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Moorebank Precinct East - Stage 2 Proposal

Air Quality Impact Assessment

SIMTA SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 4, Division 4.1, State Significant Development

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MOOREBANK PRECINCT EAST STAGE 2
AIR QUALITY IMPACT ASSESSMENT

RAMBOLL ENVIRON

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AIR QUALITY IMPACT ASSESSMENT

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EXECUTIVE SUMMARY

Introduction

An air quality impact assessment has been prepared to support the Environmental Impact Statement for approval of the Moorebank Precinct East (MPE) Stage 2 Proposal (the Proposal), comprising the construction and operation of warehouse and distribution facilities and associated infrastructure for the MPE Project.

Study approach

Local air quality impacts are assessed using a Level 2 assessment approach, in accordance with the NSW Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales,* as follows:

- Emissions are estimated for Proposal related activities.
- Dispersion modelling is used to predict ground level concentrations for key pollutants from the Proposal, at surrounding sensitive receivers.
- Cumulative impacts are assessed, taking into account the combined effect of existing baseline air quality, other local sources of emissions, reasonably foreseeable future emissions and any indirect or induced effects.

The key emissions to air during the construction phase of the Proposal are fugitive dust or particulate matter (PM), generated during site clearing, earthworks and other activities. During operations, the key emissions are associated with the combustion of diesel and other fossil fuels.

Existing environment

Previous air quality assessments for the Moorebank Precinct have demonstrated that the Liverpool monitoring site operated by the Office of Environment and Heritage (OEH) is representative of the local area and suitable to describe the existing environment. A representative meteorological dataset for 2013 is used for modelling.

Annual mean PM_{10} concentrations range from 18 µg/m³ to 21 µg/m³ and on average over the past 5 years baseline concentrations are 77% of the ambient air quality NEPM standard. Annual mean $PM_{2.5}$ concentrations range from 6 µg/m³ to 9 µg/m³ and on average over the past 5 years baseline concentrations are 103% of the NEPM standard. Exceedances of the 24-hour average reporting standards for both PM_{10} and $PM_{2.5}$ have occurred in three of the past five years.

On average over the past five years, baseline concentrations for NO_2 are 33% of the NEPM standard for annual mean and 42% for maximum 1 hour average. Relative to the NEPM standards, baseline concentrations for CO and SO_2 are even lower.

Emissions

Emissions and modelling scenarios are presented for the construction and operation of the Proposal, as follows:

- Scenario 1: Construction of the Proposal, including construction works associated with the raising of Moorebank Avenue.
- Scenario 1a: Cumulative construction of the Proposal with concurrent construction activities for MPE Stage 1 and Moorebank Precinct West (MPW) Stage 2.
- Scenario 2: Operation of the Proposal (incorporating approximately 300,000 m² of warehousing).
- Scenario 2a: Cumulative operation of the Moorebank Precinct, incorporating a combined precinct total of 750,000 TEU (250,000 TEU for the MPE Stage 1 and 500,000 TEU for the MPW Stage 2) plus 515,000 m² of warehousing (300,000 m² for MPE Stage 2 and 215,000 m² for MPW Stage 2).

Results and conclusion

The modelling results indicate that the emissions generated during construction would comply with all relevant impact assessment criteria. The predicted increase in annual average PM_{10}, $PM_{2.5}$, TSP and dust deposition is considered minor, when compared against existing background conditions. Cumulative predictions are also presented and the results indicate that the construction for the Proposal would result in no additional days over the impact assessment criteria.

For the operational phase of the Proposal the maximum increase in PM_{10} and $PM_{2.5}$ is minor. When background is added, there are no additional exceedances of the short term impact assessment criteria. The annual average background concentrations of $PM_{2.5}$ already exceed the NEPM reporting standard, therefore cumulative predictions are also above the standard at all receptors. However, the Proposal results in a minor increase in annual average $PM_{2.5}$ ($<0.1\ \mu g/m^3$ at all sensitive receptors). The predicted NO_2, CO, SO_2 and VOC concentrations are well below the relevant impact assessment criteria.

In summary, consistent with previous air quality assessments for the Moorebank Precinct, the potential air quality impacts are expected to be low risk. The proposed mitigation measures are considered sufficient to ensure off-site impacts from the Proposal are effectively managed.

CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

APPENDICES

Appendix 1
Project Figures

Appendix 2
Overview of Dispersion Modelling

Appendix 3
Assessment Locations

Appendix 4
Wind roses

Appendix 5
Emission inventory development

Appendix 6
Contour plots for key pollutants

Appendix 7
Air quality management plan

1. INTRODUCTION

Concept Plan Approval (MP 10_0193) for an intermodal terminal (IMT) facility at Moorebank, NSW (the Moorebank Precinct East Project (MPE Project) (formerly the SIMTA Project)) was received on 29 September 2014 from the NSW Department of Planning and Environment (DP&E). The Concept Plan for the MPE Project involves the development of an IMT, including a rail link to the Southern Sydney Freight Line (SSFL) within the Rail Corridor, warehouse and distribution facilities with ancillary offices, a freight village (ancillary site and operational services), stormwater, landscaping, servicing, associated works on the eastern side of Moorebank Avenue, Moorebank, and construction or operation of any part of the project, which is subject to separate approval(s) under the *Environmental Planning and Assessment Act 1979* (EP&A Act).

This Air Quality Impact Assessment (AQIA) forms part of the Environmental Impact Statement (EIS) seeking approval, under Part 4, Division 4.1 of the EP&A Act, for the construction and operation of Stage 2 of the MPE Project (herein referred to as the Proposal) under the Concept Plan Approval for the MPE Project, being the construction and operation of warehouse and distribution facilities.

This EIS has been prepared to address:

- The Secretary's Environmental Assessment Requirements (SEARs) (SSD 16-7628) for the Proposal, issued by NSW DP&E on 27 May 2016.
- The relevant requirements of the Concept Plan Approval MP 10_0913 dated 29 September 2014 (as modified).
- The relevant requirements of the approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (No. 2011/6229, granted in March 2014 by the Commonwealth Department of the Environment (DoE)) (as relevant).

This AQIA also gives consideration to the MPE Stage 1 Project (SSD 14-6766) including the mitigation measures and conditions of consent as relevant to this Proposal.

This AQIA has been prepared to provide a complete assessment of the potential air quality impacts associated with the construction and operation of the Proposal. This AQIA proposes measures to mitigate these issues and reduce any unreasonable impacts on the environment and surrounding community.

1.1 Purpose of this report

This report supports the Environmental Impact Statement (EIS) for the Proposal and has been prepared as part of a State Significant Development (SSD) Application for which approval is sought under Part 4, Division 4.1 of the EP&A Act.

This report has been prepared to address:

- The Secretary's Environmental Assessment Requirements (SEARs) (SSD 16-7628) for the Proposal, issued by NSW DP&E on 27 May 2016.
- The relevant requirements of Concept Plan Approval MP 10_0913 dated 29 September 2014 (as modified).
- The relevant requirements of the approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (No. 2011/6229, granted in March 2014 by the Commonwealth Department of the Environment (DoE)) (as relevant).

The SEARs and the Concept Plan Conditions of Approval and Statement of Commitments relevant to this study, and the section of this report where they have been addressed, are provided in **Table 1-1** and **Table 1-2**.

Table 1-1: Summary of SEARs for air quality

		Where addressed in this report
Air Quality – including but not limited to: A comprehensive air quality impact assessment including:		
a)	An assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2005) (or its later version and updates)	Refer **Section 3**
b)	An assessment of construction related impacts including dust and wind erosion from exposed surfaces and proposed mitigation measures and safeguards to control dust generation and other airborne pollutants and to minimise impacts on nearby receptors.	Refer **Section 5.2**, **6.1** and **7.1.1**

Table 1-2: Concept Plan conditions of approval and statement of commitments

Section/ number	Condition of approval / statement of commitments	Where addressed in this report
Condition of approval		
Any future Development Application shall include a comprehensive air quality impact assessment for each stage of the proposal, including:		
(a)	An assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2005) (or its later version and updates;	Refer **Section 3**
(b)	Taking into account the final project design with consideration to worst-case meteorological and operating conditions;	Refer **Section 5**
(c)	Quantitatively assessing the predicted emission of: i. Solid particles; ii. Sulphur oxides; iii. Nitrogen oxides; and iv. Hydrocarbons.	Refer **Section 3.2**

Section/ number	Condition of approval / statement of commitments	Where addressed in this report
(d)	Assessing cumulative air impacts at a local and regional level (including but not limited to contemporaneous operations such as those of the proposed Commonwealth Government MIT; and	Refer **Section 5** and **Section 5.3.4**
(e)	A comprehensive air quality management plan that includes at least the following information: i. Explicit linkage of proposed emission controls to the site specific best practice determination assessment and assessed emissions; ii. The timeframe for implementation of all identified emission controls; iii. Proposed key performance indicator(s) for emission controls; iv. Proposed means of air quality monitoring including location (on and off-site), frequency and duration; v. Poor air quality response mechanisms; vi. Responsibilities for demonstrating and reporting achievement of key performance indicator(s); vii. Record keeping and complaints response register; and viii. Compliance reporting.	Refer **Section 7**
Statement of commitments		
The Proponent commits to undertaking a review of national and international 'best practice' for the design and operation of intermodal facilities to identify reasonable and feasible management strategies to reduce air quality and noise impacts associated with construction and operation of the intermodal terminal development stages of the proposal.		Refer **Section 7**. Not applicable for this stage of the development
The Proponent will undertake an air quality monitoring programme during the initial phases of both construction and operation of the SIMTA site in accordance with the Air Quality Impact Assessment and including: • Nuisance Dust • Air Emissions – PM_{10} and Nitrogen Dioxide		Refer to **Section 7**.
The Proponent shall consider the need to develop a vehicle efficiency and emissions reduction program for the facility to encourage good maintenance and efficient vehicle selection, taking into account the results of the air quality monitoring programme.		Refer **Section 7**. Not applicable for this stage of the development
The Proponent commits to the preparation of a Construction Environmental Management Plan prior to the construction of each stage to provide air quality and dust management mitigation procedures to be adopted during each of the construction phases of the development.		Refer **Section 7**. CEMPs have been prepared for each stage of development.

1.2 Overview of the Proposal

The Proposal involves the construction and operation of Stage 2 of the MPE Project, comprising warehousing and distribution facilities on the MPE site and upgrades to approximately 1.4 kilometres of Moorebank Avenue between the northern MPE site boundary and 120 metres south of the southern MPE site boundary.

Key components of the Proposal include:

- Warehousing comprising approximately 300,000m^2 GFA, additional ancillary offices and the ancillary freight village
- Establishment of an internal road network, and connection of the Proposal to the surrounding public road network
- Ancillary supporting infrastructure within the Proposal site, including:
  - Stormwater, drainage and flooding infrastructure
  - Utilities relocation and installation
  - Vegetation clearing, remediation, earthworks, signage and landscaping
- Subdivision of the MPE Stage 2 site
- The Moorebank Avenue upgrade would be comprised of the following key components:
  - Modifications to the existing lane configuration, including some widening
  - Earthworks, including construction of embankments and tie-ins to existing Moorebank Avenue road level at the Proposal’s southern and northern extents
  - Raking of the existing pavement and installation of new road pavement
  - Establishment of temporary drainage infrastructure, including temporary basins and / or swales
  - Raising the vertical alignment by about two metres from the existing levels, including kerbs, gutters and a sealed shoulder
  - Signalling and intersection works
- Upgrading existing intersections along Moorebank Avenue, including:
  - Moorebank Avenue / MPE Stage 2 access
  - Moorebank Avenue / MPE Stage 1 northern access
  - Moorebank Avenue / MPE Stage 2 central access
  - MPW Northern Access / MPE Stage 2 southern emergency access

The Proposal would interact with the MPE Stage 1 Project (SSD_6766) via the transfer of containers between the MPE Stage 1 IMT and the Proposal’s warehousing and distribution facilities. This transfer of freight would be via a fleet of heavy vehicles capable of being loaded with containers and owned by SIMTA. The fleet of vehicles would be stored and used on the MPE Stage 2 site, but registered and suitable for on-road use. The Proposal is expected to operate 24 hours a day, seven days per week.

To facilitate operation of the Proposal, the following construction activities would be carried out across and surrounding the Proposal site (area on which the Proposal is to be developed):

- Vegetation clearance
- Remediation works
- Demolition of existing buildings and infrastructure on the Proposal site
- Earthworks and levelling of the Proposal site, including within the terminal hardstand
- Drainage and utilities installation
- Establishment of hardstand across the Proposal site, including the terminal hardstand
- Construction of a temporary diversion road to allow for traffic management along the Moorebank Avenue site during construction (including temporary signalised intersections adjacent to the existing intersections) (the Moorebank Avenue Diversion Road)

- Construction of warehouses and distribution facilities, ancillary offices and the ancillary freight village
- Construction works associated with signage, landscaping, stormwater and drainage works.

Construction works associated with signage, landscaping, stormwater and drainage works. The Proposal would operate 24 hours a day, 7 days a week.

An overview of the Proposal is shown in **Figure A1-1 (Appendix 1)**.

1.3 Key terms relevant to the proposal

Table 1-3 provides a summary of the key terms relevant to the Proposal, which are included throughout this report.

Table 1-3: Summary of key terms used throughout this document

Term	Definition
General terms	
The Moorebank Precinct	Refers to the whole Moorebank intermodal precinct, i.e. the MPE site and the MPW site
Moorebank Precinct West (MPW) Project (formerly the MIC Project)	The MPW Intermodal Terminal Facility as approved under the MPW Concept Plan Approval (SSD_5066) and the MPW EPBC Approval (No. 2011/6086).
Moorebank Precinct West (MPW) site (formerly the MIC site)	The site which is the subject of the MPW Concept Plan Approval, MPW EPBC Approval and MPW Planning Proposal. The MPW site does not include the rail link as referenced in the MPW Concept Plan Approval or MPE Concept Plan Approval.
Moorebank Precinct East (MPE) Concept Plan Approval (formerly the SIMTA Concept Plan Approval)	MPE Concept Plan Approval (SSD_0193) granted by the NSW Department of Planning and Environment on 29 September 2014 for the development of former defence land at Moorebank to be developed in three stages; a rail link connecting the site to the Southern Sydney Freight Line, an intermodal terminal, warehousing and distribution facilities and a freight village.
Moorebank Precinct East (MPE) Project (formerly the SIMTA Project)	The MPE Intermodal Terminal Facility, including a rail link and warehouse and distribution facilities at Moorebank (eastern side of Moorebank Avenue) as approved by the Concept Plan Approval (MP 10_0913) and the MPE Stage 1 Approval (14_6766).
Moorebank Precinct East (MPE) Site (formerly the SIMTA Site)	Including the former DSNDC site and the land owned by SIMTA which is subject to the Concept Plan Approval. The MPE site does not include the rail corridor, which relates to the land on which the rail link is to be constructed.
Statement of Commitments (SoC)	Recommendations provided in the specialist consultant reports prepared as part of the MPE Concept Plan application to mitigate environmental impacts, monitor environmental performance and/or achieve a positive environmentally sustainable outcome in respect of the MPE Project. The Statement of Commitments have been proposed by SIMTA as the Proponent of the MPE Concept Plan Approval.
MPE Stage 1 Project-specific terms	
MPE Stage 1	Stage 1 (14-6766) of the MPE Concept Plan Approval for the development of the MPE Intermodal Terminal Facility, including the rail link at Moorebank. This reference also includes associated conditions of approval and environmental management measures which form part of the documentation for the approval.
MPE Stage 1 site	Includes the MPE Stage 1 site and the Rail Corridor, i.e. the area for which approval (construction and operation) was sought within the MPE Stage 1 Proposal EIS.
MPE Stage 2 specific terms	
MPE Stage 2 Proposal/ the Proposal	The subject of this EIS; being Stage 2 of the MPE Concept Plan Approval including the construction and operation of 300,000m^2 of warehousing

Term	Definition
	and distribution facilities on the MPE site and the Moorebank Avenue upgrade within the Moorebank Precinct.
MPE Stage 2 site	The area within the MPE site which would be disturbed by the MPE Stage 2 Proposal (including the operational area and construction area). The MPE Stage 2 site includes the former DSNDC site and the land owned by SIMTA which is subject to the MPE Concept Plan Approval. The MPE site does not include the rail corridor, which relates to the land on which the rail link is to be constructed.
The Moorebank Avenue site	The extent of construction works to facilitate the construction of the Moorebank Avenue upgrade.
The Moorebank Avenue upgrade	Raising of the vertical alignment of Moorebank Avenue for 1.5 kilometres of its length by about two metres, from the northern boundary of the MPE site to approximately 120 metres south of the MPE site. The Moorebank Avenue upgrade also includes upgrades to intersections, ancillary works and the construction of an on-site detention basin to the west of Moorebank Avenue within the MPW site.
Construction area	Extent of construction works, namely areas to be disturbed during the construction of the MPE Stage 2 Proposal (the Proposal).
Operational area	Extent of operational activities for the operation of the MPE Stage 2 Proposal (the Proposal).

2. PROPOSAL OVERVIEW

2.1 Regional context

The MPE site, including the Proposal site, is located approximately 27 km south-west of the Sydney Central Business District (CBD) and approximately 26 km west of Port Botany. The MPE site is situated within the Liverpool Local Government Area (LGA), in Sydney's South West subregion, approximately 2.5 km from the Liverpool City Centre.

The MPE site is located approximately 800 m south of the intersection of Moorebank Avenue and the M5 Motorway. The M5 Motorway provides the main road link between the MPE site, and the key employment and industrial areas within Sydney's West and South-Western subregions, the Sydney orbital network and the National Road Network. The M5 connects with the M7 Motorway to the west, providing access to the Greater Metropolitan Region and NSW road network. Similarly the M5 Motorway is the principal connection to Sydney's north and north-east via the Hume Highway.

The regional context of the Proposal is shown in **Figure A1-2 (Appendix 1)**.

2.2 Local context

The Proposal site is located approximately 2.5 km south of the Liverpool City Centre, 800 m south of the Moorebank Avenue/M5 Motorway interchange and one kilometre to the east of the SSFL providing convenient access to and from the site for rail freight (via a dedicated freight rail line) and for trucks via the Sydney Motorway Network.

The land surrounding the Proposal site comprises:

- The MPW site, formerly the School of Military Engineering (SME), on the western side of Moorebank Avenue directly adjacent to the MPE site (subject to the MPW Concept Plan Approval), which is owned by the Commonwealth;
- The East Hills Rail Corridor to the south of the MPE site, which is owned and operated by Sydney Trains;
- The Holsworthy Military Reserve, to the south of the East Hills Rail Corridor, which is owned by the Commonwealth; The Boot Land, to the immediate east of the MPE site between the eastern site boundary and the Wattle Grove residential area, which is owned by the Commonwealth.
- The southern Boot Land, to the immediate south of the MPE site between the southern site boundary and the East Hills Rail Corridor, which is owned by the Commonwealth.

Glenfield Waste Services, south-west of the Proposal is proposing to develop a Materials Recycling Facility on land owned by the Glenfield Waste Services Group within the boundary of the current landfill site at Glenfield. The facility is proposed to recycle a maximum of 450,000 tonnes of material per year. The Glenfield Waste Services Proposal is the subject of a DA (SSD_6249) under Part 4, Division 4.1 of the EP&A Act.

A number of residential suburbs are located in proximity to the Proposal site. The approximate distances of these suburbs to the MPE Stage 2 site and the Moorebank Avenue site are provided in **Table 2-1.**

Table 2-1: Distance to residential suburbs from the Proposal site

Suburb	Distance to MPE Stage 2 site	Distance to Moorebank Avenue site
Wattle Grove	360 m to the north-east	865 m to the north-east
Moorebank	1300 m to the north	1430 m to the north
Casula	820 m to the west	760 m to the west
Glenfield	1830 m to the south-west	1540 m to the south-west

The closest industrial precinct to the Proposal is at Moorebank, comprising around 200 hectares of industrial development. This area includes (but is not limited to) the Yulong and ABB sites to the south of the M5 Motorway and the Goodman MFive Business Park and Miscellaneous industrial and commercial development to the north of the M5 Motorway. The majority of this development is located to the north of the M5 Motorway between Newbridge Road, the Georges River and Anzac Creek. The Moorebank Industrial Area supports a range of industrial and commercial uses, including freight and logistics, heavy and light manufacturing, offices and business park developments.

There are other areas of industrial development near the Proposal at Warwick Farm to the north, Chipping Norton to the north-east, Prestons to the west and Glenfield and Ingleburn to the south-west. The local context of the Proposal is shown in **Figure A1-3 (Appendix 1)**.

2.3 Construction overview

Construction of the Proposal is proposed to take between 24 and 36 months, commencing in the final quarter of 2017, with the completion of construction in the third quarter of 2019 (should construction take 24 months). The final construction program will depend on the market demand for warehouses to be constructed on the MPE Stage 2 site.

The construction works have been divided into seven 'works periods' which are interrelated and also may overlap, as shown below. Subject to confirmation of construction staging, the order of these construction works periods may shift slightly.

- Works period A - pre-construction activities.
- Works period B - site preparation activities.
- Works period C – construction of the Moorebank Avenue diversion road
- Works period D - bulk earthworks, drainage and utilities.
- Works period E – pavement works along Moorebank Avenue.
- Works period F – warehouse construction and internal fit-out.
- Works period G - miscellaneous construction and finishing works.

An indicative construction programme and full description of the activities included in each works period is outlined in the main body of the EIS. Construction works would generally be undertaken during standard daytime construction working hours, being:

- 7 am to 6 pm Monday to Friday
- 8 am to 1 pm Saturday
- No works on Sunday or Public Holidays.

Bulk earthworks activities and construction works to facilitate the Moorebank Avenue upgrade during peak construction periods may be undertaken outside of standard construction hours, but not during the night-time (i.e. 10pm to 7am). An overview of the construction layout is shown in **Figure A1-4 (Appendix 1)**.

2.4 Operations overview

The Proposal involves the construction and operation of Stage 2 of the MPE Project, comprising warehousing and distribution facilities on the MPE site and upgrades to approximately two kilometres of Moorebank Avenue between Anzac Road and 200 metres south of the MPE site.

The Proposal would interact with the MPE Stage 1 Project (SSD_6766) via the transfer of containers between the MPE Stage 1 IMT and the Proposal's warehousing and distribution facilities. The vehicle movements associated with the transfer of containers between the MPE Stage 1 IMT and the Proposal would be within the Proposal site only, and would not impact on the surrounding road network.

The Proposal is expected to operate 24 hours a day, seven days per week.

2.4.1 Warehousing

The Proposal would provide up to 300,000m^2 of warehousing across the MPE Stage 2 site, with ancillary offices attached. The Proposal would include eight warehouses, which would be up to 21 metres in height and would range in size from 20,350m^2 to 61,500m^2. The Proposal would also include some internal fitout of the warehouses, namely the installation of racking and associated services. The Proposal would seek approval for the construction of these warehouses and also the operation of these warehouses by future tenants.

The indicative layout of the warehouses are shown in **Figure A1-4 (Appendix 1)**.

2.4.2 Freight village

A freight village including amenities would be provided on the MPE site as part of the Proposal. The ancillary freight village would be located in the north-west of the Proposal site, directly north of Warehouse 1 and east of Moorebank Avenue. The freight village would include five buildings which would provide for a mixture of retail, commercial and light industrial land uses, with a combined GFA of approximately 8,000m^2.

2.4.3 Vehicle movements and access

Access to and from the Proposal site would be via the existing DSNDC northern access, to the north of the MPE Stage 1 Project. Site access at this location would allow for vehicular access to warehouse and distribution facilities to enable the direct delivery and dispatch of goods to the warehouses.

<u>Internal roads</u>

The MPE Stage 2 site includes two main internal roads, which provided the main east-west and north-south traffic movements throughout the MPE Stage 2 site. On entering the MPE Stage 2 site, light and heavy vehicles would travel along an east-west oriented internal road (internal road 1). Internal road 1 would connect at its easternmost point to a second north-south oriented internal road (internal road 2).

Internal roads 1 and 2 would connect to three service roads which would provide vehicle access to warehouses, loading docks and car parking.

Internal road 2 would provide for traffic movements along the entire eastern perimeter of the Proposal, and would have a cul-de-sac at both the northern and southern ends to allow vehicles to turn around. The internal roads would be two lanes wide (one lane in each direction) and would be wide enough to accommodate heavy vehicle turning movements, including B-doubles.

<u>Service roads</u>

Three service roads would connect to the internal roads within the MPE Stage 2 site. The service roads would provide access to loading docks at warehouses for heavy vehicles to park and be packed with materials which have been received and stored within the warehouses. Service roads would also enable access to light vehicle parking for users of the warehouses. Each service road would have a cul-de-sac for vehicles to turn around, which would be able to accommodate turning movements of B-doubles.

Service road 1 would connect to internal road 1 via a T-intersection, and would provide access to Warehouse 1, Warehouse 2 and the ancillary freight village. Two additional service roads would connect to internal road 2 via t-intersections; service road 2 would provide access for warehouses 3, 4 and 5, and service road 3 would provide access to warehouses 6, 7 and 8.

Transfer roads

There would be three Transfer roads within the MPE Stage 2 site. These roads would provide connections between the warehouses and the MPE Stage 1 IMT. It is intended that the transfer of freight between the Stage 1 IMT and warehouses would be via an internal fleet of vehicles which would remain on the MPE Stage 2 site and would not use the external road network.

Transfer road 1 would travel mostly along the same path as internal road 1 and provide access between the Stage 1 IMT facility and Warehouses 1, 2 and 3. Transfer road 2 would travel through the centre of the MPE Stage 2 site and would provide access between the Stage 1 IMT facility and Warehouses 4, 5, 6 and 8. Transfer road 3 would travel along the southern boundary of the MPE site, and provide access between the Stage 1 IMT facility and Warehouses 7 and 8.

With the exception of transfer road 1, which travels along the same path as internal road 1, the movement of internal fleet vehicles along transfer roads would be separated from light and heavy vehicles entering and exiting the MPE Stage 2 site to maintain efficiency and to provide for a safe internal road network.

2.4.4 Roadworks – Moorebank Avenue

As part of the Proposal, Moorebank Avenue would be upgraded for about 1.4 kilometres. The Moorebank Avenue upgrade commences from approximately 95 metres south of the northern boundary of the MPE site to approximately120 metres south of the southern MPE site boundary. The Moorebank avenue upgrade is located within the existing Moorebank Avenue road corridor and along the eastern boundary of the MPW site (refer to **Figure A1-1 (Appendix 1)** for extent of works).

The Moorebank Avenue upgrade would be comprised of the following key components:

- Modifications to the existing lane configuration, including some widening
- Signalling and intersection works.
- Raising the vertical alignment by about two metres from the existing levels, including kerbs, gutters and a sealed shoulder

3. STUDY APPROACH

3.1 Assessment approach

The approach to the assessment follows guidelines recommended in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") (NSW Environment Protection Authority (EPA), 2005a).

Localised air quality impacts as a result of the Proposal have been assessed using a Level 2 assessment approach in general accordance with the Approved Methods (refined dispersion modelling technique using site-specific input data). The assessment approach for the Proposal is as follows:

- Emissions were estimated for Proposal related activities, using best practice emission estimation techniques.
- Dispersion modelling was undertaken using a regulatory dispersion model to predict ground level concentrations for key pollutants as a result of the Proposal at nearby sensitive receivers.
- Assessment of cumulative impacts, taking into account the combined effect of existing baseline air quality, other local sources of emissions, reasonably foreseeable future emissions and any indirect or induced effects on air quality.

3.2 Pollutant indicators

The key emissions to air during the construction phase of the Proposal are fugitive dust or particulate matter (PM) generated during demolition, site clearing and earthworks. During operation of the Proposal, the key emissions would be associated with the combustion of diesel and other fossil fuels.

The air quality indicators that have been considered in this report are summarised in **Table 3-1**.

Table 3-1: Air quality indicators for assessment

Phase	Emission source	Air quality indicator
Construction	Fugitive dust	Particulate matter (TSP[1], PM_{10}[2] and $PM_{2.5}$[3])
		Nuisance dust (dust deposition)
Operations	Diesel and fossil fuel combustion	PM_{10} and $PM_{2.5}$
		Oxides of nitrogen (NO_x)
		Sulphur dioxide (SO_2)
		Carbon monoxide (CO).
		Volatile organic compounds (VOCs)

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

3.3 Assessment criteria for particulate matter

When first regulated, assessment of airborne particulate matter (PM) was based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometers (µm) in diameter. As air sampling technology has improved and the importance of particle size and chemical composition became more apparent, ambient air quality standards have been revised to focus on PM of smaller diameters (i.e. finer particles), which are thought to be most dangerous to human health.

Contemporary air quality assessment typically focuses on "coarse" and "fine" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$[1].

[1] Particulate matter with an aerodynamic diameter of less than 10 µm and 2.5 µm respectively.

Air quality criteria for PM in Australia are provided for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. Impact assessment criteria are prescribed by the NSW EPA for TSP and PM_{10}, however not for $PM_{2.5}$.

Under the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), national reporting standards were initially prescribed for 24-hour average PM_{10} concentrations (National Environmental Protection Council (NEPC), 1998). The AAQ NEPM was revised in 2003 to include 'advisory reporting standards' for $PM_{2.5}$ (NEPC, 2003) and again in 2015 to adopt these 'advisory reporting standards' as formal standards for $PM_{2.5}$ (NEPC, 2015). The latest variation also introduces an annual reporting standard for PM_{10} and establishes long term goals for $PM_{2.5}$, to be achieved by 2025 (NEPC, 2015).

It is noted that the purpose of the AAQ NEPM is to attain *'ambient air quality that allows for the adequate protection of human health and wellbeing',* and compliance with the AAQ NEPM is assessed through air quality monitoring data collected and reported by each state and territory. The AAQ NEPM standards are therefore not necessarily applicable to the assessment of impacts of emissions sources on individual sensitive receptors and for the purpose of this report, impacts have been preferentially assessed against the NSW EPA's impact assessment criteria. In the case of $PM_{2.5}$, where impact assessment criteria do not exist, impacts are reported against the latest AAQ NEPM standards.

The NSW EPA's impact assessment criteria and AAQ NEPM standards and goals for PM, against which the potential impacts of the Proposal have been assessed, are presented in **Table 3-2**.

Table 3-2: Impact assessment criteria for PM

<table>
<tr><th>PM metric</th><th>Averaging period</th><th>Concentration (µg/m³)</th><th>Purpose</th></tr>
<tr><td>TSP</td><td>Annual</td><td>90</td><td>NSW EPA impact assessment criteria</td></tr>
<tr><td rowspan="4">PM_{10}</td><td rowspan="2">24 hour</td><td>50</td><td>NSW EPA impact assessment criteria</td></tr>
<tr><td>50</td><td>AAQ NEPM national reporting standard</td></tr>
<tr><td rowspan="2">Annual</td><td>30</td><td>NSW EPA impact assessment criteria</td></tr>
<tr><td>25</td><td>AAQ NEPM national reporting standard</td></tr>
<tr><td rowspan="4">$PM_{2.5}$</td><td rowspan="2">24 hour</td><td>25</td><td>AAQ NEPM national reporting standard</td></tr>
<tr><td>20</td><td>AAQ NEPM national reporting standard</td></tr>
<tr><td rowspan="2">Annual</td><td>8</td><td>AAQ NEPM goal for 2025</td></tr>
<tr><td>7</td><td>AAQ NEPM goal for 2025</td></tr>
</table>

For the construction phase of the Proposal, amenity impacts associated with construction dust need to be considered. The NSW EPA impact assessment criteria for dust deposition are summarised in **Table 3-3**, which include the maximum acceptable increase and total dust deposition rates to minimise the impacts of construction dust on sensitive receivers as much as possible.

Cumulative annual average dust deposition rates within residential areas, which are in excess of 4 $g/m^2/month$, are generally considered to indicate that nuisance dust impacts may occur.

Table 3-3: Impact assessment criteria for nuisance dust

Pollutant	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust	2 g/m2/month	4 g/m2/month

3.4 Assessment of gaseous pollutants

3.4.1 Oxides of nitrogen

Oxides of nitrogen are produced when fossil fuels are combusted in internal combustion engines (such as motor vehicles). Nitrogen oxides (NO_x) emitted by fossil fuel combustion are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is the regulated component. NO is much less harmful to humans than NO_2, and is not generally considered a risk at the concentrations normally found in urban environments. Concern with NO is related more to its transformation to NO_2 and its role in the formation of photochemical smog.

The dominant mechanism for short-term conversion of NO to NO_2 is through oxidation with atmospheric ozone (O_3) as an exhaust plume travels from source, based on the following equation:

$$NO + O_3 \equiv NO_2 + O_2$$

Therefore, to predict the ground-level concentration of NO_2 it is important to account for the transformation of NO_x to NO_2.

3.4.2 Carbon monoxide

Carbon monoxide (CO) is produced from the incomplete combustion of fuels, where carbon is only partially oxidised instead of being fully oxidised to form carbon dioxide. CO can be harmful to humans because its affinity for haemoglobin is more than 200 times greater than that of oxygen. When CO is inhaled, it is taken up by the blood and therefore reduces the capacity of the blood to transport oxygen, although this process is reversible. Symptoms of CO intoxication are lethargy and headaches. These symptoms are generally not apparent until relatively high ambient atmospheric concentrations of CO are reached.

3.4.3 Sulfur dioxide

Sulfur dioxide (SO_2) is formed when fuel containing sulfur (mainly coal and oil) is burned. The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in pulmonary defences, and aggravation of existing cardiovascular disease. SO_2 is a major precursor to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility. Emissions of SO_2 from diesel exhaust have progressively declined in Australia as increasingly stringent sulfur fuel standards have been introduced. Under the *Fuel Quality Standards Act* (2000) (Cwlth), the maximum sulfur content of diesel fuel is now 10 ppm, which is just 2% of what it was less than 10 years ago.

3.4.4 Volatile organic compounds

Volatile organic components (VOCs) refer to a collection of various compounds, several of which are considered air toxics. Air toxics are present in the air in low concentrations; however, characteristics such as toxicity or persistence mean that they can be hazardous to human, plant or animal life. There is evidence that cancer, birth defects, genetic damage, immuno-deficiency, respiratory and nervous system disorders can be linked to exposure to occupational levels of air toxics.

Organic hydrocarbons (HC) also include reactive organic compounds which play a role in the formation of photochemical smog. While many VOC species are emitted from combustion of fossil fuels, benzene, 1,3-butadiene and polycyclic aromatic hydrocarbons (PAHs) have been considered in this assessment as they are categorized in the Approved Methods as principal toxic air pollutants and are among the species with the most stringent air quality impact assessment criteria.

3.4.5 Speciation of total VOC emissions

The assessment of individual VOCs are based on the speciation profiles reported by the US EPA and in the NSW emissions inventory for the Greater Metropolitan Region of NSW (GMR).

Emissions of 1,3-butadiene, benzene and PAHs as a result of the Proposal have been derived based on the percentage of total VOCs for each species presented in **Table 3-4**.

Table 3-4: Speciation profiles for VOCs

Source	% of total VOC		
	Benzene	**1,3-butadiene**	**PAHs**
Warehousing (gas combustion)[1]	1.6%	0.7%	0.1%
Light vehicles[2]	4.95%	1.27%	0.56%
Trucks[3]	1.07%	0.4%	1.65%

Source:
[1] Based on speciated emission factors outlined in AP42 3.2 Natural Gas-fired Reciprocating Engines
[2] Based on speciation profiles for petrol vehicles in Table D1 of NSW EPA (2012b)
[3] Based on speciation profiles for deisel vehicles in Table D4 of NSW EPA (2012b)

3.4.6 Impact assessment criteria for gaseous pollutants

The impact assessment criteria for gaseous products of combustion are summarised in **Table 3-5**. The impact assessment criteria for 'criteria pollutants[2]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (i.e. consideration of background is required for criteria pollutants). The impact assessment criteria for 'air toxics' are applied at, and beyond the site boundary and reported as the 99.9th percentile of the dispersion modelling predictions. Only incremental impacts for these pollutants need be reported. Air toxics include the various VOC components of diesel exhaust emissions.

Table 3-5: Impact assessment criteria for gaseous products of combustion

Pollutant	Averaging period	Concentration	
		µg/m³ [1]	**pphm[2]**
NO_2	1-hour	246	12
	Annual	62	3
SO_2	10-minute	712	25
	1-hour	570	20
	24-hour	228	8
	Annual	60	2
CO	15-minute	100,000	8,700
	1-hour	30,000	2,500
	8-hour	10,000	900
1,3-butadiene	1-hour[3]	40	1.8
Benzene	1-hour[3]	29	0.9
PAHs (as BaP)	1-hour[3]	0.4	-

Note 1: Gas volumes for criteria pollutants expressed at 0°C and 1 atmosphere, and principal toxics at 25°C
Note 2: pphm – parts per hundred million
Note 3: Expressed as the 99.9th Percentile Value.

[2] '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.

3.5 Dispersion model selection

Local air quality impacts as a result of the Proposal have been modelled using AERMOD. AERMOD is the US EPA's recommended steady-state plume dispersion model for regulatory purposes and is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings including rural and urban environments, as well as flat and complex terrain. AERMOD is able to predict pollutant concentrations from point, area and volume sources in addition to 'open pit' sources.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006. Ausplume, a steady state Gaussian plume dispersion model developed by the Victorian EPA and recommended in the Approved Methods for simple near-field applications, is largely based on the ISC model. Compared to ISC and Ausplume, AERMOD represents an advanced new-generation model, which requires additional meteorological and land use inputs to provide more refined predictions.

The most important feature of AERMOD, compared to ISC and Ausplume, is its modification of the basic dispersion model to account more effectively for a variety of meteorological factors and surface characteristics. In particular, it uses the Monin-Obukhov length scale rather than Pasquill-Gifford stability categories to account for the effects of atmospheric stratification. In comparison, Ausplume and ISC parameterise dispersion based on semi-empirical fits to field observations and meteorological extrapolations, AERMOD uses surface-layer and boundary layer theory for improved characterisation of the planetary boundary layer turbulence structure.

AERMOD has been approved by the EPA for use in NSW on a number of projects and is likely to be included in the EPA's impending review of the Approved Methods. Further detail on model set up, in particular the process for preparation of meteorological data in the AERMET pre-processor, is provided in **Appendix 2**.

3.6 Cumulative impacts

Cumulative impacts have been assessed by combining the contribution of emissions to air as a result of the Proposal with the following sources:

- The existing ambient air quality environment, described based on baseline monitoring data collected in the vicinity of the Proposal (described in **Section 4.2**).
- Approved future sources of air emissions near the Proposal, including the construction and future operation of the MPE Stage 1 Project and the MPW Stage 2 Project.

It is noted that the Glenfield Waste Services (GWS) site, located to the southwest of the Proposal site, has a current SSD application for a Material Recycling Facility, capable of processing up to 450,000 tonnes per annum of general solid waste. An Air Quality Assessment prepared for the application (SLR, 2015) indicates that concentrations of $PM_{2.5}$ from the facility would be minor (annual average < 0.2 µg/m^3). As $PM_{2.5}$ is the key limiting pollutant for the operation of the Proposal, no further cumulative consideration of the GWS site is considered.

3.7 Assessment locations

A number of residential suburbs are located in proximity to the Proposal site, including:

- Wattle Grove, located approximately 640 m from the Proposal site.
- Moorebank, located approximately 870 m from the Proposal site.
- Casula, located approximately 1.3 km from the Proposal site.
- Glenfield, located approximately 2 km from the Proposal site.

Locations representative of these residential areas and other sensitive receptors such as schools and day care centres have also been identified and selected as discrete sensitive receptors. The locations are consistent with those reported in all previous air quality assessments for the Moorebank Precinct.

The assessment locations are shown in **Figure 3-1** and listed in **Appendix 3**.

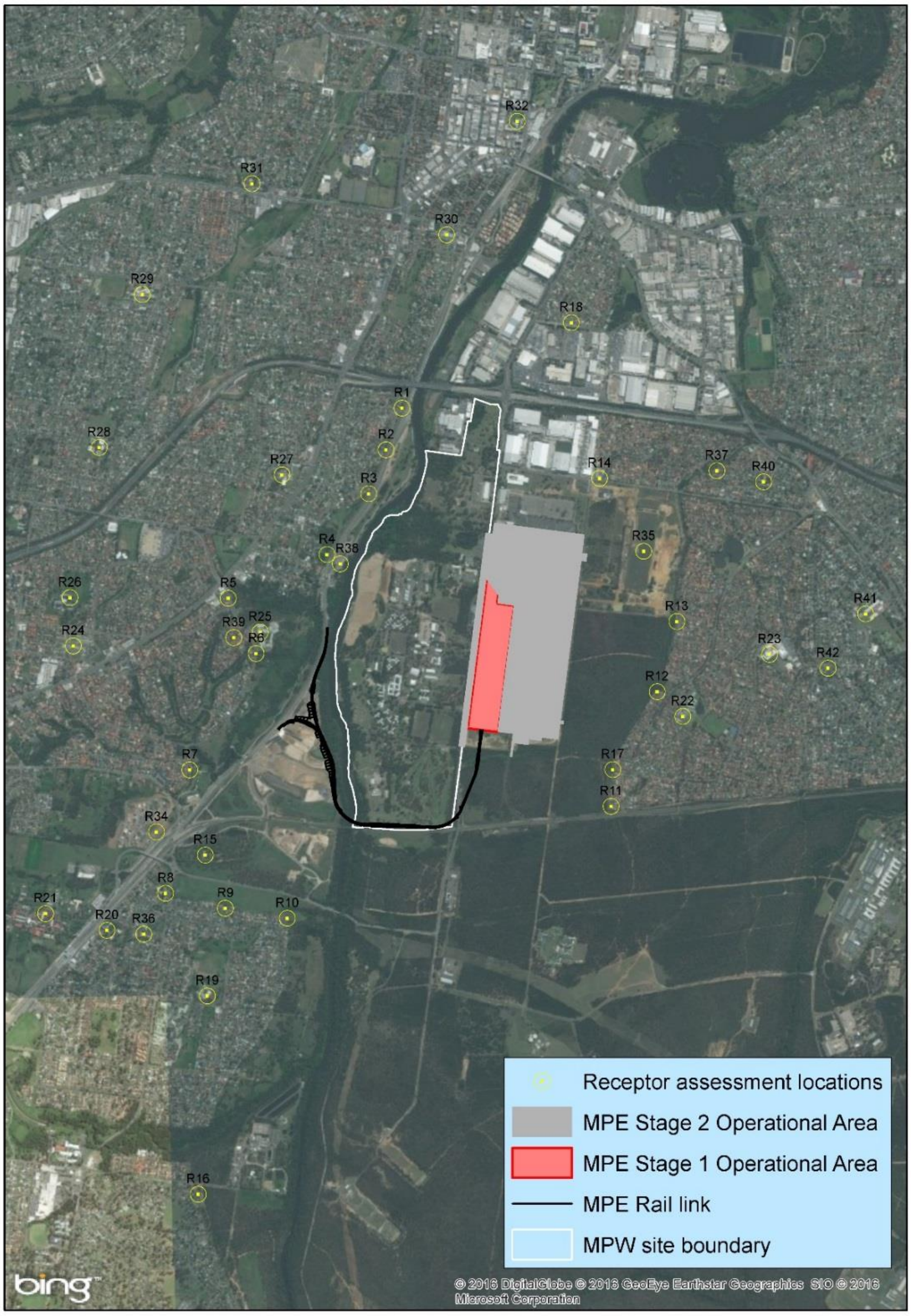


Figure 3-1: Receptor locations

4. EXISTING ENVIRONMENT

4.1 Meteorology

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

Previous air quality assessments prepared for the MPE Stage 1 Project, and the MPW Stage 2 Proposal have demonstrated that the Liverpool monitoring site operated by the Office of Environment and Heritage (OEH) is representative of the local area, largely due to the proximity of the station to the Proposal site, the elevation at which it is sited and the uncomplicated intervening topography (ENVIRON, 2014; ENVIRON, 2015b).

An analysis of the most recent 5 years of wind data from the OEH's Liverpool site shows that there was relatively little inter-annual variability in wind speed and direction between 2011 and 2014, with a slight shift in 2015 from southwest to westerly flow (see **Appendix 2**). The 2013 meteorological dataset used in the MPE Stage 1 air quality assessment (ENVIRON, 2015b) remains a suitable representative dataset for modelling, and is adopted for this assessment.

4.1.1 Prevailing winds

An annual wind rose of recorded wind speed and direction data from the OEH's Liverpool station during 2013 is presented in **Figure 4-1**. The annual recorded wind pattern is dominated by southwest to westerly airflow. The highest wind speeds recorded at the location are most frequently experienced from the southwest to westerly direction.

The average recorded wind speed for 2013 was approximately 2 m/s, with calm conditions (wind speeds less than 0.5 m/s) occurring approximately 12% of the time.

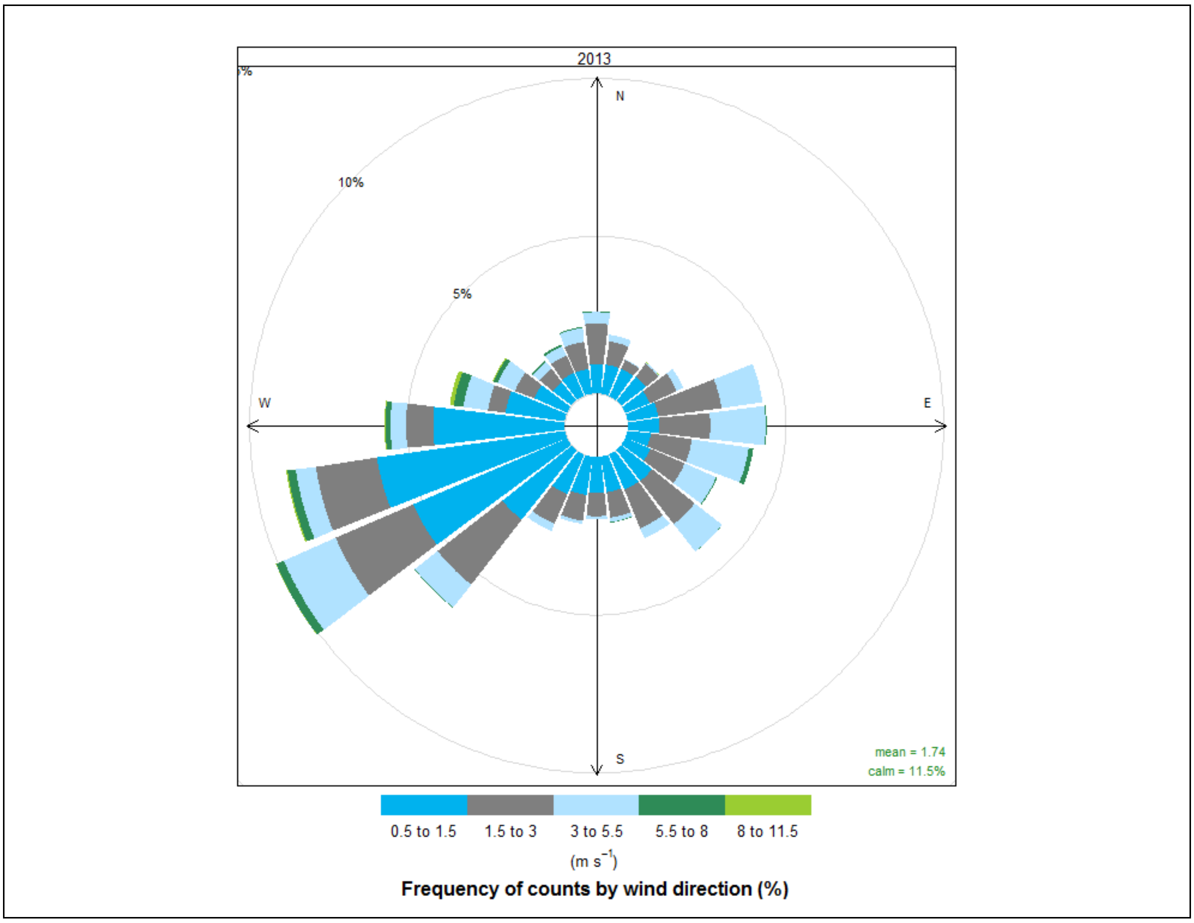


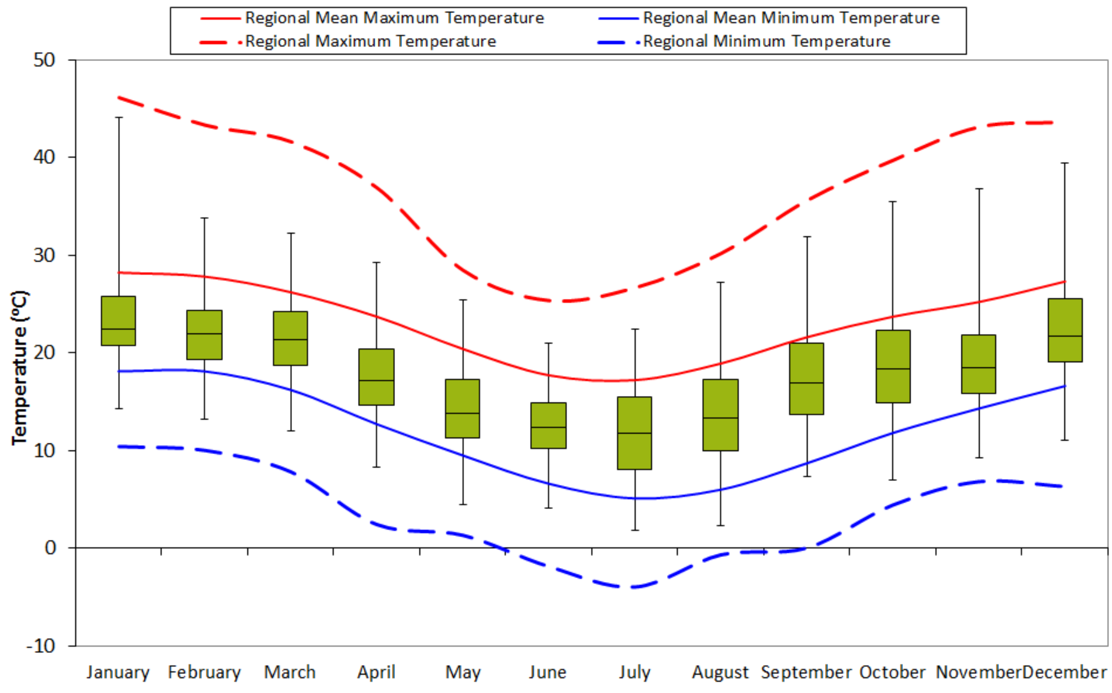
Figure 4-1: Annual wind rose for 2013 – OEH site at Liverpool

Seasonal and diurnal wind roses for the 2013 OEH Liverpool station dataset are presented within **Appendix 4**. The dominant southwest to westerly component evident in the annual wind direction profile is most defined during autumn and winter (both day and night time hours) and spring (night time hours only). There is a shift in wind during daylight hours in summer, where a dominant easterly flow is evident. Mean wind speeds are higher during day time hours and the occurrence of calm wind conditions are more frequent at night.

4.1.2 Ambient temperature

Figure 4-2 presents the monthly variation in recorded temperature during 2013 compared with the recorded regional mean, minimum and maximum temperatures.

Monthly mean minimum temperatures are in the range of 5°C to 18°C, with monthly mean maximum temperatures of 17°C to 28°C, based on the long-term average record from the Bureau of Meteorology (BoM) Bankstown Airport Automatic Weather Station (AWS). Peak temperatures occur during the summer months, with the highest temperatures typically being recorded between November and March. The lowest temperatures are usually experienced between May and September. The temperatures recorded during 2013 at the OEH Liverpool station have been compared with long-term trends recorded at the BoM Bankstown Airport AWS to determine the representativeness of the dataset. There is good agreement between temperatures recorded during 2013 and the recorded historical trends, indicating that the dataset is representative of conditions experienced in the region.



Note: Temperatures recorded during 2013 at the OEH Liverpool station 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 BoM Bankstown Airport are depicted as line graphs.

Figure 4-2: Temperature comparison between OEH Liverpool 2013 data and historical averages (1968-2013) – BoM Bankstown Airport

4.1.3 Rainfall

Precipitation is important to air pollution studies, as it impacts on dust generation potential and represents a removal mechanism for atmospheric pollutants. Based on historical data recorded since 1968 at Bankstown Airport, the region is characterised by moderate rainfall, with a mean annual rainfall of 870 mm, and an annual rainfall range between 493 mm and 1,398 mm.

There is significant variation in monthly rainfall throughout the year, with the summer and autumn months typically experiencing higher falls than the remainder of the year. To provide a conservative (upper bound) estimate of the pollutant concentrations, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report.

4.1.4 Atmospheric stability and boundary layer depth

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

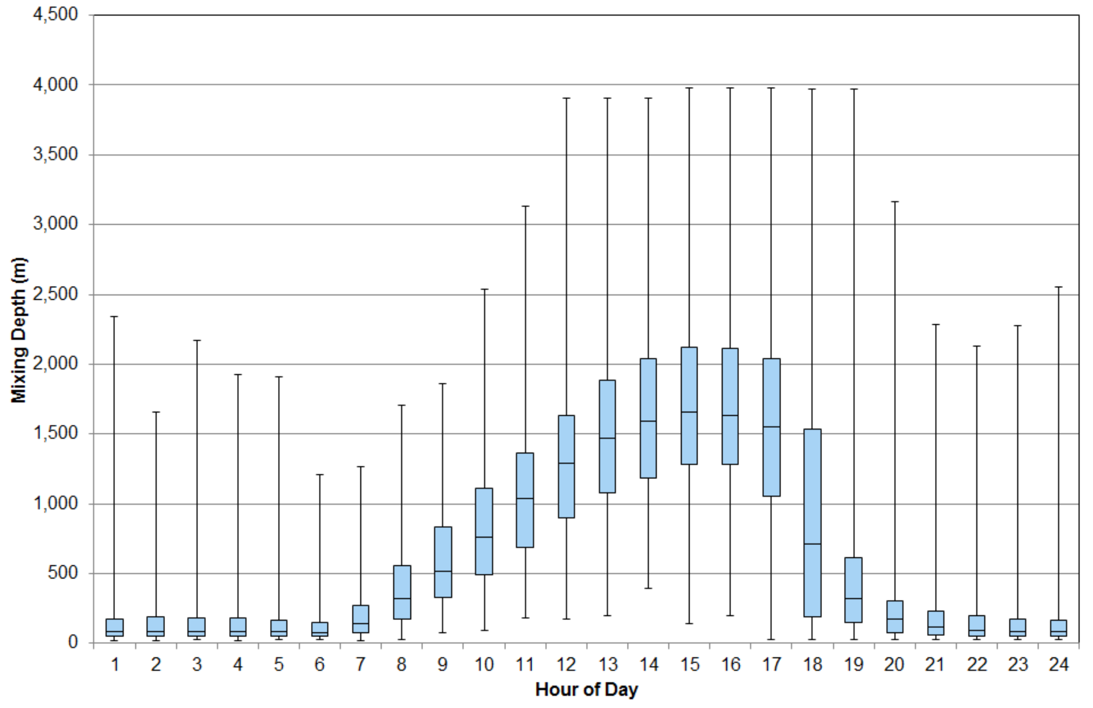
During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Elevated inversions may occur for a variety of reasons including anticyclonic subsidence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

Hourly-varying atmospheric boundary layer heights were generated for modelling by AERMET, the meteorological processor for the AERMOD dispersion model, using a combination of surface observations from the on-site weather station, sunrise and sunset times and adjusted TAPM[3]-predicted upper air temperature profile. The variation in average boundary layer heights by hour of the day is illustrated in **Figure 4-3**, which shows that greater boundary layer heights are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.

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 4-4 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET for modelling. 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.

[3] The Air Pollution Model (TAPM) is a prognostic meteorological model, developed by CSIRO. As described in ENVIRON (2015a and b) TAPM is used to supplement the meteorological monitoring data. It is used for parameters not measured (i.e. upper air profile data) and to fill in gaps in the data record.



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

Figure 4-3: AERMET-generated diurnal variations in average boundary layer depth

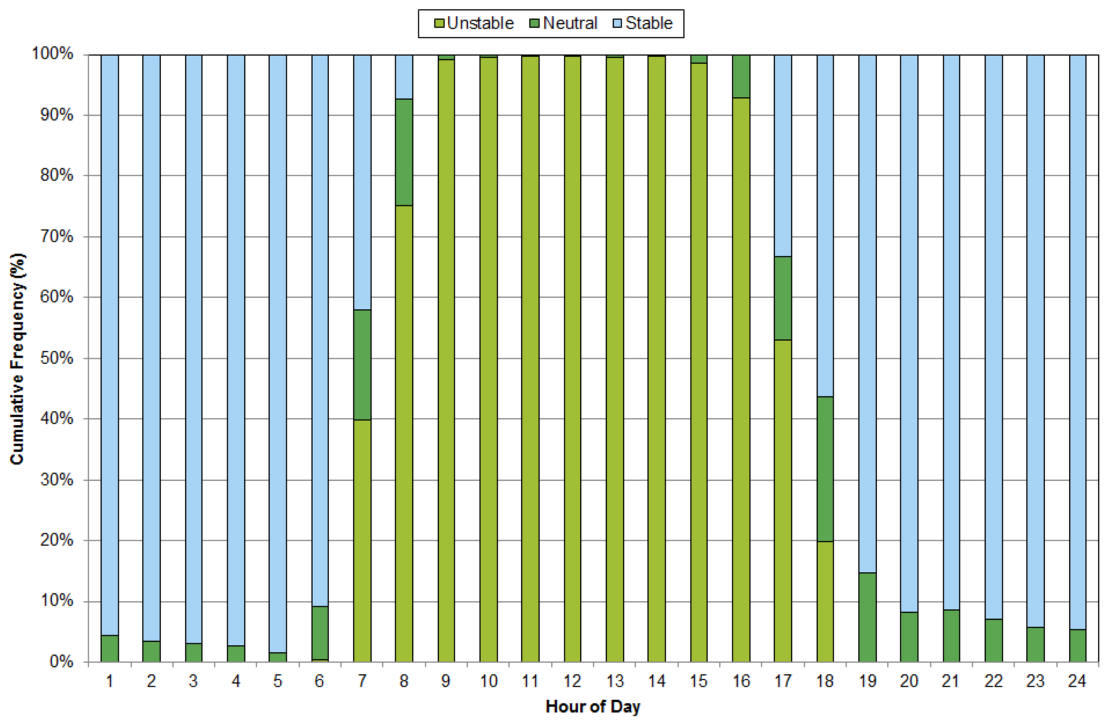


Figure 4-4: Diurnal variations in AERMET-generated atmospheric stability

4.2 Baseline ambient air quality

For this report, background air quality is described with reference to monitoring data from a nearby monitoring station operated by the OEH. The Liverpool OEH site is located on Rose Street, situated in a mixed residential and commercial area and approximately 2.5 km northwest of the Proposal. The monitoring station measures PM_{10}, $PM_{2.5}$, NO_2, O_3 and CO, however does not include monitoring for SO_2 and reference is therefore also made to the OEH monitoring site at Chullora, located approximately 12 km northeast of the Proposal site.

Ambient air quality monitoring data has also been collected at the Proposal site, initially established for the MPW Concept Plan EIS (Parsons Brinckerhoff, 2014a). However, insufficient data is available from this source to adequately describe baseline conditions. The MPW Concept Plan EIS compared the onsite data with the OEH Liverpool station and found that concentrations recorded at the OEH Liverpool station were generally higher and concluded that the OEH Liverpool station data provided a suitable conservative dataset for use in the assessment. For the purpose of the air quality impact assessment for the Proposal, the same assumptions have been adopted, and the OEH Liverpool station data has been used.

4.2.1 Summary statistics

The relevant summary statistics for PM_{10} and $PM_{2.5}$ for the previous five years from the Liverpool OEH monitoring site are presented in **Table 4-1**. Annual mean PM_{10} concentrations range from 18 µg/m³ to 21 µg/m³ and on average over the past 5 years baseline concentrations are 77% of the AAQ NEPM standard. Annual mean $PM_{2.5}$ concentrations range from 6 µg/m³ to 9 µg/m³ and on average over the past 5 years baseline concentrations are 103% of the AAQ NEPM standard. Exceedances of the 24-hour average reporting standards for both PM_{10} and $PM_{2.5}$ have occurred in three of the past five years and are typically associated with bushfires, back burning and/or dust storms (NSW EPA, 2016).

Table 4-1: Summary statistics (µg/m³) for particulate matter – Liverpool OEH monitoring site

Pollutant	Statistic	2011	2012	2013	2014	2015
PM_{10}	Mean	18.2	19.8	21.1	19.1	18.6
	Max daily	68.8	42.5	98.5	40.8	68.6
	99th percentile	58.5	65.9	71.9	57.7	56.6
	95th percentile	37.9	41.6	45.5	39.3	38.9
	Days over 50 µg/m³	1	0	3	0	1
$PM_{2.5}$	Mean	5.9	8.5	9.5	8.7	8.5
	Max daily	38.0	24.9	73.8	24.3	32.2
	99th percentile	28.4	32.9	39.5	32.6	38.6
	95th percentile	16.6	22.6	25.8	21.9	22.7
	Days over 25 µg/m³	2	0	2	0	2

Existing concentrations of PM_{10} and $PM_{2.5}$ for the Liverpool area are strongly influenced by vehicle emissions and wood heaters. Evidence of this can be seen by plotting the mean hourly PM_{10} and $PM_{2.5}$ by hour of the day and by month of the year for the previous 5 years.

Figure 4-5 shows the mean hourly concentration by hour of the day (left panel), month of the year (middle panel) and day of the week (right panel) for PM_{10} and $PM_{2.5}$. For PM_{10}, there is a morning peak in concentrations around 7am-8am, an afternoon inter-peak at 2-3pm and an evening peak at 6pm, most likely driven by vehicle emissions. PM_{10} concentrations are also clearly lower on Saturdays and Sundays, due to less vehicle emissions, and generally higher in warmer months, due to dryer conditions with greater potential for fugitive dust.

For $PM_{2.5}$ the monthly profile shows that $PM_{2.5}$ concentrations are highest in cooler months, which is evidence of the influence of wood heater emissions. The evening peak occurs later than PM_{10}, around 9pm, and the morning peak occurs earlier, prior to 6am, again evidence of the influence of wood heaters.

Although $PM_{2.5}$ concentrations for the Liverpool area are currently non-compliant with the NEPM AAQ standards, regulatory initiatives such as the NSW EPA Clean Air Plan outline potential actions for wood heaters and transport emissions, which are expected to play an important role in driving down long term ambient concentrations by 2027 (State of NSW, 2016).

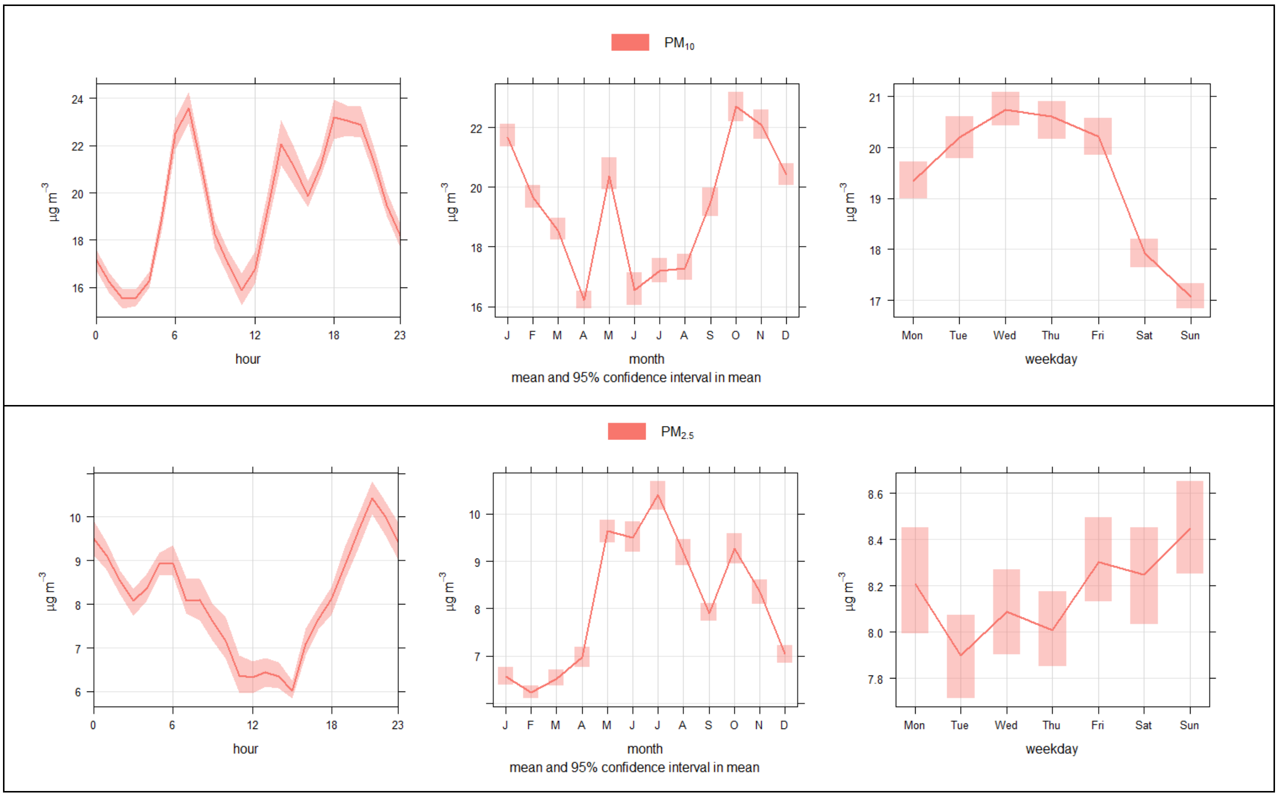


Figure 4-5: Time variation plot of PM_{10} and $PM_{2.5}$ for the Liverpool area

The relevant summary statistics for the NO_2, SO_2 and CO for the previous five years from the Liverpool OEH site are presented in **Table 4-1**. There have been no exceedances of the air quality standards in Liverpool for the previous five years and in general, background air quality for these pollutants is considered good.

On average over the past five years, baseline concentrations for NO_2 are 33% of the AAQ NEPM standard for annual mean and 42% for maximum 1 hour average.

Relative to the AAQ NEPM standards, baseline concentrations for CO and SO_2 are even lower. For example, maximum 1-hour baseline concentrations are 12% of the AAQ NEPM standard for CO and 10% for SO_2.

Table 4-2: Air quality statistics (μg/m³) for gaseous pollutants – Liverpool OEH monitoring site

Pollutant	Statistic	2011	2012	2013	2014	2015
NO_2	Mean	19.8	18.0	22.9	21.3	20.1
	Max hourly	94.3	94.3	114.8	90.2	123.0
CO	Max hourly	3.8	3.3	5.0	3.1	2.9
	Max 8-hour rolling	3.0	2.4	2.6	2.8	2.3
SO_2	Mean	2.6	2.2	1.6	1.9	1.5
	Max hourly	60.1	74.4	71.5	34.3	54.3
	Max daily	12.6	13.6	11.2	9.0	10.3
Note: SO_2 is not measured at Liverpool and data are therefore presented for the Chullora monitoring site for the 5 year period 2010 - 2014						

4.2.2 TSP concentration and nuisance dust deposition

TSP concentrations are not measured in the vicinity of the Proposal site, however historical measurements of TSP and PM_{10} in Sydney[4] indicate that PM_{10}/TSP ratios in urban areas typically range from 0.4 to 0.5. These ratios can be applied to the PM_{10} concentration data to derive an annual average TSP concentration.

Monitoring for dust deposition as part of the MPW Concept Plan Approval was conducted at three locations across the suburbs of Wattle Grove, Casula and Glenfield. Dust deposition levels range from 0.6 g/m²/month and 0.8 g/m²/month, expressed as an annual average (insoluble solids).

4.2.3 Adopted background for cumulative assessment

To demonstrate compliance with the impact assessment described in Section 3, consideration of cumulative air quality impacts is required, including how the Proposal will interact with existing and future sources of air emissions. A number of existing and potential future sources in the area will influence the local air shed to varying degrees, including, but not limited to:

- Traffic emissions from the wider road network including the South Western Motorway (M5).
- Emissions from diesel locomotives using the Southern Sydney Freight Line (SSFL) and the East Hills rail line.
- Existing commercial and industrial facilities, including the Greenhills Industrial Estate and Moorebank Business Park to the north.
- The Glenfield Waste Facility to the southwest of the site.
- Emissions from aircraft at Bankstown Airport to the northeast.
- The MPE Stage 1 Project and MPW Stage 2 Project.

Baseline or background air quality is assumed to include the contribution from all existing emissions sources.

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

Cumulative assessment for annual average PM_{10}, $PM_{2.5}$ and NO_2 and is based on the five year average of the mean background concentrations presented in **Table 4-1** and **Table 4-2**.

As previously described, background concentrations of $PM_{2.5}$ already exceed the NEPM AAQ reporting standard, therefore assessment of impacts will also be discussed in the context of the incremental increase from the Proposal.

For short term impacts, daily varying PM_{10} and $PM_{2.5}$ concentrations and hourly varying concentrations for NO_2 are paired with modelling predictions for assessment of cumulative impacts.

Cumulative assessment for CO and SO_2 impacts (1 hour, 8 hour, 24-hour and annual) is based on the maximum background concentration for the five year period presented in **Table 4-2**. This conservative approach is possible due to the relatively low background concentrations for these pollutants.

The background values are adopted for cumulative assessment are summarised in **Table 4-3**.

Table 4-3: Adopted background for cumulative assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average	Daily varying
	Annual average	19.4 µg/m³
$PM_{2.5}$	24-hour average	Daily varying
	Annual average	8.2 µg/m³
NO_2	1-hour average	Hourly varying
	Annual average	20.4 µg/m³
CO	1-hour average	5.0 mg/m³
	8-hour average	30 mg/m³
SO_2	1-hour average	74.4 µg/m³
	24-hour average	13.6 µg/m³
	Annual average	2.6 µg/m³
TSP	Annual average	48.4 µg/m³
Dust deposition	Annual average	1 g/m²/month

5. EMISSION INVENTORY

5.1 Emissions scenarios

Emissions and modelling scenarios for the construction and operation of the Proposal are as follows:

Proposal scenarios

- Scenario 1: Construction of the Proposal, including construction works associated with the MPE Stage 2 site and the Moorebank Avenue upgrade.
- Scenario 2: Operation of the Proposal, as described in Section 2.4.

Cumulative scenarios

- Scenario 1a: Concurrent construction of the Proposal with construction of the MPE Stage 1 Project and MPW Stage 2 Project.
- Scenario 2a: Cumulative operation of the Moorebank Precinct, incorporating a combined precinct total 750,000 TEU (250,000 TEU for the MPE Stage 1 and 500,000 TEU for the MPW Stage 2) plus 515,000 m^2 of warehousing (300,000 m^2 for MPE Stage 2 and 215,000 m^2 for MPW Stage 2).

5.2 Scenario 1 - Construction phase emissions

Construction of the Proposal has been indicatively divided into seven 'works periods' as listed in **Section 2.3**. The stage of construction which incorporates activities with the greatest potential for dust emissions is the bulk earthworks (works period E). The indicative construction program shows that bulk earthworks may overlap with the construction works for Moorebank Avenue (including the diversion road (works period C) and pavement and intersection works (works period D)).

Therefore, a representative worst case construction scenario is selected to include bulk earthworks and construction activities associated with Moorebank Avenue upgrades.

Emission factors developed by the US EPA[5] have been applied to estimate the amount of dust generated by each construction activity, as follows:

- Hauling of imported fill material along unsealed haulage routes.
- Trucks unloading fill material.
- Fill material re-handle using dozers and excavators.
- Vegetation cleaning and topsoil stripping.
- Graders on internal road construction.
- Wind erosion from exposed surfaces and stockpiles.

Emissions are estimated based on the following assumptions:

- For bulk earthworks, a total of 600,000 cubic metres (1,320,000 tonnes) of imported fill will be placed, stockpiled, spread and compacted.
- Four dozers are assumed to operate 11 hours per day at 70% utilisation on site preparation, vegetation clearing, topsoil stripping.
- Two graders are assumed to operate 11 hours per day at 70% utilisation on road construction.
- Emissions from hauling are estimated based on a haul route travel distance of 3 km for each trip. Each truck is assumed to import 50 tonnes of fill, corresponding to approximately 26,400 trucks per annum or approximately 220 return trips per day.
- Emissions from material handling is based on a combined 1,320,000 tonnes being re-handled up to 4 times (i.e. trucks unloading, front end loaders (FEL) or excavators re-handling).
- Approximately 30% of the imported fill would be crushed / screened.
- A total area of 35 hectares is assumed as exposed for wind erosion.
- Water carts are used to control emissions from hauling, graders and for dozers pushing fill material. A control of 75% is assumed for watering on haul roads and 50% for graders and dozers. An additional control of 40% is applied to hauling, to account for speed limits

[5] United States Environmental Protection Agency (US EPA) AP-42 Compilation of Air Pollutant Emission Factors (US EPA, 1998b, US EPA, 2004, US EPA, 2006)

keeping average vehicle travel speeds to 40km/hr (Foley et al, 1996) (combined control of 85%).

Emissions from onsite diesel consumption are based on an estimated combined daily diesel consumption of 400 litres per hour with all equipment assumed to operate for 11 hours per day at 70% utilisation. US EPA Tier 1 emission factors (kg/kL) for non-road equipment are used to estimate emissions. Diesel exhaust emissions associated with on-road trucks are also estimated using aggregated emission factors developed by the NSW EPA for the 2008 GMR emissions inventory (NSW EPA, 2012b) which are incorporated into the EPA's Air Quality Appraisal Tool (AQAT) (PAEHolmes, 2013). A return trip distance of 3 km is assumed and 234 heavy vehicles trips per day.

A summary of the estimated emissions for the duration of construction of the Proposal is presented in **Table 5-1**.

Table 5-1: Emissions estimates for construction phase of MPE Stage 2 (kg/annum)

Source / Activity	**TSP**	**PM_{10}**	**$PM_{2.5}$**
Hauling on unsealed roads	22,447	7,210	577
Trucks unloading fill	456	216	32.7
Material handling (excavators, FEL, stockpiles)	456	863	32.7
Dozers (vegetation stripping, topsoil clearing, fill)	10,483	4,421	1,101
Crushing	238	107	19.8
Screening	436	147	9.9
Graders on road construction	4,963	1,734	154
Wind erosion	29,750	14,875	2,231
Diesel combustion (onsite equipment)	733	733	692
On-road trucks diesel combustion	36.5	36.5	35.4
Total	**69,998**	**30,342**	**4,885**

5.2.1 Scenario 1a – cumulative construction scenario

For assessment of cumulative impacts, construction phase emissions for the MPE Stage 1 and MPW Stage 2 are included in the modelling, based on the information presented in Ramboll Environ (2016).

5.3 Scenario 2 - operational phase emissions

The emissions sources for the operational phase of the Proposal include:

- External light vehicles (LV) and heavy vehicles (HV) servicing the Proposal.
- Internal transfer trucks, transferring containers from the IMT to warehouses.
- LPG forklifts operating within the warehousing areas.
- Warehouse cooling and heating (using gas fired boilers).

The development of emission estimates require detailed activity data (number of trucks, fleet composition, distances travelled, times in mode, equipment types, fuel usage etc.). This activity data is then used to derive emission estimates, based on published emission factors, for each activity.

5.3.1 Emissions from traffic

The forecast traffic volumes for the MPE Stage 2 have been provided by the traffic modeller for light vehicles (LV) and heavy vehicles (HV). These forecast volumes are used in emission estimation for the following traffic sources:

- Light and heavy vehicles servicing the warehousing area.
- Heavy vehicles travelling along the internal transfer roads, between the terminals and warehousing area.

The forecast average daily traffic (ADT) volumes adopted for emissions estimation are presented in **Table 5-2**.

Table 5-2: Forecast traffic volumes adopted for emissions estimation

Traffic source	ADT - LV	ADT - HV	Peak LV (% of ADT)	Peak HV (% of ADT)
Warehouse traffic to external network	3,872	564	8.5%	9.2%
Terminal to warehouses (via internal transfer roads)	-	582	-	-

Emission factors for vehicles in travel mode are expressed in g/km. The distance travelled in a given hour (or day) is based on the number of truck movements and total travel distance per trip. For warehouse traffic, the travel distance is assumed to be 1 km (from Proposal site entrance to the junction of the M5 and Moorebank Avenue) plus an internal travel distance of 1.5 km for each trip on the perimeter road of the warehousing area. For internal transfer from the terminal to the warehouses, a distance of 0.2 km is assumed for the two internal transfer roads.

Truck emissions (in travel mode) were calculated using aggregated emission factors developed by the NSW EPA for the 2008 GMR emissions inventory (NSW EPA, 2012b). The NSW EPA commissioned the development of an Air Quality Appraisal Tool (PAEHomes, 2013), a spreadsheet which incorporates the GMR emission factors as well as information on road types, default traffic mixes and base traffic speeds and allows for calculations to be made for specific years (2008, 2011, 2016, 2021 and 2026) based on available fleet data.

For the Proposal, 2021 has been selected as the representative year for operational air emission calculations. Other inputs for emission calculations assume a commercial arterial road, 2% grade and a speed limit of 50 km/hr for external roads and 20 km/hr for internal roads. Emission estimates for trucks in travel mode are assumed to account for the type of short term idling expected for the Proposal and therefore idling emissions are not considered separately.

For warehouse HV travelling on the external network, we have assumed 30% are rigid trucks and 70% are articulated trucks, based on data from the traffic modelling.

For LV, the following splits are assumed:

- 75% petrol passenger vehicles
- 5% diesel passenger vehicles
- 10% light duty commercial petrol vehicles
- 5% light duty commercial diesel vehicles
- 5% heavy duty commercial petrol vehicles

The emission estimates for LV and HV movements are presented in **Table 5-3**.

Table 5-3: Estimated emissions for vehicle movements (kg/annum)

Source	CO	HC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Warehouse traffic - HV	298	69	4,515	106	102	-	73
Warehouse traffic - LV	12,020	781	2,006	77	74	-	822
Terminal transfer to warehouse	80	10	411	10	10	-	10

Note: Emissions of SO_2 are proportional to the sulphur content of the fuel and can be estimated if fuel consumption is known. In the absence of data on fuel consumption, we have assumed SO_2 emissions to be negligible, a reasonable assumption given that the regulated sulphur fuel content in Australia is very low.

5.3.2 Warehousing

The emission sources associated with the operation of warehousing on the Proposal site include:

- LNG forklifts operating within the warehousing area.
- Warehouse office heating and cooling, which are assumed to utilise natural gas boilers.

The warehousing area would employ up to 24 LNG forklifts and it is assumed that each would operate 24/7 at a utilisation rate of 50%. Emission estimates have been made based on US EPA emission factors for forklifts (US EPA, 2010) presented in **Table 5-4**.

Table 5-4: US EPA emission factors for forklifts (g/kWh)

Source	CO	HC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Forklifts	2.9	1.2	0.7	0.04	0.04	0.08	-

Note: 1 Emission factors are given for NOx and non-methane hydrocarbons (NMHC) combined (4.0) and is split 0.9 / 0.1 respectively.

Emissions are estimated using equation 3 below and the annual emissions are shown in **Table 5-5**.

$$\text{Emissions } (kg|annum) = \frac{\text{EF (g/kWh)} \times \text{P (kW)} \times \text{OpHrs} \times \text{LF}}{1000} \quad \text{Eq.3}$$

Where:

EF = Emission factor in grams per kilowatt hour (g/kWh)

P = Rated power in kilowatts (kW) (224 kW)

OpHrs = Operating hours for piece of equipment (8760 hours per year x 24 forklifts x 50% utilisation)

LF = Average operational load factor (0.2)

Emissions from warehouse heating and cooling are estimated based on an energy use intensity of 150 MJ/m^2/year and a warehouse footprint of 300,000 m^2. Emission factors (kg/GJ) for natural gas boilers are taken from the National Pollution Inventory (NPI) emission estimation manual for combustion in boilers (≤30 MW wall fired boilers). A summary of the emissions from warehousing are presented in **Table 5-5**.

Table 5-5: Estimated emissions from warehousing (kg/annum)

Source	CO	HC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
LNG forklifts	13,716	5,493	3,114	175	170	387	5,785
Heating/cooling	1,845	-	2,187	162	162	2.9	121
Total	**15,561**	**5,493**	**5,301**	**337**	**332**	**390**	**5,905**

5.3.3 Emissions summary

A summary of the annual emissions for the Proposal are presented in **Table 5-6**. Emissions source contributions for key pollutants are presented in **Figure 5-1**.

Based on the emission factors and activity data assumptions used in this report, warehouse heating and cooling and the operation of warehouse forklifts are the largest emissions sources.

Table 5-6: Summary of annual emissions for MPE Stage 2 (tonnes/annum)

Source	CO	HC	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC
Warehouse traffic - HV	298	69	4,515	106	102	-	73
Warehouse traffic - LV	12,020	781	2,006	77	74	-	822
Terminal transfer to warehouse	80	10	411	10	10	-	10
Warehouse forklifts	13,716	5,493	3,114	175	170	387	5,785
Warehouse heating/cooling	1,845	-	2,187	162	162	2.9	121
Total	**27,960**	**6,353**	**12,234**	**529**	**518**	**390**	**6,810**

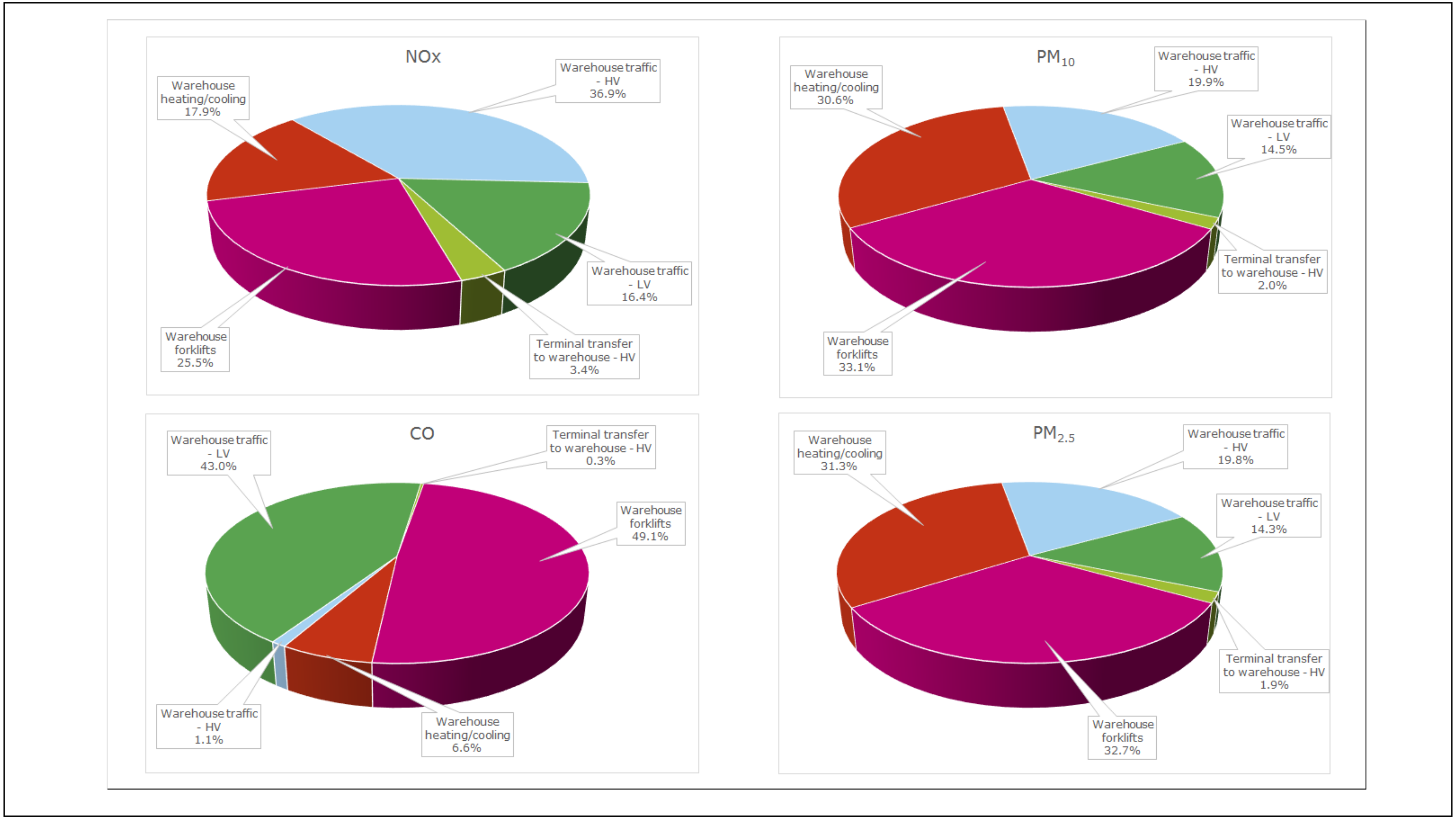


Figure 5-1: Summary of annual emissions breakdown by source

5.3.4 Scenario 2a – cumulative operations scenario

For assessment of cumulative impacts, operational phase emissions for the MPE Stage 1 and MPW Stage 2 are included in the modelling, based on the information presented in the respective air quality assessments (ENVIRON, 2015b; Ramboll Environ, 2016).

It is noted that the air quality assessment for the MPE Stage 1 Project used the site entrance as the operational boundary for emissions estimation from traffic, whereas for the MPW Stage 2 Project, emissions from traffic travelling along Moorebank Avenue to the M5 were included in addition to onsite vehicle movements. Therefore, for consistency, the emissions from external terminal traffic for MPE Stage 1, travelling along Moorebank avenue to the M5, have been added to the MPE Stage 1 traffic, for assessment of cumulative impacts in this report.

6. IMPACT ASSESSMENT

6.1 Construction phase

The modelling predictions for construction are presented in **Table 6-1** for the sensitive receptors identified in **Section 3.7**.

The modelling results indicate that the construction phase emissions comply with all relevant impact assessment criteria. The maximum predicted increase in annual average PM_{10} (0.4 µg/m³), $PM_{2.5}$ (0.1 µg/m³), TSP (0.6 µg/m³) and dust deposition (0.3 g/m²/month) are considered minor when compared against existing background conditions. The highest predicted short-term impacts occur at the Joint Logistics Unit (north of the Proposal site), with a maximum 24-hour PM_{10} of 4.2 µg/m³ and maximum 24-hour $PM_{2.5}$ of 1.3 µg/m³.

Cumulative construction predictions are also presented in **Table 6-1**, and represent the simultaneous construction of the MPE Stage 1 Project, MPW Stage 2 Project and the background ambient air quality values derived in **Section 4.2.3**. For cumulative 24-hour impacts, modelling predictions are paired with daily background PM_{10} and $PM_{2.5}$ concentrations.

The background dataset contains existing exceedances of the impact assessment criteria (three days for PM_{10} and two days for $PM_{2.5}$). The cumulative 24-hour average PM_{10} is therefore presented as the 4th highest (excluding the three days already over) and the cumulative 24-hour average $PM_{2.5}$ is presented as the 3rd highest (excluding the two days already over). The results indicate that the construction for the Proposal would result in no additional days over the criteria.

The annual average background concentrations of $PM_{2.5}$ already exceed the NEPM AAQ reporting standard, therefore cumulative predictions are also above the standard at all receptors. It is noted, however, that the Proposal results in a relatively minor increase in annual average $PM_{2.5}$ (<0.1 µg/m³ at all sensitive receptors).

Contour plots of ground level concentrations for the key pollutants (PM_{10} and $PM_{2.5}$) are presented in **Appendix 6**.

Table 6-1: Construction phase – modelling predictions for selected sensitive receptors

Receptor	PM_{10} (µg/m³)				$PM_{2.5}$ (µg/m³)				TSP (µg/m³)		Dust Deposition	
	24-Hour Max		Annual Ave		24-Hour Max		Annual Ave		Annual Ave		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative
Goal	50 µg/m³		30 µg/m³		25 µg/m³		8 µg/m³		90 µg/m³		2g/m²/m	4g/m²/m
Receptor Max	**4.2**	**49.6**	**0.4**	**21.0**	**1.3**	**24.6**	**0.1**	**8.8**	**0.6**	**50.6**	**0.3**	**3.1**
R1	0.4	48.2	0.1	19.8	0.1	23.9	0.02	8.4	0.1	48.9	0.03	1.5
R2	0.5	48.3	0.1	20.0	0.2	24.0	0.03	8.5	0.1	49.2	0.04	1.7
R3	1.7	48.3	0.1	20.3	0.6	24.2	0.03	8.6	0.2	49.7	0.06	2.2
R4	1.9	48.3	0.1	20.4	0.6	24.1	0.03	8.6	0.1	50.1	0.05	2.6
R5	1.0	47.9	0.0	19.6	0.3	23.7	0.01	8.3	0.1	49.0	0.03	1.5
R6	0.7	48.0	0.1	19.7	0.2	23.8	0.01	8.4	0.1	49.3	0.03	1.8
R7	0.3	48.0	0.0	19.8	0.1	24.0	0.01	8.4	0.0	48.9	0.01	1.5
R8	0.2	47.9	0.0	19.6	0.1	23.8	0.01	8.3	0.0	48.6	0.01	1.2
R9	0.3	47.9	0.0	19.6	0.1	23.8	0.01	8.3	0.0	48.7	0.01	1.3
R10	0.1	48.0	0.0	19.7	0.1	23.9	0.01	8.4	0.0	48.8	0.01	1.3
R11	0.9	48.3	0.1	20.0	0.3	24.2	0.03	8.5	0.1	49.2	0.05	1.7
R12	3.0	48.6	0.3	20.3	0.9	24.4	0.07	8.7	0.4	49.7	0.19	2.1
R13	3.4	48.9	0.3	20.3	1.0	24.1	0.08	8.6	0.5	49.7	0.24	2.1
R14	1.2	49.3	0.2	20.1	0.4	24.0	0.06	8.5	0.3	49.3	0.10	1.7
R15	0.2	48.0	0.0	19.7	0.1	23.9	0.01	8.4	0.0	48.7	0.01	1.3
R16	0.3	47.9	0.0	19.4	0.1	23.7	0.00	8.3	0.0	48.5	0.00	1.1
R17	1.6	48.5	0.2	20.2	0.5	24.3	0.05	8.6	0.3	49.4	0.10	1.9
R18	0.3	48.1	0.1	19.6	0.1	23.8	0.01	8.3	0.1	48.7	0.01	1.2
R19	0.3	47.9	0.0	19.5	0.1	23.7	0.00	8.3	0.0	48.6	0.00	1.2
R20	0.2	47.9	0.0	19.5	0.0	23.8	0.00	8.3	0.0	48.5	0.00	1.1
R21	0.2	47.9	0.0	19.5	0.1	23.7	0.00	8.3	0.0	48.5	0.00	1.1

Receptor	PM10 (µg/m³)				PM2.5 (µg/m³)				TSP (µg/m³)		Dust Deposition	
	24-Hour Max		Annual Ave		24-Hour Max		Annual Ave		Annual Ave		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative
Goal	50 µg/m³		30 µg/m³		25 µg/m³		8 µg/m³		90 µg/m³		2g/m²/m	4g/m²/m
Receptor Max	**4.2**	**49.6**	**0.4**	**21.0**	**1.3**	**24.6**	**0.1**	**8.8**	**0.6**	**50.6**	**0.3**	**3.1**
R22	2.3	48.3	0.2	20.0	0.7	24.3	0.05	8.5	0.3	49.3	0.13	1.8
R23	1.7	48.2	0.1	19.8	0.5	24.0	0.04	8.4	0.2	49.0	0.10	1.5
R24	0.4	47.9	0.0	19.5	0.1	23.7	0.01	8.3	0.0	48.6	0.01	1.2
R25	0.9	48.0	0.1	19.7	0.3	23.8	0.01	8.3	0.1	49.2	0.03	1.8
R26	0.5	47.9	0.0	19.5	0.2	23.7	0.01	8.3	0.0	48.6	0.01	1.2
R27	1.3	48.2	0.1	19.7	0.4	23.7	0.01	8.3	0.1	49.0	0.03	1.6
R28	0.7	47.9	0.0	19.5	0.3	23.7	0.01	8.3	0.0	48.6	0.01	1.2
R29	0.2	48.0	0.0	19.5	0.1	23.7	0.01	8.3	0.0	48.6	0.01	1.1
R30	0.2	48.0	0.0	19.5	0.1	23.7	0.01	8.3	0.0	48.6	0.01	1.2
R31	0.1	47.9	0.0	19.5	0.0	23.7	0.01	8.3	0.0	48.5	0.01	1.1
R32	0.2	47.9	0.0	19.5	0.0	23.7	0.01	8.3	0.0	48.5	0.01	1.1
R34	0.2	48.0	0.0	19.6	0.0	23.9	0.01	8.4	0.0	48.7	0.01	1.3
R35	4.2	49.6	0.4	20.4	1.3	24.2	0.11	8.7	0.6	49.9	0.30	2.1
R36	0.2	47.9	0.0	19.5	0.1	23.7	0.00	8.3	0.0	48.6	0.00	1.2
R37	1.8	48.6	0.1	19.8	0.5	23.8	0.03	8.4	0.2	49.0	0.07	1.5
R38	0.9	48.5	0.1	21.0	0.3	24.6	0.03	8.8	0.1	50.6	0.05	3.1

6.2 Operational phase

Operational impacts to air quality as a result of the Proposal have been considered with regards to PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2 and VOCs.

6.2.1 Particulate Matter

The predicted PM_{10} and $PM_{2.5}$ concentrations are presented in **Table 6-2**. Cumulative operational predictions have been determined based the combined operational emissions from the operation of the MPE Stage 1 Project, MPW Stage 2 Project and the background ambient air quality values derived in **Section 4.2.3**. As discussed previously, for cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations, the results exclude days where the background ambient air quality data for PM_{10} and $PM_{2.5}$ already exceed the criteria.

The maximum increase in annual average PM_{10} and $PM_{2.5}$ (0.1 µg/m³) and 24-hour average PM_{10} and $PM_{2.5}$ (0.2 µg/m³) as a result of the Proposal is minor when compared to existing background conditions. When background is added, there are no additional exceedances of the short term impact assessment criteria. The annual average background concentrations of $PM_{2.5}$ already exceed the NEPM AAQ reporting standard, therefore cumulative predictions are also above the standard at all receptors. It is noted, however, that the Proposal results in a relatively minor increase in annual average $PM_{2.5}$ (0.1 µg/m³ at all sensitive receptors).

6.2.2 Nitrogen Dioxide, Carbon Monoxide and Sulfur Dioxide

The predicted NO_2, CO and SO_2 concentrations from the operation of the Proposal are presented in **Table 6-3**. **Table 6-3** shows that the predicted NO_2 concentrations associated with the operation of the Proposal are based on the conservative assumption that 100% of NO is converted to NO_2, both for short-term and annual average predictions. This simplified (and conservative) conversion method can be applied in this case because predictions are well below the relevant impact assessment criteria. Cumulative results for NO_2 are derived by adding emissions for MPE Stage 1, MPW Stage 2 and the background values derived in **Section 4.2** to the predicted NO_x concentrations. The cumulative 1-hour NO_2 is derived by pairing each 1-hour average modelling prediction for MPE Stage 1, MPE Stage 2 and MPW Stage 2 with the corresponding background for that hour.

Cumulative concentrations presented for CO and SO_2 (1 hour, 8 hour and 24-hour) are derived by adding the maximum predicted short term concentrations (for MPE Stage 1, MPE Stage 2 and MPW Stage 2) to the maximum background concentration. Notwithstanding this conservative assumption (that the maximum modelled concentration occurs at the same time as the maximum background), all predicted concentrations are well below the impact assessment criteria. As inferred in **Section 4.2**, ambient concentrations of CO and SO_2 are not a significant air quality issue for the Sydney area.

Contour plots of ground level concentrations for the key pollutants (PM_{10}, $PM_{2.5}$ and NO_2) are presented in **Appendix 6**.

Table 6-2: PM_{10} and $PM_{2.5}$ modelling predictions for selected sensitive receptors

Receptor	PM_{10} concentration (µg/m³)				$PM_{2.5}$ concentration (µg/m³)			
	24-Hour Max		Annual Ave		24-Hour Max		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Increment al increase	Cumulative	Incremental increase	Cumulative
Goal	50 µg/m³		30 µg/m³		25 µg/m³		8 µg/m³	
Receptor Max	**0.2**	**48.5**	**0.1**	**20.0**	**0.2**	**24.3**	**0.1**	**8.8**
R1	0.1	48.2	0.04	19.8	0.1	24.1	0.0	8.6
R2	0.1	48.4	0.04	19.9	0.1	24.2	0.0	8.7
R3	0.1	48.4	0.04	20.0	0.1	24.3	0.0	8.8
R4	0.1	48.2	0.03	19.8	0.1	24.0	0.0	8.6
R5	0.0	47.9	0.00	19.4	0.0	23.7	0.0	8.3
R6	0.0	47.9	0.01	19.5	0.0	23.7	0.0	8.3
R7	0.0	48.0	0.01	19.6	0.0	23.8	0.0	8.4
R8	0.0	47.9	0.01	19.5	0.0	23.8	0.0	8.3
R9	0.0	48.0	0.01	19.5	0.0	23.8	0.0	8.3
R10	0.0	48.0	0.01	19.5	0.0	23.8	0.0	8.4
R11	0.1	48.1	0.04	19.7	0.1	24.0	0.0	8.5
R12	0.1	48.2	0.06	19.8	0.1	24.1	0.1	8.6
R13	0.1	48.3	0.06	19.8	0.1	24.1	0.1	8.6
R14	0.2	48.5	0.08	19.9	0.2	24.3	0.1	8.8
R15	0.0	48.0	0.01	19.5	0.0	23.8	0.0	8.4
R16	0.0	47.9	0.00	19.4	0.0	23.6	0.0	8.3
R17	0.1	48.2	0.05	19.8	0.1	24.1	0.1	8.6
R18	0.1	48.0	0.03	19.6	0.1	23.8	0.0	8.4
R19	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3
R20	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3

Receptor	PM10 concentration (µg/m³)				PM2.5 concentration (µg/m³)			
	24-Hour Max		Annual Ave		24-Hour Max		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Increment al increase	Cumulative	Incremental increase	Cumulative
Goal	50 µg/m³		30 µg/m³		25 µg/m³		8 µg/m³	
Receptor Max	**0.2**	**48.5**	**0.1**	**20.0**	**0.2**	**24.3**	**0.1**	**8.8**
R21	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3
R22	0.1	48.1	0.04	19.7	0.1	24.0	0.0	8.5
R23	0.1	48.1	0.03	19.6	0.1	23.9	0.0	8.4
R24	0.0	47.9	0.00	19.4	0.0	23.7	0.0	8.3
R25	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3
R26	0.0	47.9	0.00	19.4	0.0	23.7	0.0	8.3
R27	0.0	48.1	0.01	19.5	0.0	23.7	0.0	8.4
R28	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3
R29	0.0	48.0	0.01	19.4	0.0	23.7	0.0	8.3
R30	0.0	48.0	0.01	19.5	0.0	23.8	0.0	8.4
R31	0.0	47.9	0.01	19.5	0.0	23.7	0.0	8.3
R32	0.0	47.9	0.01	19.4	0.0	23.7	0.0	8.3
R34	0.0	48.0	0.01	19.5	0.0	23.8	0.0	8.4
R35	0.2	48.4	0.09	19.9	0.2	24.2	0.1	8.7
R36	0.0	47.9	0.01	19.4	0.0	23.8	0.0	8.3
R37	0.1	48.2	0.03	19.6	0.1	23.9	0.0	8.5
R38	0.1	48.4	0.04	20.0	0.1	24.3	0.0	8.8

Table 6-3: NO_2, CO and SO_2 modelling predictions for selected sensitive receptors

Receptor	NO_2 concentration (µg/m^3)				CO concentration (mg/m^3)				SO_2 concentration (µg/m^3)					
	1-Hour Max		Annual Ave		1-Hour Max		8-Hour Max		1-Hour Max		24-Hour Max		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative
Goal	246 µg/m3		62 µg/m3		30 mg/m3		10 mg/m3		570 µg/m3		228 µg/m3		60 µg/m3	
Receptor Max	**32.9**	**187.7**	**2.2**	**37.1**	**0.05**	**5.1**	**0.02**	**3.1**	**0.61**	**75.4**	**0.15**	**13.8**	**0.07**	**2.7**
R1	21.5	128.8	1.1	32.0	0.03	5.1	0.01	3.1	0.2	75.0	0.04	13.7	0.02	2.7
R2	24.3	166.5	1.2	35.4	0.03	5.1	0.01	3.1	0.3	75.3	0.06	13.8	0.02	2.7
R3	17.4	171.6	1.1	36.8	0.02	5.1	0.01	3.1	0.2	75.2	0.05	13.8	0.02	2.7
R4	16.3	134.6	0.7	31.6	0.03	5.1	0.01	3.1	0.4	75.2	0.07	13.7	0.02	2.7
R5	6.5	80.4	0.1	22.2	0.01	5.1	0.00	3.1	0.2	74.7	0.03	13.6	0.00	2.6
R6	7.5	79.9	0.2	23.4	0.01	5.1	0.00	3.1	0.2	74.8	0.03	13.6	0.01	2.7
R7	5.9	90.7	0.3	27.1	0.01	5.0	0.00	3.0	0.1	74.6	0.02	13.6	0.01	2.7
R8	4.4	78.2	0.2	23.9	0.01	5.0	0.00	3.0	0.1	74.6	0.01	13.6	0.01	2.7
R9	6.1	78.3	0.2	24.1	0.01	5.1	0.00	3.1	0.1	74.7	0.02	13.6	0.01	2.7
R10	5.5	83.9	0.3	25.4	0.01	5.0	0.00	3.0	0.1	74.6	0.02	13.6	0.01	2.7
R11	20.6	124.4	0.9	29.0	0.04	5.1	0.01	3.1	0.4	74.9	0.07	13.7	0.03	2.7
R12	23.7	129.9	1.5	31.2	0.04	5.1	0.01	3.1	0.4	75.0	0.10	13.7	0.04	2.7
R13	22.9	126.5	1.5	31.3	0.04	5.1	0.01	3.1	0.5	75.1	0.10	13.7	0.04	2.7
R14	32.9	187.7	2.1	36.8	0.05	5.1	0.02	3.1	0.6	75.4	0.13	13.8	0.05	2.7
R15	5.1	82.3	0.3	25.1	0.01	5.0	0.00	3.0	0.1	74.6	0.02	13.6	0.01	2.7
R16	5.9	84.8	0.1	21.7	0.01	5.1	0.00	3.0	0.1	74.7	0.01	13.6	0.00	2.6
R17	23.0	142.1	1.3	31.0	0.04	5.1	0.01	3.1	0.4	75.0	0.09	13.7	0.04	2.7
R18	14.1	90.1	0.8	26.6	0.02	5.1	0.00	3.1	0.2	74.8	0.03	13.6	0.01	2.7
R19	7.0	93.7	0.1	22.4	0.01	5.1	0.00	3.1	0.2	74.8	0.02	13.6	0.00	2.6
R20	5.0	78.2	0.2	22.9	0.01	5.0	0.00	3.0	0.1	74.6	0.01	13.6	0.00	2.6

Receptor	NO_2 concentration (µg/m³)				CO concentration (mg/m³)				SO_2 concentration (µg/m³)					
	1-Hour Max		Annual Ave		1-Hour Max		8-Hour Max		1-Hour Max		24-Hour Max		Annual Ave	
	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative	Incremental increase	Cumulative
Goal	246 µg/m3		62 µg/m3		30 mg/m3		10 mg/m3		570 µg/m3		228 µg/m3		60 µg/m3	
Receptor Max	**32.9**	**187.7**	**2.2**	**37.1**	**0.05**	**5.1**	**0.02**	**3.1**	**0.61**	**75.4**	**0.15**	**13.8**	**0.07**	**2.7**
R21	5.5	78.1	0.1	22.5	0.01	5.1	0.00	3.0	0.1	74.7	0.01	13.6	0.00	2.6
R22	19.9	112.4	1.1	29.0	0.04	5.1	0.01	3.1	0.3	74.9	0.07	13.7	0.03	2.7
R23	13.4	88.9	0.7	26.4	0.02	5.1	0.01	3.1	0.3	74.8	0.05	13.6	0.02	2.7
R24	7.3	79.4	0.1	22.1	0.01	5.1	0.00	3.1	0.2	74.7	0.02	13.6	0.00	2.6
R25	8.0	80.3	0.2	23.0	0.02	5.1	0.01	3.1	0.2	74.8	0.03	13.7	0.01	2.7
R26	7.0	79.6	0.1	21.9	0.01	5.1	0.00	3.1	0.2	74.7	0.02	13.6	0.00	2.6
R27	15.2	125.4	0.3	24.6	0.03	5.1	0.01	3.1	0.3	75.0	0.03	13.6	0.01	2.7
R28	9.7	89.3	0.2	22.6	0.02	5.1	0.00	3.1	0.2	74.8	0.02	13.6	0.00	2.6
R29	9.5	100.4	0.2	23.0	0.01	5.1	0.00	3.1	0.1	74.7	0.02	13.6	0.00	2.7
R30	10.3	92.0	0.4	24.6	0.01	5.1	0.00	3.0	0.1	74.7	0.02	13.6	0.01	2.7
R31	6.7	78.2	0.2	23.1	0.01	5.0	0.00	3.0	0.1	74.6	0.01	13.6	0.01	2.7
R32	7.1	78.2	0.3	23.0	0.01	5.0	0.00	3.0	0.1	74.6	0.01	13.6	0.01	2.7
R34	4.7	80.5	0.2	24.9	0.01	5.0	0.00	3.0	0.1	74.6	0.02	13.6	0.01	2.7
R35	27.7	162.5	2.1	34.7	0.05	5.1	0.02	3.1	0.6	75.3	0.15	13.8	0.07	2.7
R36	7.1	79.7	0.2	22.8	0.01	5.1	0.00	3.1	0.1	74.8	0.01	13.6	0.00	2.6
R37	12.4	106.3	0.9	27.9	0.02	5.1	0.01	3.1	0.2	74.8	0.06	13.7	0.02	2.7
R38	16.5	176.8	1.0	37.1	0.02	5.1	0.01	3.1	0.3	75.3	0.05	13.8	0.02	2.7

6.2.3 Assessment of VOCs

The maximum predicted incremental concentrations of 1,3-butadiene, benzene and PAHs (expressed as 99.9th percentiles) are presented in **Table 6-4**. Impact assessment criteria are applied at and beyond the site boundary and therefore results presented as the grid maximum (the highest prediction across the entire modelling grid) can be used to determine compliance.

The results in **Table 6-4** show that all VOCs are below the relevant assessment criteria.

Table 6-4: Assessment of VOC concentrations

Pollutant	Criteria (µg/m^3)	Predicted concentration (µg/m^3)	
		Receptor maximum	Grid maximum
1,3 Butadiene	40	0.07	0.35
Benzene	29	0.19	0.97
PAH (as BaP)	0.4	0.02	0.07

7. MITIGATION AND MONITORING

7.1 Mitigation

7.1.1 Construction phase

The principal emissions to air from the construction phase of the Proposal would be a result of dust generation from construction activities including:

- Vegetation clearing / earthmoving during site preparation.
- Handling (loading / unloading) of spoil material.
- Handling (loading / unloading) of fill material.
- Demolition of existing structures.
- Movement of heavy plant and machinery within the site on unsealed areas.
- Wind erosion from exposed surfaces.

Prior to commencement of construction work, the construction contractor will prepare a Construction Environmental Management Plan (CEMP). The air quality management measures for the CEMP are outlined in **Appendix 7** and would include:

- Deploying water carts to ensure exposed areas and topsoils/subsoil are kept moist.
- Modifying working practices by limiting clearing, stripping and spoil handling during periods of adverse weather (hot, dry and windy conditions) and when dust is seen leaving the site.
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.
- Where possible, dampening structures using water sprays prior to demolition.
- Operation of a water cart on all unsealed internal roadways and travel routes and enforcing a speed limit of 30km/hr.
- Coordinating delivery and removal of materials to avoid unnecessary trips.
- Minimising the number of work faces on stockpiles and temporary stabilisation (compaction of surface, water sprays, seeding, veneering).

7.1.2 Operational phase

Emissions from on-road registered vehicles visiting the site would be regulated under the Australian Design Rules (ADRs), which set the national vehicle emission standards (exhaust emissions) and and Fuel Quality Standards Act (2000), which provides the legislative framework for setting national fuel quality standards. On-road registered trucks would be used for internal container transfer and these would also be covered under ADRs and fuel quality standard regulations.

Where possible, policies would be implemented across the Proposal site which aim to minimise truck idling..

Operation of the warehouses on the MPE Stage 2 site would not be controlled by SIMTA as the Proponent, and precinct wide air quality management and monitoring requirements for prospective tenants would not be enforced.

Responsibility for the management of emissions associated with warehousing, including forklifts and gas heating / cooling, would therefore fall with each tenant. Local air quality impacts could be minimised by tenants using grid electricity for heating / cooling and electric forklifts.

7.2 Monitoring

The modelling predictions presented in the report indicate that the risk of adverse air quality impacts from the Proposal are low. The incremental increase in key pollutants (PM_{10} and $PM_{2.5}$) at the surrounding residential areas would be largely indistinguishable from the existing background and project specific air quality monitoring is therefore not warranted.

8. CONCLUSION

Activities associated with the construction and operation of the Proposal have been assessed for potential impacts on local air quality, including cumulative effects from the concurrent operation of the MPE Stage 1 Project.

The modelling results indicate that the construction phase emissions comply with all relevant impact assessment criteria. The maximum predicted increase in annual average PM_{10} (0.4 µg/m³), $PM_{2.5}$ (0.1 µg/m³), TSP (0.6 µg/m³) and dust deposition (0.3 g/m²/month) are considered minor when compared against existing background ambient air quality conditions, and a small percentage of the relevant impact assessment criteria. The highest predicted short-term impacts would occur at the DJLU Facility immediately north of the Proposal, with a maximum incremental increase in 24-hour PM_{10} of 4.2 µg/m³ and maximum 24-hour $PM_{2.5}$ of 1.3 µg/m³, representing 8.4% and 5.2% of the relevant criteria or standard. Cumulative predictions are also presented and the results indicate that the construction for the Proposal would comply with all relevant impact assessment criteria, for all pollutants.

For the operational phase of the Proposal, the potential impacts from emissions of PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2 and VOCs were assessed, including consideration of a cumulative scenario, based on the simultaneous operation of the Proposal with the air quality emissions from the MPE Stage 1 Project, the MPW Stage 2 Project and the existing background ambient air quality.

The maximum predicted increase in annual average PM_{10} and $PM_{2.5}$ (0.1 µg/m³) and 24-hour average PM_{10} and $PM_{2.5}$ (0.2 µg/m³) during operation of the Proposal are considered to be minor, when compared to existing background ambient air quality conditions, and a small percentage of the relevant impact assessment criteria.

When background ambient air quality conditions are added to MPE Stage 2 operational air emissions, there are no additional exceedances of the short term impact assessment criteria. The annual average background concentrations of $PM_{2.5}$ for Liverpool have exceeded the NEPM AAQ reporting standard in most recent years, therefore cumulative predictions are also above the standard at all receptors. It is noted, however, that the Proposal results in a relatively minor increase in annual average $PM_{2.5}$ (0.1 µg/m³ at all sensitive receptors).

The predicted NO_2, CO, SO_2 and VOC concentrations are well below the relevant impact assessment criteria during operation of the Proposal.

It is noted that the assessment of air quality impacts as a result of construction and operation of the Proposal incorporates a level of conservativeness, for example, the construction phase emission estimates do not account for natural mitigation due to rainfall and the operational phase modelling does not incorporate removal of particles due to wet or dry deposition. Other modelling settings, such as the selection of rural instead of urban dispersion coefficients also provide a conservatively high prediction of impact.

In summary, consistent with previous air quality assessments for the Moorebank Precinct, the potential air quality impacts are expected to be low risk at nearby sensitive receivers. The proposed mitigation measures are considered sufficient to ensure off-site impacts from the Proposal are effectively managed. Given the minor nature of change in air quality as a result of the operation of the Proposal, operational air quality monitoring is not proposed or considered necessary.

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APPENDIX 1
PROJECT FIGURES

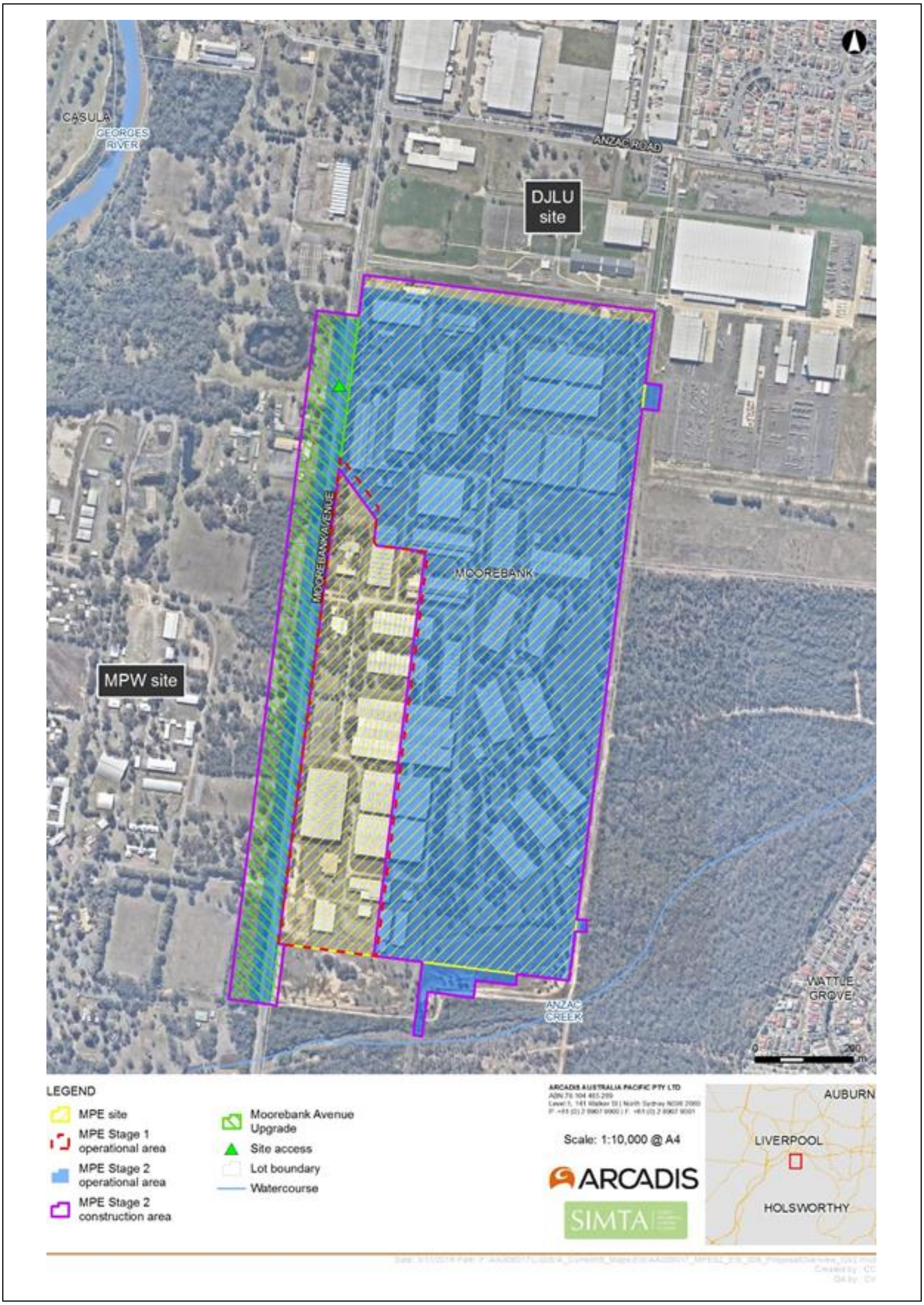


Figure A1-1: Overview of the proposal

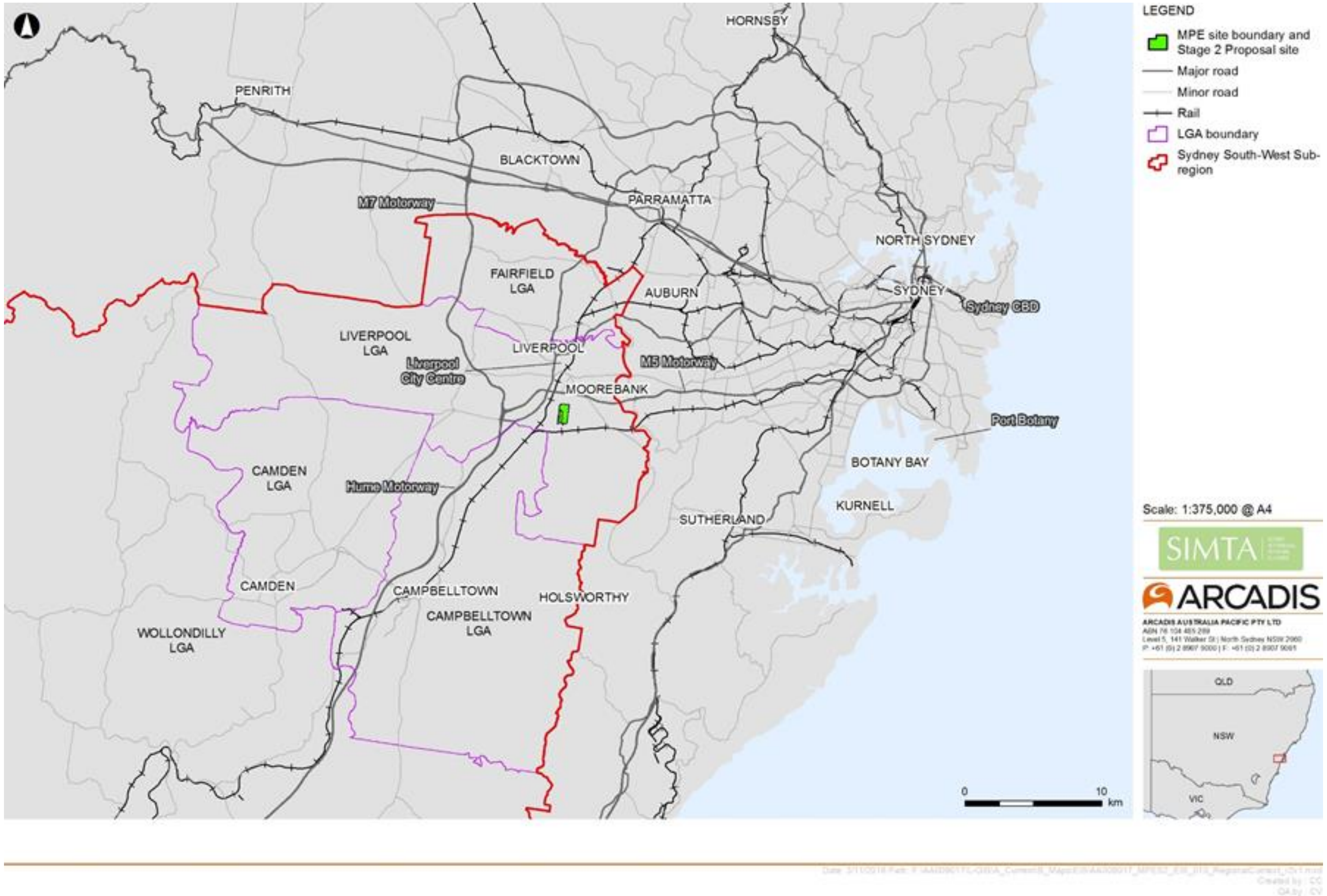


Figure A1-2: Regional context

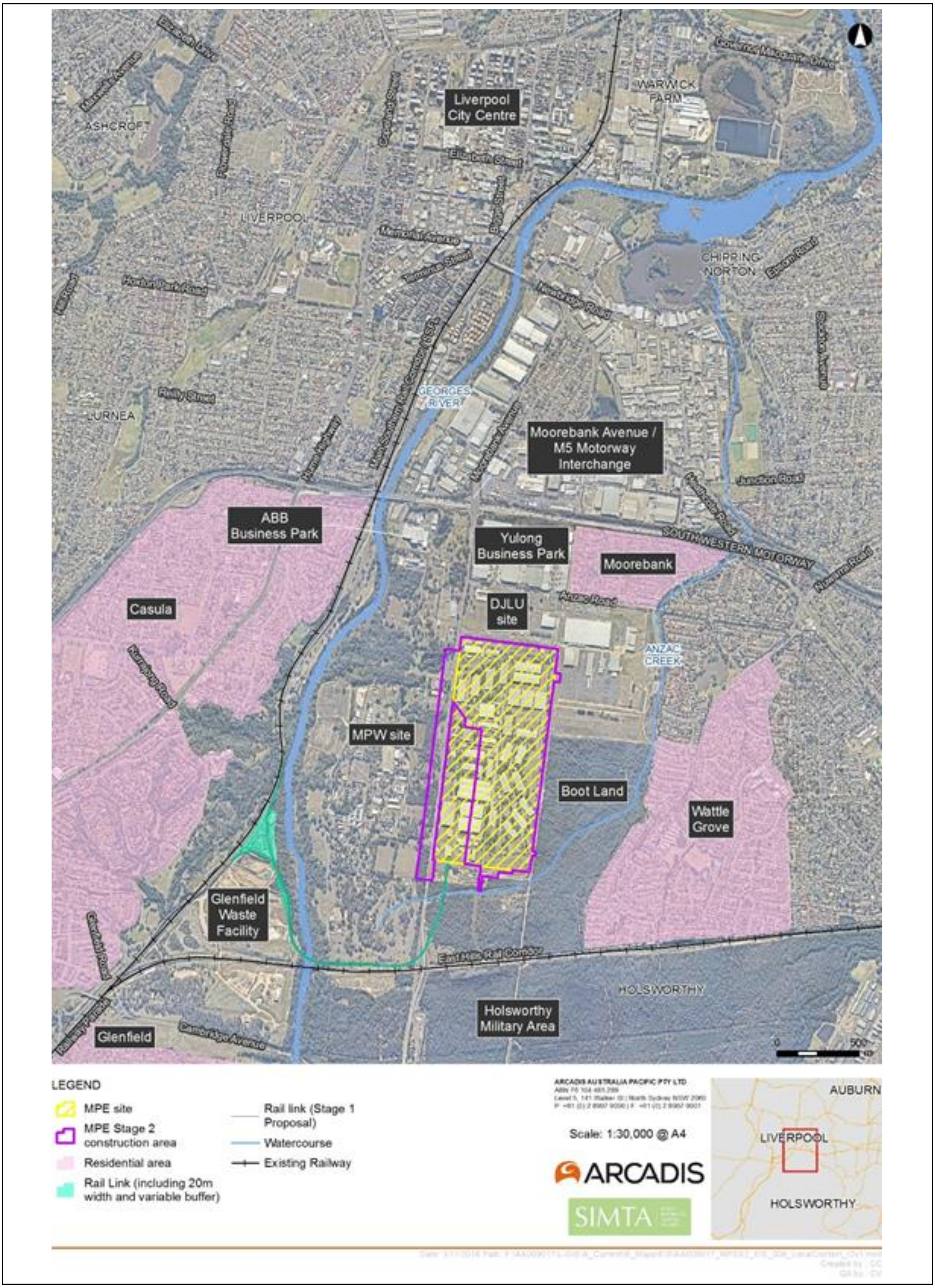


Figure A1-3: Local context

Figure A1-4: Construction layout

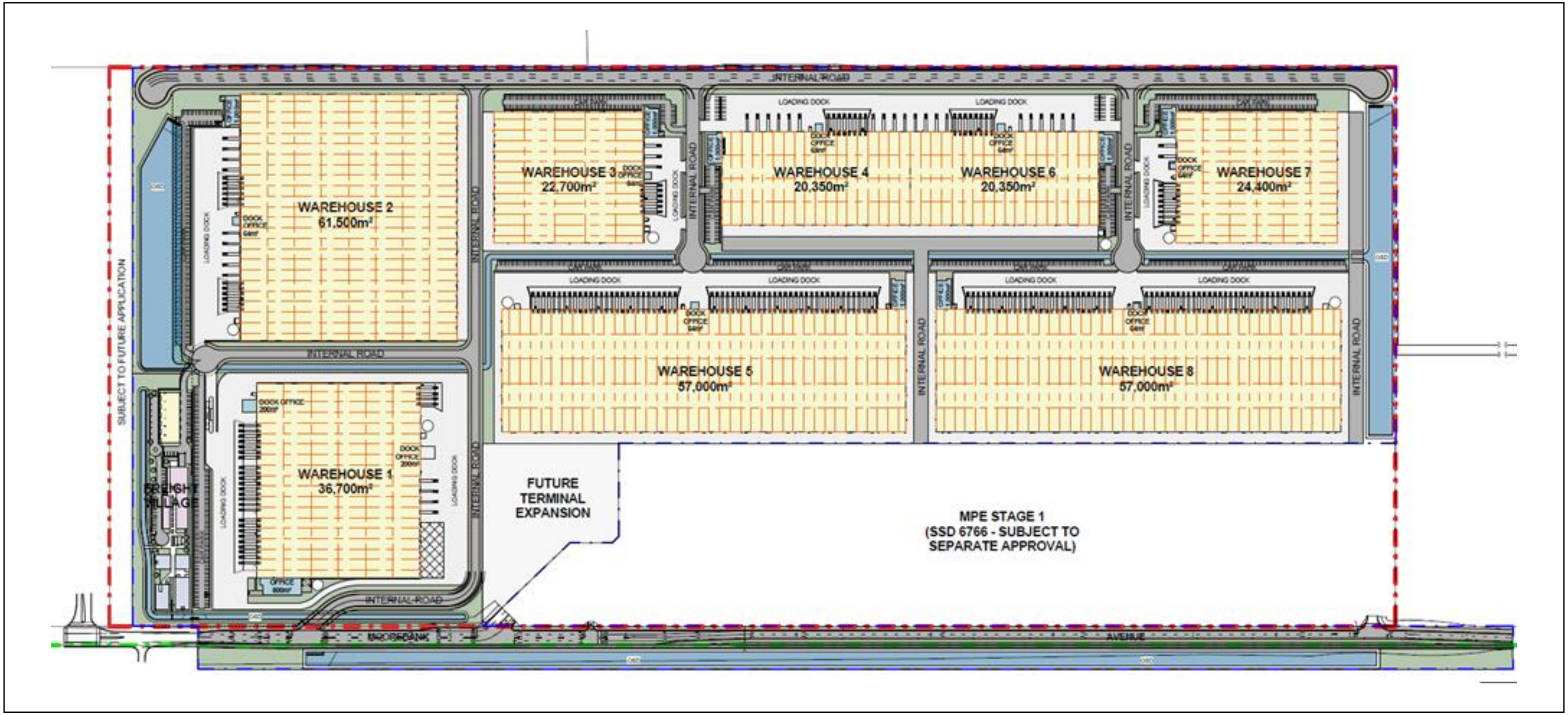


Figure A1-5: Warehouse layout

APPENDIX 2
OVERVIEW OF DISPERSION MODELLING

Local air quality modelling is presented using the AERMOD system, which is composed of two pre-processors that generate the input files required by the AERMOD dispersion model: AERMET (for the preparation of meteorological data) and AERMAP (for the preparation of terrain data).

AERMET is run using the 'onsite' processing option using hourly measurements from the Liverpool OEH meteorological station. The year chosen for modelling is 2013, which gaps in the dataset were supplemented with prognostic meteorological data from TAPM.

TAPM was also used to derive a vertical temperature profile for modelling. The TAPM vertical temperature profile was adjusted by first substituting the predicted 10 m above ground temperature with hourly measured temperature at 10 m. 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 and included in the AERMET input data.

Values for surface roughness length, albedo, and Bowen ratio were selected using the AERSURFACE Utility by assigning appropriate land use types in the vicinity of the Project. Surface roughness length is the height at which the mean horizontal wind speed approaches zero and is related to the roughness characteristics of the surrounding area. For example, low flat landscapes are assigned a lower surface roughness length than urban or forest areas. Bowen ratio relates to the amount of moisture at the surface and plays an important role in deriving Monin-Obukhov length and therefore atmospheric stability. Albedo is defined as the fraction of incoming solar radiation reflected from the ground when the sun is overhead.

Terrain data for the wider modelling domain was sourced from NASA's Shuttle Radar Topography Mission (SRTM) data. This data set provided a high-resolution topography at 3 arc-second (~90 m) grid spacing.

All emissions source activities for construction and operation are represented by a series of volume sources, located according to site layout. For the operational phase, no plume deposition or depletion was modelled, and therefore all pollutants were essential modelled as gas phase pollutants. For construction phases, where the most significant emissions source is fugitive dust, options for plume deposition and depletion were used and modelling was completed for three size fractions, TSP, PM_{10} and $PM_{2.5}$ based on a mean particle diameter of 20 microns, 10 microns and 1 micron, respectively.

APPENDIX 3
ASSESSMENT LOCATIONS

Table A1-1: Assessment locations surrounding the project site

Name/Location	ID	Location (m MGA, Zone 55)	
		Easting	Northing
Lakewood Crescent, Casula	R1	307535	6242509
St Andrews Boulevard, Casula	R2	307430	6242235
Buckland Road, Casula	R3	307317	6241949
Dunmore Crescent, Casula	R4	307044	6241551
Leacocks Lane, Casula	R5	306397	6241264
Leacocks Lane, Casula	R6	306579	6240902
Slessor Road, Casula	R7	306145	6240139
Canterbury Road, Glenfield	R8	305986	6239330
Ferguson Street, Glenfield	R9	306378	6239233
Goodenough Street, Glenfield	R10	306783	6239167
Wallcliff Court, Wattle Grove	R11	308903	6239900
Corryton Court, Wattle Grove	R12	309206	6240651
Martindale Court, Wattle Grove	R13	309335	6241111
Anzac Road, Wattle Grove	R14	308829	6242049
Cambridge Avenue, Glenfield	R15	306246	6239580
Guise Public School	R16	306200	6237359
Yallum Court, Wattle Grove	R17	308916	6240141
Church Road, Liverpool	R18	308643	6243069
Glenwood Public School, Glenfield	R19	306259	6238659
Glenfield Public School, Glenfield	R20	305604	6239088
Hurlstone Agricultural School	R21	305200	6239198
Wattle Grove Public School	R22	309373	6240489
St Marks Coptic College, Wattle Grove	R23	309942	6240895
Maple Grove Retirement Village, Casula	R24	305381	6240952
All Saints Catholic College	R25	306606	6241042
Casula High School	R26	305360	6241268
Casula Primary School, Casula	R27	306749	6242073
Lurnea High School	R28	305552	6242252
St Francis Xaviers Catholic Church	R29	305834	6243254
Impact Church Liverpool	R30	307828	6243646
Liverpool West Public School	R31	306552	6243980
Liverpool Public School / TAFE NSW	R32	308289	6244388
Glenfield Rise Development, Glenfield	R34	305927	6239733
DJLU Facility	R35	309117	6241571
Playground Learning Centre Glenfield	R36	305845	6239063
Wattle Grove Long Day Care Centre	R37	309596	6242100
Casula Powerhouse Arts Centre	R38	307130	6241489
Little Peters Child Care	R39	306434	6241005
Anzac Village Pre School	R40	309903	6242025
St Christophers. Holsworthy	R41	310572	6241161
Learn and Play Pre School	R42	310324	6240806

APPENDIX 4
WIND ROSES

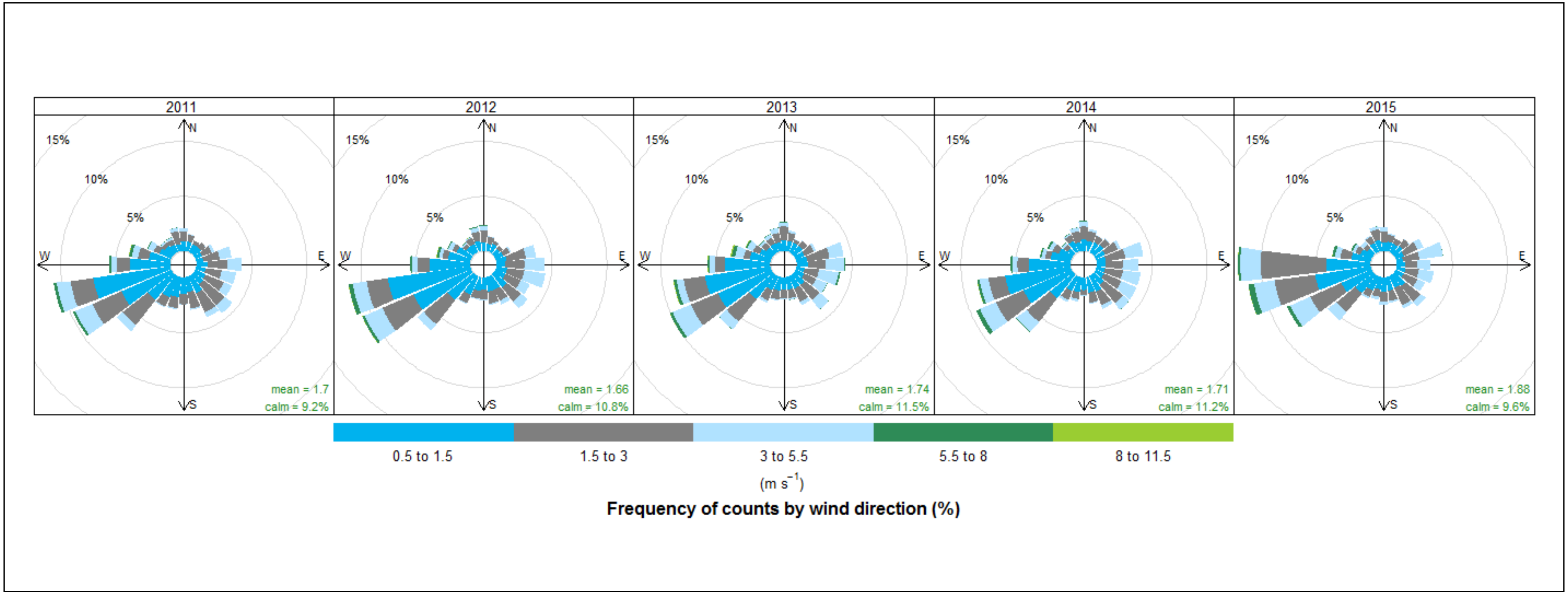


Figure A2-1: Annual wind roses for Liverpool OEH site

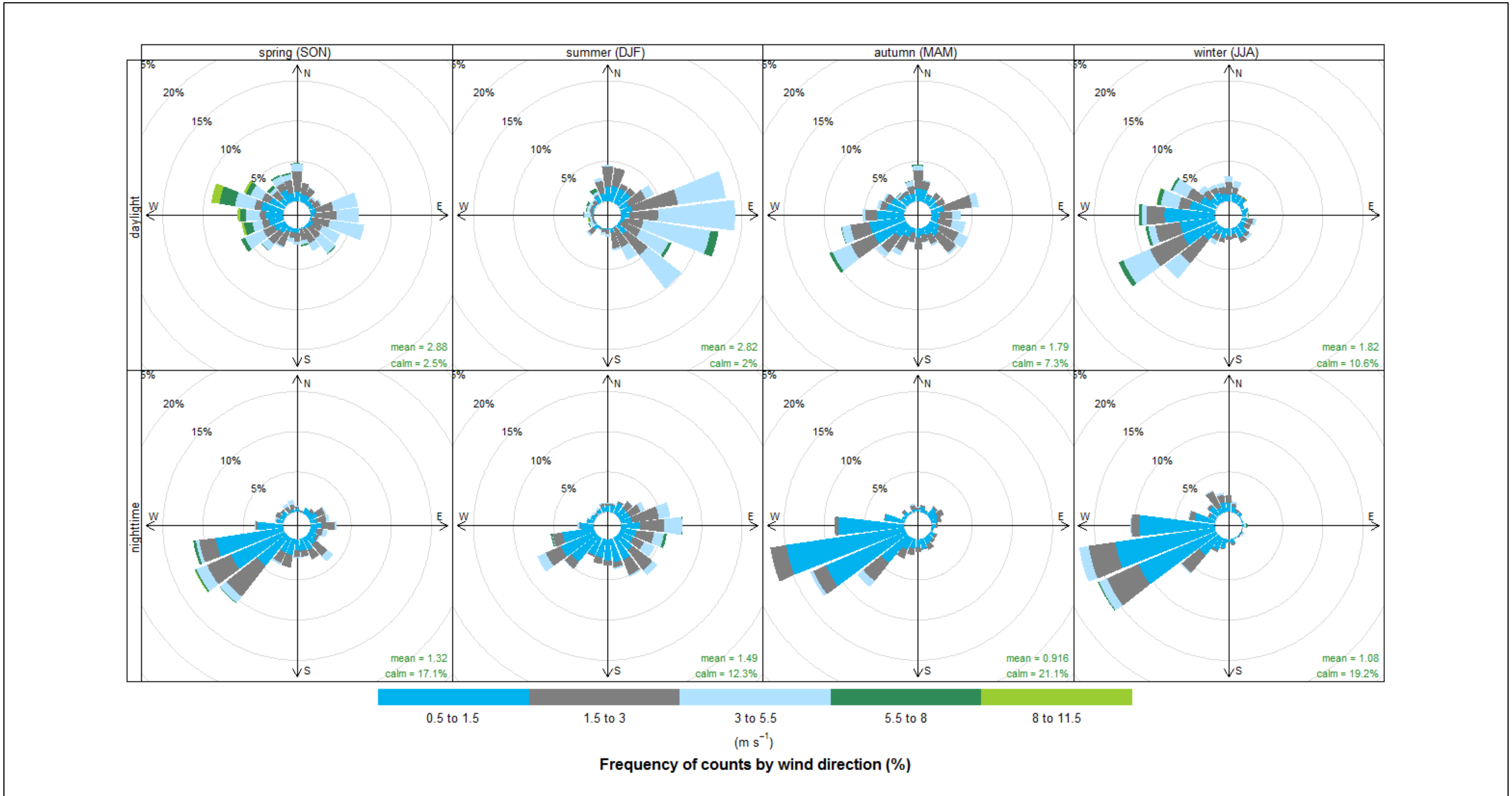


Figure A2-2: Seasonal and diurnal wind roses for Liverpool OEH site

APPENDIX 5
EMISSION INVENTORY DEVELOPMENT

Construction phase emission inventory

Fugitive dust emissions were estimated using United States Environmental Protection Authority (USEPA) AP-42 emission factors and predictive equations taken from the following chapters:

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

The material properties listed in **Table A5-1** are used as input to the various emission factor equations listed in **Table A5-2** to derived site specific uncontrolled emission factors for each source.

Table A4-1: Material properties

Properties	Value
Silt Content of Unpaved Roads	5%
Silt Content of topsoil, spoil, fill material	8%
Moisture Content of topsoil, spoil, fill material	4%

Emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates. Fine particles (PM_{10} and $PM_{2.5}$) were estimated using the fraction specific equations or ratios for the different particle size fractions available within the literature (shown in **Table A5-2**).

Table A4-2: Equations and emission factors

Inventory activity	Units	TSP emission factor/equation	PM_{10} emission factor/equation	$PM_{2.5}$ emission factor/equation	EF source
Material handling	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP42 13.2.4
Dozers	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	AP42 11.9
Wind erosion from exposed areas	kg/ha/h	0.85×1000	0.5 * TSP	0.075 * TSP	AP42 11.9
Hauling on unsealed roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W \times 1.1023}{3}\right)^{0.45}$	AP42 13.2.2
Grading roads	kg/VKT	$0.0034 \times S^{2.5}$	$0.00336 \times S^{2.0}$	$0.0001054 \times S^{2.5}$	AP42 11.9

APPENDIX 6
CONTOUR PLOTS FOR KEY POLLUTANTS

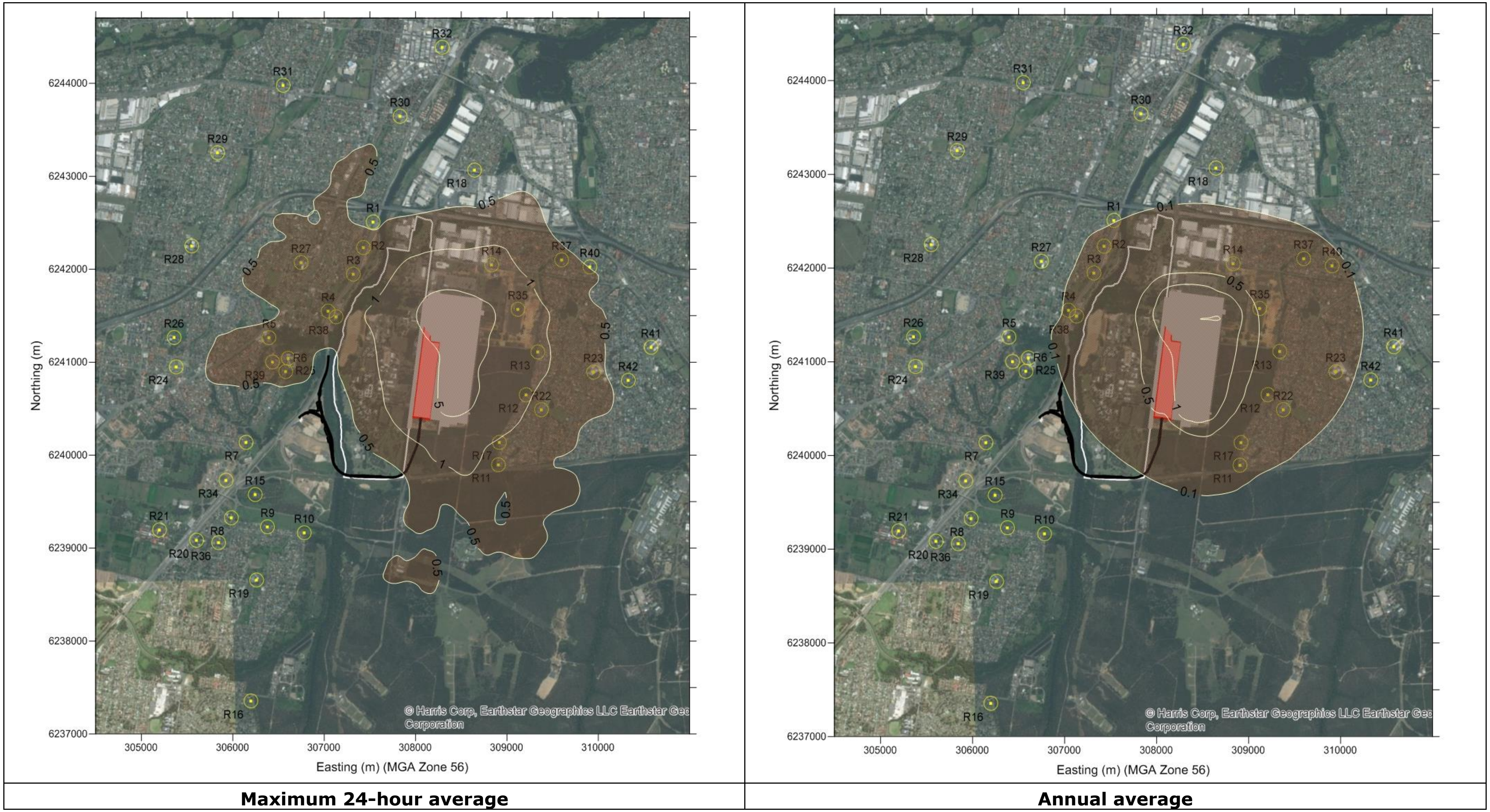


Figure A5-1: Contour plots of maximum 24-hour and annual average PM_{10} (µg/m³) during construction phase

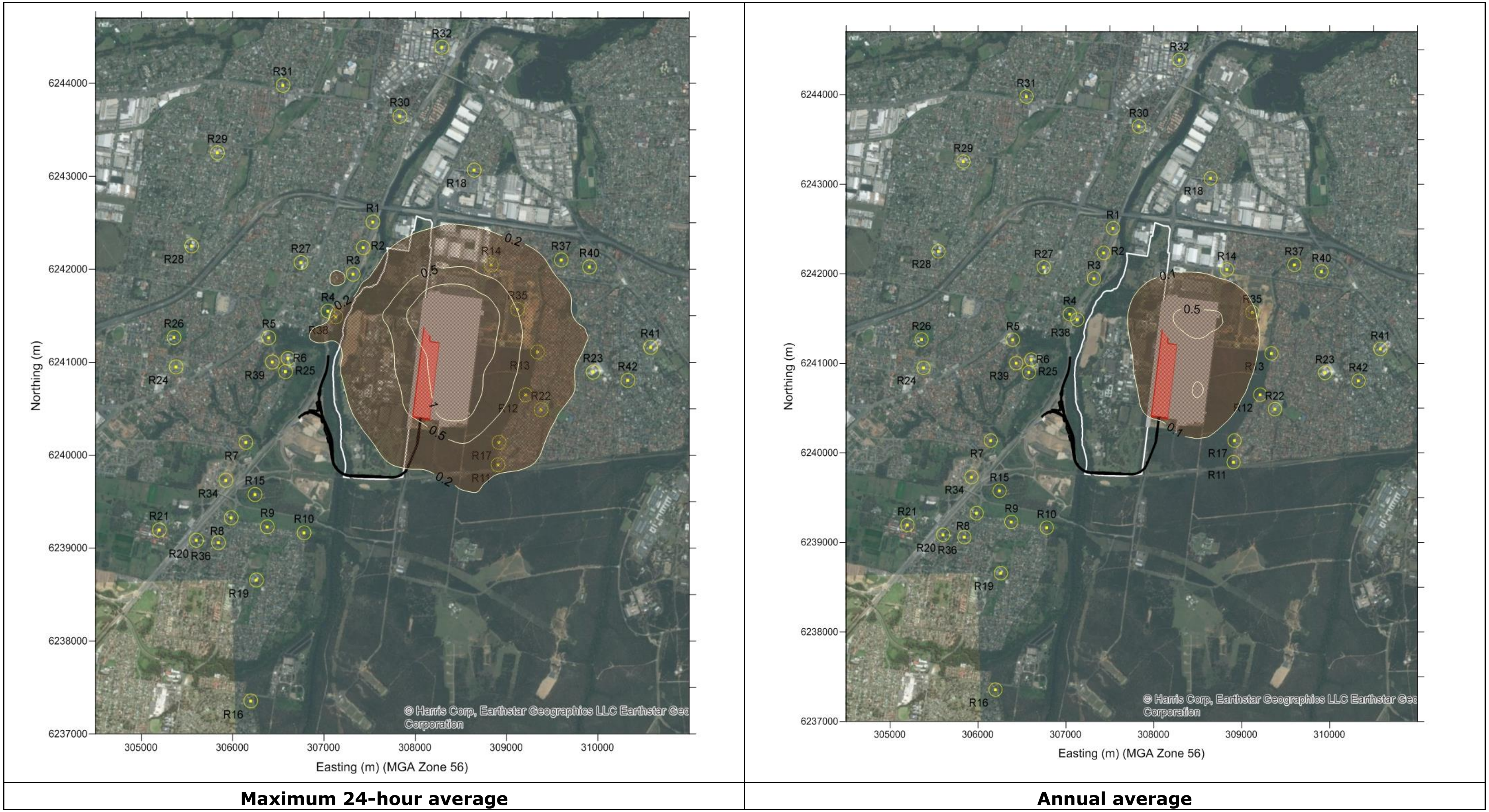


Figure A5-1: Contour plots of maximum 24-hour and annual average $PM_{2.5}$ ($\mu g/m^3$) during construction phase

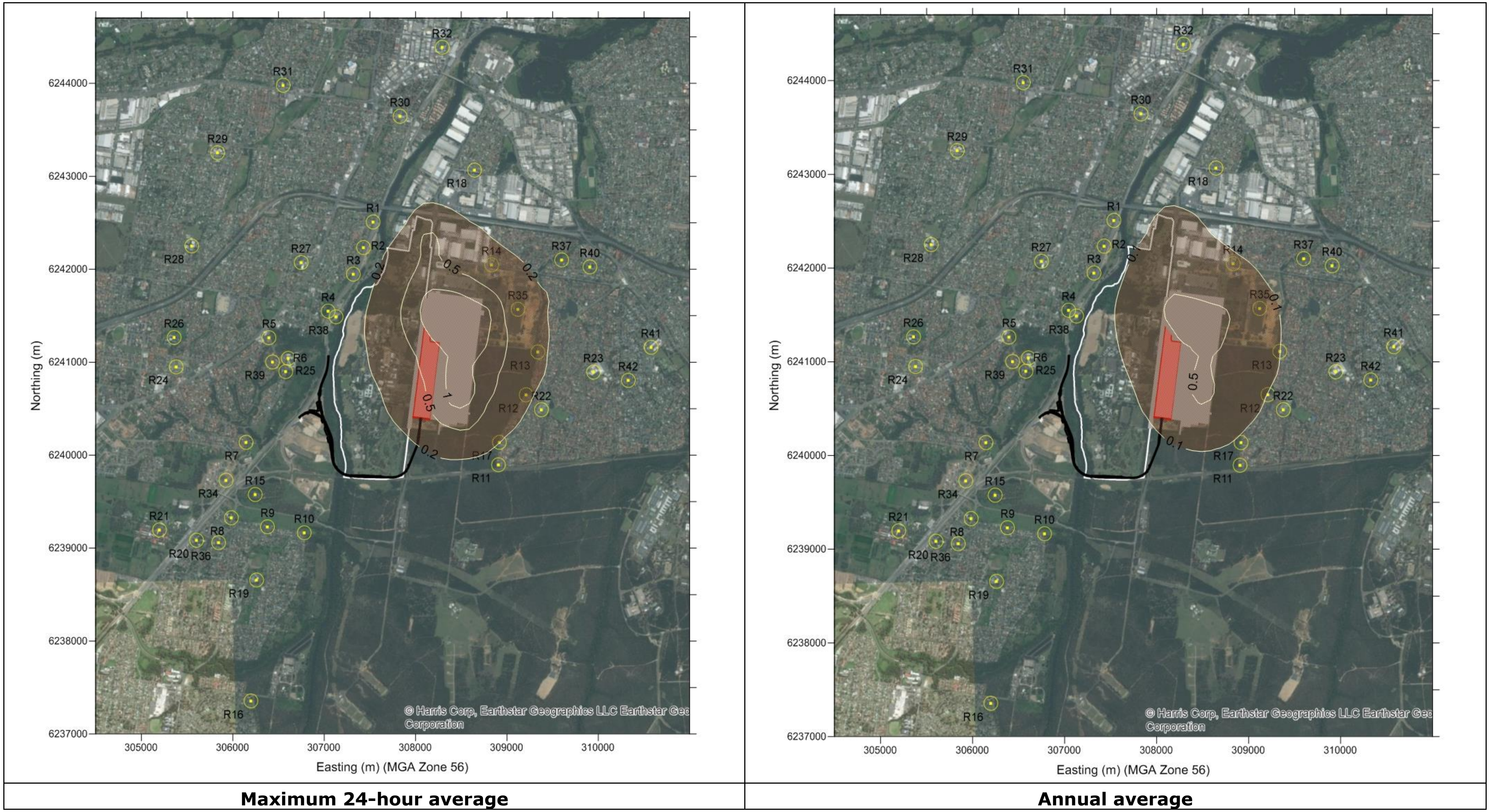
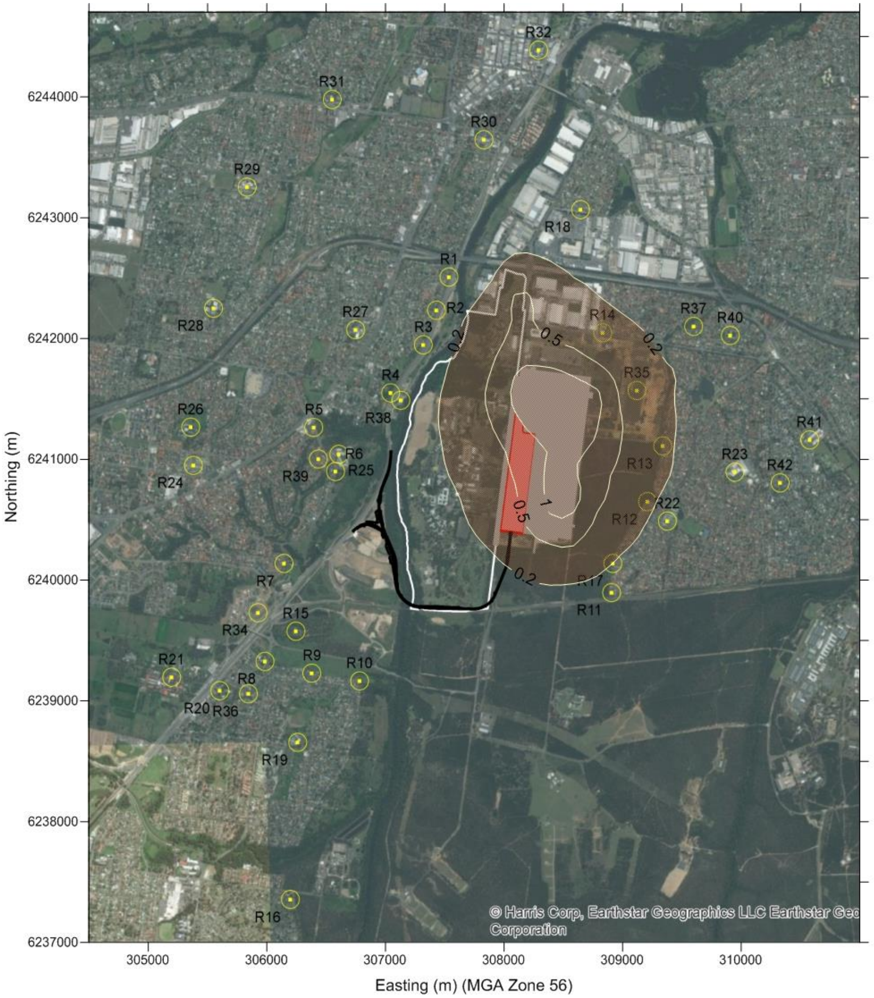
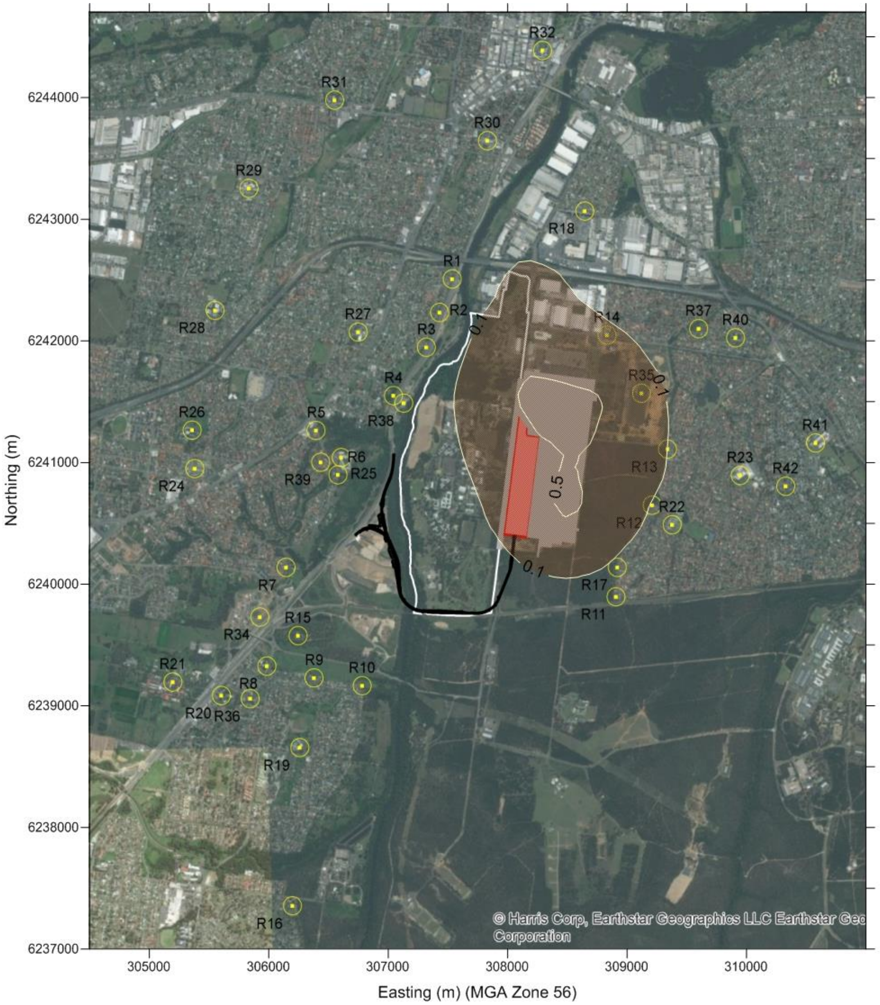


Figure A5-1: Contour plots of maximum 24-hour and annual average PM_{10} (µg/m³) during operational phase

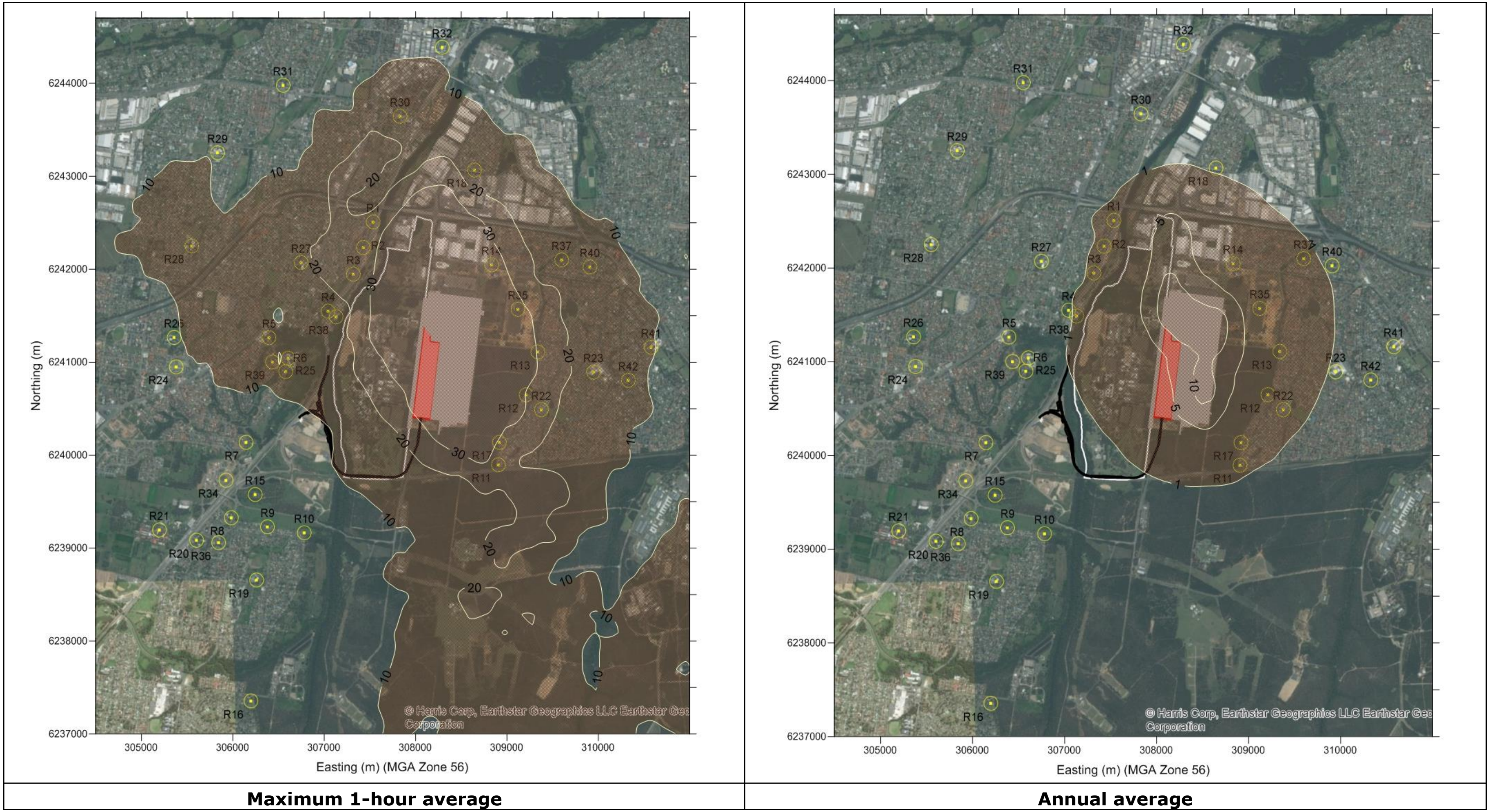


Maximum 24-hour average



Annual average

FigureA5-1: Contour plots of maximum 24-hour and annual average $PM_{2.5}$ (µg/m³) during operational phase



FigureA5-1: Contour plots of maximum 1-hour and annual average NO_2 (µg/m³) during operational phase

APPENDIX 7
AIR QUALITY MANAGEMENT PLAN

Construction phase

D2.1 Dust management measures

The principal emissions during the construction will be dust from the following activities:

- Vegetation clearing / earthmoving during site preparation and road upgrades.
- Handling (loading / unloading) of spoil material.
- Handling (loading / unloading) of fill material.
- Demolition of existing structures.
- Movement of heavy plant and machinery within the site on unsealed areas.
- Wind erosion from exposed surfaces.

Prior to commencement of construction work, the construction contractor will prepare a Construction Environmental Management Plan (CEMP). The air quality management measures for the CEMP are outlined below.

Clearing, site preparation and excavation

Emissions from site clearing, vegetation removal, topsoil clearing and excavation, particularly during dry and windy conditions, can be effectively controlled by increasing the moisture content of the soil / surface. The contractor would deploy water carts periodically during construction to ensure exposure areas and topsoils/subsoil are kept moist. Other controls that will be implemented as necessary are:

- Modifying working practices by limiting clearing, stripping and spoil handling during periods of adverse weather (hot, dry and windy conditions) and when dust is seen leaving the site.
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.

Demolition of existing structures

Where possible, materials and structures will be dampened using water sprays prior to demolition. During adverse weather (hot, dry and windy conditions), consideration will be given to modify demolition activities when dust is seen leaving the site. Special consideration, including boundary monitoring will need to be given to the demolition of buildings containing asbestos in accordance with relevant guidelines and legislation.

Haulage and heavy plant and equipment movements

Vehicles travelling over paved or unpaved surfaces produce wheel generated dust and can result in dirt track-out on paved surfaces surrounding the work areas. Mitigation measures implemented for construction include:

- Operation of a water cart on all unsealed internal roadways and travel routes.
- All vehicles on-site should be confined to a designated route with a speed limit of 30km/hr enforced.
- Trips and trip distances should be controlled and reduced where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips.
- Dirt track-out should be managed using shaker grids and / or wheel cleaning. Dirt that has been tracked onto public roads should be cleaned as soon as practicable.
- All trucks delivering fill or leaving the site with spoil material will have their load covered.

Wind erosion

Wind erosion from exposed ground should be limited by avoiding unnecessary vegetation and topsoil clearing and limiting to the minimum footprint required. Wind erosion from temporary stockpiles will be limited by minimising the number of work faces on stockpiles and through temporary stabilisation (compaction of surface, water sprays, seeding, veneering).

D2.2 Site environmental responsibility

During construction, environmental management will be the responsibility of the construction contractor. The Construction Manager (CM) will be responsible for the day to day construction activities of the Proposal site, including the implementation of dust controls. The CM will:

- Oversee the implementation of environmental management plans and policies.
- Consider and advise senior management on compliance obligations.
- Have the authority to recommend reasonable steps to manage adverse impacts.
- Have the authority to recommend cessation of activities on-site.

The management and reporting of environmental aspects will be the responsibility of the CM, with specific tasks delegated to on-site personnel. All site personnel will undergo appropriate induction training and individual responsibilities for ensuring that procedures are adhered to will be clearly identified. The relevant roles and responsibility should be outlined in the CEMP.

D2.3 Construction dust monitoring

Visual checks would be made and reported on an environmental inspection report. The daily visual checks will:

- Inspect and report on excessive dust being generated at source (wheel generated dust, scrapers/graders, dozers, excavators, wind erosion).
- Inspect and report on water cart activity and effectiveness.
- Inspect and report on dust leaving the site.
- Non-conformance (dust leaving the site) would be reported immediately to the CM or management.

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