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CABRAMATTA LOOP PROJECT

ENVIRONMENTAL IMPACT STATEMENT

TECHNICAL REPORT 3 —
AIR QUALITY IMPACT ASSESSMENT

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CABRAMATTA LOOP PROJECT

TECHNICAL REPORT

TECHNICAL REPORT 3 —

AIR QUALITY IMPACT ASSESSMENT

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Australian Rail Track Corporation

Cabramatta Loop Project

Environmental Impact Statement

Technical Report 3 - Air Quality Impact Assessment

August 2019

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Glossary

Term	Definition
AQIA	Air Quality Impact Assessment
Ausplume	A software implementation of the Gaussian plume dispersion model based on the Victorian Environment Protection Authority's *Plume Calculation Procedure* (EPAV 1985)
AWS	Automated Weather System
BoM	Bureau of Meteorology
CALMET	CALMET is a meteorological model which includes a diagnostic wind find generator containing objective analysis and parameterized treatments of slope flows, kinematic terrain effects, terrain blocking effects , and a divergence minimization procedure, and a micro-meteorological model for overland and overwater boundary layers
CALPUFF	CALPUFF is a non-steady-state Lagrangian Gaussian puff model contain modules for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation.
CO	Carbon monoxide
HC	Hydrocarbons
NO	Nitrogen monoxide
NO_2	Nitrogen Dioxide
O_3	Ozone
OEH	Office of Environment and Heritage
Pasquill-Gifford	Stability classification used in atmospheric dispersion models to define the turbulent state of the atmosphere
$PM_{2.5}$	Particulate matter (airborne dust) with a size of 2.5 micrograms
PM_{10}	Particulate matter (airborne dust) with a size of 10 micrograms
Project	The construction and operation of the Cabramatta Loop.
Project site	Refers to the area that would be directly disturbed by construction of the project (for example, as a result of ground disturbance and the construction of foundations for structures). It includes the location of construction activities, compounds and work sites, and the location of permanent operational infrastructure.
SO_2	Sulfur dioxide
TAPM	TAPM is an air pollution model that predicts three-dimensional meteorology and air pollution concentrations
TSP	Total Suspended Particles – airborne dust
µg/m3	Microgram per metre cubed
UTM	Universal Transverse Mercator coordinate system

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Executive Summary

Australian Rail Track Corporation proposes to construct and operate a passing loop for up to 1,300 metre length trains on the Southern Sydney Freight Line between Sydney Trains' Cabramatta and Warwick Farm stations. The Cabramatta Loop Project would allow freight trains to pass and provide additional rail freight capacity along the SSFL.

An air quality assessment of construction and operational activities associated with the project has been undertaken. A conservative construction dust assessment was undertaken based on typical construction equipment. The assessment concluded that there may be short term air quality impacts within 25 metres of the project boundary.

The operational assessment considered three situations that accounted for five operating scenarios corresponding to the existing 2018 scenario and future build and no build for years 2023 and 2033. Operational air quality impacts are not anticipated for any pollutants except for annual average $PM_{2.5}$. The exceedance is attributable to the existing sources rather than the project operations. Operational air quality impacts from the Project were not deemed to be significant.

Specific mitigation measures to reduce the impact form the construction and operation of the project have been recommended.

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1. Introduction

1.1 Overview

Australian Rail Track Corporation (ARTC) proposes to construct and operate a passing loop for up to 1,300 metre length trains on the Southern Sydney Freight Line (SSFL) between Sydney Trains' Cabramatta and Warwick Farm stations. The Cabramatta Loop Project ('the project') would allow freight trains to pass and provide additional rail freight capacity along the SSFL.

The project is State significant infrastructure in accordance with Division 5.2 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, the project needs approval from the NSW Minister for Planning and Public Spaces.

This report has been prepared to accompany the environmental impact statement (EIS) to support the application for approval of the project, and address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 17 May 2018.

1.2 The project

1.2.1 Location

The project is generally located within the existing rail corridor between the Hume Highway and Cabramatta Road East road overbridges in the suburbs of Warwick Farm and Cabramatta. In addition, the project includes works to Broomfield Street adjacent to the rail corridor in Cabramatta.

The rail corridor is owned by the NSW Government (RailCorp) and leased to ARTC.

The location of the project is shown on Figure 1.1.

1.2.2 Key features

The key features of the project include:

- new rail track – providing a 1.65 kilometre long section of new track with connections to the existing track at the northern and southern ends
- track realignment – moving about 550 metres of existing track sideways (slewing) to make room for the new track
- bridge works – constructing two new bridge structures adjacent to the existing rail bridges over Sussex Street and Cabramatta Creek
- road works – reconfiguring Broomfield Street for a distance of about 680 metres between Sussex and Bridge streets.

Ancillary work would include communication upgrades, works to existing retaining and noise walls, drainage work and protecting/relocating utilities. In addition, minor works in the form of new signalling would be installed at a number of locations within the rail corridor (indicative locations provided in the EIS).

The key features of the project are shown on Figure 1.2.

Further information on the project is provided in the EIS.

Figure 1.1 Location of the project

Figure 1.2 Key features of the project

1.2.3 Timing

Subject to approval of the project, construction is planned to start in early 2021, and is expected to take about two years. Construction is expected to be completed in early 2023.

It is anticipated that some features of the project would be constructed while the existing rail line continues to operate. Other features of the project would need to be constructed during programmed weekend rail possession periods when rail services along the line cease to operate. Possession periods typically occur for 48 hours four times per year.

1.2.4 Operation

The project would operate as part of the SSFL and would continue to be managed by ARTC. ARTC is not responsible for the operation of rolling stock. Train services are currently, and would continue to be, provided by a variety of operators.

Following the completion of works, the existing functionality of Broomfield Street would be restored, with one travel lane in each direction, kerb-side parking on both sides and a shared path on the western side of the street.

1.3 Purpose of this report

The purpose of this report is to assess the potential air quality impacts from the operation and construction of the proposal. This air quality assessment addresses the relevant SEARs for the EIS, as outlined in Table 1.1 and the comments of EPA on the SEARs as outlined in Table 1.2.

Table 1.1 SEARs relevant to this assessment

Requirements	Where addressed in this report
3(2)Assessment of Key Issues	
For each key issue the Proponent must: (a) Describe the biophysical and socio-economic environment, as far as it is relevant to that issue (b) Describe the legislative and policy context, as far as it is relevant to the issue (c) Identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts (d) identify, describe and quantify (if possible) the impacts associated with the issue, including the likelihood and consequence (including worst case scenario) of the impact (comprehensive risk assessment), and the cumulative impacts (e) detail how likely impacts that have not been avoided through design will be minimised, and the predicted effectiveness of these measures (against performance criteria where relevant)	Section 2 Section 1.4 Section 6 Refer to the EIS Section 7
4. Air Quality	
1. The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines.	Section 6.1 and 6.2
2. The Proponent must ensure the AQIA also includes: (a) Demonstration of compliance with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation (2010);* and (b) a cumulative local and regional air quality impact assessment.	Section 2.1 Section 6.2 Construction impacts; and Section 6.3 Operational impacts
3. The Proponent must assess potential environmental impacts from the excavation, handling, storage on site and transport of the waste particularly with relation to sediment/leachate control, noise and dust.	Section 6.1 Construction impacts; and Section 6.2 Operational impacts
Current guidelines	
• *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) • *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC, 2005) • Technical Framework – *Assessment and Management of Odour form Stationary Sources in NSW* (DEC, 2006)	Section 3
12. Health and Safety	
1. The proponent must assess the potential health impacts of the project, in accordance with the current guidelines.	Section 6 and Section 7

The *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC, 2005) was not considered relevant as no sampling was undertaken as part of this scope of works. The Technical Framework – *Assessment and Management of Odour from Stationary Sources in*

NSW (DEC, 2006) was not considered relevant as odour was regarded as an insignificant emission from the project.

Table 1.2 EPA Air Quality Assessment comments

Comments	Where addressed in this report
The EPA notes that the SEARs require the proponent to undertake an air quality assessment for construction and operational phases of the project. The EPA recommends that the assessment includes:	
a. An assessment of the impact of exhaust emissions from locomotive and other motorised equipment being operated on the project site, including locomotives idling on the network	Section 6
b. Measures to control and minimise locomotive exhaust emissions including best practice locomotive emissions performance for in-service e locomotives, and measures to limit the need for locomotives to idle on the network, and to minimise the impact of exhaust emissions from idling locomotives.	Section 7

1.3.2 Structure of this report

The structure of the report is outlined below:

- **Section 1 – Introduction:** This section introduces the project and describes the site.
- **Section 2 – Existing environment**: This section describes the existing environmental characteristics of the site relevant to the air quality assessment.
- **Section 3 – Regulatory requirements:** This section provides an overview of air quality criteria.
- **Section 4 – Project emissions**: This section details the estimated emission rates emitted from the construction and operation of the project.
- **Section 5 – Methodology**: This section outlines the assessment methodology and process followed to synthesize meteorology for the project site.
- **Section 6 – Impact Assessment:** This section presents a summary of the construction and operational pollutant impact assessment results.
- **Section 7 – Mitigation**: This section provides an overview of the proposed air quality mitigation measures undertaken during the project.
- **Section 8 – Conclusion**: This section presents a summary of the air quality findings and sets out the principal conclusions for the assessment.

1.4 Legislative and policy context to the assessment

The relevant legislation and government guidance for the air quality assessment of the potential impacts of the project are:

- *Protection of the Environment Operations Act 1997*
- *Protection of the Environment Operations (Clean Air) Regulation 2010*
- *National Environment Protection (Ambient Air Quality) Measure (2015)* (Air NEPM)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) (Approved Methods)

The *Protection of the Environment Operations (POEO) Act 1997* provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Companies and property owners are legally bound to control emissions from construction sites under the POEO Act. Activities undertaken onsite must not contribute to environmental degradation, and pollution and air emissions must not exceed the standards.

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) provides regulatory measures to control emissions from motor vehicles, fuels, and industry. The project would be operated to ensure it complies with the Clean Air Regulation.

The Air NEPM sets national standards for the six key air pollutants to which most Australians are exposed: Carbon monoxide (CO), Ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead and particulates. Under the Air NEPM, all Australians have the same level of air quality protection.

The Approved Methods lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW. It considers the above-mentioned legislation and constructs pollutant assessment criteria.

1.5 Methodology

The air quality assessment involved the following tasks:

- A desktop review of site plans, aerial photographs and topographic maps undertaken to gain an understanding of the existing environment in terms of local terrain, existing/proposed operations and sensitive receptors within the study area.
- The applicable air quality assessment criteria was outlined.
- A review of available background air quality in the local area was undertaken using Office of Environment and Heritage (OEH) air quality monitoring data.
- Meteorological modelling was undertaken to gain understanding of the local wind climate for use as model input for conducting atmospheric dispersion modelling.
- A construction emissions inventory was created to include emissions to air from the construction of the project (primarily particulates).
- An operational emissions inventory was created to include locomotives on the project using the report *Diesel Locomotive Fuel Efficiency and Emissions Testing: Prepared for NSW EPA* (ABMARC, 2016) and National Pollutant Inventory (NPI) emission factors.
- Dispersion modelling to predict construction and operational impacts at nearby receivers in the study area using regulatory approved models was undertaken.

General mitigation measures were provided for construction and operation of the proposal to mitigate potential impacts which could arise as a result of the project.

1.6 Assumptions

This air quality assessment relied upon the following assumptions:

- Emissions from construction activities are undertaken based on an overview of the proposed construction methodology and were characterised using generic emission factors published in the *Western Regional Air Partnership Fugitive Dust Handbook* (WRAP) (Countess Environmental, 2006).
- Locomotive movements were provided by ARTC.

- Locomotive emission rates sourced from the *Diesel Locomotive Fuel Efficiency and Emissions Testing*: *Prepared for NSW EPA* (ABMARC, 2016) and National Pollutant Inventory (NPI) emission factors. Locomotive alternator power output for operation at each notch was sourced from a diesel locomotive emissions report prepared by Lilley (1996).
- Notch settings are based on locomotive speeds determined by analysis of driver route diagrams provided by ARTC.
- Operational characteristics and likely operational scenarios of the loop are supplied by the project team.
- Modelling assumptions are provided in Section **6** of this report.

2. Existing Environment

2.1 Existing background air quality

2.1.1 Regional sources of air pollution

The National Pollution Inventory (NPI) provides public information about the emissions in specific regions in Australia. The NPI is implemented and enforced by the NSW EPA. The regulation requires industrial facilities in NSW to report the types and amount of certain substances being emitted. It is then collated and uploaded in the NPI database.

The 2016/2017 reporting period is the most recent available NPI data in the area. A 25 by 25-kilometre)search (the approximate modelling domain) for possible sources of air pollution in the area found 85 facilities, including landfill, sewage treatment, brick plant, paper manufacturing, animal feeds manufacturing and waste recycling. The total emissions are summarised in Table 2.1 while the complete list of search results from the NPI database are shown in Appendix B. Among these facilities, only AGL Kemps Creek Landfill Cogeneration, PPG Villawood and Weston Animal Nutrition Enfield reported PM_{10} emissions.

Table 2.1 Emissions by substance from NPI search in 2016/2017 reporting period

Pollutants	Emission (Kg)	Number of facilities
PM_{10}	22,197	3
$PM_{2.5}$	578	1
Oxides of Nitrogen	87,543	19
Carbon monoxide	1,216,944	34
Sulphur dioxide	110,649	41
Benzene	91.4	5

Ambient air pollutant concentrations recorded at Liverpool and Chullora OEH stations include emissions from all regional sources. Cumulative assessment of all regional sources of air pollution are accounted for by including the ambient air quality concentrations measured at the Liverpool and Chullora OEH stations and adding them to incremental site impacts.

2.1.2 Local sources of air pollution

The project site is situated in a mixed residential and commercial area. Contributions to air quality are deemed to be predominantly from local sources. Sources of air pollution in the immediate vicinity (within 1 km) of the project site include the following emissions:

- vehicle emissions especially from the primary highways such as Hume Highway, Horsley Drive, Elizabeth Drive and Newbridge Road
- suspended dust along roadways, characterized by pulverized pavement materials, particles from brake lining and tyres
- residential emissions such as domestic products (e.g. garden fertilizer, paint) as well as fuel combustion from domestic machineries such as lawn mowers, air-conditioning, etc.
- fugitive dust and diesel emissions from existing rail movements along the network between Warwick Farm and Cabramatta Stations
- secondary particulate emissions from freight and passenger train movement (i.e. wheel and brake action on rail lines, wagon turbulence in the rail corridor and windblown particulates).

2.1.3 Climate

BoM provides climatological data on the nearest monitoring station to the project at the Bankstown Airport (site 066137). The station is located approximately 4.75 kilometres east of Warwick Farm Station. Historical data at the Bankstown Airport weather station have been used to characterise the climate of the area and are presented in Table 2.2.

The annual average daily minimum and maximum temperatures are 12 °C and 23.3 °C, respectively. On average, January is the hottest month with an average daily maximum temperature of 28.4 °C. July is the coldest month, with an average daily minimum temperature of 5.1 °C.

Rainy days usually occurred during the months of late spring (November) through summer and early autumn (March). February was observed to have the highest mean rainfall of 102 millimetres while July was observed to have the lowest mean rainfall of 43 millimetres.

The annual average rainfall is 872 millimetres, which occurred over an average of 82 days a year.

Table 2.2 Historical meteorological data at Bankstown Airport BoM Weather Station

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)[a]	28.4	27.9	26.4	23.8	20.6	17.8	17.3	19	21.7	23.9	25.4	27.5	23.3
Mean minimum temperature (°C)[a]	18.2	18.2	16.3	12.8	9.4	6.8	5.1	6	8.7	11.8	14.4	16.7	12
Mean rainfall (mm)[a]	91.8	102.1	98.7	84.5	64.7	80.7	43.1	49.5	43.9	58.4	76.5	67.5	871.8
Mean number of days of rain ≥ 1 mm[a]	8	7.9	8.5	6.7	6.7	6.8	5.2	4.6	5.4	6.7	8	7.1	81.6
Mean 9 am wind speed (km/h)[b]	8.2	7.4	6.6	6.7	6.7	6.6	6.6	9	10.3	10.6	9.7	9.1	8.1
Mean 3 pm wind speed (km/h)[b]	20.9	19	17.6	15.3	12.9	13.6	14.1	17.6	19.9	20.9	21.6	22.6	18
Mean 9 am relative humidity (%)[b]	72	77	77	75	79	80	78	70	64	62	67	67	72
Mean 3 pm relative humidity (%)[b]	54	57	55	54	55	55	50	44	45	48	52	51	52

a – Historical data from 1968 to 2018
b – Historical data from 1968 to 2010

2.1.4 Existing air quality

The NSW OEH operates ambient air quality monitoring stations in selected areas around NSW. The nearest station to the site is Liverpool, however Chullora has been included as it contains background data for SO_2.

Daily pollutant average and maximum ambient concentrations for the modelled year (2013, see section 5.2.1 for a discussion on why 2013 was selected as the most appropriate representative year) are presented in Table 2.3.

Table 2.3 Ambient air quality daily concentrations (2013)

Pollutant concentrations		OEH monitoring site	
		Liverpool	Chullora
SO_2	Average (µg/m^3)	-	2.6
	Maximum (µg/m^3)	-	31.4
NO	Average (µg/m^3)	18.4	17.2
	Maximum (µg/m^3)	290.3	413.3
NO_2	Average (µg/m^3)	20.7	24.4
	Maximum (µg/m^3)	105.3	103.4
O_3	Average (µg/m^3)	29.4	27.4
	Maximum (µg/m^3)	229.3	205.8
CO	Average (µg/m^3)	0.5	0.3
	Maximum (µg/m^3)	4.6	4.0
PM_{10}	Average (µg/m^3)	21.0	18.3
	Maximum (µg/m^3)	98.5	69.4
	70th percentile (µg/m^3)	25.2	20.6
$PM_{2.5}$	Average (µg/m^3)	9.4	8.4
	Maximum (µg/m^3)	73.8	49.1
	70th percentile (µg/m^3)	10.8	9.5

'-' denotes data not sampled at the site

The maximum recorded PM_{10} and $PM_{2.5}$ background concentrations at the Liverpool OEH station exceed the assessment criteria (assessment criteria further explained in section 3). Background concentrations of all other pollutants were below the assessment criteria. The top 10 measured PM_{10} and $PM_{2.5}$ concentrations at the nearest station (OEH Liverpool) are provided below in Table 2.4. These are used for a cumulative assessment of operational particulate impacts. Days when the measured value already exceeds the criteria are removed from the dataset when assessing compliance with impact assessment criteria.

Table 2.4 Top ranked PM_{10} and $PM_{2.5}$ concentrations

Rank	Date	PM_{10} concentration (µg/m^3)	Date	$PM_{2.5}$ concentration (µg/m^3)
Impact assessment criteria	50		25	
1	21/10/2013	**98.5**	21/10/2013	**73.8**
2	04/09/2013	**52.8**	28/04/2013	**27**
3	08/11/2013	**50.4**	19/10/2013	24.8
4	22/10/2013	44.7	08/11/2013	24.3
5	06/09/2013	44.1	03/11/2013	22.9
6	07/11/2013	42.6	13/07/2013	22.2
7	19/10/2013	40.6	10/06/2013	22.2
8	10/09/2013	39.9	28/07/2013	21.8
9	10/01/2013	38.6	26/07/2013	21.6
10	12/01/2013	38.6	12/07/2013	21.3

Additional data including graphs for the data are provided in Appendix C.

2.2 Sensitive receptors

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2016) defines sensitive receptors as locations where people are likely to work or reside and may include a dwelling, school, hospital, office or recreation areas.

The project is located in a mixed urban area. The land adjacent to the rail corridor is predominantly residential and recreational with smaller sections of business and general industrial.

Due to the extent of the project, there are many nearby sensitive receptors. Rather than identifying all sensitive receptors, representative sensitive receptors closest to the project footprint have been chosen. It is expected that the closest receptors will experience the worst-case air quality impacts. If potential air quality impacts from the project comply with the impact assessment criteria at the nearest receptors, then those situated at a greater distance will also likely comply. Contour maps of predicted emissions show results for all locations within the study area.

The location of the representative sensitive receptors to the site are presented in Table 2.5 along with the coordinates and receptor type. The location of representative sensitive receptors at the site is shown ion Figure 2.1.

Table 2.5 Representative sensitive receptors locations

Receptor	X Coordinate (m)	Y Coordinate (m)	Description	Address
R01	309421	6247617	Cabramatta station	Cabramatta
R02	309339	6247492	Cabramatta Inn	170 Cabramatta Rd
R03	309413	6247369	Residential	106 Broomfield St
R04	309318	6247261	Residential	228 Railway Pde
R05	309369	6247091	Residential	4 Broomfield St
R06	309273	6246981	Cabramatta Smash Repairs	240 Railway Pde
R07	309332	6246834	Residential	168 Broomfield St
R08	309214	6246713	Cabramatta Rugby League Club	24 Susses St
R09	309262	6246378	Jacquie Osmond Reserve	1 Hume Hwy
R10	309186	6246331	Stroud Park	Warwick Farm
R11	309213	6246095	Peter Warren Skoda	13 Hume Hwy
R12	309145	6246025	Lawrence Hargraves School	3 Station St
R13	309181	6245870	Peter Warren Honda Automotive Service	13 Hume Hwy
R14	309108	6245846	Residential	3 Station St
R15	309168	6245774	Peter Warren Mercedes-Benz	13 Hume Hwy

Paper Size ISO A4

0 70 140 210 280

Meters

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1966
Grid: AGD 1966 ISG 56 1

N

Australia Rail Track Corp Ltd
Cabramatta Rail Loop
Air Quality Assessment

Project No. **22-19800**
Revision No. **0**
Date **07/08/2019**

Site and sensitive receptor locations

FIGURE 2.1

G:\22\19800\GIS\Maps\2219800_CabramattaLoop\AirQualityAssess_0.aprx\2219800_AQ001_Site_Receptor_Location_0
Print date: 07 Aug 2019 - 11:21

Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

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3. Air quality criteria

3.1 Project impact assessment criteria

Assessment criteria has been taken from the Approved Methods. These criteria should be met at existing or future off-site sensitive receptors. The assessment criteria is provided as cumulative impacts, where the predicted impact of the project is added to the background levels in order to assess the pollutants impacts. To determine the level of air quality impacts, emissions from the project must be assessed against the assessment criteria as shown in Table 3.1.

Table 3.1 Impact assessment criteria (Approved Methods, 2016)

Pollutant	Averaging period	Percentile	Assessment criteria ($\mu g/m^3$)
TSP	Annual	100th	90
PM_{10}	24 hour	100th	50
	Annual	100th	25
$PM_{2.5}$	24 hour	100th	25
	Annual	100th	8
CO	15 minute	100th	100,000
	1 hour	100th	30,000
	8 hour	100th	10,000
NO_2	1 hour	100th	246
	Annual	100th	62
SO_2	10 minute	100th	712
	1 hour	100th	570
	24 hour	100th	228
	Annual	100th	60
Benzene	1 hour	99.9th	29

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4. Project emissions

4.1 Emissions overview

Air quality may be impacted by a number of pollutants, each of which has different emission sources and effects on human health and the environment. The air quality assessment of the project focuses on the highest-risk impacts with the potential to occur during the construction and operation of the project.

This section details the anticipated air emissions from the construction and operation of the project.

4.2 Construction phase

Pollutant emissions

Dust and particulate matter was identified as the primary emission to air during the construction of the project. Other air emissions such as combustion products (e.g. vehicle exhaust) will also be present during construction and maintenance activities. The combustion exhaust emissions from vehicles, plant and equipment are expected to be insignificant compared to existing combustion engine emissions from road and rail traffic.

Construction and maintenance vehicles are expected to travel along the alignment and resulting emissions will be discontinuous, transient, and mobile. Particulate (TSP, PM_{10} and $PM_{2.5}$) emissions from the exhaust of mobile plant and stationary engines are accounted for in the emission factors for earthmoving and handling (emissions factors further discussed in Section 4.2.1) used in the air quality assessment. Therefore, combustion vehicle exhaust emissions have not been considered further in this assessment.

It is expected that all maintenance works undertaken will involve little or minor dust generating activities, be infrequent and short in duration. Dust generation from maintenance works is considered insignificant and not further assessed in this report.

Emission activities

Construction activities that generate dust include earthworks and the handling and transfer of earth and other material.

The key features of the project that could generate dust include:

- new rail track – providing a 1.65 kilometre long section of new track with connections to the existing track at the northern and southern ends
- track realignment – moving about 550 metres of existing track sideways (slewing) to make room for the new track
- bridge works – constructing two new bridge structures adjacent to the existing rail bridges over Sussex Street and Cabramatta Creek
- road works – reconfiguring Broomfield Street for a distance of about 680 metres between Sussex and Bridge streets
- compounds and work areas within the project
- minor works in the form of new signalling would be installed at a number of locations within the rail corridor outside the project site.

Plant, equipment and activities likely to generate dust include:

- use of earth working plant including excavators, bull dozers and front end loaders

- trucks dumping soil and aggregate
- drilling
- scraper/Graders
- wheel generated dust from vehicle movements on unsealed surfaces.

Ancillary work would include communication and signalling upgrades, works to existing retaining and noise walls, drainage work and protecting/relocating utilities.

4.2.1 Emissions inventory

Dust emissions from construction activities have been calculated using recommended particulate emission factors for general construction operations. The derived emission rates were characterised using recommended emission factors for average conditions published in the *Western Regional Air Partnership Fugitive Dust Handbook* (WRAP) (Countess Environmental, 2006). These emissions factors are calculated assuming standard earth moving operations. Based on the project description, it is anticipated that actual construction activities will only involve infrequent moderate earthworks.

Total suspended particles and dust deposition is usually assessed against annual criteria however, these criteria are less relevant to the project as construction works would be transient and short term. The primary emission of concern during the construction phase was found to be dust as PM_{10}. As a result, for this project, air quality was assessed in terms of distances at which the relevant criteria are achieved at any time.

The dust emission factors used in the construction assessment are provided in Table 4.1. The emission factors have been sourced directly from literature where applicable, however where TSP and $PM_{2.5}$ emission factors were not provided, the following assumptions were made (assumptions taken from WRAP, 2006):

- TSP/PM_{10} ratio assumed to be a factor of 2 (based on ratio for wind erosion WRAP, 2006)
- $PM_{2.5}$/PM_{10} ratio assumed to be 0.1 (based on ratio for fugitive dust from construction and demolition activities WRAP, 2006)

Table 4.1 Dust emission factors for construction activities

Construction activity	Particle size emission factors (g/m^2/s)			Source
	PM_{10}	Total suspended particles (TSP)	$PM_{2.5}$	
General and fixed construction activities	9.515E-06	1.903E-05	9.515E-07	WRAP – Recommended PM_{10} emission factors for construction operations Level 1 (Average conditions).

The following assumptions have been applied to the construction air quality assessment:

- General construction activities have been conservatively modelled as 20 (width) by 100 metre (length) areas along the length of the rail. The modelled area (20 by 100 metre area) is a representative area used to consider worst case construction impacts. It does not correspond with a specific location along the rail alignment. The 100 metre length is considered an appropriate interval to calculate the worst case air quality buffer distances from the project. Air quality impacts were assessed perpendicular from the alignment beginning at the centre and extending 50 metres outwards.

- The modelling approach considers a general worst case for any of the key features of the project identified in Section 4.2 that could create particulate emissions, and a general buffer distance from the project site was determined to meet the criteria.
- Emission factor used assume - WRAP – Recommended PM_{10} emission factors for construction operations Level 1 (Average conditions).
- Adequate water supplies will be available to undertake dust suppression watering.

4.3 Operation phase

Air quality emissions from the project are produced from locomotive movements along the track and locomotives idling.

4.3.1 Particulate matter

Emissions of particulate matter from freight trains are predominantly associated with the following:

- wheel and brake actions on rail lines
- entrainment of surface particles in the rail corridor
- combustion-related particle emissions of diesel locomotives.

However, the particulate matter emissions from wheel and brake actions, as well as entrainment of surface particles emissions are deemed minor (Parsons Brinckerhoff, 2012). They are sufficiently small such that they can be treated as insignificant and therefore have not been included in the dispersion modelling. Combustion related particle emissions were the only particulate source considered in this assessment.

4.3.2 Gaseous emissions from rail movements

Gaseous emissions associated with the operation of the project are combustion engines products from diesel freight and passenger locomotives movements along the track, and idling. Combustion engines produce emissions that predominantly comprise of the following pollutants:

- nitrogen dioxide (NO_2)
- carbon monoxide (CO)
- hydrocarbons (HC)
- sulfur dioxide (SO_2)
- particulate matter with diameter less than 10 microns (PM_{10}) and less than 2.5 microns ($PM_{2.5}$).

The quantity of the above pollutants emitted by locomotive operation depends on the following locomotive operational parameters:

- locomotive type
- locomotive speed
- locomotive notch
- locomotive movement (pass bys) frequency
- locomotive duration of idling.

4.3.3 Operational scenarios

To account for all present and future operational possibilities, the following operational scenarios provided by ARTC have been considered:

- existing (2018)
- at opening build (2023)
- at opening no build (2023)
- 10 year future no build (2033)
- 10 year future with project (2033).

The following sections outline the locomotive parameters for each of the above operational scenarios.

4.3.4 Locomotive emissions

Adopted locomotive emission rates were based on a recent investigation titled *Diesel Locomotive Fuel Efficiency and Emissions Testing: Prepared for NSW EPA* (ABMARC, 2016). The study examined the fuel efficiency and emission performance of two classes of locomotive that are commonly used in NSW freight operations. Average fuel efficiency and emission performance was available for NO_X, CO, Hydrocarbons (HC) and particulate matter.

The Approved Methods does not provide an assessment criteria for total HC. HC emissions for the purpose of this study are assumed to be benzene in order to be assessed against an appropriate impact assessment criteria. Benzene would only make up a fraction of total hydrocarbon emissions. Consequently, HC emissions were speciated into benzene emissions based on emission factors presented in the *National Pollutant Inventory emission estimation technique manual for combustion engines Version 3 (2008)*.

It is expected that most freight trains on the existing rail line and duplication would consist of locomotives like the NR Class locomotive (NR121) and 93 class locomotives (9317). Data for a 93 class locomotive (9317) was adopted to model train pass by emission rates and is a conservative scenario.

The locomotive alternator power output for operation at each notch was sourced from a diesel locomotive emissions report prepared by Lilley (1996). The emission of SO_2 was calculated based on a sulfur fuel content of 5000 ppm using an emission factor from the *National Pollutant Inventory emission estimation technique manual for combustion engines Version 3 (2008)*. $PM_{2.5}$ emissions were estimated as 0.97 times the PM_{10} emission as recommended in *Emission Factors for Locomotives (US EPA, 2009)*. The adopted locomotive emission rates are presented in Table 4.2.

Table 4.2 Locomotive pollutant emission rates (emissions per locomotive)

Operating notch	Alternator output (kW)	Pollutant					
		NO_X (g/hr)	CO (g/hr)	HC (as Benzene) (g/hr)	SO_2 (g/hr)	PM_{10} (g/hr)	$PM_{2.5}$ (g/hr)
Idle	6	317	42	0	7	6	6
1	180	3,762	193	2	221	40	38
2	335	5,695	302	2	410	54	52
3	750	14,775	1,020	5	919	143	138
4	920	16,652	2,291	6	1127	147	143
5	1,390	19,182	2,016	7	1703	167	162
6	2,000	25,200	1,940	9	2450	200	194
7	2,630	32,612	2,051	10	3222	237	230
8	2,940	29,400	3,146	11	3602	235	228

4.3.5 Locomotive speed

Locomotive speed profiles were determined through analysis of driver route diagrams on the track between Cabramatta and Warwick Farm stations. Locomotive emissions were estimated based on the speed that resulted in maximum emissions to air.

Locomotive maximum and minimum speeds are presented in Table 4.3.

Table 4.3 Locomotive maximum and minimum speeds

Scenario	Train Speed (km/hr)	
	max	min
2018 Existing	80	70
2023 At opening no build	80	70
2023 At opening with project	80	70
2033 Future no build	80	70
2033 Future with project	80	70

4.3.6 Locomotive notch

Locomotive notch setting can fluctuate significantly based on various factors including train speed and terrain incline or decline. Estimated notch settings for each operational scenario are presented in Table 4.4.

Table 4.4 Locomotive notch setting

Scenario	Notch setting	
	max	min
2018 Existing	7	6
2023 At opening no build	7	6
2023 At opening with project	7	6

Scenario	Notch setting	
	max	min
2033 Future no build	7	6
2033 Future with project	7	6

4.3.7 Locomotive movements

Locomotive movements (pass by) on both the SSFL and the Transport for NSW line were included in this assessment to account for cumulative worst case locomotive movements. Locomotive movements on the SSFL line were supplied by ARTC. A summary of SSFL freight rail movements is shown in Table 4.5.

Table 4.5 Locomotive movements on SSFL line

Scenario	Train Type	SSFL Train movements per weekday period					
		Day (7am - 10pm)		Night (10pm - 7am)		Daily	
		Up	Down	Up	Down	Up	Down
2018 Existing	Freight	6	6	4	4	10	10
2023 At opening no build	Freight	15	15	9	9	24	24
2023 At opening with project	Freight	15	15	9	9	24	24
2033 Future no build	Freight	15	15	9	9	24	24
2033 Future with project	Freight	22.5	22.5	13.5	13.5	36	36

Existing (2018) locomotive movements on the TfNSW line were taken from rail observations undertaken by GHD from 12/10/18 to 1/11/18. Future (2023 and 2033) locomotive movements on the TfNSW line were provided by ARTC based on data supplied by Sydney trains. A summary of TfNSW freight rail movements is shown in Table 4.6.

Table 4.6 Locomotive movements on TfNSW line

Scenario	Train Type	TfNSW Train movements per weekday period					
		Day (7am - 10pm)		Night (10pm - 7am)		Daily	
		Up	Down	Up	Down	Up	Down
2018	Freight					7	6
2023	Freight	5	3	2	5	7	8
2033	Freight	5	3	2	5	7	8

A cumulative summary of locomotive movements on both lines is shown in Table 4.7.

Table 4.7 Cumulative locomotive movements

Scenario	Train Type	SSFL		TfNSW		Cumulative
		Up	Down	Up	Down	
2018 Existing	Freight	10	10	7	6	34
2023 At opening no build	Freight	24	24	7	8	63
2023 At opening with project	Freight	24	24	7	8	63
2033 Future no build	Freight	24	24	7	8	63
2033 Future with project	Freight	36	36	7	8	87

Maximum hourly and daily locomotive movements are provided in Table 4.8.

Table 4.8 Locomotive pass by quantities

Scenario	Maximum locomotive pass bys in the time period		
	1 hour period (locomotives per hour)	24 hours period (locomotives per day)	24 hour period equivalent (locomotives per hour)
2018 Existing	1.5	33.6	1.4
2023 At opening no build	2.8	63	2.6
2023 At opening with project	2.8	63	2.6
2033 Future no build	2.8	63	2.6
2033 Future with project	3.8	87	3.6

4.3.8 Locomotive movement emissions

The total pollutant emissions from locomotive movements for each scenario averaged over 1 hour and 24 hour periods are presented in Table 4.9. Locomotive emissions were calculated assuming worst case notch and speed that resulted in the highest emissions. A notch of 7 and a speed of 70 km/hr was assumed.

Table 4.9 Scenario emissions rates

Scenario	Pollutant emission rate (g/s)					
	NO_X	CO	Benzene	SO_2	PM_{10}	$PM_{2.5}$
1 hour average emissions						
2018 Existing	0.39	0.025	0.00012	0.039	0.0029	0.0028
2023 At opening no build	0.72	0.045	0.00023	0.071	0.0052	0.0051
2023 At opening with project	0.72	0.045	0.00023	0.071	0.0052	0.0051
2033 Future no build	0.72	0.045	0.00023	0.071	0.0052	0.0051
2033 Future with project	0.98	0.062	0.00031	0.097	0.0071	0.0069
24 hour average emissions						
2018 Existing	0.36	0.023	0.00011	0.036	0.0026	0.0026
2023 At opening no build	0.68	0.043	0.00021	0.067	0.0049	0.0048
2023 At opening with project	0.68	0.043	0.00021	0.067	0.0049	0.0048
2033 Future no build	0.68	0.043	0.00021	0.067	0.0049	0.0048
2033 Future with project	0.94	0.059	0.00030	0.093	0.0068	0.0066

4.3.9 Idling locomotive emissions

Idling locomotive emissions have been calculated assuming that one locomotive will be idling for 30 minutes out of every hour time period. Based on discussions with ARTC, it is understood that locomotives could line up and idle at the signals at either end of the loop. To conservatively account for any idling scenario, it has been assumed that two locomotives (one at either end) will be idling for 30 minutes out of every one hour time period, 24 hours per day. It is acknowledged that this is unlikely to occur but has been included to assess worst case locomotive idling. Emissions from one idling locomotive are presented in Table 4.10.

Table 4.10 Idling locomotive emissions

Scenario	Pollutant emission rate (g/s)					
	NO_X	CO	Benzene	SO_2	PM_{10}	$PM_{2.5}$
Idling locomotive at every scenario	0.04	0.006	0.00004	0.001	0.0008	0.0008

4.3.10 Modelled situations

Three of the assessed operational scenarios (2023 At opening no build, 2023 At opening with project and 2033 Future no build scenario) result in the same emission rate. Consequently, all three scenarios will have the same impact on nearby receptors. To consolidate the results, these three scenarios have been grouped together and named ‘Situation 2’. The modelled situations in this assessment are presented in Table 4.11. These three situations include all possible scenarios in regards to emissions from the project.

Table 4.11 Modelled situations

Situation	Locomotive movement scenario	Number of idling locomotives
Situation 1	2018 Existing	2
Situation 2	2023 At opening no build, 2023 At opening with project and 2033 Future no build (all have same emissions)	2
Situation 3	2033 Future with project	2

5. Meteorology

5.1 Overview

Local meteorology including long term wind speed and direction, and atmospheric stability can influence how pollutants are dispersed into the local environment.

Site specific meteorology for the project was produced using a model called CALMET. The CALMET simulation produced a 3D wind field for the modelled year. Prognostic TAPM data was used alongside observations taken at one NSW Bureau of Meteorology (BoM) site and one Office of Environment and Heritage (OEH) site as inputs into the CALMET model. Details of the procedure undertaken to produce the site specific meteorology is outlined in the following sections.

5.2 Methodology

The characterisation of local wind patterns generally requires accurate site-representative hourly recordings of wind direction and speed over a period of at least a year.

Existing observational data is available from the Bankstown AWS (BoM ID: 66137) and Liverpool OEH sites.

In order to produce a representative site-specific meteorological data set encompassing the meteorological data from the observational site, the following methodology was applied:

- producing a 3D gridded dataset with the prognostic model TAPM
- using the TAPM 3D gridded dataset as an initial guess field for the CALMET meteorological model
- using data from the observation site (Bankstown AWS and Liverpool OEH) for surface level observations.

5.2.1 Representative year selection

An analysis of meteorological data from the nearest station in the recent five years to select a period considered most representative of ‘normal’ conditions is recommended by the NSW Approved Methods (EPA, 2016).

Monitoring stations near the project site are Bankstown Airport BoM station and Liverpool OEH Station. Both stations are less than five kilometres from the project site. A comprehensive analysis from hourly meteorological data in the recent five years for both stations were used to determine the representative year for the project study. Probability density function graphs of the wind speed and direction over the five years at these stations are provided in Appendix A.

The analysis shows that the year 2013 at Bankstown Airport BoM station is the most representative year and station based on a review of temperature, humidity, wind speed and wind direction. The year 2013 in NSW was also identified as not being excessively wet or dry.

5.2.2 Prognostic meteorology

The TAPM prognostic model was run to obtain a coarse meteorological 3D gridded dataset for the site for the selected year (2013). This dataset is based on synoptic observations, local terrain and land use information with a resolution of 1000 meters. The TAPM model parameters are summarised in Table 5.1 and are selected in accordance with the Approved Methods.

Table 5.1 Selected TAPM model settings

Parameter	Value
Modelled Year	01 December 2012 to 01 January 2014
Domain centre	Latitude: -33 degrees 54 minutes Longitude: 150 degrees 56 minutes
Site location	309254 m E; 6246586 m S Zone 55
Number of vertical levels	25
Number of Easting Grid Points	25
Number of Northing Grid Points	25
Outer Grid Spacing Number of Grids (nests)	30,000 m x 30,000 m 4
Grid Resolution	Level 1 – 30,000 m Level 2 – 10,000 m Level 3 – 3,000 m Level 4 – 1,000 m

5.3 CALMET modelling

The US EPA Approved version of CALMET (Version 5) was used to resolve the wind field around the subject site to a 200 metres spatial resolution. The application of CALMET for this purpose is an approved modelling approach in NSW as per the Approved Methods with model guidance documentation provided[1] .

Upon completion of the broad scale TAPM modelling runs, a CALMET simulation was set up to run for the model period, combining the three dimensional gridded data output from the TAPM model with the site specific surface data from the Bankstown Airport BoM station and Liverpool OEH Station. This approach is consistent with guidance documentation.

All model settings were selected based on the recommendations provided in the model guidance documentation CALMET was run using the “Hybrid” mode with the TAPM data provided as an initial guess field.

The southwest corner of the CALMET domain, or the origin, was located at UTM Zone 56 coordinates 309,254 metres east and 6246,586 metres north. The CALMET domain extended 22 kilometres to the east and north.

The CALMET domain consisted of 110 grids in both the east and north directions, with a grid resolution of 0.2 kilometre.

CALMET settings were selected as per the model guidance document for “Hybrid” mode.

The TERRAD, RMAX and R variables were set to the values presented in Table 5.2 based on an inspection of the terrain elevations in the immediate vicinity of the subject site, based on model guidance. The CALMET model parameters are summarised in Table 5.2.

Terrain and land use data used for the CALMET modelling are presented on Figure 5.1 and Figure 5.2.

[1] Barclay, J & Scire, J, 2011, Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the ‘Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia’, prepared for NSW Office of Environment and Heritage, Sydney, March 2011

Table 5.2 Summary of CALMET model parameters

Parameter	Value
Modelled period	1 January 2013 to 31 December 2013
Mode	Hybrid (NOOBS = 1)
UTM zone	56
Domain origin (south-west corner)	Easting: 309,254 m Northing: 6246,586 m
Domain size	110 x 110 at 0.2 km resolution (22.0 km x 22.0 km)
Number of vertical levels	11
Vertical levels (m)	20, 40, 60, 90, 120, 180, 250, 500, 1000, 2000, 3000
CALMET settings for hybrid mode Settings selected in accordance with (OEH, 2011)	TERRAD = 5.0 km RMAX1 = 8.0 km RMAX2 = 8.0 km RMIN = 0.1 km R1 = 6.0 km R2 = 6.0 km
Initial guess field	TAPM .m3d file used as an initial guess field for CALMET.
Surface data	Bankstown Airport BoM station E: 313.855 km N: 6245.099 Liverpool OEH Station E: 306.440 N : 6243.322
Upper air data	No site specific upper air data is utilised. Upper air data is included within the TAPM .m3d initial guess field.
Land use and terrain data	Land use data was manually developed through assessment of aerial imagery to accurately reflect the land use in the area. High-resolution terrain data was sourced from the STRM 1-second (~30 m) database.

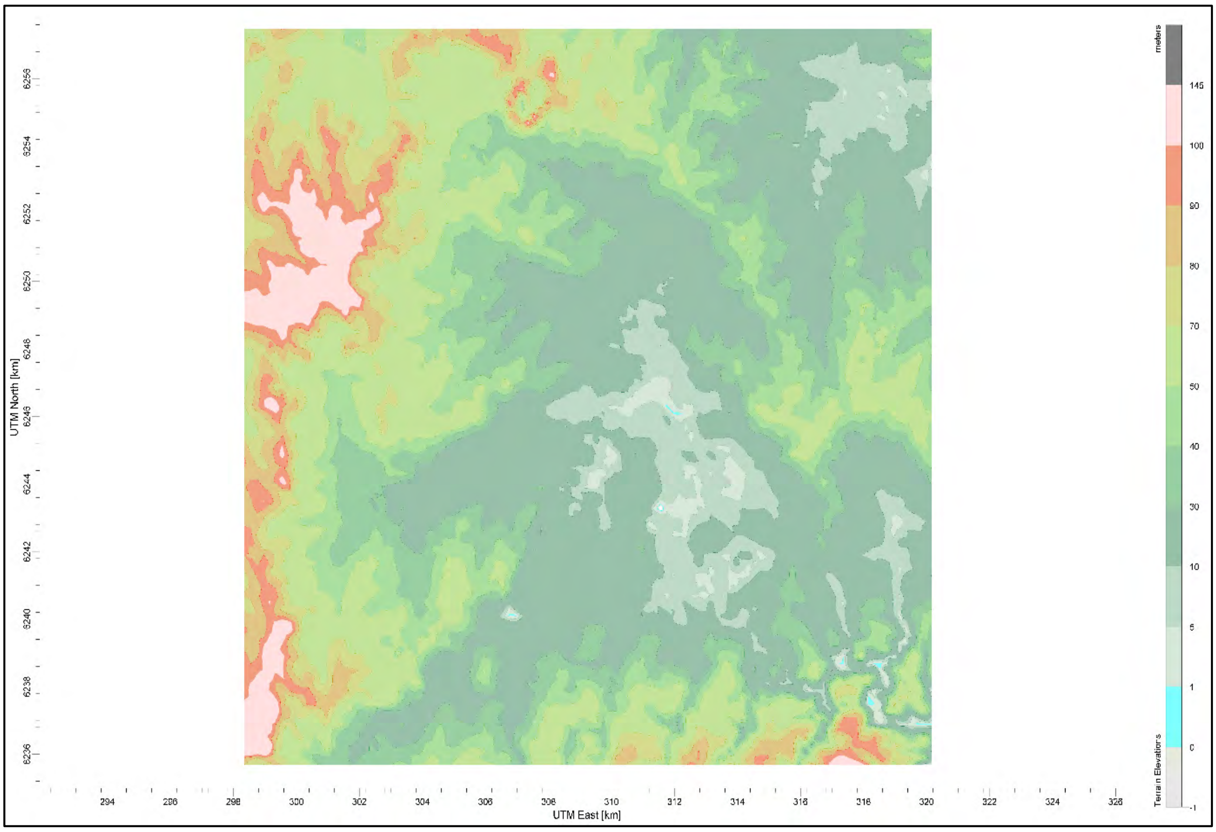


Figure 5.1 Terrain data used for CALMET modelling

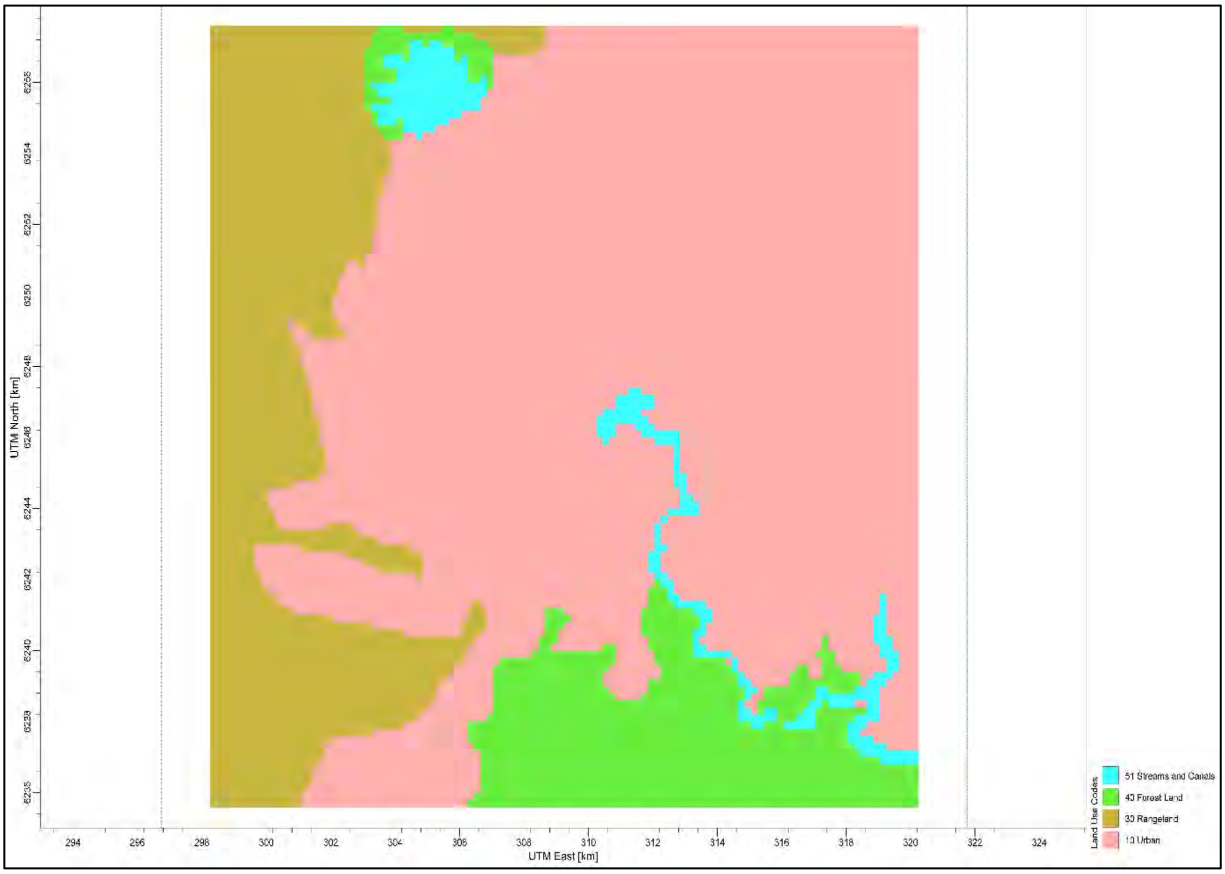


Figure 5.2 Land use data used for CALMET modelling

The local meteorology largely determines the pattern of off-site air quality impact on receptors (houses, businesses and industry). The effect of wind on dispersion patterns can be examined using the wind and stability class distributions at the site from the dataset that is produced by CALMET. The winds at the site are most readily displayed by means of wind rose plots, giving the distribution of winds and the wind speeds from these directions.

The features of particular interest in this assessment are: (i) the dominant wind directions and (ii) the relative incidence of stable light wind conditions that yield minimal mixing (defines peak impacts from ground-based sources).

5.3.1 Annual pattern in wind

The average wind rose for the entire data period taken at the project site is shown on Figure 5.3 and shows the following features:

- The predominant annual average wind directions are from the west.
- The majority of lower wind speeds (2 – 4 m/s) are from the west.
- The average wind speed measured was 3.22 metres per second
- Calms (winds speeds less than 0.5 m/s) occurred 1.35 % of the time

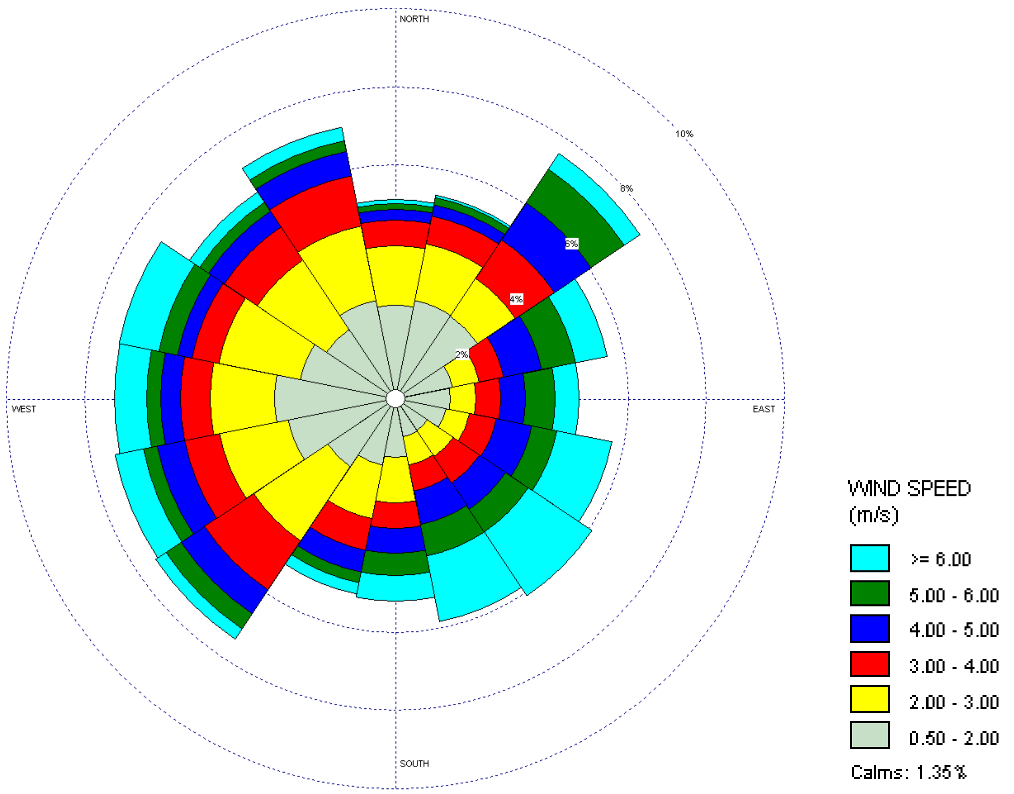
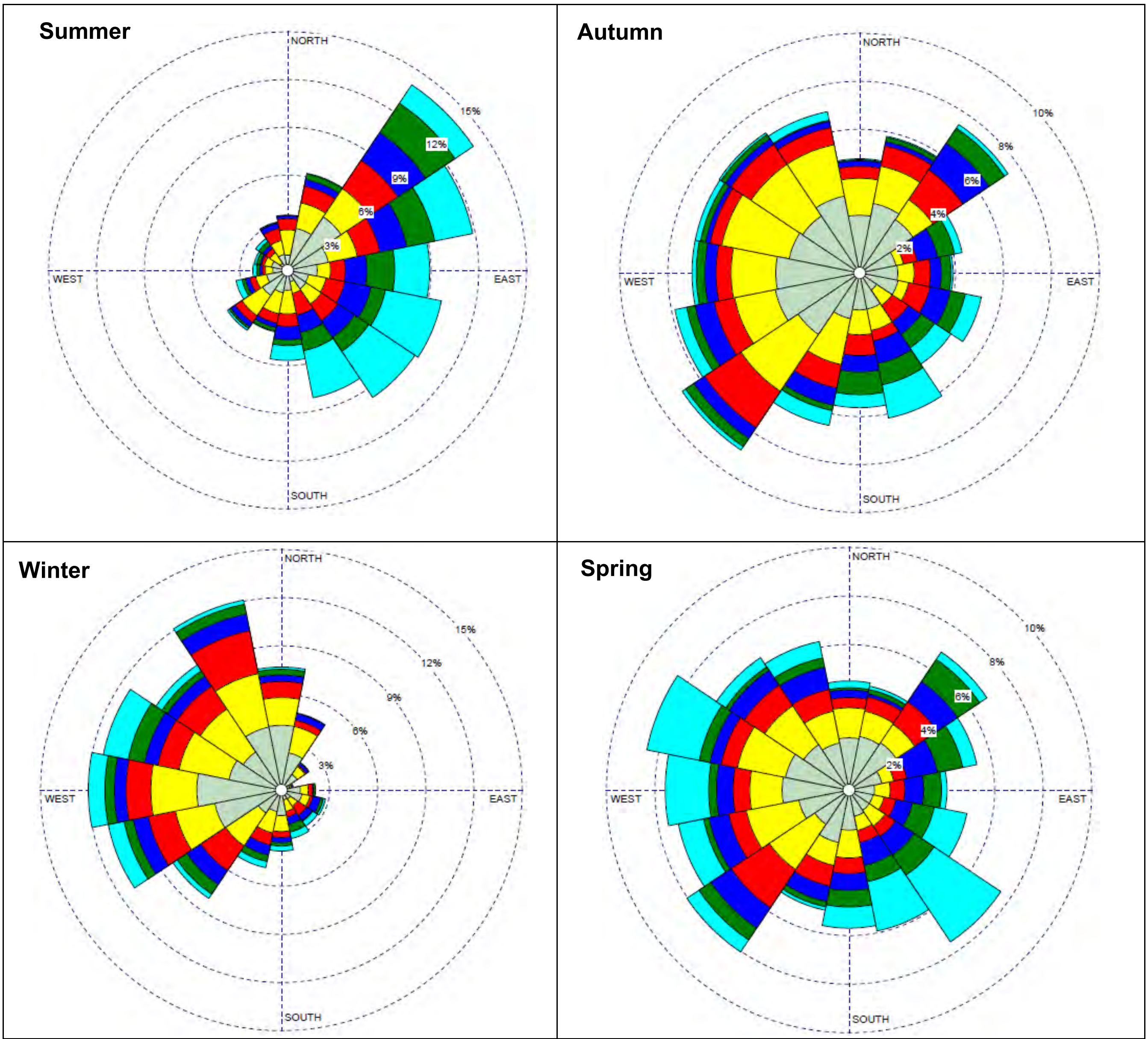


Figure 5.3 Wind rose from CALMET at site location for 2013

5.3.2 Seasonal variation in wind pattern

The seasonal wind roses for 2013 are presented on Figure 5.4 and show that:

- During summer the predominant wind direction is from the northeast and southeast.
- During winter, north westerly and westerly winds are the most dominant.
- Autumn and spring are transitional periods. During these seasons both summer and winter patterns are observed.



Season	%Complete Record	Average WS (m/s)	Calms Frequency (%)
Summer	100%	3.78	0.83
Autumn	100%	2.77	1.27
Winter	100%	2.77	1.36
Spring	100%	3.57	1.92

Figure 5.4 Seasonal wind roses for 2013

5.4 Pattern of atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability, and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and solar insolation are used to define the stability category as shown in Table 5.3, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of each stability category.

Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 5.3 Stability category relationship to wind speed, and stability characteristics

Stability category	Wind speed range (m/s) [a]	Stability characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud;
D	≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period
E	3.4 – 5.4 [b]	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds

a Data sourced from the Turner's Key to the P-G stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am)
b Assumed to only occur at night, during Net Radiation Index categories of –2.

Figure 5.5 shows the frequency of stability class for all hours of the model generated dataset. The following observations were made:

- Stable atmosphere conditions (classes E and F) occur 47 % of the time.
- Unstable atmospheres (classes A, B and C) occur about 30 % of the time.
- Neutral atmosphere conditions (class D) occur 23pe of the time.

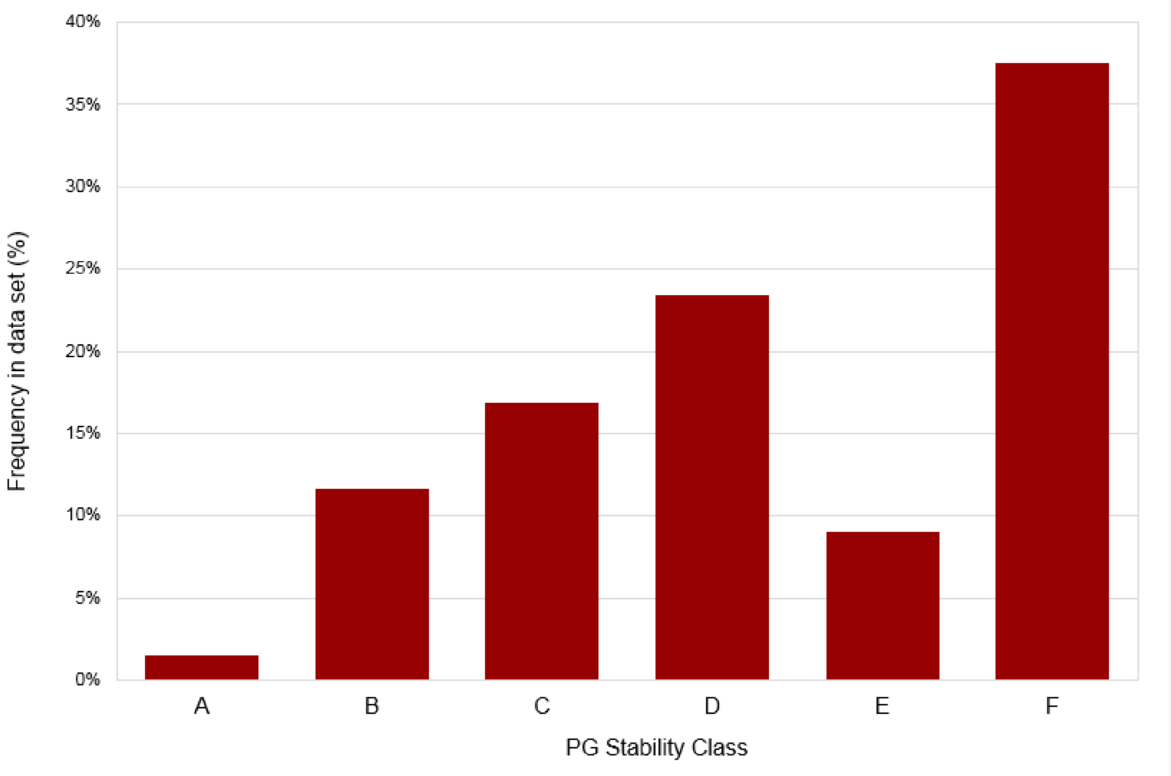


Figure 5.5 Distribution of stability class for the model period (2013)

6. Impact Assessment

This section presents the predicted air quality impacts for the construction and operation of the project.

6.1 Construction impact assessment

6.1.1 Construction model settings

Dispersion modelling for construction impacts was undertaken using AUSPLUME 6.0, a Gaussian plume dispersion model developed by the EPAV[2] to assess the impact of airborne pollutants by computationally predicting downwind concentrations for the model inputs representative of pollutant emissions at a given physical site under a range of hourly varying meteorological conditions over a period of a year or more.

AUSPLUME was chosen to model construction impacts for the project using a simple method to create concentration versus distance graphs for pollutants based on general construction activities.

Key components of the model configuration are summarised below:

- 12 month meteorological dataset was extracted at the site from the CALMET run detailed in section 5.
- Model runs were undertaken for 24 hour and annual averaging periods.
- Horizontal dispersion was parameterised according to equations for the sigma-theta curves.
- Surface roughness height of 0.6 m was used, typical of mixed commercial and residential land use.
- General construction activities have been conservatively modelled as 20 m (width) by 100 m (length) areas along the length of the rail. The 100 m length is considered an appropriate discretisation interval to calculate the worst case air quality buffer distances from the easement.
- Emission factor used assume - WRAP – Recommended PM_{10} emission factors for construction operations Level 1 (average conditions).

6.1.2 Background for construction impacts

The Approved Methods approach to assess potential particulate impacts is to add the measured hourly background concentration to corresponding predictions based on representative local measurements. Due to the length of the new rail track and the fact that construction will move along the alignment (construction of the track will not likely occur in any one location for more than a few days), another method to assess potential construction impacts has been used.

The 70th percentile concentration of PM_{10} and $PM_{2.5}$ at Liverpool OEH station has been presented in Table 2.3 for consideration in the cumulative impact assessment. It is noted that the maximum measured 24 hour average PM_{10} and $PM_{2.5}$ concentration at Liverpool OEH station exceeds the criteria in 2013. Consequently, an alternative method for the cumulative construction assessment was undertaken. The use of the Victorian Protocol for Environmental Management (PEM) (2007) method, where the maximum predicted 24-hour average project

[11] http://www.epa.vic.gov.au/air/epa/ausplume-pub391.asp

emissions are added to a 70th percentile 24-hour average background concentration of PM_{10}, was undertaken as is commonly done in Victoria and Queensland for 24 hour average criteria.

This is considered appropriate as construction-based dust emissions will be time and space variant and highly variable in emission load due to activity and localised weather conditions. This non-continuous emission rate associated with construction cannot be meaningfully assessed concurrently with a contemporaneous background at a site not representative of the local area.

6.1.3 Construction model impacts

Given the primary air quality concern during construction is dust, a screening level dust assessment was undertaken for proposed construction activities with consideration of the Approved Methods (EPA, 2016). The modelled scenario assumes construction works occurring along the rail corridor and the predicted worst-case PM_{10}, $PM_{2.5}$ and TSP concentrations are presented below as concentration versus distance graphs. The 70th percentile 24 hour background concentration was added to incremental 24 hour impacts to assess the cumulative 24 hour PM_{10} and $PM_{2.5}$ impacts (as discussed in Section 6.1.2).

Daily incremental and cumulative impacts from construction of the project are shown on Figure 6.1 and Figure 6.2. Annual incremental and cumulative impacts from construction of the project are shown on Figure 6.3, Figure 6.4 and Figure 6.5. The results indicate the following:

- All particulate concentrations (daily and annual TSP, PM_{10} and $PM_{2.5}$) are composed of high background concentration and relatively low incremental site impacts
- Daily PM_{10} and $PM_{2.5}$ criteria are met at 25 metres from and on the boundary of the construction area, respectively.
- Annual TSP and PM_{10} are met at 2 and 30 metres from the boundary of the construction area, respectively. Annual $PM_{2.5}$ results are higher than the criteria as the 9.4 µg/m^3 background concentration from the nearest station is already above the criteria.

Impact of works outside the project site

Construction works undertaken outside the project site boundary (signalling works and utility relocation and protection works) have the potential to generate dust and impact nearby receptors. It is expected that all construction works undertaken outside the boundary site will involve little or minor dust generating activities. Impacts from these works would likely be less than the above mentioned results shown in Figure 6.1 to Figure 6.5 as only small trenches would be dug for conduits and cables. Mitigation measures outlined in Section 7 should be implemented to minimise dust impacts from construction works undertaken outside the project site boundary.

6.1.4 Impact on health

It is acknowledged that a number of sensitive receptors are located within 25 metres from the project site and could experience short term elevated PM_{10} concentrations. It is expected that the location and intensity of construction works undertaken will vary significantly as the project is undertaken. Consequently, no long term impacts are expected from the project. Implementation of the mitigation measures provided in section 7 would further minimise elevated PM_{10} concentrations and reduce potential impacts. No adverse health impacts are expected.

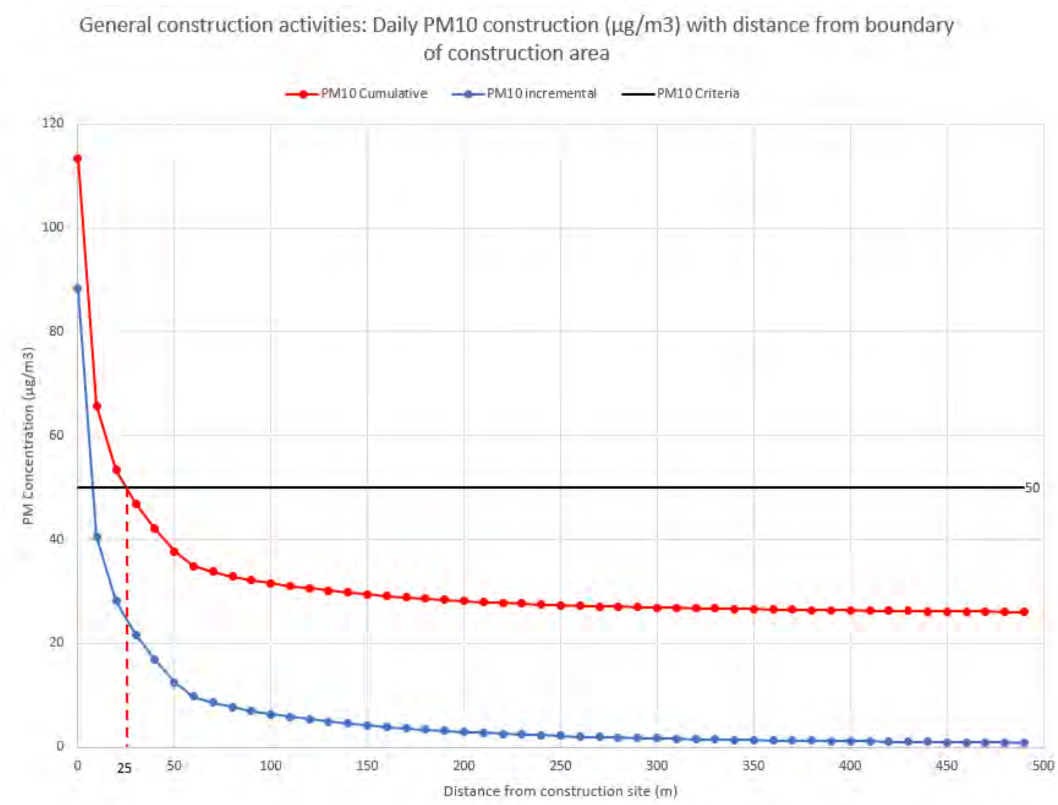


Figure 6.1 Daily PM_{10} concentrations with distance from boundary of construction area (incremental and cumulative)

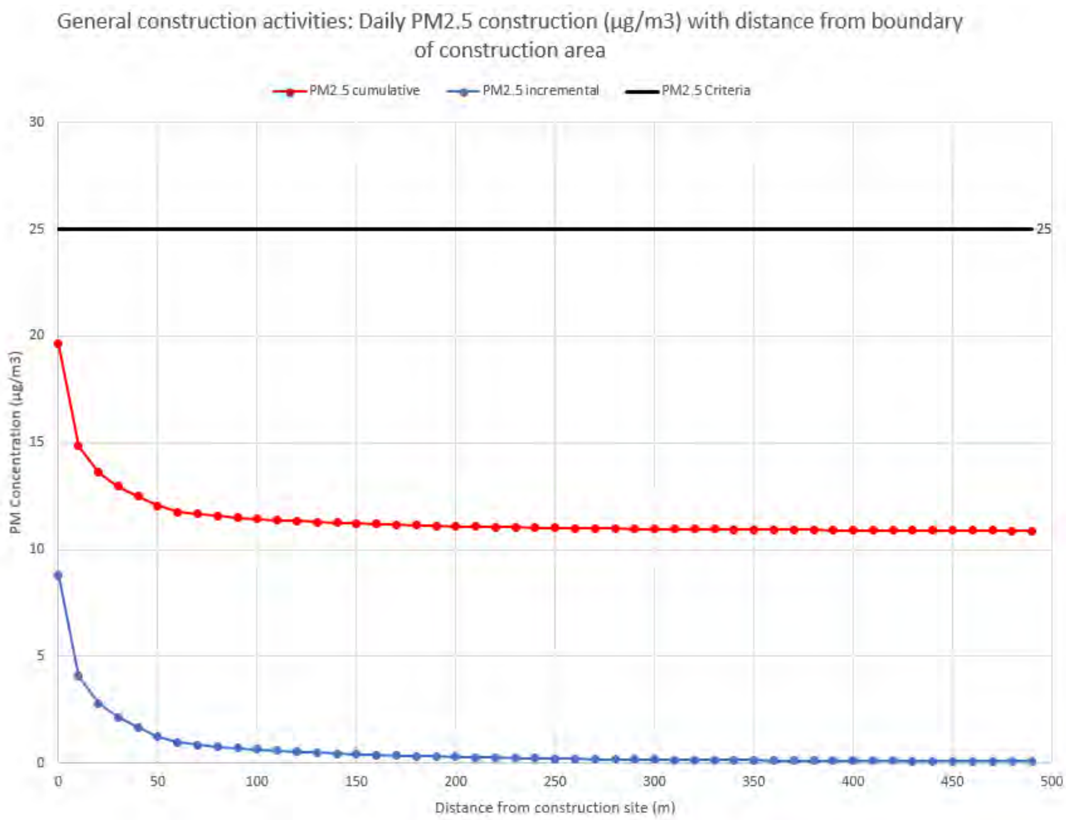


Figure 6.2 Daily $PM_{2.5}$ concentrations with distance from boundary of construction area (incremental and cumulative)

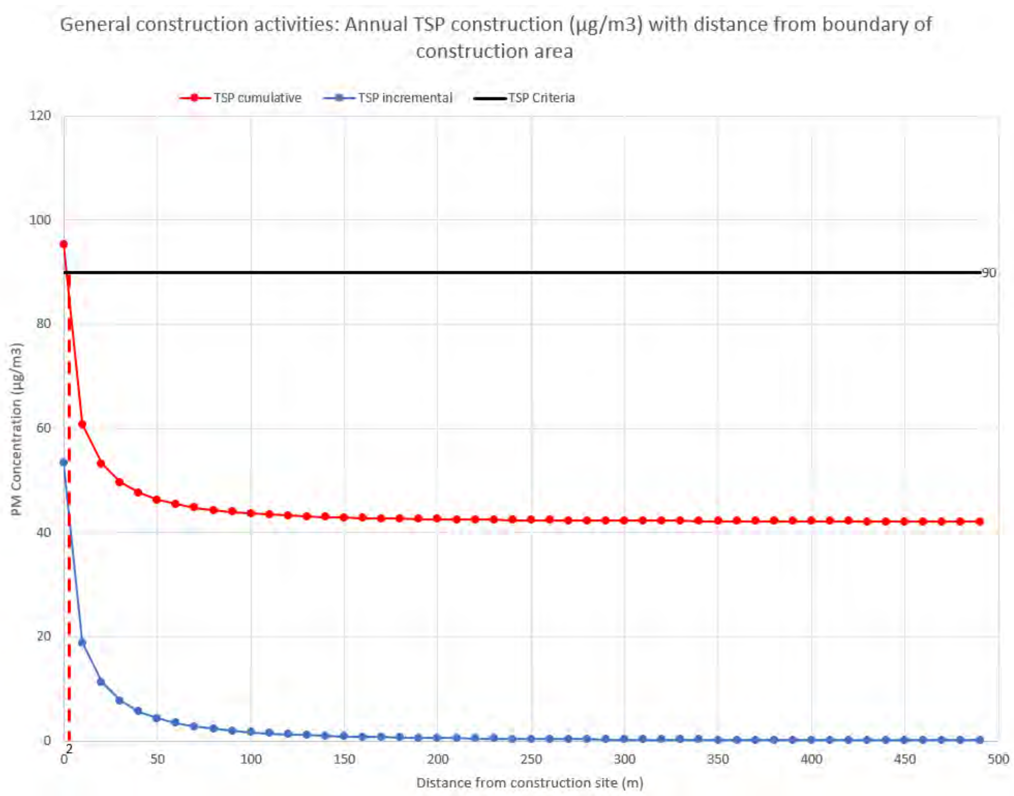


Figure 6.3 Annual TSP concentration with distance from boundary of construction area (incremental and cumulative)

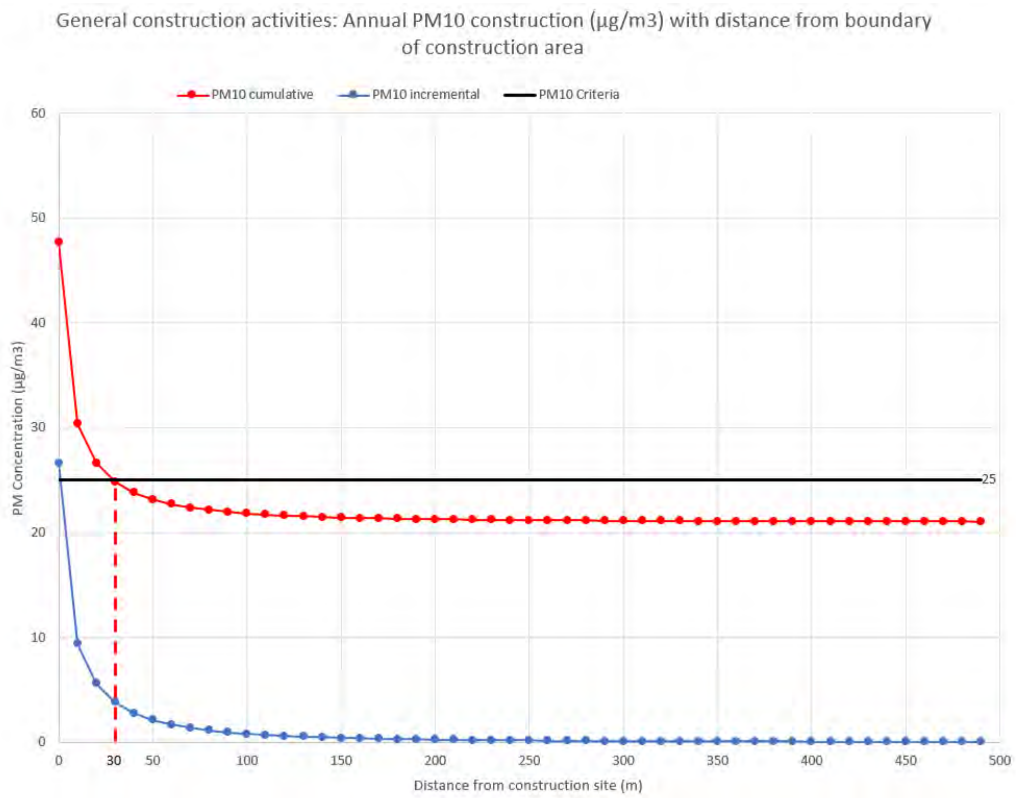


Figure 6.4 Annual PM_{10} concentration with distance from boundary of construction area (incremental and cumulative)

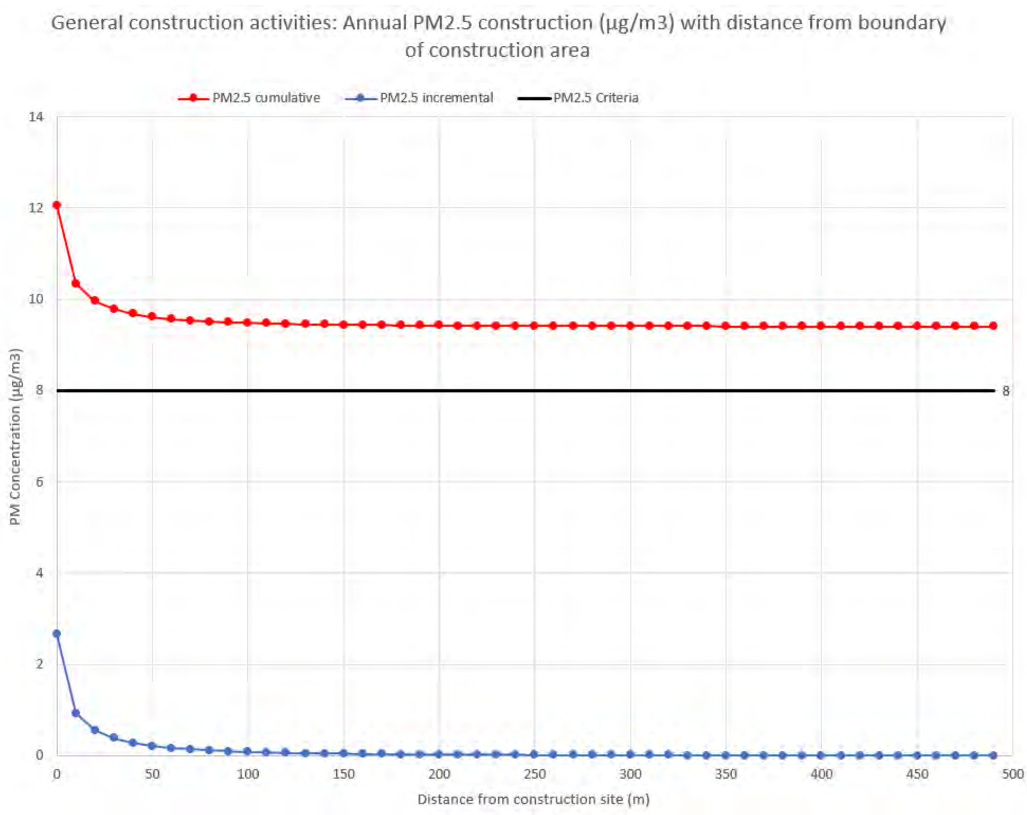


Figure 6.5 Annual $PM_{2.5}$ concentration with distance from boundary of construction area (incremental and cumulative)

6.1.5 Summary of key findings

Key findings of the construction impact assessment are:

- The primary emission of concern during the construction phase was found to be dust as PM_{10} assessed over a 24 hour averaging period.
- All particulate concentrations (daily and annual TSP, PM_{10} and $PM_{2.5}$) are composed of high background concentrations and relatively low incremental site impacts
- Daily PM_{10} and $PM_{2.5}$ criteria are met at 25 metres from and on the boundary of the construction area.

6.2 Operational impact assessment

6.2.1 Operational model settings

Atmospheric dispersion modelling was carried out using the CALPUFF version 6 dispersion model. CALPUFF is a non-steady-state, Lagrangian puff dispersion model. It is accepted for use by the OEH and NSW EPA for application in environments where wind patterns and plume dispersion is strongly influenced by complex terrain, the land-sea interface or where there is a high frequency of stable calm night-time conditions. CALPUFF was chosen to model the project locomotives along the alignment simultaneously as described below.

All model settings were selected based on the recommendations provided in the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia (2011)*.

For this assessment, the CALPUFF dispersion model was used to predict ground-level concentrations of pollutants from the proposal. The grid size used in the CALPUFF model was equivalent to the CALMET domain. The same grid resolution of 200 metre used for the CALMET model run was used in CALPUFF.

Chemical transformations were not modelled within CALPUFF, however as discussed in more detail below, the formation of NO_2 from NO_x from combustion has been assessed using Method 2 in the Approved Methods (NSW EPA, 2016). Method 2 limits the conversion of NO_x into NO_2 based on ambient ozone concentrations taking into consideration of NO reacting with ozone in the atmosphere to form NO_2. Background ozone data was sourced from the OEH station at Liverpool for the year 2013.

Assumptions

- Locomotive movements were modelled as 100 volume sources (line volume) along the passing loop and SSFL track.
- Idling locomotives were modelled as a 4.5 m tall stack.

6.2.2 Operational impacts

Locomotive emissions from Situations 1, 2 and 3 (refer section 4.3.10) were assessed to account for all existing and future scenarios. The worst case 1 hour and 24 hour emissions from each situation were modelled.

Worst case 1 hour emissions were used to assess pollutant 10 minute, 15 minute, 1 hour and 8 hour averaged criteria. Worst case 24 hour emissions were used to assess pollutant 24 hour and annually averaged criteria.

The Approved Methods include a criteria for SO_2 and CO using an averaging period of 10 and 15 minutes respectively. Due to modelling constraints, the CALPUFF model calculates concentrations at 1 hour averaged intervals. Therefore, the 10 minute SO_2 and 15 minute CO averaged concentrations have been calculated from the 1 hour averaged concentration using the peak to mean ratio shown in the equation below:

$$C_t = C_{60} \times \left(\frac{60}{t}\right)^{0.2}$$

Where;

C_t = Concentration of pollutant over averaging time t

C_{60} = Concentration of pollutant over a 60 minute averaging time

t = desired averaging time of pollutant in minutes

Cumulative pollutant concentrations have been calculated using background pollutant data from the Liverpool and Chullora OEH monitoring stations.

6.2.3 Predicted NO_2 impacts

NO_2 concentrations were predicted as incremental and cumulative annual and 1 hour 100^{th} percentile concentrations. Annual and 1 hour NO_2 concentrations were calculated using Method 2 from the Approved Methods. Hourly background NO_2 and O_3 data was sourced from the Liverpool OEH monitoring station and matched with obtained predicted hourly NOx concentrations.

Predicted NO_2 concentrations are presented in Table 6.1. No incremental or cumulative exceedances of the criteria are predicted.

Table 6.1 Predicted incremental and cumulative NO_2 concentrations

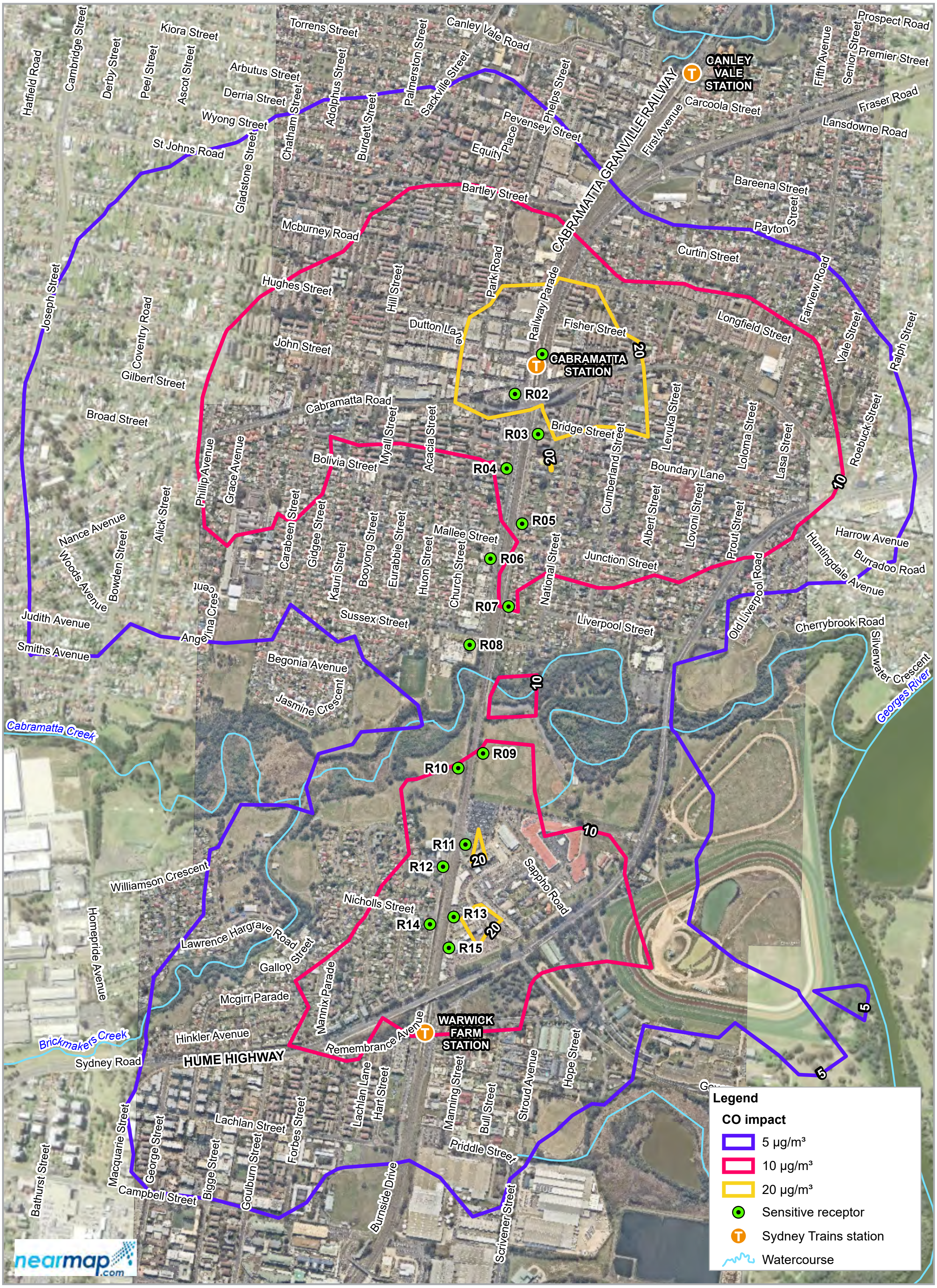
Receptor	NO_2 concentrations ($\mu g/m^3$)											
	Incremental						Cumulative					
Averaging period	1 hour			Annual			1 hour			Annual		
Situation	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Criteria ($\mu g/m^3$)	246			62			246			62		
R01	69	72	74	2	2	2	105	105	105	21	21	22
R02	57	65	78	4	6	7	109	111	112	23	25	26
R03	55	70	79	5	8	10	108	117	124	25	27	29
R04	49	78	81	4	6	7	109	111	114	23	25	27
R05	51	57	75	4	6	8	105	105	109	23	26	28
R06	49	71	79	3	5	6	108	109	113	22	24	26
R07	51	73	79	4	6	8	105	107	113	23	26	27
R08	43	77	80	2	4	5	108	111	114	22	23	25
R09	40	73	79	4	6	7	105	110	114	23	25	27
R10	40	64	78	3	5	7	108	109	112	23	25	26
R11	45	77	89	5	7	9	106	113	118	24	27	29
R12	45	62	69	4	6	8	109	110	120	23	26	28
R13	77	83	88	6	9	11	111	117	122	25	28	30
R14	53	61	68	4	6	8	109	111	117	23	26	27
R15	65	81	86	6	9	11	107	115	119	25	29	31

6.2.4 Predicted CO impacts

The predicted incremental 15 minute, 1 hour and 8 hour 100th percentile CO concentrations and cumulative 1 hour concentrations are presented in Table 6.2. The highest recorded background CO concentration of 4.6 µg/m^3 was added in predicted incremental concentration for the cumulative assessment. No incremental or cumulative exceedances of the criteria are predicted. A contour plot of the maximum incremental 1 hour CO impact during the worst case situation (situation 3) is presented on Figure 6.6.

Table 6.2 Predicted incremental CO concentrations

Receptor	Incremental CO concentrations (µg/m^3)									Cumulative CO concentrations (µg/m^3)		
Averaging period	15 minutes			1 hour			8 hours			1 hour		
Situation	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Criteria (µg/m^3)	100,000			30,000			10,000			30,000		
R01	25	33	38	19	25	29	5	9	12	24	29	34
R02	20	29	39	15	22	29	8	14	19	20	26	34
R03	16	22	30	12	17	23	6	10	13	17	22	28
R04	10	19	25	8	14	19	4	8	10	12	19	24
R05	8	15	20	6	11	15	3	5	7	11	16	20
R06	8	14	19	6	11	15	3	5	6	11	15	19
R07	7	12	16	5	9	12	3	5	7	10	14	17
R08	6	11	15	4	8	11	2	4	5	9	13	16
R09	8	14	18	6	10	14	3	6	8	10	15	19
R10	6	11	15	5	8	11	2	4	5	9	13	16
R11	9	15	21	7	12	16	4	7	10	11	16	20
R12	8	14	19	6	11	14	3	6	8	10	15	19
R13	11	17	22	8	13	17	5	9	12	13	18	22
R14	8	13	18	6	10	14	5	8	11	11	15	18
R15	12	18	24	9	14	18	6	11	15	14	18	23



Paper Size ISO A4

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1966
Grid: AGD 1966 ISG 56 1

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Cabramatta Rail Loop
Air Quality Assessment

Predicted maximum incremental 1 hour CO impact (µg/m³)

Project No. 22-19800
Revision No. 0
Date 17/04/2019

FIGURE 6.6

G:\22\19800\GIS\Maps\2219800_CabramattaLoop\AirQualityAssess_0.aprx\2219800_AQ002_CO_Hourly_Contours_0
Print date: 17 Apr 2019 - 16:51

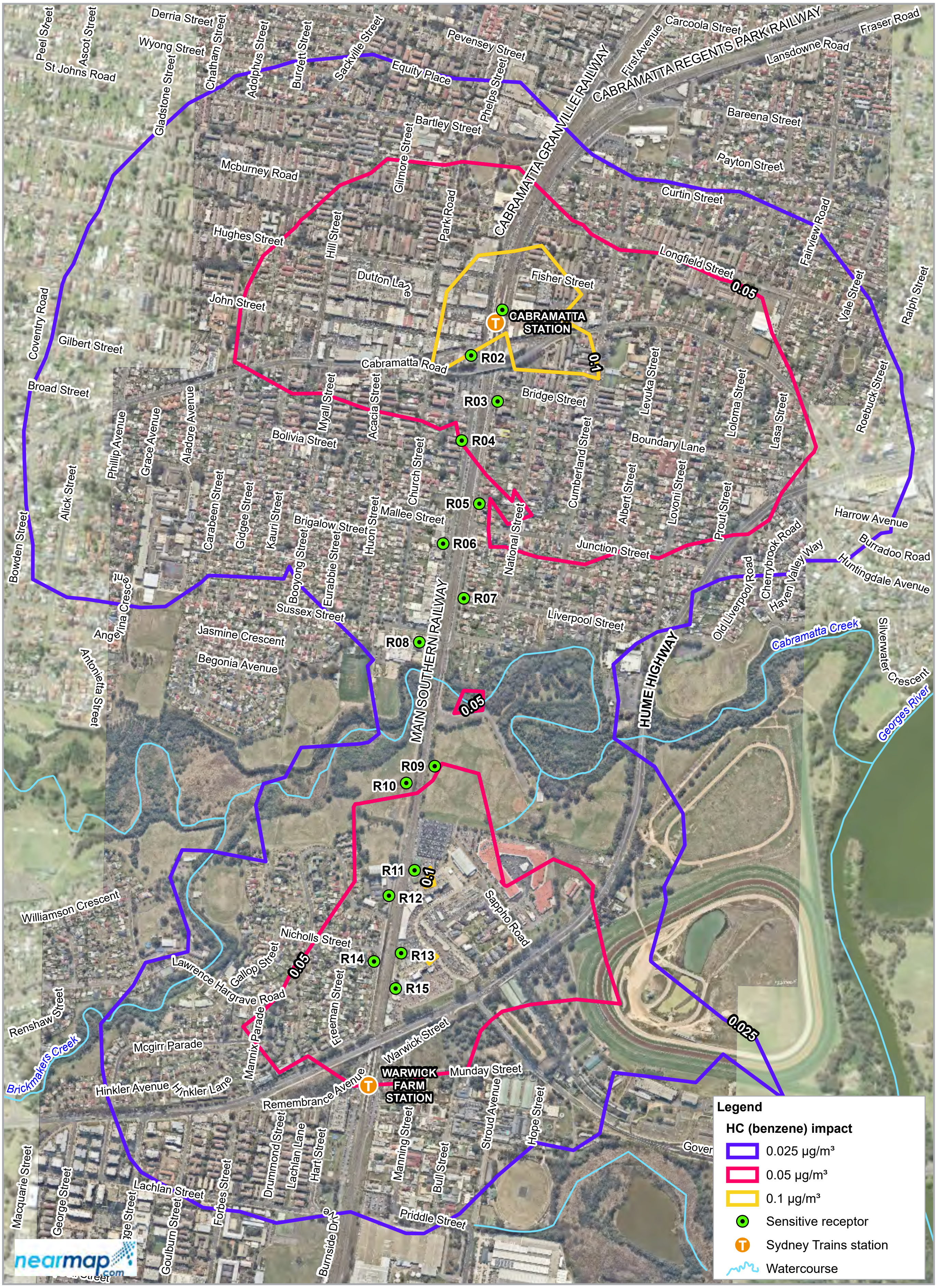
Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

6.2.5 Predicted HC (as benzene) impacts

The predicted incremental 1 hour 99.9th percentile HC concentration (as benzene) is presented in Table 6.3. No incremental exceedances of the criteria are predicted. A contour plot of predicted incremental HC (as benzene) concentrations during the worst case situation (situation 3) is provided on Figure 6.7.

Table 6.3 Predicted incremental HC (as benzene) concentrations

Receptor	HC (as Benzene) concentration ($\mu g/m^3$)		
Averaging period	1 hour		
Situation	Situation 1	Situation 2	Situation 3
Criteria ($\mu g/m^3$)	29		
R01	0.07	0.09	0.10
R02	0.07	0.09	0.13
R03	0.06	0.08	0.10
R04	0.03	0.05	0.07
R05	0.03	0.05	0.06
R06	0.02	0.04	0.05
R07	0.02	0.04	0.06
R08	0.01	0.03	0.04
R09	0.02	0.04	0.06
R10	0.02	0.04	0.05
R11	0.03	0.05	0.07
R12	0.03	0.05	0.06
R13	0.03	0.06	0.07
R14	0.03	0.05	0.07
R15	0.04	0.06	0.08
Maximum in study area	0.07	0.09	0.13



Paper Size ISO A4

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1966
Grid: AGD 1966 ISG 56 1

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Cabramatta Rail Loop
Air Quality Assessment

Predicted incremental 1 hour HC (as benzene) impact (µg/m³, 99.9th percentile)

Project No.	22-19800
Revision No.	0
Date	17/04/2019

FIGURE 6.7

G:\22\19800\GIS\Maps\2219800_CabramattaLoop\AirQualityAssess_0.aprx
\2219800_AQ003_Benzene_Hourly_Contours_0
Print date: 17 Apr 2019 - 16:51

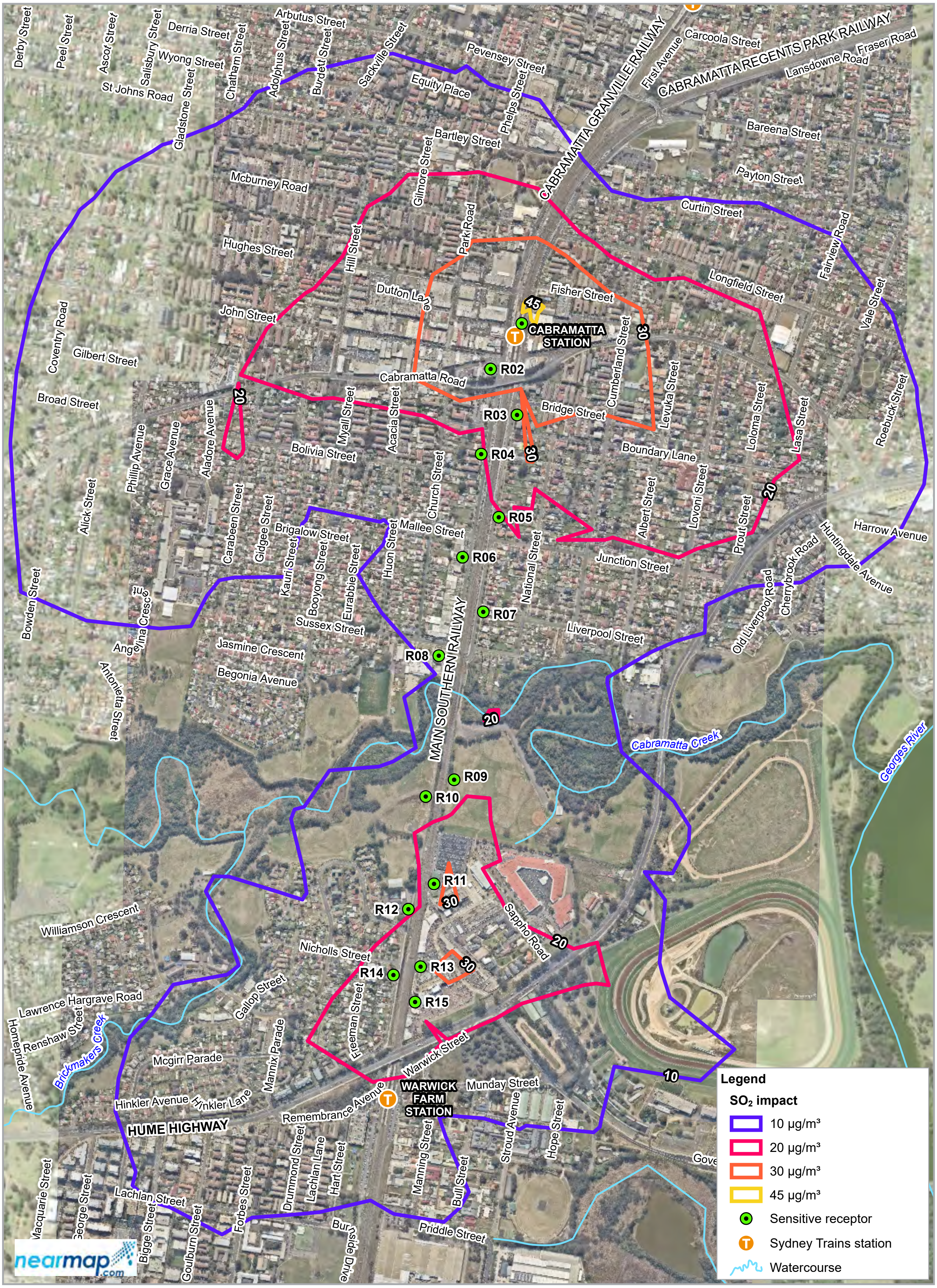
Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

6.2.6 Predicted SO_2 impacts

The predicted incremental and cumulative 100th percentile SO_2 concentrations are presented in Table 6.4. Maximum background SO_2 concentrations were obtained from the Chullora OEH monitoring station for all averaging periods. No incremental or cumulative criteria exceedances are predicted. A contour plot of predicted incremental 1 hour SO_2 concentrations during the worst case situation (situation 3) is provided on Figure 6.8.

Table 6.4 Predicted incremental and cumulative SO_2 concentrations

Receptor	SO_2 concentrations (µg/m^3)																				
	Incremental												Cumulative								
Averaging period	10 minutes			1 hour			24 hour			Annual			1 hour			24 hour			Annual		
Situation	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Criteria (µg/m^3)	712			570			228			60			570			228			60		
R01	18	34	46	13	23	32	2	4	6	0	1	1	44	55	63	10	12	14	3	3	3
R02	27	48	66	19	34	46	4	7	10	1	1	2	50	65	77	12	15	18	3	4	4
R03	21	38	52	15	27	36	4	7	9	1	2	3	46	58	68	11	15	17	4	5	6
R04	17	31	43	12	22	30	3	5	7	1	1	2	44	53	61	11	13	15	3	4	4
R05	14	25	34	10	17	24	2	4	6	1	2	2	41	49	55	10	12	14	3	4	5
R06	13	24	33	9	17	23	2	3	5	1	1	1	41	48	54	10	11	12	3	4	4
R07	11	20	28	8	14	19	2	4	6	1	1	2	39	46	51	10	12	13	3	4	5
R08	10	18	25	7	13	17	2	3	4	0	1	1	38	44	49	9	11	12	3	3	4
R09	12	22	30	9	16	21	2	4	6	1	1	2	40	47	53	10	12	13	3	4	4
R10	10	18	25	7	13	18	2	3	4	1	1	1	39	44	49	9	11	12	3	4	4
R11	14	25	34	10	17	23	2	5	6	1	2	3	41	49	55	10	13	14	4	4	5
R12	13	24	32	9	17	23	3	5	7	1	1	2	41	48	54	10	13	14	3	4	5
R13	15	27	36	10	19	25	4	7	9	1	3	4	42	50	57	12	15	17	4	5	6
R14	12	22	30	9	16	21	3	6	8	1	2	2	40	47	53	11	14	16	3	4	5
R15	16	30	40	11	21	28	4	8	12	2	3	4	43	52	60	12	16	19	4	6	7



Paper Size ISO A4

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1966
Grid: AGD 1966 ISG 56 1

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Air Quality Assessment

Project No.	22-19800
Revision No.	0
Date	17/04/2019

Predicted maximum incremental 1 hour SO_2 impact (µg/m³)

FIGURE 6.8

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Print date: 17 Apr 2019 - 16:51

Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

6.2.7 Predicted PM_{10} impacts

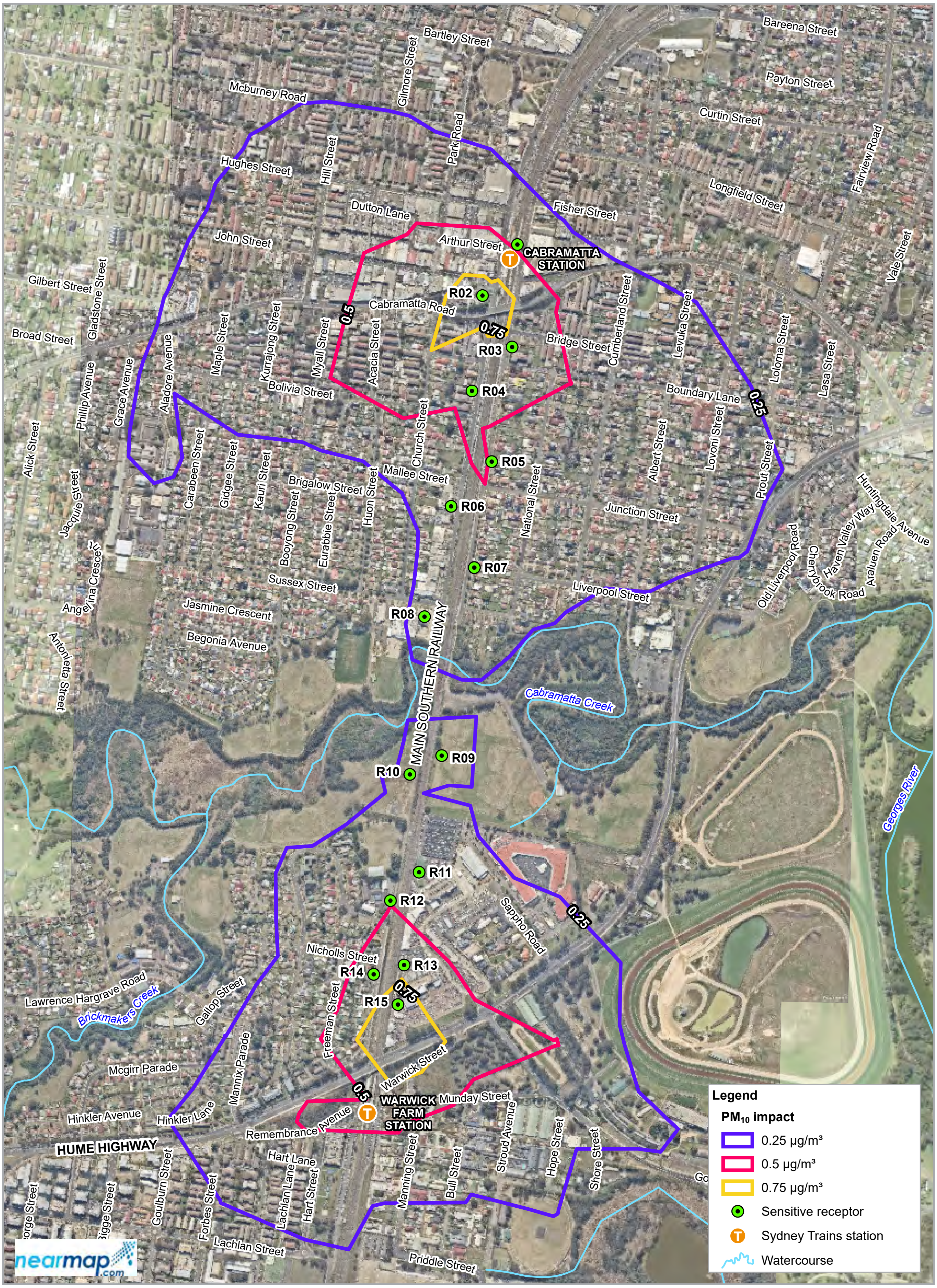
The predicted 24 hour and annual 100th percentile PM_{10} concentrations are presented in Table 6.5. Background PM_{10} concentrations were sourced from the Liverpool OEH monitoring station. The recorded daily maximum for 2013 is higher than the criteria of 50 µg/m³. As recommended in the Approved Methods, all background concentrations already above the assessment criteria were excluded to determine cumulative 24 hour impacts.

The 2013 annual average PM_{10} of 21 µg/m³ was added to predicted incremental concentrations for the cumulative annual assessment.

No incremental or cumulative criteria exceedances are predicted for both daily and annual averaging periods. A contour plot of the predicted incremental 24 hour PM_{10} concentrations during the worst case situation (situation 3) is provided on Figure 6.9.

Table 6.5 Predicted incremental and cumulative PM_{10} concentrations

Receptor	PM_{10} concentrations (µg/m³)											
	Incremental						Cumulative					
Averaging period	24 hour			Annual			24 hour			Annual		
Situation	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Criteria	50			25			50			25		
R01	0.2	0.3	0.5	0.0	0.1	0.1	44.8	44.8	44.8	21.0	21.1	21.1
R02	0.4	0.6	0.8	0.1	0.1	0.2	44.7	44.8	44.8	21.1	21.1	21.2
R03	0.3	0.5	0.7	0.1	0.2	0.2	44.8	44.9	44.9	21.1	21.2	21.2
R04	0.2	0.4	0.6	0.1	0.1	0.1	44.8	44.8	44.8	21.1	21.1	21.1
R05	0.2	0.3	0.4	0.1	0.1	0.2	44.8	44.8	44.9	21.1	21.1	21.2
R06	0.1	0.2	0.3	0.0	0.1	0.1	44.7	44.8	44.8	21.0	21.1	21.1
R07	0.2	0.3	0.4	0.1	0.1	0.1	44.8	44.8	44.8	21.1	21.1	21.1
R08	0.1	0.2	0.3	0.0	0.1	0.1	44.7	44.8	44.8	21.0	21.1	21.1
R09	0.2	0.3	0.4	0.1	0.1	0.1	44.8	44.8	44.8	21.1	21.1	21.1
R10	0.1	0.2	0.3	0.0	0.1	0.1	44.8	44.8	44.8	21.0	21.1	21.1
R11	0.2	0.3	0.5	0.1	0.1	0.2	44.8	44.8	44.9	21.1	21.1	21.2
R12	0.2	0.3	0.5	0.1	0.1	0.1	44.8	44.8	44.9	21.1	21.1	21.1
R13	0.3	0.5	0.7	0.1	0.2	0.3	44.8	44.9	44.9	21.1	21.2	21.3
R14	0.2	0.4	0.6	0.1	0.1	0.2	44.8	44.8	44.9	21.1	21.1	21.2
R15	0.3	0.6	0.8	0.1	0.2	0.3	44.8	44.9	44.9	21.1	21.2	21.3



Paper Size ISO A4

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: Australian 1966
Grid: AGD 1966 ISG 56 1

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Cabramatta Rail Loop
Air Quality Assessment

Predicted maximum incremental 24 hour PM_{10} impact (μg/m³)

Project No. 22-19800
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FIGURE 6.9

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Print date: 06 Aug 2019 - 16:39

Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

6.2.8 Predicted $PM_{2.5}$ impacts

The predicted 24 hour and annual 100th percentile $PM_{2.5}$ concentrations (predicted plus background) are presented in Table 6.6. Background $PM_{2.5}$ concentrations were sourced from the Liverpool OEH monitoring station where the recorded daily maximum for 2013 was higher than the criteria of 25 µg/m^3. As recommended in the Approved Methods all background concentrations above the assessment criteria are excluded to determine cumulative 24 hour impacts.

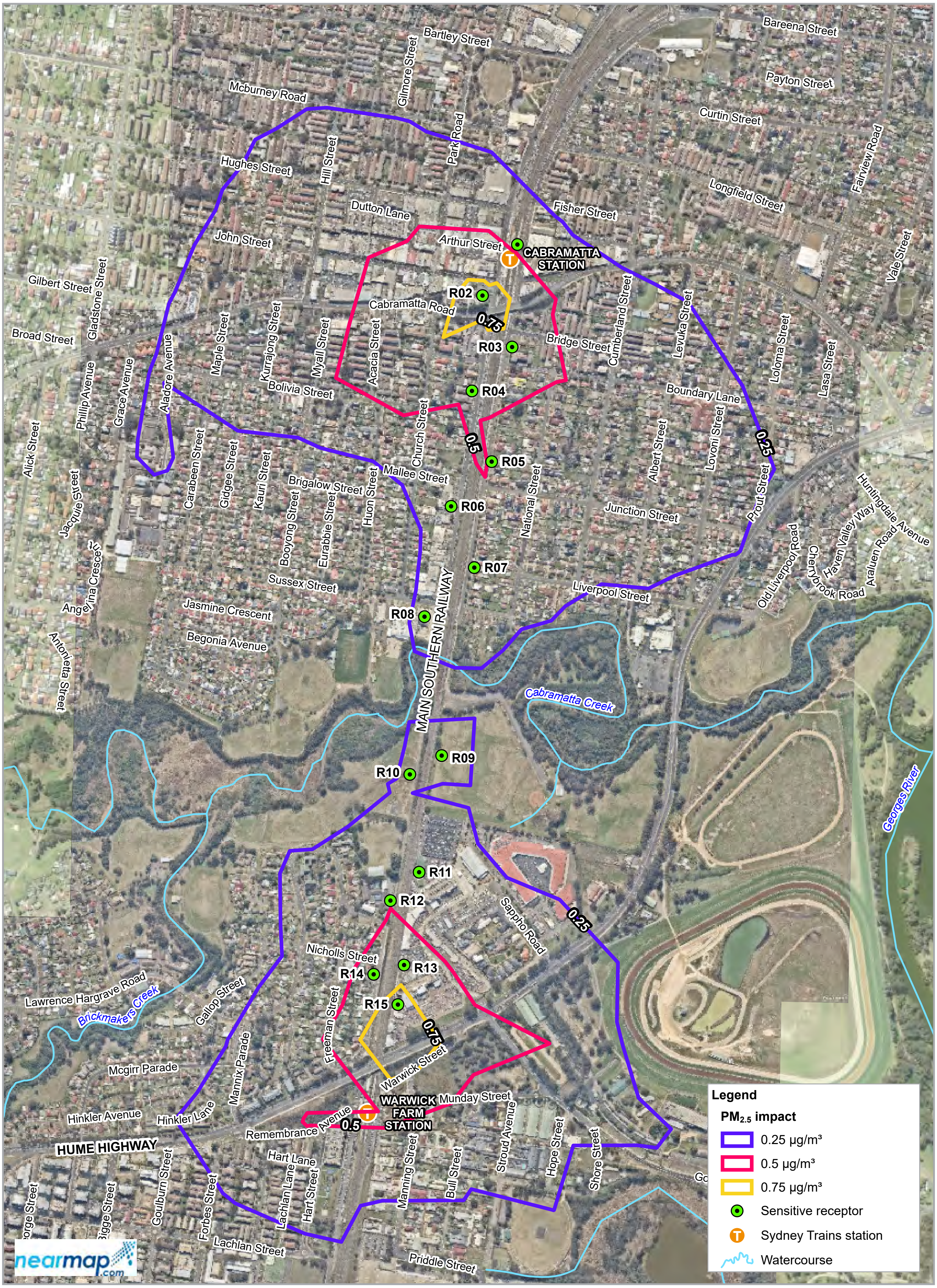
The 2013 annual average $PM_{2.5}$ recorded at the Liverpool OEH station was 9.4 µg/m^3. This exceeds the annual $PM_{2.5}$ criteria supplied in the Approved Methods of 8 µg/m^3. Consequently, all predicted annual $PM_{2.5}$ concentrations exceed the assessment criteria (exceedances are bolded in Table 6.6). Incremental increases in $PM_{2.5}$ due to the proposal range from 0 to 0.2 µg/m^3.

The predicted exceedances to the annual $PM_{2.5}$ criteria are attributable to the existing sources rather than the Cabramatta Loop operations. General mitigation measures for operation of the proposal to help reduce any additional impacts are discussed in section 7 of this report.

A contour plot of the predicted incremental 24 hour $PM_{2.5}$ concentrations during the worst case situation (situation 3) is provided on Figure 6.10.

Table 6.6 Predicted incremental and cumulative $PM_{2.5}$ concentrations

Receptor	$PM_{2.5}$ concentrations (µg/m^3)											
	Incremental						Cumulative					
Averaging period	24 hour			Annual			24 hour			Annual		
Situation	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Criteria	25			8			25			8		
R01	0.2	0.3	0.5	0.0	0.1	0.1	22.0	22.0	22.0	9.4	**9.5**	**9.5**
R02	0.4	0.6	0.8	0.1	0.1	0.2	22.0	22.1	22.1	9.5	**9.5**	**9.6**
R03	0.3	0.5	0.7	0.1	0.2	0.2	22.1	22.2	22.2	9.5	**9.6**	**9.6**
R04	0.2	0.4	0.6	0.0	0.1	0.1	22.0	22.1	22.1	9.5	**9.5**	**9.5**
R05	0.2	0.3	0.4	0.0	0.1	0.2	22.1	22.1	22.2	9.5	**9.5**	**9.6**
R06	0.1	0.2	0.3	0.0	0.1	0.1	22.0	22.1	22.1	9.4	**9.5**	**9.5**
R07	0.2	0.3	0.4	0.0	0.1	0.1	22.1	22.1	22.1	9.5	**9.5**	**9.5**
R08	0.1	0.2	0.3	0.0	0.1	0.1	22.0	22.0	22.1	9.4	**9.5**	**9.5**
R09	0.2	0.3	0.4	0.0	0.1	0.1	22.1	22.1	22.1	9.5	**9.5**	**9.5**
R10	0.1	0.2	0.3	0.0	0.1	0.1	22.0	22.1	22.1	9.4	**9.5**	**9.5**
R11	0.2	0.3	0.5	0.0	0.1	0.2	22.1	22.1	22.2	9.5	**9.5**	**9.6**
R12	0.2	0.3	0.5	0.0	0.1	0.1	22.0	22.1	22.1	9.5	**9.5**	**9.5**
R13	0.3	0.5	0.7	0.1	0.2	0.3	22.1	22.2	22.2	9.5	**9.6**	**9.7**
R14	0.2	0.4	0.6	0.0	0.1	0.2	22.0	22.1	22.1	**9.4**	**9.5**	**9.6**
R15	0.3	0.6	0.8	0.1	0.2	0.3	22.1	22.2	22.3	**9.5**	**9.6**	**9.7**



Paper Size ISO A4

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Meters

Map Projection: Transverse Mercator
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Grid: AGD 1966 ISG 56 1

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Air Quality Assessment

Predicted maximum incremental 24 hour $PM_{2.5}$ impact (µg/m³)

Project No. 22-19800
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FIGURE 6.10

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Print date: 06 Aug 2019 - 16:39

Data source: LPI: DTDB\DCDB, 2017. Nearmap: Aerial imagery, 2018.LPI_Imagery_Best: © Department of Finance, Services & Innovation 2017. Created by: tmorton

6.2.9 Impact on health

No additional exceedances of the assessment criteria are expected as a result from the project. Existing annual background $PM_{2.5}$ levels exceed the criteria and the proposal will have minor incremental increases to this at the nearest sensitive receptors.

The assessment criteria taken from Air NEPM and Approved Methods were designed to protect human health. Consequently, no adverse impacts on human health are expected.

6.2.10 Summary of key findings

A cumulative air quality impact assessment has been undertaken of the proposed SSFL line and the existing TfNSW line. Key findings are:

- The assessment predicts no additional exceedances of the assessment criteria for any of the assessed pollutants
- Existing annual background $PM_{2.5}$ levels exceed the criteria and the proposal will have minor incremental increases to this at the nearest sensitive receptors
- General mitigation measures for operation of the proposal to help reduce any additional impacts are discussed in section 7 of this report

7. Recommended mitigation and management measures

This section outlines mitigation measures to be implemented during construction and operation of the project to minimise air quality emissions and resulting impacts. Implementation of the below mentioned mitigation measures should reduce the predicted air quality impacts in Section 6. Mitigation measures are supplied in Table 7.1.

Table 7.1 Mitigation measures

Stage	Impact	Mitigation measure
Construction	Elevated Particulate matter (PM_{10}) at receptors within 25 metres of the construction boundary – minor and temporary	Dust suppression will be undertaken as required using water sprays, water carts or other media on: • unpaved work areas subject to traffic or wind • sand, spoil and aggregate stockpiles • during the loading and unloading of dust generating materials.
		If the works are creating levels of dust which may significantly impact on residential amenity, the works will be modified or stopped until the dust hazard is reduced to an acceptable level.
		Construction vehicles with potential for loss of loads (such as dust or litter) will be covered when using public roads.
		Plant and equipment will be maintained in good condition to minimise spills and air emissions that may cause nuisance.
		Aim to minimise the size of stockpiles where possible.
Operation	Emissions – Negligible	The project will be managed in accordance with the Southern Sydney Freight Line Operational Air Quality Management Plan (ARTC, 2012).
		All locomotives and equipment operating on the project shall be maintained in accordance with manufacturer and ARTC requirements.

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8. Conclusion

GHD has undertaken an air quality assessment for the construction and operation of the project.

Construction air quality impacts were modelled and assessed for typical construction scenarios. Dust impacts from construction activities have been assessed based on the proposed construction area with works assumed to occur all year in any one location, however it is important to note that many construction activities are mobile, transient and intermittent and likely to take place over a shorter period than one year.

The assessment found that there may be short term air quality impacts within 25 m of the project boundary. Implementation of mitigation and management measures to minimise dust will reduce impacts.

The operational assessment considered three situations that accounted for 5 operating scenarios corresponding to the existing 2018 scenario and future build and no build for years 2023 and 2033. Operational air quality impacts are not anticipated for any pollutants except for annual average $PM_{2.5}$. The exceedance is attributable to the existing sources rather than the project operations. Operational air quality impacts from the Project were not deemed to be significant.

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Appendices

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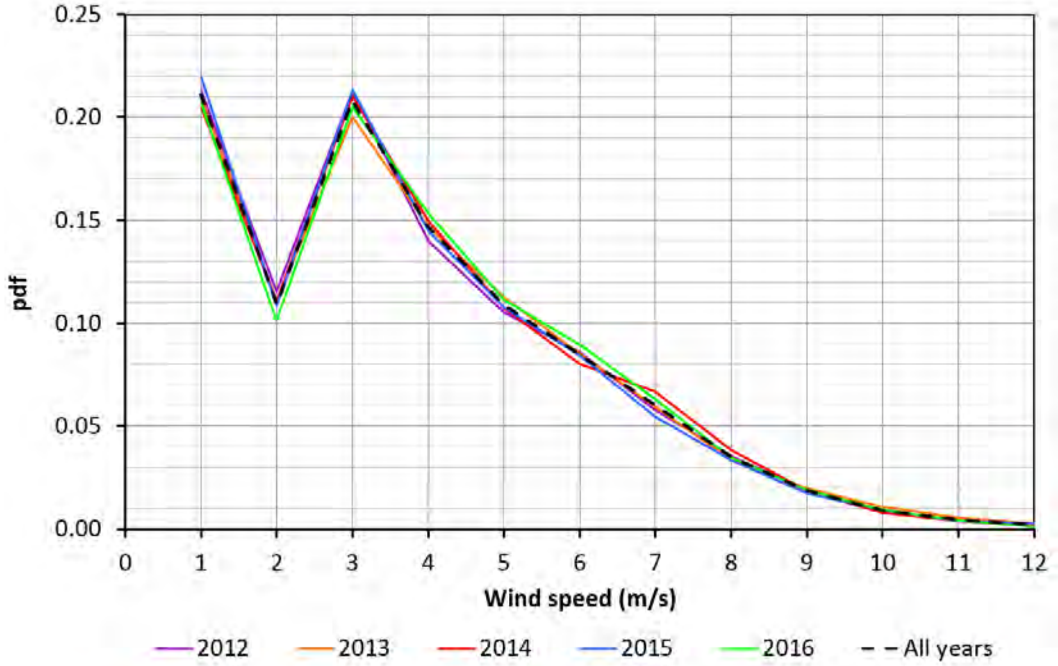
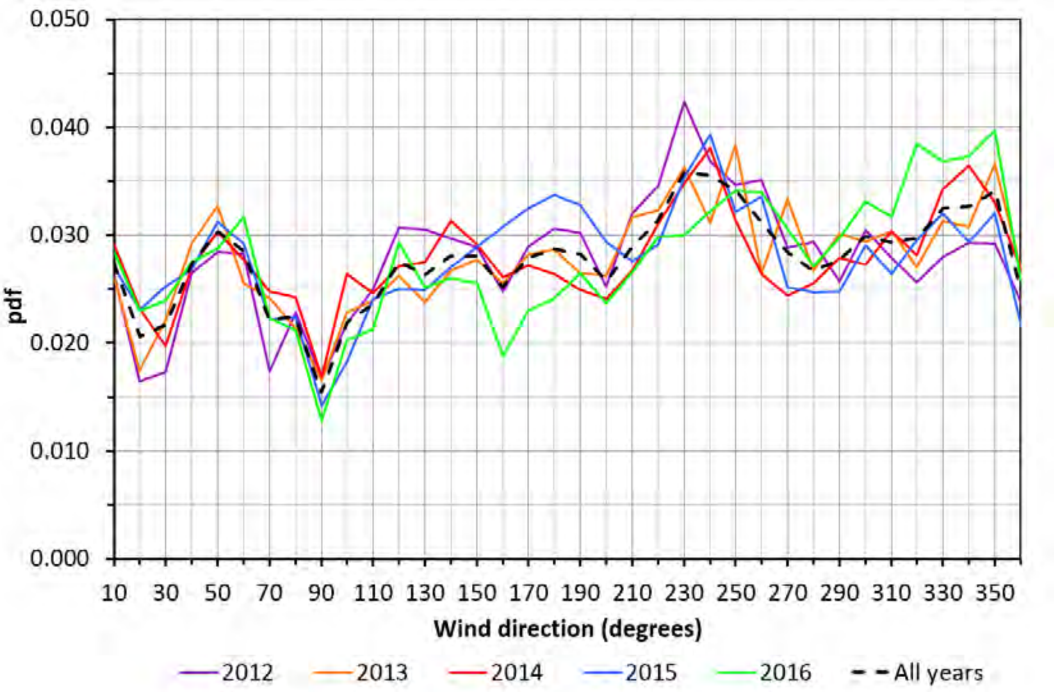
Appendix A – Probability density function of wind speed and direction over the five years

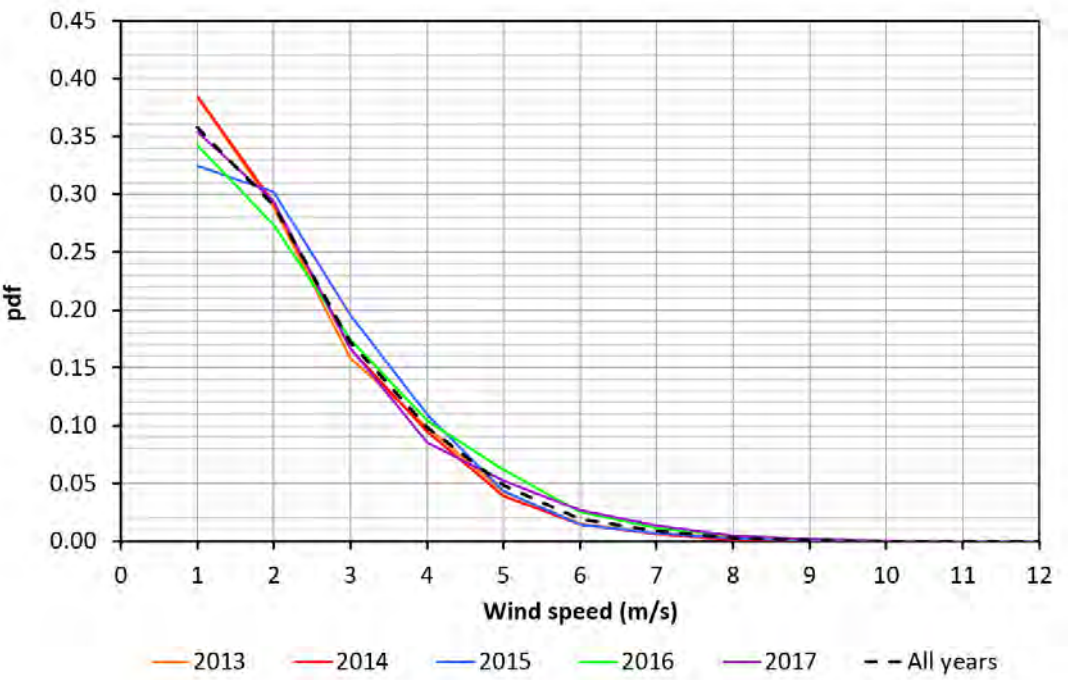
Probability density function of wind speed and direction over the five years

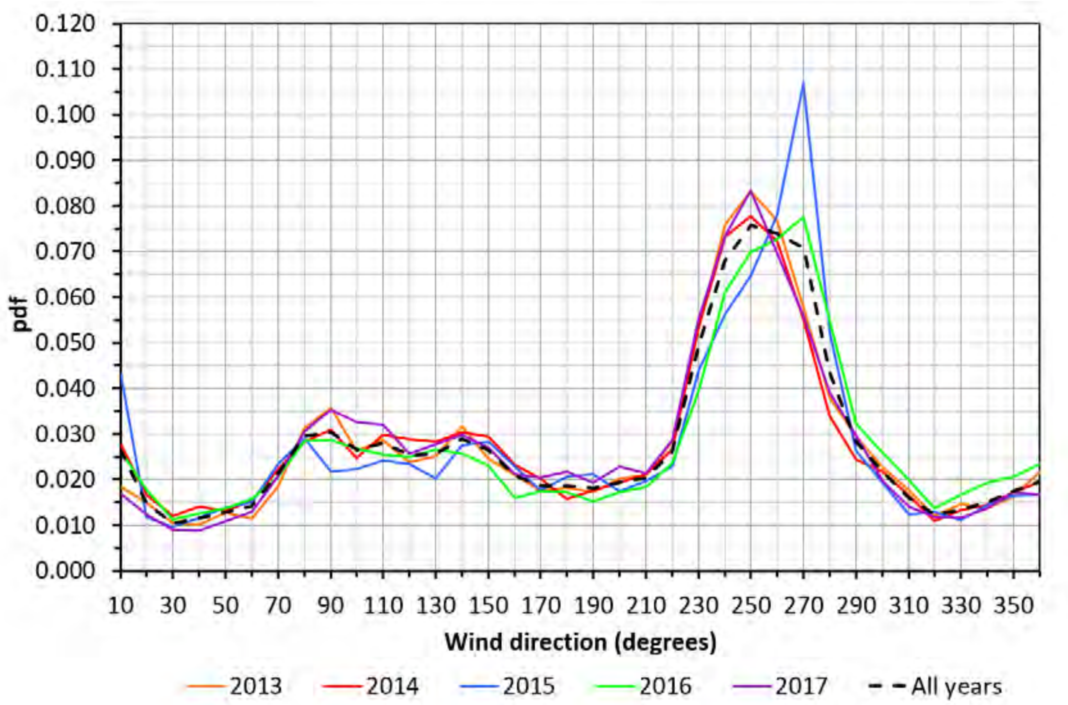
a. Bankstown Airport BoM Station





b. Liverpool OEH Station





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Appendix B – Regional sources of air pollution (Sourced from NPI database)

Regional sources of air pollution (Sourced from NPI database)

Pollutant	Facility Name	Emissions (Kg)
Particulate Matter 10.0 um	Weston Animal Nutrition Enfield [Enfield-NSW]	20,916.7
Particulate Matter 10.0 um	PPG VILLAWOOD [Villawood-NSW]	702.0
Particulate Matter 10.0 um	AGL Kemps Creek Landfill Cogeneration [Kemps Creek-NSW]	578.2
Particulate Matter 2.5 um	AGL Kemps Creek Landfill Cogeneration [Kemps Creek-NSW]	578.2359
Oxides of Nitrogen	AGL Kemps Creek Landfill Cogeneration [Kemps Creek-NSW]	27,482
Oxides of Nitrogen	Boral Recycling Widemere [Wetherill Park-NSW]	15,891
Oxides of Nitrogen	Visy Board Warwick Farm [Warwick Farm-NSW]	6,834
Oxides of Nitrogen	Orora Fibre Packaging Revesby [Revesby-NSW]	6,459
Oxides of Nitrogen	PMP Print Moorebank [Moorebank-NSW]	4,726
Oxides of Nitrogen	Offset Alpine Printing Lidcombe [Lidcombe-NSW]	4,210
Oxides of Nitrogen	Horsley Park Meter Station [Horsley Park-NSW]	4,191
Oxides of Nitrogen	CSR Viridian Ingleburn [Ingleburn-NSW]	2,878
Oxides of Nitrogen	Orora Beverage Cans [Revesby-NSW]	2,518
Oxides of Nitrogen	VISY Beverage Smithfield [Smithfield-NSW]	2,205
Oxides of Nitrogen	Goodman Fielder Erskine Park [Erskine Park-NSW]	2,001
Oxides of Nitrogen	Albright & Wilson (Aust Ltd) [Wetherill Park-NSW]	1,837
Oxides of Nitrogen	Weston Milling - Enfield [Enfield-NSW]	1,370
Oxides of Nitrogen	Pax Australia [Ingleburn-NSW]	1,346
Oxides of Nitrogen	RMAX Smithfield [Smithfield-NSW]	1,131
Oxides of Nitrogen	Erskine Park [Erskine Park-NSW]	1,036
Oxides of Nitrogen	Steritech [Wetherill Park-NSW]	748
Oxides of Nitrogen	Spotless Facility Services Punchbowl [Punchbowl-NSW]	410
Oxides of Nitrogen	Coca-Cola Amatil Eastern Creek [Eastern Creek-NSW]	270
Carbon monoxide	Austral Brick Plants 1,2,3 Horsley Park [Horsley Park-NSW]	389,900
Carbon monoxide	PGH Bricks and Pavers Cecil Park [Cecil Park-NSW]	178,556
Carbon monoxide	Eastern Creek Renewable Energy Facility [Eastern Creek-NSW]	132,746
Carbon monoxide	CSR Gyprock - Wetherill Park [Wetherill Park-NSW]	131,768
Carbon monoxide	Boral Plasterboard Camellia [Camellia-NSW]	120,693
Carbon monoxide	Earth Power Waste Treatment [Camellia-NSW]	67,411
Carbon monoxide	AGL Kemps Creek Landfill Cogeneration [Kemps Creek-NSW]	59,452
Carbon monoxide	EDL Eastern Creek Electricity Generation [Eastern Creek-NSW]	54,200
Carbon monoxide	Glenfield Sewage Treatment Plant [Macquarie Fields-NSW]	29,485
Carbon monoxide	Visy Board Warwick Farm [Warwick Farm-NSW]	4,858
Carbon monoxide	Boral Recycling Widemere [Wetherill Park-NSW]	4,363
Carbon monoxide	Moorebank Bakery [Moorebank-NSW]	3,971
Carbon monoxide	Horsley Park Meter Station [Horsley Park-NSW]	3,532
Carbon monoxide	Coca-Cola Amatil Eastern Creek [Eastern Creek-NSW]	3,186
Carbon monoxide	PMP Print Moorebank [Moorebank-NSW]	3,186
Carbon monoxide	Orora Fibre Packaging Revesby [Revesby-NSW]	2,930
Carbon monoxide	Offset Alpine Printing Lidcombe [Lidcombe-NSW]	2,809
Carbon monoxide	Goodman Fielder Erskine Park [Erskine Park-NSW]	2,716
Carbon monoxide	Albright & Wilson (Aust Ltd) [Wetherill Park-NSW]	2,701
Carbon monoxide	Galvanising Services Yagoona [Yagoona-NSW]	2,590
Carbon monoxide	ARYZTA Liverpool [Liverpool-NSW]	2,364
Carbon monoxide	CSR Viridian Ingleburn [Ingleburn-NSW]	2,141
Carbon monoxide	Orora Beverage Cans [Revesby-NSW]	2,015
Carbon monoxide	VISY Beverage Smithfield [Smithfield-NSW]	1,707
Carbon monoxide	Steritech [Wetherill Park-NSW]	1,261
Carbon monoxide	Pax Australia [Ingleburn-NSW]	1,079
Carbon monoxide	VIP Packaging Granville [Granville-NSW]	1,052
Carbon monoxide	RMAX Smithfield [Smithfield-NSW]	922
Carbon monoxide	Erskine Park [Erskine Park-NSW]	865
Carbon monoxide	Weston Milling - Enfield [Enfield-NSW]	825
Carbon monoxide	Spotless Facility Services Punchbowl [Punchbowl-NSW]	692

Pollutant	Facility Name	Emissions (Kg)
Carbon monoxide	Weston Animal Nutrition Enfield [Enfield-NSW]	349
Carbon monoxide	Speedibake Ermington [Ermington-NSW]	337
Carbon monoxide	MAURI anz Camellia [Camellia-NSW]	283
Sulfur dioxide	PGH Bricks and Pavers Horsley Park [Horsley Park-NSW]	46,059.8
Sulfur dioxide	Austral Bricks Punchbowl [Punchbowl-NSW]	31,001.0
Sulfur dioxide	Eastern Creek Renewable Energy Facility [Eastern Creek-NSW]	13,633.3
Sulfur dioxide	AGL Kemps Creek Landfill Cogeneration [Kemps Creek-NSW]	11,441.6
Sulfur dioxide	Glenfield Sewage Treatment Plant [Macquarie Fields-NSW]	5,714.0
Sulfur dioxide	Daniels Health [Silverwater-NSW]	1,875.0
Sulfur dioxide	Snackbrands Australia Smithfield [Smithfield-NSW]	76.7
Sulfur dioxide	Homebush Bay Liquid Treatment Plant [Homebush Bay-NSW]	67.3
Sulfur dioxide	Primo Chullora [Chullora-NSW]	60.7
Sulfur dioxide	Hannanprint - Warwick Farm [Warwick Farm-NSW]	57.3
Sulfur dioxide	Caroma Industries Wetherill Park [Wetherill Park-NSW]	49.7
Sulfur dioxide	Horsley Park Meter Station [Horsley Park-NSW]	46.3
Sulfur dioxide	Dairy Farmers Wetherill Park [Wetherill Park-NSW]	45.3
Sulfur dioxide	PMP Print Moorebank [Moorebank-NSW]	45.0
Sulfur dioxide	Moorebank Bakery [Moorebank-NSW]	36.5
Sulfur dioxide	Albright & Wilson (Aust Ltd) [Wetherill Park-NSW]	32.0
Sulfur dioxide	ARYZTA Liverpool [Liverpool-NSW]	31.0
Sulfur dioxide	Parmalat Lidcombe [Lidcombe-NSW]	29.6
Sulfur dioxide	Offset Alpine Printing Lidcombe [Lidcombe-NSW]	27.3
Sulfur dioxide	Visy Board Warwick Farm [Warwick Farm-NSW]	26.6
Sulfur dioxide	Cleanaway Waste Oil Recycling Wetherill Park [Wetherill Park-NSW]	26.0
Sulfur dioxide	Orora Fibre Packaging Revesby [Revesby-NSW]	24.3
Sulfur dioxide	The Daily Drinks Company Smithfield [Smithfield-NSW]	23.3
Sulfur dioxide	Goodman Fielder Erskine Park [Erskine Park-NSW]	21.5
Sulfur dioxide	CSR Viridian Ingleburn [Ingleburn-NSW]	17.9
Sulfur dioxide	VISY Beverage Smithfield [Smithfield-NSW]	16.7
Sulfur dioxide	Steritech [Wetherill Park-NSW]	16.5
Sulfur dioxide	James Hardie Rosehill [Rosehill-NSW]	16.4
Sulfur dioxide	Orora Beverage Cans [Revesby-NSW]	15.0
Sulfur dioxide	Galvanising Services Yagoona [Yagoona-NSW]	13.8
Sulfur dioxide	Weston Animal Nutrition Enfield [Enfield-NSW]	13.7
Sulfur dioxide	Speedibake Ermington [Ermington-NSW]	13.3
Sulfur dioxide	VIP Packaging Granville [Granville-NSW]	12.3
Sulfur dioxide	Erskine Park [Erskine Park-NSW]	11.0
Sulfur dioxide	MAURI anz Camellia [Camellia-NSW]	10.8
Sulfur dioxide	RMAX Smithfield [Smithfield-NSW]	10.8
Sulfur dioxide	Polyfoam (Sydney) Pty Ltd [Moorebank-NSW]	10.3
Sulfur dioxide	Boral Recycling Widemere [Wetherill Park-NSW]	9.5
Sulfur dioxide	Spotless Facility Services Punchbowl [Punchbowl-NSW]	9.1
Sulfur dioxide	Pax Australia [Ingleburn-NSW]	1.4
Sulfur dioxide	Weston Milling - Enfield [Enfield-NSW]	0.0
Benzene	Silverwater Terminal [Silverwater-NSW]	56.0
Benzene	Tooheys Brewery Lidcombe [Lidcombe-NSW]	14.8
Benzene	Viva Energy Parramatta Terminal [Rosehill-NSW]	12.3
Benzene	Eastern Creek Renewable Energy Facility [Eastern Creek-NSW]	6.5
Benzene	Caltex Energy NSW Smithfield Depot [Smithfield-NSW]	1.8

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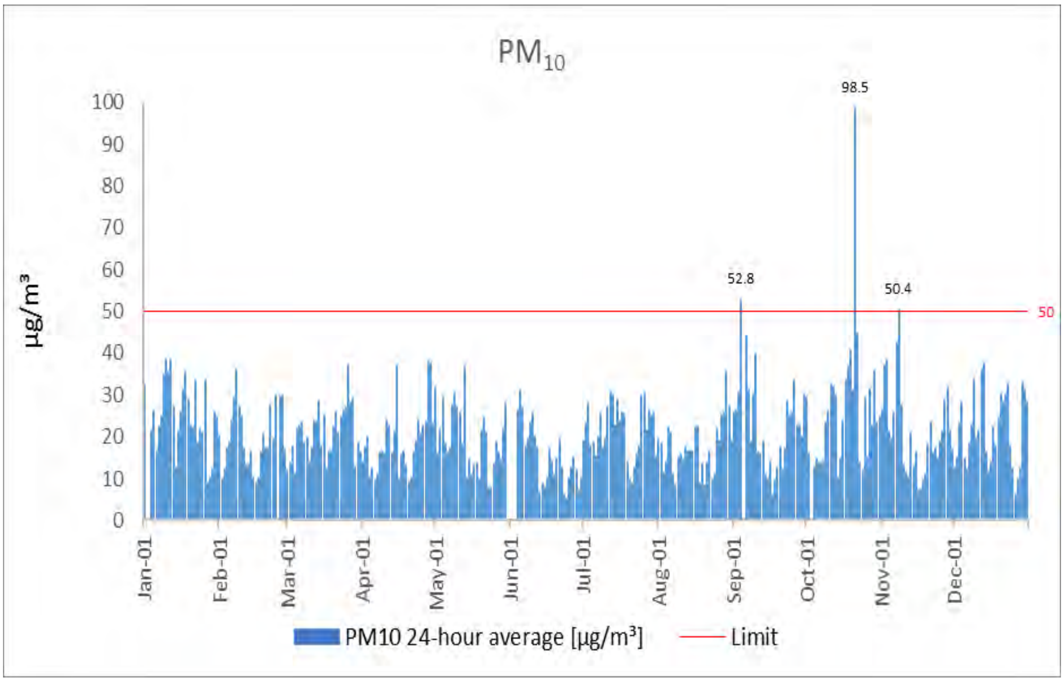
Appendix C – Background concentrations

PM_{10}

Annual background concentration of PM_{10} at Liverpool OEH Monitoring Station

Year	Annual average (μg/m³)	Maximum 24-hour average (μg/m³)
Impact Assessment Criteria	**25**	**50**
2013	21.0	**98.5**
2014	19.1	40.8
2015	18.5	**68.6**
2016	19.6	**68.7**
2017	20.8	**74.0**

Background concentration of 24-hour average PM10 at Liverpool OEH monitoring station for 2013

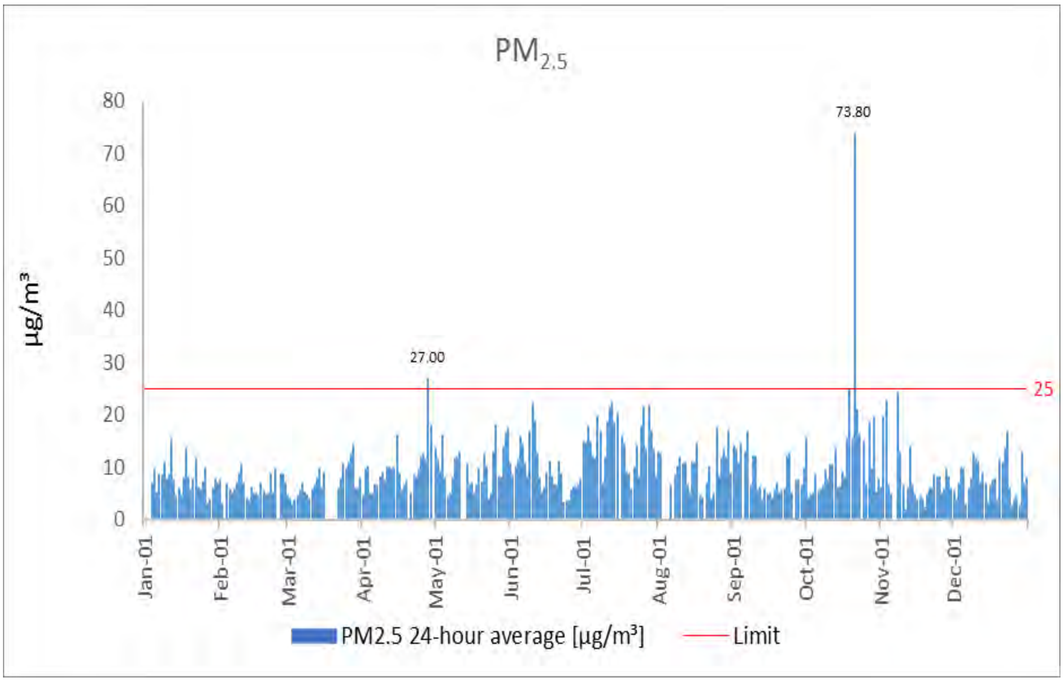


$PM_{2.5}$

Annual background concentration of PM2.5 at Liverpool OEH Monitoring Station

Year	Annual average (µg/m³)	Maximum 24-hour average (µg/m³)
Impact Assessment Criteria	8	25
2013	9.4	73.8
2014	8.6	24.3
2015	8.5	32.2
2016	8.7	50.8
2017	8.9	56.4

Background concentration of 24-hour average PM2.5 concentration at Liverpool OEH monitoring station for 2013

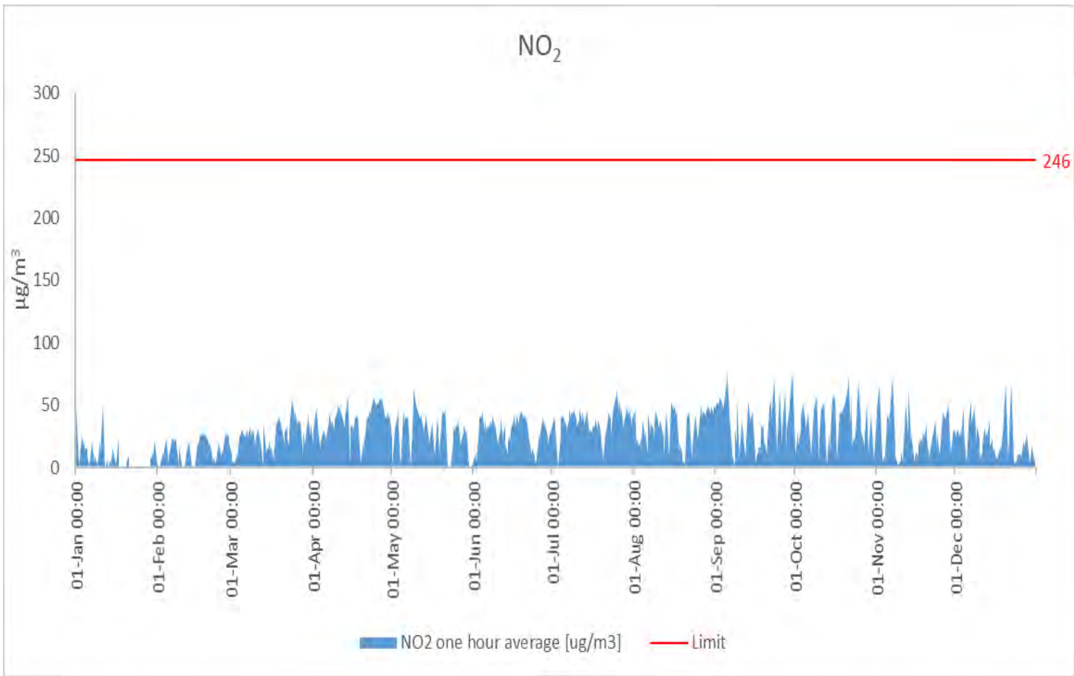


Nitrogen dioxide (NO_2)

Annual background concentration of NO2 at Liverpool OEH Monitoring Station

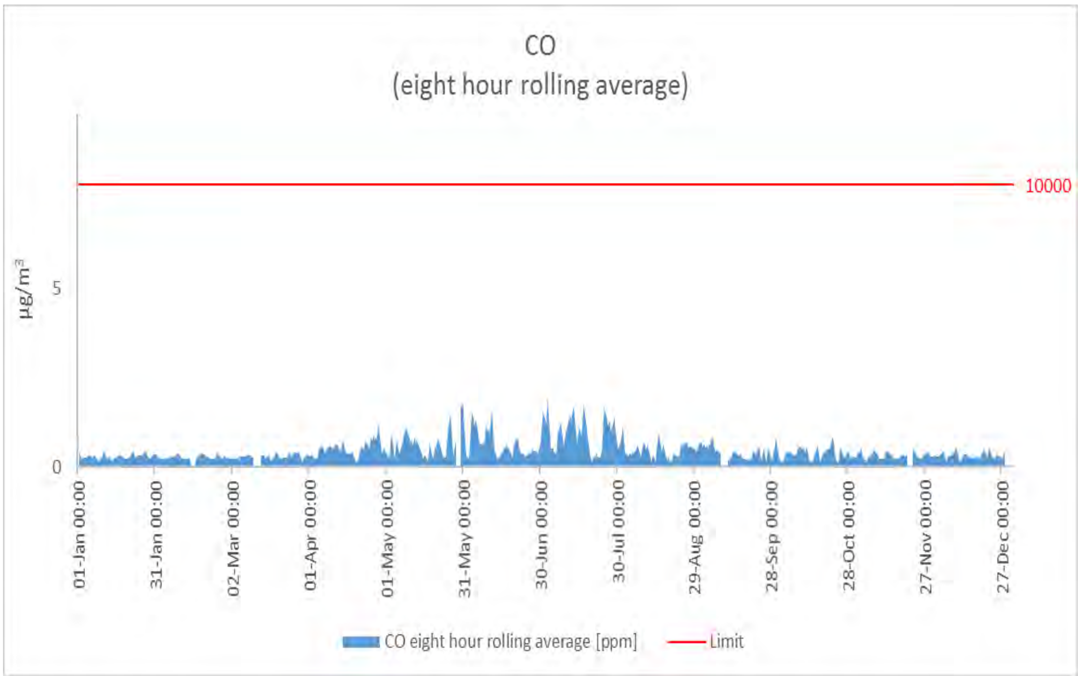
Year	Annual average (µg/m³)	Maximum one-hour average (µg/m³)
Impact Assessment Criteria	62	246
2013	20.7	105.3
2014	18.8	82.7
2015	18.8	112.8
2016	22.6	88.4
2017	22.6	120.3

Background concentration of hourly average NO2 at Liverpool OEH monitoring station for 2013

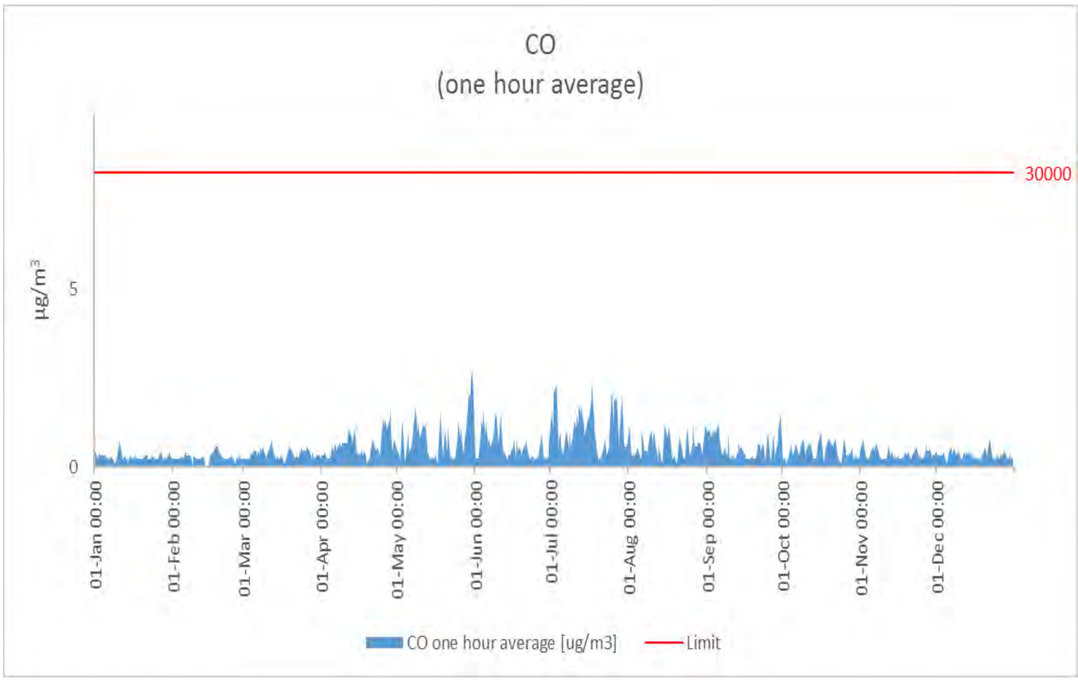


Carbon monoxide (CO)

Background concentration of eight hour rolling average CO at Liverpool OEH monitoring station for 2013



Background concentration of hourly average CO at Liverpool OEH monitoring station for 2013



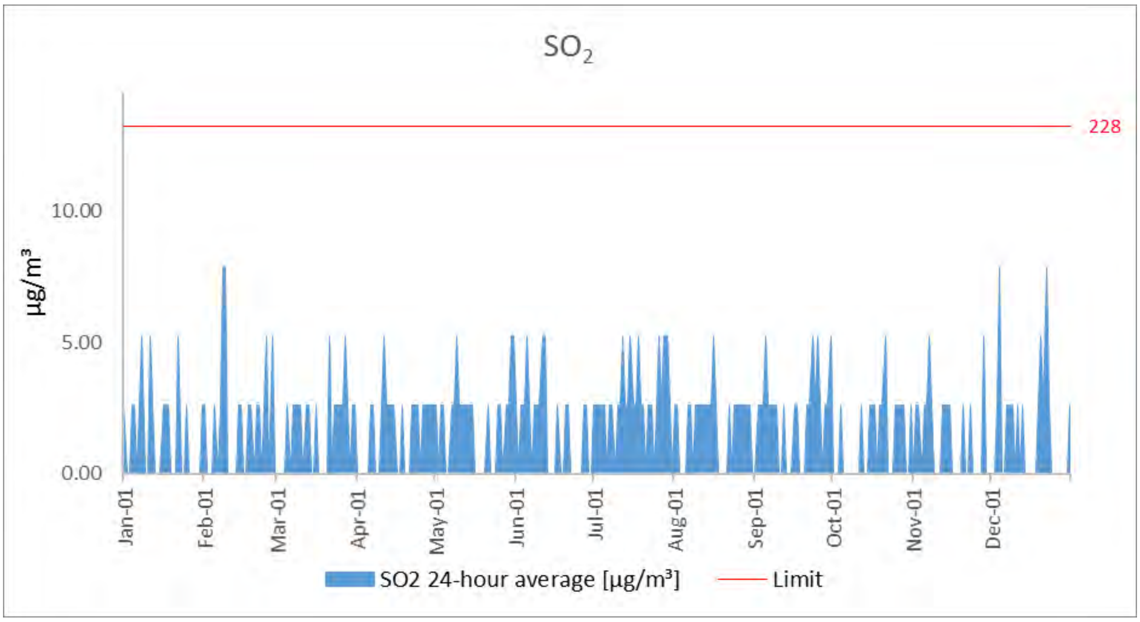
Sulphur dioxide (SO_2)

Annual background concentration of SO2 at Chullora OEH Monitoring Station

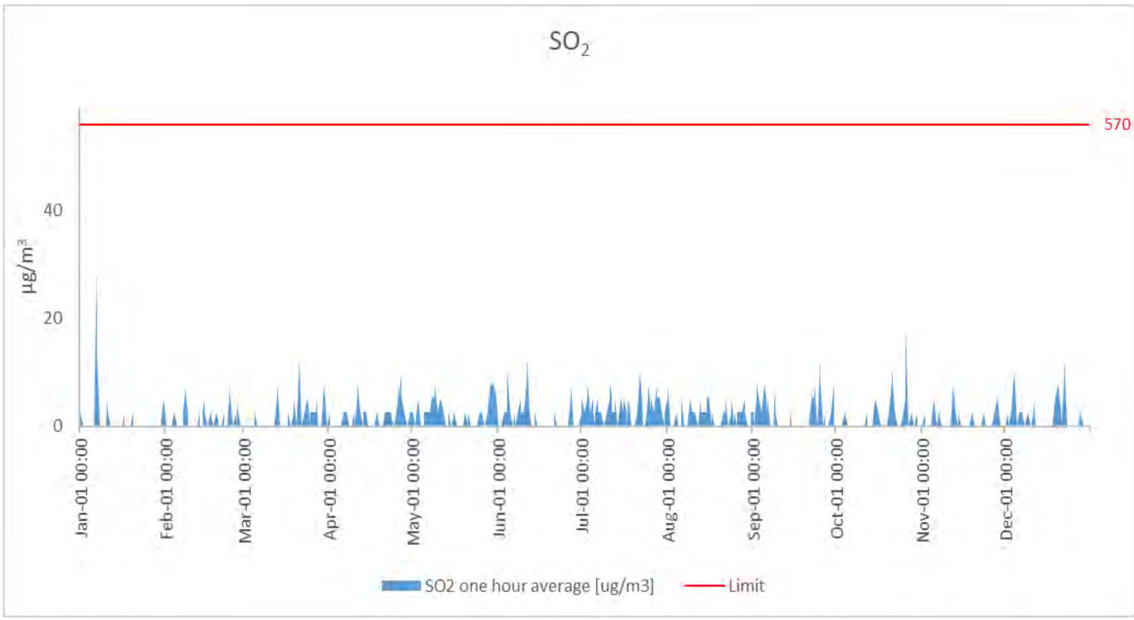
Year	Annual average (µg/m³)	Maximum one-hour average (µg/m³)
Impact Assessment Criteria	60	570
2013	2.6	31.4
2014	2.6	49.8
2015	2.6	36.7
2016	2.6	36.7
2017	2.6	36.7

* No data is available for SO_2 at the Liverpool site.

Background concentration of 24-hour average SO2 at Chullora OEH monitoring station for 2013



Background concentration of hourly average SO2 at Chullora OEH monitoring station for 2013



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Revision	Author	Reviewer		Approved for Issue		
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