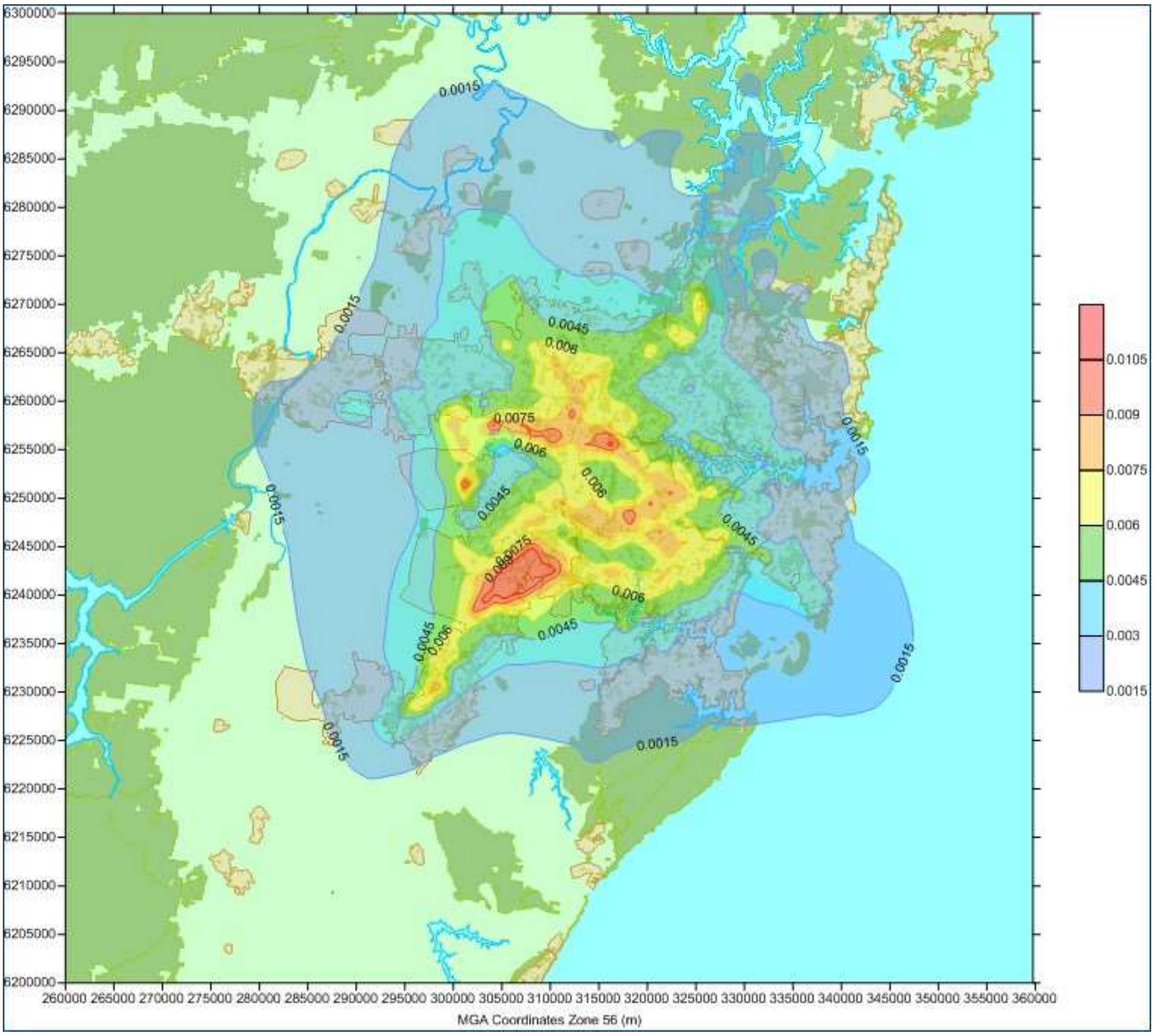

Figure A-33: PM$_{10}$ 24-hour average emissions with the Project (µg/m^3)

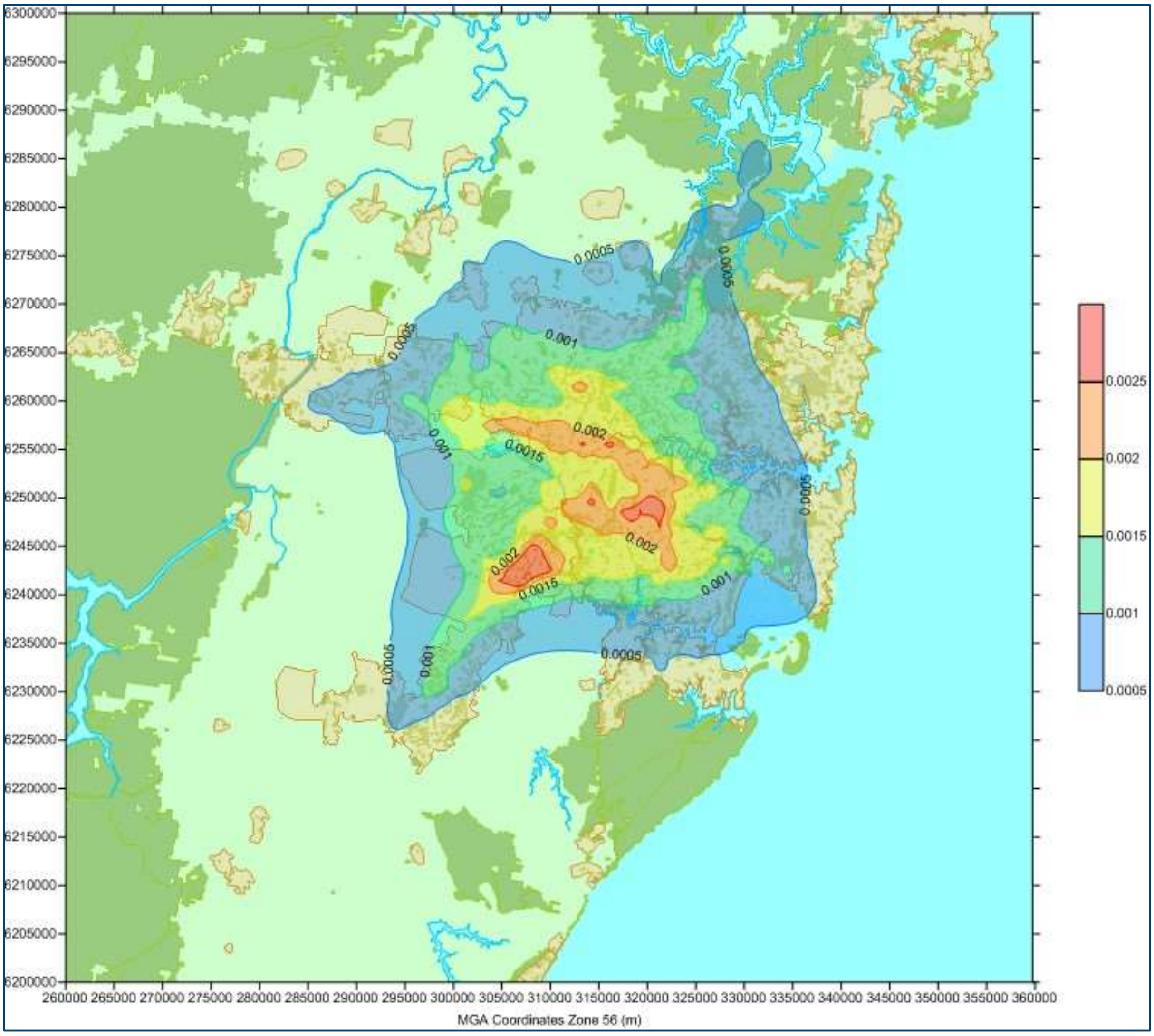

Figure A-34: PM$_{10}$ annual average emissions with the Project (µg/m^3)

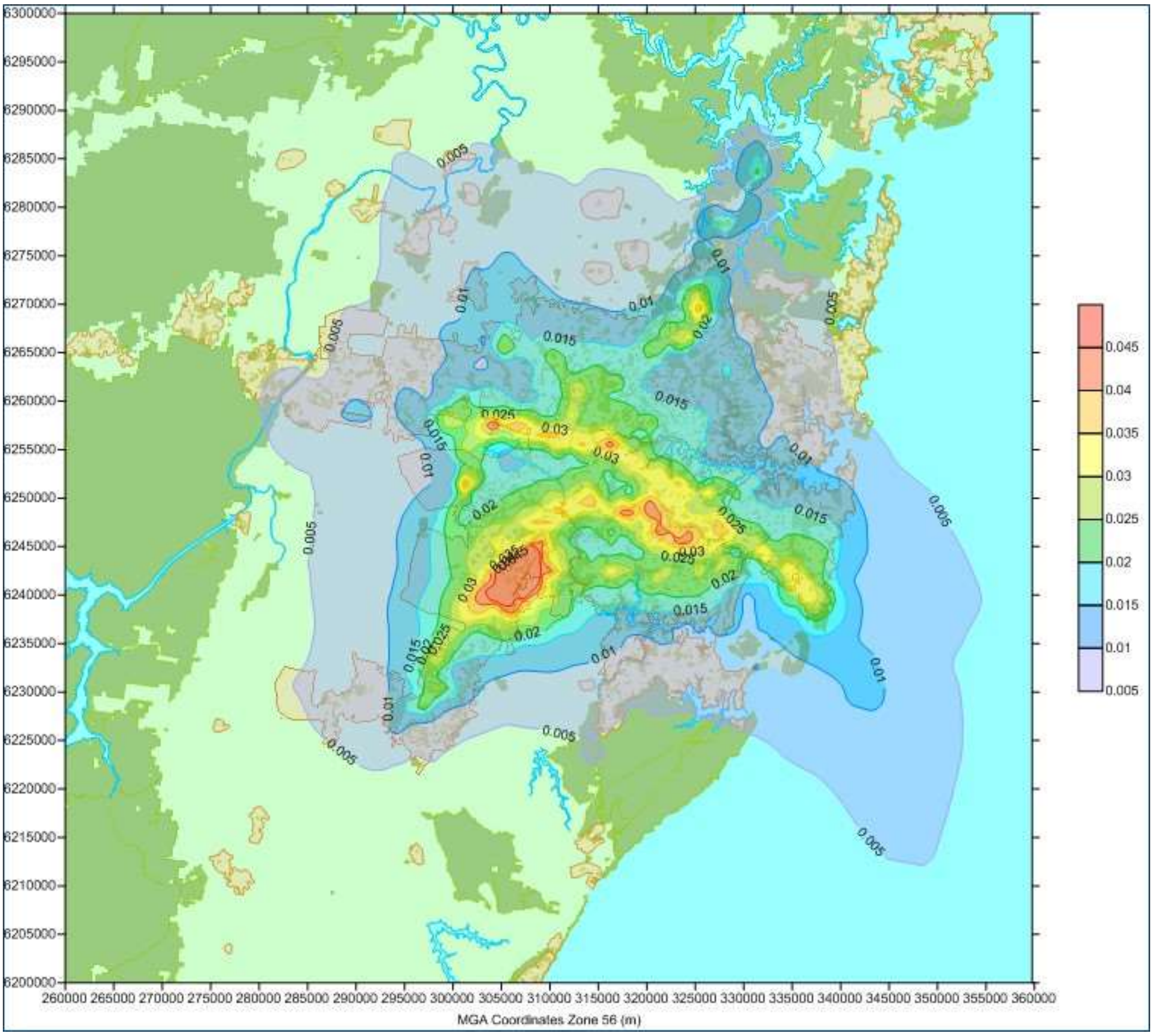

Figure A-35: VOC 1-hour average emissions with the Project (µg/m³)

Appendix B

CALMET/CALPUFF Input Variables

Table C10-1: CALMET input variables

Parameter	Value
Terrain radius of influence (TERRAD)	10km
Vertical extrapolation of surface wind observations (IEXTRP)	-4
Layer dependent weighting factor of surface vs. upper air wind observations (BIAS [NZ])	-1,-0.5,-0.25,0,0,0,0,0
Weighting parameter for Step 1 wind field vs. Observations	R1 =5km, R2 =5km
Maximum radius of influence for meteorological stations in Layer 1 and layers aloft	RMAX1=10km, RMAX2=10km

Table C10-2: CALPUFF input variables

Parameter	**Used option**	**Value**
Aqueous phase transformation modelled?	No	0
Boundary conditions modelled?	No	0
CGRUP (Species groups)	No	-
Chemical transformation	Not modelled	0
Dry deposition modelled?	Yes	1
Gravitational settling (plume tilt) modelled?	No	0
Horizontal size of puff (m) beyond which time-dependent dispersion equations (Heffter) are used to determine sigma-y and sigma-z	Default	550
Individual source conditions saved?	No	0
Maximum length of a slug (met. grid units)	Default	1
Maximum mixing height	Default	3000
Maximum number of sampling steps for one puff/slug during one time step	-	60
Maximum number of slugs/puffs release from one source during one time step	-	60
Maximum sigma z allowed to avoid numerical problem in calculating virtual time or distance	Default	5.00E+06
Maximum travel distance of a puff/slug during one sampling step	Default	1
Method used to compute dispersion coefficients?	Internally calculated sigma v, sigma w using micrometeorological variables	2
Method used for lagrangian timescale for Sigma-y	Draxler default 617.284	0
Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables	Standard CALPUFF subroutines	1
Minimum mixing height	Default	50
Minimum sigma y for a new puff/slug	Default	1
Minimum sigma z for a new puff/slug	Default	1
Minimum turbulence velocities sigma-v and sigma-w for each stability class over land and over water	Default	-
Near-field puffs modelled as elongated slugs?	No	0
Plume path coefficients for each stability class	Default	-
Potential temperature gradient for stable classes E, F	Default	-
Puff splitting allowed?	No	0
Range of land use categories for which urban dispersion is assumed	Default	-
Slug - to - puff transition criterion factor	Default	10
Stability class used to determine plume growth rates for puffs above the boundary layer	Default	5
Sub grid-scale complex terrain	Not Modelled	0
Switch for using Heffter equation for sigma-z	Default(Not use Heffter)	0
Terrain adjustment method	Default(Partial plume path adjustment)	3
Vegetation state in unirrigated areas	Default(Active and unstressed)	1
Vertical dispersion constant for stable conditions	Default	0.01
Vertical distribution used in the near field	Default (Gaussian)	1
Wet removal modelled?	No	0
Wind speed classes	Default	-
Wind speed profile power-law exponents for stabilities	Default	-