MOOREBANK INTERMODAL COMPANY

Moorebank Intermodal Terminal Project Environmental Impact Statement

Volume 6

October 2014

PARSONS BRINCKERHOFF

Technical Paper 7
Local Air Quality Impact Assessment

Technical Paper 7 – Local Air Quality Impact Assessment

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Proposed Moorebank Intermodal Terminal - Local Air Quality Impact Assessment

Prepared for:
Parsons Brinckerhoff

Prepared by:
ENVIRON Australia Pty Ltd

Date:
29 September 2014

Project Number:
AS121562

ENVIRON

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VERSION CONTROL RECORD

Document File Name	Date Issued	Version	Author	Reviewer
AS121562_MIMT_AQIA_Final_300614	30 June 2014	FINAL	Scott Fishwick	Brian Bell
AS121562_MIMT_AQIA_Final_Rev1_290914	29 September 2014	Revision 1	Scott Fishwick	Brian Bell

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Executive Summary

ENVIRON Australia Pty Ltd (ENVIRON) was commissioned by Parsons Brinckerhoff Pty Limited (Parsons Brinckerhoff) to undertake an Air Quality Impact Assessment (AQIA) for the proposed Moorebank Intermodal Terminal (IMT) Project (the Project).

The Project involves the construction and operation of an IMT and associated infrastructure, facilities and warehousing at Moorebank, in the southwestern suburbs of Sydney. The Project includes a rail link and road entry and exit points, connecting the Project site to existing regional rail and road networks. The Project proponent is Moorebank Intermodal Company (MIC), a government business enterprise set up to facilitate the development of the Project.

Three rail access options for the Project were assessed:

- *northern rail access option* —rail access from the north-western corner of the IMT site, passing through the former Casula Powerhouse Golf Course (which is currently owned by Liverpool City Council (LCC)) and crossing the Georges River and floodplain;
- *central rail access option* —rail access from the centre of the western boundary of the IMT site, passing through Commonwealth land on the western bank of the Georges River (referred to as the ‘hourglass land’); and
- *southern rail access option* — rail access from the south-western corner of the IMT site, passing through the Glenfield Landfill site (owned by Glenfield Waste Services) and crossing the Georges River and floodplain.

For each rail access option, four scenarios capturing key periods during the development of the Project site and increasing in IMT operations were configured and assessed – a total of 12 emissions scenarios. These scenarios provide a representative, upper bound assessment of the potential air quality impacts of the Project’s construction and operation. Air emission sources associated with the construction and operational stages were identified and quantified.

Pollutants assessed in this report include particulate matter (PM) and combustion-related gaseous pollutants.

Particulate matter size fractions quantified and assessed during the study comprised total suspended particulates (TSP), particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), and particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$). The finer particle size fractions are of interest due to their health risk potential.

Combustion-related gaseous pollutants of interest include oxides of nitrogen (NO_x) and specifically nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). While numerous VOC species are emitted during the combustion of diesel fuel, the study focussed primarily on the compounds benzene, toluene, xylenes, 1,3-butadine, formaldehyde and acetaldehyde to assess the potential health impact of individual organic pollutants.

Emissions were estimated using a range of published emissions factor sources, including United Stated Environment Protect Agency (US-EPA) and Australian National Pollution

Inventory (NPI) emission factor documentation. Key findings of the emissions inventory included:

- emissions of TSP and PM_{10} would be higher during the construction phases of the Project; and
- emissions of diesel combustion related pollutants (specifically $PM_{2.5}$, NO_x, SO_2, CO, VOCs and PAHs) would increase in line with increasing IMT operations.

Existing air quality was quantified using available monitoring data sources, including onsite monitoring equipment and the nearby NSW Office of Environment and Heritage (OEH) Liverpool monitoring station. Meteorological conditions were characterised using data from the OEH Liverpool station and supported by Bureau of Meteorology stations at Holsworthy and Bankstown. Data recorded during 2013 was adopted for this assessment.

During 2013, baseline PM_{10} and $PM_{2.5}$ concentrations were shown to exceed the 24-hour average NSW Environment Protection Authority (EPA) assessment criterion on three occasions, and the National Environment Protection Measure (NEPM) advisory reporting goal on two occasions. Analysis of this data highlighted that the exceedances coincided with the wide-spread bushfire events that occurred across NSW during late 2013.

In cases where existing ambient air pollutant concentrations may exceed the impact assessment criteria, the NSW EPA requires the project proponent to demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity.

Due to the extensive bushfires in 2013, the five-year annual average (between 2009 and 2013) PM_{10} and $PM_{2.5}$ concentrations recorded at the OEH Liverpool station were calculated to reflect annual average concentrations of these pollutants in the local area. Elevated PM concentrations associated with natural events, including bushfires and dust storms, were retained in the calculation of the five-year average concentrations, resulting in a conservative annual average baseline concentration for PM_{10} and $PM_{2.5}$.

All other baseline concentrations of recoded air pollutants analysed for 2013 were below applicable NSW EPA assessment criteria.

Atmospheric dispersion modelling carried out as part of this assessment used the AMS/US-EPA regulatory model (AERMOD). Inputs to the model included local topographic data, calculated emissions and hourly-varying meteorology from the OEH Liverpool station. Project-only (incremental) ground level concentrations and deposition rates were for an area covering 7 km by 7 km centered over the Project site, with a grid resolution of 200 m. Additionally, model predictions were made at 38 sensitive receptor locations, representative of the local area.

Key findings of the air quality assessment are:

- incremental (Project-only impacts excluding the contribution of ambient air quality) air pollutant concentrations and dust deposition rates associated with all modelled scenarios were predicted to be within NSW EPA criteria and NEPM advisory reporting goals at all surrounding receptor locations;

- taking elevated background airborne PM concentrations into account, no exceedance days were predicted for 24-hour average PM_{10} and $PM_{2.5}$ beyond those already recorded due to bushfire events in 2013;
- exceedance of the annual average NEPM advisory reporting goal for cumulative $PM_{2.5}$ is predicted for one receptor (R33) in each Project phase after Phase B (Scenario 4 onwards). Whilst this receptor was relocated in 2014 it has been retained in the assessment for completeness. The likely future land use at R33 would be associated with the SIMTA project. The elevated ambient background is the key contributor to these exceedances; and
- all incremental cumulative and gaseous pollutants assessed are below applicable NSW EPA assessment criterion for all scenarios,

In addition to the assessment of emissions from the Project site, modelling was conducted to account for potential cumulative impacts of operations at the Project site and potential operations at the at the adjacent SIMTA site. Three cumulative assessment scenarios were developed accounting for possible future site configurations at the two sites. The findings of this cumulative assessment are as follows:

- cumulative incremental (Moorebank IMT and SIMTA only) concentrations are below NSW EPA and NEPM advisory reporting goals at all surrounding receptor locations;
- additional exceedance of the NSW EPA 24-hour average PM_{10} criterion and NEPM advisory reporting goal for 24-hour average $PM_{2.5}$ is predicted to occur at R33 when existing air quality is accounted for;
- cumulative annual average (Moorebank IMT and SIMTA-only increment + background) $PM_{2.5}$ concentrations are in exceedance of the NEPM advisory reporting goal at receptor R33;
- exceedance at R33 is attributable to the location of R33 directly amongst SIMTA site emission sources; and
- no other cumulative (Moorebank IMT and SIMTA -only increment + background) pollutant exceedances are predicted for any scenario at any of the surrounding receptor locations.

Construction dust mitigation measures would be adopted in the Dust Management Plan to ensure that sensitive receptors are not adversely affected during construction activities. Typical dust control measures implemented during construction operations were accounted for in the assessment. Further impact reductions can be achieved by applying additional dust management measures, including the use of real-time monitoring to trigger contingency actions during dust risk periods.

An Air Quality Management Plan for the operation of the Project should be prepared to ensure that potential air impacts are minimised and the relevant ambient air quality criteria are complied with.

It is recommended that ambient air quality monitoring be undertaken as part of the Project's construction phase. This should include:

- on-site monthly dust deposition monitoring to measure dust fallout from the Project's operation at boundary points and selected sensitive receiver locations with reference to the air quality criteria;
- ongoing operation of the existing on-site air quality monitoring station (that records continuous measurements of NO_x, PM_{10} and $PM_{2.5}$) to ensure that the ambient air quality criteria are met. The existing station may need to be relocated depending on site construction works and regulator recommendations; and
- ongoing operation of the existing on-site meteorological monitoring station. The location of this station should be reviewed to ensure compliance with relevant Australian Standard documentation.

The results of the assessment indicate that, air quality criteria exceedances would be restricted to cumulative annual average $PM_{2.5}$ concentrations. The potential health risks associated with predicted $PM_{2.5}$ concentrations are further considered within the Human Health Risk Assessment (HHRA). Typical mitigation measures implemented during construction operations, and progressive improvements in combustion engine exhaust emissions for on-road diesel trucks and locomotives, were accounted for in the assessment. However, the application of additional management measures such as real-time dust monitoring and management during the construction phase, and the use of lower emitting equipment during the operational stages, will further reduce the predicted Project-related impacts. It is also noted that the PM_{10} and $PM_{2.5}$ concentrations predicted during this assessment are expected to be overstated if Euro VI emission standards are introduced for on-road heavy duty vehicles.

The predictive dispersion modelling demonstrates that concentrations of most pollutants (TSP, PM_{10}, NO_x, CO, SO_2, benzene, toluene, xylene, 1,3-butadiene, acetaldehyde and PAHs) emitted from the Project would be below acceptable ambient air quality criteria and would not adversely affect the receiving environment. Exceedance of the $PM_{2.5}$ advisory reporting goals are predicted, but only at a receptor location that is marked for the SIMTA development.

Where the Moorebank IMT Project operates simultaneously with operations at the proposed SIMTA site, the air impacts are predicted to be greater than for the operation of the Moorebank IMT Project alone. It is considered that the improvement of engine standard compliance for the truck (Euro VI) and locomotive (minimum Tier 2) fleets servicing the Project would significantly reduce impacts associated with $PM_{2.5}$.

This assessment focuses on the local impacts of the Project. A separate regional air quality impact assessment has been conducted to assess the change in air quality impacts across the Sydney metropolitan region.

1 Introduction

ENVIRON Australia Pty Ltd (ENVIRON) was commissioned by Parsons Brinckerhoff Pty Limited (Parsons Brinckerhoff) to undertake an Air Quality Impact Assessment (AQIA) for the proposed Moorebank Intermodal Terminal (IMT) Project (the Project).

The Project involves the construction and operation of an IMT and associated infrastructure, including warehousing and other facilities' at Moorebank, in the southwestern suburbs of Sydney. The purpose of the IMT is to facilitate the distribution of freight to and from Port Botany. A detailed description of the Project is presented in **Section 2**.

The Project includes a rail link and road entry and exit points, connecting the Project site to existing regional rail and road networks. The Project proponent is Moorebank Intermodal Company (MIC), a Government Business Enterprise set up to facilitate the development of the Project.

This AQIA has principally been guided by the NSW Environment Protection Authority (NSW EPA, then Department of Environment and Conservation (DEC)) document *The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods for Modelling", DEC 2005).

1.1 Study objective

The primary objectives of the AQIA are to identify potential air quality impacts associated with the construction and operation of the Project, satisfy the relevant federal and state assessment requirements and make recommendations on additional mitigation measures if required.

1.2 Environmental Assessment Requirements for air quality

This AQIA has been prepared by ENVIRON to address environmental impact assessment requirements of both the Commonwealth Department of Environment's (DoE) Environmental Impact Statement (EIS) Guidelines and the NSW Department of Planning and Environment's (NSW DP&E) Environmental Assessment Requirements (EARs).

Specifically this report addresses the requirements outlined in **Table 1**.

This study investigates local air quality impacts only. The regional air quality and greenhouse gas components of the DoE EIS and EARs specified in **Table 1** have not been addressed in this study. The Regional Air Quality Impact Assessment (TAS 2014) and Greenhouse Gas Assessment (Parsons Brinckerhoff 2014) have been addressed in separate reports.

This AQIA has been prepared for inclusion with the Moorebank IMT Project Environmental Impact Statement (EIS) and has been prepared with reference to the following legislation and guidelines:

- New South Wales Protection of the Environment and Operations Act 1997.
- National Environment Protection (Ambient Air Quality) Measure (1998).
- National Environment Protection (Air Toxics) Measure (2004).
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005).

- New South Wales, Protection of the Environment Operations Regulation 2010.

Table 1: EIS requirements addressed within this report

Requirement	Section of AQIA
DoE EIS Guidelines	
• A discussion of the known and potential developments in the local region on the environmental values of land, impacts to air and water and public health. This assessment may include air and water sheds affected by the proposal.	• Section 6
• Describe the existing air quality site, including a description of the relationship of the site to the regional air drainage basin and of diurnal and seasonal variations in air pollution levels and the influence of short term weather phenomena. Reference must be made to levels of hydrocarbons, suspended particulate matter, carbon monoxide, oxides of nitrogen, sulphur dioxide, ozone, reactive organic compounds, lead and air toxics. The description must include relevant weather characteristics including winds, fogs and temperature inversions and any topographic features which may affect the dispersion of air pollutants.	• Section 5, Section 6
• Analyse and describe the changes to the local and regional air drainage basin as a result of construction and operational phases of the action. The analysis must consider diurnal and seasonal variations in air pollution levels and the influence of short term weather phenomena. The analysis must provide results for the following: hydrocarbons, suspended particulate matter, carbon monoxide, oxides of nitrogen, sulphur (sulphur) dioxide, ozone, reactive organic compounds, lead and air toxics.	• Local impacts - Section 10, Section 12 • Regional impacts – refer to Regional Air Quality Impact Assessment.
NSW DP&E Environmental Assessment Requirements	
• Air pollutants, including an assessment of potential air pollution sources (including identifying locomotive standards), dust deposition, total suspended particulates, PM_{10} and atmospheric pollutants of concern for local and regional air quality.	• Section 8, Section 10, Section 12
• Consideration of relevant weather characteristics, seasonal variations and topographic features that may affect the dispersion of atmospheric pollutants.	• Section 3, Section 5
• Identify impacts of the pollutants on human health, including cumulative impacts from background air pollution.	• Section 10, Section 12
• A Scope 1 greenhouse gas assessment, as defined by the Greenhouse Gas Protocol, and	• Refer to Technical Paper - Greenhouse Gas Assessment
• Taking into account the *Australian Greenhouse Office Factors and Methods workbook* (AGO 2006), *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC) and the *National Environmental Protection Measures for Ambient Air Quality* (National Protection Council).	• Section 5, Section 6 Section 9

2 Project overview

The Project involves the development of approximately 220 hectares (ha) of land at the Project site (refer to **Figure 1**) for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the Project site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue.

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

The Project proponent is Moorebank Intermodal Company (MIC), a Government Business Enterprise set up to facilitate the development of the Project.

The Project site is currently largely occupied by the Department of Defence's (Defence) School of Military Engineering (SME). Under the approved Moorebank Units Relocation Project, the SME is planned to be relocated to Holsworthy Barracks by mid-2015, which would enable the construction of the Project to commence at that time.

The key features/components of the Project comprise:

- *an IMEX freight terminal* – designed to handle up to 1.05 million TEU (20 foot equivalent units) per annum (525,000 TEU inbound and 525,000 TEU outbound) of IMEX containerised freight to service 'port shuttle' train services between Port Botany and the Project;
- *an Interstate freight terminal* – designed to handle up to 500,000 TEU per annum (250,000 TEU inbound and 250,000 TEU outbound) of interstate containerised freight to service freight trains travelling to and from regional and interstate destinations; and
- *warehousing facilities* – with capacity for up to 300,000 square metres (m^2) of warehousing to provide an interface between the IMT and commercial users of the facilities such as freight forwarders, logistics facilities and retail distribution centres.

The proposal concept described in the main EIS (refer Chapters 7 and 8) provides an indicative layout and operational concept for the Project, while retaining flexibility for future developers and operators of the Project. The proposal concept is indicative only and subject to further refinement during detailed design stage.

2.1 Rail access options and layouts

The Project is intended to connect to the SSFL, which was commissioned in January 2013 within the Main South Railway Line corridor. The SSFL connects Port Botany to west and south-western Sydney, and would provide a direct route for freight trains from Port Botany to the Project site.

Three separate rail access options are included as part of the proposal concept as detailed in the EIS, as shown in **Figure 1**. These options comprise:

- *northern rail access option* — with rail access from the north-western corner of the IMT site, passing through the former Casula Powerhouse Golf Course (which is currently owned by Liverpool City Council (LCC)) and crossing the Georges River and floodplain;
- *central rail access option* — with rail access from the centre of the western boundary of the IMT site, passing through Commonwealth land on the western bank of the Georges River (referred to as the 'hourglass land'); and
- *southern rail access option* — rail access from the south-western corner of the IMT site, passing through the Glenfield Landfill site (owned by Glenfield Waste Services) and crossing the Georges River and floodplain.

In order to maintain flexibility for future developers and operators of the Project, the proposal concept, as presented in the EIS, provides three indicative IMT internal layouts; one for each of three proposed rail access options. Once the developer/operator has been appointed, the Project would progress to the detailed design phase and one of the three rail access options identified above would be selected.

Indicative layout plans of the northern, central and southern rail access option are presented in **Figure 2**, **Figure 3** and **Figure 4** respectively.

2.2 Indicative Project development phasing

The Project is proposed to be phased (staged) in its development, as summarised in **Figure 5**. The proposed indicative phasing includes both construction and operational phases, which are likely to overlap at certain times. For the purposes of assessment of the Project, five project development phases have been identified and detailed in the EIS. These are indicative only, but illustrate the type of construction and operation activities that would occur over time at the Project site.

The Project would likely commence in 2015 with the Early Works development phase and would progress with concurrent construction and operation through to the Project Full Build Phase (operation of full IMEX terminal, warehousing and interstate terminal) by approximately 2030.

The development phasing is proposed in line with the forecast market demand for processing of containers through the Project.

2.3 Road access to the site

Freight trucks would access the Project site from Moorebank Avenue, via the M5 Motorway. Trucks would then access the M7 Motorway and Hume Highway by the M5 Motorway (see **Figure 1**). An upgrade to Moorebank Avenue would be included as part of the first phase of Project development (Project Phase A) to enable safe and efficient access to the Project site.

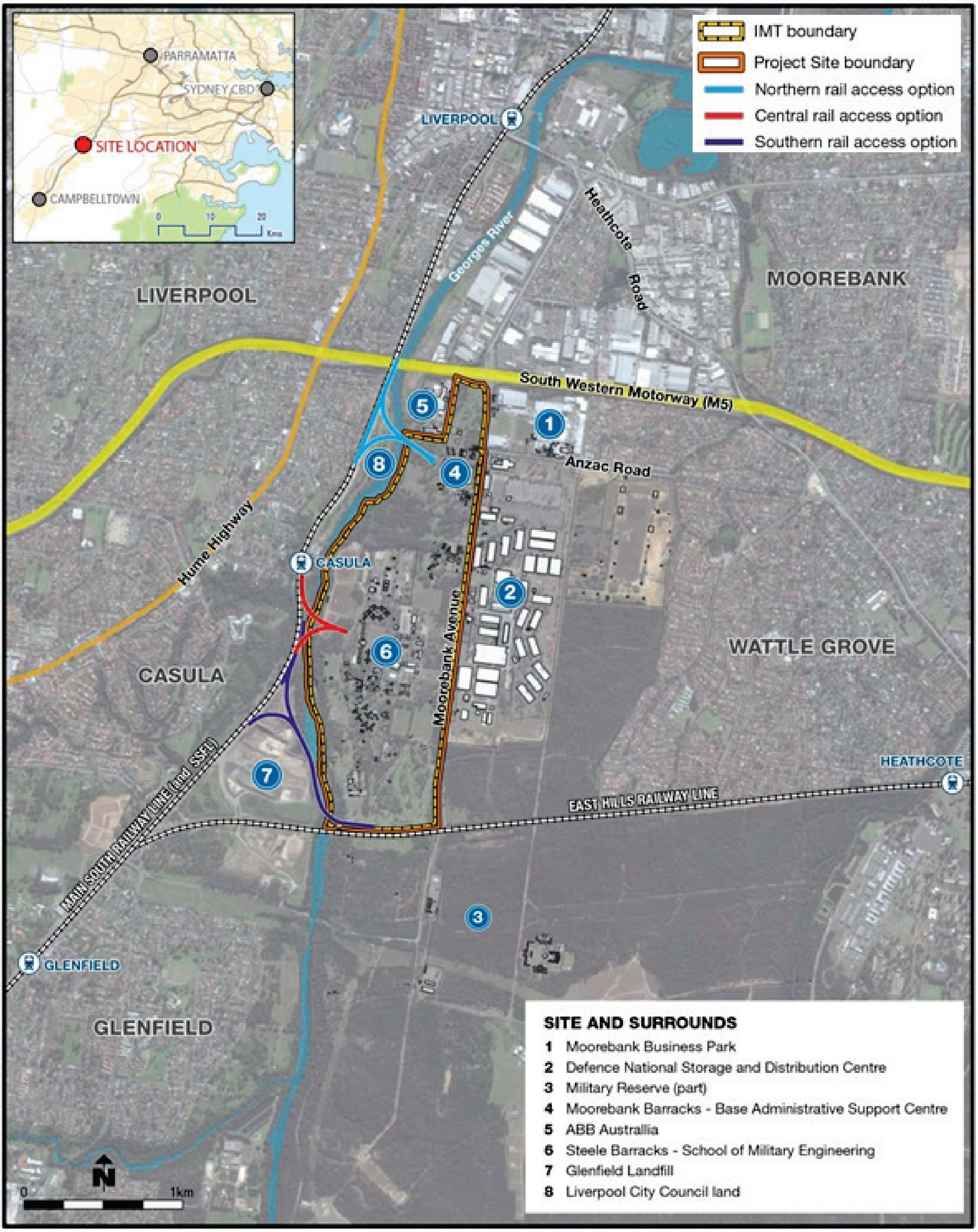


Figure 1: Project site and context

Source: Parsons Brinckerhoff 2014

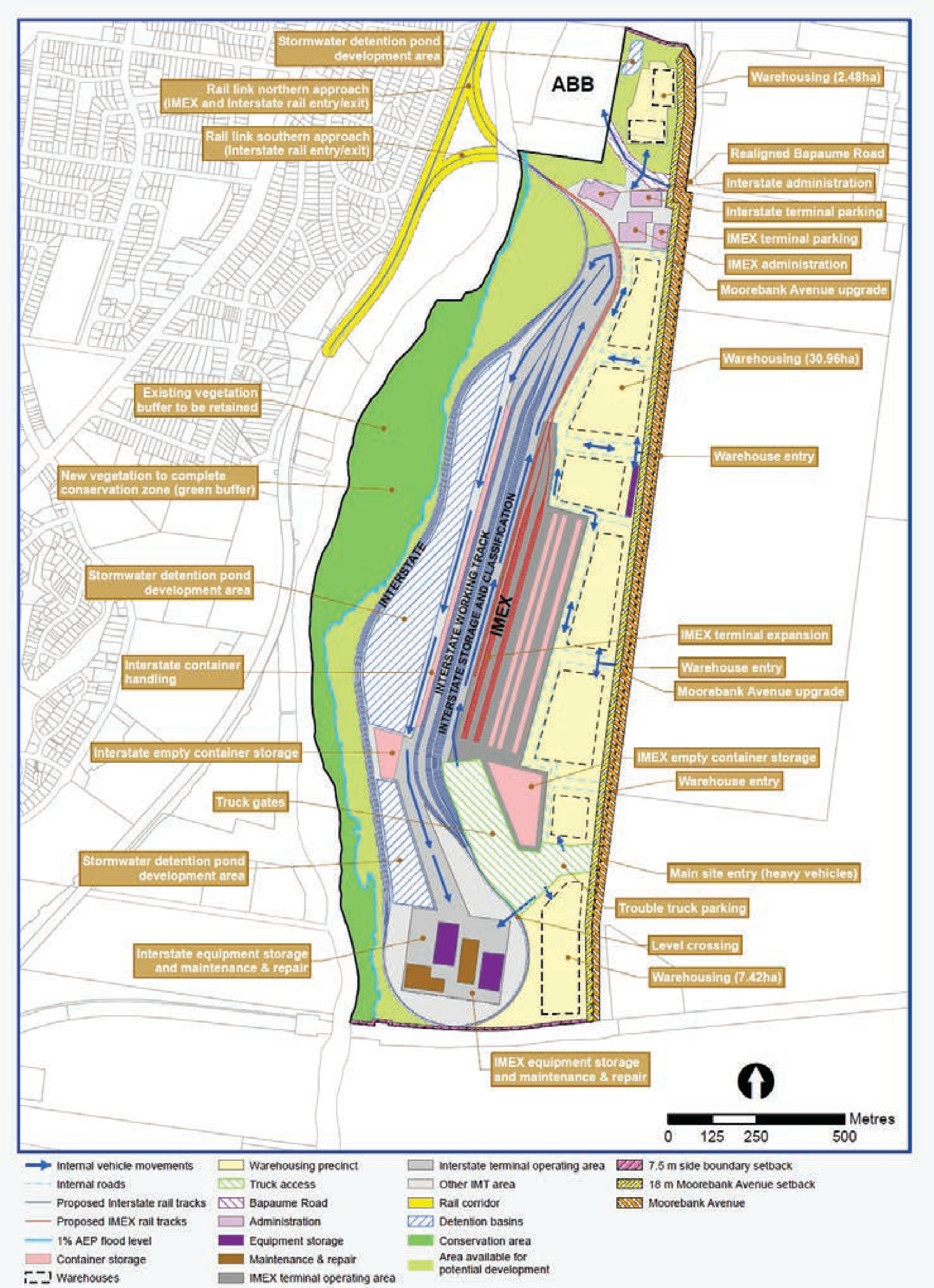


Figure 2: Indicative IMT layout associated with the northern rail access option at Full Build

Source: Parsons Brinckerhoff 2014

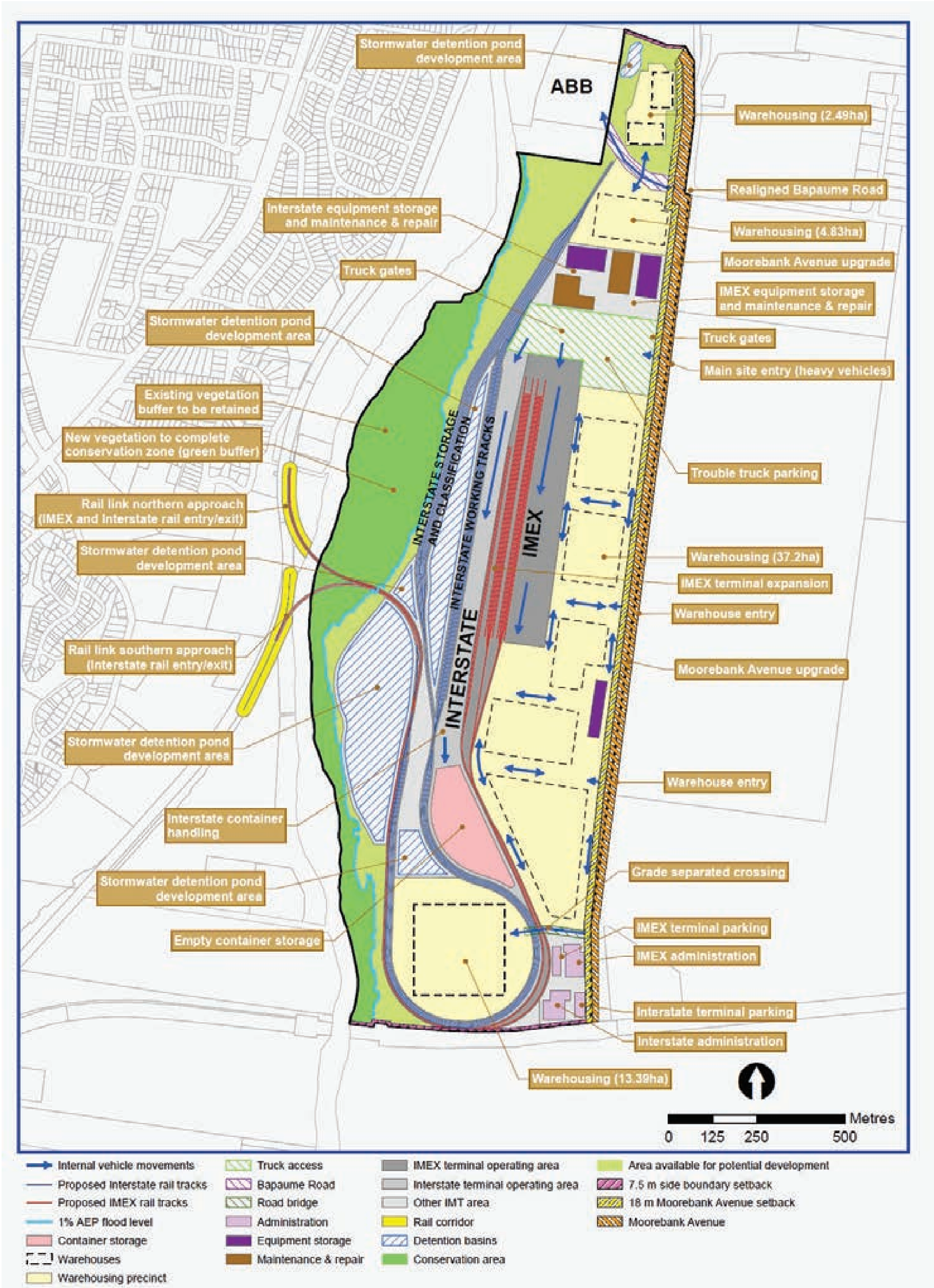


Figure 3: Indicative IMT layout associated with the central rail access option at Full Build

Source: Parsons Brinckerhoff 2014

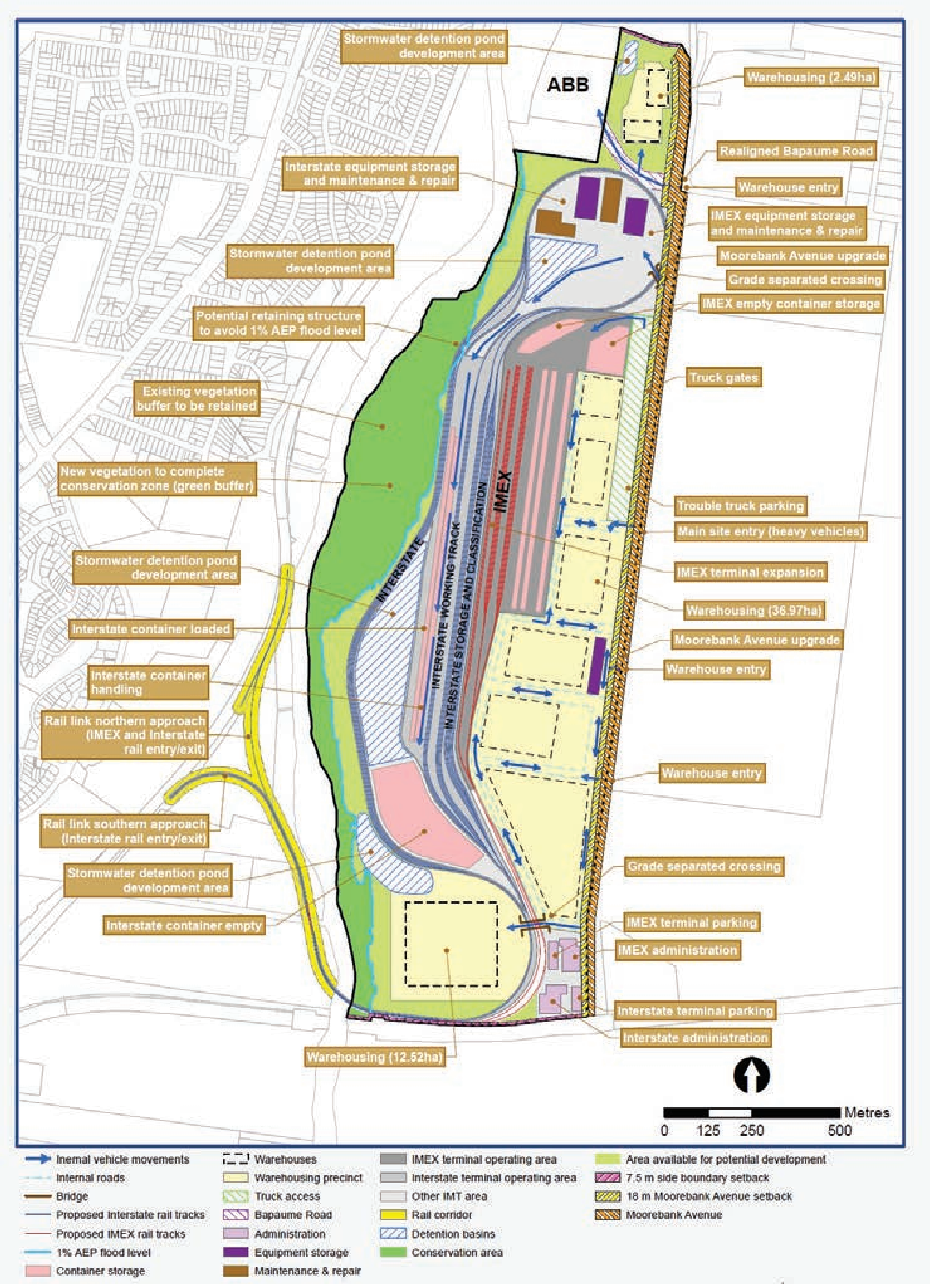


Figure 4: Indicative IMT layout associated with the southern rail access option at Full Build

Source: Parsons Brinckerhoff 2014

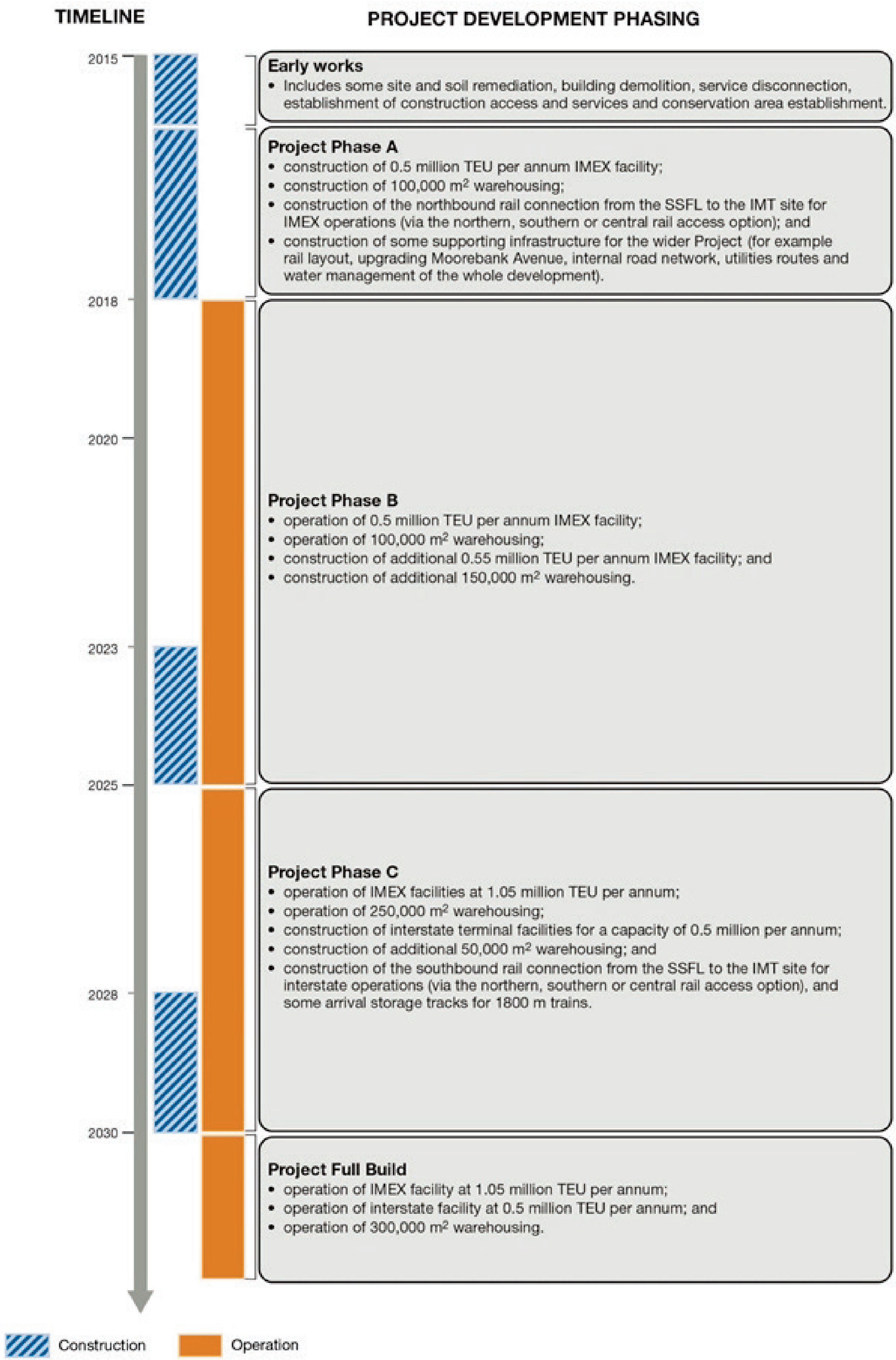


Figure 5: Project development phasing

Source: Parsons Brinckerhoff 2014

3 Project setting

3.1 Existing land use and topography

The proposed Project site is situated in Moorebank, NSW, approximately 28 km west-southwest of the Sydney central business district. The Project site is approximately 220 ha in area, and is surrounded by the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Defence land (Refer **Figure 1**).

To the north of the Site, the local area is generally characterised by industrial and commercial land uses, including the adjacent Asea Brown Boveri (ABB) Australia's Medium Voltage Production Facility.

To the east of the Site, land use is predominately industrial and commercial, with extensive Defence land further east (including the Holsworthy military area).

To the west of the Site is the Georges River, with a generally well established riparian area, that is heavily vegetated in parts. The Leacock Recreation Park and Casula Powerhouse Arts Centre recreational areas used by members of the community, are located on the west bank of the Georges River. The areas west and north-west of the Georges River mark a transition to low-density residential development and associated commercial developments and community facilities within the suburbs of Casula and Liverpool.

To the south of the Site is the East Hills Railway Line. Large areas of bushland and the Defence's Holsworthy Barracks are further south of the railway line. The Glenfield Landfill facility is located to the south-west of the Project site.

The Project site is situated at a relatively low elevation on the edge of the Georges River, with an approximate elevation range of between 10 m Australian Height Datum (AHD) along the western site boundary and 25 m AHD towards the southern boundary. Beyond the site boundary, the terrain is lightly undulating to the north and east, while the terrain height increases to the south and west, most sharply on the immediate opposite side of the Georges River to the western boundary of the Project site.

Figure 6 illustrates the topography of the area surrounding the Project site.

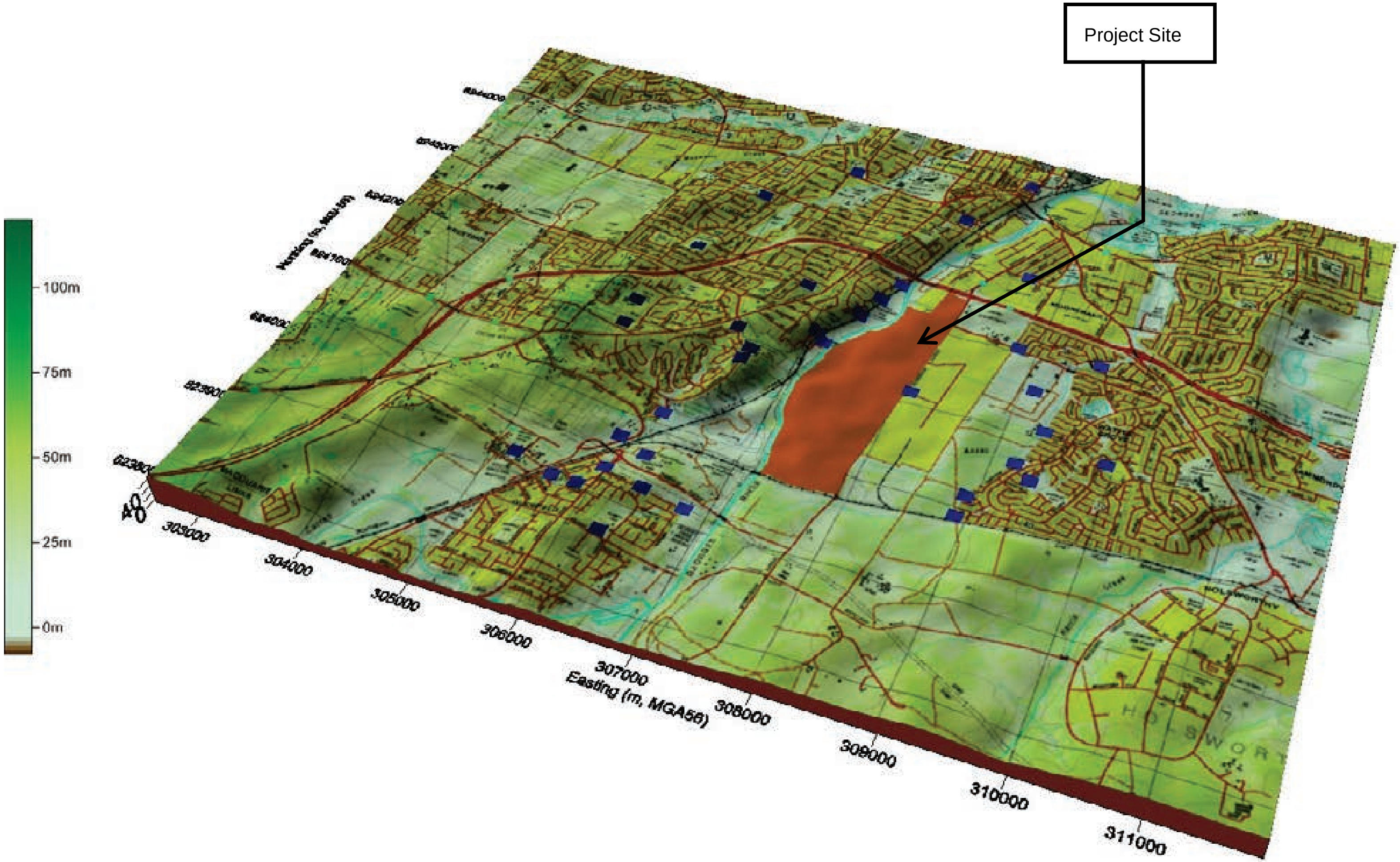


Figure 6: Topography Surrounding the Project site

Note: The vertical scale has been exaggerated by a factor of four. Blue squares mark sensitive receptor locations.

3.2 Surrounding sensitive residences

The Project site is located in the vicinity of industrial, residential and recreational land. The Approved Methods for Modelling (DEC 2005) define a sensitive receiver as follows:

> A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area.

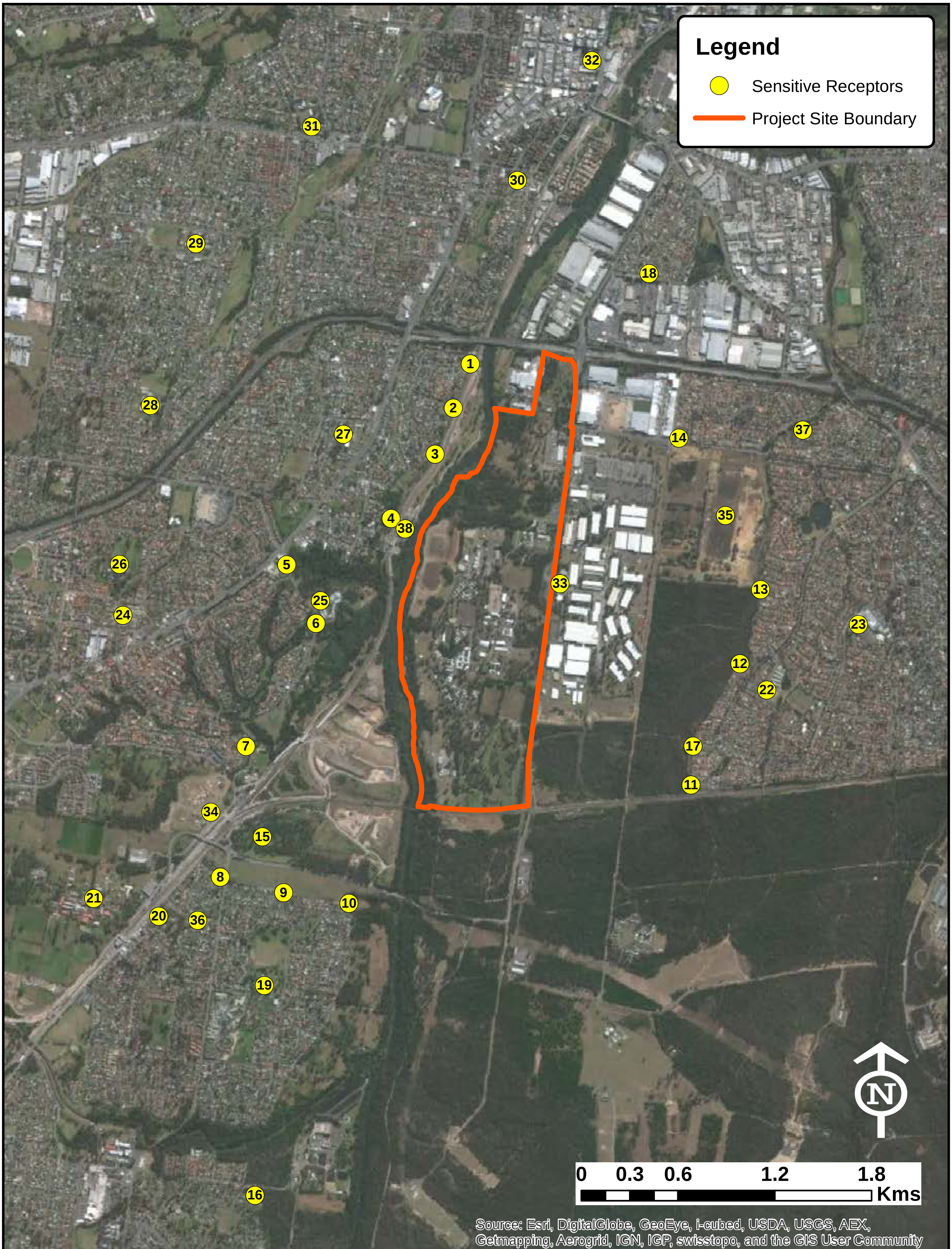
In order to assess potential air quality impacts in the region surrounding the Project site, 38 sensitive receptor locations have been identified for use in this study. While not all sensitive receptors in the surrounding area were included, the receptor locations were selected to present air quality results for the closest dwellings or establishments in each of the surrounding suburbs, therefore ensuring that maximum exposure potentials were accounted for.

The receptors include, but are not necessarily limited to, residential properties, schools and aged care facilities near the Project site. The closest sensitive receptor is the historical Defence National Storage Distribution Centre (DNSDC) facility (Receiver 33), located adjacent to the eastern boundary. In 2014, the DNSDC facility was relocated to a new site approximately 1.5 km northeast of the current location (Receptor 35). Although, the DNSDC facility has moved from Receptor 33, the land on which it is currently situated is proposed to be developed by the Sydney Intermodal Terminal Alliance (SIMTA); hence Receiver 33 has been retained in the AQIA.

The details of each assessment location are presented within **Table 2**, while **Figure 7** illustrates the location of these sensitive receptor locations relative to the Project site.

Table 2: Selected surrounding sensitive receptor locations

Residence ID	Location (m, MGA56)		Description	Elevation (m, AHD)
	Easting	Northing		
R1	307535	6242509	Lakewood Crescent, Casula	13
R2	307430	6242235	St Andrews Boulevard, Casula	18
R3	307317	6241949	Buckland Road, Casula	23
R4	307044	6241551	Dunmore Crescent, Casula	32
R5	306397	6241264	Leacocks Lane, Casula	57
R6	306579	6240902	Leacocks Lane, Casula	51
R7	306145	6240139	Slessor Road, Casula	16
R8	305986	6239330	Canterbury Road, Glenfield	27
R9	306378	6239233	Ferguson Street, Glenfield	30
R10	306783	6239167	Goodenough Street, Glenfield	16
R11	308903	6239900	Wallcliff Court, Wattle Grove	21
R12	309206	6240651	Corryton Court, Wattle Grove	14
R13	309335	6241111	Martindale Court, Wattle Grove	13
R14	308829	6242049	Anzac Road, Wattle Grove	16
R15	306246	6239580	Cambridge Avenue, Glenfield	27
R16	306200	6237359	Guise Public School	38
R17	308916	6240141	Yallum Court, Wattle Grove	18
R18	308643	6243069	Church Road, Liverpool	10
R19	306259	6238659	Glenwood Public School, Glenfield	40
R20	305604	6239088	Glenfield Public School, Glenfield	30
R21	305200	6239198	Hurlstone Agricultural School	34
R22	309373	6240489	Wattle Grove Public School	18
R23	309942	6240895	St Marks Coptic College, Wattle Grove	18
R24	305381	6240952	Maple Grove Retirement Village, Casula	52
R25	306606	6241042	All Saints Catholic College	53
R26	305360	6241268	Casula High School	54
R27	306749	6242073	Casula Primary School, Casula	43
R28	305552	6242252	Lurnea High School	43
R29	305834	6243254	St Francis Xaviers Catholic Church	34
R30	307828	6243646	Impact Church Liverpool	19
R31	306552	6243980	Liverpool West Public School	23
R32	308289	6244388	Liverpool Public School / TAFE NSW	25
R33	308092	6241149	Former DNSDC / Possible SIMTA Site	16
R34	305927	6239733	Glenfield Rise Development, Glenfield	22
R35	309117	6241571	New DNSDC Facility	14
R36	305845	6239063	Playground Learning Centre Glenfield	35
R37	309596	6242100	Wattle Grove Long Day Care Centre	12
R38	307130	6241489	Casula Powerhouse Arts Centre	16



ENVIRON

Sensitive Receptor Locations

FIGURE

7

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Project AS121562

4 Air quality criteria

To satisfy the requirements of the NSW EPA, proposed operations must demonstrate that cumulative air pollutant concentrations, taking into account incremental concentrations due to the Project's emissions and ambient background concentrations, are within ambient air quality limits.

For proposed developments within NSW, ground level assessment criteria specified by the Approved Methods for Modelling are applicable. These assessment criteria are designed to maintain an ambient air quality that allows for adequate protection of human health and well-being.

Air quality pollutants predicted to be generated by the construction and operation of the Project are assessed within this study, focusing on particulate matter and fuel combustion related pollutants. These include:

- Total Suspended Particulates (TSP).
- Particulate Matter less than 10 microns in equivalent aerodynamic diameter (PM_{10});
- Particulate Matter less than 2.5 microns in equivalent aerodynamic diameter ($PM_{2.5}$);
- Dust Deposition;
- Oxides of Nitrogen (NO_x), with a specific focus on Nitrogen Dioxide (NO_2);
- Sulphur Dioxide (SO_2);
- Carbon Monoxide (CO);
- Volatile Organic Compounds (VOCs), with a specific focus on the individual compounds benzene, toluene, xylene (total xylene), 1,3-butadine, formaldehyde and acetaldehyde; and
- Polycyclic aromatic hydrocarbons (as benzo[a]pyrene) (PAHs).

While many individual VOC species could be emitted by the combustion of fuel during the construction and operational phases of the Project, it is considered that the compounds listed above will provide a sufficient analysis of impacts from VOC emissions for the purpose of this assessment.

Criteria applicable to the above air quality indicators are summarised in the following sections.

4.1 Airborne particulate matter

The impact of particles on human health is largely dependent on (i) particle characteristics, particularly particle size and chemical composition, and (ii) the duration, frequency and magnitude of exposure. The potential for particles to be inhaled and deposited in the lung is a function of the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density (the deposition of particles in different regions of the respiratory system depends on their aerodynamic characteristics).

The nasal openings permit large dust particles to enter the nasal region, along with much finer airborne particulates (less than 10 µm in equivalent aerodynamic diameter). The larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. Smaller particles (less than 10 µm) pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Particles are removed by impacting with the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (Dockery and Pope, 1993).

Air quality limits for particulates are typically given for various particle size fractions, including TSP, inhalable particulates or PM_{10}, and respirable particulates or $PM_{2.5}$. Although TSP is defined as all particulate with an aerodynamic diameter of less than 50-100 µm, an effective upper limit of 30 µm equivalent aerodynamic diameter is frequently assigned (US-EPA, 2010). PM_{10} and $PM_{2.5}$ require specific consideration due to their health impact potential.

Air quality standards for particulates are summarised in **Table 3**.

Table 3: Air Quality Assessment Criteria for Airborne Particulates

Pollutant	Averaging Period	Concentration ($\mu g/m^3$)	Reference
TSP	Annual	90	NSW EPA[(1)(2)]
PM_{10}	24 hours	50	NSW EPA[(1)]
	24 hours	50[(4)]	NEPM[(3)]
	Annual	30	NSW EPA[(1)]
$PM_{2.5}$	24 hours	25	NEPM[(5)]
	Annual	8	NEPM[(5)]

Note 1: *Approved Methods for Modelling*
Note 2: NSW EPA impact assessment criterion based on the subsequently rescinded National Health and Medical Research Council (NHMRC) recommended goal
Note 3: NEPC, 1998, *National Environment Protection (Ambient Air Quality) Measure,* as amended
Note 4: Provision made for up to five exceedances of the limit per year
Note 5: Advisory reporting goal issued by the NEPC (NEPC, 2003)

The NSW EPA has not published an ambient air quality criterion for $PM_{2.5}$. Reference may however be made to the $PM_{2.5}$ advisory reporting standards and goals issued by the NEPC (NEPC, 2003), as referenced in **Table 3**.

The air quality impact assessment criteria for airborne particulate concentrations are applicable at the nearest existing or likely future off-site dwellings or establishments. In assessing against these criteria, the total air pollutant concentration (incremental plus background concentration) must be reported as the 100^{th} percentile in concentration units consistent with the impact assessment criteria and compared with the relevant impact assessment criteria.

4.2 Dust deposition criteria

Nuisance dust deposition is regulated through the stipulation of maximum permissible dust deposition rates. The NSW EPA impact assessment criteria for dust deposition are summarised in **Table 4** illustrating the allowable increment in dust deposition rates above ambient (background) dust deposition rates which would be acceptable so that dust nuisance could be avoided. Furthermore, a limit is set for total cumulative dust deposition rates which include existing deposition and any increment due to a proposed development. 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 are potentially occurring.

Table 4: Dust Deposition Criteria published by OEH

Pollutant	Maximum annual average increase in dust deposition	Maximum annual average total dust deposited level
Deposited dust (assessed as insoluble solids)	2 g/m^2/month	4 g/m^2/month

Source: *Approved Methods for Modelling*

4.3 Gaseous air pollutants

Emissions may occur as a result of fuel combustion from processes associated with the Project, principally idling and moving locomotives, trucks and freight handling equipment. Key combustion-related pollutants of interest include NO_2, SO_2, CO and VOCs. While numerous VOC species are emitted following the combustion of diesel fuel, this assessment focussed primarily on the compounds benzene, toluene, xylene (total xylene), 1,3-butadine, formaldehyde and acetaldehyde to assess the potential health impact of individual organic species. These species are quantifiable based on available emission factors, and may be used as markers of the relative toxicity of organic compounds from combustion.

Air quality limits applicable to these potential gaseous emissions are summarised in **Table 5**.

The air quality impact assessment criteria for SO_2, NO_2 and CO are applicable at the nearest existing or likely future off-site dwellings or establishments. In assessing against these criteria, the total concentration (incremental plus background concentration) must be reported as the 100th percentile in concentration units consistent with and compared to the relevant impact assessment criteria (DEC, 2005).

The criteria specified for benzene, ethylbenzene, 1,3-butadine, and formaldehyde are applicable at and beyond the boundary of the facility. For a Level 2 assessment as is undertaken in the current study, the incremental concentration (predicted concentration due to the pollutant source alone) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

The impact assessment criteria given for toluene, xylenes and acetaldehyde are applicable at any existing or likely future off-site dwelling or establishment. The incremental concentration (predicted concentration due to the Project in isolation) must be reported as the 99.9th percentile 1-hour average (DEC, 2005).

Table 5: Criteria for gaseous air pollutants

Pollutant	Averaging period	Concentration		Reference
		µg/m³ [1]	pphm[2]	
NO_2	1-hour	246	12	NSW EPA[3]
	Annual	62	3	NSW EPA[3]
SO_2	10-minute	712	25	NSW EPA[3]
	1-hour	570	20	NSW EPA[3]
	24-hour	228	8	NSW EPA[3]
	Annual	60	2	NSW EPA[3]
CO	15-minute	100,000	8,700	NSW EPA[3]
	1-hour	30,000	2,500	NSW EPA[3]
	8-hour	10,000	900	NSW EPA[3]
Benzene	1-hour	31	0.9	NSW EPA[3,4,5]
Toluene	1-hour	370	9	NSW EPA[3,4,6]
Xylene (total)	1-hour	190	4	NSW EPA[3,4,6]
1,3-butadine	1-hour	43	1.8	NSW EPA[3,4,5]
Formaldehyde	1-hour	24	1.8	NSW EPA[3,4,5]
Acetaldehyde	1-hour	45	2.3	NSW EPA[3,4,6]
PAHs (as BaP)	1-hour	0.4	-	NSW EPA[3]

Note 1: Gas volumes expressed at 0°C and 1 atmosphere

Note 2: pphm – parts per hundred million

Note 3: *Approved Methods for Modelling*

Note 4: For a Level 2 Assessment (defined within the *Approved Methods for Modelling*), expressed as the 99.9th Percentile Value. The current assessment constitutes a Level 2 Assessment

Note 5: Assessment criteria specified for toxic air pollutant

Note 6: Assessment criteria summarised for odorous air pollutants

5 Climate and meteorology

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

The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the boundary layer (the general term for the layer of the atmosphere adjacent to the earth's surface) and other factors such as wind speed and direction.

Thermal turbulence is driven by incoming solar radiation during daylight hours. Mechanical turbulence is associated with wind speed, in combination with the surface roughness of the surrounding area. The stability of the atmosphere increases with a decrease in thermal and mechanical turbulence.

Air pollutant dispersion consists of vertical and horizontal components of motion. Vertical motion is defined by the stability of the atmosphere (e.g. a stable atmosphere has low vertical dispersion potential) and the depth of the surface-mixing layer, typically the vertical distance between the earth's surface and a temperature inversion during the day.

The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field (i.e. wind speed and direction). The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume 'stretching'. The wind direction, and the variability in wind direction, determines the general path that the pollutants will follow.

Airborne particulate concentration levels therefore fluctuate in response to changes in atmospheric stability, mixing depth and winds (Oke, 2003; Sturman and Tapper, 2006; Seinfeld and Pandis, 2006).

In order to characterise the dispersion meteorology of the region surrounding the Project, long-term climate records, time-resolved meteorological monitoring data and meteorological modelling for the region were drawn upon, as documented in the following sections.

5.1 Climate records and meteorological data

A meteorological monitoring station was established at the Project site in July 2012. The data from this site were reviewed and collated to determine the suitability of the on-site monitoring data for use in this assessment. The review highlighted that the on-site monitoring was not suitable for the following reasons:

- A high percentage of missing data points since the commencement of monitoring, the on-site monitoring dataset did not satisfy the requirement of 90% completeness specified within the Approved Methods for modelling; and
- The siting of the meteorological monitoring equipment in the vicinity of existing on-site structures was considered to have adversely influenced the recorded wind speed and direction. The representativeness of the dataset for the local area is therefore considered to be questionable.

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

In the absence of suitable on-site meteorological monitoring data, a combination of local monitoring datasets and meteorological modelling were drawn upon. The following data sets were used in the meteorological analysis:

- 1-hour average meteorological data from the NSW Office of Environment and Heritage (OEH) ambient air quality monitoring station at Liverpool, located approximately 1.5 km northwest of the Project site (2011 to 2013);
- 1-hour average meteorological data from Bureau of Meteorology (BoM) Automatic Weather Station (AWS) locations at Holsworthy Control Range (Station Number 067117) and Bankstown Airport (Station Number 066137), located approximately 1.6 km southeast and 6 km northeast of the Project site respectively (2009 to 2013)[1]; and
- long-term climate statistics (1968 to 2014) obtained from the BoM Bankstown Airport station. It is noted that this station represents the longest and most comprehensive climate record in the local area. Temperature and rainfall records were accessed from this station to demonstrate the suitability of the meteorological dataset adopted.

The location of the meteorological monitoring stations are illustrated in **Figure 8**.

Of the above monitoring datasets, it is considered that the OEH Liverpool data are likely to be most representative of the Project site. The OEH Liverpool station is situated at a similar elevation (22 m AHD) to the elevation range of the Project site (10 m to 25 m AHD). The local topography (as discussed in **Section 3.1**) is largely uncomplicated and it is unlikely that meteorological conditions experienced at the Project site would deviate significantly from those recorded by the OEH Liverpool station. It is noted that the BoM Holsworthy Control Range is situated at a higher (40 m AHD), more exposed location. While not used in this assessment in the dispersion modelling conducted, data from this station has been used to analyse regional trends in meteorological conditions.

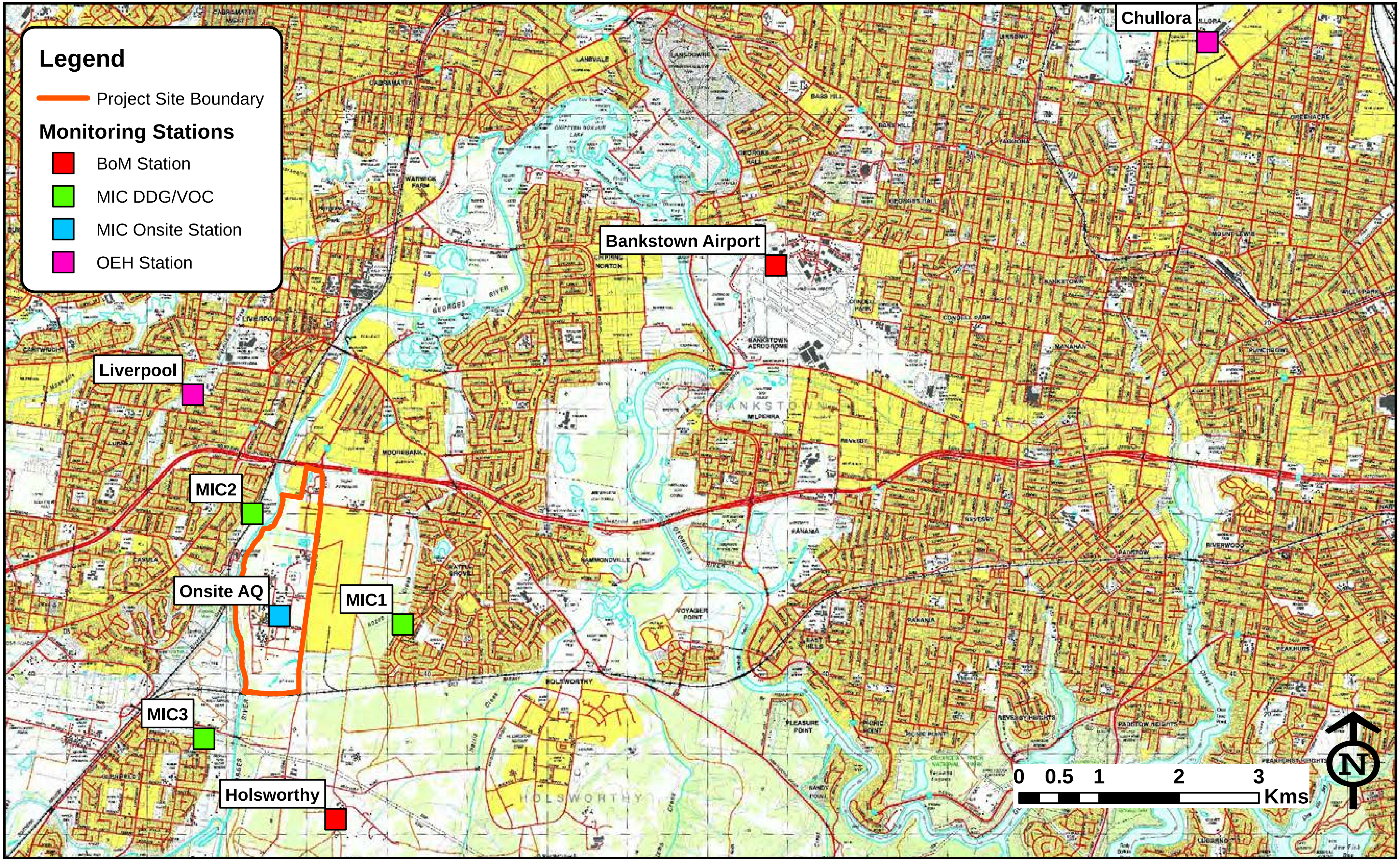
In addition to the above meteorological observation datasets, the CSIRO meteorological model TAPM was used to generate parameters not routinely measure by these stations, specifically the vertical temperature profile. TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling, with the following refinements:

- Modelling to 300 m grid cell resolution (i.e. at better than the 1 km resolution specified); and
- Inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data).

The TAPM vertical temperature profile was adjusted by first substituting the predicted 10 m above ground temperature with hourly recorded temperature at 10 m (in this assessment,

[1] It is noted that only hourly cloud cover data for 2013 was utilised from the Bankstown Airport AWS within this assessment

sourced from the OEH Liverpool station). 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.



ENVIRON

Location of Surrounding Meteorological and Air Quality Monitoring Stations

FIGURE

8

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PROJECT: AS121562

5.2 Prevailing annual wind regime

5.2.1 Inter-annual variability

The available meteorological data from the OEH Liverpool monitoring station were analysed for the period between 2011 and 2013. To determine the variability between the years of data reviewed, the frequency of recorded wind speed and direction was calculated for each year and presented in **Figure 9** and **Figure 10** respectively.

It can be seen from these figures that the wind direction and speed statistics recorded by the OEH Liverpool station is very similar across the three years. All years exhibit a dominant southwest to west component (220° to 280°), with hourly wind speeds less than 4 m/s between 93% and 95% of the year.

Additionally, inter-annual analysis of wind speed and direction data recorded at the BoM Holsworthy Control Range AWS was also completed and the results are presented in **Figure 11** and **Figure 12** respectively.

Similar to the frequency analysis conducted for the OEH Liverpool data, there is strong agreement in recorded wind speed and direction between 2009 and 2013 at the BoM Holsworthy Control Range AWS. All years, with the exception of 2013, exhibit a dominant southwest to west component (220° to 280°), with hourly wind speeds less than 8 m/s between 93% and 96% of the year. The 2013 wind direction frequency profile highlights a higher westerly component than the previous four years. The reason for this difference is unclear, however this difference is not considered significant from an interannual comparison perspective.

It is noted that the recorded wind direction profile is generally similar between the two stations (i.e. dominant southwest to west component). However, the BoM Holsworthy Control Range AWS experiences higher wind speeds relative to the OEH Liverpool station. This is attributable to the difference in elevation between the two sites (40 m AHD at Holsworthy Control Range versus 21m AHD at Liverpool, as previously discussed) and lower surrounding surface roughness (cleared, vacant land at the BoM station versus low-density residential development at the OEH station).

On the basis of the similarity between the analysed years presented for both the OEH Liverpool and BoM Holsworthy Control Range stations, it is considered that there is not a substantial difference in wind speed and direction experienced across the local area on an interannual basis. The 2013 OEH Liverpool dataset was adopted within this assessment as it represents the most recent complete annual dataset available at the time of this AQIS.

Appendix A presents annual wind roses for the years 2011 through to 2013 for OEH Liverpool and 2009 to 2013 for BoM Holsworthy Control Range.

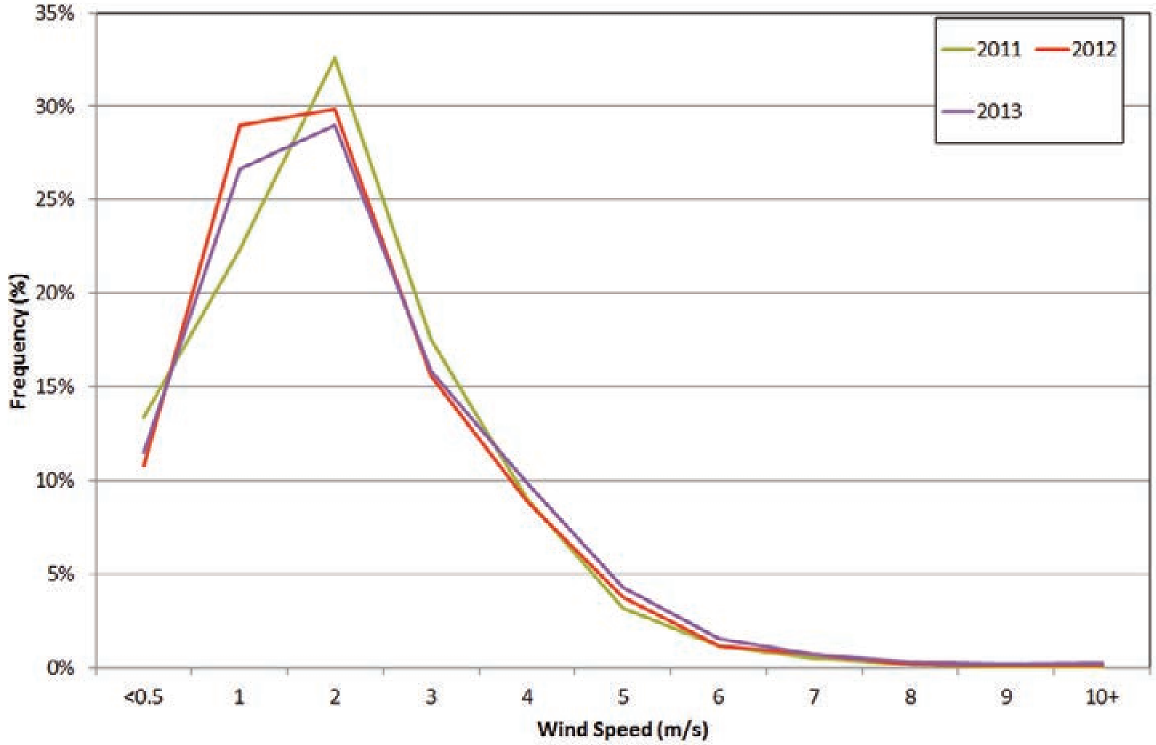

Figure 9: Wind speed frequency comparison – OEH Liverpool observations – 2011 to 2013

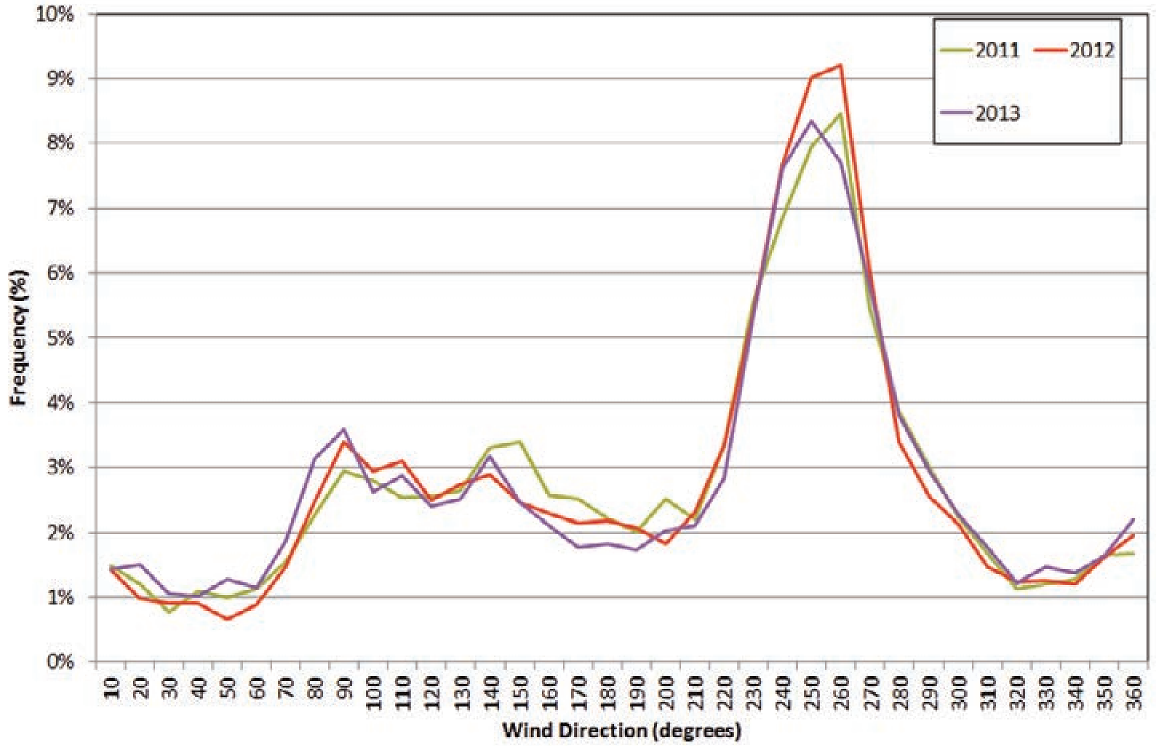

Figure 10: Wind direction frequency comparison – OEH Liverpool observations – 2011 to 2013

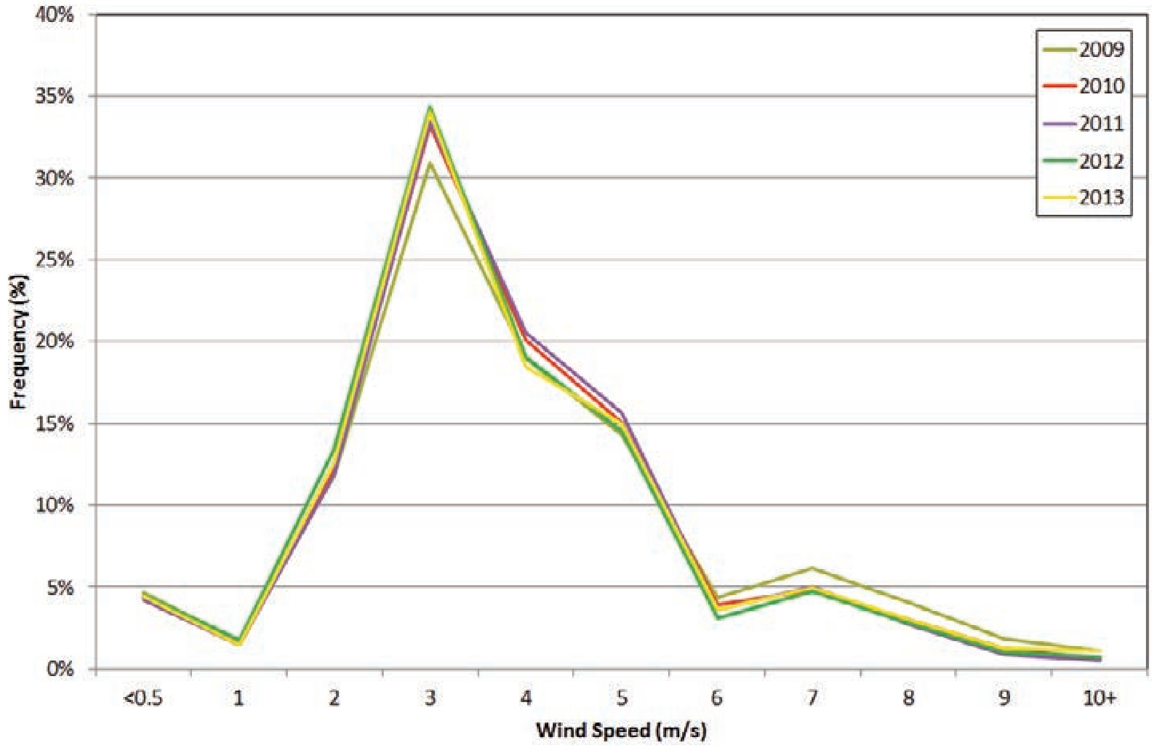

Figure 11: Wind speed frequency comparison – BoM Holsworthy Control Range observations – 2009 to 2013

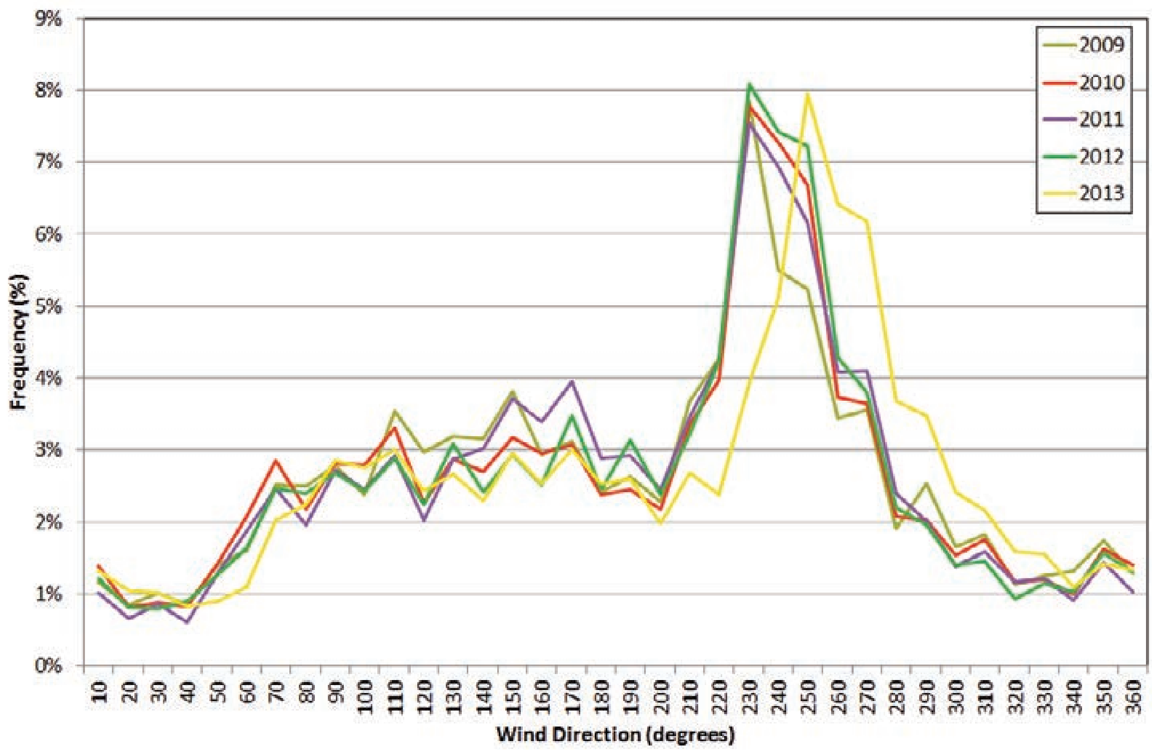

Figure 12: Wind direction frequency comparison – BoM Holsworthy Control Range observations – 2009 to 2013

5.2.2 Annual wind regime – 2013 OEH Liverpool

The wind rose of recorded wind speed and direction data from the OEH Liverpool station during 2013 is presented in **Figure 13**. 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 1.8 m/s, with a frequency of calm conditions (wind speeds less than 0.5 m/s) occurring in the order of 12% of the time.

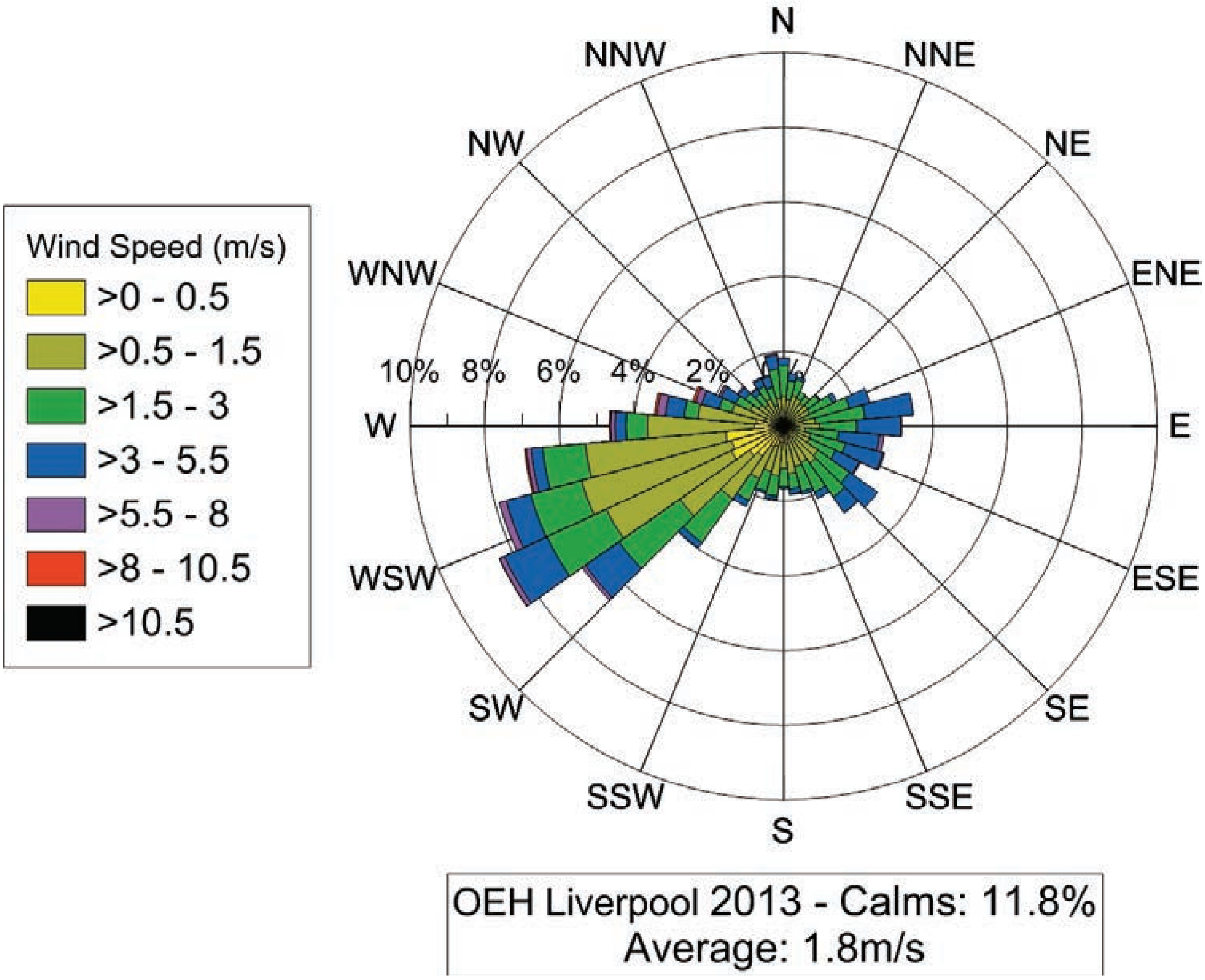

Figure 13: Annual wind rose – OEH Liverpool - 2013

5.3 Seasonal and diurnal wind regime

Seasonal and diurnal (dividing the day into four periods) wind roses for 2013 OEH Liverpool station dataset are presented within **Appendix A**.

Seasonal variation is evident in the data recorded at the OEH Liverpool station. The dominant southwest to westerly component evident in the annual wind direction profile is most defined during the autumn, winter and spring months, while summer experiences a dominant easterly flow. Wind speed is greatest during summer and spring, while the incidence of calms is highest during the autumn and winter months.

Diurnal variation in the recorded wind regime is also notable at the OEH Liverpool site. Wind speeds are greatest during the daylight periods, with dominant easterly flow occurring between midday and late afternoon. Wind speeds are notably lower between the evening and early morning hours, with the southwesterly component the dominant wind direction.

5.4 Ambient temperature

Monthly mean minimum temperatures are in the range of 5°C to 18°C, with monthly mean maxima of 17°C to 28°C, based on the long-term average record from the BoM Bankstown Airport AWS. Peak temperature occur during summer months with the highest temperatures typically being recorded between November and March. The lowest temperatures are usually experienced between May and September.

The temperature recorded during 2013 at the OEH Liverpool station has been compared with long-term trends recorded at the BoM Bankstown Airport AWS to determine the representativeness of the dataset. **Figure 14** presents the monthly variation in recorded temperature during 2013 compared with the recorded regional mean, minimum and maximum temperatures. 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.

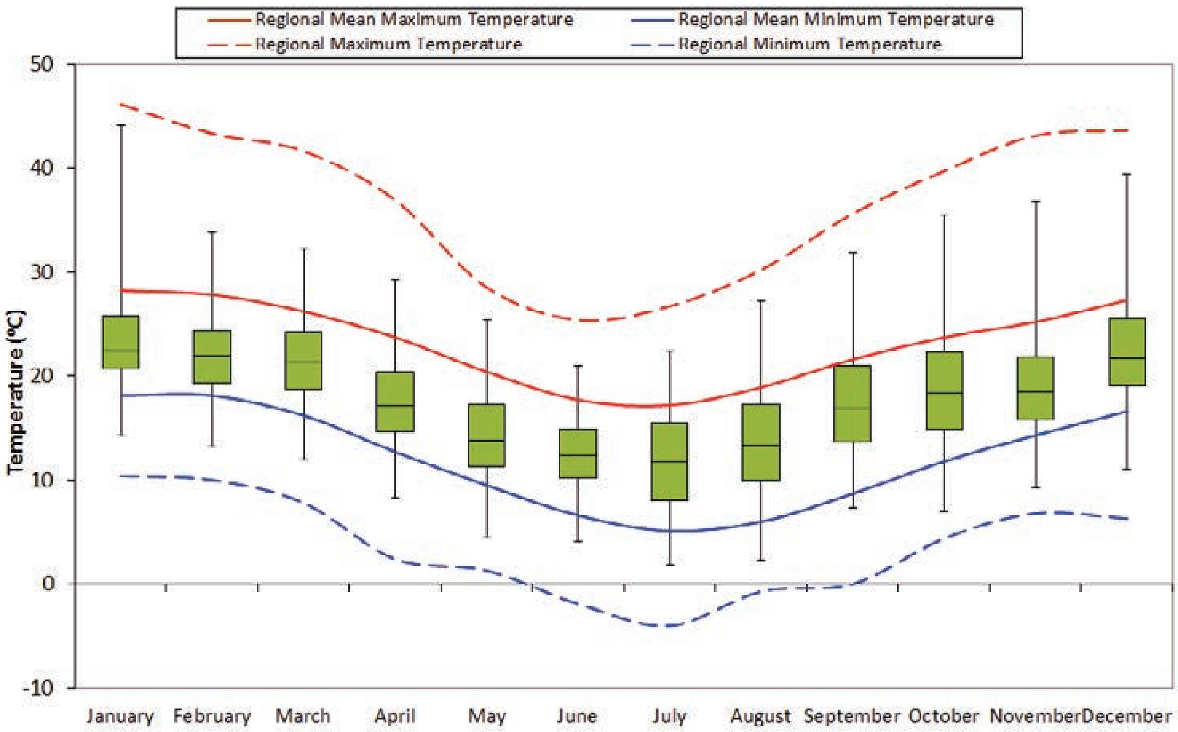

Figure 14: Temperature comparison between OEH Liverpool 2013 data and historical averages (1968-2013) – BoM Bankstown Airport

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.

5.5 Rainfall

Precipitation is important to air pollution studies since 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 airborne particulate matter concentrations occurring due to the Project, wet deposition (removal of particles from the air by rainfall) was excluded from the dispersion modelling simulations undertaken in this report.

5.6 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 depths were generated for the OEH Liverpool station by AERMET, the meteorological processor for the AERMOD dispersion model (see **Section 9.1** for further information), using a combination of surface observations from the OEH Liverpool station, sunrise and sunset times and adjusted TAPM-predicted upper air temperature profile. The variation in average boundary layer depth by hour of the day for the OEH Liverpool station is illustrated in **Figure 15**. It can be seen that greater boundary layer depths are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere respectively. As turbulence increases during the day-time, so too does the depth of the boundary layer, generally contributing to greater mixing depths and potential for 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). Wharton and Lundquist (2010) provide typical value ranges for L for widely referenced atmospheric stability classes, as listed within **Table 6**.

Table 6: Monin-Obukhov length with respect to atmospheric stability

Monin-Obukhov length (L) range	Stability class
-50 < L < 0	Very Unstable
-600 < L < -50	Unstable
|L| > 600	Neutral
100 < L < 600	Stable
0 < L < 100	Very Stable

Source: Table 2, Wharton and Lundquist (2010)

Figure 16 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by AERMET based on the data recorded by the OEH Liverpool station during 2013. The diurnal profile presented illustrates that atmospheric instability increases during daylight hours as convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for atmospheric dispersion of emissions would be greatest during day time hours and lowest during evening through to early morning hours.

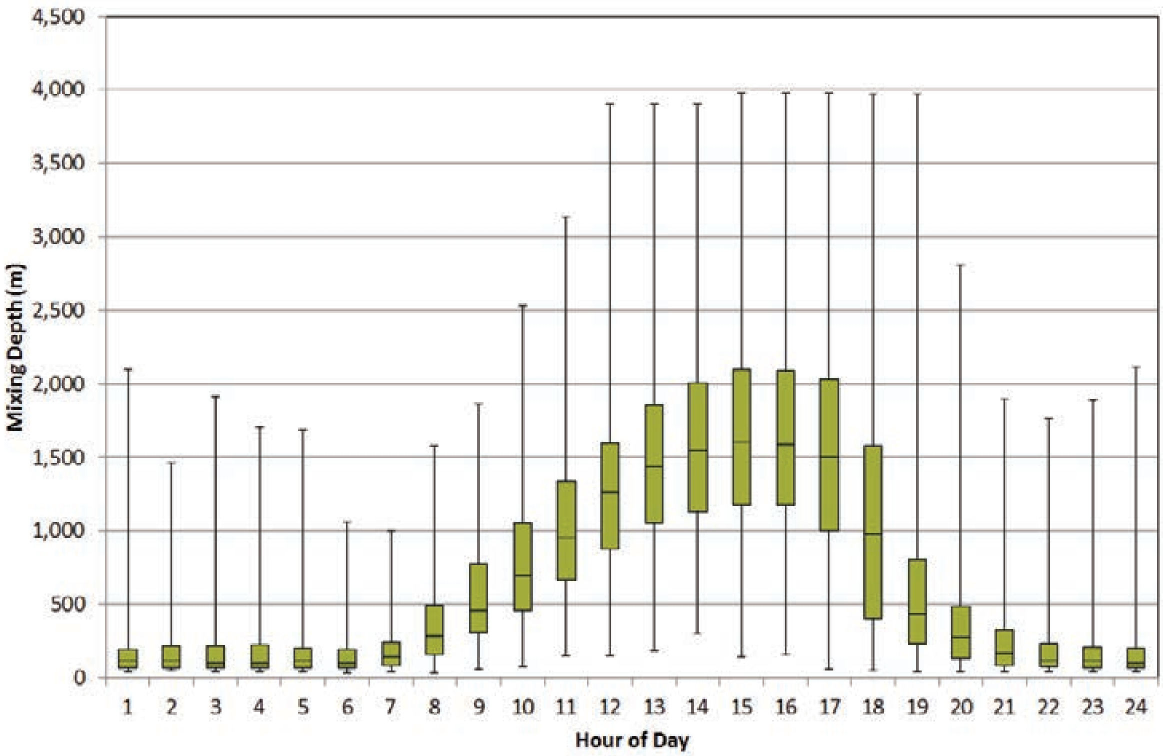

Figure 15: AERMET-generated diurnal variations in average boundary layer depth – OEH Liverpool - 2013

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.

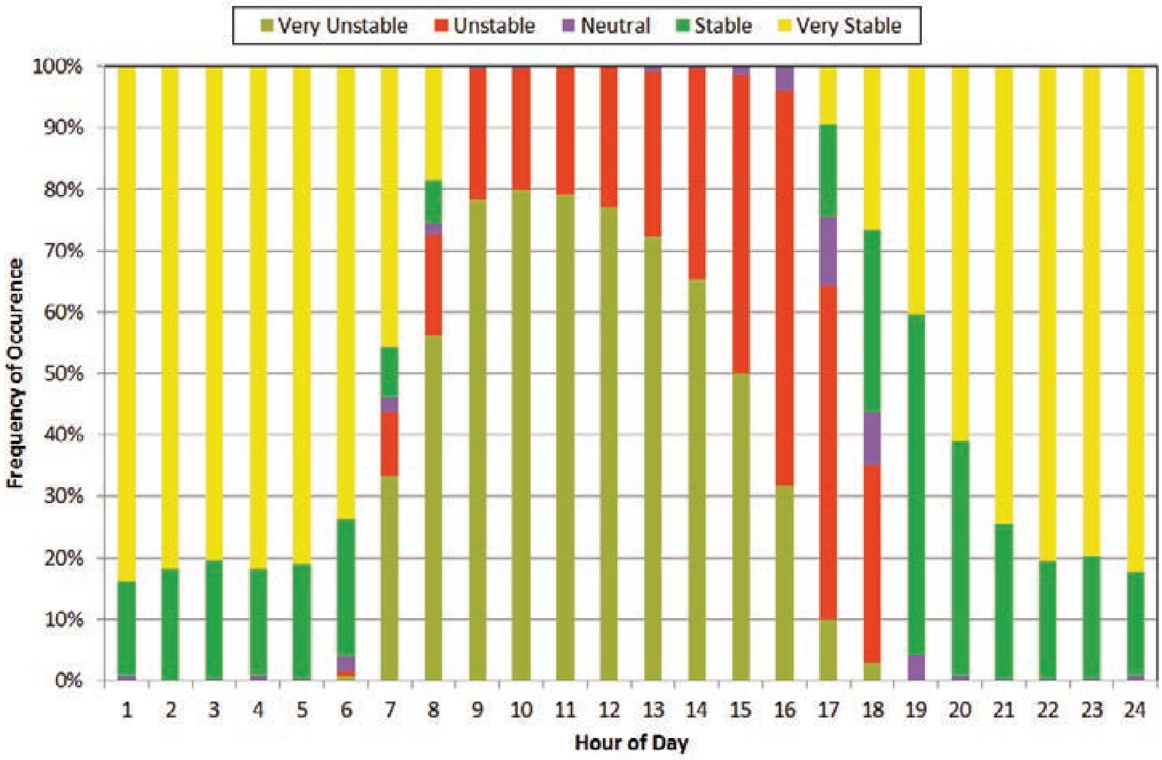

Figure 16: Diurnal variations in AERMET-generated atmospheric stability for OEH Liverpool - 2013

6 Ambient air quality characterisation

The quantification of cumulative air pollution concentrations and the assessment of compliance with ambient air quality criteria necessitate the characterisation of baseline air quality. The following sections provide a review of surrounding air pollution sources and air quality monitoring data.

6.1 Existing sources of air emissions

A number of industrial and non-industrial sources in the Project area have the potential to influence the local air shed to varying degrees. These include, but are not limited to:

- existing industries to the east and north-east of the Project site (including Greenhills Industrial Estate, Moorebank Business Park);
- the existing landfill (Glenfield Landfill) to the south-west;
- traffic emissions from the existing road network including the South Western Motorway (M5) directly bordering the northern boundary of the site;
- emissions from locomotives on the Southern Sydney Freight Line (SSFL) to the west of the Project boundary;
- locomotive emissions from the East Hills rail line to the south of the Project boundary; and
- emissions from aircraft at Bankstown Airport to the northeast.

These sources are likely to give rise to emissions of air pollutants, including particulate matter (TSP, PM_{10} and $PM_{2.5}$), NO_x, SO_2, CO, VOCs, heavy metals and odour.

6.2 Monitoring data available for baseline air quality characterisation

In addition to the meteorological station (**Section 5.1**), ambient air quality monitoring equipment has been established at the Project site. The air quality monitoring equipment was commissioned in July 2012 and comprises of the following:

- continuous monitoring of NO_x and PM_{10} at a location within the Project site;
- dust deposition gauges at three selected sensitive receiver locations; and
- diffusion tubes monitoring benzene, toluene, ethylbenzene and xylene (BTEX) and ozone at three selected sensitive receiver locations.

In addition to the data recorded by on-site air quality monitoring equipment, data from the NSW EPA ambient air quality monitoring stations at Liverpool and Chullora were collated for use in quantifying baseline air quality.

The Liverpool monitoring site is located on Rose Street, approximately 1.5 km northwest of the Project site. It is situated in a mixed residential and commercial area in Sydney's south-west region at an elevation of 22 m AHD. The Liverpool monitoring station measures the following pollutants on a continuous basis: PM_{10}, $PM_{2.5}$, NO_2, O_3 and CO.

The Chullora monitoring site is located on Worth Street, approximately 13 km north-east of the Project site. It is situated in a mixed residential and commercial area in Sydney's south-west region at an elevation of 10 m AHD. In the absence of such monitoring at the Liverpool station, measurements of SO_2 have been adopted from the Chullora.

The locations of the air quality monitoring sites referenced in this report are illustrated in **Figure 8**.

6.2.1 PM_{10}

Hourly-average PM_{10} data were collated from both the on-site and OEH Liverpool air quality monitoring stations, with 24-hour average concentrations calculated. It is noted that only days with a data completeness for hourly-average concentrations of greater than 75% were included in the calculation of 24-hour average concentrations. The key statistics of the 2013 24-hour average PM_{10} datasets are presented in **Table 7**.

Table 7: 2013 PM_{10} monitoring statitics – On-site and OEH Liverpool – 24-hour averages

Parameter	On-site Station	OEH Liverpool
Number of Observations	353	363
Average	14.2 µg/m³	21.1 µg/m³
Lower Quartile	9.1 µg/m³	14.3 µg/m³
Median	12.5 µg/m³	19.6 µg/m³
Upper Quartile	17.6 µg/m³	26.5 µg/m³
Minimum	3.5 µg/m³	5.2 µg/m³
Maximum	84.7 µg/m³	98.5 µg/m³
Number of Days > 50 µg/m³	2	3
Highest Concentration < 50 µg/m³	43.6 µg/m³	47.9 µg/m³

A time-series of 24-hour average PM_{10} concentrations recorded at the on-site and OEH Liverpool stations is presented in **Figure 17**, while a scatterplot of concurrent 24-hour average PM_{10} concentrations recorded at the two stations is presented in **Figure 18**.

The following key points are identified from the table and figures:

- The PM_{10} concentrations recorded at the on-site station and OEH Liverpool station exhibit similarities, both in magnitude and the daily variability of concentrations;
- The OEH Liverpool experienced higher concentrations than the concentrations recorded at the on-site station during 2013;
- Given that concentrations are higher at the OEH Liverpool station than the on-site station, it is considered appropriate to adopt the OEH dataset to account for emissions from neighbouring sources such as the M5 motorway, SSFL and Glenfield Landfill;
- Exceedances of the NSW EPA criterion of 50 µg/m³ were experienced at both monitoring stations, directly attributable to extensive bushfire events in the Greater Sydney Metropolitan Region between September and November 2013; and

- Average PM_{10} concentrations at both the on-site and OEH Liverpool stations were below the NSW EPA criterion of 30 µg/m³.

Long term trends in recorded PM_{10} concentrations at the OEH Liverpool station were analysed from data recorded between 2009 and 2013. For each year, **Table 8** presents the annual average and maximum 24-hour average PM_{10} concentrations and the number of days where the 24-hour average concentration was greater than the NSW EPA assessment criterion of 50 µg/m³.

Table 8: Historical PM_{10} monitoring statitics – 2009 to 2013 – OEH Liverpool

Year	Annual Average PM_{10} (µg/m³)	Maximum 24-hour Average PM_{10} (µg/m³)	Number of Exceedance Days (>50 µg/m³)
2009	25.8	1,579.8	8
2010	17.0	41.1	0
2011	18.1	68.8	1
2012	19.8	42.5	0
2013	21.0	98.5	3

The following points are noted:

- the 2009 calendar year experienced higher PM_{10} concentrations than the following four years, however 2009 was notable for the occurrence of significant dust storm events that occurred across the east coast of Australia;
- in the past five years, 2013 was a relatively high year with regards to PM_{10} concentrations. This is considered to be largely attributable to the occurrence of significant bushfire events around Sydney and within NSW; and
- the average PM_{10} concentration recorded at the OEH Liverpool station between 2009 and 2013, incorporating natural particulate matter events (bushfires and dust storms) was 20.4 µg/m³.

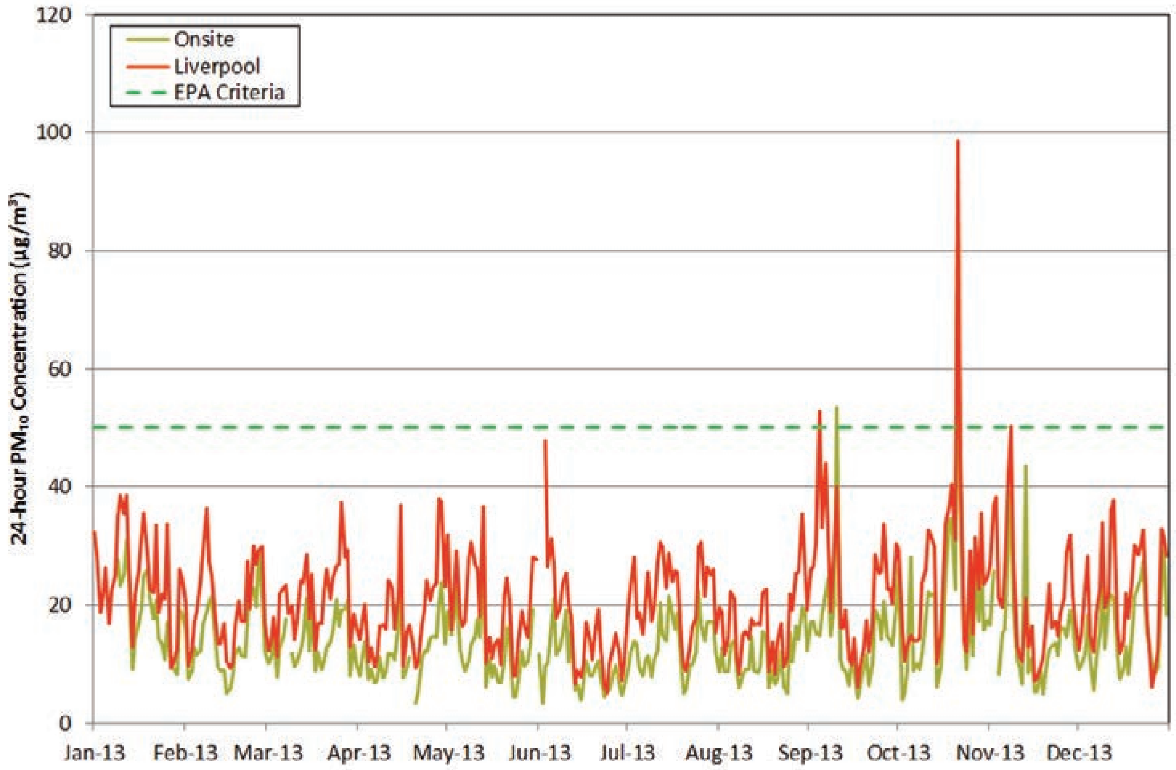

Figure 17: Timeseries comparison of 24-hour average PM_{10} concentrations during 2013 – On-site vs OEH Liverpool

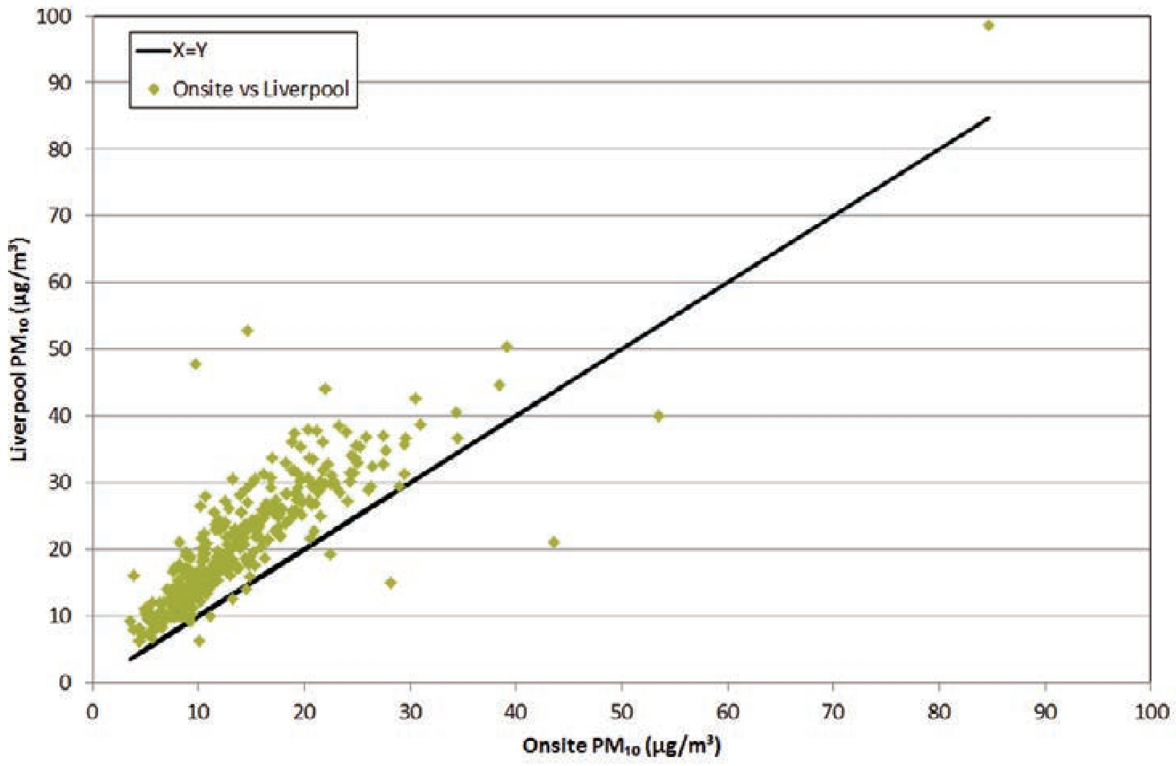

Figure 18: Scatterplot comparison of concurrent 24-hour average PM_{10} concentrations during 2013 – On-site vs OEH Liverpool

6.2.2 $PM_{2.5}$

A $PM_{2.5}$ monitoring station was established at the on-site air quality monitoring station in February 2014. For consistency with the 2013 calendar year PM_{10} monitoring dataset (Section 6.2.1), hourly-average $PM_{2.5}$ data were collated from the OEH Liverpool air quality monitoring station, with 24-hour average concentrations calculated. As with the PM_{10} dataset, only days with a data completeness for hourly-average concentrations of greater than 75% were included in the calculation of 24-hour average concentrations. The key statistics of the 2013 OEH Liverpool 24-hour average $PM_{2.5}$ dataset are presented in **Table 7**.

Table 9: 2013 $PM_{2.5}$ Monitoring Statitics – OEH Liverpool – 24-hour average

Parameter	OEH Liverpool
Number of Observations	340
Average	9.4 µg/m³
Lower Quartile	5.8 µg/m³
Median	8.1 µg/m³
Upper Quartile	11.7 µg/m³
Minimum	1.9 µg/m³
Maximum	73.8 µg/m³
Number of Days > 25 µg/m³	2
Highest Concentration < 25 µg/m³	23.6 µg/m³

A time-series of 24-hour average PM_{10} concentrations recorded at the OEH Liverpool station is presented in **Figure 17**.

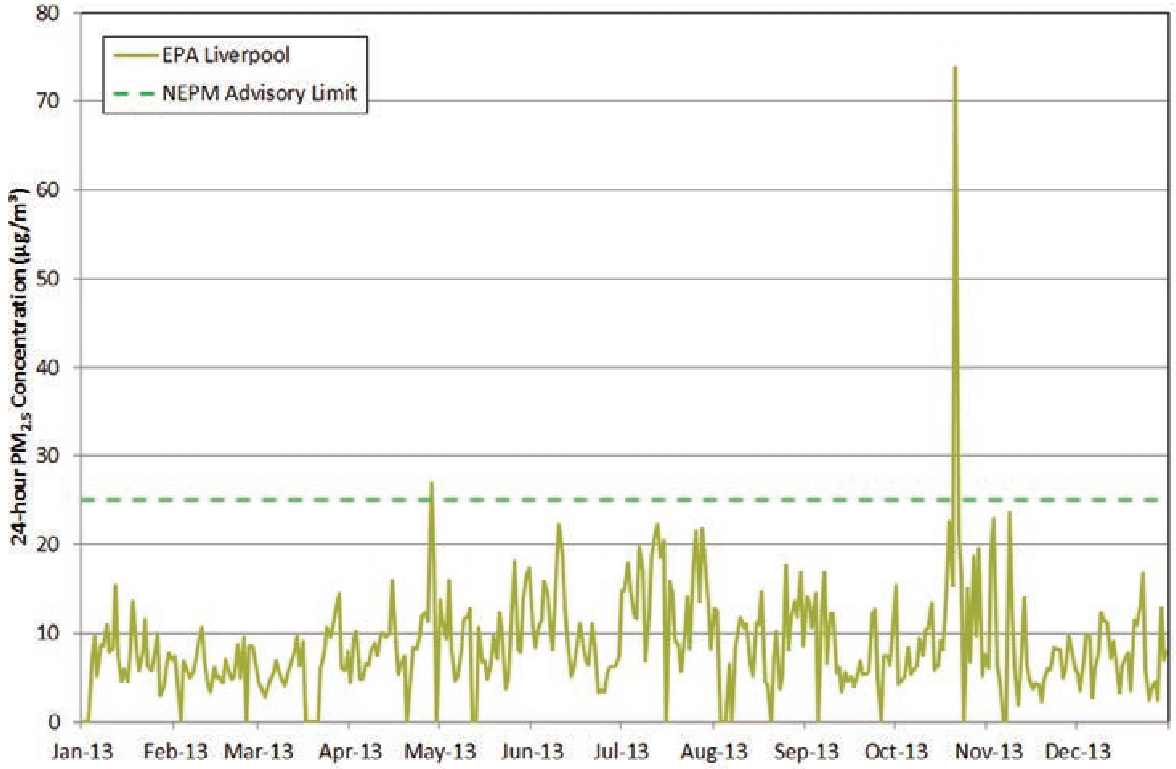

Figure 19: Timeseries of 24-hour average $PM_{2.5}$ concentrations during 2013 – OEH Liverpool

The following key points are identified from the table and figures:

- two exceedances of the NEPM 24-hour average advisory reporting goal for $PM_{2.5}$ were recorded during 2013 and are attributed to hazard reduction burns (late April 2013) and bushfire events (between September and November 2013) in the Greater Sydney Metropolitan Region;
- the annual average $PM_{2.5}$ concentration recorded during 2013 at the OEH Liverpool station was 9.4 µg/m³ and is in exceedance of the NEPM advisory reporting goal of 8 µg/m³; and
- the removal concentrations recorded during the hazard reduction burns and bushfire events that occurred between September and November 2013 reduces the annual average $PM_{2.5}$ concentration to 7.2 µg/m³, highlighting the influence of these events on ambient $PM_{2.5}$ concentrations

Long term trends in recorded $PM_{2.5}$ concentrations at the OEH Liverpool station were analysed from data recorded between 2009 and 2013. For each year, **Table 8** presents the annual average and maximum 24-hour average $PM_{2.5}$ concentrations and the number of days where the 24-hour average concentration was greater than the NEPM advisory reporting goal of 25 µg/m³.

Table 10: Historical $PM_{2.5}$ monitoring statitics – 2009 to 2013 – OEH Liverpool

Year	Annual Average PM_{10} (µg/m³)	Maximum 24-hour Average $PM_{2.5}$ (µg/m³)	Number of Exceedance Days (>25 µg/m³)
2009	8.3	268.1	3
2010	6.3	21.8	0
2011	5.9	38.0	2
2012	8.5	24.9	0
2013	9.4	73.8	2

The following points are noted:

- on average, the 2013 calendar year experienced higher $PM_{2.5}$ concentrations than the annual average in the previous four years. It is considered that this elevated average is directly attributable to the significant bushfire events in Sydney and NSW during the latter half of 2013;
- as with PM_{10}, 2009 experienced elevated $PM_{2.5}$ concentrations due largely to the occurrence of significant dust storm events that occurred across the east coast of Australia; and
- the average $PM_{2.5}$ concentration recorded at the OEH Liverpool station between 2009 and 2013, incorporating natural particulate matter events (bushfires and dust storms) was 7.64 µg/m³;
- excluding the concentrations recorded during the hazard reduction burns and bushfire events that occurred between September and November 2013 reduces the five-year average $PM_{2.5}$ concentration from 7.6 µg/m³ to 7.2 µg/m³.

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6.2.3 TSP

No publicly available TSP monitoring is conducted in the vicinity of the Project site. Historically, the NSW OEH recorded concurrent 24-hour average TSP and PM_{10} concentrations on a one-in-six day sampling regime at Earlwood, Rozelle and the Sydney CBD, with this monitoring discontinuing in 2004. NSW OEH quarterly air quality monitoring reports for 2003 and 2004 were reviewed for concurrent PM_{10} and TSP concentrations. This data highlighted that on average, PM_{10} concentrations recorded by the NSW OEH were 48% of TSP concentrations.

In the absence concurrent TSP monitoring data, this PM_{10}/TSP relationship from the 2003-2004 NSW OEH monitoring reports has been applied to the OEH Liverpool station PM_{10} monitoring data. Over the five year period between 2009 and 2013, this returns an average TSP concentration of 42.6 µg/m³.

6.2.4 Dust deposition

Monitoring for dust deposition has been conducted at three locations surrounding the Project site since August 2012. Recorded monthly dust deposition levels (as total insoluble solids) since August 2012 are presented in **Table 7**. It can be seen from these results that the recorded deposition levels are well below the NSW EPA criterion of 4 g/m^2/month. Across all three locations, the 12-month average deposition levels range from 0.6 g/m^2/month and 0.8 g/m^2/month

Table 11: Dust deposition monitoring – Project site (g/m^2/month)

Month	Monitoring Location		
	Corryton Ct, Wattle Grove (MIC1)	Buckland St, Casula (MIC2)	Goodenough St, Glenfield (MIC3)
Aug-12	1.6	1.3	0.9
Sep-12	1.3	1.1	1.1
Oct-12	1.1	0.9	0.8
Nov-12	0.6	0.8	0.7
Dec-12	0.6	0.5	1.0
Jan-13	1.2	0.9	0.8
Feb-13	0.8	0.5	0.4
Mar-13	0.4	0.6	0.7
Apr-13	0.3	0.3	0.3
May-13	0.8	0.4	0.5
Jun-13	0.6	0.5	0.4
Jul-13	0.3	0.3	0.3
Aug-13	0.4	0.6	0.5
Sep-13	0.5	0.8	0.6
Oct-13	0.8	1.0	1.5
Nov-13	1.0	2.2	0.8
Dec-13	0.6	1.2	1.0
Jan-14	0.8	0.5	1.1
Feb-14	1.0	0.8	0.6
Mar-14	0.9	0.5	0.8

A time-series of monthly average dust deposition levels recorded at the Project site is presented in **Figure 17**.

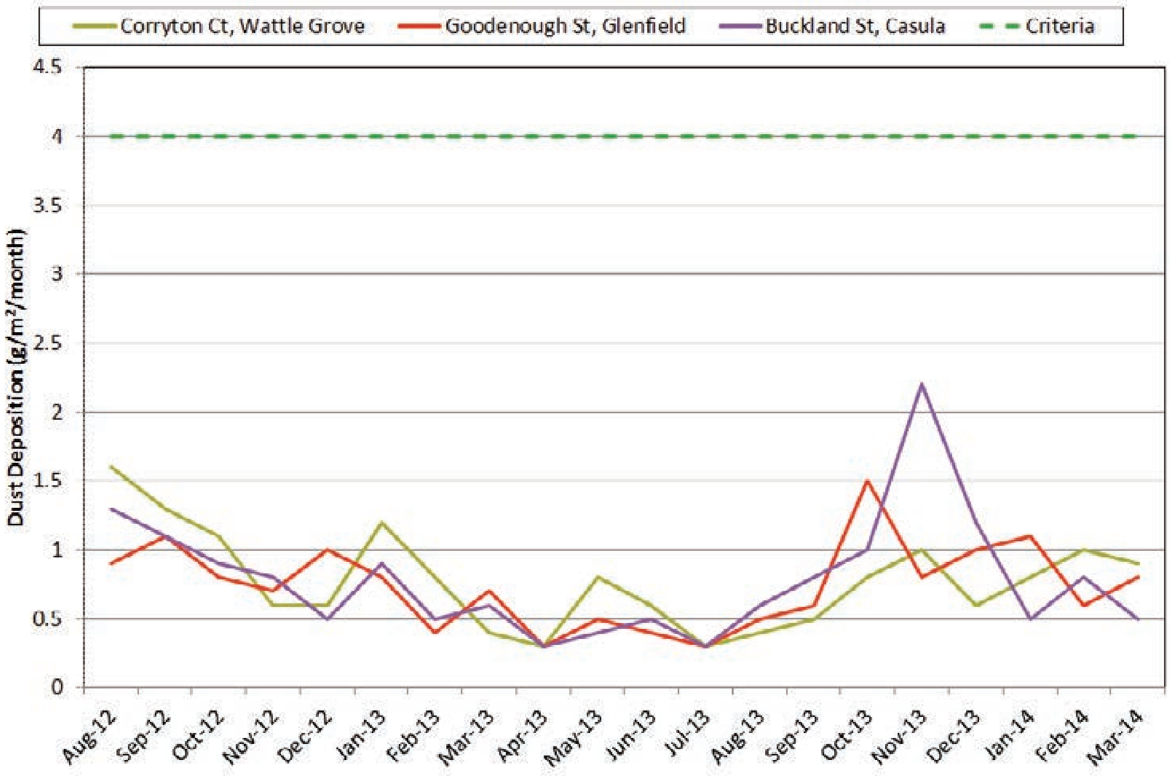

Figure 20: Monthly average dust deposition levels – Project site

6.2.5 Nitrogen dioxide

Hourly average NO_2 monitoring data were obtained from the on-site and OEH Liverpool monitoring stations.

Table 12 presents the 1-hour maximum and annual average NO_2 concentrations recorded at the on-site and OEH Liverpool monitoring stations during 2013. Concentrations at both stations were below the applicable NSW EPA criteria. On average, the Liverpool station recorded higher NO_2 concentrations than the on-site station.

A time-series of recorded 1-hour average NO_2 concentrations at the two stations is presented in **Figure 21**.

Table 12: Recorded NO_2 concentrations – 2013 – On-site and OEH Liverpool

Location	1-hour maximum and annual average NO_2 concentration (ppb)	
	Average	Maximum
On-site	6.5	75
Liverpool	11.6	56
NSW EPA Criterion	**30**	**120**

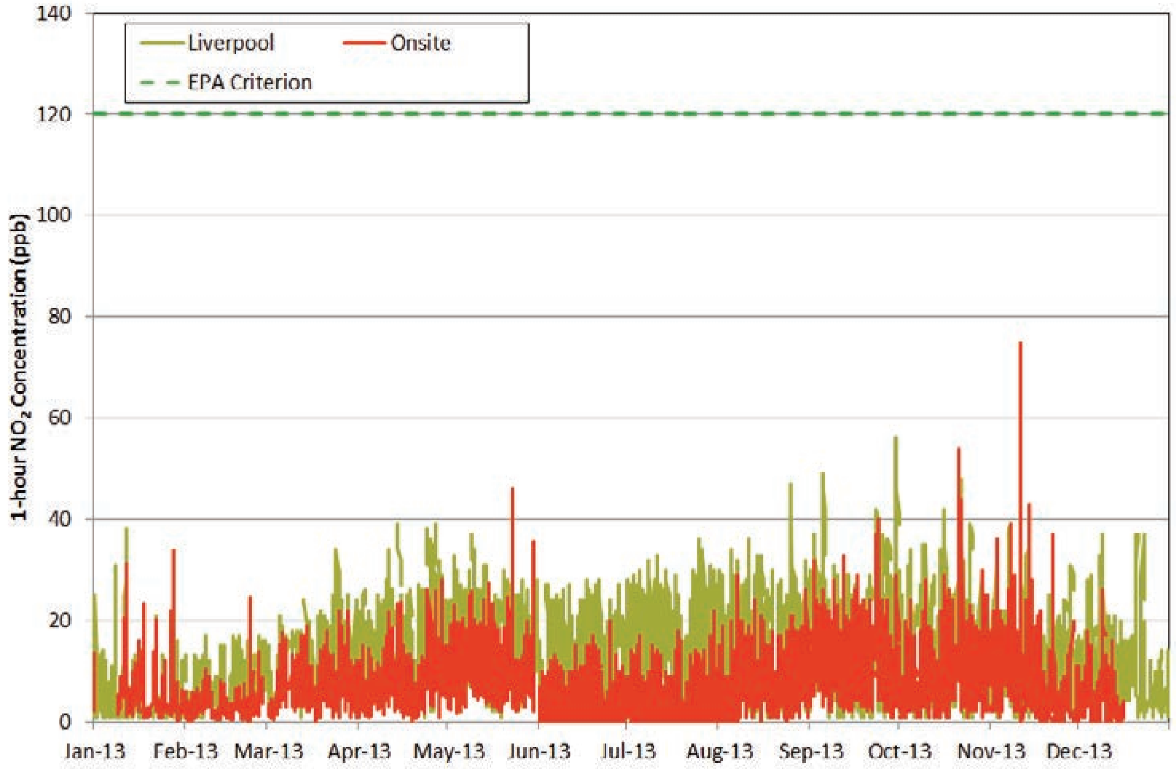

Figure 21: Time-series of 1-hour average NO_2 concentrations – 2013 – On-site and OEH Liverpool

6.2.6 Sulphur Dioxide

In the absence of measurements at both the on-site and OEH Liverpool station, hourly average SO_2 monitoring data were obtained from the OEH Chullora monitoring station. The OEH Chullora station is the closest OEH station geographically to the Project site.

Table 12 presents the 10-minute, 1-hour and 24-hour average maximum and annual average SO_2 concentrations recorded at the OEH Chullora monitoring stations during 2013. Concentrations at both stations were below the applicable NSW EPA criteria. As presented in **Table 5**, the NSW EPA prescribe assessment criterion for 10-minute SO_2 concentrations. As concentrations for this averaging period were not available in the Chullora monitoring dataset, the maximum 10-minute average SO_2 concentration has been derived from the maximum 1-hour average SO_2 concentration using the empirical equation listed in **Section 9.6.1**.

A time-series of recorded 1-hour average NO_2 concentrations at the two stations is presented in **Figure 21**. The recorded concentrations are well below the ambient criteria.

Table 13: Recorded SO_2 concentrations – 2013 – OEH Chullora

Averaging period	Maximum SO_2 concentration (ppb)	NSW EPA criterion (ppb)
10-minute	35.2	**250**
1-hour	12.0	**200**
24-hour	3.2	**80**
Annual	0.7	**20**

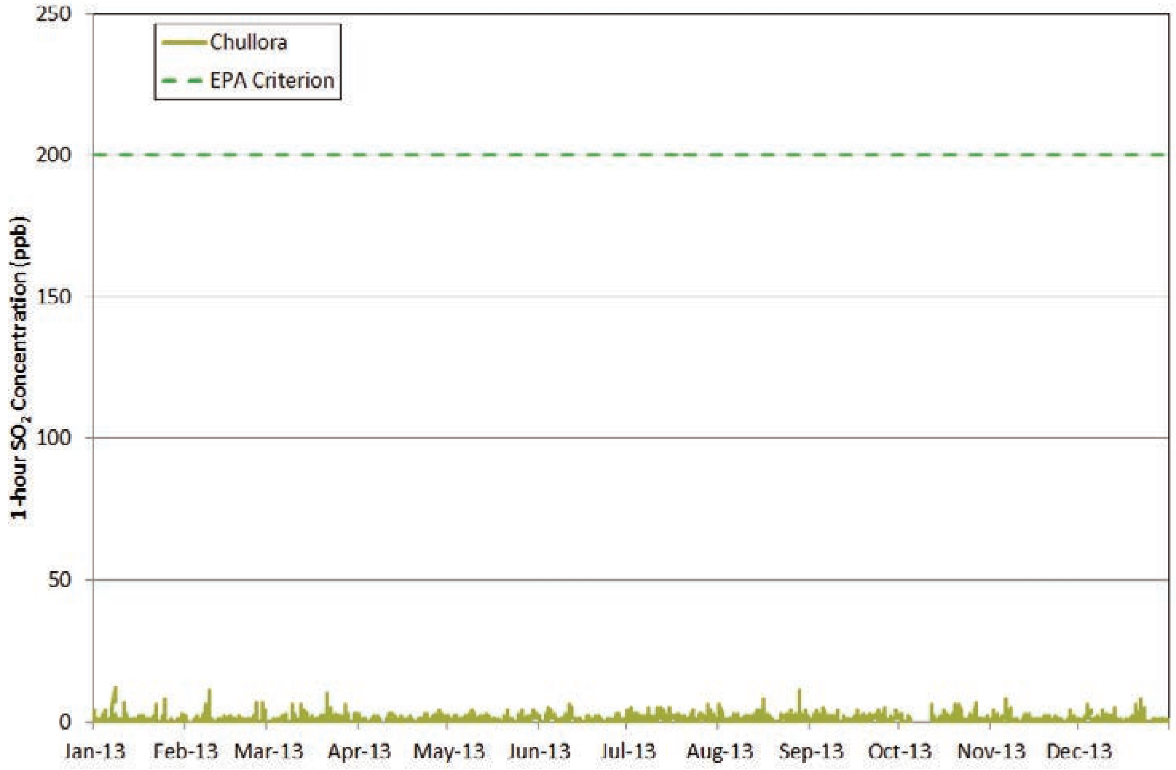

Figure 22: Time-series of 1-hour average SO_2 concentrations – 2013 – On-site and OEH Liverpool

6.2.7 Carbon Monoxide

Hourly average CO monitoring data were obtained from the OEH Liverpool monitoring station.

Table 12 presents the 15-minute, 1-hour and 8-hour average maximum CO concentrations recorded at the OEH Liverpool monitoring station during 2013. Concentrations of CO were below the applicable NSW EPA criteria. As presented in **Table 5**, the NSW EPA prescribe assessment criterion for 15-minute CO concentrations. As concentrations for this averaging period were not available in the Liverpool monitoring dataset, the maximum 15-minute average CO concentration has been derived from the maximum 1-hour average CO concentration using the empirical equation listed in **Section 9.6.1**.

A time-series of recorded 1-hour average CO concentrations is presented in **Figure 21**.

Table 14: Recorded CO concentrations – 2013 – OEH Liverpool		
Averaging period	**Maximum CO concentration (ppm)**	**NSW EPA criterion (ppm)**
15-minute	9.2	**87**
1-hour	4.0	**25**
8-hour	1.8	**9**

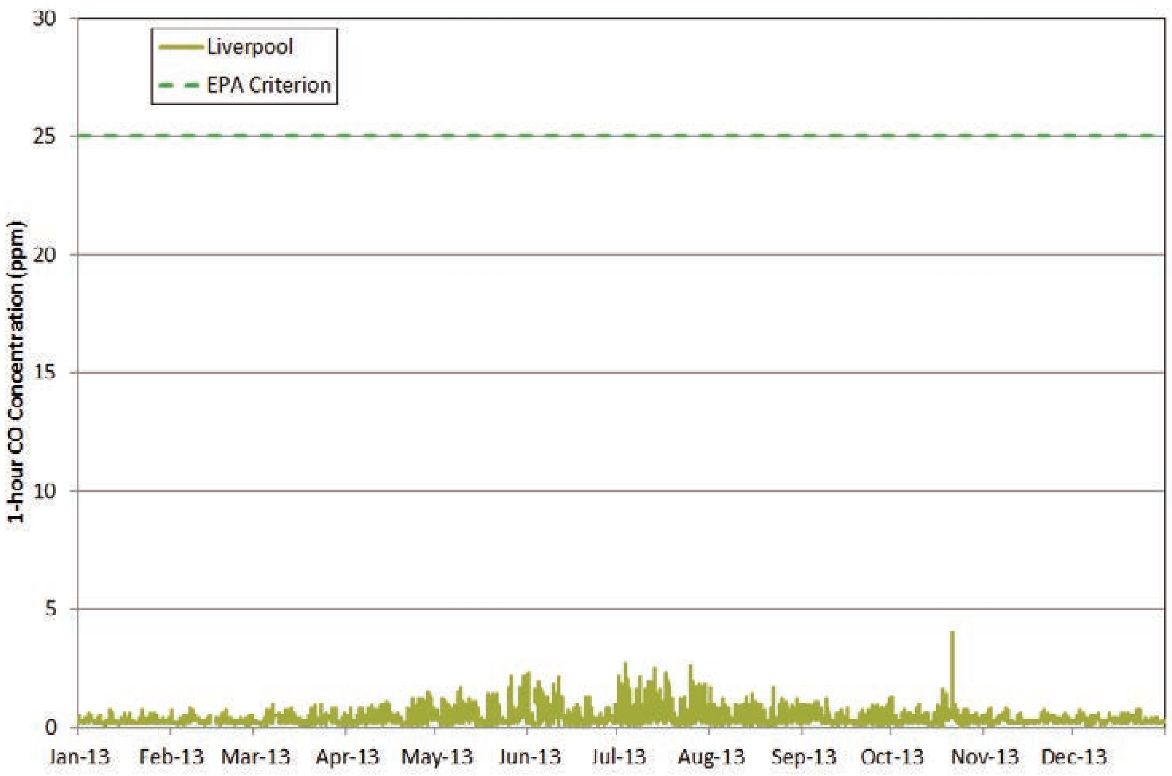

Figure 23: Time-series of 1-hour average CO concentrations – 2013 –OEH Liverpool

6.2.8 VOCs

Monitoring is conducted for BTEX (benzene, toluene, ethylbenzene and xylene) at three locations surrounding the Project site using a Radiello diffusion tube. Annual average concentrations are summarised in **Table 15** and reference made to National Environment Protection (Air Toxics) Measure Monitoring Investigation Levels (December 2004) applicable to annual averages. Measured concentrations were below NEPM Monitoring Investigation Levels.

Given that the OEH impact assessment criteria for benzene, toluene, ethylbenzene and total xylene are applicable to incremental (project-related) concentrations rather than cumulative concentrations, the measured baseline BTEX measurements are not included in a quantitative cumulative assessment. It is however of note that baseline levels are well within NEPM Monitoring Investigation Levels.

Table 15: Annual average BTEX concentrations measured at Project site 2012-2013

Year	Benzene (µg/m³)	Toluene (µg/m³)	Ethylbenzene (µg/m³)	o, m and p-xylene, i.e. total xylene (µg/m³)
Corryton Ct, Wattle Grove (MIC1)				
2012[2]	1.1	6.2	0.9	3.5
2013	3.3	14.6	2.9	10.9
Buckland St, Casula (MIC2)				
2012[2]	1.5	7.3	1.4	6.0
2013	5.0	25.0	5.2	20.0
Goodenough St, Glenfield (MIC3)				
2012[2]	1.6	8.1	1.2	5.5
2013	5.5	28.1	8.9	29.5
NEPM Monitoring Investigation Level [1]	**10.3**	**406**	**None**	**935**

Note 1: NEPM Monitoring Investigation Level expressed at 25°C? and 1 atmosphere

Note 2: 2012 only includes data between August and December 2012

6.2.9 Ozone

Monitoring for O_3 is conducted at three locations surrounding the Project site using Radiello diffusion tubes. Annual average concentrations are summarised in **Table 15** . It is noted that there is no air ambient air quality criterion that directly relates to the ozone monitoring timeframe using the diffusion tubes.

Table 16: O_3 monitoring – Project site

Month	O_3 Concentration by monitoring location (µg/m³)		
	Corryton Ct, Wattle Grove (MIC1)	Buckland St, Casula (MIC2)	Goodenough St, Glenfield (MIC3)
2012	80	54	75
2013	58	62	64

In addition to the Project site monitoring data, hourly average O_3 monitoring data was obtained from the OEH Liverpool monitoring station.

Table 12 presents the 1-hour and 8-hour average maximum O_3 concentrations recorded at the OEH Liverpool monitoring station during 2013. It can be seen that both the 1-hour and 4-hour O_3 criterion were exceeded during 2013 at the OEH Liverpool station. It is noted that the exceedance occurred during the period of bushfires in the Greater Sydney Metropolitan Region in late October 2013.

A time-series of recorded 1-hour average O_3 concentrations is presented in **Figure 21**.

The hourly-varying O_3 concentrations recorded at the OEH Liverpool station have been used to convert model predictions of NO_x from the Project to NO_2 (see **Section 9.6.1**).

Table 17: Recorded O_3 concentrations – 2013 – OEH Liverpool		
Averaging period	**Maximum O_3 concentration (ppb)**	**NSW EPA criterion (ppb)**
1-hour	117	**100**
4-hour	102	**80**

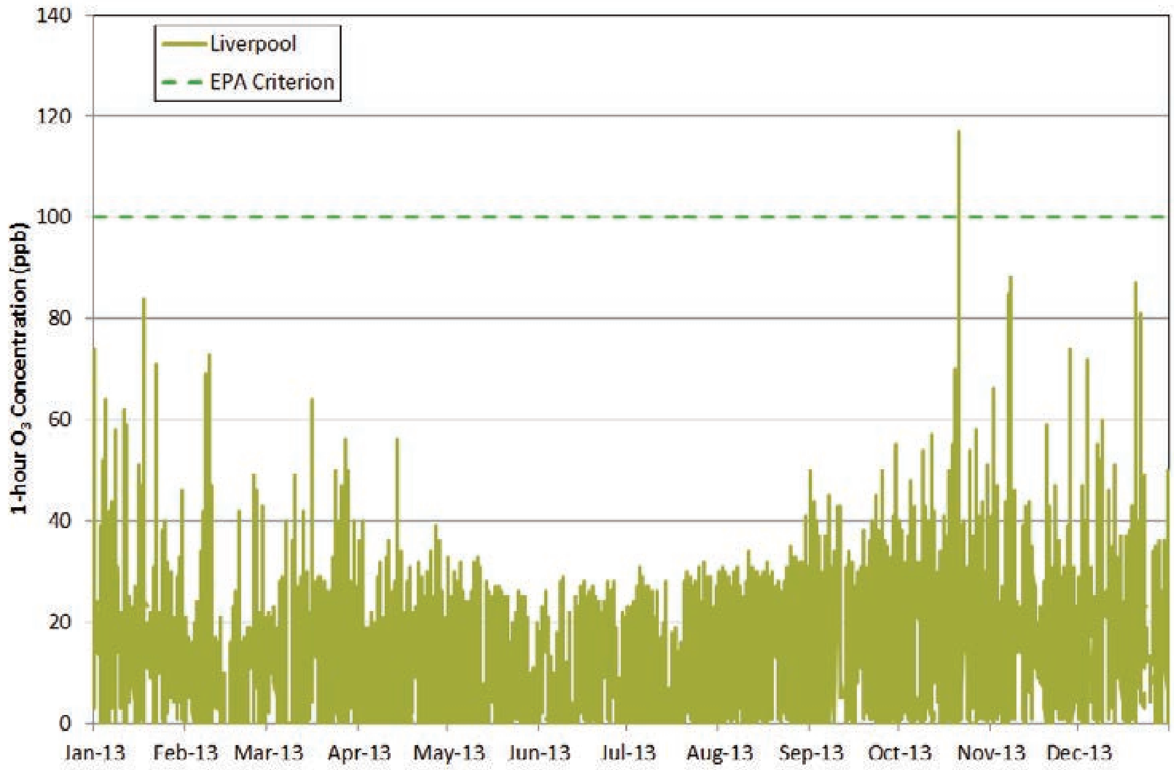

Figure 24: Time-series of 1-hour average O_3 concentrations – 2013 –OEH Liverpool

6.3 Baseline ambient air quality concentrations and levels

The Approved Methods for Modelling requires that predicted impacts from the Project (derived through dispersion modelling) of TSP, PM_{10}, dust deposition, NO_2, SO_2 and CO should be combined with existing background levels before comparison with the applicable impact assessment criteria. While not listed as a pollutant for assessment within the Approved Methods for Modelling, $PM_{2.5}$ has been addressed in the same manner.

For these pollutants, Section 5.1.1 of the Approved Methods for Modelling provides guidance on accounting for background concentrations in air quality impact assessments. For a Level 2 assessment as is undertaken in the current study, background air quality data should incorporate at least one year of hourly varying data contemporaneous with the meteorological monitoring data. At each receptor, each individual dispersion model prediction should be paired with the corresponding background concentration to obtain total cumulative impact.

Therefore, in order to assess the cumulative impacts of predicted concentrations from the Project with existing background concentrations, the monitoring results presented in the preceding sections will be adopted as baseline. These baseline levels are summarised in **Table 18**.

6.3.1 Exceedances in background air quality

As presented in **Section 6.2**, exceedances of the 24-hour average NSW EPA PM_{10} assessment criterion and NEPM advisory reporting goal for $PM_{2.5}$ occurred during 2013 (3 exceedance days for PM_{10}, 2 exceedance days for $PM_{2.5}$). Section 5.1.3 of the Approved Methods for Modelling states that in the event that exceedances of criteria in baseline conditions occurs, the assessment must demonstrate that no additional exceedances of the criteria would occur due to emissions from the Project. This approach has been applied within this report, with further details provided in **Section 9.5**.

Table 18: Adopted baseline air quality – Project site

Pollutant	Averaging period	Concentration (µg/m³ except where noted)	Source / notes
TSP	Annual	42.6	Derived from OEH Liverpool 5 Year Average for PM_{10} and Sydney PM_{10}/TSP relationship
PM_{10}	24-hour	24-hourly Varying 2013 (100th Percentile = 98.5)	OEH Liverpool
	Annual	20.4	OEH Liverpool 5 Year Average
$PM_{2.5}$	24-hour	24-hourly Varying 2013 (100th Percentile = 73.8)	OEH Liverpool
	Annual	7.6	OEH Liverpool 5 Year Average
Dust Deposition	Annual	0.8 g/m^2/month	Maximum 12-month average deposition across Project site monitoring locations
NO_2	1-hour	Hourly Varying 2013 (100th Percentile = 114.8)	OEH Liverpool
	Annual	22.7	
SO_2	10-minute	100th Percentile = 100.7	Derived from 1-hour maximum at OEH Chullora
	1-hour	Hourly Varying 2013 (100th Percentile = 34.3)	OEH Chullora
	24-hour	24-hourly Varying 2013 (100th Percentile = 8.9)	
	Annual	1.9	
CO	15-minute	100th Percentile = 11,500	Derived from 1-hour maximum at OEH Liverpool
	1-hour	Hourly Varying 2013 (100th Percentile = 5,000)	OEH Liverpool
	8-hour	8-hourly Varying 2013 (100th Percentile = 2,250)	

NOTE: Recorded NO_2, SO_2 and CO concentrations converted from ppb or ppm to µg/m³ assuming 0°C and 1 atmosphere

7 Early works phase

An Early Works development phase would be required prior to the commencement of Phase A construction activities (planned for 2016), as highlighted in **Figure 5**. This phase is expected to start in July 2015 and would occur for approximately six months. The key activities included within the Early Works development phase include:

- establishment of construction facilities which may include laydown area, site offices, hygiene units, kitchen facilities and wheel wash facilities;
- demolition or relocation of existing buildings, structures and buildings containing hazardous materials;
- some contaminated land remediation including removal of unexploded ordnance and explosive ordnance waste if found, removal of asbestos contaminated buildings and remediation of an area known to contain asbestos;
- relocation of hollow bearing trees (i.e. those that provide ecologically important roosting habitats);
- service utility terminations and diversions;
- establishment of the conservation area within the plant and equipment operation training area including seed banking and planting; and
- heritage impact mitigation works including archaeological salvage of Aboriginal and European potential archaeological deposit sites.

The Early Works phase would have the potential to generate air quality emissions, primarily particulate matter (TSP, PM_{10} and $PM_{2.5}$) through the demolition of structures, the handling and transportation of material and the remediation of contaminated areas. **Table 19** presents the expected material volumes to be handled during the Early Works phase.

Table 19: Earthworks estimates – early works phase

Activity	Item	Approx. quantity of earthworks (m^3)
Building demolition	Residential buildings	11,337
	Warehouses	7,116
	Office buildings	4,775
	Asbestos removal	287
Remediation	Remediation of Area 18	5,510

A preliminary Remediation Action Plan (RAP) has been prepared for the Project and is included in Technical Paper 5 – *Environmental Site Assessment (Phase 2)* of the Project EIS. The RAP identifies the processes and methods that would be followed during the investigation and remediation of the contaminated material. In addition, Section 10.1 of the RAP identifies remedial contingencies to effectively deal with contaminated material that has not been previously identified. The RAP would be updated and finalised before the start of the Early Works development phase, which would include remedial contingency methodologies.

It is noted that the amount of excavated material estimated for remediation activities (5,510 m^3 as per **Table 19**) represents approximately 1% of material to be excavated during Phase A of the Project (further details presented in **Section 8.2**). Given the expected magnitude of the earthworks and the short term nature of Early Works construction and remediation activities, it is considered that the potential air emissions and related impacts from this phase of the Project would be negligible.

It is considered that through the implementation of recommended and proposed control measures, as specified in **Section 11**, air quality emissions and associated impacts to the local environment would be low. Emissions from the Early Works phase have not been considered further within this report.

8 Emission estimation

Air emission sources associated with the construction and operation phases of the Project were identified and quantified through the application of National Pollution Inventory (NPI) and United States Environmental Protection Agency (US-EPA) AP-42 emission estimation techniques.

Particulate releases were quantified for various particle size fractions. TSP emissions were estimated and used in the modelling to predict dust deposition rates. Fine particulate (PM_{10} and $PM_{2.5}$) emissions were estimated using ratios for the different particle size fractions available within the literature (principally the US-EPA AP-42), as documented in subsequent sections. Gaseous products of combustion for which emissions were quantified were SO_2, NO_x, CO and VOCs (benzene, toluene, xylenes, 1,3-butadine, formaldehyde and acetaldehyde) and PAHs.

8.1 Emission scenarios

As identified in **Section 2**, the Project will be progressively developed over an approximate 15 year period, with full operations proposed to occur in 2030. There are three proposed Project layouts, each defined by the location of site rail entry/exit (northern, central and southern).

For each of the three Project layouts, four emission scenarios have been developed, corresponding to Phase A, Phase B, Phase C and Project Full Build (Full Build), equating to 12 emissions scenarios in total. **Figure 5** provides a detailed definition of each Project phase, while **Table 20** provides a summary of each scenario.

Table 20: Project emission scenarios

Project Phase	Construction	Operations	Scenario ID
Phase A – (2016/2017)	✓		Scenario 1 – Northern Scenario 2 – Central Scenario 3 – Southern
Phase B – (2023/2024)	✓	✓	Scenario 4 – Northern Scenario 5 – Central Scenario 6 – Southern
Phase C – (2028/2029)	✓	✓	Scenario 7 – Northern Scenario 8 – Central Scenario 9 – Southern
Full Build – (2030)		✓	Scenario 10 – Northern Scenario 11 – Central Scenario 12 – Southern

8.2 Construction activities

During construction the main potential air quality related impacts would be associated with the generation of particulate matter and fuel combustion emissions from the movement of on-site machinery, wind erosion, bulk earthworks, material storage and associated vehicular traffic within the construction footprint.

Indicative earthworks totals for each site configuration and phase have been provided by Parsons Brinckerhoff and listed within **Table 21**. It can be seen from these values that construction activities are greatest during Phase A. It is noted that the duration of each construction phase is expected to be two years. Material totals presented in **Table 21** were divided by two to calculate annual construction phase emissions.

Table 21: Bulk earthworks estimates

Item	Phase A	Phase B	Phase C	Total
Northern rail access option				
Total excavated cut (m^3)	682,670	434,430	434,430	1,551,530
Total fill required (m^3)	346,350	206,090	313,670	866,110
Excavated material for disposal (unsuitable for use on-site) (m^3)	518,690	330,080	330,080	1,178,850
Import required (m^3) (fill required – acceptable material)	N/A	N/A	53,040	53,040
Central rail access option				
Total excavated cut (m^3)	819,350	449,940	403,400	1,672,690
Total fill required (m^3)	393,350	213,450	432,480	1,039,280
Excavated material for disposal (unsuitable for use on-site) (m^3)	578,950	341,870	306,500	1,227,320
Import required (m^3) (fill required – acceptable material)	N/A	N/A	190,437	190,437
Southern rail access option				
Total excavated cut (m^3)	640,840	480,980	434,430	1,556,250
Total fill required (m^3)	367,740	228,170	369,100	965,010
Excavated material for disposal (unsuitable for use on-site) (m^3)	485,210	365,440	330,080	1,180,730
Import required (m^3) (fill required – acceptable material)	N/A	N/A	108,444	108,444

8.2.1 Dust emissions

Air pollutant emissions during the construction phase will largely comprise of particulate matter (TSP, PM_{10} and $PM_{2.5}$). Particulate matter emission sources associated with construction activities at the Project site would include:

- vehicle movements on paved and unpaved roads;
- erosion of stockpiles and freshly exposed areas on-site;

- handling, transfer and storage of materials;
- heavy earthwork operations such as excavation and earth moving activities; and
- re-contouring of land and soil exposure for reseeding.

Construction work would be undertaken between the hours of 7am and 6pm.

8.2.2 Vehicle emissions

During construction, emissions are likely to be associated with the combustion of diesel fuel and petrol by machinery and vehicles. The operation of on-site machinery during construction and general site operations would generate CO, NO_X, SO_2, particulate matter (PM_{10} and $PM_{2.5}$) and trace amounts of un-combusted hydrocarbons. The emission rates and impact potential will depend on a range of factors including the number and power output of the combustion engines, the quality of the fuel, and the age and condition of the combustion engines.

During construction, daily maximum truck trips to the Project site delivering equipment and materials as well as the removal of extracted materials are projected to total 965 for Phase A, 972 for Phase B and 197 for Phase C. Combustion emissions from these trucks have been included in the dispersion modelling assessment. A comparatively small number of other mobile sources (excavators, bulldozers, scrapers) would be operating on-site each day, however it is expected that very low levels of combustion emissions would be generated by these activities. Such sources have therefore not been considered further in this assessment.

8.2.3 Odour emissions

Part of the excavation works includes the removal of potentially contaminated soils from within the construction footprint. As a result of the contaminated soils being exposed to the ambient air environment there is potential for some odorous emissions to be released. On-site surveys of the soils identified that there were few volatile contaminants and odorous compounds detected (Parsons Brinckerhoff 2014b). The primary contamination was asbestos and heavy metals.

Additionally, it is noted that the proposed southern rail access option of the Project would involve construction activities occurring on land currently occupied by the Glenfield Landfill. It is understood that the Glenfield Landfill involves the disposal of inert material such as building and construction waste and smaller quantities of garden and timber waste but not the disposal of putrescible waste, limiting the potential for odourous emissions if the area is excavated.

In the event that construction activities were to occur at the Glenfield Landfill site, a comprehensive construction management plan, with specific focus on the control and minimisation of odour emissions, would be prepared.

Overall, odorous emissions are not expected to significant during excavation works related to the Project.

8.3 Operational activities

The main air emission sources during the operation phase of the Project include:

- emission from locomotives entering/exiting and idling at the Project site;
- switch engines transporting wagons and idling;
- emissions from mobile on-site equipment, including in-terminal transport vehicles (ITV), sidepicks and forklifts;
- emissions from Off-terminal transport vehicles (OTVs) entering/exiting and idling at the Project site;
- emissions from petrol and diesel vehicles e.g. trucks, cars;
- miscellaneous emission sources (e.g. fuel and chemical storage); and
- LNG-fired heating/cooling of warehousing areas.

A list of operations-related equipment by Project phase is presented in **Table 22**.

Table 22: Operations phase equipment schedule

Equipment type	Fuel type	Early Works / Phase A	Phase B	Phase C	Full Build
Working track Rail Mounted Gantry (RMG)	Electric	1	1	4	9
RMG	Electric	2	2	10	16
Side pick	LNG	2	2	4	6
ITV	LNG	5	5	26	53
Bomb cart	n/a	4	4	21	47
Yard chassis	n/a	2	2	18	23
Switch engine	Diesel	1	1	2	3
Forklift	LNG	0	0	34	34

8.3.1 Emissions from diesel locomotives and switch engines

Air emissions would be generated from diesel fuel combustion by freight train locomotives travelling to and from the IMEX and interstate terminals and the switch engines used to transport the wagons within the working tracks.

Locomotive and switch engine emissions would include particulate matter fractions (TSP, PM_{10} and $PM_{2.5}$), CO, CO_2, NO_x, SO_2, VOCs and PAHs.

8.3.2 On-site mobile equipment

On-site mobile emission sources would likely include forklifts, side picks and ITVs. This equipment would be used to transport the TEUs to the warehousing facilities and container storage facilities. Forklifts would be limited to the warehouses and would not be required until Phase B of the Project when the warehousing facilities become operational. The side picks and ITVs would be operating throughout the site.

All forklifts, side picks and ITVs will be powered by liquefied natural gas (LNG). Emissions from LNG equipment will include NO_X, $PM_{2.5}$, CO, VOCs and PAHs.

8.3.3 OTVs, diesel and petrol vehicles

Emissions are anticipated to arise from the combustion of diesel and petrol fuel by delivery trucks, heavy goods vehicles, and employee and visitor cars entering and leaving the Project site. The estimated number of vehicles that would enter the site is presented in **Table 23**.

Table 23: Maximum hourly and daily traffic movements

Project phase	**Maximum traffic movements (one way) by operations area and vehicle type**						
	Period	**IMEX**		**IS**		**Warehousing**	
		HV	**LV**	**HV**	**LV**	**HV**	**LV**
Phase B	Hourly	30	16	-	-	16	10
	Daily	710	168	-	-	387	755
Phase C	Hourly	63	32	-	-	35	20
	Daily	1,506	337	-	-	822	1,887
Full Build	Hourly	62	32	25	32	82	20
	Daily	1,516	337	565	261	1,963	2,264

Note: HV = Heavy Vehicle, LV = Light Vehicle

Combustion emissions from the OTVs and passenger vehicles include NO_x, PM_{10}, $PM_{2.5}$, SO_2 and CO, VOCs and PAHs.

8.3.4 Miscellaneous emissions

Emissions could be generated by fugitive releases from fuel and chemicals stored on-site (e.g. LNG, diesel, lubricant oils, cleaning chemicals), however these emissions are likely to be minor relative to fuel combustion emissions and have not been considered further.

Some minor odour emissions may be generated as part of the Project's general operation, primarily associated with an on-site sewage treatment plant. Details relating to the on-site sewage treatment plant were not available for assessment at the time of reporting. It is proposed that the on-site sewage treatment plant would be minor in size, servicing only the Project site. In order to minimise potential odour impacts to the surrounding environment, the on-site sewage treatment plant would be located at an appropriate buffer distance from surrounding sensitive receptors and integratemodern plant design and odour emission treatment technologies. Odour emissions from an on-site sewage treatment plant have not been considered further in this assessment and would be considered in detail at a future design stage.

8.4 Emissions summary

Full details relating to the calculated Project emissions are provided in **Appendix B**.

Summaries of total annual estimate emissions by site layout and phase are presented in **Table 24**. Further, a breakdown of estimated annual construction and operational emissions by Project phase is presented in **Table 25**, **Table 26**, **Table 27** and **Figure 25**, **Figure 26** and **Figure 27** for northern, central and southern site configuration respectively.

These tables and figures highlight the following:

- emissions of TSP and PM_{10} are higher during the construction phases of the Project and are greatest during Phase A; and
- diesel combustion related pollutants (specifically $PM_{2.5}$, NO_x, SO_2, CO, VOCs and PAHs) emissions increase in line with increasing operations between Phase B and Full Build.

To provide an indication of the key contributing sources to air pollutants during Full Build (full build operations), **Figure 28** illustrates the contribution of diesel locomotives and switch engines, on-site mobile equipment, offsite trucks, passenger vehicles and warehouse heating and cooling to all calculated air pollutants. Of note are the following:

- diesel locomotives and switch engines are significant contributors of SO_2, NO_x, PM_{10}, $PM_{2.5}$ and PAHs;
- on-site mobile equipment (ITVs, sidepicks and forklifts) are the highest contributor to CO and VOC emissions;
- OTVs are a key contributor to the majority of combustion pollutants calculated, in particular NO_x, PM_{10} and $PM_{2.5}$, SO_2 and PAHs;
- warehouse heating and cooling and passenger vehicles are comparatively insignificant for all pollutants relative to other Project sources.

Table 24: Annual total Emissions by layout option (kg/annum)

Operational phase	TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOCs	PAHs
Northern Option								
Phase A	43,240.4	14,223.2	2,515.0	21,668.7	24.6	8,168.8	1,202.5	9.6
Phase B	23,680.4	9,020.6	3,523.1	98,454.1	126.1	38,675.6	11,417.9	19.0
Phase C	27,077.1	12,473.0	6,142.3	146,128.3	136.3	180,549.2	67,898.8	10.6
Full Build	7,691.0	7,691.0	7,551.4	262,224.4	246.5	289,794.3	133,083.5	18.9
Central Option								
Phase A	46,385.8	14,595.0	2,549.7	21,668.7	24.6	8,168.8	1,202.5	9.6
Phase B	29,214.9	11,693.2	3,925.5	98,454.1	126.1	38,675.6	11,417.9	19.0
Phase C	28,767.1	12,875.5	6,200.1	146,128.3	136.3	180,549.2	67,898.8	10.6
Full Build	7,691.0	7,691.0	7,551.4	262,224.4	246.5	289,794.3	133,083.5	18.9
Southern Option								
Phase A	40,845.7	13,386.8	2,396.1	21,668.7	24.6	8,168.8	1,202.5	9.6
Phase B	26,112.9	9,988.9	3,671.8	98,454.1	126.1	38,675.6	11,417.9	19.0
Phase C	29,352.6	13,391.2	6,279.8	146,128.3	136.3	180,549.2	67,898.8	10.6
Full Build	7,691.0	7,691.0	7,551.4	262,224.4	246.5	289,794.3	133,083.5	18.9

Table 25: Annual calculated emissions summary – Northern configuration

Pollutant	Construction emissions (kg/annum)	Operations emissions (kg/annum)	Total emissions (kg/annum)
Phase A – 2016/2017			
TSP	43,240.4	-	43,240.4
PM_{10}	14,223.2	-	14,223.2
$PM_{2.5}$	2,515.0	-	2,515.0
NO_x	21,668.7	-	21,668.7
SO_2	24.6	-	24.6
CO	8,168.8	-	8,168.8
VOC	1,202.5	-	1,202.5
PAH	9.6	-	9.6
Phase B – 2023/2024			
TSP	21,678.9	2,001.5	23,680.4
PM_{10}	7,019.0	2,001.5	9,020.6
$PM_{2.5}$	1,574.1	1,949.0	3,523.1
NO_x	21,875.1	76,579.0	98,454.1
SO_2	24.8	101.3	126.1
CO	8,246.6	30,429.0	38,675.6
VOC	1,213.9	10,204.0	11,417.9
PAH	9.7	9.3	19.0
Phase C – 2028/2029			
TSP	22,573.6	4,503.5	27,077.1
PM_{10}	7,944.6	4,528.4	12,473.0
$PM_{2.5}$	1,713.4	4,428.9	6,142.3
NO_x	3,377.7	142,750.6	146,128.3
SO_2	3.2	133.0	136.3
CO	1,061.6	179,487.6	180,549.2
VOC	156.9	67,741.9	67,898.8

Table 25: Annual calculated emissions summary – Northern configuration			
Pollutant	**Construction emissions (kg/annum)**	**Operations emissions (kg/annum)**	**Total emissions (kg/annum)**
PAH	0.5	10.1	10.6
Full Build – 2030			
TSP	-	7,691.0	7,691.0
PM_{10}	-	7,691.0	7,691.0
$PM_{2.5}$	-	7,551.4	7,551.4
NO_x	-	262,224.4	262,224.4
SO_2	-	246.5	246.5
CO	-	289,794.3	289,794.3
VOC	-	133,083.5	133,083.5
PAH	-	18.9	18.9

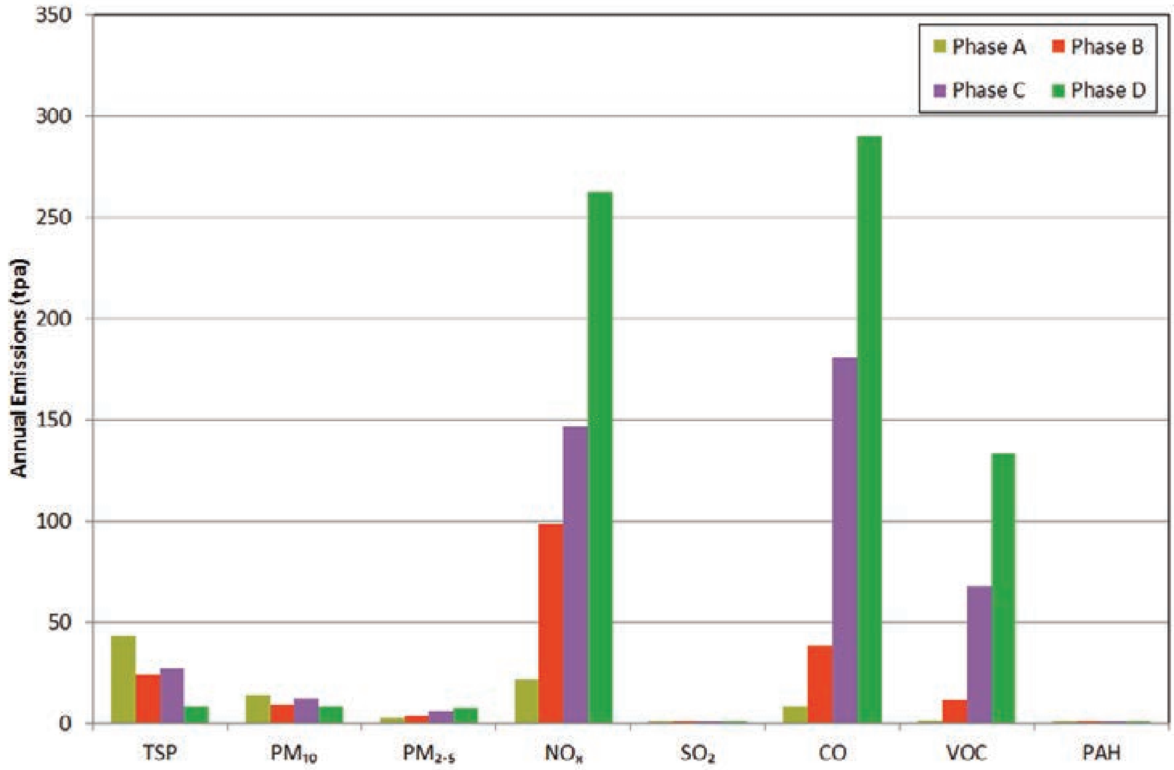

Figure 25: Annual emissions – Northern configuration

Table 26: Annual calculated emissions summary – Central configuration

Pollutant	Construction emissions (kg/annum)	Operations emissions (kg/annum)	Total emissions (kg/annum)
Phase A – 2016/2017			
TSP	46,385.8	-	46,385.8
PM_{10}	14,595.0	-	14,595.0
$PM_{2.5}$	2,549.7	-	2,549.7
NO_x	21,668.7	-	21,668.7
SO_2	24.6	-	24.6
CO	8,168.8	-	8,168.8
VOC	1,202.5	-	1,202.5
PAH	9.6	-	9.6
Phase B – 2023/2024			
TSP	27,213.4	2,001.5	29,214.9
PM_{10}	9,691.7	2,001.5	11,693.2
$PM_{2.5}$	1,976.5	1,949.0	3,925.5
NO_x	21,875.1	76,579.0	98,454.1
SO_2	24.8	101.3	126.1
CO	8,246.6	30,429.0	38,675.6
VOC	1,213.9	10,204.0	11,417.9
PAH	9.7	9.3	19.0
Phase C – 2028/2029			
TSP	24,263.6	4,503.5	28,767.1
PM_{10}	8,347.1	4,528.4	12,875.5
$PM_{2.5}$	1,771.3	4,428.9	6,200.1
NO_x	3,377.7	142,750.6	146,128.3
SO_2	3.2	133.0	136.3
CO	1,061.6	179,487.6	180,549.2
VOC	156.9	67,741.9	67,898.8

Table 26: Annual calculated emissions summary – Central configuration			
Pollutant	**Construction emissions (kg/annum)**	**Operations emissions (kg/annum)**	**Total emissions (kg/annum)**
PAH	0.5	10.1	10.6
Full Build – 2030			
TSP	-	7,691.0	7,691.0
PM_{10}	-	7,691.0	7,691.0
$PM_{2.5}$	-	7,551.4	7,551.4
NO_x	-	262,224.4	262,224.4
SO_2	-	246.5	246.5
CO	-	289,794.3	289,794.3
VOC	-	133,083.5	133,083.5
PAH	-	18.9	18.9

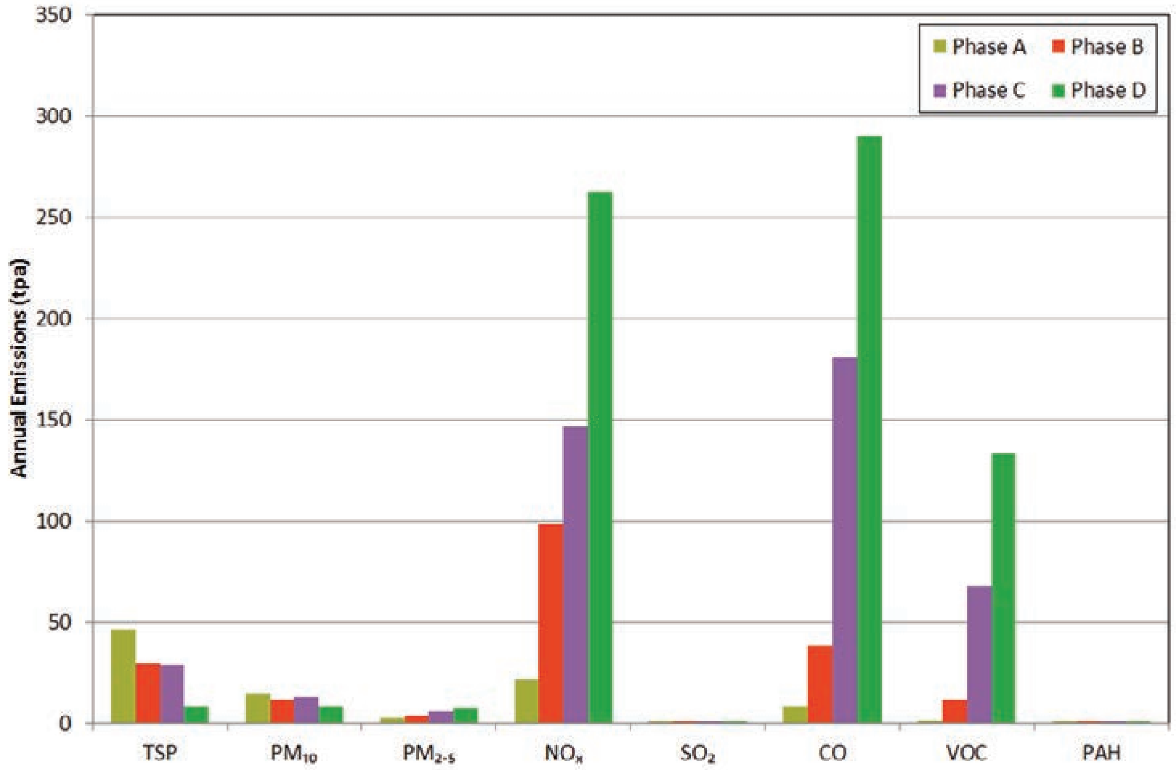

Figure 26: Annual emissions – Central configuration

Table 27: Annual calculated emissions summary – Southern configuration

Pollutant	Construction emissions (kg/annum)	Operations emissions (kg/annum)	Total emissions (kg/annum)
Phase A – 2016/2017			
TSP	40,845.7	-	40,845.7
PM_{10}	13,386.8	-	13,386.8
$PM_{2.5}$	2,396.1	-	2,396.1
NO_x	21,668.7	-	21,668.7
SO_2	24.6	-	24.6
CO	8,168.8	-	8,168.8
VOC	1,202.5	-	1,202.5
PAH	9.6	-	9.6
Phase B – 2023/2024			
TSP	24,111.4	2,001.5	26,112.9
PM_{10}	7,987.4	2,001.5	9,988.9
$PM_{2.5}$	1,722.8	1,949.0	3,671.8
NO_x	21,875.1	76,579.0	98,454.1
SO_2	24.8	101.3	126.1
CO	8,246.6	30,429.0	38,675.6
VOC	1,213.9	10,204.0	11,417.9
PAH	9.7	9.3	19.0
Phase C – 2028/2029			
TSP	24,849.1	4,503.5	29,352.6
PM_{10}	8,862.8	4,528.4	13,391.2
$PM_{2.5}$	1,850.9	4,428.9	6,279.8
NO_x	3,377.7	142,750.6	146,128.3
SO_2	3.2	133.0	136.3
CO	1,061.6	179,487.6	180,549.2
VOC	156.9	67,741.9	67,898.8

Table 27: Annual calculated emissions summary – Southern configuration

Pollutant	Construction emissions (kg/annum)	Operations emissions (kg/annum)	Total emissions (kg/annum)
PAH	0.5	10.1	10.6
Full Build – 2030			
TSP	-	7,691.0	7,691.0
PM_{10}	-	7,691.0	7,691.0
$PM_{2.5}$	-	7,551.4	7,551.4
NO_x	-	262,224.4	262,224.4
SO_2	-	246.5	246.5
CO	-	289,794.3	289,794.3
VOC	-	133,083.5	133,083.5
PAH	-	18.9	18.9

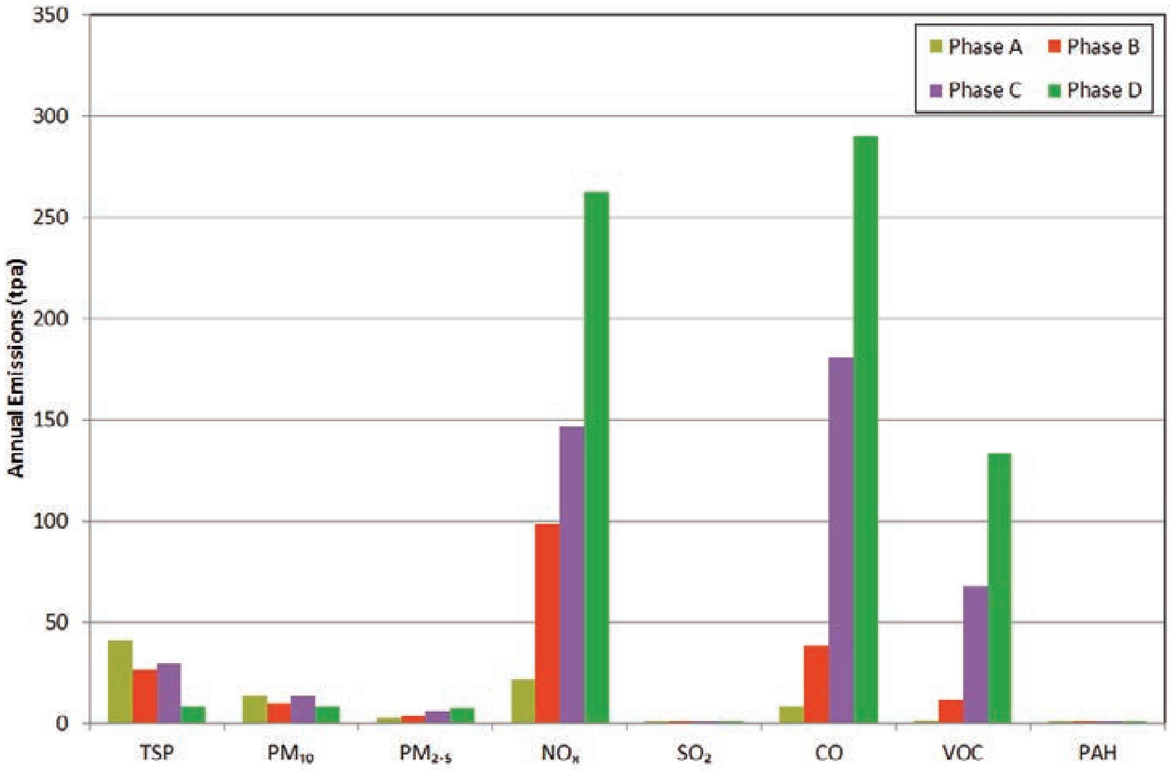

Figure 27: Annual emissions – Southern configuration

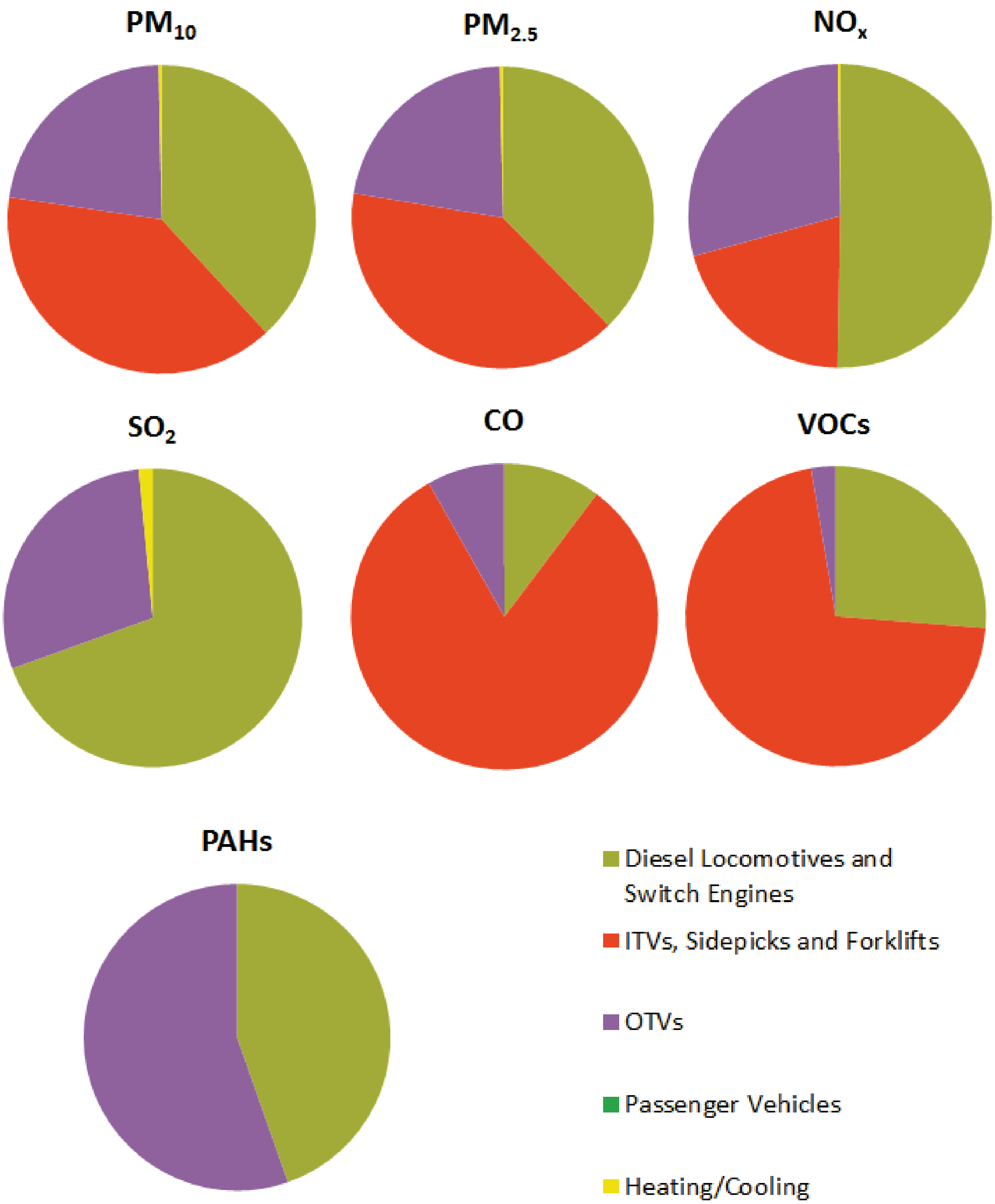

Figure 28: Source contribution to annual emissions – Full Build (Full Build) – all site configuration options

9 Dispersion modelling methodology

9.1 Dispersion model selection and application

The atmospheric dispersion modelling carried out within this assessment used the AMS/US-EPA regulatory model (AERMOD) (US-EPA, 2004).

AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain.

AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it is considered to provide more realistic results with concentrations that are generally lower and more representative of actual concentrations compared to the ISC model.

Compared to ISC, AERMOD represents an advanced new-generation model which requires additional meteorological and land-use inputs to provide more refined predictions.

Predicted concentrations and deposition rates were calculated for a regular Cartesian receptor grid covering a 7 km by 7 km computational domain centered over the Project site, with a grid resolution of 200 m. In addition, concentrations and deposition rates were predicted at the sensitive receptor locations listed in **Table 2** and along the Project site boundary.

Simulations were undertaken for the 12 month period between 1 January 2013 and 31 December 2013 using the OEH Liverpool meteorological monitoring dataset as input (see Section 5 for description of input meteorology).

9.2 Modelling scenarios

As identified in **Section 2**, three potential site configuration options (northern, central and southern) have been proposed for assessment by MIC. Within this AQIA for each site configuration, four stages of construction and operation have been assessed to determine the potential impact of emissions of particulate matter and combustion pollutants from the Project on the surrounding environment.

It is noted for construction scenarios, wind erosion and materials handling emissions are varied relative to hourly wind speed. Further details are provided in **Appendix B**.

9.3 Source and emissions data

The methodology and results of the emissions inventory developed for this study are presented in **Section 8** and **Appendix B**. Maps illustrating the location of modelled emission sources for each scenario are presented in **Appendix B**.

9.4 Model results

Dispersion simulations were undertaken and results analysed for TSP, PM_{10}, $PM_{2.5}$, dust deposition, SO_2, NO_2, CO, VOCs (benzene, toluene, xylenes, 1,3-butadine, formaldehyde and acetaldehyde) and PAHs. Incremental Project-related concentrations and deposition rates occurring due to the proposed activities across the Project site were modelled. Model results are expressed as the maximum (or 99.9th percentile as applicable) predicted concentration for each averaging period at the selected assessment locations over the 2013 modelling period.

It is noted that predictions of TSP and dust deposition impacts for Full Build operations (Scenario 10, 11 and 12) were not included in the assessment as the major source of coarse dust would arise from construction activities. These operations are completed in during Phase C (Scenario 7, 8 and 9).

The results are presented in the following formats:

- discussion of key results for each modelling scenario in **Section 10**;
- tabulated results of concentrations and dust deposition rates at the selected assessment locations are presented in **Appendix C**; and
- isopleth plots, illustrating spatial variations in Project-related incremental concentrations for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D** are provided in **Appendix D**.

Isopleth plots of the maximum 1-hour and 24-hour average concentrations presented in **Appendix D** do not represent the dispersion pattern on any individual time period, but rather illustrate the maximum concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2013 modelling period. It is noted that based on the modelling results presented in **Section 10**, PM_{10}, $PM_{2.5}$ and NO_2 are the most significant in comparison with applicable impact assessment criterion. Due to the large number of modelling scenarios and pollutants in this assessment, only plots of PM_{10}, $PM_{2.5}$ and NO_2 have been provided in **Appendix D**.

9.5 Cumulative impacts

The cumulative impact to surrounding sensitive receptors was assessed through the combination of ground level concentration predictions resulting from activities on the Project site and the existing air quality environment (as documented in **Section 6**).

For PM_{10}, $PM_{2.5}$, NO_x, SO_2 and CO, hourly average pollutant concentration measurements recorded by the OEH Liverpool and Chullora (SO_2) have been paired with the corresponding ground level predictions at the surrounding sensitive receptors to determine cumulative impacts for comparison against the applicable assessment criteria.

As stated in **Section 6.2.1**, the NSW EPA assessment criterion of 50 µg/m³ for 24-hour average PM_{10} was exceeded on three occasions day during 2013 at the OEH Liverpool station. Additionally, the 24-hour average $PM_{2.5}$ NEPM advisory reporting goal of 25 µg/m³ was exceeded on two occasions. These exceedances were all attributable to bushfire related impacts.

Consequently, the background levels adopted for the Project will include exceedances of the PM_{10} and $PM_{2.5}$ criterion without any increment associated with the Project operations.

Section 5.1.3 of the Approved Methods provides the following guidance for dealing with elevated background concentrations when assessing cumulative impacts associated with proposed developments:

> In some locations, existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time. In such circumstances, a licensee must

demonstrate that no additional exceedances of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical.

In accordance with the Approved Methods, the likelihood of further exceedances of the impact assessment criterion occurring due to the Project was evaluated.

9.6 Approach to the assessment of other pollutants

9.6.1 Short-term averaging periods

Dispersion models in general only predict on time scales of 1 hour or greater. To estimate the 10 minute SO_2 and 15 minute CO concentrations from the one hour predictions, the following empirical relationship has been used:

$$C_t = C_{60}\left[\frac{60}{t}\right]^{0.6}$$

Source: Hanna et al. (1977) as quoted in MFE (2004).

Where:

Ct = concentration of pollutant at time t.

C_{60} = concentration of pollutant based on averaging time of 60 minutes.

T = required averaging time in minutes.

It is noted that, as per MFE (2004), the value of 0.6 used in the above equation is associated with the dispersion of emissions from low-level releases in stable atmospheres. Consequently, the use of 0.6 is considered conservative for the conversion of 1-hour average concentrations to 15-minute concentrations.

9.6.2 Modelling of NO_x emissions

NO_x emissions associated with fuel combustion are primarily emitted as NO with some NO_2. The transformation in the atmosphere of NO to NO_2 was accounted for using the US-EPA's Ozone Limiting Method (OLM) which requires ambient ozone data, as per the Approved Methods for Modelling.

Reference has been made to the hourly-varying O_3 concentrations recorded at the OEH Liverpool station.

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

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

Where:

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

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

MIN = The minimum of the two quantities within the braces

$[O_3]_{BKGD}$ = The background ambient O_3 concentration – Hourly Varying OEH Liverpool as µg/m^3.

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

$[NO_2]_{BKGD}$ = The background ambient NO_2 concentration – Hourly Varying OEH Liverpool as µg/m^3.

The US-EPA's OLM assumes that all of the available O_3 in the atmosphere will react with NO until either all of the O_3, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. Furthermore, the method assumes that the complete mixing of the plume NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the plume reaches the ground level receiver of the maximum ground level NO_X concentration. Consequently, concentrations of the NO_2 reported within this assessment should be viewed as conservative, providing an upper bound estimate of NO_2 concentrations.

It is noted that, due to the application of the OLM approach, **Appendix D** presents 1-hour and annual average NO_x concentrations rather than converted NO_2 concentrations.

9.6.3 Volatile Organic Compounds (VOCs)

Predicted ground level concentrations of VOCs from the Project have been speciated as benzene, toluene, xylenes, 1,3-butadine, formaldehyde and acetaldehyde.

The percentage composition by pollutant adopted for this assessment is based on the speciation profiles contained within the 2008 Calendar Year Air Emissions Inventory for the Greater Metropolitan Region in NSW (OEH 2012). As multiple vehicle types (i.e. off-road, on-road and locomotives) will be used during the operation of the Project, the weighted average (based on 2030 VOC emissions) for each speciation profile has been adopted.

The adopted percentage of total VOC for individual pollutants is presented in **Table 28**.

Table 28: Percentage composition of speciated VOCs

VOC Species	Weighted average by emissions source[1]		
	Diesel VOC profile (6% of Total VOC)[2]	LNG VOCs (94% of Total VOC)[3]	Adopted percentage
Benzene	0.93	0.11	0.16
Toluene	0.31	0.04	0.06
Xylene	0.50	0.04	0.07
1,3-butadiene	0.31	-	0.02
Formaldehyde	9.89	0.81	1.35
Acetaldehyde	3.29	0.03	0.23

Note 1: based on Full Build Project emissions (**Section 8**)

Note 2: US-EPA Speciate V4.2 – Profile 5557 Diesel Exhaust - Reformulated Diesel - Hot Start

Note 3: US-EPA Speciate V3.2 – Profile 1001 - Internal Combustion Engine - Natural Gas

9.6.4 Lead

The sale of leaded petrol in cars was phased out by the Australian Government by 1 January 2002 and has not been available since this date. Diesel and LNG are the primary fuel types at the Project site for both the construction and operation phases and are not sources of lead emissions. There are no other known potential sources of lead emissions at the Project site and no further assessment of lead impacts has been undertaken.

9.6.5 Ozone

Ozone is a secondary pollutant and is therefore not a direct emission from on-site sources during the construction and operation of the Project. Ozone is considered a regional scale pollutant is addressed in the Moorebank IMT Regional Air Quality Impact Assessment report (TAS 2014).

10 Dispersion modelling results

Air quality assessments undertaken in accordance with the Approved Methods for Modelling generally provide a conservative (upper bound) estimate of the potential for air quality impacts occurring due to a project.

During this assessment modelling scenarios were established for the Project to provide an upper bound assessment of Project-related air emissions and related risks, taking into account existing air quality.

10.1 Summary of modelling results

10.1.1 Scenario 1 – Phase A Northern option

The results for Scenario 1 are presented within **Appendix C**. There were no exceedances of any NSW EPA criteria and NEPM advisory reporting goals predicted for the assessed particulate matter or combustion pollutants across all surrounding receptor locations during Phase A Northern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.2 Scenario 2 – Phase A Central option

The results for Scenario 2 are presented within **Appendix C**. There were no exceedances of any NSW EPA criteria and NEPM advisory reporting goals predicted for the assessed particulate matter or combustion pollutants across all surrounding receptor locations during Phase A Central Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.3 Scenario 3 – Phase A Southern option

The results for Scenario 3 are presented within **Appendix C**. There were no exceedances of any NSW EPA criteria and NEPM advisory reporting goals predicted for the assessed particulate matter or combustion pollutants across all surrounding receptor locations during Phase A Southern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.4 Scenario 4 – Phase B Northern option

The results for Scenario 4 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedances were predicted to occur due to cumulative concentrations during proposed Phase B Northern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase B Northern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.5 Scenario 5 – Phase B Central option

The results for Scenario 5 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Phase B Central Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase B Central Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.6 Scenario 6 – Phase B Southern option

The results for Scenario 6 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Phase B Southern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase B Southern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.7 Scenario 7 – Phase C Northern option

The results for Scenario 7 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Phase C Northern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase C Northern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.8 Scenario 8 – Phase C Central option

The results for Scenario 8 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Phase C Central Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase C Central Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.9 Scenario 9 – Phase C Southern option

The results for Scenario 9 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Phase C Southern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Phase C Southern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.10 Scenario 10 – Full Build Northern option

The results for Scenario 10 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Full Build Northern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Full Build Northern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.11 Scenario 11 – Full Build Central option

The results for Scenario 11 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Full Build Central Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Full Build Central Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.1.12 Scenario 12 – Full Build Southern option

The results for Scenario 12 are presented within **Appendix C**. Air pollutant concentrations and dust deposition rates due solely to the Project were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedance was predicted to occur due to cumulative concentrations during proposed Full Build Southern Option activities, accounting for existing air quality:

- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during Full Build Southern Option.

Incremental (Project-only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix D**.

10.2 Discussion of results

The following key points are taken from the modelling results generated for the Project:

- Project-only incremental concentrations and dust deposition rates for all site configuration options and phases are below NSW EPA and NEPM advisory reporting goals at all surrounding receptor locations;
- No additional criteria exceedances, beyond those already in the baseline, are predicted for cumulative (Project-only increment + background) 24-hour average PM_{10} or $PM_{2.5}$ concentrations;
- Cumulative annual average (Project-only increment + background) $PM_{2.5}$ is exceeded a receptor R33 only for scenarios involving the operational intermodal facility. It is noted that the background concentration is elevated relative to the NEPM advisory reporting goal and contributes the majority of the cumulative concentration at R33.
- No other cumulative (Project-only increment + background) pollutant exceedances are predicted for any scenario at any of the surrounding receptor locations.

Expanded discussion on these key points is provided below.

Incremental (Project-only impacts excluding the contribution of ambient air quality) air pollutant concentrations and dust deposition rates associated with all modelled scenarios were predicted to be within NSW EPA criteria and NEPM advisory reporting goals.

Taking elevated background airborne particulate matter concentrations into account, the maximum cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are in exceedance of the applicable NSW EPA criteria and NEPM advisory reporting goals, however as discussed in **Section 6**, the peak ambient concentrations are already above the goals due to the influence of extensive bushfires in late 2013. The pairing of the model predictions at each receptor with the daily varying ambient background concentrations show that no exceedances beyond those attributable to natural events would occur as a result of construction or operational emissions at the Project site.

Exceedance of the annual average NEPM advisory reporting goal for cumulative $PM_{2.5}$ is predicted for receptor R33 in each Project phase after Phase B (Scenario 4 onwards). As stated in **Section 3.2**, R33 corresponds to the former location of the DNSDC headquarters. The DNSDC facility was relocated to the new site in 2014 and consequently this receptor is no longer an existing sensitive receptor location. As the future land use at the former DNSDC site is likely to be related to the SIMTA project, receptor location R33 has been retained within this assessment for completeness.

The cumulative annual average $PM_{2.5}$ concentrations for all four project phases for the Southern site option are presented **Figure 29**, with the contribution of Project-only increment and OEH Liverpool background presented. It can be seen that the exceedance at R33 is attributable primarily to the background concentrations. As highlighted in **Section 6.2.2**, the five year $PM_{2.5}$ average concentration recorded at the OEH Liverpool station includes extreme natural events such as dust storms and bushfires and is notably higher than concentrations recorded during the same period at other locations in Sydney. The background concentration of 7.6 $\mu g/m^3$ is very close to the advisory reporting goal of 8 $\mu g/m^3$ and is the key contributing factor to the predicted exceedances at R33 (approximately 90% of total cumulative concentration at a minimum).

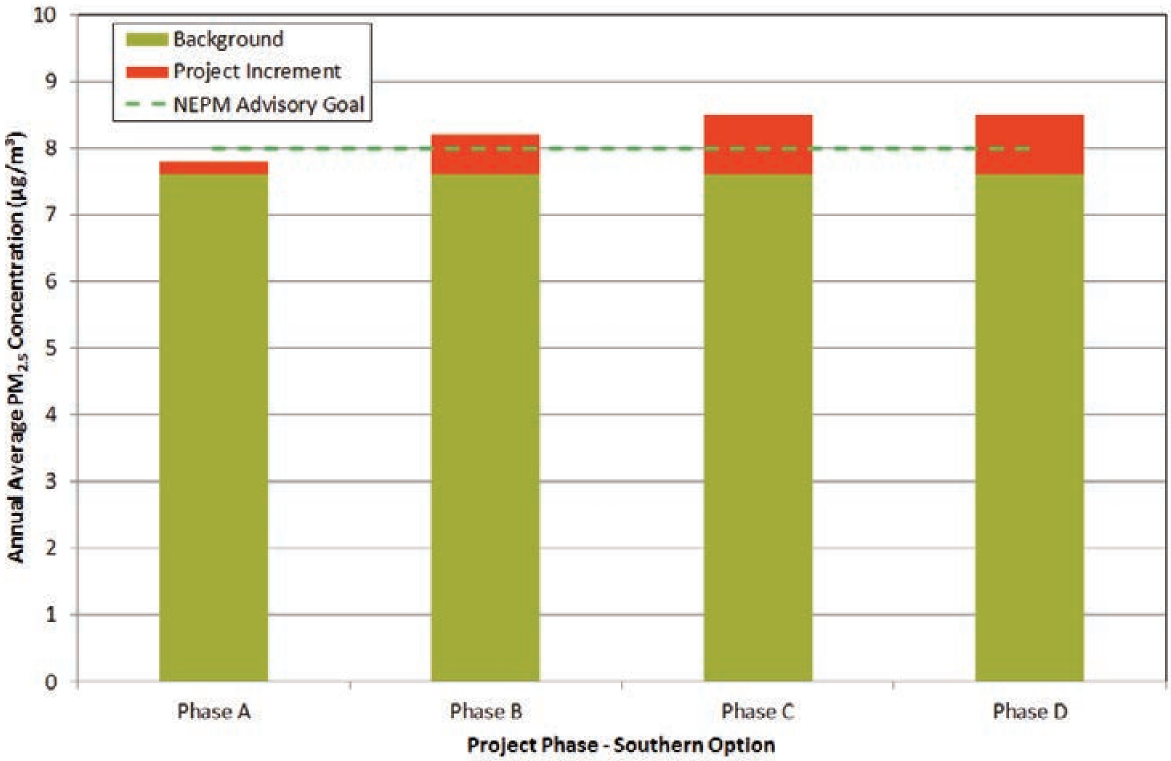

Figure 29: Contribution of Project-only increment and OEH Liverpool background to cumulative annual average $PM_{2.5}$ concentrations – Southern Option

It is considered that based on the small magnitude of incremental concentrations predicted for all pollutants assessed at all surrounding receptors and the conservative nature of emission estimates (including limited accounting for future improvement of engine emissions, adoption of older locomotive emission standards, etc.), the likelihood of adverse impacts arising from the construction and operation of the Project in the surrounding environment is very low. The difference between the air quality effects arising from the three options assessed (North, Central and South) is considered marginal.

10.2.1 Short term average concentrations

As stated in **Section 4.3** and **Section 6.2**, the NSW EPA prescribes short term (sub-hourly) air quality impact assessment criteria within the Approved Methods for Modelling. Specifically relevant to emissions from the Project are the 10-minute SO_2 criterion and 15-minute CO criterion.

The atmospheric dispersion modelling conducted within this assessment was conducted for hourly time steps. In order to assess compliance with the short term criteria, an empirical relationship, as detailed in **Section 9.6.1**, was used to adjust predicted maximum 1-hour average concentrations.

To undertake a conservative assessment of short term concentrations of SO_2 and CO. the maximum predicted incremental (Project only) 1-hour average concentrations across all modelling scenarios and receptor locations were identified and then converted to the short term averaging period (10-minute or 15-minute). **Table 29** presents the results of this conversion.

Table 29: Derived short term concentrations for SO_2 and CO – all scenarios

Pollutant	Maximum 1-hour Average Project Increment (µg/m^3)[1]	Derived Short Term Concentration (µg/m^3)		NSW EPA Criteria (µg/m^3)
		Increment	Cumulative	
SO_2	0.2	0.6	101.3	712
CO	188.9	434.0	11,934	100,000

Note: Averaging period is 10-minutes for SO_2 and15-minutes for CO.

Note 1: Maximum 1-hour average concentration presented is maximum predicted across all receptors and modelling scenarios.

It can be seen from the results in **Table 29** that the derived incremental maximum 10-minute SO_2 and 15-minute CO concentrations are significantly lower than the applicable NSW EPA criteria. Further, when the derived maximum baseline concentrations (as per **Section 6.2**) are paired with model predictions, the cumulative concentrations are also well below the short term assessment criterion.

11 Mitigation and management measures

Further assessment of the potential impacts of the Project and more detailed development of mitigation measures would be conducted during the detailed design phase of the Project, and future development assessments.

To minimise impacts arising from the Project on the receiving air environment, mitigation measures are proposed for the construction and operation phase of the Project as outlined in the following sections. Typical mitigation measures implemented during construction operations, and progressive reductions in combustion engine exhaust emissions for on road diesel trucks and locomotives accounted for in the Project predictions are documented in **Appendix B**. Other management measures outlined in this section but not accounted for in the assessment will reduce predicted Project-related impacts.

11.1 Construction phase

During construction of the Project the potential air quality impacts would be localised and occur over defined periods (lasting approximately two years per phase) between 2015 and 2030. Emissions of particulate matter (PM_{10}, $PM_{2.5}$, TSP and deposited dust) from wind erosion, material handling and transport and pollutants associated with combustion engines from heavy vehicles entering and exiting the site represent the greatest potential for air quality impacts during construction. The implementation of appropriate management practices would mitigate the extent of impacts on nearby sensitive receptors.

A Dust Management Plan (DMP) which forms part of the Construction Environmental Management Plan (CEMP) would identify triggers and procedures for the effective management of particulate emissions. The implementation of effective management practices would minimise the potential for impact. The following mitigation measures and safeguards, or equivalent, are recommended during the construction phase of the Project:

- dust minimisation measures should be developed and implemented prior to commencement of construction. The *NSW Coal Mining Benchmarking Study: Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (OEH 2011) should be referenced for best practice measures for dust management;
- methods for management of emissions should be incorporated into project inductions, training and pre-start talks;
- activities with the potential to cause significant emissions such as material delivery and load out and bulk earthworks should be identified in the CEMP. Work practices which minimise emissions during these activities should be investigated and applied where reasonable and feasible;
- a mechanism for managing complaints should be put in place for the duration of the construction phase;
- limit vehicle movements to designated entries and exits, routes, working areas and parking areas. Site exits should be fitted with hardstand material, rumble grids or other appropriate measures to limit the amount of material transported off-site (where required);

- work/site compounds and exposed areas should be screened to assist in capturing airborne particles and reduce potential entrainment of particles from areas susceptible to wind erosion;
- visually monitor dust and where necessary implement the following measures:
  - apply water (or alternative measures) to exposed surfaces that are causing dust generation. Surfaces may include any stockpiles, hardstand areas and other exposed surfaces. Regular watering should ensure that the soil is moist to achieve 50% control of dust emissions from scrapers, graders and dozers.
  - appropriately cover loads on trucks transporting material to and from the construction site. Securely fix tailgates of road transport trucks prior to loading and immediately after unloading.
  - prevent, where possible, or remove, mud and dirt being tracked onto sealed road surfaces.
- apply regular watering to internal unsealed access roadways and work areas. Application rates should be related to atmospheric conditions (e.g. prolonged dry periods) and the intensity of construction operations. Paved roads should be regularly swept and watered when necessary;
- dust generating activities (particularly clearing and excavating) should be avoided or minimised during dry and windy conditions;
- site speed limits of 20 km/hr should be imposed on all vehicles at the site;
- graders should be limited to a speed of 8 km/hr to reduce potential dust emissions;
- exposed areas and stockpiles should be limited in area and duration. For example, stage vegetation stripping or grading where possible, cover unconsolidated stockpiles, or apply hydro mulch or other revegetation applicant to stockpiles or surfaces left standing for extended periods;
- revegetation or rehabilitation activities should proceed once construction activities are completed within a disturbed area that is no longer required;
- construction plant and equipment should be well maintained and regularly serviced so that vehicle emissions remain within relevant standards;
- potentially contaminated soils should be managed to ensure that excavation works are completed during optimal dispersive conditions to minimise odourous emissions;
- emissions from the trucks should be regulated in accordance with the requirements prescribed in the NEPM (Diesel Vehicle Emissions) (NEPM 2001);
- ensure that all construction vehicles are tuned to not release excessive level of smoke from the exhaust and are compliant with OEHs Smokey Vehicles Program under the NSW Protection of the *Environment and Operations Act 1997 (POEO Act)* and POEO Regulations (2010);
- all on-road trucks to comply with the Euro 5 emission standards;
- all new off-road construction equipment meet, at minimum, the US-EPA Tier 3 emission standards for non-road diesel engines; and
- establishment of Action Response Levels (ARLs) for use with real-time dust management. These aid in the assessment of impact potential, and establish an early

warning system during adverse trends, reducing complaint potential and non-compliance issues. An ARL trigger would be a defined measurement of elevated dust levels for a prescribed period.

These mitigation measures may require extra attention during periods of adverse meteorological conditions such as during high wind events and dry weather.

11.2 Operation

Combustion engine emissions (NO_x, CO, SO_2, $PM_{2.5}$, PM_{10}, VOCs and PAHs) from locomotives, mobile LNG equipment and OTVs represent the greatest potential for air quality impacts during operation. The implementation of appropriate management practices would mitigate the potential for impacts at nearby sensitive receivers.

An air quality management plan (AQMP) for the operation of the Project would be prepared and would identify triggers and procedures for dealing with these conditions. The implementation of effective management practices would minimise the potential for impact. This section identifies the measures and safeguards, or equivalent, that are recommended during the operations of the Project.

11.2.1 On-site equipment

Operational practice mitigation measures

The following mitigation measures should include the principle of Best Available Control Techniques (BACT) and be put in place to minimise emissions to atmosphere:

- manage site traffic to ensure trucks do not queue and idle along public roads adjacent to the site. This can be achiever though the implementation and enforcement of an idling limit for trucks on site and at troubled parking area;
- investigate the possibility of reducing locomotives idling times on-site;
- optimise the use of trucks capable of transporting multiple TEU's simultaneously to achieve maximum efficiency on-site and reduce air emissions;
- vehicles should be tuned to not release excessive level of smoke from the exhaust and are compliant with OEHs Smokey Vehicles Program under the POEO Act and POEO Regulations;
- a documented testing program should be implemented at regular intervals;
- emissions from the trucks should be regulated by the NEPM (Diesel Vehicle Emissions) (NEPM 2001);
- no emission standards are available under the NSW or Federal legislative framework for locomotives. Emissions from locomotives should follow international standards, such as those provided for under United States legislation 'Final Rule: Control of Emissions of Air Pollution from Locomotives and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder' (US-EPA 2012) and should meet the Tier 2+ or above emission standard for all new locomotives entering the site; and
- no emission standards are available under the NSW or Federal legislative framework for shunting engines. Emissions from shunting engines should follow international standards, such as those provided for under United States legislation 'Final Rule: Control of Emissions of Air Pollution from Locomotives and Marine Compression-

Ignition Engines Less Than 30 litres per Cylinder' (US-EPA 2012) and should meet the Tier 2+ or above emission standard. Older locomotives should up graded to meet Tier 1 or Tier 2+ emission standards where reasonable and feasible.

Cleaner fuel technology

Proposals to implement cleaner fuels and engine technologies could significantly reduce emissions from on-site activities. It is noted that no clean fuel technologies have been incorporated into the emission calculations in this assessment, consequently further emission reductions could be achieved with the implementation of such technologies. These would be investigated at detailed design stage and may include but are not limited to:

- refrigerated on-site containers to be electrically powered;
- only hybrid cars (electric/LNG/CNG/LPG) to be used on-site;
- consideration that older diesel trucks have latest emission reduction technology installed e.g. retrofitting of particle filters, installation of catalytic convertors or replacement with newer less polluting diesel engines to ensure emissions requirements conform to the Australian Design Rule ADR80/03;
- all on-road trucks to comply with the Euro 5 emission standards;
- all new off-road construction equipment meet, at a minimum, the US-EPA Tier 3 emission standards for non-road diesel engines. US-EPA Tier 4 emission standard equipment should be adopted where available and viable;
- consideration of the use of hybrid locomotives or cleaner fuels for locomotives e.g. locomotives powered by batteries with a small diesel engine for recharging the batteries and for additional power (as currently used on the Burlington Northern Santa Fe railway, California, USA); and
- consideration of the use of fuel cells, LNG and electric powered locomotives.

Strategic planning and management

Strategic planning of the Project will benefit both local air quality in addition to increased efficiency, communications and on-site safety. The following proposals should be considered as part of an effective and integrated strategic management plan:

- investigation into the feasibility of increasing the fraction of container traffic that moves by rail;
- implementation of terminal appointment systems and appropriate time slots for site access for truck and rail deliveries to avoid unnecessary on-site air emissions during peak periods;
- minimising the potential for fluctuating demand forecasts for equipment among carriers, railways and the terminal through effective communication;
- using the latest information technologies such as Intelligent Transportation Systems (ITS) applied to transportation operations which can result in improved transportation efficiency and environmental impact; and
- consideration of the use of a virtual container yard to assist with incorporating on-site operational efficiencies to ensure on-site air emissions are minimised.

11.2.2 Miscellaneous emissions

All other on-site sources are considered minor and of minimal significance. Notwithstanding this, mitigation measures should be further investigated at detailed design stage as follows:

- all chemicals and fuels should be stored in containers as per appropriate regulations and guidelines;
- the on-site storage of fuel should be kept to a minimum;
- unloading of fuels (diesel or LNG) should be vented via return hoses that recirculate vapours from fuel receiving to delivery vessels;
- tanks to be fitted with a conservation vent (to prevent air inflow and vapour escape until a pre-set vacuum or pressure develops); and
- strategies in place to reduce usage of chemical and fuels in additional to using alternative fuel technologies as recommended in the NSW Action for Air (DECCW 2009). Particular focus should be on those products with the potential to release high levels of air toxics.

11.2.3 Odour

Based on the small scale of the proposed sewage treatment plant, intermittent localised impacts may occur but are expected to be minimal. Worse case impacts are expected to be limited to short-term events.

Odour emissions should be controlled through the implementation of Best Management Practice (BMP) .The following mitigation measures and safeguards are recommended for the operational works:

- providing covering for inlet works;
- extraction of inlet works foul air gases to a soil bed filter for treatment; and
- contingencies in place for potential loss of aeration – backup generator for power supply and storage of lime for dosing to the process units in the event that anaerobic conditions occur.

11.3 Future monitoring

It is recommended that ambient air quality monitoring is undertaken as part of the Project's construction phase. This should include, but is not limited to:

- on-site monthly dust deposition monitoring to measure dust fallout from the Project's operation at boundary points and selected sensitive receiver locations and compared to the air quality criteria;
- the existing on-site air quality monitoring station (that records continuous measurements of NO_x, PM_{10} and $PM_{2.5}$) continue to operate to ensure that the ambient air quality criteria are met. The existing station may need relocation based on site construction works and regulator recommendations;
- the existing on-site meteorological monitoring station location should be reviewed to ensure compliance with relevant Australian Standard documentation.

12 SIMTA cumulative scenario

SIMTA is proposing to develop an IMT facility on the site currently occupied by the DNSDC on Moorebank Avenue, Moorebank. In light of this, the EARs require a cumulative assessment of the impacts that would occur in the event that both projects were developed. This chapter provides a description of the approach to the cumulative impact assessment of the Moorebank IMT Project and the proposed development on the SIMTA site and the potential impacts identified from the assessment.

12.1 Approach to cumulative impact assessment with the Moorebank IMT Project and the SIMTA development

The site for the SIMTA development is to the immediate east of the Moorebank IMT Project site and the two projects would, if both approved, operate simultaneously. In accordance with the DGRs an assessment of potential cumulative impacts levels is required to assess these simultaneous operations.

The line capacity of the SSFL is likely to constrain the development and operational capacity of the two IMTs. Even assuming future upgrades are made to the line, including additional passing loops and intermediate signalling, the SSFL is likely to be capacity-constrained above a throughput of 1.7 million TEUs.

In order to assess cumulative impacts from operations at the two sites, accounting for the line capacity of the SSFL, the following three scenarios (presented in **Table 30**) have been developed:

Table 30: Cumulative Moorebank IMT and SIMTA assessment scenarios

Scenario	Moorebank IMT Project site	SIMTA Site
Cumulative Scenario 1	• 1.05 million TEUs (IMEX facility) and 0.5 million TEUs (interstate facility) throughput capacity • 300,000 m^2 Warehousing • Northern rail access option	• 300,000 m^2 Warehousing
Cumulative Scenario 2	• 0.5 million TEUs (IMEX facility) and 0.5 million TEUs (interstate facility) throughput capacity • 300,000 m^2 Warehousing • Southern rail access option	• 0.5 million TEUs (IMEX facility) throughput capacity • 300,000 m^2 Warehousing
Cumulative Scenario 3	• 0.5 million TEUs (interstate facility) throughput capacity • 300,000 m^2 Warehousing • Southern rail access option	• 1 million TEUs (IMEX facility) throughput capacity • 300,000 m^2 Warehousing

An air quality impact assessment was conducted for the SIMTA site by Pacific Environment in 2013 (PEL, 2013). The SIMTA air quality impact assessment (PEL, 2013) assumed an operational scenario of 1 million TEU throughput capacity and 300,000 m^2 of onsite warehousing. Wherever possible, that assessment has been referenced to quantify emissions and impacts arising from the SIMTA site.

These cumulative modelling scenarios accounting for possible simultaneous operations have been assessed in order to provide the local community and assessment agencies with adequate information on potential cumulative impacts of developments on these two sites.

For the cumulative scenarios it is assumed that:

- operations at the Moorebank IMT site are based on the Full Build Southern site configuration scenario;
- both sites are assumed to be operational 24 hours a day seven days a week; and
- the assessment would consider cumulative operations of the two developments at year 2030 – when both are at full build operational levels. This allows for an assessment of potential 'worst case' impacts resulting from the two developments.

12.1.1 Cumulative SIMTA emissions

It is noted that as the PEL (2013) SIMTA assessment only assessed PM_{10}, $PM_{2.5}$ and NO_2 concentrations, the cumulative modelling scenarios only give attention to these three pollutants.

Emissions from the Moorebank IMT site are based on the emission calculations for the Southern site configuration Full Build (2030 operations) presented within **Section 8**. Cumulative scenario 1 emissions are consistent with Scenario 12 emissions, while cumulative scenario 2 and 3 have reduced emissions based on the described reduction in TEU throughput capacity.

Emission rates presented for the SIMTA site by PEL (2013) have been adopted for the estimation of emissions based on the three configured cumulative scenario options (**Table 30**).

Annual emissions for the Moorebank IMT and SIMTA sources for each of the three cumulative scenarios are presented in **Table 31**. A summary of the key differences between the emission estimation factors are presented in **Table 32**.

The primary differences between the emissions inventories developed for the Moorebank IMT and SIMTA projects are attributable to differences in project design. In particular, according to PEL (2013), the SIMTA project proposes the use of Tier 3, zero idling locomotive engines, the minimisation of onsite truck idling and the use Tier 3 TEU handling equipment (sidepicks, stackers, etc), all of which are less conservative assumptions than used in the Moorebank IMT assessment. It is noted that passenger vehicles were not explicitly accounted for in the SIMTA assessment, however based on contribution of these sources to the Moorebank IMT emissions inventory, emissions from this source would be minor relative to other SIMTA sources. The use of the SIMTA assessment (PEL, 2013) emissions inventory is considered appropriate for the assessment of cumulative impacts with the Moorebank IMT project as it accounts for the specific designs of the SIMTA project.

The emissions presented in presented in **Table 31** were input into the dispersion model configured and detailed in **Section 9**. Source locations and dimensions for the SIMTA site were input as presented in the PEL 2013 assessment.

Table 31: Calculated annual SIMTA emissions

Pollutant	Annual Emission (kg/annum)	
	Moorebank IMT Site	SIMTA
Cumulative Scenario 1		
PM_{10}	7,691.0	3,752.8
$PM_{2.5}$	7,551.4	3,640.2
NO_x	262,224.4	37,843.2
Cumulative Scenario 2		
PM_{10}	3,966.7	3,856.9
$PM_{2.5}$	3,908.7	3,741.1
NO_x	123,282.6	43,046.6
Cumulative Scenario 3		
PM_{10}	2,098.2	3,960.9
$PM_{2.5}$	2,066.1	3,842.1
NO_x	66,948.2	48,250.1

Table 32: Comparison of Moorebank IMT and SIMTA air quality assessment emission factors

Emission Source	Moorebank IMT Project	SIMTA Site (PEL 2013)
On-road trucks	NSW EPA GMR Factors 2008. Idling emissions included	NSW EPA GMR Factors 2008. No idling emissions
Locomotives	US-EPA (2009) Tier 1 and Tier 2 (50-50 split). Idling emissions included	US-EPA (2009) Tier 3. Zero Idling Emissions
Switching Engines	US-EPA (2009)	Not included in project design
Forklifts	UE-EPA (2010) Tier 2	NPI via SKM Sydney Ports Assessment
Sidepicks / Stackers / Lifters	UE-EPA (2010) Tier 2	UE-EPA (2010) Tier 3
Passenger Vehicles	NPI (2008)	Not accounted for

12.2 Summary of modelling results

12.2.1 Cumulative Scenario 1

The results for the Cumulative Scenario 1 are presented within **Appendix E**. Air pollutant concentrations due solely to the combination of emissions from the two proposed operations were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedances were predicted to occur due to cumulative concentrations during Cumulative Scenario 1 activities, accounting for existing air quality:

- one additional exceedance of the cumulative 24-hour average PM_{10} assessment criterion at R33;
- five additional exceedances of the cumulative 24-hour average $PM_{2.5}$ advisory reporting goal at R33; and
- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during the Cumulative Scenario 1. Incremental (cumulative SIMTA concentration only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix F**.

12.2.2 Cumulative Scenario 2

The results for the Cumulative Scenario 2 are presented within **Appendix E**. Air pollutant concentrations due solely to the combination of emissions from the two proposed operations were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedances were predicted to occur due to cumulative concentrations during Cumulative Scenario 2 activities, accounting for existing air quality:

- one additional exceedance of the cumulative 24-hour average PM_{10} assessment criterion at R33;
- four additional exceedances of the cumulative 24-hour average $PM_{2.5}$ advisory reporting goal at R33; and
- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during the Cumulative Scenario 2. Incremental (cumulative SIMTA concentration only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix F**.

12.2.3 Cumulative Scenario 3

The results for the combined Cumulative Scenario 3 are presented within **Appendix E**. Air pollutant concentrations due solely to the combination of emissions from the two proposed operations were predicted to be within NSW EPA criteria and NEPM advisory reporting goals. The following criteria exceedances were predicted to occur due to cumulative concentrations during Cumulative Scenario 3 activities, accounting for existing air quality:

- three additional exceedances of the cumulative 24-hour average $PM_{2.5}$ advisory reporting goal at R33; and
- exceedance of the cumulative annual average $PM_{2.5}$ advisory reporting goal at R33.

No other exceedances were predicted across the remaining sensitive receptors for all pollutants assessed during the Cumulative Scenario 3. Incremental (cumulative SIMTA concentration only) isopleth plots for PM_{10}, $PM_{2.5}$ and NO_x are presented in **Appendix F**.

12.3 Summary of impacts

The following key points are taken from the cumulative modelling results generated for the operations at the Moorebank IMT site and SIMTA site:

- Cumulative incremental (Moorebank IMT and SIMTA only) concentrations are below NSW EPA and NEPM advisory reporting goals at all surrounding receptor locations;
- Additional exceedance of the NSW EPA 24-hour average PM_{10} criterion and NEPM advisory reporting goal for 24-hour average $PM_{2.5}$ is predicted to occur at R33 when existing air quality is accounted for;
- Cumulative annual average (Moorebank IMT and SIMTA-only increment + background) $PM_{2.5}$ concentrations are in exceedance of the NEPM advisory reporting goal at receptor R33.
- Exceedance at R33 is attributable to the location of R33 directly amongst SIMTA site emission sources.
- No other cumulative (Moorebank IMT and SIMTA -only increment + background) pollutant exceedances are predicted for any scenario at any of the surrounding receptor locations.

Expanded discussion on these key points is provided below.

Incremental (Project-only impacts excluding the contribution of ambient air quality) air pollutant concentrations and dust deposition rates associated with all modelled scenarios were predicted to be within NSW EPA criteria and NEPM advisory reporting goals.

Taking elevated background airborne particulate matter concentrations into account, the maximum cumulative 24-hour average PM_{10} and $PM_{2.5}$ concentrations are in exceedance of the applicable NSW EPA criteria and NEPM advisory reporting goals, however as discussed in **Section 6**, the peak ambient concentrations are already above the goals due to the influence of extensive bushfires in late 2013. With the exception of 24-hour average concentration predictions for receptor R33, the pairing of the model predictions at each receptor with the daily varying ambient background concentrations show that no additional exceedance events would occur, beyond those attributable to natural events, as a result of cumulative operational emissions from the Project site and adjacent SIMTA site.

Exceedance of the cumulative 24-hour average PM_{10} EPA assessment criterion and 24-hour and annual average $PM_{2.5}$ advisory reporting goals is predicted for receptor R33. The critical factor driving the exceedances at R33 is the fact that the receptor is located within emission sources on the SIMTA site, with SIMTA emissions contributing notably to concentrations at this location. To illustrate this fact, the contribution to cumulative annual average $PM_{2.5}$ concentrations at R33 is presented in **Figure 30**. This figure shows the contribution from SIMTA is far greater than the contribution from the Moorebank IMT site at R33 and is a function of the location of R33 within SIMTA emission sources. It is therefore not considered appropriate to assess cumulative impacts at R33.

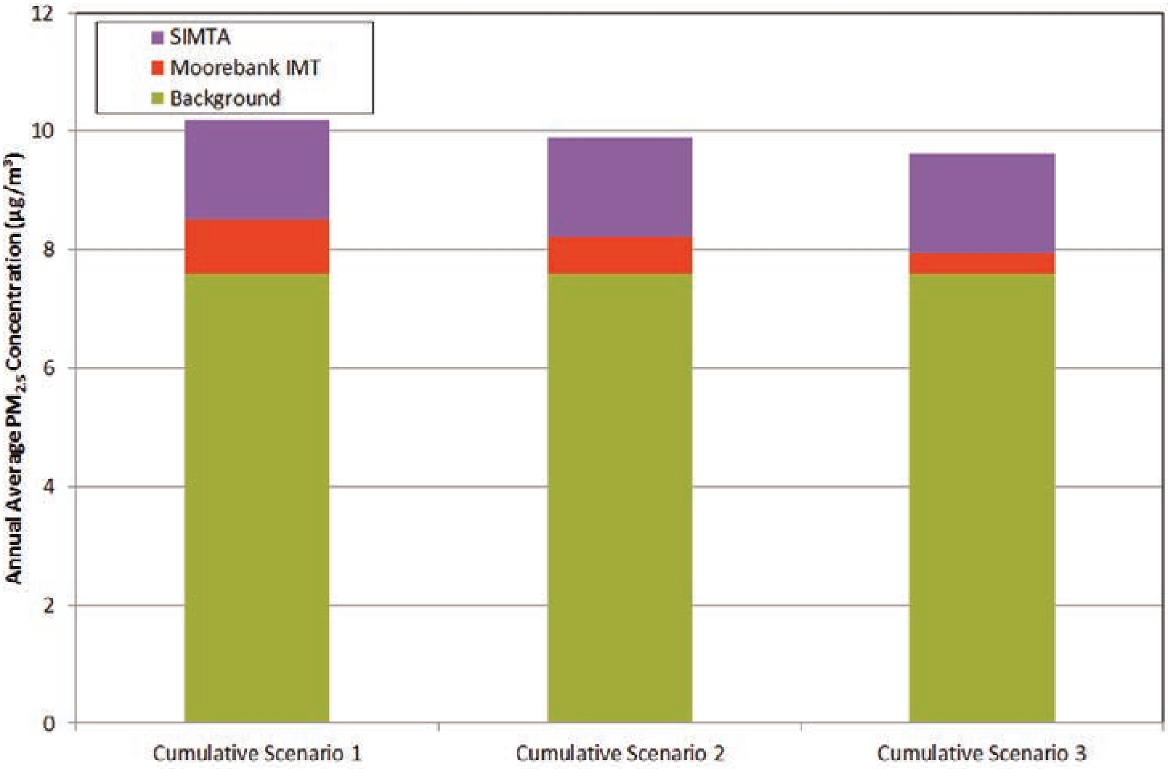

Figure 30: Contribution to annual average $PM_{2.5}$ concentrations at Receptor R33 – Cumulative Moorebank IMT and SIMTA scenarios

It is considered that based on the magnitude of incremental concentrations predicted for all pollutants assessed at all surrounding receptors, excluding R33 which is located amongst SIMTA emission sources, the likelihood of adverse impacts in the surrounding environment arising from cumulative operations at the two sites is very low.

12.4 Mitigation options

The Moorebank IMT and SIMTA projects would be responsible for the management and control of air emissions from their respective sites under Cumulative SIMTA Scenario operating conditions. In all cases the objective is for each development to meet the ambient air quality goals established as part of regulatory approvals and licensing.

The design and implementation of air quality mitigation would need to be determined for the final staged operations during the detailed design phase and, as required, be included in future environmental assessments for the Moorebank IMT Project.

The recommended air quality management and mitigation measures in **Section 11** of this report are appropriate for the management of air quality from the Moorebank IMT Project. Dependent upon the potential constraint of the SIMTA development the Moorebank IMT Project may be required to implement further air quality mitigation to comply with the relevant ambient air criteria and goals than would be otherwise required if the SIMTA development did not proceed.

In managing air emissions during operations and responding to adverse comments or complaints to air quality there would need to be regular meetings between the proponents of the Moorebank IMT and SIMTA projects to review potential simultaneous operations and where required provide coordinated management of potential issues.

13 Conclusions

This report has quantitatively assessed the potential local air quality impacts associated with the construction and operation of the proposed Moorebank IMT Project. Three potential site configuration options (northern, central and southern) were reviewed, with four emission scenarios (representing the various stages of construction and operation) configured for each.

Dispersion modelling has been used to predict off-site incremental pollutant concentrations for the Project. Cumulative impacts were assessed by the pairing these incremental predicted concentrations with ambient air quality monitoring data from on-site and nearby OEH monitoring stations. Meteorological conditions used in the dispersion modelling were largely sourced from the OEH Liverpool monitoring station. The dispersion conditions for the area were characterised using available OEH and BoM meteorological data. Dispersion modelling was conducted using the US-EPA regulatory model AERMOD with ground level concentrations predicted for impacts for NO_2, CO, PM_{10}, $PM_{2.5}$, SO_2, TSP, deposited dust, VOCs and PAHs.

The findings of the assessment are summarised as follows:

- incremental (Project-only impacts excluding the contribution of ambient air quality) air pollutant concentrations and dust deposition rates associated with all modelled scenarios were predicted to be within NSW EPA criteria and NEPM advisory reporting goals at all surrounding receptor locations;
- taking elevated background airborne PM concentrations into account, no exceedances were predicted for 24-hour average PM_{10} and $PM_{2.5}$ beyond those already recorded due to bushfire events in 2013;
- exceedance of the annual average NEPM advisory reporting goal for cumulative $PM_{2.5}$ is predicted for one receptor (R33) in each Project phase after Phase B (Scenario 4 onwards). It is noted that this receptor was relocated in 2014, however has been retained for completeness. The likely future land use at R33 would be associated with the SIMTA project. The elevated ambient background is the key contributor to these exceedances; and
- all incremental cumulative and gaseous pollutants assessed are below applicable NSW EPA assessment criterion for all scenarios,

In addition to the assessment of emissions from the Project site, modelling was conducted to account for potential cumulative impacts of operations at the Project site and potential operations at the at the adjacent SIMTA site. Three cumulative assessment scenarios were developed accounting for possible future site configurations at the two sites. The findings of this cumulative assessment are as follows:

- cumulative incremental (Moorebank IMT and SIMTA only) concentrations are below NSW EPA and NEPM advisory reporting goals at all surrounding receptor locations;
- additional exceedance of the NSW EPA 24-hour average PM_{10} criterion and NEPM advisory reporting goal for 24-hour average $PM_{2.5}$ is predicted to occur at R33 when existing air quality is accounted for;

- cumulative annual average (Moorebank IMT and SIMTA-only increment + background) $PM_{2.5}$ concentrations are in exceedance of the NEPM advisory reporting goal at receptor R33;
- exceedance at R33 is attributable to the location of R33 directly amongst SIMTA site emission sources; and
- no other cumulative (Moorebank IMT and SIMTA -only increment + background) pollutant exceedances are predicted for any scenario at any of the surrounding receptor locations.

Construction dust mitigation measures would be adopted in the Dust Management Plan to ensure that sensitive receptors are not adversely affected during construction activities. Typical dust control measures implemented during construction operations were accounted for in the assessment. Further impact reductions can be achieved by applying additional dust management measures, including the use of real-time monitoring to trigger contingency actions during dust risk periods.

An AQMP for the operation of the Project should be prepared to ensure that potential air impacts are minimised and the relevant ambient air quality criteria are complied with.

It is recommended that ambient air quality monitoring be undertaken as part of the Project's construction phase. This should include:

- on-site monthly dust deposition monitoring to measure dust fallout from the Project's operation at boundary points and selected sensitive receiver locations with reference to the air quality criteria;
- ongoing operation of the existing on-site air quality monitoring station (that records continuous measurements of NO_x, PM_{10} and $PM_{2.5}$) to ensure that the ambient air quality criteria are met. The existing station may need to be relocated depending on site construction works and regulator recommendations; and
- ongoing operation of the existing on-site meteorological monitoring station. The location of this station should be reviewed to ensure compliance with relevant Australian Standard documentation.

The results of the assessment indicate that, air quality criteria exceedances would be restricted to cumulative annual average $PM_{2.5}$ concentrations. The potential health risks associated with predicted $PM_{2.5}$ concentrations are further considered within the Human Health Risk Assessment (HHRA). Typical mitigation measures implemented during construction operations, and progressive improvements in combustion engine exhaust emissions for on-road diesel trucks and locomotives, were accounted for in the assessment. However, the application of additional management measures such as real-time dust monitoring and management during the construction phase, and the use of lower emitting equipment during the operational stages, will further reduce the predicted Project-related impacts. It is also noted that the PM_{10} and $PM_{2.5}$ concentrations predicted during this assessment are expected to be overstated if Euro VI emission standards are introduced for on-road heavy duty vehicles.

The predictive dispersion modelling demonstrates that concentrations of most pollutants (TSP, PM_{10}, NO_x, CO, SO_2, benzene, toluene, xylene, 1,3-butadiene, acetaldehyde and PAHs) emitted from the Project would be below acceptable ambient air quality criteria and would not adversely affect the receiving environment. Exceedance of the $PM_{2.5}$ advisory reporting goals are predicted, but only at a receptor location that is marked for the SIMTA development.

Where the Moorebank IMT Project operates simultaneously with operations at the proposed SIMTA site, the air impacts are predicted to be greater than for the operation of the Moorebank IMT Project alone. It is considered that the improvement of engine standard compliance for the truck (Euro VI) and locomotive (minimum Tier 2) fleets servicing the Project would significantly reduce impacts associated with $PM_{2.5}$.

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15 Glossary of Acronyms And Symbols

$\mu g/m^3$	Micrograms per cubic metre
ha	Hectare
km/hr	Kilometres per hour
mg/m^3	Milligrams per cubic metre
m	Metre
m^2	Square metres
ppb	Parts per billion
ppm	Parts per million
ABB	Asea Brown Boveri
AMG	Australian Map Grid
AERMOD	AMS/US-EPA regulatory model
AQMP	Air Quality Management Plan
ARI	Annual Recurrence Interval
AWS	Automatic Weather Station
BACT	Best available control technology
BMP	Best management practice
BoM	Bureau of Meteorology
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEC	Department of Environment and Conservation
DECCW	Department of the Environment, Climate Change and Water
Deposited dust	Any particulate matter that falls out from suspension in the atmosphere. This measurement is expressed in units of mass per area per unit time (e.g. g/m^2/month).
DGRs	Director General's Requirements
Defence	Department of Defence
DoE	Department of Environment
DoFD	Department of Finance and Deregulation
EARs	Environmental Assessment Requirements
EIS	Environmental Impact Statement
Fugitive dust	Dust derived from a mixture of sources (non-point source) or not easily defined sources. Examples of fugitive dust include dust from vehicular traffic on unpaved roads, materials transport and handling, and un-vegetated soils and surfaces.
GFA	Ground floor area
GMR	Greater Metropolitan Region
IAC	Impact assessment criteria
IMEX	Import/export
IMT	Intermodal Terminal
ITS	Intelligent Transportation Systems
ISC	Industrial Source Complex model
ITV	In-terminal vehicle
L	Monin-Obukhov length
LGA	Local Government Area
LNG	Liquefied Natural Gas
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Ambient Air Quality) Measure. National Environment Protection Measures are broad framework-setting statutory instruments defined under the (National Environment Protection Council (New South Wales) Act 1995). They outline agreed national objectives for

	protecting or managing particular aspects of the environment. NEPMs are similar to environmental protection policies and may consist of any combination of goals, standards, protocols, and guidelines.
NHMRC	National Health and Medical Research Council
NMHC	Non-methane hydrocarbons
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NSW	New South Wales
NSW DP&E	NSW Department of Planning & Environment
NSW EPA	NSW Environment Protection Authority
Nuisance dust	Dust which reduces environmental amenity without necessarily resulting in material harm. Nuisance dust comprises particles with diameters nominally from about 1 millimetre to 50 micrometre (microns).
OEH	Office of the Environment and Heritage
OEH	Office of Environment and Heritage
OLM	Ozone Limiting Method
Organic compounds	Organic compounds include (but not limited to) reactive organics, VOCs, SVOCs (semi), NHMC and PAHs
OTV	On the road trucks
PAHs	Polycyclic Aromatic Hydrocarbons
PM	Particulate matter
PM_{10}	Particulate matter less than or equal to 10 µm in aerodynamic diameter.
$PM_{2.5}$	Particulate matter less than or equal to 2.5 µm in aerodynamic diameter.
POEO Act	Protection of the Environment and Operations Act (1997)
POEO Regulations	Protection of the Environment and Operations Regulations (2010)
Project	Moorebank Intermodal Terminal
REL	Reference Exposure Level
RMG	Rail mounted gantry
SIMTA	Sydney Intermodal Terminal Alliance
SME	School of Military Engineering
SO_2	sulphur dioxide
SSD	State significant development
SSFL	South Sydney Freight Line
STP	Sewerage Treatment Plant
SWC	Sydney Water Corporation
TEOM	Tapered Element Oscillating Microbalance
TEU	Twenty foot equivalent unit
TSP	Total Suspended Particulates
TVOC	Total volatile organic compounds
UTM	Universal Transverse Mercator
VOCs	Volatile organic compounds