St Marys Freight Hub
Pacific National
08-Mar-2019

St Marys Freight Hub

Air Quality Impact Assessment

St Marys Freight Hub

St Marys Freight Hub

Air Quality Impact Assessment

Client: Pacific National

ABN: 39 098 060 550

Prepared by

AECOM Australia Pty Ltd
17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

08-Mar-2019

Job No.: 60593074

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

St Marys Freight Hub

Quality Information

Document	St Marys Freight Hub
Ref	60593074
Date	08-Mar-2019
Prepared by	Julian Ward/ Paul Wenta
Reviewed by	Kristen Clarke

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
Draft A	7-Mar-2019	Draft	David Rollings	
Final	08-Mar-2019	Final	David Rollings Associate Director - Air Quality	

Table of Contents

1.0 Introduction

1.1 Background

As part of an effort to increase the efficiency of the Port Botany container distribution network Pacific National proposes to build and operate an intermodal freight container terminal to be located in the St Marys area in western Sydney.

1.2 Purpose of this Report

This report presents the results of an Air Quality Impact Assessment (AQIA) of the proposed St Marys Freight Hub (the Project area) which was completed in two stages. The first stage was a qualitative assessment of site works/building construction with the second stage being a quantitative assessment of ongoing operations of the Terminal.

1.3 Project Scope

There are two stages in the scope of the assessment, the first stage being a qualitative assessment of the proposed earthworks and construction activities and the second stage a quantitative assessment of terminal operations. The scope of the assessments included the following:

- Identification of relevant ambient air quality criteria;
- Discussion of existing air quality based on available Office of Environment and Heritage (OEH) data;
- Discussion of local meteorology and climate conditions based on available Bureau of Meteorology (BoM) data;
- Identification of potential sources of air emissions from surrounding land uses;
- A qualitative risk assessment of particulate emissions from earthmoving and construction activities;
- A quantitative assessment of emissions associated with road and rail activities associated with terminal operations; and
- Provision of recommendations including suggestion of potential safeguards.

The AQIA has been prepared with consideration given to the following guidelines:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, 2016*. This document was generally referenced as a source of factors needing to be considered when assessing air quality projects.
- *Guidance on the assessment of dust from demolition and construction, UK Institute of Air Quality Management (IAQM), 2014*. This document provides a qualitative risk assessment process for the potential impact of dust generated from demolition, earthmoving and construction activities.

2.0 Project Description

2.1 Location

The Project site is located on the south western edge of the St Marys Industrial Precinct as shown in **Figure 1**. The site comprises predominantly flat cleared land and an existing rail siding and is zoned IN1 General Industrial under the *Penrith Local Environmental Plan 2010* (PCC 2010).

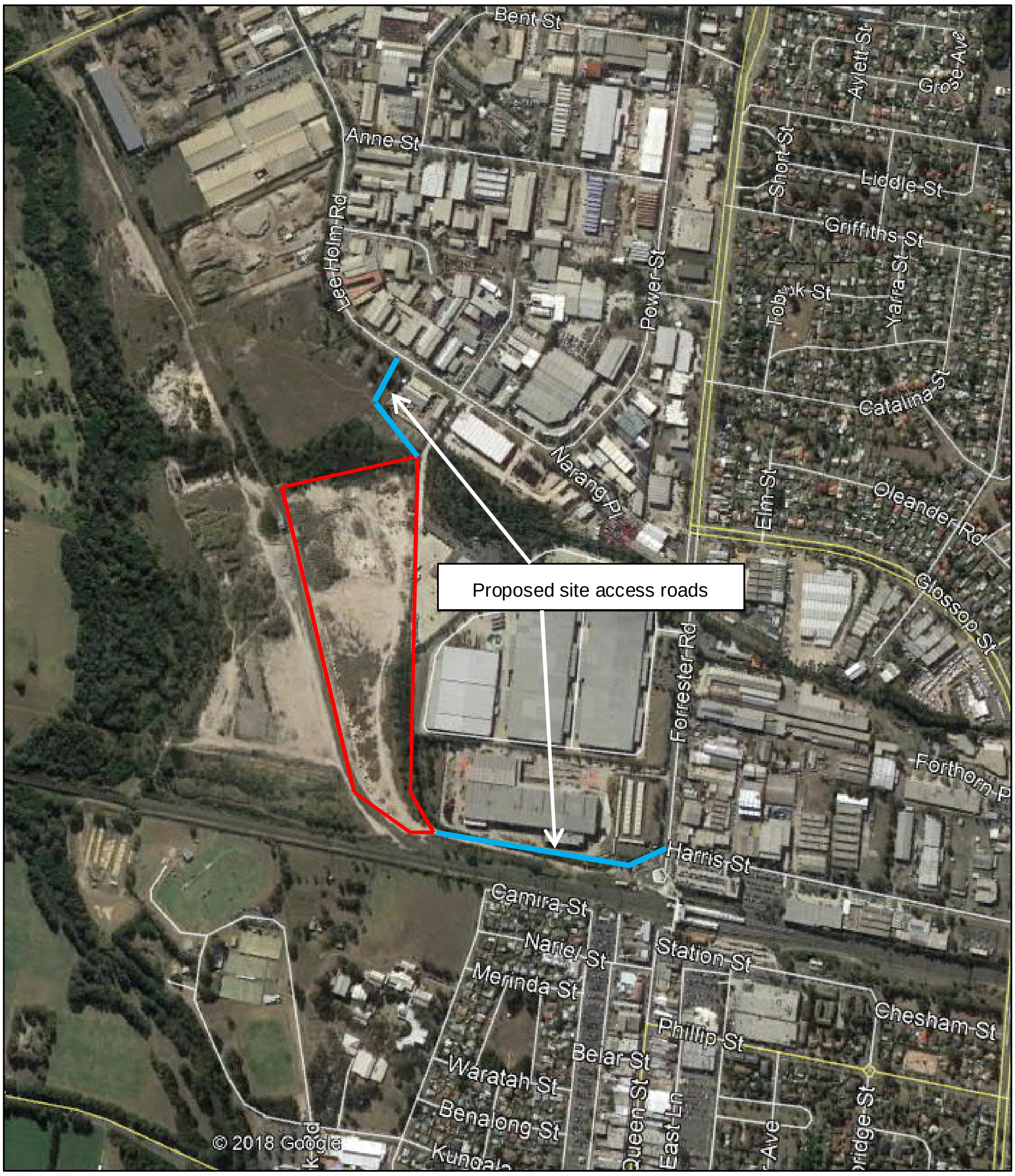


Figure 1 Project Site Location and Proposed Site Access Roads

2.2 Proposed Construction and Operation

The proposal site would facilitate the introduction of a new container rail shuttle between Port Botany and Greater Western Sydney. It would allow an increase of the volume of import and export freight moved via rail and relieve the regional and state road network of heavy vehicle and container traffic, including primary freight roads servicing Port Botany.

Containers will be loaded onto/unloaded from trains and heavy vehicles; and transferred to designated container storage areas by mobile container handling equipment (reach stackers and forklifts).

The development would comprise the following:

- Construction of hardstand areas for container storage and laydown and loading/unloading areas:
- Construction of new internal roads for light and heavy vehicles:
- Construction of buildings such as offices, wash bays and parking areas: and
- Installation of services and ancillary works.

Earthworks proposed works to be carried out in the Project area include:

- Installation/relocation of utilities;
- Levelling of the site;
- Construction of asphalt pavement hardstand areas for container storage and laydown;
- Upgrading of rail infrastructure sidings;
- Construction of new access roads from Lee Holm Road and Forrester Road; and
- Construction of a sedimentation pond.

The scale of the proposed earthworks and construction activities are:

- Approximately six to seven hectares (600,000 to 700,000m^2) of earthworks; and
- Construction of approximately 50,000 m^3 of industrial and office buildings.

The site would be operational 24 hours per day, 7 days per week with 80% of heavy vehicle movements expected to occur between 6 am and 6 pm. The site has three road frontages, Forrester Road, Lee Holm Road and Christie Street. Heavy vehicle access is proposed to be via Lee Holm Road and light vehicle access is proposed to be via Forrester Road.

2.3 Potential Sources of Air Emissions

Potential sources of air emissions from construction and operation activities at the facility would include:

- Dust emissions from earthworks and bulk material stockpiles;
- Dust emissions from construction materials at loading and unloading transfer points; and
- Combustion emissions from operational mobile equipment such as train locomotives, forklifts and trucks.

2.4 Pollutants of Interest

Potential pollutants of interest during construction and operation would include dust and fuel combustion products including:

- Particulate matter equal to or less than 10 microns in diameter (PM_{10}).
- Particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$).
- Oxides of Nitrogen (NO_x).
- Carbon Monoxide (CO).
- Volatile Organic Compounds (VOC's) (Benzene, Toluene, Ethyl Benzene, Xylene and Naphthalene).

3.0 Ambient Air Quality Criteria

In order to determine the potential effects of general air quality in the air shed, ambient pollutant concentrations can be compared to relevant impact assessment criteria. In NSW, the criteria are specified in *Table 7.1; Impact assessment criteria* of the NSW Environment Protection Authority (EPA) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) and represent maximum allowable pollution levels at the boundary of the premises. The criteria for the relevant pollutants of concern are reproduced in **Table 1** below**.**

Table 1 Regulatory air quality criteria (µg/m^3)

Pollutant of Concern	Averaging Period	Criteria
Particulate Matter (PM_{10})	Maximum 24 hour average	50 µg/m^3
	Annual average	25 µg/m^3
Particulate Matter ($PM_{2.5}$)	Maximum 24 hour average	25 µg/m^3
	Annual average	8 µg/m^3
Nitrogen dioxide (NO_2)	Maximum 1 hour average	246 µg/m^3
	Annual average	62 µg/m^3
Carbon Monoxide (CO)	Maximum 15 minute average	100,000 µg/m^3
	Maximum 1 hour average	30,000 µg/m^3
	Maximum 8 hour average	10,000 µg/m^3
Benzene (C_6H_6)	99.9th Percentile 1-hour average	29 µg/m^3
Toluene (C_7H_8)	99.9th Percentile 1-hour average	360 µg/m^3
Ethylbenzene (C_8H_{10})	99.9th Percentile 1-hour average	8000 µg/m^3
Xylene (C_8H_{10})	99.9th Percentile 1-hour average	190 µg/m^3
µg/m^3 = micrograms per cubic metre		

DoE – Department of the Environment NEPC – National Environment Protection Council

4.0 Existing Environment

4.1 Meteorology

Meteorology defines the direction of pollution transport along with the rate of mixing and hence dispersion in the atmosphere. An analysis of the meteorology aids in the understanding of whether pollution from a source is likely to influence a particular location.

The Bureau of Meteorology (BOM) operates a network of monitoring stations around the state. Local meteorological data was taken from the monitoring location at Penrith which is located approximately nine kilometres to the west of the Project area.

Historical meteorological data including average temperatures; rainfall; relative humidity; wind speed and wind roses showing the average monthly wind conditions at 9am and 3pm were obtained from the BOM meteorological station at Penrith located 8 km from the site (BoM 2019). The Penrith weather station provided 24 years of data from 1995 to 2018 which has been reproduced in **Figure 2**, **Figure 3** and **Table 2** below.

The highest average maximum temperature of 31.2ºC occurs in January whilst July is the coldest month with an average minimum temperature of 5.3ºC. Rainfall is highest in February (average rainfall of 116.9mm) and lowest in July (average rainfall of 28.2mm). Annual average rainfall is 717.0mm. Wind data shows the following patterns:

- January to March - morning winds are light, predominantly from the south with calm conditions from 3 to 17%. Afternoon winds increase in strength changing to predominantly east and southeast with very low (1%) calm conditions.
- April to June - morning winds are light and variable with calm conditions from 15 to 26%. Afternoon winds increase in strength but remaining variable with low (1 to 4%) calm conditions.
- July to August - morning winds are light and variable with calm conditions from 20 to 28%. Afternoon winds increase in strength changing to predominantly from the west with low (2 to 3%) calm conditions.
- September to December - morning winds are light and predominantly from the north or south with calm conditions moderate between 2 and 8%. Afternoon winds increase in strength changing to variable in September and October and predominantly from the east in November and December with very low (1%) calm conditions.

The meteorological data indicates variable wind direction throughout the year with a general trend of a summer easterly/winter westerly pattern. Given the variable wind pattern and the surrounding landuse, there are no indications of any potential air quality impacts due to prevailing meteorology.

St Marys Freight Hub

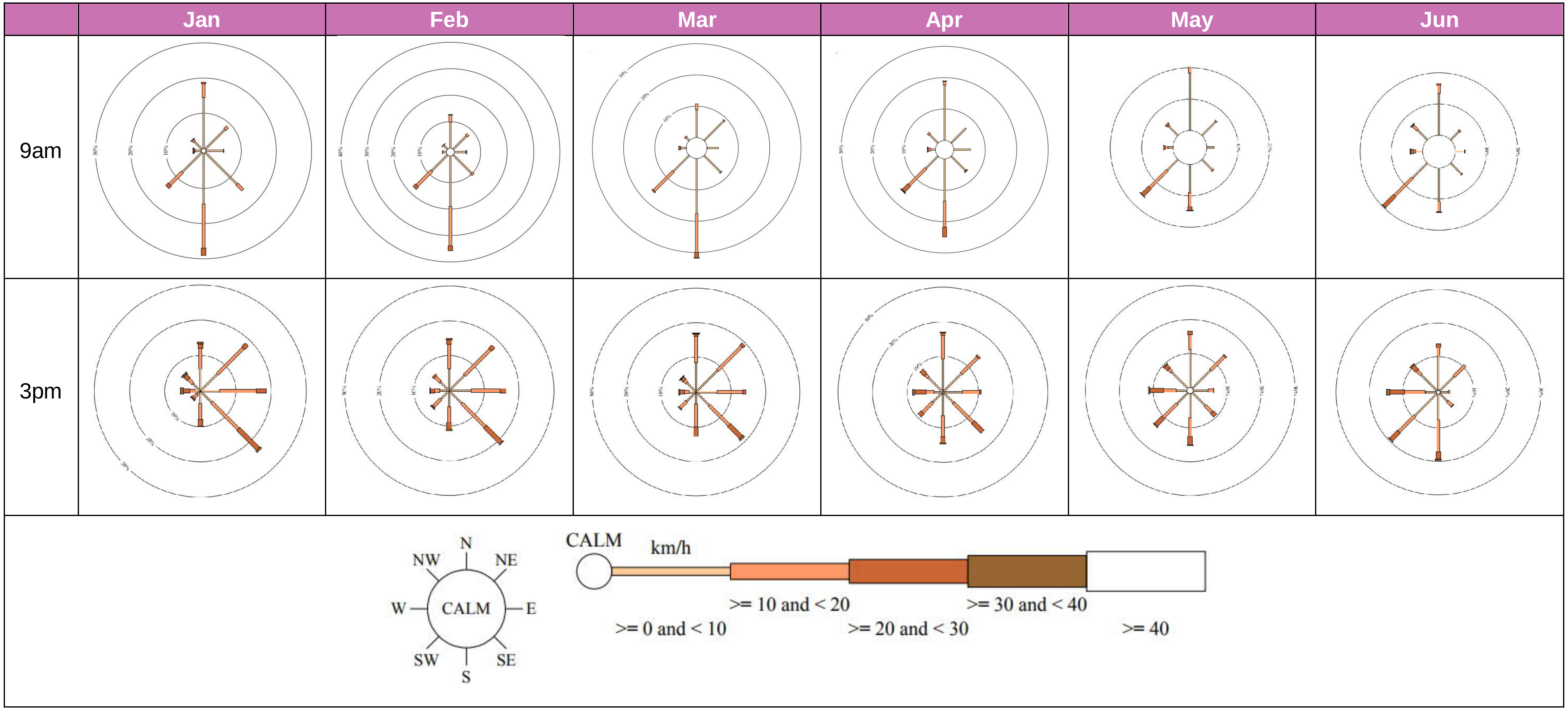


Figure 2 9 am and 3 pm Wind Roses; Penrith; January to June; 1995–2018

St Marys Freight Hub

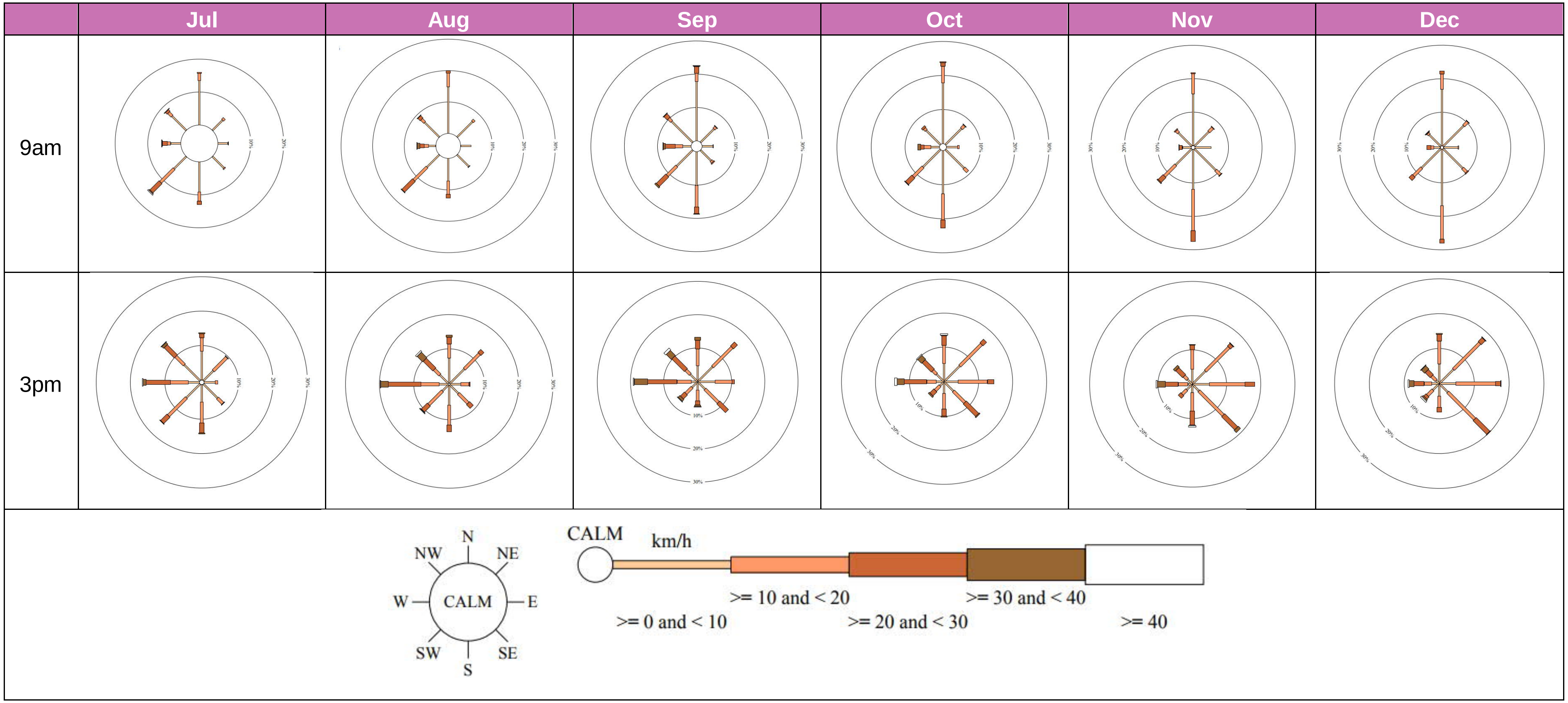


Figure 3 9 am and 3 pm Wind Roses; Penrith; July to December; 1995–2018

Table 2 Climate Statistics, Penrith; 1995 – 2018

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Average maximum temperature (°C)	31.2	29.6	27.6	24.6	21.2	18.1	17.9	19.9	23.3	25.8	27.5	29.6	24.7
Average minimum temperature (°C)	18.7	18.5	16.8	13.2	9.3	7.0	5.3	6.2	9.4	12.2	15.1	17.1	12.4
Rainfall													
Average rainfall (mm)	94.1	116.9	76.6	48.9	36.0	50.4	28.2	29.3	30.5	56.0	82.7	63.3	717.0
Decile 5 (median) rainfall (mm)	92.1	87.4	51.8	34.2	24.8	33.6	19.2	18.8	25.9	45.8	66.3	59.3	699.1
Average number of days of rain ≥ 1 mm	7.5	7.8	7.8	5.5	4.2	5.7	3.9	3.4	4.6	5.5	7.8	7.3	71.0
9 am conditions													
Average 9am temperature (°C)	22.3	21.7	19.7	17.6	13.8	10.5	9.6	11.7	15.8	18.5	19.6	21.4	16.8
Average 9am relative humidity (%)	73	79	80	76	81	85	83	72	64	60	68	69	74
Average 9am wind speed (km/h)	9.3	9.2	7.7	8.1	7.2	7.7	7.4	8.7	10.5	10.6	10.4	9.3	8.8
Calms 9am (%)	3	7	17	15	27	26	28	20	8	5	3	2	14
3 pm conditions													
Average 3pm temperature (°C)	29.0	27.7	26.1	23.3	19.8	17.1	16.6	18.6	21.7	23.7	25.3	27.6	23.0
Average 3pm relative humidity (%)	47	53	52	49	52	55	50	41	40	41	46	45	48
Average 3pm wind speed (km/h)	15.7	14.3	13.7	13.2	12.2	12.7	13.5	16.5	18.4	18.0	17.4	16.4	15.2
Calms 3pm (%)	<1	<1	1	1	4	3	3	2	1	1	<1	<1	1

http://www.bom.gov.au/climate/averages/tables/cw_067113.shtml; accessed 21 February 2019

4.2 Existing Air Quality

The NSW Office of Environment and Heritage (OEH) operate several ambient air quality monitoring locations across the Sydney region. The St Marys monitoring site which is located in close proximity to the Project area location continuously monitors both PM_{10} and $PM_{2.5}$, nitrogen dioxide (NO_2) but not carbon monoxide (CO). The nearest OEH monitoring site where CO is monitored is located at Prospect (approximately 12 kilometres to the east of the Project area). Relevant data from these two sites for the five year period from 2014 ($PM_{2.5}$ commenced in 2016) to 2018 is summarised in the following sections.

4.2.1 Particulate Matter (PM_{10})

Table 3 and **Figure 4** present the PM_{10} data for the St Marys OEH site for the years 2014 to 2018.

Table 3 Ambient PM_{10} Concentrations 2014 – 2018 at St Marys OEH monitoring location

Statistic	24 hour average PM_{10} Concentration - µg/m^3				
	2014	2015	2016	2017	2018
Maximum 24 hour concentration	45.0	53.0	100.2	49.8	100.5
24 hour Criterion	50				
24 hour exceedance count	0	1	3	0	2
Statistic	**Annual average PM_{10} Concentration - µg/m^3**				
	2014	**2015**	**2016**	**2017**	**2018**
Annual Average	16.7	15.0	16.1	16.2	19.4
Annual Average Criterion	25				

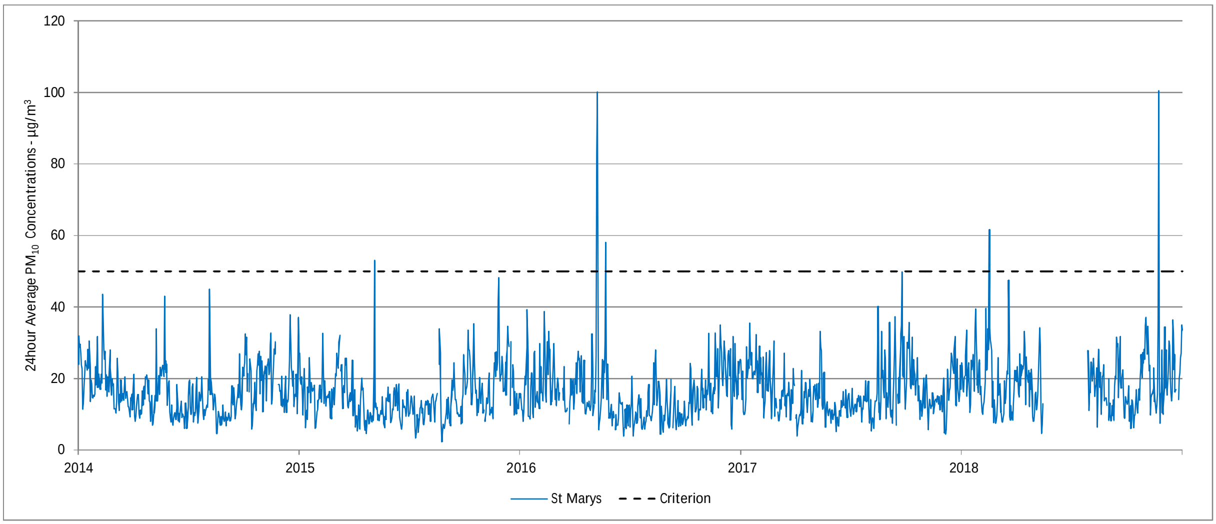


Figure 4 OEH St Marys PM_{10} 24 hour Average Monitoring Data – 2014-2018

The data shows no exceedances of the 24 hour criterion for 2014 and 2017; one exceedance (6 May) in 2015; four exceedances (7, 8, 19, 22 May) in 2016; and two exceedances (15 February and 22 November) in 2018. The OEH *Annual Air Quality Statement* for 2016 and Rural Fire Service (RFS) information for 2018 indicate that the 2016 and 2018 exceedances were all due to exceptional events which are defined as events related to bushfires, hazard reduction burns and dust storms.

Annual average values show a relatively small range across the years with all years below the annual average criterion.

4.2.2 Particulate Matter (PM2.5)

Table 4 and **Figure 5** present the $PM_{2.5}$ data for the St Marys site for the years 2016 to 2018.

Table 4 Ambient $PM_{2.5}$ Concentrations 2016 – 2018 at St Marys OEH monitoring location

Statistic	24 hour average $PM_{2.5}$ Concentration - µg/m3		
	2016	2017	2018
Maximum 24 hour concentration	93.2	38.2	80.5
24 hour Criterion	**25**		
24 hour exceedance count	5	3	3
Statistic	**Annual average $PM_{2.5}$ Concentration - µg/m3**		
	2016	2017	2018
Annual Average	7.8	7.0	7.8
Annual Average Criterion	**8**		

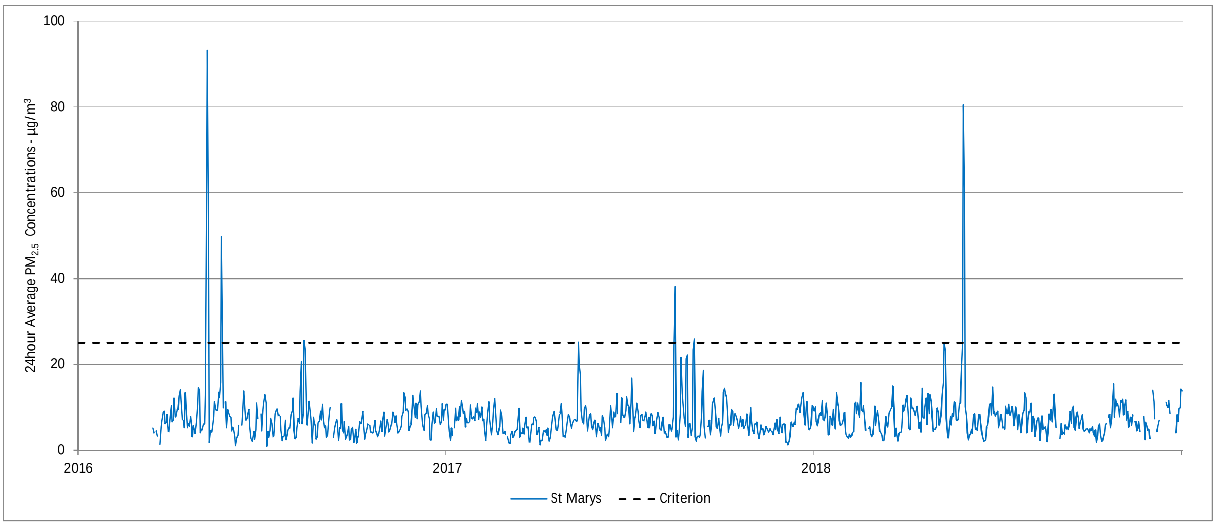


Figure 5 OEH St Marys $PM_{2.5}$ 24 hour Average Monitoring Data – 2016-2018

The data shows the following exceedances; five (7, 8, 9, 19, 22 May and 12 August) in 2016; three (11 May, 15 August and 3 September) in 2017 and two (28 and 29 May) in 2018. OEH *Annual Air Quality Statements* for 2016 and 2017 and RFS information for 2018 indicate that these exceedances were all due to exceptional events which are defined as events related to bushfires, hazard reduction burns and dust storms.

Annual average values show a relatively small range across the years with all years below the annual average criterion.

4.2.3 Nitrogen Dioxide

Table 5 and **Figure 6** present the nitrogen dioxide data for the St Marys site for the years 2014 to 2018.

Table 5 Ambient NO_2 Concentrations 2014 – 2018 at St Marys OEH monitoring location

Statistic	1 hour average NO_2 Concentration - µg/m3				
	2014	2015	2016	2017	2018
1hour Max	64	68	86	76	76
1hour Criterion	246				
Statistic	Annual average NO_2 Concentration - µg/m3				
	2014	2015	2016	2017	2018
Annual Average	23	23	24	26	27
Annual Average Criterion	62				

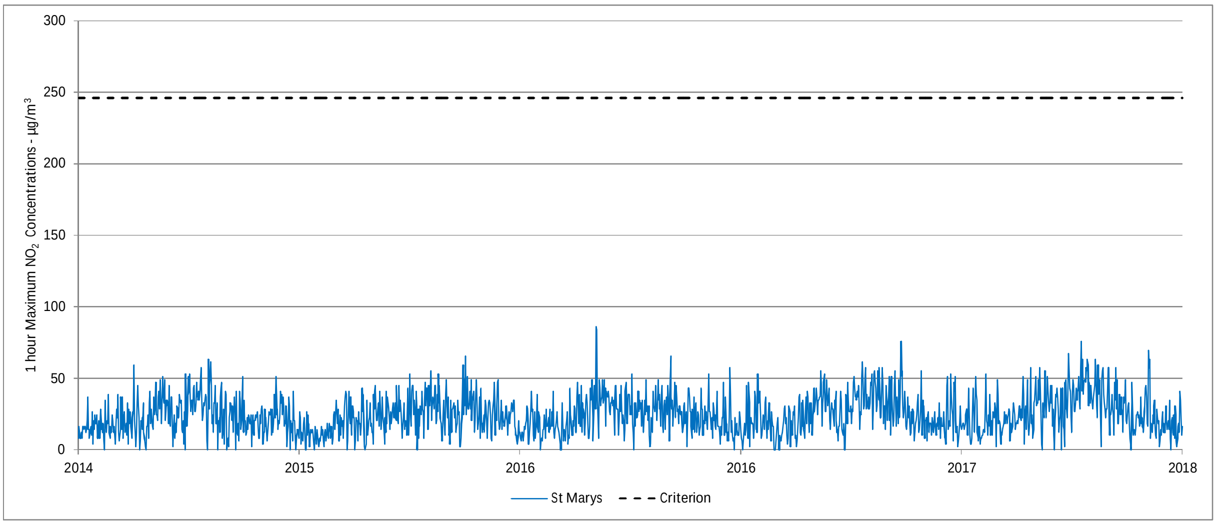


Figure 6 OEH St Marys NO_2 1 hour Maximum Monitoring Data – 2014-2018

The data shows no exceedances of the 24 hour or annual criteria for all years from 2014 to 2018 with maximum hourly and annual average values less than half of the relevant criterion.

4.2.4 Carbon Monoxide

Table 6, **Figure 7** and **Figure 8** present the carbon monoxide data for the Prospect site for the years 2014 to 2018.

Table 6 Ambient CO Concentrations 2014 – 2018 at Prospect OEH monitoring location

Statistic	Maximum 1 hour average CO Concentration - µg/m3				
	2014	2015	2016	2017	2018
1 hour Max	2,400	2,200	1,800	1,800	1,500
1 hour Criterion	30,000				
Statistic	Maximum Rolling 8 hour average CO Concentration - µg/m3				
	2014	2015	2016	2017	2018
Annual Average	1,500	1,700	1,700	1,300	1,300
Rolling 8 hour Average Criterion	10,000				

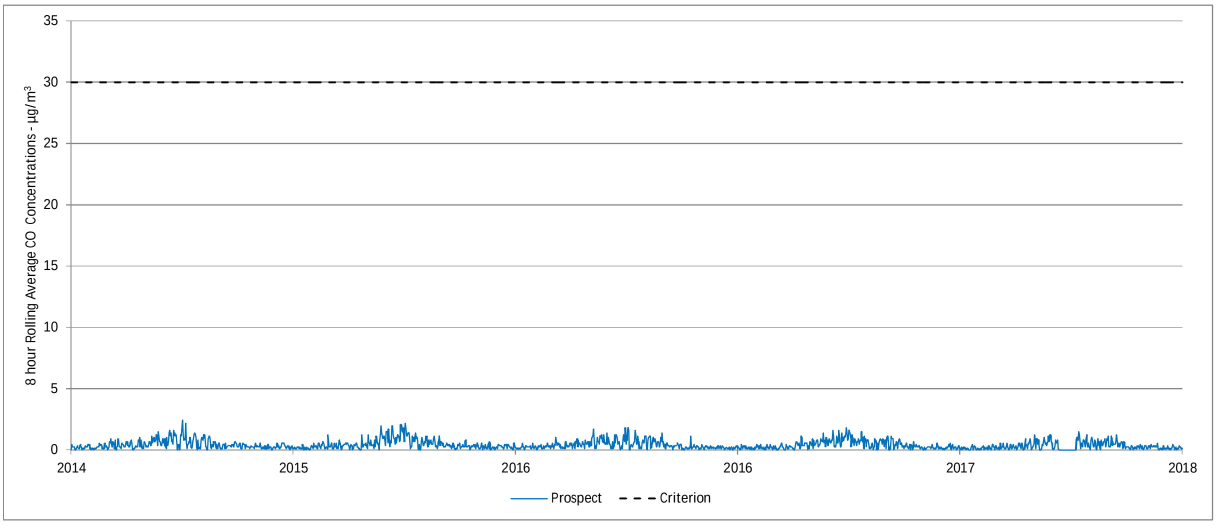


Figure 7 OEH Prospect CO Maximum Daily 1 hour average Monitoring Data – 2014-2018

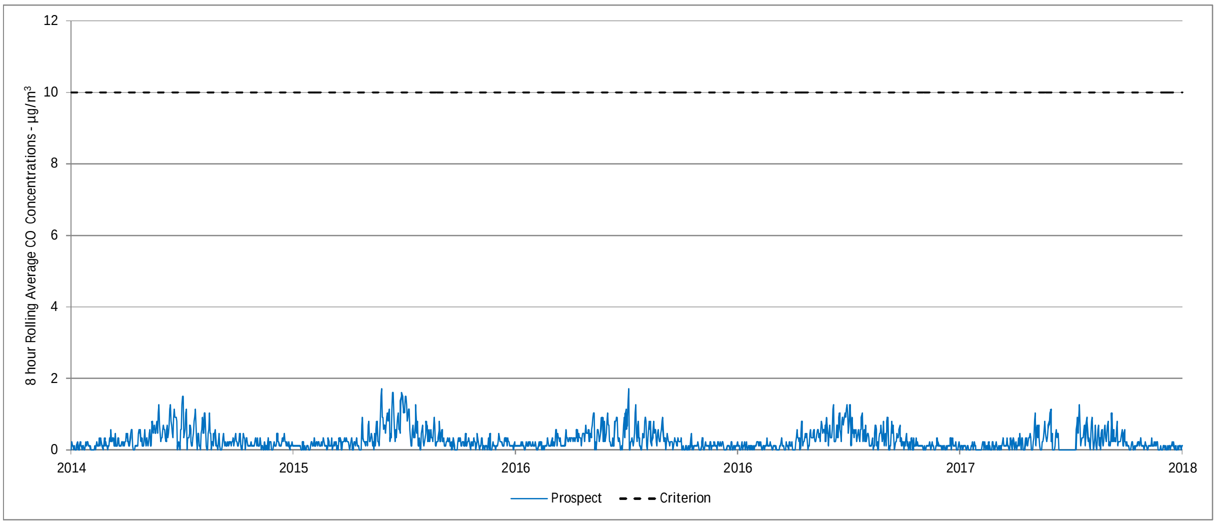


Figure 8 OEH Prospect CO Maximum Daily 8 hour Rolling Average Monitoring Data – 2014-2018

The data shows no exceedances of the 1 hour or rolling 8 hour average criteria for all years from 2014 to 2018 with one hour values less than a tenth of the relevant criterion and rolling 8 hour average values less than a sixth of the relevant criterion.

St Marys Freight Hub

4.2.5 Summary of Existing Air Quality

A summary of adopted background air quality concentrations for the project are presented in **Table 7** . These background concentrations were combined with modelling results to provide cumulative pollutant concentrations which were assessed against relevant air quality criteria. The values were taken as the maximum recorded for the past five years, except for 24-hour PM_{10} and $PM_{2.5}$, which were taken as the highest observation below criterion at the St Marys station for the 2016 year. The 24-hour PM_{10} and $PM_{2.5}$ values were chosen in an attempt to show that PM_{10} and $PM_{2.5}$ contribution from the project would not cause additional exceedances beyond those that already exist.

Table 7 Summary of adopted background pollutant concentrations

Pollutant of Concern	Averaging Period	Background Concentration (µg/m³)
Particulate Matter (PM_{10})	24 hour	45.6[1]
	Annual	19.4
Particulate Matter ($PM_{2.5}$)	24 hour	23.5[1]
	Annual	7.8
Nitrogen dioxide (NO_2)	1 hour	86
	Annual	27
Carbon Monoxide (CO)	15 minute	3,167[2]
	1 hour	2,400
	8 hour	1,700

[1]Taken as the highest observation below criterion at the St Marys station for the 2016 year.
[2]Calculated from the 1-hour CO concentration according to a power-law ratio

4.3 Terrain

The Project area is situated in the western hinterland of the Sydney basin. The terrain is generally flat with slightly undulating terrain sloping toward the east of the Project area. The local relief surrounding the Project area is minor and is not expected to greatly influence the dispersion of air pollutants potentially emitted during construction and operation activities.

4.4 Land Use and Sensitive Receptors

The Project area is situated on the south western edge of the St Marys Industrial Precinct. The broader site is surrounded by industrial properties to the north and east, parkland to the west and the main western railway line to the south. The north western perimeter of the residential suburb of St Marys is located approximately 150 metres to the southeast. No major industrial pollution sources are located in the proximity of the Project area with road and rail traffic the only likely pollution sources.

5.0 Assessment Methodology

5.1 Construction Impact Assessment

A semi-quantitative risk assessment of potential dust impacts on surrounding sensitive receptors was undertaken for the construction phase of the Project. The assessment was based on the methodology described in the UK Institute of Air Quality Management (IAQM) document, *Guidance on the assessment of dust from demolition and construction*. The risk of dust soiling and human health impacts due to particulate matter (PM_{10}) on surrounding areas were determined based on the scale of activities and proximity to sensitive receptors. The IAQM method uses a four-step process to assess dust impacts:

- Step 1: Screening based on distance to nearest sensitive receptors.
- Step 2: Assess risk of dust impacts from activities based on:
  - Scale and nature of the works, which determines the potential dust emission magnitude; and
  - Sensitivity of the area.
- Step 3: Determine site-specific mitigation for dust-emitting activities.
- Step 4: Reassess risk of dust impacts after mitigation has been considered.

Assessment of potential impacts during construction of the Project is shown in **Section 6.1**

5.2 Operational Impact Assessment

5.2.1 Overview

The air dispersion modelling conducted for this assessment was undertaken using the CALPUFF modelling suite with prognostic meteorological data derived from The Air Pollution Model (TAPM). The data available for this Project and a discussion of the methodologies required to implement CALPUFF are discussed in the following sections.

The flow diagram in **Figure 5-1** shows the general process of programs used for this AQIA and the input data required for the dispersion model.

Further details on the inputs to each process are provided in this section.

St Marys Freight Hub

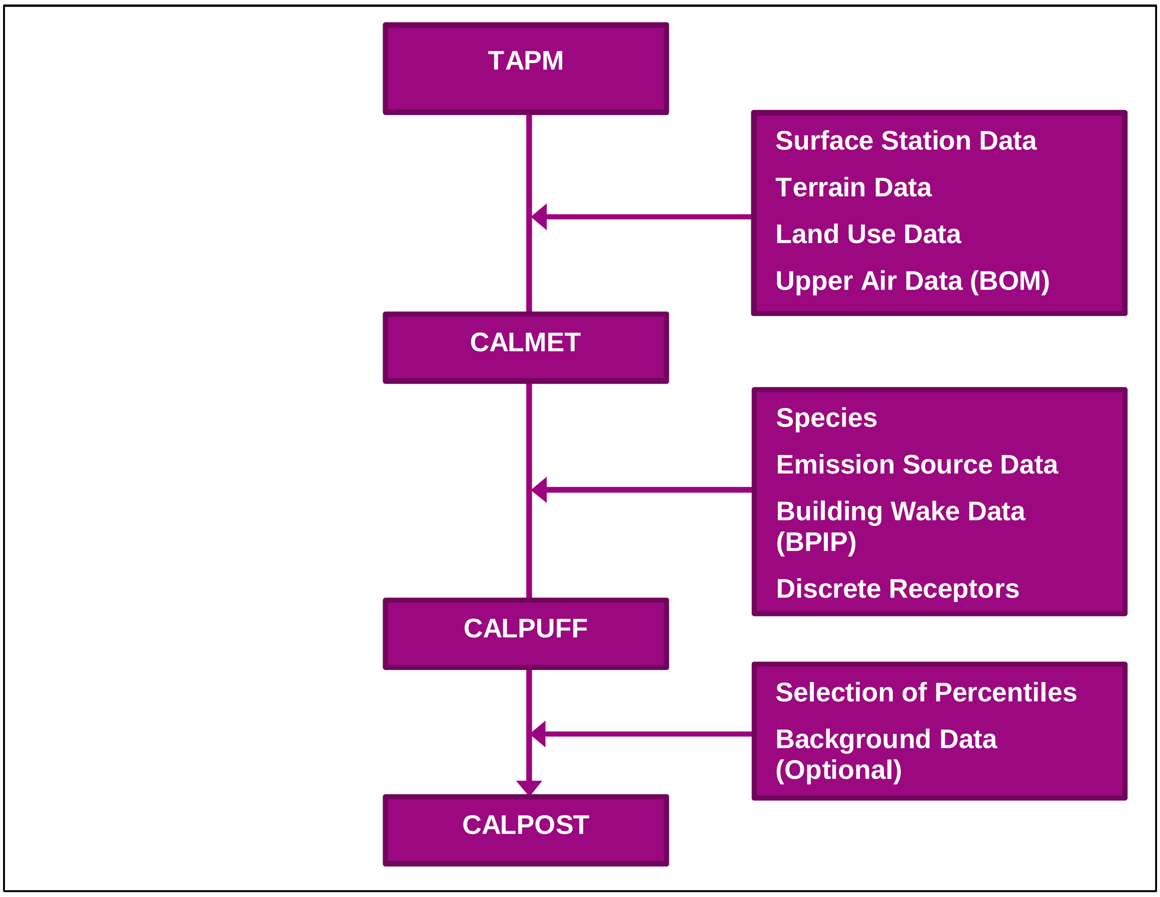


Figure 5-1 AQIA Model Program and Input Flow Chart

5.2.2 Model Scenarios

A single modelling scenario was undertaken for the purpose of this assessment. The scenario was based on expected normal locomotive and truck movements during operation. More detail is provided in **Section 5.2.6**.

5.2.3 Dispersion models

5.2.3.1 TAPM meteorological model

TAPM predicts three-dimensional meteorology, including terrain-induced circulations. TAPM is a PC-based interface that is connected to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic-scale meteorological analyses for various regions around the world. TAPM is used to predict meteorological parameters at both ground level and at heights of up to 8,000 m above the surface; these data are required by the CALPUFF model. The TAPM output file requires processing through a program such as CALTAPM to generate a file that is used within CALMET to generate the three-dimensional wind fields required by the CALPUFF dispersion model.

The NSW EPA has released guidance documentation (Barclay and Scire, 2011) on the optimum settings for the use of the CALPUFF modelling system. One modelling approach provided in the document is the use of a ‘Hybrid Mode’ whereby numerical prognostic three-dimensional meteorological model data, in a 3D.DAT file, along with surface observation data gained from a representative nearby surface monitoring station, are combined. The CALTAPM program converts the TAPM data into a 3D.DAT file, which can be input directly into the CALMET meteorological processer.

5.2.3.2 CALPUFF air dispersion model suite

Various air dispersion models are required for the successful modelling of air quality impacts from the Site. These are:

- the Air Pollution Model (TAPM), which is used to generate prognostic meteorological data; CALTAPM, which is used to process the TAPM output into a format suitable for input into the CALMET model;
- CALMET, which generates three-dimensional wind fields used in the dispersion modelling;
- CALPUFF, which predicts the movement and concentration of pollutants; and
- CALPOST, which is used to process the CALPUFF output files.

CALPUFF is the NSW EPA model of choice for areas that are affected by coastal breezes, coastal fumigation or complex terrain. The Site is located in a coastal area and, hence, the CALPUFF model was chosen for use in the AQIA. The CALPUFF modelling system consists of three main components and a set of pre-processing and post-processing programs. The main components of the modelling system are CALMET (a diagnostic three-dimensional meteorological model), CALPUFF (an air quality dispersion model), and CALPOST (a post-processing package). The main CALPUFF related software package programs are described in the following sections.

5.2.3.2.1 CALMET

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. CALMET produces a meteorological file that is used within the CALPUFF model to predict the movement of pollution.

5.2.3.2.2 CALPUFF

CALPUFF is a non-steady-state three-dimensional Gaussian puff model developed for the US Environmental Protection Agency (US EPA) and approved by the NSW EPA for use in situations where basic Gaussian plume models are not effective, such as areas with complex meteorological or topographical conditions, including coastal areas with re-circulating sea breezes. The CALPUFF model substantially overcomes the basic limitations of the steady-state Gaussian plume models, and as such, was chosen as the most suitable dispersion model for the AQIA and Site Model. Some examples of applications for which CALPUFF may be suitable include:

- near-field impacts in complex flow or dispersion situations:
    - complex terrain;
    - stagnation, inversion, recirculation, and fumigation conditions;
    - overwater transport and coastal conditions; and
    - light wind speed and calm wind conditions.
- long range transport;
- visibility assessments and Class I area impact studies[1];
- criteria pollutant modelling, including in assessment of development applications;
- secondary pollutant formation and particulate matter modelling; and
- buoyant area and line sources (e.g. forest fires and aluminium reduction facilities).

5.2.3.2.3 CALPOST

The CALPOST program is used to process the outputs of the CALPUFF program into a format defined by the user. Results can be tabulated for selected options including percentiles, selected days, gridded results or discrete locations, and can be adjusted to account for chemical transformation and background values.

---

[1] A Class 1 area impact study refers to A "Class 1" area is a geographic area recognized by the US EPA as being of the highest environmental quality and requiring maximum protection.

The program default settings were used for the CALPOST program, ensuring that the correct averaging periods, percentiles and receptors were selected to meet the NSW EPA ambient pollutant criteria assessed (EPA, 2017).

5.2.4 Model setup

5.2.4.1 Key model input parameters

A summary of the data and parameters used as inputs to TAPM, CALMET and CALPUFF is presented in **Table 8**. The CALMET and CALPUFF settings have been chosen in accordance with the following documents:

- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Barclay & Scire 2011); and
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2017)

Table 8 Summary of model input parameters

Parameter	Input
TAPM	
Horizontal resolution	40 x 40 grid points; outer grid spacing 30,000 m x 30,000 m with an inner grid spacing of 1,000 metres.
Grid centre coordinates (mX, mY)	293234, 6258701
Vertical levels	Defaults
Land use data	Default TAPM database
Simulation length	1 January – 31 December 2016
CALMET (v6.42)	
Meteorological grid domain	34.8 km x 34 km
Meteorological grid resolution	200 m resolution (174 x 170 grid cells)
Reference grid coordinate (centre)	291080, 6264710
Cell face heights in vertical grid	0, 20, 40, 60, 100, 140, 180, 260, 500, 800, 1500, 2200, 3000 m
Simulation length	1 year (2016)
Surface meteorological stations	Bringelly (OEH) 2016 Prospect (BoM) 2016 Richmond (BoM) 2016 St Marys (OEH) 2016 TAPM
Upper air meteorological station	5 TAPM upper air stations.
Terrain and land use data	Terrain elevations were extracted from the NASA Shuttle Radar Topography Mission Version 3 data set (SRTM1 30 metre resolution). Land use data taken from GLCC Australia Pacific (~1 km resolution)
TERRAD (Terrain radius of influence)	5 km
RMAX1 (Radius of influence of meteorological stations: surface)	4.5 km
RMAX2 (Radius of influence of meteorological stations: aloft)	5 km
R1 (Observation weighting: surface)	3 km

Parameter	Input
R2 (Observation weighting: aloft)	2 km
IEXTRP (Vertical extrapolation of surface wind observation)	- 4 (extrapolate using similarity theory, exclude upper air observations from layer 1)
BIAS (NZ) (Layer dependent weighting factor for initial guess field)	-1, -0.8, -0.5, 0, 0, 0, 0.5, 0.8, 1, 1, 1, 1
CALPUFF (v7.2.1)	
Computational grid	34.8 km x 34 km approximately centred on the site
Sampling grid	3 km x 3 km Sampling grid approximately centred on the Site. Grid spacing 50 m
Receptors	Discrete Receptors : 104
Dispersion option	Dispersion coefficient. Use turbulence computed from micrometeorology
Meteorological modelling period	1 January 2016 – 31 December 2016

The CALMET settings have been selected in accordance with Barclay & Scire (2011). A review of the prepared CALMET meteorological data using the above settings, as provided **Appendix B**, shows a strong correlation between measured surface patterns and predicted data. It is therefore concluded that the meteorological data used in the assessment is fit for purpose.

5.2.4.2 Dispersion meteorology

The meteorological data is used by the CALPUFF model in different ways to estimate the dispersion of air pollutants:

- ambient temperature is used to incorporate thermal buoyancy effects when calculating the rise and dispersion of pollutant plumes;
- wind direction determines the direction in which pollutants would be carried;
- wind speed influences the dilution and entrainment of the plume into the air continuum;
- atmospheric stability class is a measure of atmospheric turbulence and the dispersive properties of the atmosphere. Most dispersion models utilise six stability classes, ranging from A (very unstable) to F (stable/very stable); and
- vertical mixing height is the height at which vertical mixing occurs in the atmosphere.

Meteorological data for the period January – December 2016 were used in this assessment. Prognostic meteorological data were generated using TAPM for upper air conditions for a 30 km x 30 km grid with a 1 km grid spacing centred close to the Project Area. The TAPM output (processed using CALTAPM) was then used, with surface station data from Bureau of Meteorology and OEH monitoring stations, as input into the CALMET meteorological module to compute the wind fields used by CALPUFF. Analysis of the meteorological data used in the modelling are provided in **Appendix B**. The analysis concluded that the data were considered to be representative of meteorological conditions around the site.

5.2.5 Terrain

Digital terrain data used to generate the upper air prognostic meteorological data were obtained from the TAPM 9 second DEM database covering an area of 30 km by 30 km on a 1 km grid, roughly centred on the Project Area. For the CALMET model, the geophysical processor was used to convert land use and terrain data from WebGIS (SRTM1 for terrain at approximately a 30 m resolution) and GLCC Australia Pacific (approximate 1 km resolution) throughout the meteorological domain.

Additional terrain and land use information used in the CALMET Model is provided in **Table 8**.

5.2.6 Emission rates

Operational emission rates for locomotives, forklifts and trucks were estimated for inclusion in the model. Emission estimation methods for each source type are presented in the following sections.

5.2.6.1 Locomotive Emissions

Locomotive emissions were estimated for two locomotives; one idling and one moving under power at Notch 2. Modelled stack and operational parameters for the locomotives are presented in **Table 9**. Locomotive engine parameters are presented in **Table 10**. Emission factors and calculated emission rates are presented in **Table 11**.

Table 9 Locomotive stack and operational parameters

Parameter	Units	Loco Operation		Comments/Assumptions
		Idling	Notch 2	
Exit Diameter	m	0.5	0.5	Based on CARB 2004
Exit Area	m^2	0.196	0.196	Calculated
Exit Temperature	^0C	68	130	ABMARC 2015
Velocity	m/s	3	3	Based on CARB 2004
Flow Rate	m^3/s	0.589	0.589	Calculated
Stack Height	m	4.5	4.5	Estimated to be the same as locomotive height
No. of Sources	Int.	2		Based on shunting video provided by Pacific National
Hours of Operation	hr/day	24		Proposed

Table 10 Locomotive engine parameters

Parameter	Units	Power Ratio (Notch)		
		Idle	2	8 (Full Power)
Power Fraction	%	2.3	11.2	100
Engine Power	kW	56.6	275.5	2460
Operating Temperature	^0C	68	130	333
Engine parameters sourced from ABMARC 2015				

Table 11 Locomotive emission factors and emission rates

Parameter	Units	Notch		Reference
		Idle	2	
PM_{10} Emission factor	g/kWhr	1.210	0.328	ABMARC 2015
PM_{10} Emission rate	kg/hr	0.068	0.090	-
	g/s	0.019	0.025	-
$PM_{2.5}$ Emission factor	g/kWhr	1.162	0.315	ABMARC 2015
$PM_{2.5}$ Emission rate	kg/hr	0.066	0.087	-
	g/s	0.018	0.024	-
NOx Emission factor	g/kWhr	95.70	8.850	ABMARC 2015
NOx Emission rate	kg/hr	5.415	2.438	-
	g/s	1.504	0.677	-
CO Emission factor	g/kWhr	30.90	1.740	ABMARC 2015
CO Emission rate	kg/hr	1.748	0.479	-
	g/s	0.486	0.133	-
SO_2 Emission factor	g/kWhr	0.036	0.003	SO_2 to NOx ratio from NPI 2008
SO_2 Emission rate	kg/hr	0.002	0.001	-
	g/s	0.0006	0.0003	-
THC Emission factor	g/kWhr	16.20	0.719	ABMARC 2015
THC Emission rate	kg/hr	0.917	0.198	-
	g/s	0.255	0.055	-
Benzene Emission factor	g/kWhr	0.365	0.016	Benzene to THC Ratio from NSW EPA 2012
Benzene Emission rate	kg/hr	0.021	0.004	-
	g/s	0.006	0.001	-

5.2.6.2 Mobile Plant Emissions

Emissions for a single forklift truck were included in the modelling. Operational parameters, engine and stack parameters and adopted emission factors for the forklift are presented in **Table 12**.

Table 12 Forklift parameters and emission factors

Parameter	Value	Units	Comments & Assumptions
Omega Forklift Truck E Series	1	-	Assumed
Operation	24	hrs/day	Assume 24/7 operation as site can accept deliveries at any time
Utilisation	100%	use/hr	Conservatively it is assumed that the truck is in operation all hour every hour
Stack Height	5	m	Assumed
Stack Temperature	350	^{0}C	
Stack Velocity	10	m/s	
Stack Diameter	0.3	m	
Stack Flow Rate	0.707	m^3/s	
Engine power	250	kW	Information Provided by Pacific National
Emission Factors			
CO	3.5	g/kWh	Euro Stage III A Emission Standard compliant for nonroad diesel engines
NO_x	4.0	g/kWh	Euro Stage III A Emission Standard for HC+NOX (Conservative estimate)
THC	0.2	g/kWh	Euro Stage III B Emission Standard for HC
TSP	0.2	g/kWh	Assumes TSP = PM_{10}
PM_{10}	0.2	g/kWh	Euro Stage III A Emission Standard compliant for nonroad diesel engines
$PM_{2.5}$	0.018	g/kWh	Assumes 9% of PM_{10} is $PM_{2.5}$ (from NPI 2008)

5.2.6.3 Trucks

Truck emissions included in the model were based on truck type and projected daily truck movements provided by Pacific National. Daily truck movements by hour-of-day are presented in **Table 13**.

Table 13 Truck numbers by hour of day

Hour of Day	Number of Trucks
1	1.5
2	1.5
3	1.5
4	3
5	3
6	8.2
7	8.6
8	15
9	15
10	15

Hour of Day	Number of Trucks
11	15
12	15
13	15
14	15
15	14
16	14
17	15
18	15
19	4.5
20	7.2
21	7
22	4.5
23	3
24	1.5
Total daily trucks	**218**

Pollutant emission factors for trucks were estimated using the COPERT Australia model. Adopted emission factors are presented in **Table 14**.

Table 14 Truck emission factors

Pollutant	Emission Factor	Units	Reference
CO	1.999	g/km	Based on COPERT Results for 2020 ADR 80/02 @ 10km/hr
NOx	7.270	g/km	Based on COPERT Results for 2020 ADR 80/02 @ 10km/hr
THC	0.109	g/km	Based on COPERT Results for 2020 ADR 80/02 @ 10km/hr
TSP	0.133	g/km	Assumes TSP = PM_{10}
PM10	0.133	g/km	Based on COPERT Results for 2020 ADR 80/02 @ 10km/hr
PM2.5	0.095	g/km	Based on COPERT Results for 2020 ADR 80/02 @ 10km/hr

5.2.6.4 Modelled Emission Rates

A summary of modelled emission rates for locomotives and the forklift are presented in **Table 15**. The emission rates for the locomotive point sources were taken as the highest of the idle and Notch 2 emission rates presented in **Table 11**.

Table 15 Point Source Constant Emission Rates

Source	No. Sources	Emission Rates (g/s)						
		CO	NO_x	TSP	PM_{10}	$PM_{2.5}$	Total VOCs	Benzene
Locomotive	2	0.486	1.504	0.025	0.025	0.024	0.255	5.73E-03

Source	No. Sources	Emission Rates (g/s)						
		CO	NO_x	TSP	PM_{10}	$PM_{2.5}$	Total VOCs	Benzene
Forklift	1	0.243	0.278	0.014	0.200	0.018	0.013	2.97E-04

A summary of hourly varying truck emission rates used in the model are presented in **Table 16**. These were based on an average distance of 2 km travelled onsite per truck.

Table 16 Hourly Varying Truck Emission Rates

Hour	Emission Rates (g/s)						
	CO	NO_x	TSP	PM_{10}	$PM_{2.5}$	Total VOCs	Benzene
1	0.00167	0.00606	0.00009	0.00011	0.00011	0.00008	2.05E-06
2	0.00167	0.00606	0.00009	0.00011	0.00011	0.00008	2.05E-06
3	0.00167	0.00606	0.00009	0.00011	0.00011	0.00008	2.05E-06
4	0.00333	0.01212	0.00018	0.00022	0.00022	0.00016	4.10E-06
5	0.00333	0.01212	0.00018	0.00022	0.00022	0.00016	4.10E-06
6	0.00911	0.03312	0.00050	0.00060	0.00060	0.00043	1.12E-05
7	0.00955	0.03474	0.00052	0.00063	0.00063	0.00045	1.18E-05
8	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
9	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
10	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
11	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
12	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
13	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
14	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
15	0.01555	0.05655	0.00085	0.00103	0.00103	0.00074	1.91E-05
16	0.01555	0.05655	0.00085	0.00103	0.00103	0.00074	1.91E-05
17	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
18	0.01666	0.06059	0.00091	0.00111	0.00111	0.00079	2.05E-05
19	0.00500	0.01818	0.00027	0.00033	0.00033	0.00024	6.15E-06
20	0.00800	0.02908	0.00044	0.00053	0.00053	0.00038	9.84E-06
21	0.00778	0.02827	0.00043	0.00052	0.00052	0.00037	9.57E-06
22	0.00500	0.01818	0.00027	0.00033	0.00033	0.00024	6.15E-06
23	0.00333	0.01212	0.00018	0.00022	0.00022	0.00016	4.10E-06
24	0.00167	0.00606	0.00009	0.00011	0.00011	0.00008	2.05E-06

6.0 Impact Assessment

6.1 Potential Construction Impacts

As described in **Section 5.1** a semi-quantitative risk assessment of potential dust impacts on surrounding sensitive receptors was undertaken for the construction phase of the Project using the IAQM four-step process.

6.1.1 Step 1: Screening Assessment

The IAQM method recommends further assessment of dust impacts for construction activities where sensitive receptors are located closer than:

- 350m from the boundary of the site.
- 50m from the route used by construction vehicles on public roads up to 500m from a site entrance.

There are a number of sensitive receptors located within 350m of the boundary of the Project area and therefore further assessment of dust impacts was undertaken.

6.1.2 Step 2: Risk Assessment of Unmitigated Impacts

6.1.2.1 Step 2A: Dust Emission Magnitude

Dust emission magnitudes are estimated according to the scale of works being undertaken and other considerations such as meteorology, types of material being used, or general construction methodology. The IAQM guidance provides examples to aid classification and these are presented in **Appendix A.**

Potential dust emission magnitudes for the Project were estimated based on the IAQM examples listed in **Appendix A**. Justification and the factors used in determining the magnitudes are presented in **Table 17**.

Table 17 Dust Emission Magnitudes in Accordance with IAQM Guidance

Activity	Potential Dust Emission Magnitude	Justification
Demolition	Not Applicable	No demolition of buildings anticipated.
Earthworks	Large	• Total Project area is approximately 9.9 hectares (990,000m^2) with excavation works limited to surface levelling of natural landscape. • Earthworks vehicles will include graders, frontend loaders, trucks and water carts. • Material to be excavated at the site will predominantly be surface soil stockpiled onsite.
Construction	Medium	• Buildings to be constructed include administration offices, wash bay, container repair shed, workshop and fuel storage area (total volume approximately 50,000 m^3). • Construction materials assumed to have low dust generating potential (e.g. steel, cladding).
Trackout	Small	• Total number of outward truck movements is expected to be below 10 movements per day as most excavated material during earthworks to be stockpiled onsite.

6.1.2.2 Step 2B: Sensitivity of the Surrounding Area

The IAQM methodology allows the sensitivity of an area to dust soiling, human health impacts due to PM_{10}, and ecological effects to be classified as high, medium, or low. Surrounding vegetation is limited to remnant native vegetation immediately to the north within 100m from the bulk of dust-emitting activities are likely to take place. The sensitivity of the surrounding area due to ecological effects was therefore not assessed further. The classifications are determined according to matrix tables provided in the IAQM guidance document. Individual matrix tables for dust soiling and human health impacts are provided. Factors used in the matrix tables to determine the sensitivity of the surrounding area are described as follows:

- Receptor sensitivity (for individual receptors in the area):
  - High sensitivity – locations where members of the public are likely to be exposed to elevated concentrations of PM_{10} for eight hours or more in a day. For example private residences, hospitals, schools, or aged care homes;
  - Medium sensitivity - places of work where exposure is likely to be eight hours or more in a day;
  - Low sensitivity – locations where exposure is transient – i.e. one or two hours maximum. For example parks, footpaths, shopping streets, playing fields.
- Ambient annual mean PM_{10} concentrations (only applicable to the human health impact matrix).
- Number of receptors in the area (categorised as 1-10, 10-100 or >100).
- Proximity of receptors to dust sources based on radii of 20m, 50m 100m and 350m from the source.

According to the IAQM guidance listed above, the overall sensitivity of the Project area to both dust soiling and human health impacts is classified as Low. The justification for this classification is provided in **Table 18**.

Table 18 Sensitivity of the Area in Accordance with IAQM Guidance

Potential Impact	Sensitivity of the Area	Justification
Dust Soiling	Low	No high-sensitivity receptors (residential) within 20m of the Project boundary. >100 high-sensitivity receptors (residential) within 350m of the Project boundary (see **Section 4.4)**.
Human Health (PM_{10})	Low	No high-sensitivity receptors (residential) within 20m of the Project boundary. >100 high-sensitivity receptors (residential) within 350m of the Project boundary (see **Section 4.4**). Annual average PM_{10} concentration in the area between 15µg/m^3 and 19µg/m^3 which is below the EPA criterion of 25 µg/m^3 (see **Section 4.2).**

6.1.2.3 Step 2C: Unmitigated Risks of Impacts

The dust emission magnitudes for each activity in **Section 6.1.2.1** were combined with the sensitivity of the area in **Table 18** to determine the risk of construction dust air quality impacts, with no mitigation applied. The risk of impacts for each activity is assessed according to the IAQM risk matrix methodology. An example of the IAQM earthworks risk matrix is provided in **Table 19**. The without mitigation dust risk impacts for each activity are summarised in **Table 20**.

Table 19 Example IAQM Risk Matrix - Earthworks

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 20 Summary of Project Dust Risks

Potential Impact	Risk of Dust Impacts on Sensitive Receptors – Without Mitigation			
	Demolition	Earthworks	Construction	Trackout
Dust Soiling	Not Applicable	Low	Low	Negligible
Human Health (PM_{10})	Not Applicable	Low	Low	Negligible

The outcome of the semi-quantitative air quality risk assessment shows that the unmitigated air emissions from the construction phase of the Project pose a Low risk of both dust soiling and human health impacts.

6.1.3 Step 3: Mitigation Strategies

A range of in-principle and Project-specific mitigation strategies aimed at reducing the likelihood of air quality impacts to offsite sensitive receptors were identified. These mitigation strategies should be considered for all work elements of the Project. Recommended mitigation strategies include:

- Orientating stockpiles of excavated material in a direction that reduces exposed surfaces to prevailing winds.
- Watering of stockpiles when required to maintain a moisture content that minimises dust generation.
- Promptly removing and disposing of spilled materials which may cause a dust nuisance.
- Storing dust generating materials in enclosures where possible.
- Restrict vehicle movements to within designated access paths.
- Ensure machinery is working correctly.
- If possible, limit dust-producing work on windy days if the wind is blowing towards receptors.
- Enclose site or specific operations where there is high potential for dust production over long periods.
- Remove excavated material and any dust generating materials from site as soon as possible, unless being reused onsite.
- Dust suppression of exposed areas as required using a water cart.
- Ensuring that trucks transporting any fine materials are covered and fitted with tight tailgates.
- Implementation of any additional mitigation options as required by the Project's Environmental Manager or as a result of community complaints.

6.1.4 Step 4: Reassessment

The final step of the IAQM methodology is to determine whether there are significant residual impacts, post mitigation, arising from a proposed development. The guidance states:

"For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be 'not significant'."

It is anticipated that the Project would not constitute an atypical case and that, with implementation of the proposed mitigation strategies described above, the residual effect (impacts) would be "**not significant**" for both dust soiling and human health impacts. The mitigation strategies listed above should be incorporated into a Construction Environmental Management Plan (CEMP) to ensure the measures are implemented during Project earthworks and construction activities.

6.2 Potential Operational Impacts

Modelling results are presented in **Table 21** and are summarised as follows:

- No exceedances of the PM_{10}, NO_2, CO, benzene, toluene, ethylbenzene or xylene criteria across all averaging periods were predicted for the project.
- Very minor exceedances of the $PM_{2.5}$ 24-hour and annual criteria were predicted for cumulative concentrations at an offsite residential area (to the southwest of the site). The predicted exceedances were largely attributed to elevated background concentrations. The project contribution was predicted to be very minor, with predicted incremental concentrations equating to approximately 9 % of the 24-hour average criterion and 7.5 % of the annual average criterion. The project contribution to $PM_{2.5}$ concentrations at nearby receptors is unlikely to result in any significant air quality impacts to nearby sensitive receptors.
- Table 21 Summary of modelling results

Pollutant of Concern	Averaging Period	Predicted Concentration (µg/m³)		Criteria (µg/m³)
		Project Contribution	Cumulative	
Particulate Matter (PM_{10})[1]	24 hour	3.7	49.3	50
	Annual	1.4	20.8	25
Particulate Matter ($PM_{2.5}$)[1]	24 hour	2.2	**25.7**	25
	Annual	0.6	**8.4**	8
Nitrogen dioxide (NO_2)[2]	1 hour	192.8	209.7	246
	Annual	9.4	16.7	62
Carbon Monoxide (CO)[2]	15 minute	385	3,552	100,000
	1 hour	292	2,692	30,000
	8 hour	105	1,805	10,000
Benzene[2]	99.9th Percentile 1-hour	0.7	-	29
Total VOC[2]	-	123.1	-	-
Toluene[2]	99.9th Percentile 1-hour	< 123.1[3]	-	360
Ethylbenzene[2]	99.9th Percentile 1-hour	< 123.1[3]	-	8000
Xylene[2]	99.9th Percentile 1-hour	< 123.1[3]	-	190

[1]Assessed as the highest predicted concentration in nearby residential land
[2]Assessed at the site boundary
[3]Less than or equal to predicted Total VOC concentration

7.0 Conclusion

The general dispersion parameters such as meteorology, terrain and surrounding land use demonstrate that due to the variable wind pattern and the lack of any complex terrain or additional sources of pollution, there is expected to be minimal air quality impacts associated with the proposed earthworks and construction activities.

The unmitigated risk of air quality impacts during earthworks and construction have been predicted to be low for dust soiling on people and property and low for human health. To further minimise the predicted level of risk, the following precautionary management and mitigation measures are recommended:

- Minimise exposed surfaces, such as stockpiles and cleared areas, including partial covering of stockpiles where practicable;
- Implement dust suppression measures, such as watering of exposed soil surfaces, dust mesh, water trucks and sprinklers to minimise dust generation;
- Avoid dust generating activities and water stockpiles and exposed areas during adverse weather conditions such as high winds and dry periods;
- Establish hard surfaced haul routes which are regularly damped down and cleaned;
- Perform regular visual inspections to identify areas that may require watering;
- Establish defined site entry and exit points to minimise tracking of soil on surrounding roads; and
- Ensure vehicles entering and leaving the site are covered to prevent escape of materials during transport.

Air quality impacts from ongoing operations, predominantly associated with road and rail traffic operations, were predicted to be below relevant EPA air quality criteria for all pollutants except $PM_{2.5}$, which were above criteria due to elevated background concentrations. Project contribution to $PM_{2.5}$ concentrations at nearby sensitive receptors was predicted to be 9 % and 7.5 % of the 24-hour and annual average criteria, respectively. The change in $PM_{2.5}$ concentrations due to operation of the project is considered to be relatively minor.

Based on the minor dust impacts during construction and predicted compliance with relevant EPA ambient criteria for all pollutants during operation with the exception to minor cumulative exceedances for $PM_{2.5}$[2]; provided appropriate mitigation measures are implemented no significant air quality impacts from construction or operation of the St Marys Freight Hub are anticipated.

[2] where incremental contribution from the project is relatively small no significant air quality impacts

References

ABMARC, Diesel Locomotive Emissions Upgrade Kit Demonstration Project - Fuel Efficiency, Emissions & Noise Testing p40, 2015.

California Environmental Protection Agency, Air Resources Board (CARB), Roseville Yard Study, 2004.

Environment Protection Authority, Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, 2017.

National Pollutant Inventory (NPI), Emissions Estimation Technique Manual Railway Yard Operations v2.0, June 2008, Table 7.

NSW EPA, Air Emission Inventory for the Greater Metropolitan Region in New South Wales- Off-road Mobile Emissions: Results - 2008 Calendar Year, 2012.

Penrith City Council (2010) *Local Environmental Plan, Penrith City Council*, Perith, NSW, Australia

UK Institute of Air Quality Management (IAQM), Guidance on the assessment of dust from demolition and construction, 2014.

BoM (2019) Climate Data Online, Penrith Accessed 21 February 2019:

http://www.bom.gov.au/climate/averages/tables/cw_067113.shtml

http://www.environment.nsw.gov.au/AQMS/search.htm (accessed 21 February 2019)

Appendix A

IAQM Dust Emission Magnitude Classification

Appendix A IAQM Dust Emission Magnitude Classification

Under the UK Institute of Air Quality Management (IAQM) document dust emission magnitudes are estimated according to the scale of works being undertaken and other considerations such as meteorology, types of material being used, or general construction methodology. The IAQM guidance provides examples to aid classification, as presented in the following excerpt from IAQM:

The dust emission magnitude is based on the scale of the anticipated works and should be classified as Small, Medium, or Large. The following are examples of how the potential dust emission magnitude for different activities can be defined. Note that, in each case, not all the criteria need to be met, and that other criteria may be used if justified in the assessment:

Demolition: Example definitions for demolition are:

- Large: Total building volume >50,000m^3, potentially dusty construction material (e.g. concrete), on-site crushing and screening, demolition activities >20m above ground level;
- Medium: Total building volume 20,000m^3 – 50,000m^3 , potentially dusty construction material, demolition activities 10-20m above ground level; and
- Small: Total building volume <20,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

Earthworks: Earthworks will primarily involve excavating material, haulage, tipping and stockpiling. This may also involve levelling the site and landscaping. Example definitions for earthworks are:

- Large: Total site area >10,000m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonnes;
- Medium: Total site area 2,500m^2 – 10,000m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4m - 8m in height, total material moved 20,000 tonnes – 100,000 tonnes; and
- Small: Total site area <2,000m^2 – soil type with large grain size, e.g. sand, <5 heavy earth moving vehicles at one time, formation of bunds <4m in height, total material moved <20,000 tonnes, earthworks during wetter months.

Construction: The key issues when determining the potential dust emission magnitude during the construction phase include the size of the building(s)/infrastructure, method of construction, construction materials, and duration of build. Example definitions for construction are:

- Large: Total building volume >100,000m^3, on site concrete batching, sandblasting;
- Medium: Total building volume 25,000m^3 – 100,000m^3, potentially dusty construction material (e.g. concrete), on site concrete batching; and
- Small: Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout: Factors which determine the dust emission magnitude are vehicle size, vehicle speed, vehicle numbers, geology and duration. As with all other potential sources, professional judgement must be applied when classifying trackout into one of the dust emission magnitude categories. Example definitions for trackout are:

- Large: >50 truck (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100m;
- Medium: 10-50 truck (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50m – 100m; and
- Small: <10 truck (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50m.

Appendix B

CALMET Data Analysis

Appendix B CALMET Data Analysis

CALMET Meteorological Data Review

This section presents a summary of CALMET model predictions at the proposed project location (Site), with reference against observations recorded at the NSW EPA St Marys automatic weather station (AWS). This AWS constitutes the closest observations station within the modelling domain, which has all required data for verification, along with a similar proximity to common terrain features, and is located approximately 4 km southwest from the Site.

Winds

Wind predictions were extracted from CALMET at the Site for reference against long term (2013 to 2018) observations at OEH St Marys. The following tables present a comparison between the two data sets.

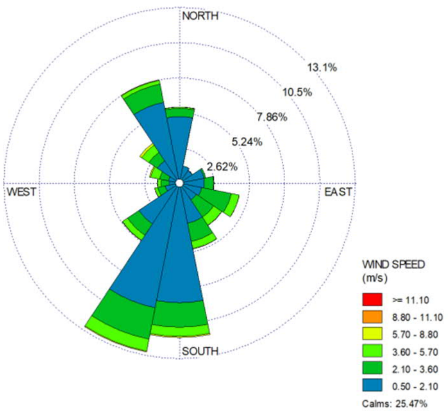
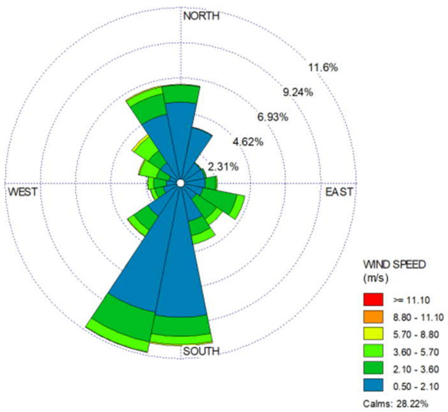
Wind speed statistics for 2016 are presented in **Table 22.** Winds predicted by CALMET at the site are very similar to those measured at the OEH site, with an average wind speed of 1.3 m/s in both data sets. A slightly higher frequency of calms are also predicted by CALMET compared with the OEH observations.

Table 22 Regional Wind Statistics Comparison

Wind Parameters	OEH St Marys 2013 – 2018	CALMET 2015
Average (m/s)	1.3	1.3
Maximum (m/s)	11.2	7.0
Calms (%) (<0.5m/s)	25.5	28.2

CALMET winds are compared against long term winds at OEH St Marys in **Table 23**. CALMET wind directions are very comparable to the long term trends.

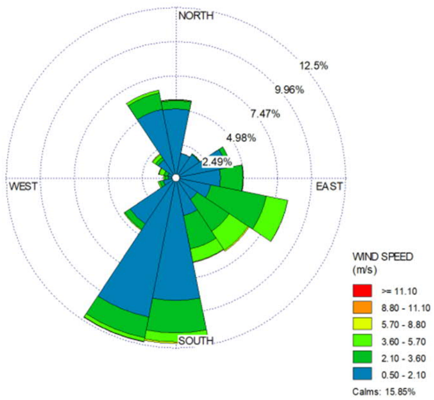
Table 23 Annual Wind Rose Comparison CALMET 2016 to Long Term (2013 – 2018) OEH St Marys

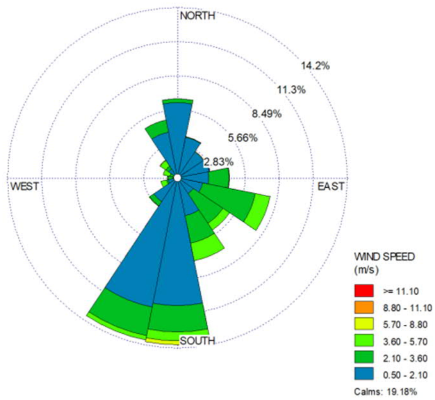
OEH St Marys 2013 – 2018	CALMET 2016
	

Seasonal winds predicted by CALMET are compared against long term winds at OEH St Marys in **Table 24**. Overall there is a good correlation between the two data sets, with some minor differences. The wind roses show the lower winds speeds predicted by CALMET at the Site compared with the St Marys observations.

Table 24 Seasonal wind rose comparison CALMET 2016 to long term (2013 – 2018) OEH St Marys

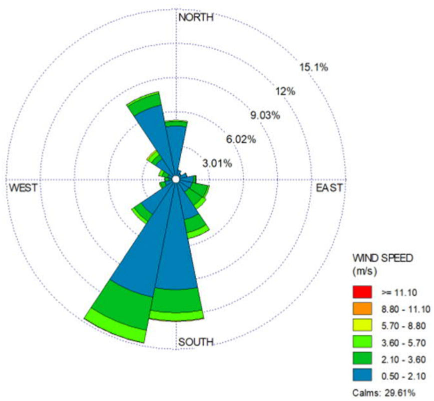
Summer Wind Rose

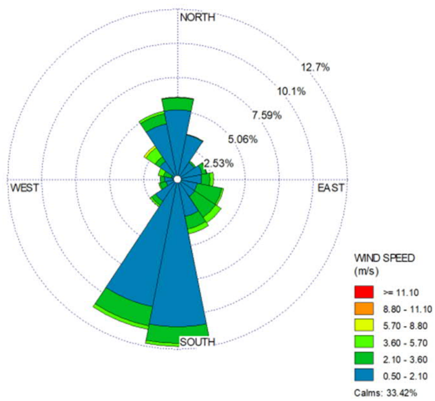




OEH St Marys 2013 - 2018 | CALMET 2016

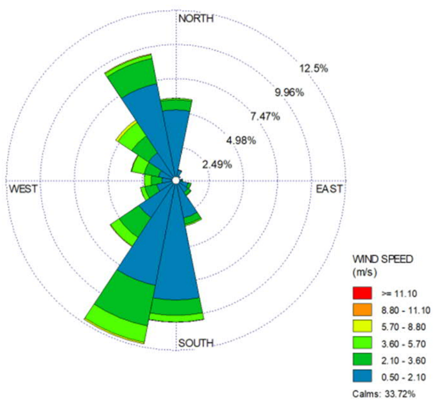
Autumn Wind Rose

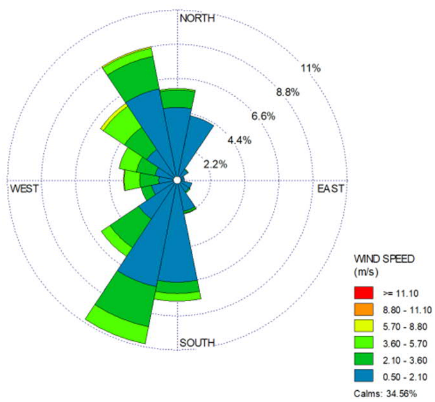




OEH St Marys 2013 - 2016 | CALMET 2016

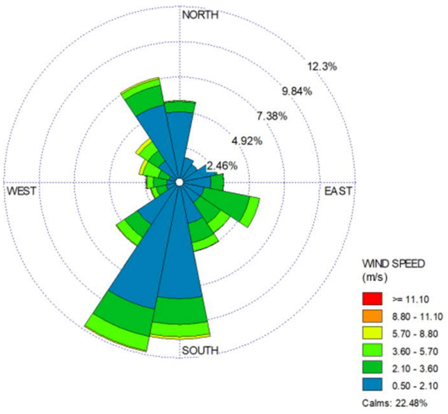
Winter Wind Rose

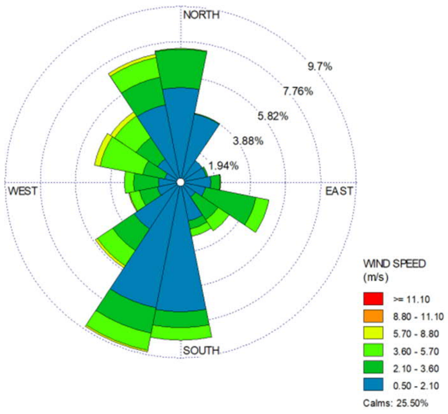




OEH St Marys 2013 - 2018 | CALMET 2016

Spring Wind Rose



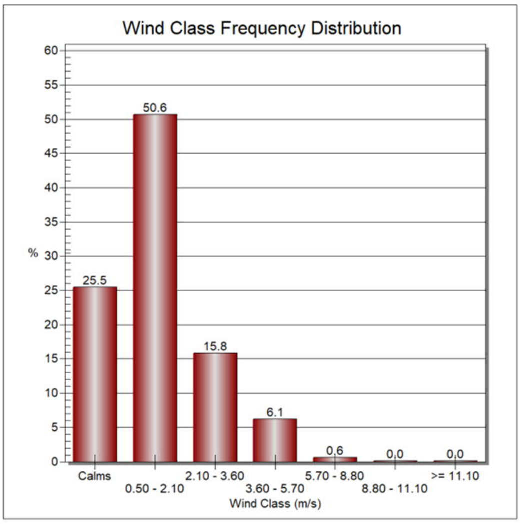


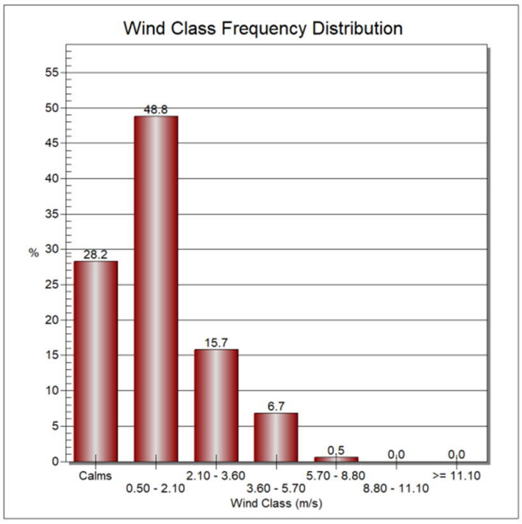
OEH St Marys 2013 - 2018	CALMET 2016

The wind speed frequencies presented in **Table 25** show some similar trends between the two datasets, with the winds being predominantly light to moderate in nature.

Table 25 Wind Speed Frequency Distributions Comparison

Wind Class Frequency





OEH St Marys 2013 - 2018	CALMET 2016

Temperature

Temperature data is estimated within the CALMET program for each hour of the meteorological data set. A comparison of the temperature vs. hour of day for CALMET is presented in **Figure 2**. The results are consistent with expected patterns for western parts of Sydney.

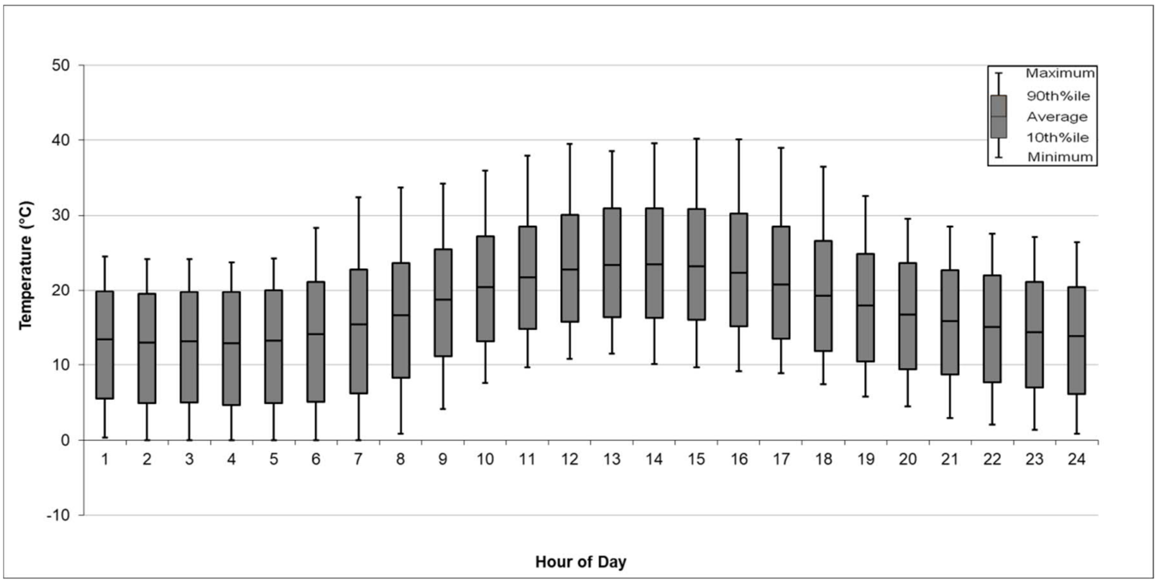


Figure 2 Box and whisker plot of temperature data for the CALMET 2016 dataset

Mixing Height

Mixing height is estimated within CALMET for stable and convective conditions (respectively), with a minimum mixing height of 50 m. **Figure 3** presents mixing height statistics by hour of day across the meteorological dataset, as generated by CALMET at the site. These results are consistent with general atmospheric processes that show increased vertical mixing with the progression of the day, as well as lower mixing heights during night time. In addition, peak mixing heights are consistent with typical ranges.

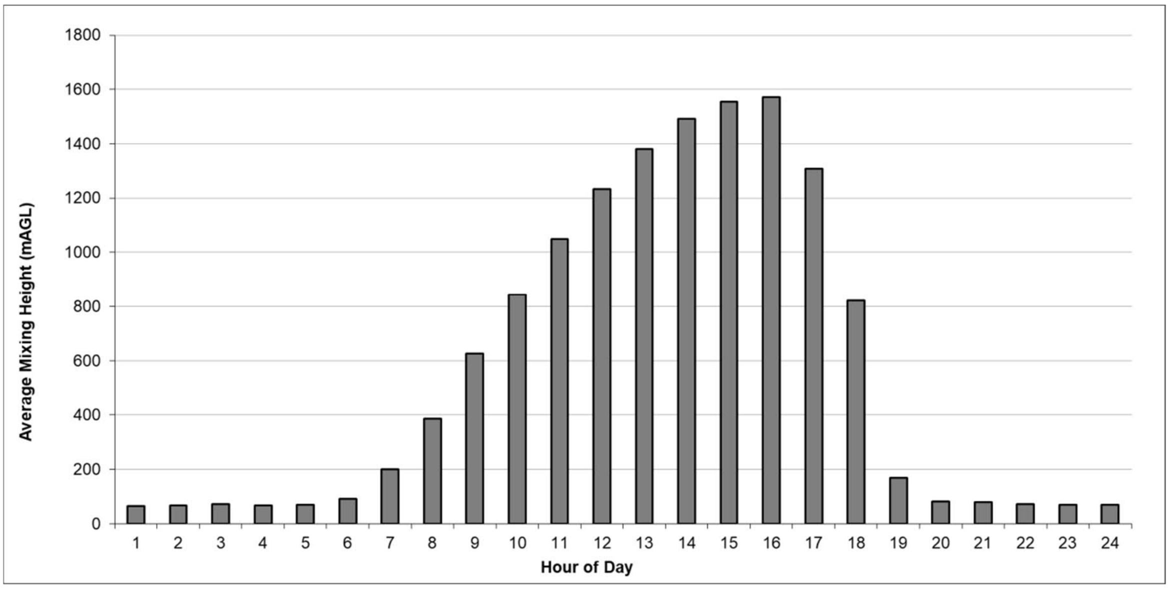


Figure 3 Mixing height statistics by hour of day for the CALMET 2016 dataset

Atmospheric Stability

Stability class is used as an indicator of atmospheric turbulence for use in meteorological models. The class of atmospheric stability generally used in these types of assessments is based on the Pasquill-Gifford-Turner (PG) scheme where six categories are used (A to F) which represent atmospheric stability from extremely unstable to moderately stable conditions respectively. The stability class of the atmosphere is based on three main characteristics, these being:

- Static stability (vertical temperature profile/structure)

St Marys Freight Hub

- Convective turbulence (caused by radiative heating of the ground)
- Mechanical turbulence (caused by surface roughness).

Whilst CALPUFF centrally uses Monin-Obukhov (MO) similarity theory to characterise the stability of the surface layer, conversions are made within the model to calculate the PG class based on Golders method (Golder 1972[3]) as a function of both MO length and surface roughness height. The PG Stability class frequencies for the CALMET dataset are provided in **Table 26**.

Table 26 Stability Class Frequency for the CALMET 2016 dataset

Stability Class	Frequency CALMET
A (Extremely Unstable)	6%
B (Moderately Unstable)	21%
C (Slightly Unstable)	17%
D (Neutral)	6%
E (Slightly Stable)	1%
F (Moderately Stable)	48%

Figure 4 and **Table 27** present an analysis of stability class frequency against wind speed for the CALMET 2016 dataset and confirm a typical distribution.

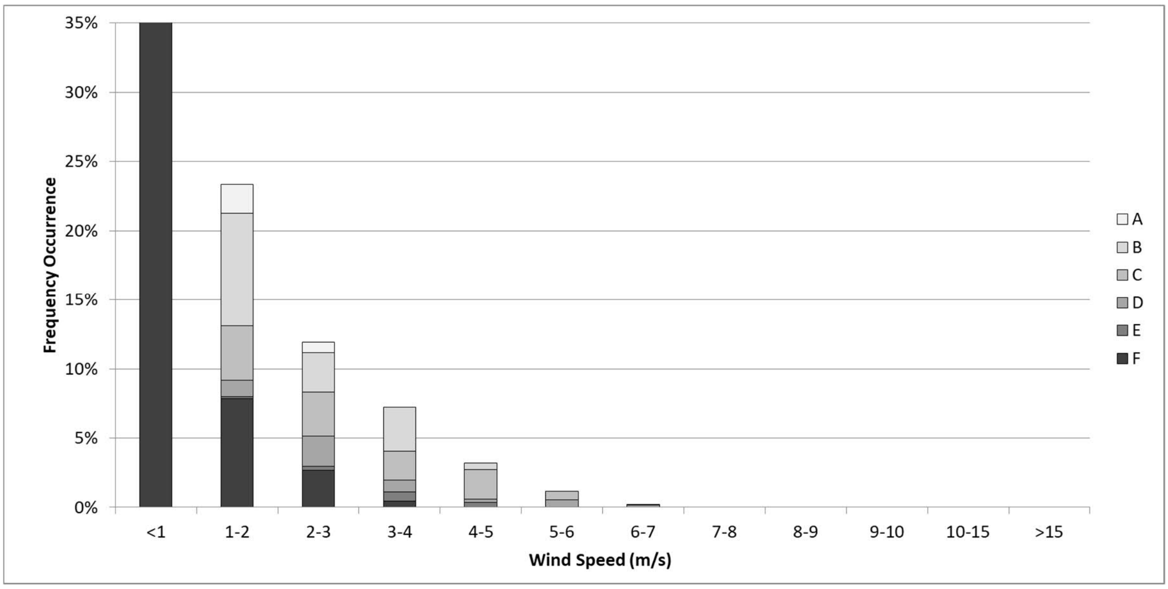


Figure 4 Stability Class Frequency by Wind Speed for the CALMET 2016 dataset

[3] Golder, D. 1972, “Relations among stability parameters in the surface layer”, Boundary Layer Meteorology, 3, 47-58

Table 27 Stability Class Frequency by Wind Speed for the CALMET 2016 dataset

Stability Class	Frequency by Wind Speed (m/s)												
	<1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-15	>15	All
A	274	180	67	0	0	0	0	0	0	0	0	0	521
B	601	714	250	278	40	0	0	0	0	0	0	0	1883
C	476	348	277	184	188	52	4	0	0	0	0	0	1529
D	32	103	192	75	21	46	14	0	0	0	0	0	483
E	0	14	24	56	29	3	0	0	0	0	0	0	126
F	3256	685	235	40	0	0	0	0	0	0	0	0	4216
TOTAL	**4639**	**2044**	**1045**	**633**	**278**	**101**	**18**	**0**	**0**	**0**	**0**	**0**	**8758**

Figure 5 presents an analysis of stability class for the CALMET dataset by hour of the day and confirms a typical distribution.

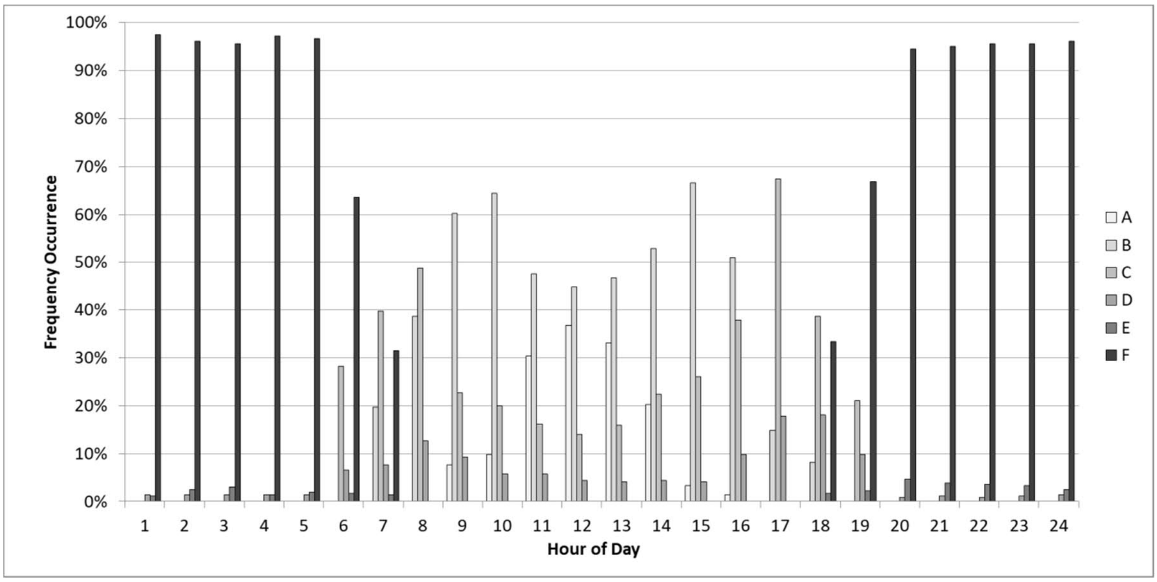


Figure 5 **Stability Class by Hour of Day for the CALMET 2016 dataset**

Conclusion

A 12-month meteorological dataset has been prepared for the site using a combination of local observations and prognostic modelling. Data has been evaluated using hourly observation data. The findings of the data analysis show that the CALMET model is performing well. The predicted meteorology is considered to be fit for purpose and acceptable for use in modelling of emissions from the site.