APPENDIX F

AIR QUALITY IMPACT ASSESSMENT

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STOCKTON SAND QUARRY

Boral Resources (NSW) Pty Ltd

23 September 2019

Job Number 17070718

Prepared by

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Air Quality Impact Assessment
Stockton Sand Quarry

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Element Environment Pty Ltd on behalf of Boral Resources (NSW) Pty Ltd (Boral). The report presents an assessment of potential air quality impacts associated with the proposed dredging operation of the inland dunes at the Stockton Sand Quarry (hereafter referred to as the Project). The Project involves the extraction of sand from the inland vegetated dunes, Stage 1 of the Project involves dry extraction by front-end loader/ excavator to a depth of 4 metres (m) Australian Height Datum (AHD) with all subsequent stages (2-6 inclusive) dredged from 4m AHD to 15m below sea level (-15m AHD).

To assess the potential air quality impacts associated with the proposed Project, this report incorporates the following aspects:

- A background and description of the existing operations and proposed Project;
- A review of the meteorological and air quality environment surrounding the Project site;
- A description of the dispersion modelling approach used to assess potential air quality impacts; and,
- Presentation of the predicted results and a discussion of the potential air quality impacts.

This air quality impact assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**). The assessment forms part of the environmental impact statement (EIS) prepared to accompany the State Significant Development (SSD) application for the Project.

2 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the maximum likely effects on air quality that may arise due to the Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

2.1 Secretary's Environmental Assessment Requirements

In preparing this Air Quality Assessment, the Secretary's Environmental Assessment Requirements issued for the Project in October 2018 have been addressed. The key matters raised for consideration in this Air Quality Assessment are outlined in **Table 2-1** along with a reference as to where the requirements are addressed in the report.

Table 2-1: Secretary's Environmental Assessment Requirements (SEAR No. 9490)

Specific Issue	General requirements	Section
Air quality – including:	A detailed air quality impact assessment (AQIA) of potential construction and operational impacts, in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy.	This report

2.2 NSW Environmental Protection Authority

This Air Quality Assessment has been prepared in general accordance with the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) and the specific requirements outlined in **Table 2-2** along with a reference to where the requirements are addressed in the report.

Table 2-2: NSW EPA agency comments for air quality (SEAR No. 9490)

Air quality		Section
Assessment Objective	Demonstrate the proposed project will incorporate and apply best management practice emission controls; and	8
	Demonstrate that the project will not cause violation of the project adopted air quality impact assessment criteria at any residential dwelling or other sensitive receptor.	7
Assessment Criteria	Define applicable assessment criteria for the proposed development referencing the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates	4
	Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations* (POEO) *Act* (1997) and the POEO (Clean Air) Regulation (2010).	4.4
Existing Environment	Provide a detailed description of the existing environment within the assessment domain, including: o geophysical form and land-uses; o location of all sensitive receptors; o existing air quality; and o local and regional prevailing meteorology.	3 & 5
	Justify all data used in the assessment, specifically including analysis of inter-annual trends (preferably five consecutive years of data), availability of monitoring data, and local topographical features.	5 & Appendix A
	Meteorological modelling must be verified against monitored data. Verification should involve comparative analysis of wind speed, wind direction and temperature, at a minimum.	6.2.1
	A review of all existing, recently approved and planned developments likely to contribute to cumulative air quality impacts must be completed.	6.4.3
Emissions Inventory	Provide a detailed description of the project and identify the key stages with regards to the potential for air emissions and impacts on the surrounding environment.	2

Air quality		Section
	Identify all sources of air emissions, including mechanically generated, combustion and transport related emissions likely to be associated with the proposed development.	6.3 & 6.4
	Estimate emissions of TSP, PM_{10}, $PM_{2.5}$, NO_x, (tonnes per year), at a minimum, for all identified sources during each key development stage. The emissions inventory should: ○ utilise USEPA (1995) (and updates) emission estimation techniques, direct ○ measurement or other method approved in writing by EPA; ○ calculate uncontrolled emissions (with no particulate matter controls in place); and ○ calculate controlled emissions (with proposed particulate matter controls in place).	6.4
	The emissions inventory must be explicitly coupled with the project description	6.4
	Provide a detailed summary and justification of all parameters adopted within all emission estimation calculations, including site specific measurements, proponent recommended values or published literature.	6.5 & Appendix C
	Document, including quantification and justification, all air quality emission control techniques/practices proposed for implementation during the project. As a minimum, consideration must be given to source control techniques, emission control through planning and reactive/predictive management techniques.	Appendix C
Best Practice Determination	Based on the TSP, PM_{10} and $PM_{2.5}$ emissions inventories calculated for the proposed development.	Appendix C
	Demonstrate that the proposed control techniques/practices are consistent with best management practice.	Appendix C
	Detail all sources possible sources of air pollution and activities/processes with the potential to cause air pollutants, including odours and fugitive dust emissions; and	Appendix C
	Describe in detail the measures proposed to mitigate the impacts and quantify the extent to which the mitigation measures are likely to be effective in achieving the relevant environmental outcomes.	Appendix C
Dispersion Modelling and Interpretation of Results	Atmospheric dispersion modelling should be undertaken in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates.	6
	Modelling must implement fit for purpose modelling techniques that: ○ have regard for the most up to date and scientifically accepted dispersion modelling techniques; ○ contextualise all assumptions based on current scientific understanding and available data; and ○ include a thorough validation of adopted methods and model performance.	6
	Use an appropriate atmospheric dispersion model to predict, at a minimum, incremental ground level concentrations/levels of the following: ○ 24-hour and annual average PM_{10} concentrations; ○ 24-hour and annual average $PM_{2.5}$ concentrations; and ○ 1-hour and annual average NO_2 concentrations. NO_2 concentrations should be assessed using a well justified approach for the transformation of NO_x to NO_2.	6 & 7
	Ground level concentrations of pollutants should be presented for surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable).	7
	Undertake a cumulative assessment of predicted impacts. The contribution of all identified existing and recently approved developments should be accounted for in the cumulative assessment.	7
	Cumulative 24-hour PM_{10} and $PM_{2.5}$ concentrations must be assessed in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, including appendices and updates, and/or a suitably justified probabilistic methodology.	7
	Cumulative annual average PM_{10}, $PM_{2.5}$, and NO_2 should be assessed using a sufficiently justified background concentration(s);	7

Air quality		Section
	Results of dispersion modelling should be presented as follows: ○ isopleth plots showing the geographic extent of maximum pollutant concentrations (incremental and cumulative); ○ tables presenting the maximum predicted pollutant concentrations (increment and cumulative) and the frequency of any predicted exceedances at each surrounding privately-owned properties, quarry-owned properties and other sensitive receptors (as applicable); and ○ time series and frequency distribution plots of pollutant concentrations at each private receptor location at which an exceedance is predicted to occur. Where no exceedances are predicted, the analysis must be performed for the most impacted offsite sensitive receptor.	7 & Appendix D
Air Quality Emissions Control Measures	Provide a detailed discussion of all proposed air quality emission control measures, including details of a reactive/predictive management system. The information provided must include: ○ explicit linkage of proposed emission controls to the site specific best practice determination assessment ○ timeframe for implementation of all identified emission controls; ○ key performance indicators for emission controls; ○ monitoring methods (location, frequency, duration); ○ response mechanisms; ○ responsibilities for demonstrating and reporting achievement of KPIs; ○ record keeping and complaints response register; and ○ compliance reporting.	8

3 PROJECT BACKGROUND

3.1 Project setting

The Project site is located in Fullerton Cove, approximately 9.8 kilometres (km) north-northeast of Newcastle Central Business District (CBD), within the Port Stephens LGA. The surrounding land use is a mixture of rural, residential, public recreation and environment conservation areas.

Figure 3-1 presents the location of the Project site and nearest residential receptor locations assessed as discrete receptors in this assessment. The nearest residential receptors to the Project site are located on Coxs Lane approximately 0.5km to the northwest of the site entrance. Two residential receptors located in the Fern Bay Seaside Village residential development have been included and are considered representative of this location.

Figure 3-2 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project. The Project site can be characterised as gently undulating with flat terrain to west and northwest and sand dunes to the east on Stockton Beach.

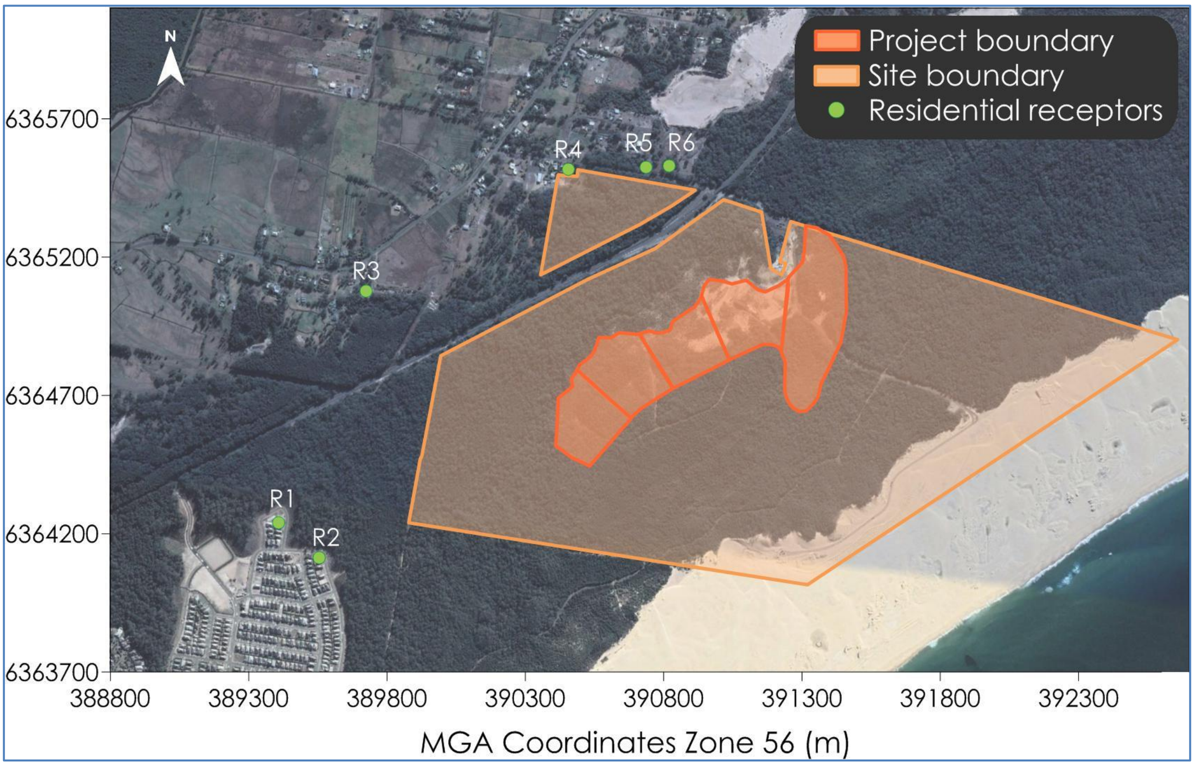


Figure 3-1: Project setting

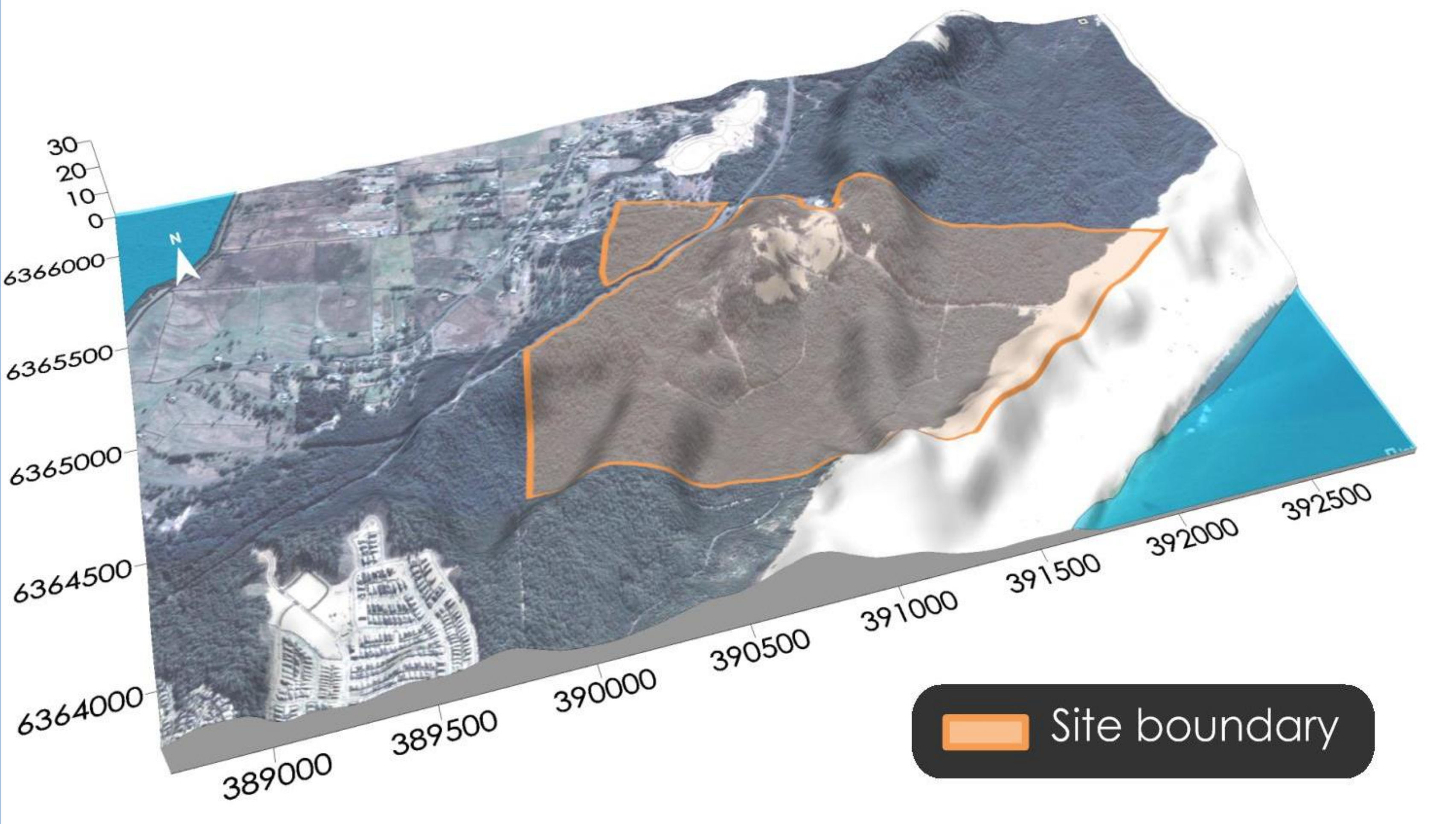


Figure 3-2: Representative visualisation of topography in the area surrounding the Project

3.2 Historical and existing operations

Under Boral's ownership there have been two primary development consents granted, including:

- DA 2010/94: The "inland extraction area" (also known as pits 1 – 6) granted by Port Stephens Council in May 1996; and
- DA 140-6-2005: The "windblown sand extraction area" (also known as the "windblown project" or pit 7) located on the transgressive dunes adjoining Stockton Beach granted by the Department of Planning in 2006.

The inland operation, DA2010/94, ceased operations in 2008, under this consent sand was extracted from the inland dunes to approximately RL 5m AHD. This project ceased operating soon after the windblown project commenced.

The windblown project is located approximately 375m south east of the Project site, and is approved to operate until 2028 and dispatch up to 500,000tpa from the site.

The windblown sand extraction area started operations in 2008 and has 20-year life, it is due to cease in 2028.

The approved scope of works and method generally includes the following:

- extraction of up to 500,000 tonnes of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass;
- processing at the pit face by mobile power screen;
- maintenance of the haul road to transport sand from extraction area;
- haulage of product from existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive rehabilitation of extracted areas.

Extraction of sand from the windblown project is current and ongoing.

3.3 Project description

As set out in **Section 3.2**, an earlier consent was granted for extraction of sand from the inland dunes. This operation was limited to the extraction of sand from above 5m AHD and ceased in 2008, rehabilitation has been ongoing.

This former extraction area is generally consistent with the Project extraction area and is the focus of this Development Application that proposes to extract sand from within the existing disturbance footprint from the existing ground level to a depth of 15m below sea level (-15m AHD). As extraction will intercept the groundwater table (at approximately 1m AHD) the primary method of sand extraction will involve dredging.

There is an estimated 9 million tonnes of sand resource within the Project extraction area. The Project would seek to permit a site wide increase in the dispatch limit to 750,000tpa (i.e. the windblown sand extraction area and the Project operations combined) up until 2028 after which the site wide limit would reduce to no more than 500,000tpa. The increase in the site wide dispatch limit is sought to permit maximum flexibility across the two project areas (located on the same site).

The Project is to be undertaken progressively in six stages, commencing with Stage 1. Similar to previous operations of the inland extraction area, sand extraction will involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation will either be mulched or stockpiled on-site for later reuse in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation efforts across the site.

Stage 1 will involve dry extraction, removing sand via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be screened and stockpiled before a front-end loader loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

Following initial extraction of sand in Stage 1 above the water table to a depth of 4m AHD, a pond will be created in the area of Stage 2 and will be large enough to float a dredge and accommodate fresh water pumping for the proposed wash plant.

The dredge will move progressively through the extraction area generally following the nominated stages. In most cases, the sand in each extraction stage is fully extracted unless constraints are encountered.

The dredge will move backwards and forwards across the active dredge pond, suctioning away against the underwater sand face. The sand / water mix will be pumped directly from the dredge via a pontoon-mounted pipeline to the wash plant in the processing area. The dredge manoeuvres around the pond and its position is stabilised by tie ropes connected to the banks around the active pond.

The dredge will then progressively extract sand in a south westerly direction in a staged process. Extraction will move to the east and culminate with the relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (to be known as Stage 6).

Sand will be extracted to a maximum depth of approximately 15m below the sea level (-15m AHD).

An overview of the staging plan for the Project is presented in **Figure 3-3**.

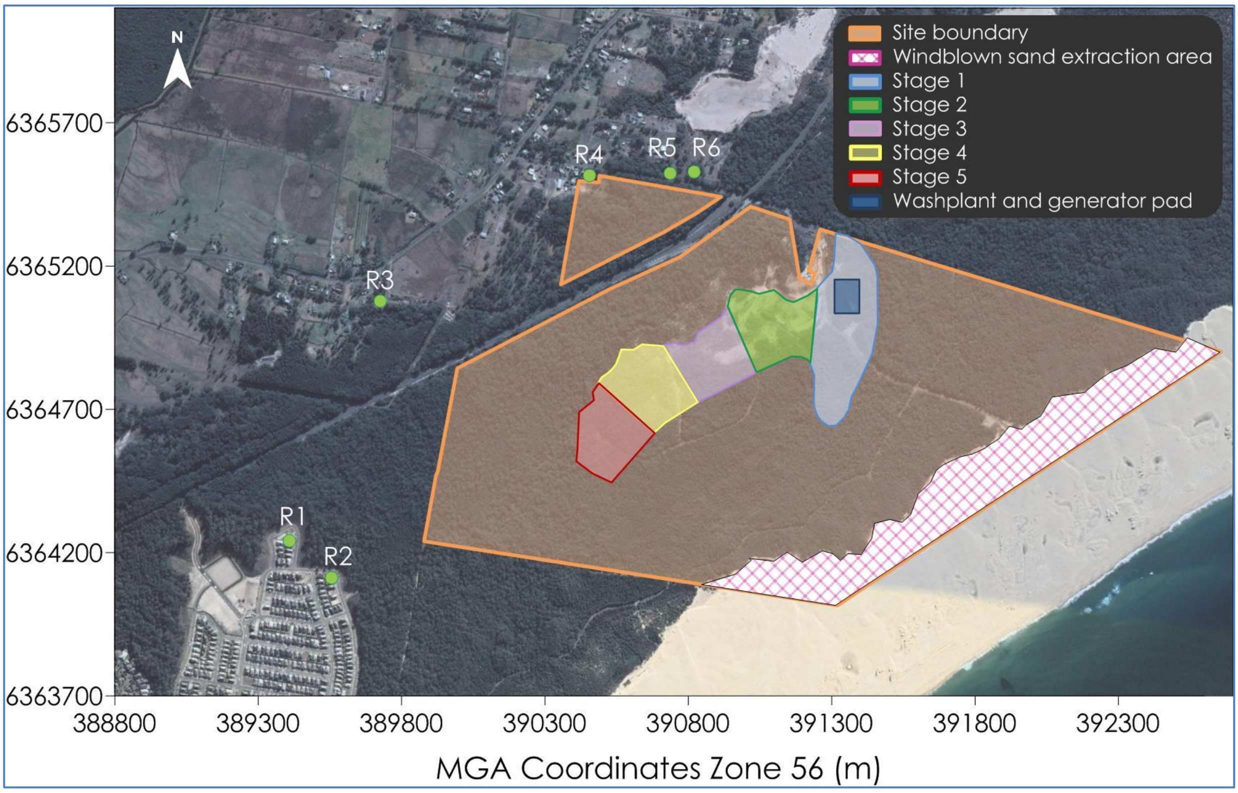


Figure 3-3: Overview of staging plan for the Project

4 AIR QUALITY CRITERIA

4.1 Particulate matter

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

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

4.2 Nitrogen dioxide

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called oxides of nitrogen (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generated.

4.3 NSW EPA impact assessment criteria

Table 4-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

The air quality goals for total impact relate to the total pollutant burden in the air and not just the contribution from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 4-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8 µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month
NO_2	1 hour	Total	246 µg/m³
	Annual	Total	62 µg/m³

Source: **NSW EPA, 2017**
µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

4.4 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW VLAMP dated September 2018 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum and extractive industry developments.

Voluntary mitigation rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-2** at any residence on privately owned land or workplace. [1]

Table 4-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24 hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: NSW Government (2018)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-3** at any residence on privately owned land, workplace or on more than 25 per cent (%) of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 4-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24-hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: NSW Government (2018)

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

4.5 Crystalline silica

Silica occurs in nature in a crystalline or amorphous form, and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

Various jurisdictions have developed criteria for acceptable levels of exposure to crystalline silica. These include the Victorian criterion adopted from Californian reference exposure level values, and

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

occupational standards. **Table 4-4** presents the Victorian impact assessment criteria (**VIC EPA, 2007**) which are the most stringent available standards for respirable crystalline silica and which are applied to the Project.

Table 4-4: Air Quality Criterion for Respirable Silica

Pollutant	Averaging period	Criterion (µg/m³)	Organisation
Respirable crystalline silica (as $PM_{2.5}$)	Annual	3	VIC EPA

Source: VIC EPA (2007)

4.6 Protection of the Environment Operations Act, 1997

The general obligations of the NSW *Protection of the Environment Operations Act, 1997* and the Regulations made under the Act (namely the NSW *Protection of the Environment Operations (Clean Air) Regulation, 2010*) would be followed for the Project. The Project would operate in accordance with the relevant regulatory framework for air quality to ensure compliance with this legislation.

5 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

5.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at Williamtown Royal Australian Air Force (RAAF) (Site No. 061078) were analysed to characterise the local climate in the proximity of the Project. Williamtown RAAF weather station is located approximately 6.1km north- northwest of the Project.

Table 5-1 and **Figure 5-1** present a summary of data from the Williamtown RAAF weather station collected over a 59 to 69 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 28.2 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 6.4°C.

Rainfall decreases during the latter half of the year, with an annual average rainfall of 1123.8 millimetres (mm) over 85.7 days. The data indicate that June is the wettest month with an average rainfall of 124.7mm over 8.4 days and September is the driest month with an average rainfall of 60.4mm over 5.6 days.

Relative humidity levels exhibit little variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 64% in October to 80% in June. Mean 3pm relative humidity levels range from 50% in August and September to 62% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. Mean 9am wind speeds range from 10.2 kilometres per hour (km/h) in March to 16.8km/h in August. Mean 3pm wind speeds range from 15.8km/h in May to 23.5km/h in November and December.

Table 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	28.2	27.7	26.3	23.7	20.4	17.7	17.2	18.7	21.5	23.8	25.6	27.4	23.2
Mean min. temp. (°C)	18.1	18.1	16.4	13.2	10.1	8.0	6.4	6.9	9.1	12.0	14.4	16.6	12.4
Rainfall													
Rainfall (mm)	98.7	117.0	120.5	111.6	109.6	124.7	70.9	72.9	60.4	73.9	82.3	78.6	1123.8
No. of rain days	7.1	7.3	8.1	7.5	7.6	8.4	6.3	6.1	5.6	7.3	7.3	7.1	85.7
9am conditions													
Mean temp. (°C)	23.0	22.5	21.2	18.2	14.3	11.6	10.5	12.2	15.7	18.8	20.5	22.2	17.6
Mean R.H. (%)	72	76	77	76	79	80	77	71	66	64	66	68	73
Mean W.S. (km/h)	11.9	10.6	10.2	11.4	13.7	15.9	16.4	16.8	15.3	14.4	14.4	12.9	13.7
3pm conditions													
Mean temp. (°C)	26.5	26.1	24.9	22.5	19.3	16.8	16.2	17.6	20.0	21.9	23.8	25.6	21.8
Mean R.H. (%)	59	62	61	59	60	60	55	50	50	54	55	56	57
Mean W.S. (km/h)	21.9	20.6	18.9	17.2	15.8	17.5	18.7	20.9	22.0	22.5	23.5	23.5	20.2

Source: **Bureau of Meteorology, 2019 (March 2019)**

R.H. – Relative Humidity, W.S. – wind speed

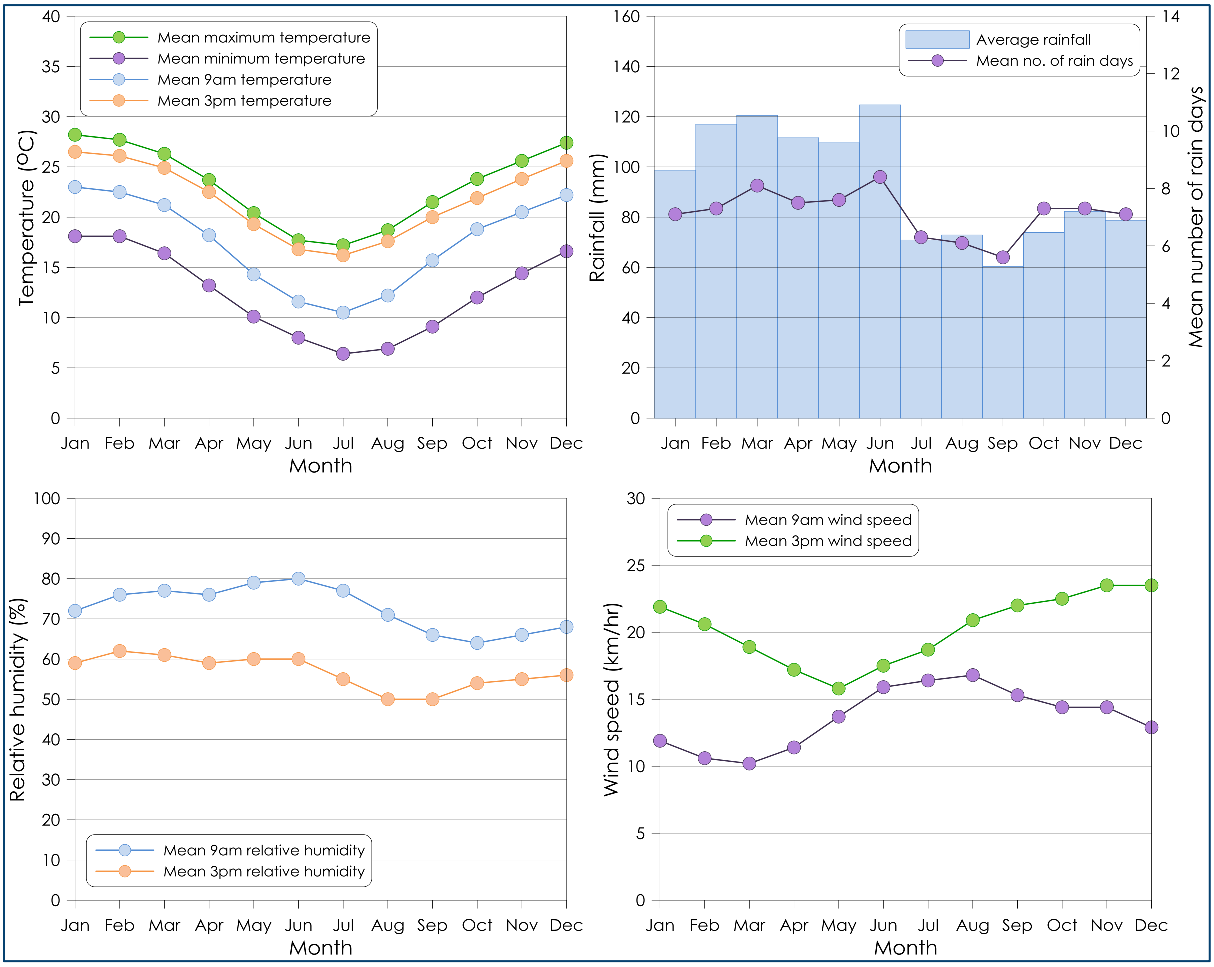


Figure 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

5.2 Local meteorological conditions

Annual and seasonal windroses for the Williamtown RAAF weather station during the 2015 calendar period are presented in **Figure 5-2**.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

On an annual basis, winds predominantly occur from the west-northwest and northwest. In summer, winds occur from the east-northeast, northeast, and the southeast quadrant. Autumn and winter have a similar distribution to the annual distribution with the dominant winds from the west-northwest and northwest. In spring, winds are varied, with winds from the northwest, northeast and east-northeast sectors most prevalent.

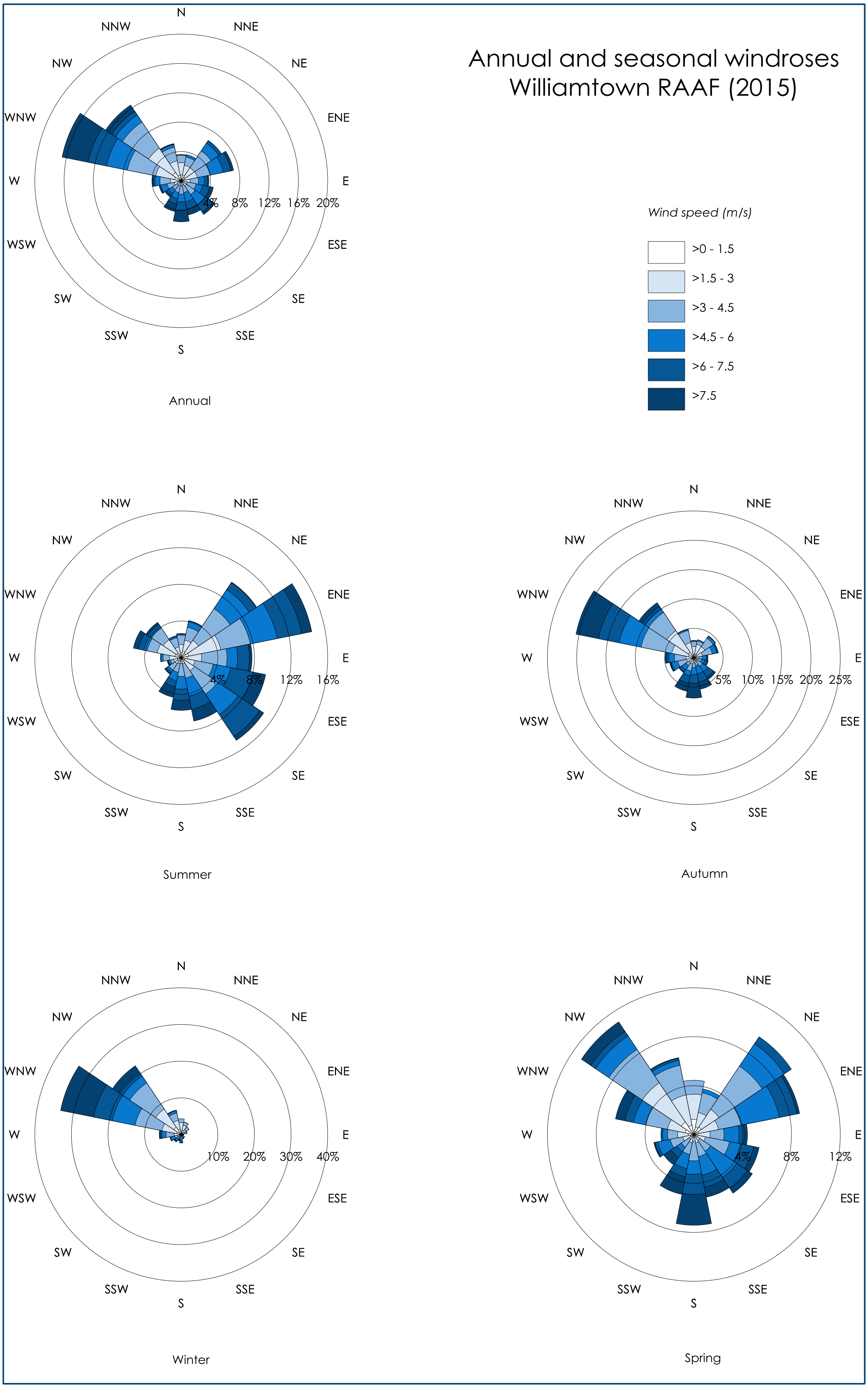


Figure 5-2 : Annual and seasonal windroses – Williamtown RAAF weather station (2015)

5.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project would include emissions from active sand quarrying, agricultural activities, anthropogenic activities such as various industrial and commercial activities and motor vehicle exhaust and also natural sources such as the local sand dunes.

Ambient air quality monitoring data from the Project site are not available. Therefore, the available data from air quality monitors operated by the NSW Office of Environment and Heritage (OEH) were used to quantify the existing background level for assessed pollutants at the Project site.

These include the Stockton, Beresfield and Wallsend monitors. The location of these monitors relative to the Project site is shown in **Figure 5-3**.

We note that there are other NSW OEH monitors within Newcastle which are subject to local industrial and urban sources which are not typically representative of the Project site. The Stockton, Beresfield and Wallsend monitors positioned in areas similar to the Project site and thus taken to be generally representative of the background levels and have been used to quantify the existing ambient levels of air pollutants in this study.

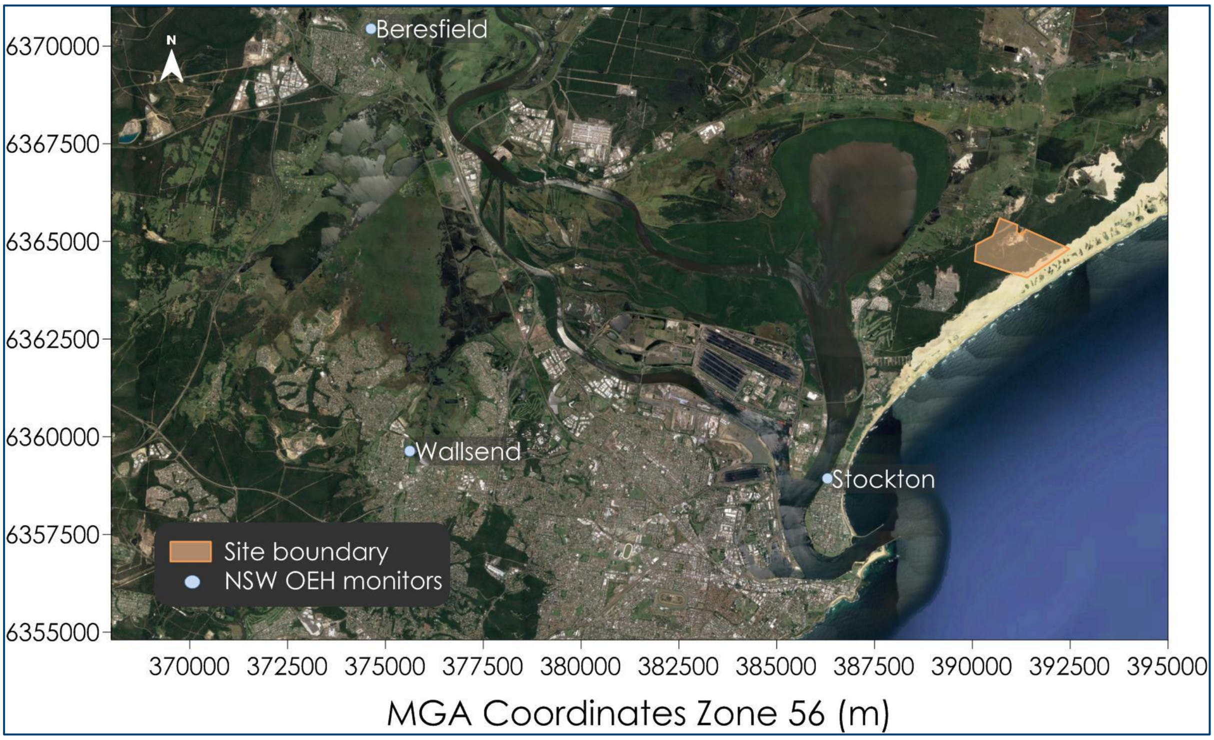


Figure 5-3: Location of NSW OEH monitors

5.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from the NSW OEH monitoring stations is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-4.**

A review of **Table 5-2** indicate that the annual average PM_{10} concentrations for all monitoring stations review were below the relevant criterion of 25µg/m³ with the exception of the Stockton monitor which exceeded the relevant criterion in each year of the review. The maximum 24-hour average PM_{10}

concentrations were found to exceed the relevant criterion of 50µg/m³ on occasion during the review period.

Table 5-2: Summary of PM_{10} levels from NSW OEH monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	19.4	16.9	**25**
2015	**35.8**	18.8	16.7	**25**
2016	**35.1**	19.1	16.6	**25**
2017	**36.4**	19.6	17.4	**25**
2018	**38.7**	21.6	19.4	**25**
	Maximum 24-hour average			
2014	**104.3**	45.4	43.4	**50**
2015	**101.4**	**64.9**	**77.5**	**50**
2016	**108.1**	48	**65.5**	**50**
2017	**96.7**	49.4	47.9	**50**
2018	**196.6**	**149.1**	**136.5**	**50**

It can be seen from **Figure 5-4** that PM_{10} concentrations nominally peak in spring and summer with the warmer weather raising the potential for drier ground, elevating the occurrence of windblown dust. Elevated PM_{10} concentrations at the Stockton monitor are largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

Anomalously high PM_{10} concentrations were recorded on 22 November 2018. An analysis into available satellite imagery (**NASA, 2019**) and other sources (**NSW OEH, 2018**) concludes elevated concentrations were due to a regional dust storm associated with a cold front which occurred on 22 November 2018. **Figure 5-5** presents satellite imagery showing the dust storm (circled in yellow) on 22 November 2018.

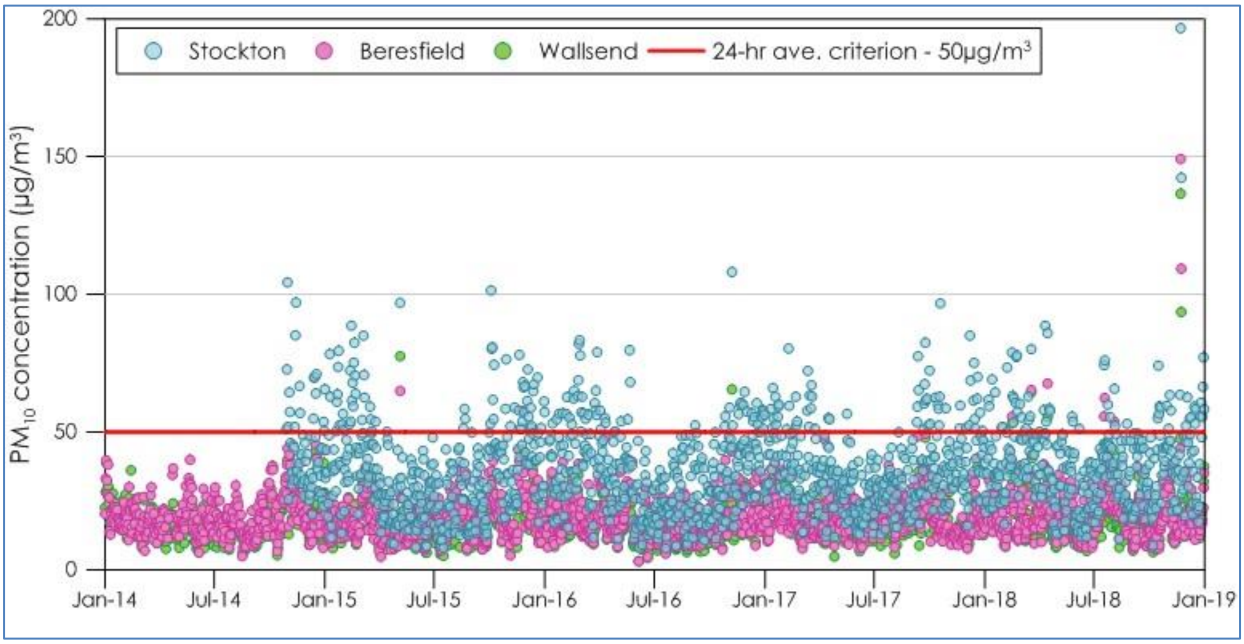
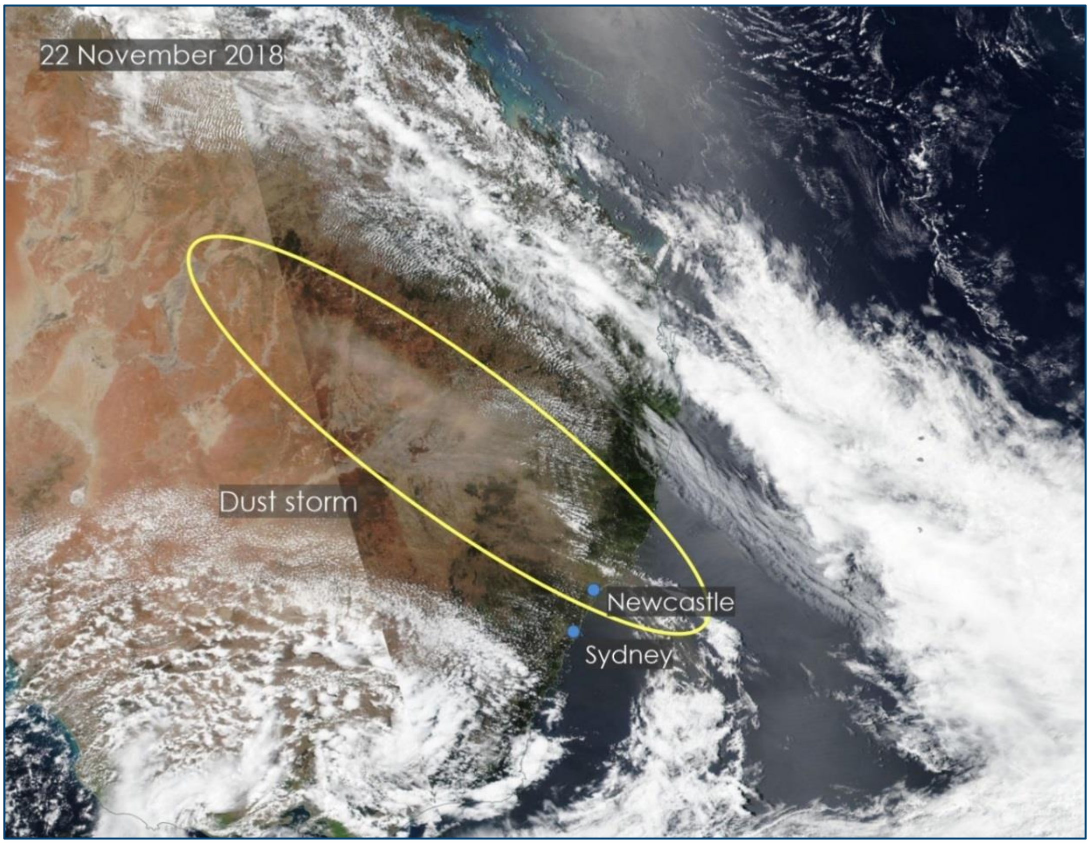


Figure 5-4: 24-hour average PM_{10} concentrations



Source: **NASA, 2019**

Figure 5-5: Satellite imagery showing dust storm on 22 November 2018

5.3.2 $PM_{2.5}$ monitoring

A summary of the available data from the NSW OEH monitoring stations is presented in **Table 5-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-6**.

Table 5-3 indicates that the annual average $PM_{2.5}$ concentrations for the monitoring stations were below the annual average criterion of 8µg/m^3 with the exception of the Stockton monitor where data were available and the Beresfield monitor during 2018. The maximum 24-hour average $PM_{2.5}$ concentrations were found to exceed the relevant criterion of 25µg/m^3 on occasion during the review period.

Table 5-3: Summary of $PM_{2.5}$ levels from NSW OEH monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	7.5	6.7	**8**
2015	**9.5**	7.3	7.3	**8**
2016	**9.7**	7.4	8.0	**8**
2017	**9.8**	7.6	7.3	**8**
2018	**10.0**	**8.7**	7.5	**8**
	Maximum 24-hour average			
2014	**25.5**	19	18	**25**
2015	**30.9**	**25.9**	24	**25**
2016	**66.4**	**27.9**	**50.7**	**25**
2017	**32**	18.7	20.4	**25**
2018	**26.9**	24.9	20.2	**25**

It can be seen from **Figure 5-6** that 24-hour average $PM_{2.5}$ concentrations are relatively evenly distributed through the year with the Stockton monitor recording overall higher levels largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

High $PM_{2.5}$ concentrations were recorded in November 2016. Satellite imagery indicates that the elevated concentrations were associated with bushfire events that occurred on 6 November 2018 with high temperatures "expected in the Hunter region…and strong winds" (**ABC News, 2019**). **Figure 5-7** presents satellite imagery showing the extent of the smoke plume on 6 November 2016.

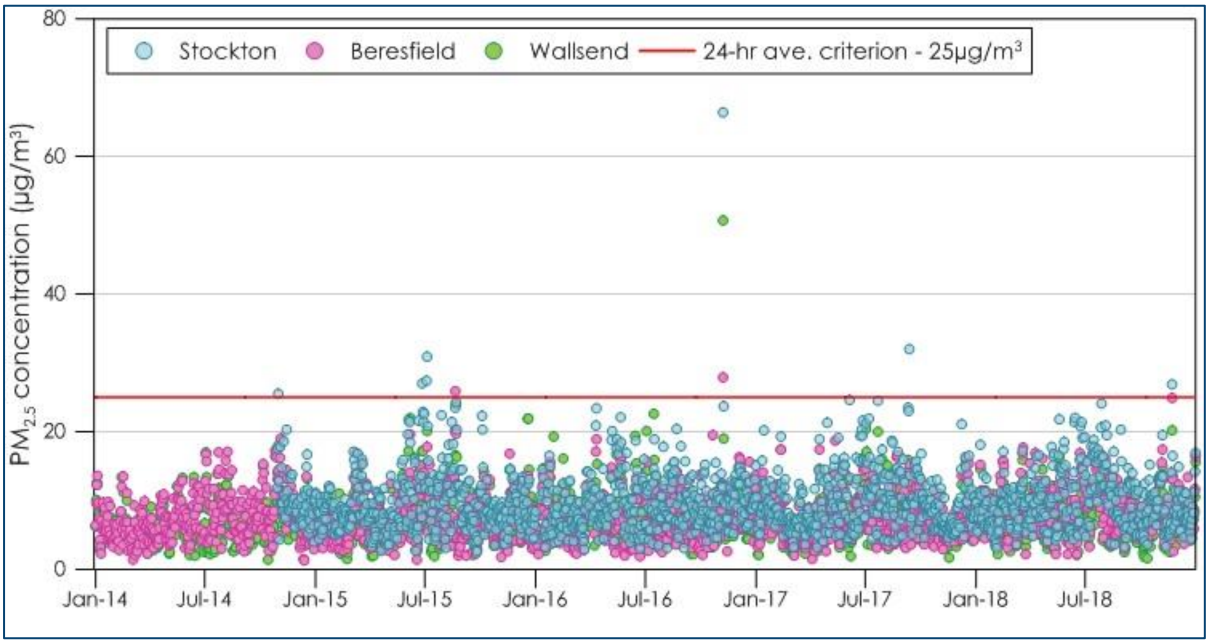


Figure 5-6: 24-hour average $PM_{2.5}$ concentrations

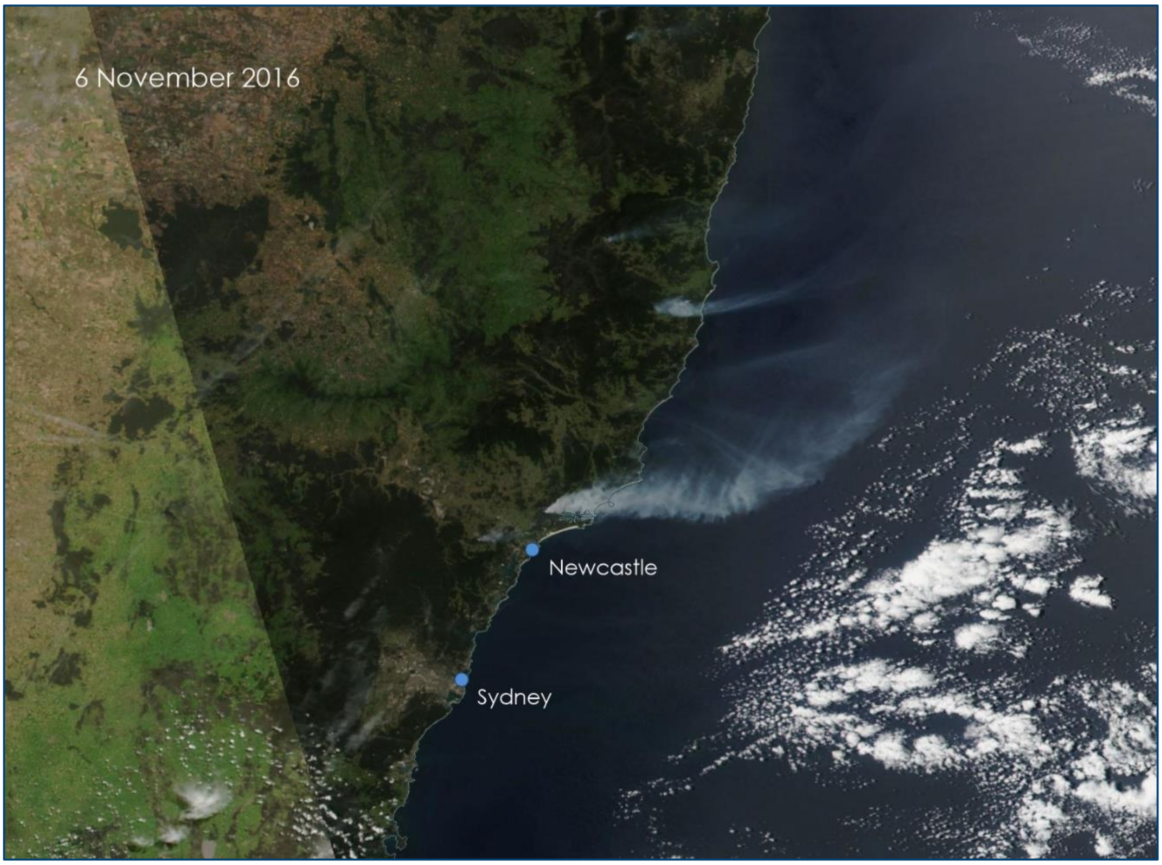


Figure 5-7: Satellite imagery showing smoke plume from bushfires on 6 November 2016

5.3.3 NO_2 monitoring

A summary of the available NO_2 data from the NSW OEH monitoring stations is presented in **Table 5-4**. The daily 1-hour maximum NO_2 concentrations are presented in **Figure 5-8**.

Table 5-4 indicates that the annual and maximum 1-hour average NO_2 concentrations for all monitors during the review period are well below the respective criterion.

It can be seen from **Figure 5-8** that concentrations are generally higher in cooler months when temperatures are low and there is less sunlight, making it more difficult for NO_2 to convert to ozone (**Department of the Environment, Climate Change and Water [DECCW], 2010**).

Table 5-4: Summary of NO_2 levels from available NSW OEH monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2014	-	18.8	15.5	**62**
2015	15.0	18.4	15.8	**62**
2016	16.5	16.0	14.8	**62**
2017	16.3	18	15.6	**62**
2018	15.5	18.0	14.1	**62**
	Maximum 1-hour average			
2014	-	80.0	69.7	**246**
2015	80.0	100.5	86.1	**246**
2016	92.3	84.1	75.9	**246**
2017	94.3	82.0	75.9	**246**
2018	90.2	82.0	71.8	**246**

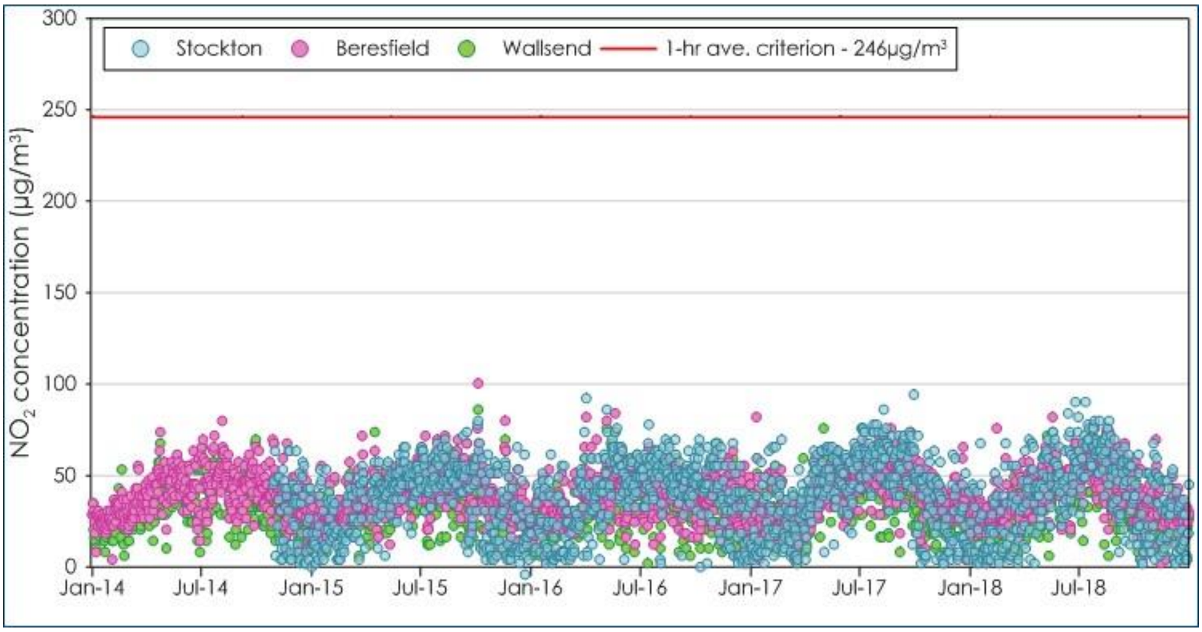


Figure 5-8: Daily 1-hour maximum NO_2 concentrations

5.3.4 Estimated background levels

As outlined above, there are no readily available site specific monitoring data, and therefore the background air quality levels from the Stockton monitor for the 2015 calendar year were used to represent the background levels for the Project.

The 2015 calendar period corresponds to the period of meteorological modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

5.3.4.1 $PM_{2.5}$ and PM_{10}

As noted, the $PM_{2.5}$ and PM_{10} concentrations at the Stockton monitor are elevated due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To account for this, background $PM_{2.5}$ and PM_{10} concentrations have been adjusted to discount the contribution associated with salt laden air and we estimate an approximate annual average $PM_{2.5}$ and PM_{10} concentration of 7.3µg/m^3 and 17.0µg/m^3, respectively. Further detailed calculations of background $PM_{2.5}$ and PM_{10} estimates are provided in **Appendix B**.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with levels measured at the Beresfield and Wallsend monitors.

5.3.4.2 TSP and Deposited dust

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between $PM_{10,}$ TSP and deposited dust concentrations and the measured PM_{10} levels.

This relationship assumes that an annual average PM_{10} concentration of 25µg/m^3 corresponds to a TSP concentration of 90µg/m^3 and a dust deposition value of 4g/m^2/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the measured annual average PM_{10} concentration of 17.0µg/m^3 indicates an approximate annual average TSP concentration and deposition value of 61.2µg/m^3 and 2.7g/m^2/month, respectively.

5.3.4.3 Summary of background levels

The background air quality levels applied in this assessment are as follows:

- 24-hour average $PM_{2.5}$ and PM_{10} concentrations - variable
- Annual average $PM_{2.5}$ concentrations – 7.3µg/m^3;
- Annual average PM_{10} concentrations – 17.0µg/m^3;
- Annual average TSP concentrations – 61.2µg/m^3;
- Annual average deposited dust levels – 2.7g/m^2/month;
- 1-hour average NO_2 concentrations – 80µg/m^3; and,
- Annual average NO_2 concentrations – 15.0µg/m^3.

6 DISPERSION MODELLING APPROACH

6.1 Introduction

For this assessment, the CALPUFF modelling suite is applied to dispersion modelling. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation, 2011**).

6.2 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from The Air Pollution Model (TAPM) with surface observations in the CALMET model.

The centre of analysis for TAPM was 32deg51min south and 151deg50min east. The simulation involved an outer grid of 30 km, with three nested grids of 10 km, 3 km and 1 km with 35 vertical grid levels. The CALMET domain was run on a 10 x 10km area with 0.1 km grid resolution.

The 2015 calendar year was selected as the meteorological year for the dispersion modelling based on analysis of long-term data trends in meteorological data and ambient air quality data recorded for the area as outlined in **Appendix A**.

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extracted data.

Figure 6-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

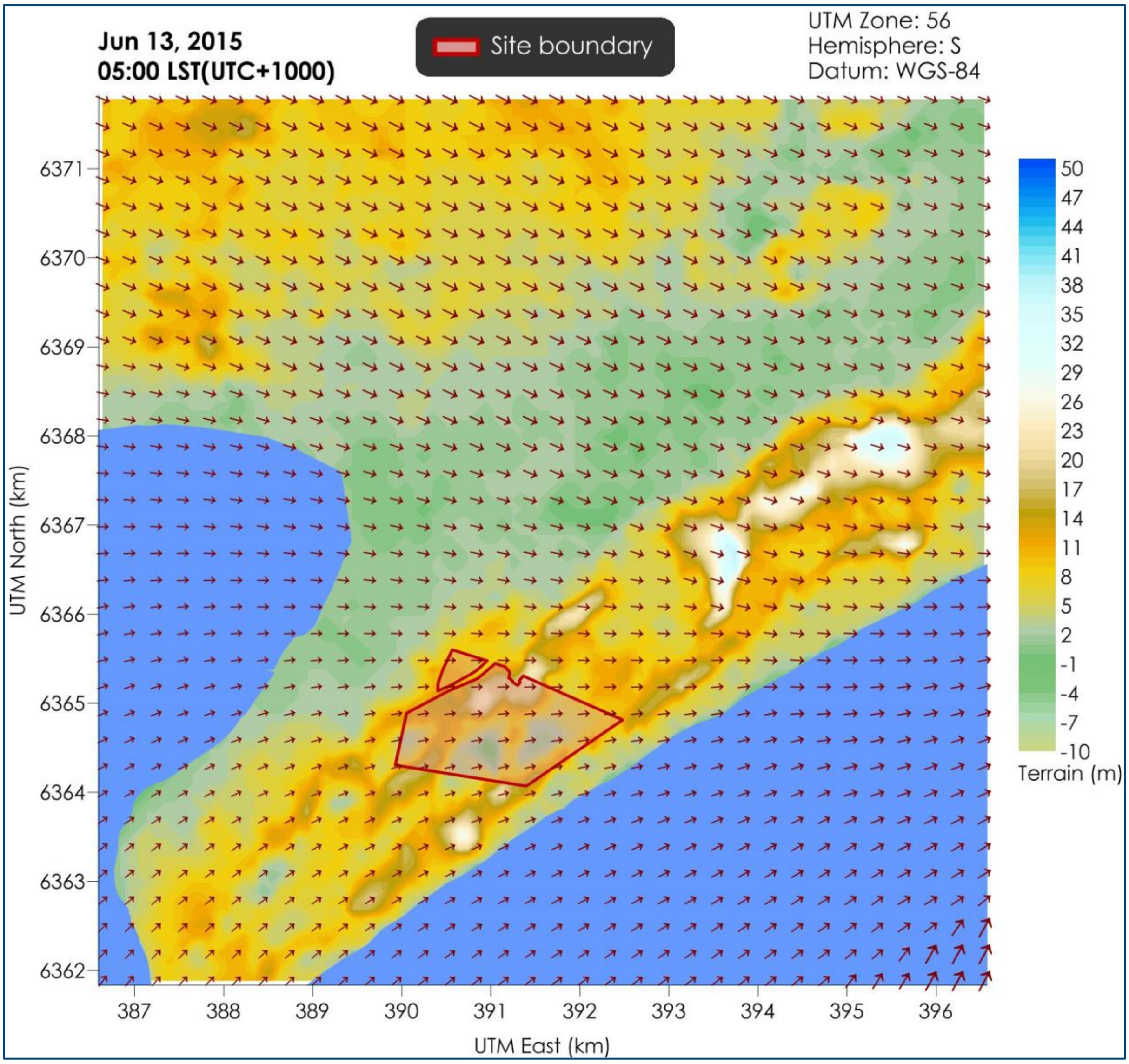


Figure 6-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

Figure 6-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 6-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

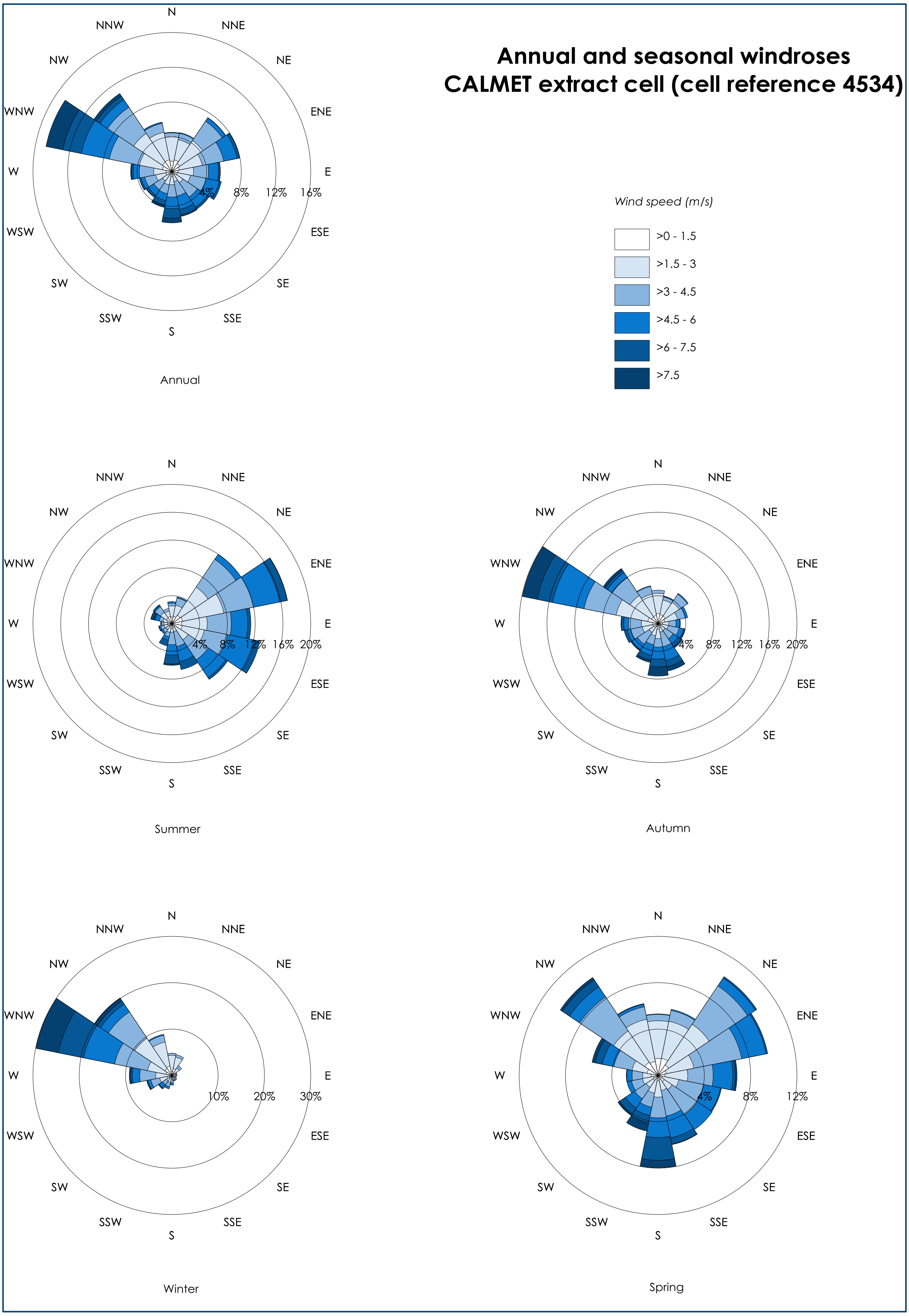


Figure 6-2: Annual and seasonal windroses from CALMET (Cell reference 4534)

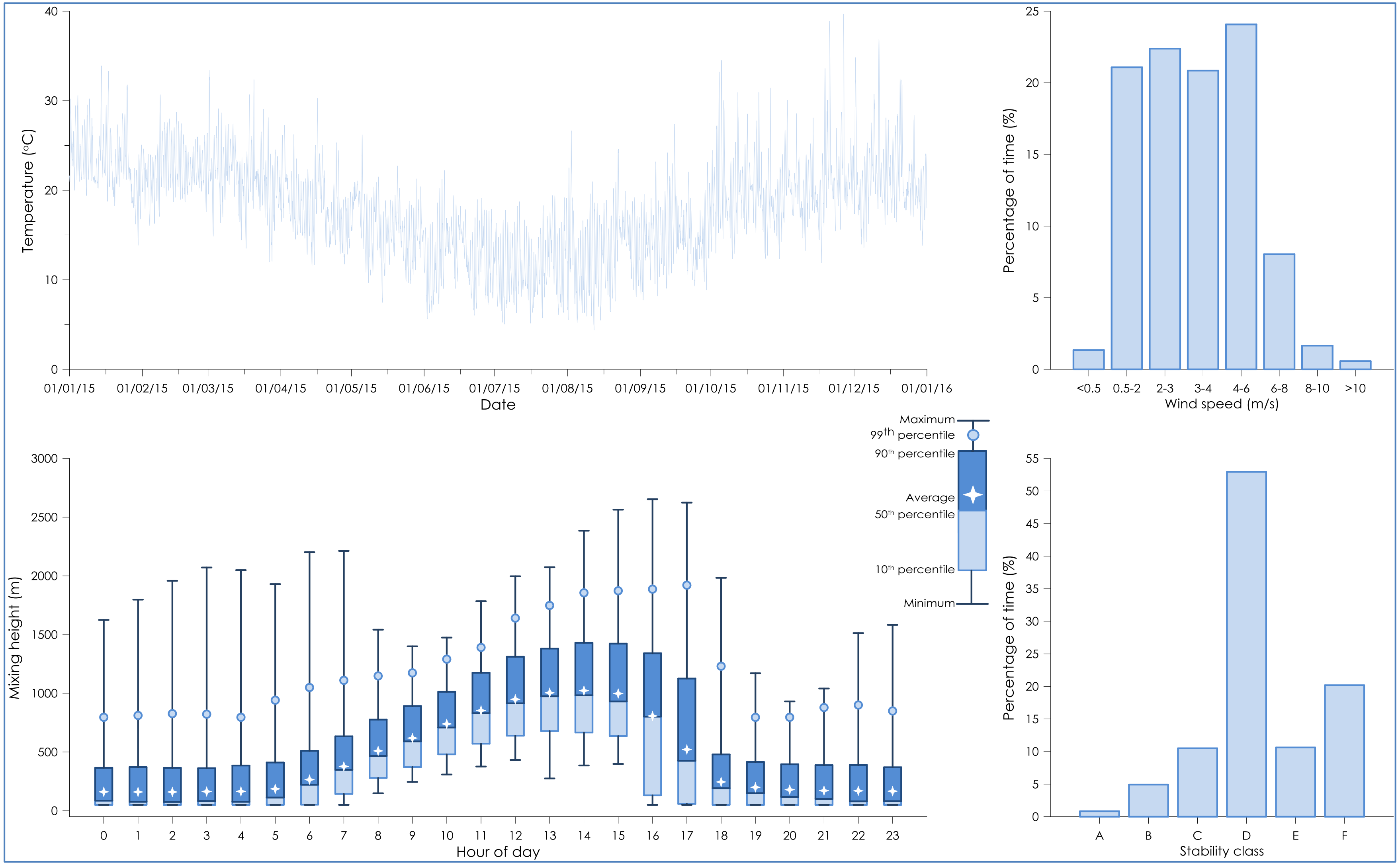


Figure 6-3: Meteorological analysis of CALMET (Cell Ref 4534)

6.3 Dispersion modelling

Dust emissions from each operational activity of the Project were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

NO_2 emissions from each operational activity of the Project were represented by a series of point sources to represent the engine exhaust associated with the diesel powered equipment in the CALPUFF model via an hourly varying emission file.

6.4 Modelling scenario

To identify a potential worst-case operating scenario for the Project, each of the activities associated with the different stages were analysed in regard to the quantity of material extracted and handled in each year, the location of the activity and the potential to generate dust at the receptor locations.

Three potential operating scenarios representing the Project were investigated in detail to identify which would likely represent a worst-case operating scenario. These include:

- Scenario 1: Sand extraction occurring from the existing windblown sand extraction area concurrently with sand extraction using an excavator in Stage 1. A maximum production rate of 750,000tpa is assumed with a maximum capacity of 250,000tpa extracted from the existing windblown sand extraction area and 500,000tpa from Stage 1 of the Project. Sand processing is occurring at the new mobile wash plant pad positioned at the north near the site entrance and 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from both existing and proposed operations.

- Scenario 2: Sand extraction occurring from Stage 1 only at a maximum production rate of 750,000tpa. Sand extraction is conducted with an excavator and sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from proposed operations only.

- Scenario 3: Sand extraction occurring from only Stage 5 at a maximum production rate of 750,000tpa. Sand extraction is conducted with an excavator and sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. The VENM is used to assist with bank stabilisation in Stage 5. In this scenario, activity is occurring closest to the receptors at Fern Bay to the Project (refer to **Figure 3-3**) with a maximum potential for dust generation to occur from proposed operations only.

6.5 Emission estimation

The significant dust generating activities associated with operation of the Project are identified as loading/unloading of material, vehicles travelling on-site, screening sand material and windblown dust from exposed areas and stockpiles. The on-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates for each of the scenarios have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

The estimated TSP emissions for activities associated with the operation of the Project for each of the scenarios are presented in **Table 6-1**. Detailed calculations of the dust emission estimates are provided in **Appendix C**.

Table 6-1: Comparison of estimated dust emissions for the Project (kg)

Activity	TSP Emissions		
	Scenario 1	Scenario 2	Scenario 3
Loading sand to haul truck at windblown sand area	357	-	-
Hauling RAW sand from windblown sand area to offsite	14,829	-	-
Excavator loading topsoil to haul truck	0.089	0.089	0.051
Hauling to topsoil stockpile	0.427	0.427	0.904
Emplacing at topsoil stockpile	0.089	0.089	0.051
Loading sand to screen	714	1,072	-
Dredging sand with dredge	-	-	-
Pumping sand to stockpile at processing area	-	-	-
Screening RAW sand (controlled - wet sand)	-	-	-
Unloading processed sand to stockpile	714	1,072	1,072
Rehandle processed sand material at product stockpile	71	107	107
Loading product sand material to haul truck	714	1,072	1,072
Hauling product sand offsite	5,931	8,897	6,117
Hauling VENM material onsite	1,038	1,165	1,165
Unloading VENM material at stockpile	100	100	100
Loading VENM material to haul truck	-	-	100
Hauling VENM material to Stage 5	-	-	1,773
Unloading VENM material at Stage 5	-	-	100
Wind erosion - exposed area	1,445	1,488	1,488
Exhaust emissions from on-site equipment	562	562	762
Total emissions	**26,478**	**15,535**	**13,856**

Based on the estimated dust emissions set out in **Table 6-1**, Scenario 1 is estimated to generate the most dust overall for the scenarios considered. It is noted that the majority of activity in Scenario 1 occurs closest to the nearest receptors compared with the activity in Scenario 3 and thus would likely show higher impacts in comparison. The dispersion modelling for the Project is based on Scenario 1 which would represent a worst-case potential operating scenario.

6.5.1 Estimated NO_X emissions

The NO_X emissions associated with operation of the Project are identified from exhaust emissions from on-site vehicle and plant equipment.

NO_X emission estimates for the Project have been calculated by analysing the various types of vehicle and plant equipment and utilising suitable emission factors sourced from DieselNet (**Ecopoint DieselNet, 2019**).

The estimated NO_X emissions associated with the Project are summarised in **Table 6-2**.

Table 6-2: Estimated annual NO_X emissions for the Project (kg)

Equipment type	Scenario 1
Cat D7 Dozer	1,435
Front end loaders - Volvo 180H	1,793
Front end loaders - Volvo 180G	2,434
Water truck - 1987 Volvo F86	1,000
Truck and dog	867
Mobile screen - Power Screen M90	765
Excavator - 40 tonne	1,566
Dump truck - 40 tonne	1,772
Suction dredge	3,716
Diesel generator	253
Wash plant	785
Total NO_X emissions	**16,387**

6.5.2 Emissions from other quarry operations

In addition to the estimated dust emissions from the Project, emissions from other nearby sand quarry operations were also modelled, in accordance with their current consents (or current proposed projects), to assess potential cumulative air quality impacts.

This assessment has included the Fullerton Cove Sand Quarry (operated by Coastal Sand and Quarry Products), located approximately 0.7km to the north of the Project and has the potential to influence the cumulative dust levels at receptors near the Project. Other sand quarry operations in the area are considered too far removed to have any tangible effect.

Emissions estimates for Fullerton Cove Sand Quarry were derived from information provided in the latest air quality assessments available in the public domain at the time of modelling (**GHD Pty Ltd, 2015**). These estimates are likely to be conservative, as in many cases, these operations do not continually operate at the maximum extraction rates assessed in their respective assessments.

Operations at the Fullerton Cove Sand Quarry are expected to cease in 2020 and there would be no dust generated from this source.

Table 6-3 summarises the emissions adopted in this assessment from Fullerton Cove Sand Quarry.

Table 6-3: Estimated annual dust emissions Fullerton Cove Sand Quarry (kg)

Operation	Emissions		
	TSP	PM_{10}	$PM_{2.5}$
Fullerton Cove Sand Quarry	26,286	7,284	791

7 DISPERSION MODELLING RESULTS

This section presents the predicted air quality levels which may arise from air emissions generated by the Project.

7.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted:

- Maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations;
- Annual average $PM_{2.5}$, PM_{10} and TSP concentrations; and,
- Annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) during the one year long modelling period.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-1 presents the predicted incremental particulate dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to the Project.

Table 7-1: Dust dispersion modelling results for residential receptors – Incremental impact

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD* (g/m²/month)
	24-hour average	Annual average	24-hour average	Annual average	Annual average	Annual average
	Air quality impact criteria					
	-	-	-	-	-	2
R1	0.1	<0.1	0.5	<0.1	0.1	<0.1
R2	<0.1	<0.1	0.5	<0.1	0.1	<0.1
R3	0.1	<0.1	0.5	<0.1	0.1	<0.1
R4	0.2	<0.1	1.1	<0.1	0.2	<0.1
R5	0.3	<0.1	1.8	0.2	0.4	<0.1
R6	0.4	<0.1	2.1	0.2	0.5	<0.1

*Deposited dust

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with estimated emissions from Fullerton Cove Sand Quarry and the estimated ambient background levels in **Section 5.4**.

The predicted cumulative annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition levels due to the Project with the estimated background levels are presented in **Table 7-2**. The results in **Table 7-2** indicate that all of the assessed residential receptors are predicted to experience levels below the relevant criteria.

Table 7-2: Dust dispersion modelling results for residential receptors – Cumulative impact

Receptor ID	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/month)
	Annual average			
	Air quality impact criteria			
	8	25	90	4
R1	7.3	17.1	61.4	2.7
R2	7.3	17.1	61.4	2.7
R3	7.3	17.1	61.4	2.7
R4	7.3	17.3	62.1	2.8
R5	7.4	18.2	65.2	2.9
R6	7.6	19.9	71.5	3.3

7.2 NO_X concentrations

Dispersion modelling of the potential NO_X emissions associated with diesel powered equipment was conducted for the modelling scenario. Modelling sources were described as point sources and impacts due to the Project were added to the ambient background level to assess potential impacts.

For the transformation of NO_x to NO_2 it has been assumed a hypothetical complete conversion level of 100% conversion occurs.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-3 presents the predicted incremental and cumulative NO_2 dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to NO_2 emissions associated with the Project and predicted cumulative levels would be below the relevant criteria.

Table 7-3: NO_2 dispersion modelling results for residential receptors

Receptor ID	Incremental		Cumulative	
	1-hour average	Annual average	1-hour average	Annual average
	Air quality impact criteria			
	-	-	246	62
R1	22.5	<0.1	102.5	15.1
R2	19.5	<0.1	99.5	15.1
R3	26.4	<0.1	106.4	15.1
R4	32.2	0.2	112.2	15.2
R5	49.1	0.3	129.1	15.3
R6	52.1	0.3	132.1	15.3

7.3 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

As shown in **Section 5.3**, the maximum measured 24-hour concentrations of $PM_{2.5}$ and PM_{10} have in the past exceeded or come close to the relevant criterion level on occasion.

As a result, the NSW EPA Level 1 contemporaneous assessment approach of adding maximum background levels to maximum predicted levels from the Project would show levels above the criterion whether or not the Project was operating.

In such situations, the NSW EPA applies a Level 2 contemporaneous assessment approach where the measured background levels are added to the day's corresponding predicted dust level from the Project.

Ambient (background) $PM_{2.5}$ and PM_{10} concentration data corresponding with the year of modelling (2015) from the NSW OEH monitoring site at Stockton have been applied in this case to represent the prevailing background levels in the vicinity of the Project and at representative residential receptor locations surrounding the Project.

Table 7-4 provides a summary of the findings from the Level 2 assessment at receptor locations for both $PM_{2.5}$ and PM_{10}. The results in **Table 7-4** indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptors for $PM_{2.5}$ and PM_{10}. Based on this result it can be inferred that the Project does not increase the number of days above the 24-hour average $PM_{2.5}$ and PM_{10} criterion at any of the receptor locations surrounding the Project.

Detailed tables of the contemporaneous assessment results are provided in **Appendix E**.

Table 7-4: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0
R2	0	0
R3	0	0
R4	0	0
R5	0	0
R6	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for selected Receptors R2, R5 and R6 are presented in **Figure 7-1** to **Figure 7-3**.

The orange bars in the figures represent the contribution from the Project and the blue bars represent the background levels. It is clear from the figures that the Project has a small influence at the assessed receptor locations and in most cases would be difficult to discern beyond the expected background level.

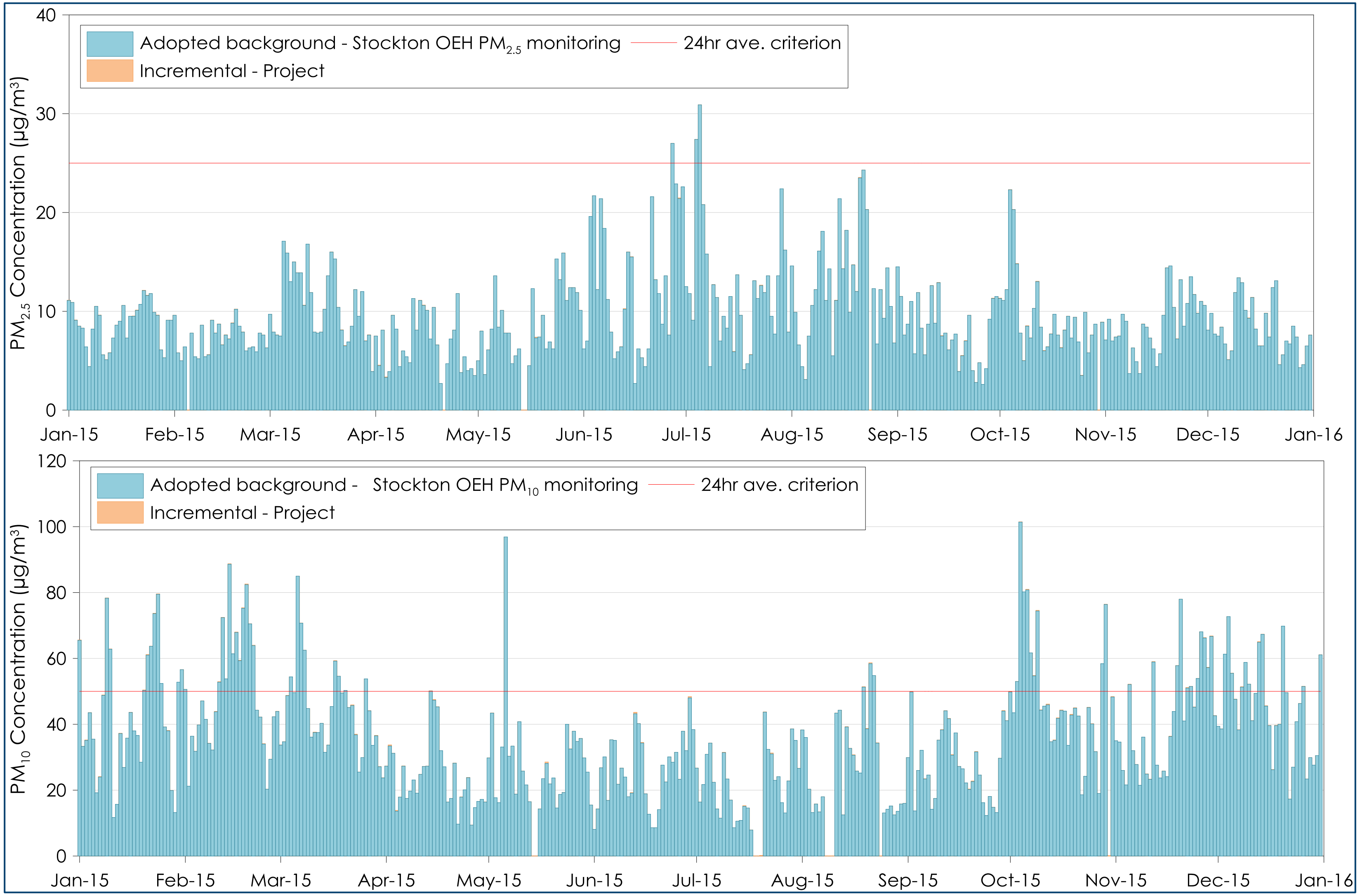


Figure 7-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R2

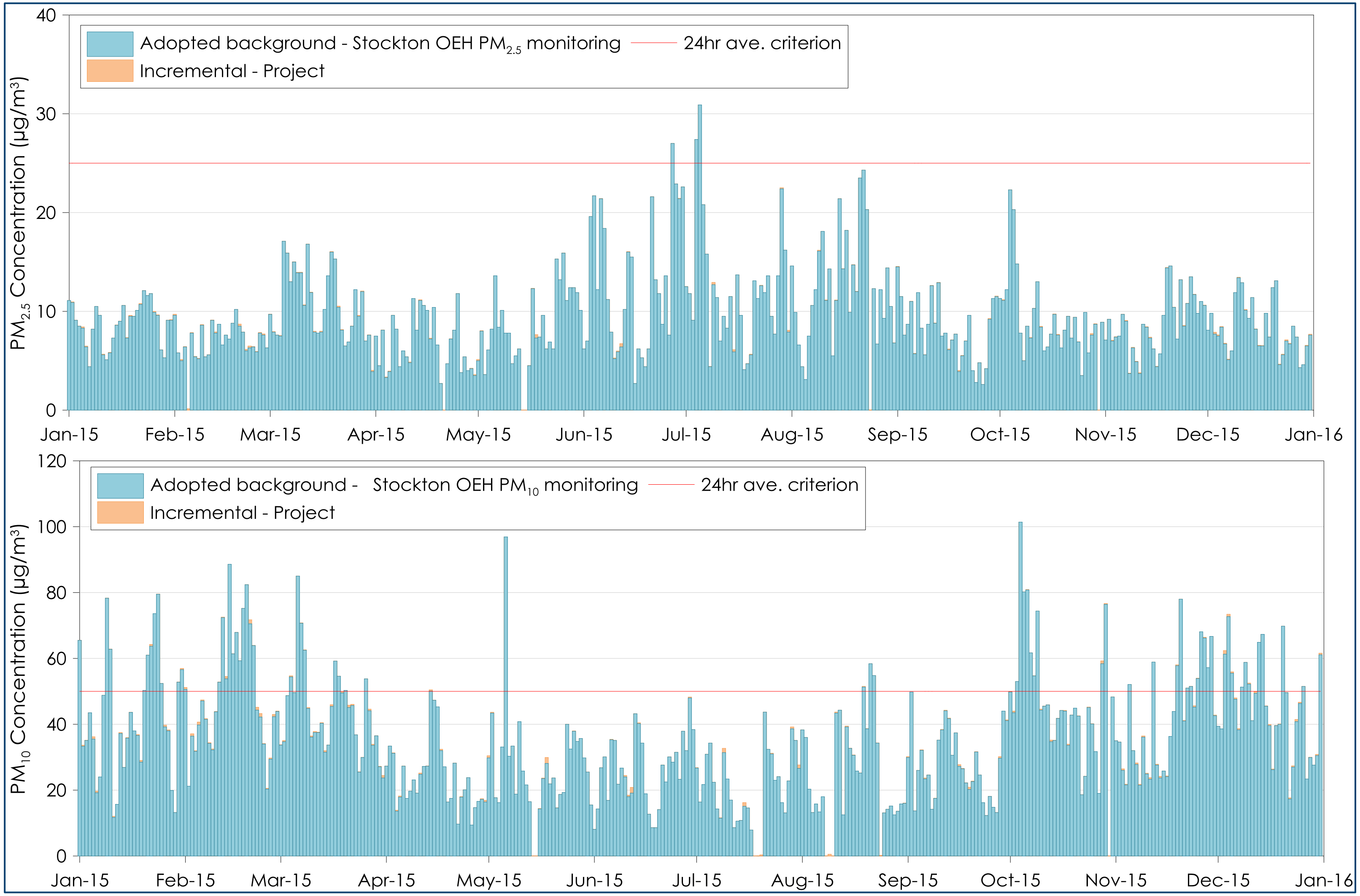


Figure 7-2: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R5

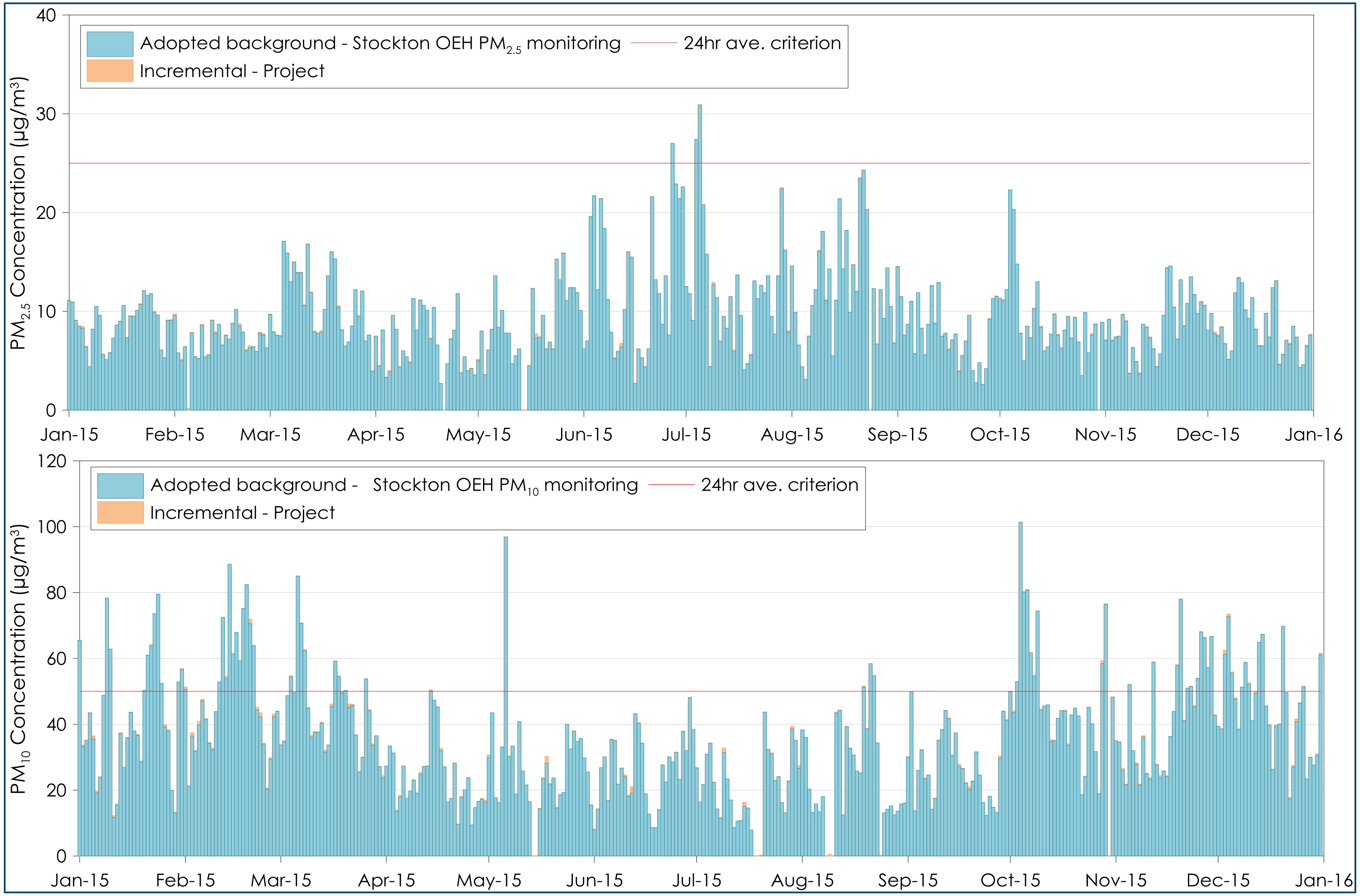


Figure 7-3: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ (above) and PM_{10} (below) concentrations for R6

7.4 Respirable crystalline silica

The assessment results show that the most affected residential receptor has a total maximum predicted incremental annual average $PM_{2.5}$ concentration level of less than 0.1µg/m^3. This level is due to the total dust from the site, and only a small portion of this dust would contain silica.

As the total level is over thirty times below the VIC EPA criteria of 3µg/m^3 for respirable crystalline silica, the actual level from the Project would be significantly below the criteria and thus, the Project would not result in an unacceptable level of respirable crystalline silica in the ambient air at residential receptors.

7.5 Assessment of impacts per VLAMP criteria

The results in **Table 7-2** indicate the predicted level at the assessed receptors would be below the applicable VLAMP mitigation and acquisition criteria.

The potential impacts due to the Project, extending over more than 25% of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

The results at the criteria level concentrations show the maximum 24-hour PM_{10} predictions would have the most spatial extent, relative to any of the other assessed dust metrics and hence 24-hour average PM_{10} represents the most impacting parameter.

Based on the isopleth diagrams in **Appendix D**, the extent of the predicted maximum 24-hour average PM_{10} level of 50µg/m^3 would not extend over more than 25% of any privately-owned land parcels, and it can be concluded that the Project would not cause impact per this criterion.

8 DUST MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust emissions.

To ensure that activities associated with the Project have a minimal effect on the surrounding environment and at residential receptor locations, it is recommended that appropriate operational and physical mitigation measures should be implemented where feasible and reasonable as outlined in **Table 8-1**.

Table 8-1: Potential operational dust mitigation options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
	Weather forecast to be checked prior to undertaking material handling or processing.
	Engines of on-site vehicles and plant to be switched off when not in use.
	Vehicles and plant are to be fitted with pollution reduction devices where practicable.
	Vehicles are to be maintained and serviced according to manufacturer's specifications.
	Visual monitoring of activities is to be undertaken to identify dust generation.
Exposed areas/stockpiles	The extent of exposed surfaces and stockpiles is to be kept to a minimum.
	Exposed areas and stockpiles are either to be covered or are to be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours.
	Minimise dust generation by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen material when excessively dusty during handling.
Hauling activities	Haul roads should be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur.
	Regularly inspect haul roads and maintain surfaces to remove potholes or depressions
	Driveways and hardstand areas to be swept/cleaned regularly as required etc.
	Vehicle traffic is to be restricted to designated routes.
	Speed limits are to be enforced.
	Vehicle loads are to be covered when travelling off-site.

Prior to commencement of operations at the Project, a detailed Air Quality Management Plan will be developed for the site. The Air Quality Management Plan would outline the measures to manage dust emissions at the site and include aspects such as key performance indicators, response mechanisms, compliance reporting and complaints management.

9 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the Project at the Stockton Sand Quarry.

Air dispersion modelling was used to predict the potential for off-site dust and NO_2 impacts in the surrounding area due to the operation of the Project. The estimated emissions of dust and NO_2 applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that the Project would have a negligible incremental and cumulative impacts at the surrounding residential receptor locations and would comply with the relevant air quality criteria.

Nevertheless, the site would apply appropriate dust management measures to ensure it minimises the potential occurrence of excessive air emissions from the site.

Overall, the assessment demonstrates that even using conservative assumptions, the Project can operate without causing any significant air quality impact at residential receptors in the surrounding environment.

10 REFERENCES

ABC News (2019)

"NSW bushfires: Crews fear soaring temperatures and strong winds may cause fires to flare", ABC News, 8 November 2016, accessed 15 March 2019 < https://www.abc.net.au/news/2016-11-08/nsw-firefighters-have-upper-hand-ahead-of-soaring-temperatures/8003924>

Bureau of Meteorology (2019)

Climate statistics for Australian locations, Bureau of Meteorology website, accessed March 2019. http://www.bom.gov.au/climate/averages

CSIRO, ANSTO & OEH (2016)

Hibberd MF, Keywood MD, Selleck PW, Cohen DD, Stelcer E, Scorgie Y & Chang L 2016, *Lower Hunter Particle Characterisation Study, Final Report*, Report prepared by CSIRO, ANSTO and the NSW Office of Environment and Heritage on behalf of the NSW Environment Protection Authority, April 2016.

DECCW (2010)

"Current air quality in New South Wales", a technical paper supporting the Clean Air Forum 2010, Department of Environment, Climate Change and Water NSW, August 2010.

Ecopoint DieselNet (2019)

Ecopoint DieselNet website, United States: Nonroad Diesel Engines. https://www.dieselnet.com/standards/us/nonroad.php#tier3, accessed 15 April 2019.

GHD Pty Ltd (2015)

Fullerton Cove Sand Quarry Modification to Project Approval 07_0145 Environmental Assessment, prepared by GHD Pty Ltd for Coastal Sand and Quarry Products Pty Limited, November 2015.

NASA (2019)

NASA Worldview Alpha website. https://earthdata.nasa.gov/labs/worldview/, accessed 15 March 2019.

NIOSH (1974)

"Criteria for a recommended standards… Occupational Exposure to Crystalline Silica", National Institute for Occupational Safety and Health, HEW Publication No. (NIOSH) 75-120.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", NSW Environment Protection Authority, January 2017.

NSW Government (2018)

"Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments", NSW Government, September 2018.

NSW OEH (2018)

"Dustwatch Report November 2018", prepared by NSW Office of Environment and Heritage, November 2018.

TRC (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 the NSW Office of Environment and Heritage by TRC Environmental Corporation.

VIC EPA (2007)

"Protocol for Environmental Management – State Environment Protection Policy (Air Quality Management) – Mining and Extractive Industries", EPA Victoria, 40 City Road, Southbank, Victoria 3006.

US EPA (1985 and update)

"Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711.

US EPA (2011)

"Health Effects of Pollution", United States Environmental Protection Agency website http://www.epa.gov/region07/air/quality/health.htm, 2011

Appendix A
Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Williamtown RAAF weather station, is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2014 to 2018 was analysed against the long-term measured wind speed, temperature and relative humidity spanning an approximate 59 to 69-year period recorded at the station.

The analysis indicates that 2014, 2016 and 2018 are closest to the long-term average for wind speed. 2014 and 2015 are closest for temperature and 2015 is closest to the long-term average for relative humidity.

This analysis indicates that considering all three variables, the 2015 period is most representative on the long-term average and was selected for modelling.

Table A-1: Statistical analysis results for Williamtown RAAF

Year	Wind speed	Temperature	Relative humidity
2014	0.5	0.6	4.0
2015	0.7	0.6	2.6
2016	0.5	0.8	4.4
2017	0.6	1.0	4.9
2018	0.5	0.8	5.1

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2015 year compared with the mean of the 2014 to 2018 data set. The 2015 year data appear to be well aligned with the mean data, particularly wind direction which is one the most critical parameters for dispersion.

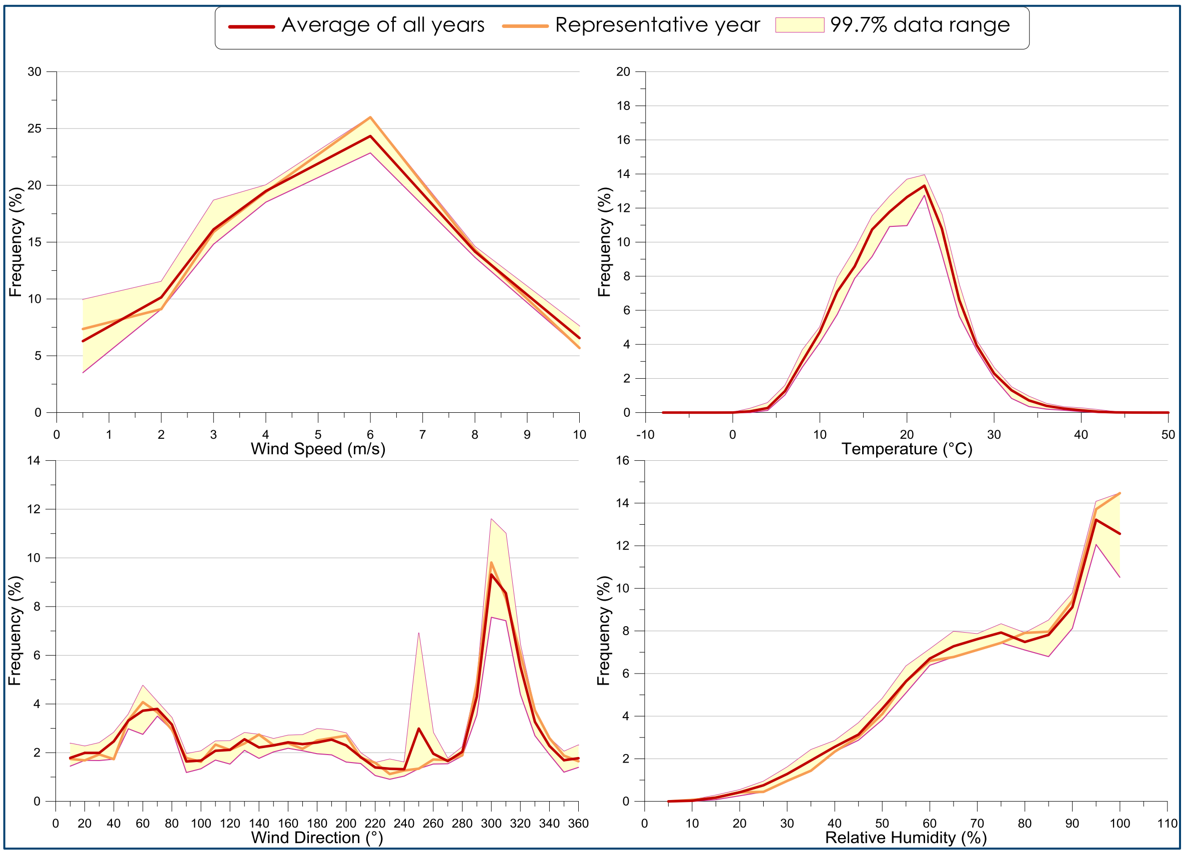


Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Estimated background levels for Stockton Monitor

Estimated background levels for Stockton Monitor

Due to the location of the Stockton OEH monitoring site, it is subject to heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach.

Figure B-1 presents a pollution rose of the hourly PM_{10}, wind speed and wind direction data recorded at Stockton during the 2015 calendar year. Recorded pollutant concentrations are presented as pseudo source locations based on the concurrent wind speed and direction data recorded at the Stockton OEH monitor. White spaces in the figures represent conditions in which no data has been recorded, and outliers are identifiable as points largely surrounded by white space.

It can be seen in **Figure B-1** that higher PM_{10} levels originate from the north-eastern directions under wind speeds below 6m/s. Higher PM_{10} levels were also recorded from the northwest and west-northwest direction under high and moderate wind speeds.

Elevated levels can be seen as patchy red areas in **Figure B-1** along a north-east axis from the monitor. This indicates that heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach were the likely primary contributors to the elevated PM_{10} levels. This is assumed for $PM_{2.5}$ levels as well.

A particle characterisation study that was conducted in the Lower Hunter has estimated that of the recorded annual averages at the Stockton OEH monitor 23% and 63% of $PM_{2.5}$ and $PM_{2.5-10}$ concentrations, respectively, are contributed from fresh sea salt particles at Stockton **(CSIRO, ANSTO & OEH 2016)**. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To estimate the annual average concentrations at the Stockton OEH Monitor without contribution from fresh sea salt particles, the difference in the measured $PM_{2.5}$ and PM_{10} annual averages excluding 63% are summed with the measured $PM_{2.5}$ annual average excluding 23% to estimate the annual average PM_{10} concentration with the contribution of fresh sea salt particles removed. The annual average $PM_{2.5}$ concentration is estimated by excluding 23% of the measured value.

Using these contributions approximate annual average $PM_{2.5}$ and PM_{10} concentrations of 7.3µg/m^3 and 17.0µg/m^3 were calculated respectively.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with level measured at the Beresfield and Wallsend monitors.

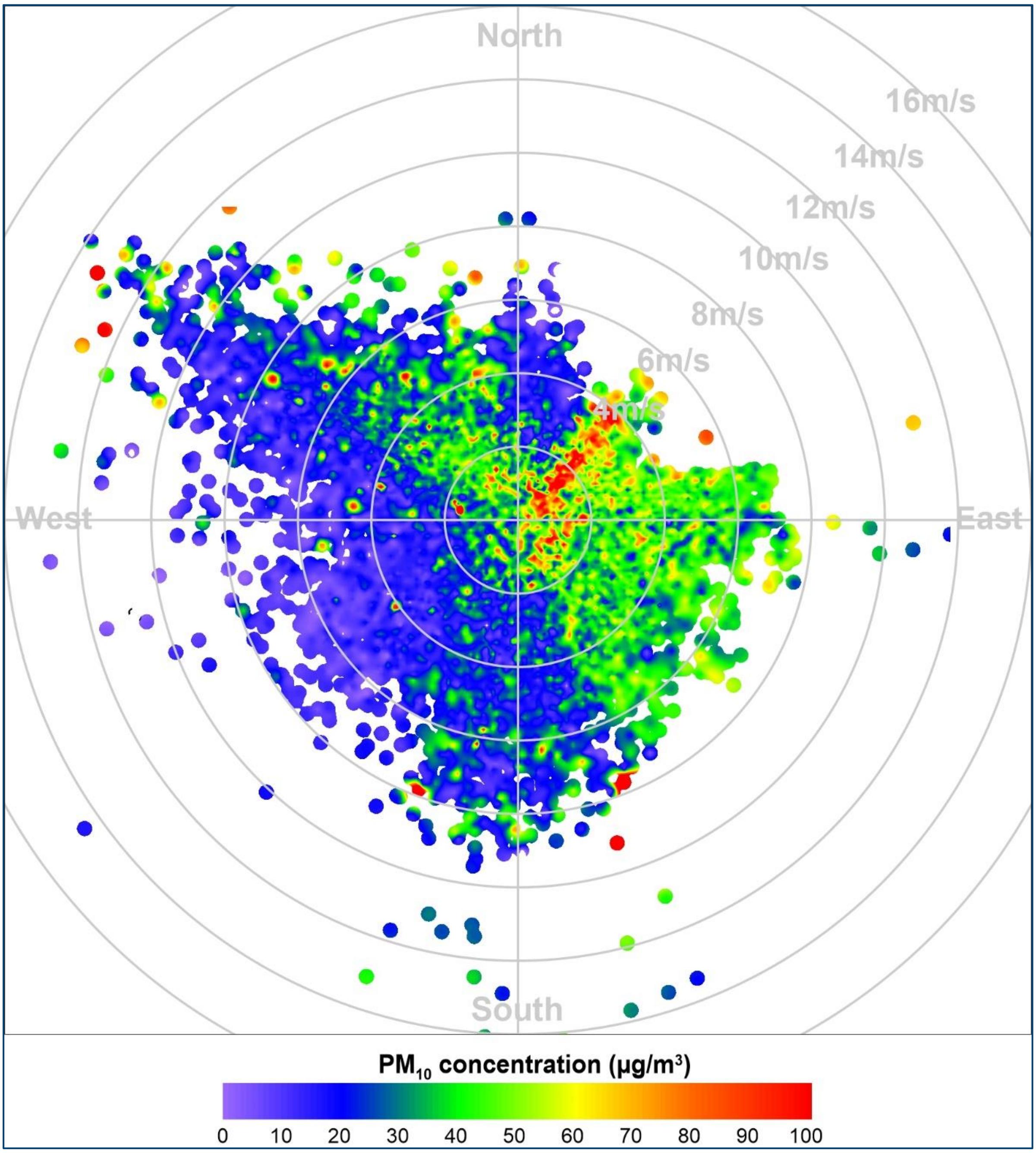


Figure B-1: PM_{10} pollution rose for Stockton Monitor for 2015

Appendix C
Emission Calculations

Emission Calculation

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**EPA NSW, 2015**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. A detailed dust emission inventory for the different scenarios are presented in **Table C-2** to **Table C-4.**

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas; and,
- Wind erosion from exposed areas – 50% control for watering of exposed areas.

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right) kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45} kg/VKT$
Screening	$EF = 0.0125\ kg/\text{tonne}$	$EF = 0.0043\ kg/\text{tonne}$	$0.075 \times TSP$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km).

Table C-2: Dust Emissions Inventory – Scenario 1

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP/PM10/ PM25	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	357	169	26	250,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	14,829	3,779	378	250,000	t/yr	0.297	0.076	0.008	kg/t	28.00	t/load	4.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.427	0.109	0.011	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/load	0.5	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading sand to screen in Stage 1	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	-	t/yr																
Pumping sand to stockpile at processing area	-	-	-	-	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0011	0.000	0.0000	kg/t												
Unloading processed sand to stockpile	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	71	34	5	50,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	714	338	51	500,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	5,931	1,512	151	500,000	t/yr	0.059	0.015	0.002	kg/t	28.00	t/load	0.8	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,038	265	26	70,000	t/yr	0.074	0.019	0.002	kg/t	28.00	t/load	1.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,445	723	108	3.4	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions from on-site equipment	562	562	546																		
Total TSP emissions (kg/yr)	**26,478**	**8,105**	**1,401**																		

Table C-3: Dust Emissions Inventory – Scenario 2

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	-	-	-	-	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	-	-	-	-	t/yr	0.000	0.000	0.000	kg/t	28.00	t/load	0.0	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.427	0.109	0.011	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/load	0.5	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.089	0.042	0.006	63	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading sand to screen in Stage 1	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	-	t/yr																
Pumping sand to stockpile at processing area	-	-	-	-	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0125	0.004	0.0009	kg/t												
Unloading processed sand to stockpile	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	107	51	8	75,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	8,897	2,268	227	750,000	t/yr	0.059	0.015	0.002	kg/t	28.00	t/load	0.8	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/load	1.1	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,488	744	112	3.5	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions from on-site equipment	562	562	546																		
Total TSP emissions (kg/yr)	**15,535**	**5,489**	**1,159**																		

Table C-4: Dust Emissions Inventory – Scenario 3

Activity	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	Emission Factor TSP	Emission Factor PM10	Emission Factor PM2.5	Units	Var. 1	Units	Var. 2	Units	Size specific EF - TSP	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	-	-	-	-	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling RAW sand from windblown sand area to offsite	-	-	-	-	t/yr	0.267	0.068	0.007	kg/t	28.00	t/load	3.6	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Excavator loading topsoil to haul truck - Stage 5	0.051	0.024	0.004	36	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling to topsoil stockpile	0.904	0.230	0.023	36	t/yr	0.127	0.032	0.003	kg/t	40.00	t/load	1.9	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Emplacing at topsoil stockpile	0.051	0.024	0.004	36	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Dredging sand with dredge	-	-	-	750,000	t/yr																
Pumping sand to stockpile at processing area	-	-	-	750,000	t/yr																
Screening RAW sand (controlled - wet sand)	-	-	-	-	t/yr	0.0125	0.004	0.0009	kg/t												
Unloading processed sand to stockpile	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Rehandle processed sand material at product stockpile	107	51	8	75,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading product sand material to haul truck	1,072	507	77	750,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling product sand offsite	6,117	1,559	156	750,000	t/yr	0.041	0.010	0.001	kg/t	28.00	t/load	0.6	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/load	1.1	km/trip	2.1/0.5/0.1	kg/VKT	4.8	S.C. in %	28	A.W. (t)	80	% Control
Unloading VENM material at stockpile	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Loading VENM material to haul truck	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Hauling VENM material to Stage 5	1,773	452	45	70,000	t/yr	0.127	0.032	0.003	kg/t	40.00	t/load	1.9	km/trip	2.6/0.7/0.1	kg/VKT	4.8	S.C. in %	48	A.W. (t)	80	% Control
Unloading VENM material at Stage 5	100	47	7	70,000	t/yr	0.00143	0.001	0.0001	kg/t	1.93	ave. of (WS/2.2)^1.3 in m/s	2.8	M.C. in %								
Wind erosion - exposed area	1,488	744	112	3.5	ha	850	425	64	kg/ha/yr											50	% Control
Exhaust emissions	762	762	739																		
Total TSP emissions (kg/yr)	**13,856**	**5,020**	**1,265**																		

Best Practice Assessment

Table C-5 presents the estimated presents the estimated baseline dust emissions estimates for the Project, with and without the proposed particulate matter controls in place. The activities highlighted in blue shading indicate where control measures have been applied.

From **Table C-5**, the application of the proposed particulate matter controls results in total dust emissions of approximate 32% of the uncontrolled baseline emissions estimates for the Project.

Table C-5: Estimated baseline dust emission estimates for the modelling Project

Activity	Controlled			Uncontrolled		
	TSP	PM_{10}	$PM_{2.5}$	TSP	PM_{10}	$PM_{2.5}$
Loading sand to haul truck at windblown sand area	357	169	26	357	169	26
Hauling RAW sand from windblown sand area to offsite	14,829	3,779	378	74,143	18,896	1,890
Excavator loading topsoil to haul truck - Stage 1	0.089	0.042	0.006	0.089	0.042	0.006
Hauling to topsoil stockpile	0.427	0.109	0.011	2.134	0.544	0.054
Emplacing at topsoil stockpile	0.089	0.042	0.006	0.089	0.042	0.006
Loading sand to screen in Stage 1	714	338	51	714	338	51
Dredging sand with dredge	-	-	-	-	-	-
Pumping sand to stockpile at processing area	-	-	-	-	-	-
Screening RAW sand (controlled - wet sand)	-	-	-	-	-	-
Unloading processed sand to stockpile	714	338	51	714	338	51
Rehandle processed sand material at product stockpile	71	34	5	71	34	5
Loading product sand material to haul truck	714	338	51	714	338	51
Hauling product sand offsite	5,931	1,512	151	29,657	7,558	756
Hauling VENM material onsite	1,038	265	26	5,190	1,323	132
Unloading VENM material at stockpile	100	47	7	100	47	7
Wind erosion - exposed area	1,445	723	108	2,890	1,445	217
Exhaust emissions from on-site equipment	562	562	546	562	562	546
Total TSP emissions (kg/yr)	**26,478**	**8,105**	**1,401**	**115,117**	**31,049**	**3,732**

From **Table C-5**, top three dust generating activities at the Project are identified as:

- Hauling on unpaved roads;
- Wind erosion from exposed areas; and,
- Loading and unloading material.

These three activities account for approximately 98% of the estimated controlled dust emissions estimates for the Project.

A summary of the evaluation of potential additional control measures is presented in **Table C-6**.

The proposed and additional recommended control measures for the Project, based on the top four dust generating activities at the Project include:

- Watering of unpaved haul roads;
- Restriction of vehicle speed to 30km/hr at the site;
- Minimise extent of exposed area;
- Watering of exposed areas for stabilisation;

- Establish rehabilitation goals and report annually on progress;
- Reduce drop height of material where practical; and,
- Assess handling activity during adverse weather conditions.

Table C-6: Summary of application of control measures for the Project

Control measure		Application at Project	Comment
Hauling on unpaved roads			
Vehicle restrictions	Reduction from 75km/hr to 50km/hr.	-	-
	Reduction from 65km/hr to 30km/hr.	Recommended	A speed limit of 30km/hr is recommended for the site. Measure is applied via signage.
Surface improvements	Pave the surface.	-	Not practical/ feasible.
	Low silt aggregate.	Yes	Haul road surfaces will be regularly maintained via watering and grading to ensure a smooth compacted surface with reduced loose surface silt.
	Oil and double chip surface.	-	Not practical/ feasible.
Surface Treatments	Watering (standard procedure).	-	-
	Watering Level 1 (2L/m²/hr).	-	-
	Watering Level 2 (>2L/m²/hr).	Yes	Application via watercart capable to delivering more than 2L/m²/ hr (multiple passes are preferred to a single drenching pass).
	Watering grader routes.	-	Not a regular control measure, but if significant dust is generated from graders, target watering is recommended at these times.
	Watering twice a day for industrial unpaved road.	-	Not a regular measure, but may be practiced, say on a very hot and windy day
	Suppressants.	-	-
	Hygroscopic salts.	-	-
	Lignosulphonates.	-	-
	Polymer emulsions.	-	-
	Tar and bitumen emulsions.	-	-
Other	Use larger vehicles rather than smaller vehicles to minimise number of trips.	-	Not practical/ feasible. Road going vehicles required.
	Use conveyors in place of haul roads.	-	Not practical/ feasible.
Wind erosion			
Avoidance	Minimise pre-strip. Environmental Management Plan (EMP) should specify a benchmark for optimal performance and report annually against benchmark.	Recommended	Recommended for this Project.
Surface stabilisation	Watering.	Yes	Targeted watering of active areas when in use (considered an appropriate control measure for this source.
	Chemical suppressants.	-	-
	Paving and cleaning.	-	-
	Apply gravel to stabilise disturbed open areas.	-	Could be considered depending on available material.
	Rehabilitation. EMP should specify a rehabilitation goal and report annually against progress to meeting goal.	Recommended	Recommended for this Project.
Wind speed reduction	Fencing, bunding, shelterbelts or in-pit dump. Height should be greater than the	-	-

Control measure		Application at Project	Comment
	height of the erodible surface.		
	Vegetative ground cover.	-	May be considered in the rehabilitation goal.
Loading and unloading			
Minimise drop height	Reduce from 3m to 1.5m	Recommended	Recommended for this Project.
Water application	Apply water during activity.	-	Not practical/ feasible.
Modify activities in windy conditions	Activities to be assessed during adverse weather conditions and modified as required. Weather forecast to be checked prior to undertaking material handling or processing.	Recommended	Recommended for this Project.

Appendix D

Isopleth Diagrams

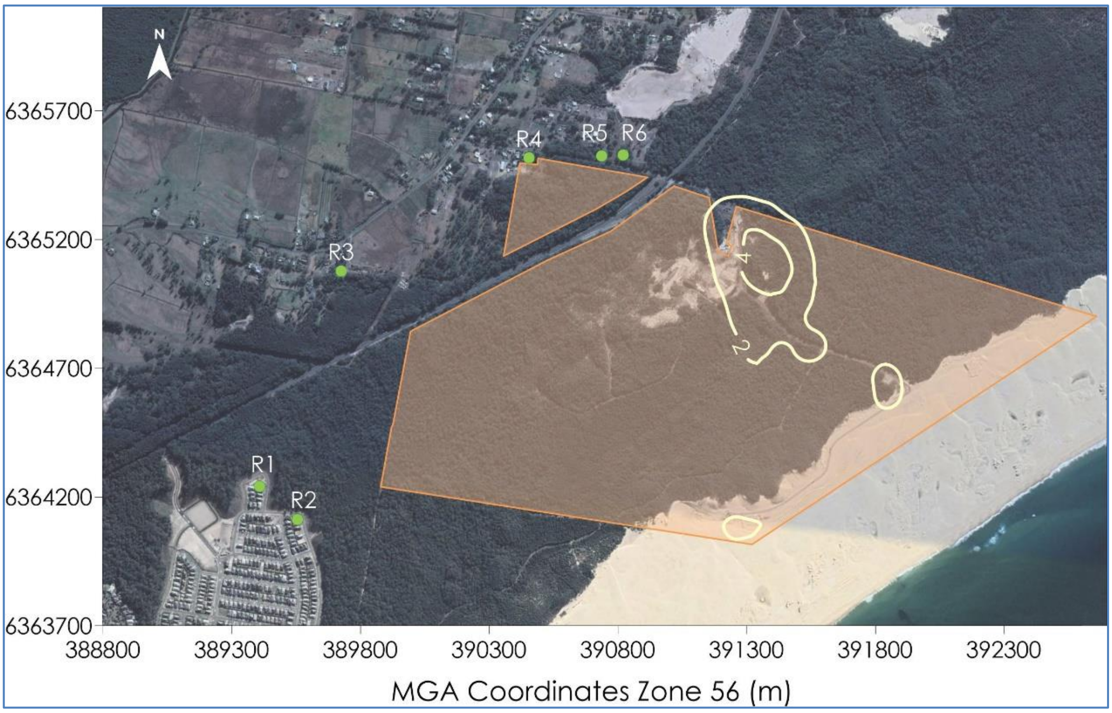


Figure D-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

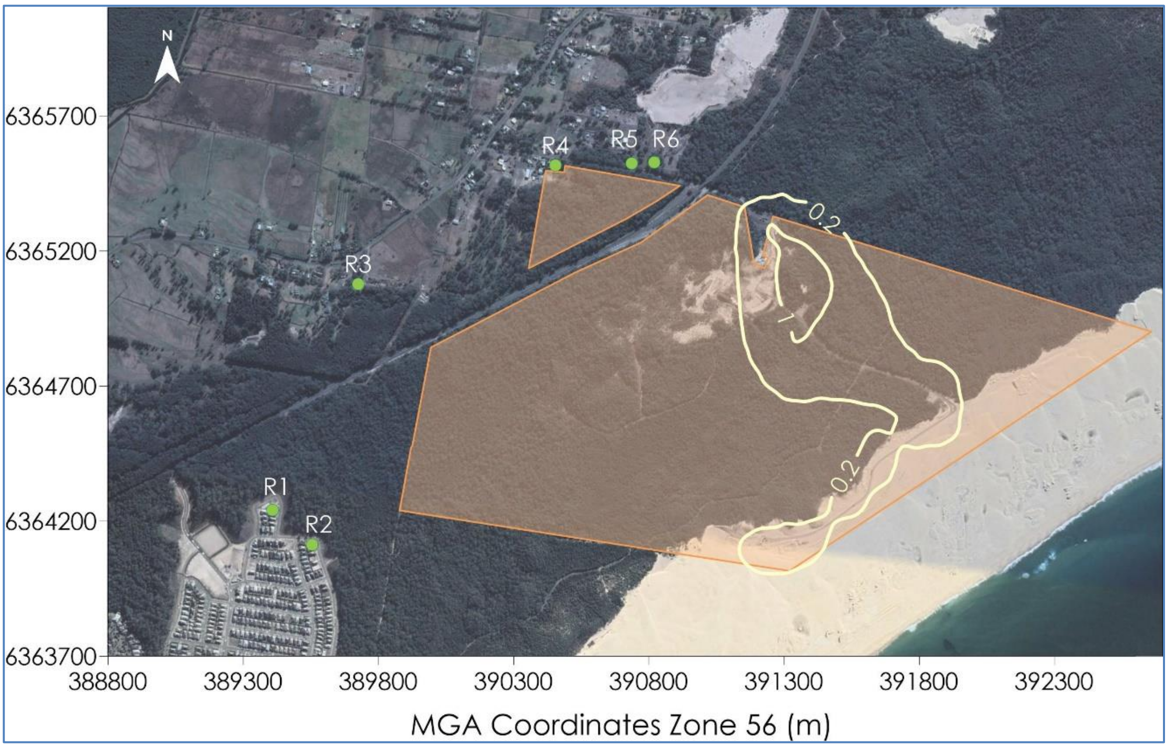


Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

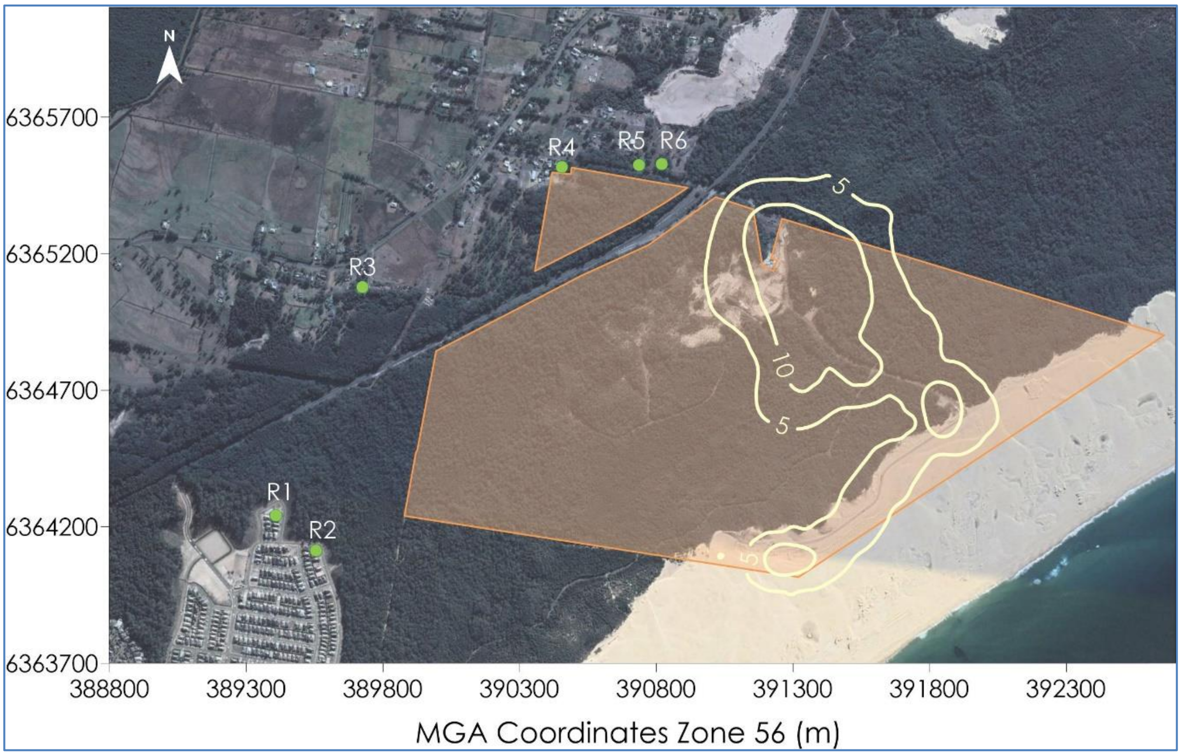


Figure D-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

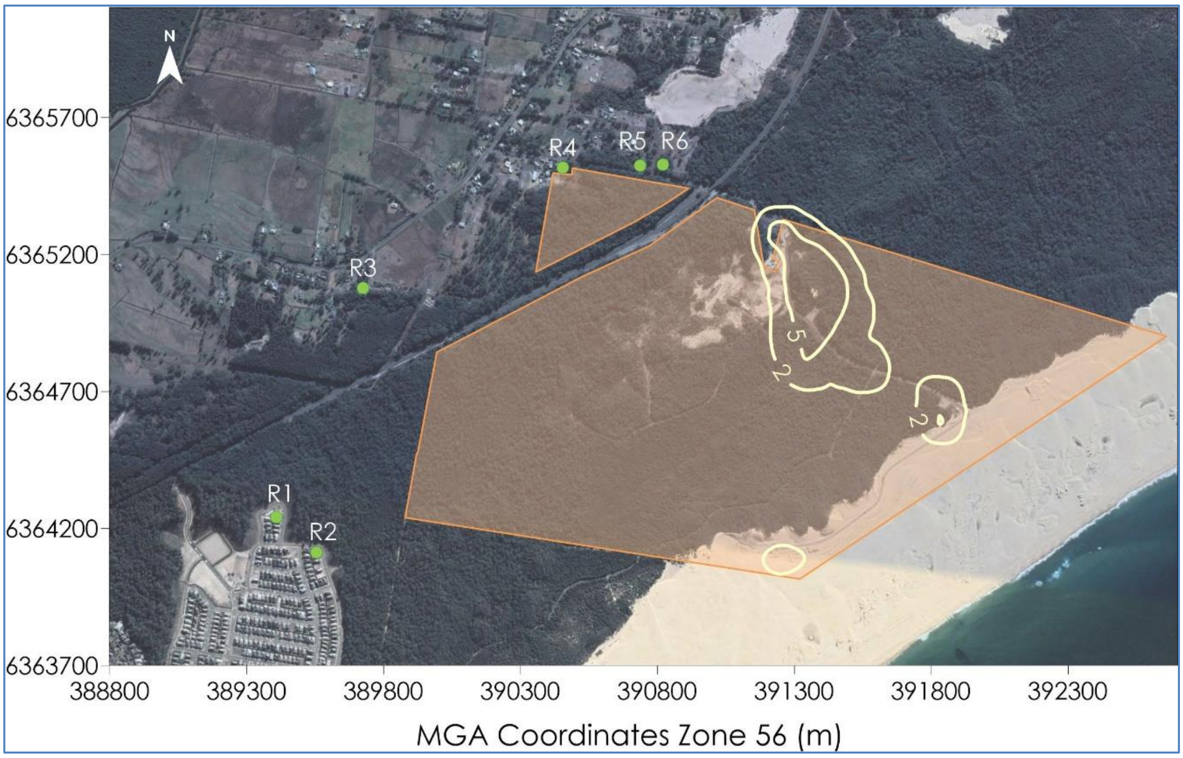


Figure D-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

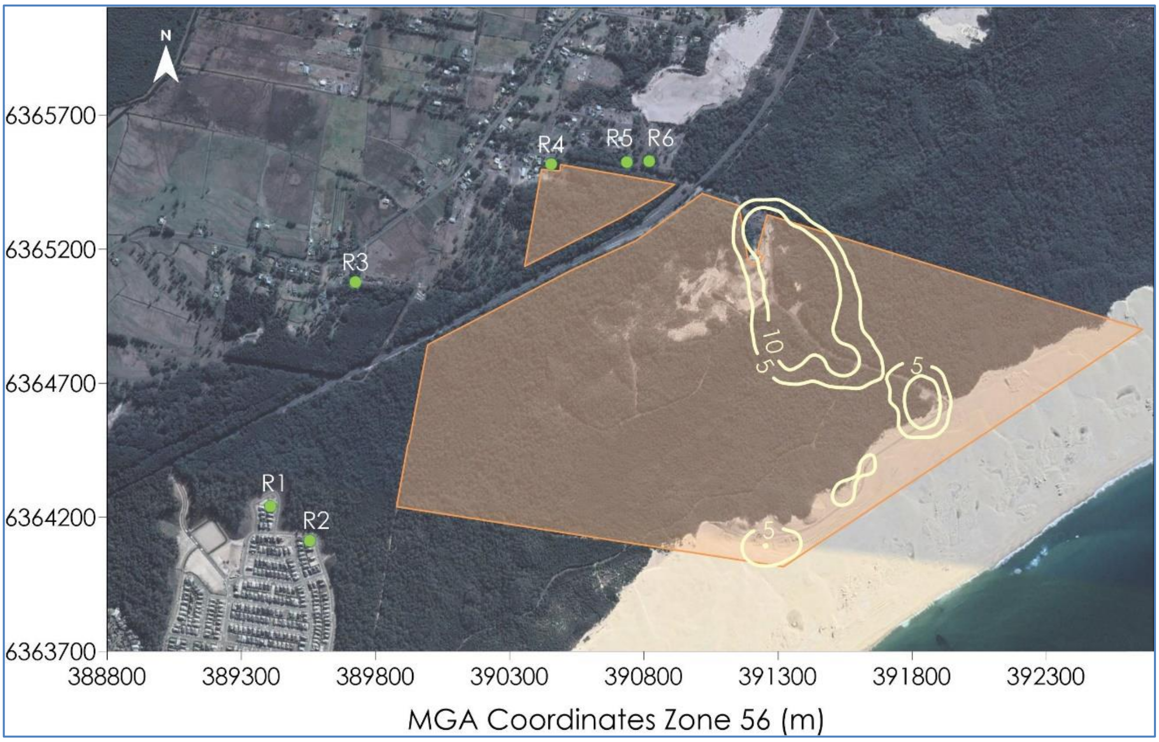


Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)

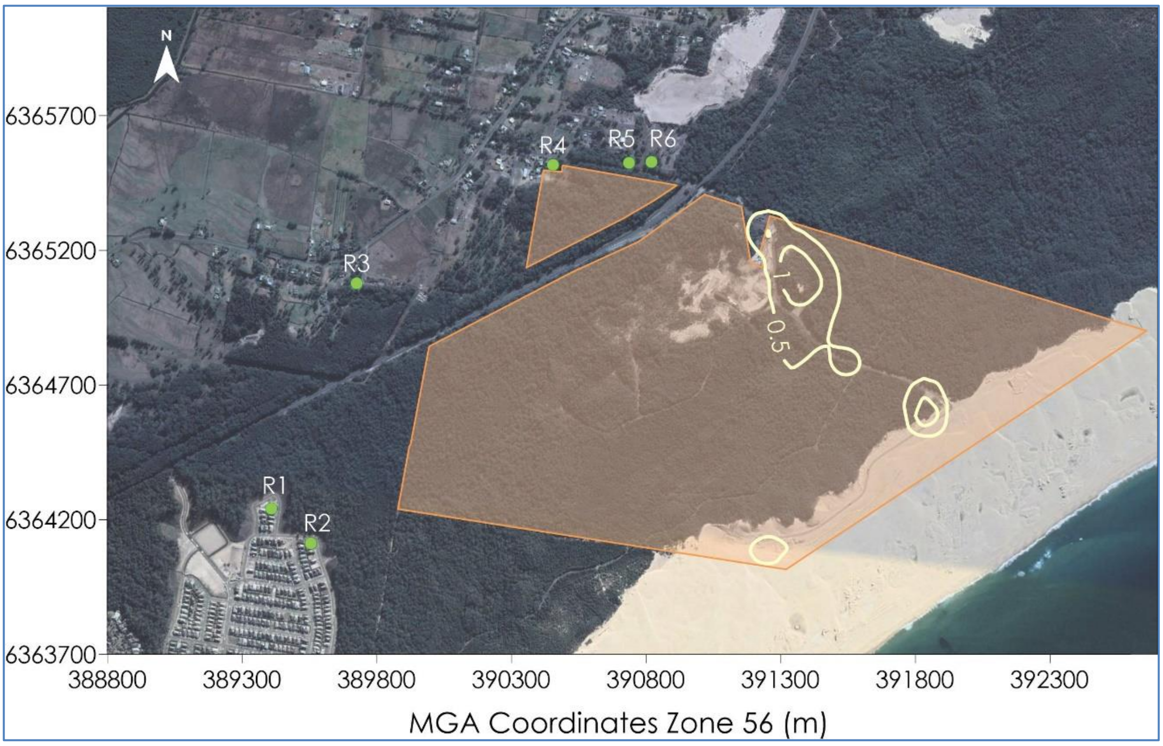


Figure D-6: Predicted incremental annual average dust deposition levels (g/m²/month)

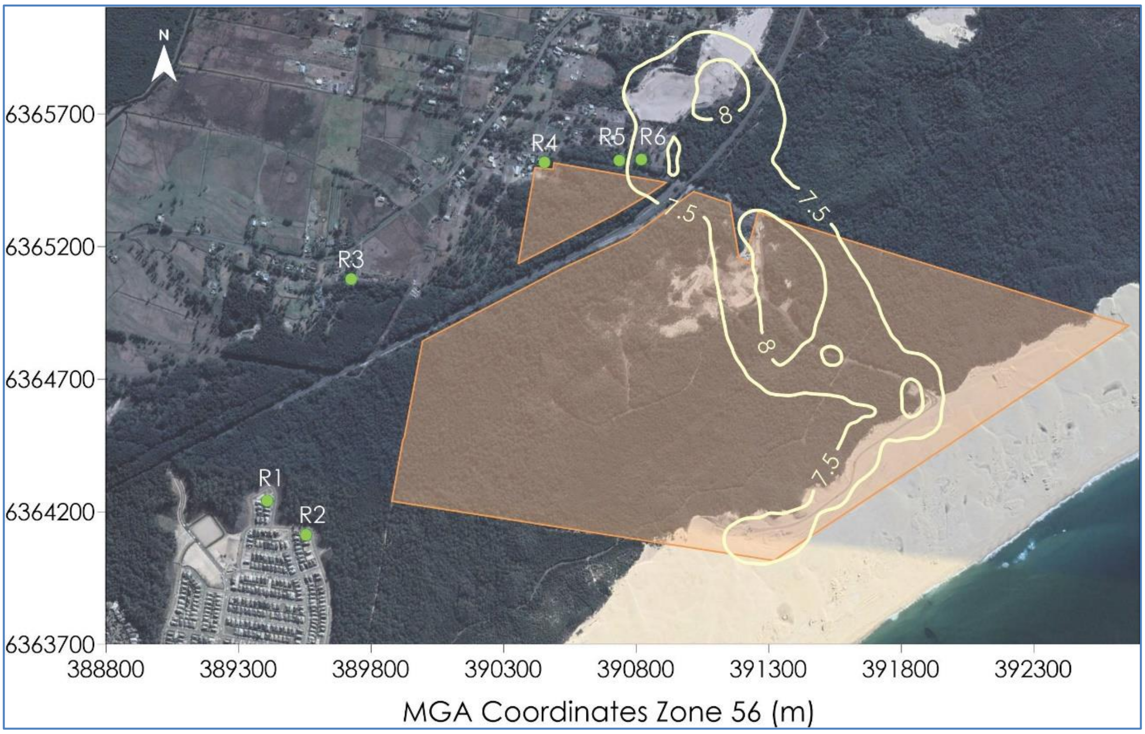


Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

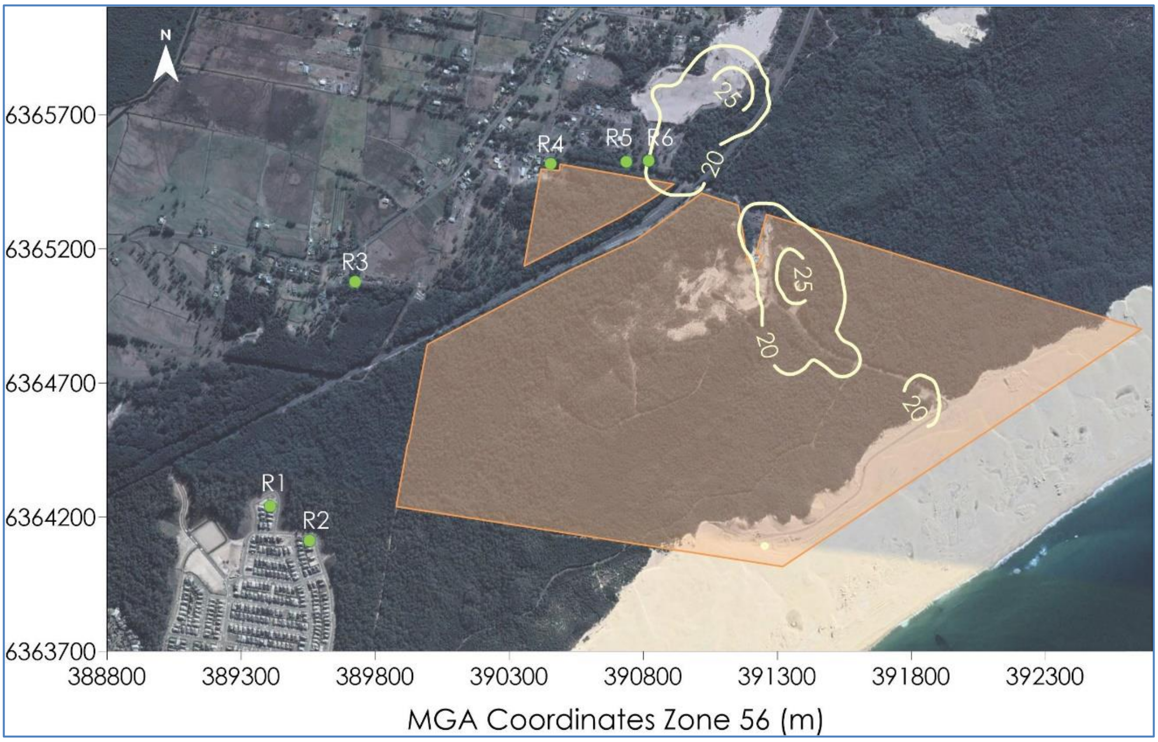


Figure D-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

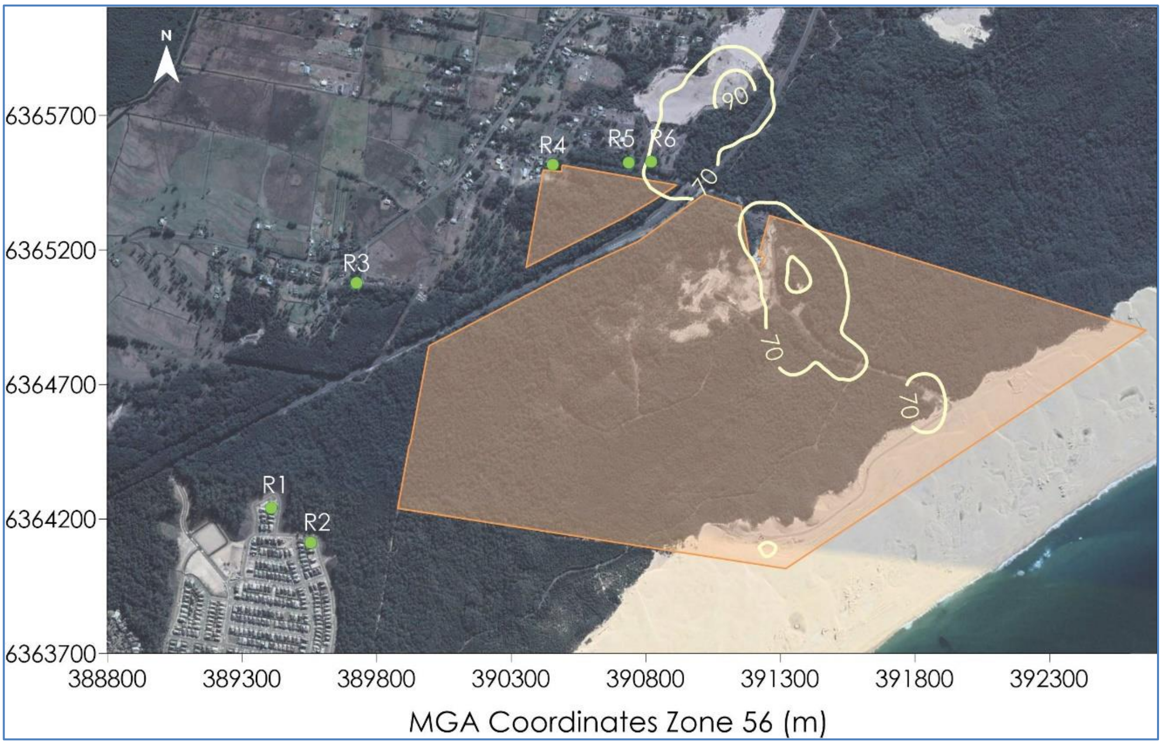


Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)

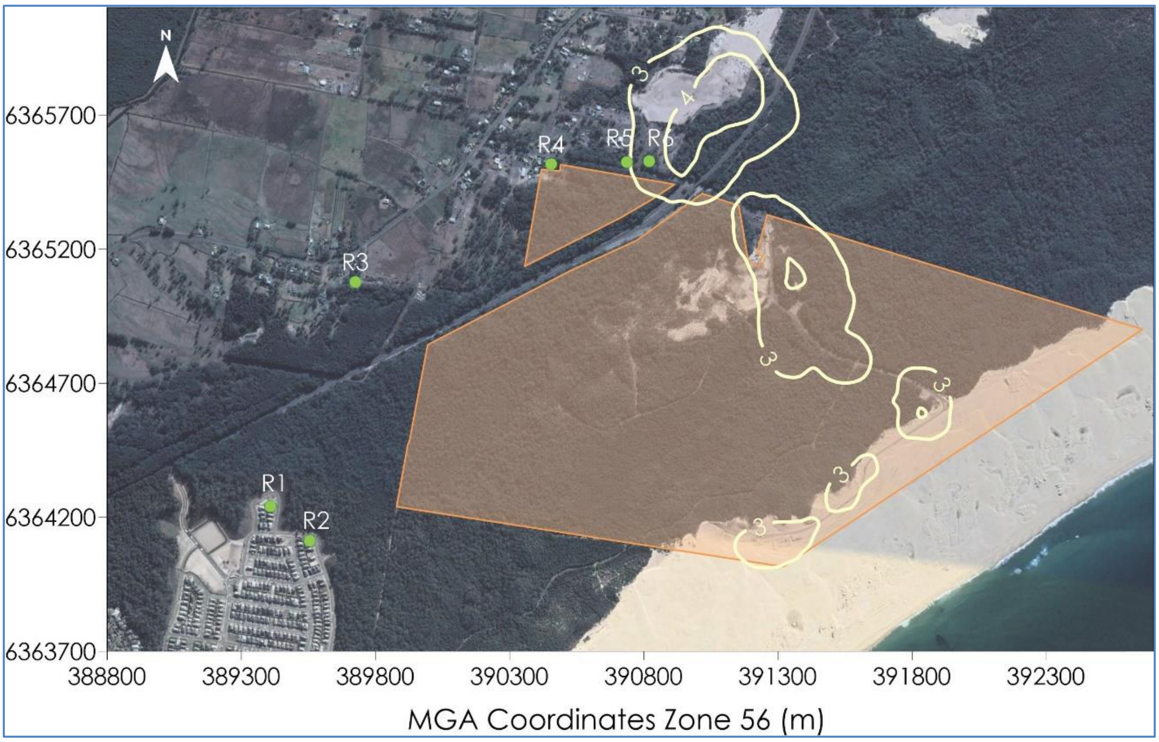


Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

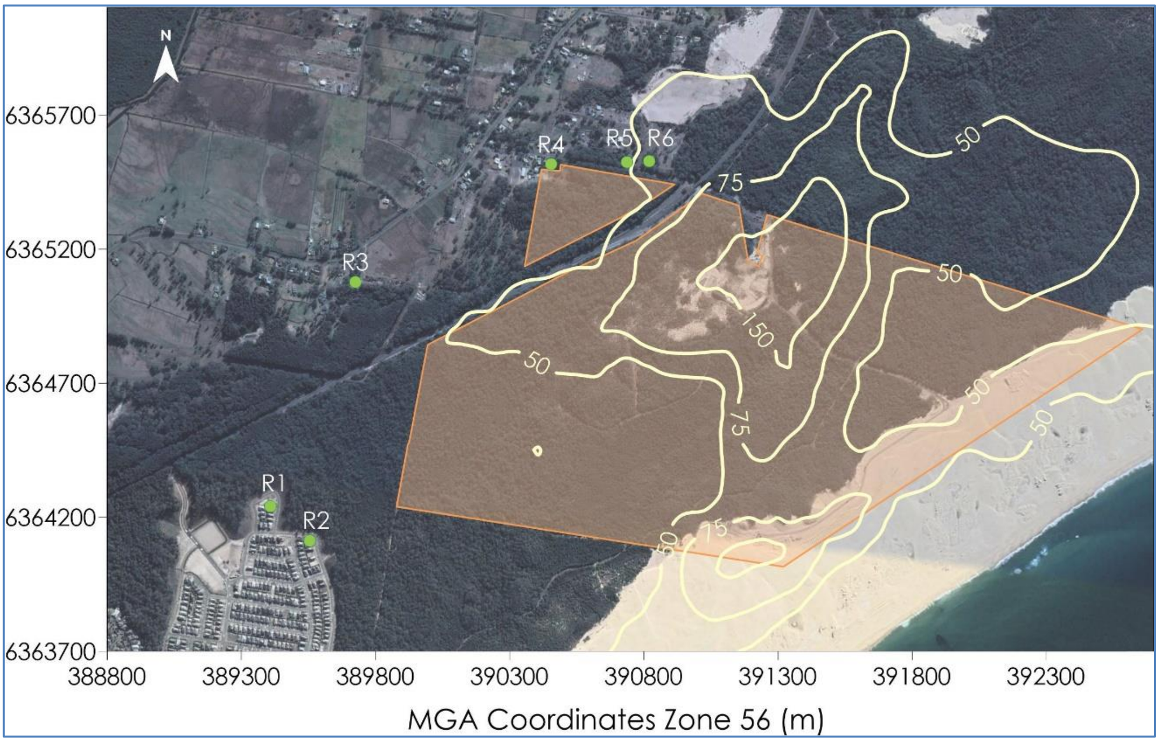


Figure D-11: Predicted incremental maximum 1-hour average NO_2 concentrations (µg/m³)

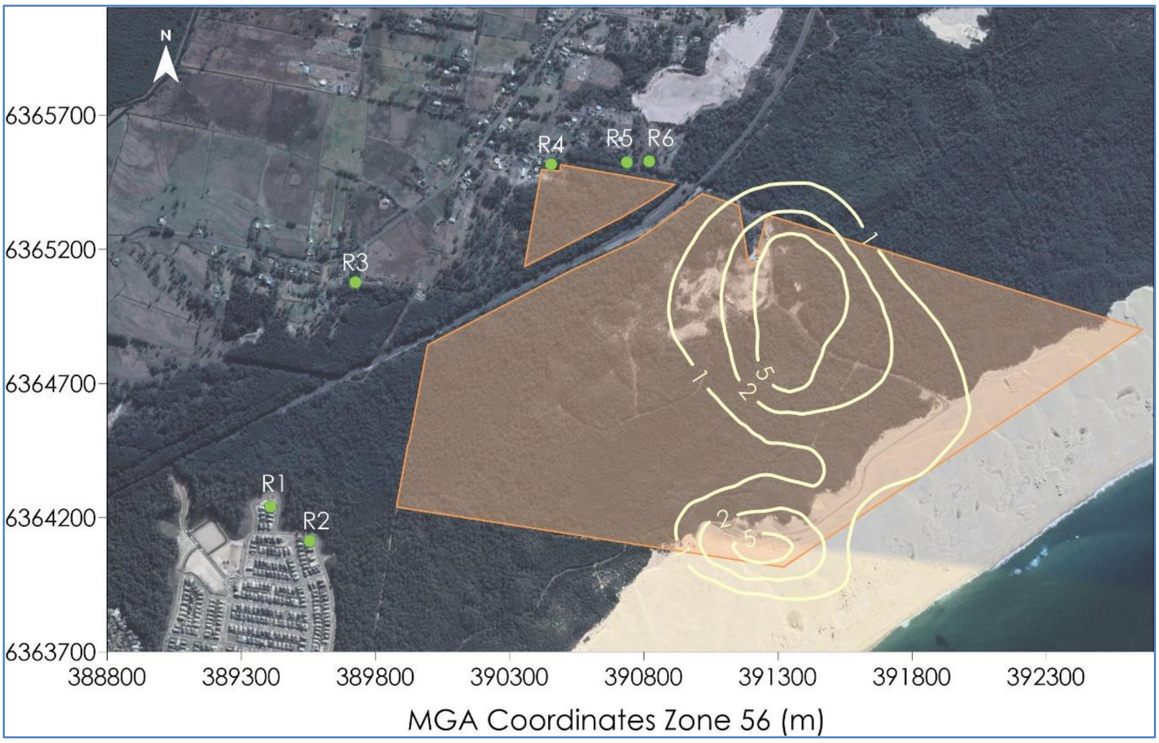


Figure D-12: Predicted incremental annual average NO_2 concentrations (µg/m³)

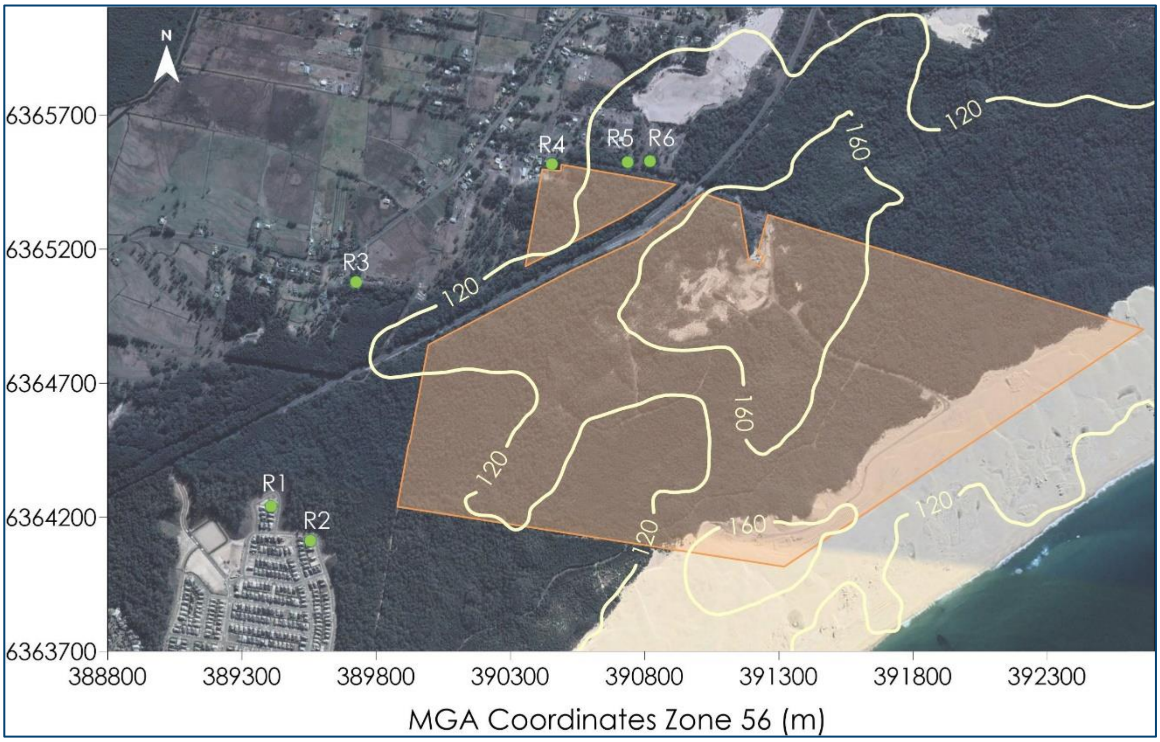


Figure D-13: Predicted cumulative maximum 1-hour average NO_2 concentrations (µg/m³)

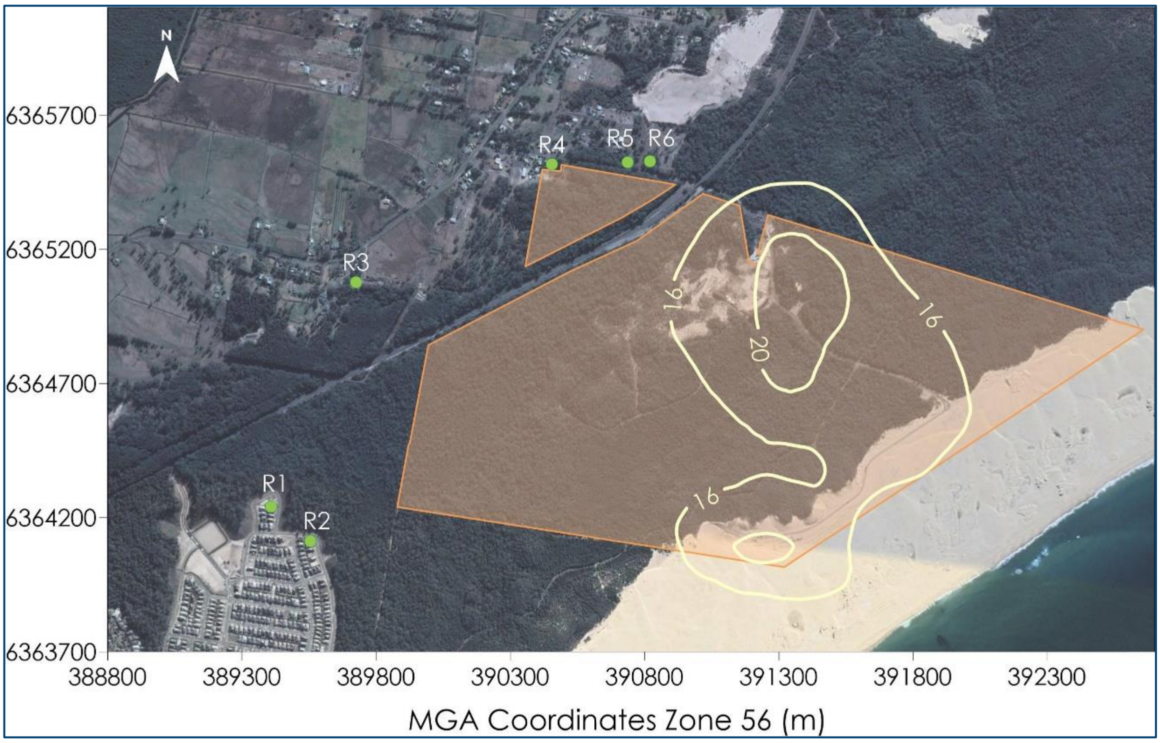


Figure D-13: Predicted cumulative annual average NO_2 concentrations (µg/m³)

Appendix E

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and a cumulative 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 46 to 47 of the Approved Methods.

The background level is the ambient level at Stockton monitoring station for $PM_{2.5}$ and PM_{10}.

The predicted increment is the predicted level to occur at the receptor due to the Project.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Tables E-1 to **E-6** and **E-8** to **E-13** each assess one receptor and shows the predicted maximum cumulative levels at each receptor surrounding the Project. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the Project.

Tables E-7 show the periods of highest background PM_{10} levels where the measured background level is already over the criteria of 50µg/m^3 at each receptor surrounding the Project which has been excluded from **Tables E-8** to **E-13**.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m^3 or above the PM_{10} criterion of 50µg/m^3 is in **bold red.**

Table E-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27.0	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.1	7.4
21/08/2015	23.5	0.1	23.6	29/06/2015	21.4	0.1	21.5
28/06/2015	22.9	0.0	22.9	4/04/2015	3.3	0.1	3.4
30/06/2015	22.6	0.0	22.6	23/07/2015	12.6	0.1	12.7
29/07/2015	22.4	0.0	22.4	21/08/2015	23.5	0.1	23.6
4/10/2015	22.3	0.0	22.3	15/07/2015	5.9	0.0	5.9
4/06/2015	21.7	0.0	21.7	2/04/2015	4.5	0.0	4.5
21/06/2015	21.6	0.0	21.6	20/09/2015	5.5	0.0	5.5
6/06/2015	21.4	0.0	21.4	20/07/2015	5.6	0.0	5.6
29/06/2015	21.4	0.1	21.5	14/10/2015	6	0.0	6.0

Table E-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	30.9	0.0	30.9				
4/07/2015	27.4	0.0	27.4				
27/06/2015	27	0.0	27.0				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.1	7.4
21/08/2015	23.5	0.1	23.6	13/06/2015	10.2	0.1	10.3
28/06/2015	22.9	0.0	22.9	29/06/2015	21.4	0.1	21.5
30/06/2015	22.6	0.0	22.6	2/04/2015	4.5	0.1	4.6
29/07/2015	22.4	0.0	22.4	23/07/2015	12.6	0.1	12.7
4/10/2015	22.3	0.0	22.3	21/08/2015	23.5	0.1	23.6
4/06/2015	21.7	0.0	21.7	4/04/2015	3.3	0.1	3.4
21/06/2015	21.6	0.0	21.6	19/10/2015	6.3	0.0	6.3
6/06/2015	21.4	0.0	21.4	12/10/2015	13	0.0	13.0
29/06/2015	21.4	0.1	21.5	15/04/2015	10.6	0.0	10.6

Table E-3: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	**30.9**	0.0	**30.9**				
4/07/2015	**27.4**	0.0	**27.4**				
27/06/2015	**27**	0.0	**27.0**				
22/08/2015	24.3	0.0	24.3	15/07/2015	5.9	0.1	6.0
21/08/2015	23.5	0.0	23.5	20/07/2015	5.6	0.1	5.7
28/06/2015	22.9	0.0	22.9	4/04/2015	3.3	0.1	3.4
30/06/2015	22.6	0.0	22.6	12/06/2015	6.4	0.1	6.5
29/07/2015	22.4	0.0	22.4	29/06/2015	21.4	0.1	21.5
4/10/2015	22.3	0.0	22.3	2/05/2015	8	0.1	8.1
4/06/2015	21.7	0.0	21.7	23/07/2015	12.6	0.1	12.7
21/06/2015	21.6	0.0	21.6	18/05/2015	7.3	0.1	7.4
6/06/2015	21.4	0.0	21.4	19/09/2015	3.9	0.1	4.0
29/06/2015	21.4	0.1	21.5	31/07/2015	7.9	0.1	8.0

Table E-4: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	**30.9**	0.0	**30.9**				
4/07/2015	**27.4**	0.0	**27.4**				
27/06/2015	**27**	0.0	**27.0**				
22/08/2015	24.3	0.0	24.3	12/06/2015	6.4	0.2	6.6
21/08/2015	23.5	0.0	23.5	18/05/2015	7.3	0.2	7.5
28/06/2015	22.9	0.0	22.9	31/07/2015	7.9	0.2	8.1
30/06/2015	22.6	0.0	22.6	15/07/2015	5.9	0.2	6.1
29/07/2015	22.4	0.0	22.4	9/07/2015	12.7	0.2	12.9
4/10/2015	22.3	0.0	22.3	22/02/2015	6	0.1	6.1
4/06/2015	21.7	0.0	21.7	20/02/2015	8.5	0.1	8.6
21/06/2015	21.6	0.0	21.6	23/02/2015	6.3	0.1	6.4
6/06/2015	21.4	0.0	21.4	3/12/2015	7.7	0.1	7.8
29/06/2015	21.4	0.1	21.5	31/03/2015	3.9	0.1	4.0

Table E-5: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	**30.9**	0.0	**30.9**				
4/07/2015	**27.4**	0.0	**27.4**				
27/06/2015	**27**	0.0	**27.0**				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.3	7.6
21/08/2015	23.5	0.0	23.5	12/06/2015	6.4	0.3	6.7
28/06/2015	22.9	0.0	22.9	9/07/2015	12.7	0.2	12.9
30/06/2015	22.6	0.0	22.6	15/07/2015	5.9	0.2	6.1
29/07/2015	22.4	0.1	22.5	20/02/2015	8.5	0.2	8.7
4/10/2015	22.3	0.0	22.3	23/02/2015	6.3	0.2	6.5
4/06/2015	21.7	0.0	21.7	3/12/2015	7.7	0.2	7.9
21/06/2015	21.6	0.0	21.6	31/07/2015	7.9	0.2	8.1
6/06/2015	21.4	0.0	21.4	22/02/2015	6	0.2	6.2
29/06/2015	21.4	0.0	21.4	5/02/2015	ND	0.1	0.1

ND – no data

Table E-6: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
5/07/2015	**30.9**	0.0	**30.9**				
4/07/2015	**27.4**	0.0	**27.4**				
27/06/2015	**27**	0.0	**27.0**				
22/08/2015	24.3	0.0	24.3	18/05/2015	7.3	0.4	7.7
21/08/2015	23.5	0.0	23.5	12/06/2015	6.4	0.4	6.8
28/06/2015	22.9	0.0	22.9	9/07/2015	12.7	0.3	13.0
30/06/2015	22.6	0.0	22.6	20/02/2015	8.5	0.2	8.7
29/07/2015	22.4	0.1	22.5	15/07/2015	5.9	0.2	6.1
4/10/2015	22.3	0.0	22.3	23/02/2015	6.3	0.2	6.5
4/06/2015	21.7	0.0	21.7	3/12/2015	7.7	0.2	7.9
21/06/2015	21.6	0.0	21.6	21/03/2015	10.4	0.2	10.6
6/06/2015	21.4	0.0	21.4	3/02/2015	5	0.2	5.2
29/06/2015	21.4	0.0	21.4	5/01/2015	8.3	0.2	8.5

Table E-7: Summary of 24-hour average PM_{10} concentration (µg/m³) above the criteria

Ranked by Highest to Lowest Background Concentrations							
Date	Measured background level	Predicted increment					
		R1	R2	R3	R4	R5	R6
4/10/2015	**101.4**	0.1	0.1	0.0	0.0	0.0	0.0
6/05/2015	**96.9**	0.0	0.0	0.0	0.0	0.0	0.0
14/02/2015	**88.6**	0.1	0.2	0.0	0.0	0.0	0.0
6/03/2015	**85**	0.0	0.0	0.0	0.0	0.0	0.1
19/02/2015	**82.4**	0.2	0.2	0.1	0.0	0.0	0.0
6/10/2015	**80.8**	0.1	0.2	0.0	0.1	0.1	0.1
5/10/2015	**80.2**	0.0	0.0	0.0	0.0	0.0	0.0
24/01/2015	**79.5**	0.1	0.1	0.1	0.1	0.1	0.1
9/01/2015	**78.3**	0.1	0.1	0.0	0.0	0.0	0.0
20/11/2015	**78**	0.0	0.0	0.0	0.0	0.0	0.0
29/10/2015	**76.4**	0.1	0.0	0.2	0.3	0.3	0.2
18/02/2015	**75.2**	0.2	0.2	0.0	0.0	0.0	0.0
9/10/2015	**74.4**	0.2	0.2	0.0	0.0	0.0	0.0
23/01/2015	**73.6**	0.1	0.1	0.0	0.0	0.0	0.0
4/12/2015	**72.7**	0.0	0.0	0.1	0.4	0.7	0.8
12/02/2015	**72.4**	0.0	0.1	0.1	0.2	0.1	0.1
7/03/2015	**70.7**	0.1	0.1	0.1	0.1	0.1	0.1
20/02/2015	**70.5**	0.0	0.0	0.1	0.6	1.2	1.4
20/12/2015	**69.8**	0.0	0.0	0.0	0.0	0.0	0.0
26/11/2015	**68.1**	0.0	0.0	0.0	0.0	0.0	0.0
16/02/2015	**67.9**	0.1	0.1	0.0	0.0	0.0	0.0
14/12/2015	**67.3**	0.1	0.1	0.0	0.0	0.0	0.0
29/11/2015	**66.7**	0.1	0.1	0.0	0.0	0.0	0.0
27/11/2015	**66.2**	0.1	0.1	0.2	0.2	0.2	0.2
1/01/2015	**65.5**	0.1	0.1	0.0	0.0	0.0	0.0
13/12/2015	**64.9**	0.2	0.2	0.0	0.0	0.0	0.0
21/02/2015	**63.9**	0.1	0.1	0.3	0.1	0.1	0.0
22/01/2015	**63.7**	0.1	0.0	0.2	0.4	0.5	0.5
10/01/2015	**62.8**	0.1	0.1	0.1	0.0	0.1	0.0
8/03/2015	**62.5**	0.0	0.0	0.0	0.1	0.1	0.1
7/10/2015	**61.7**	0.0	0.0	0.0	0.0	0.0	0.0
15/02/2015	**61.4**	0.1	0.1	0.0	0.0	0.0	0.0
3/12/2015	**61.3**	0.0	0.0	0.1	0.6	1.1	1.2
31/12/2015	**61.1**	0.0	0.0	0.1	0.4	0.5	0.5
21/01/2015	**61**	0.2	0.2	0.0	0.0	0.0	0.0
17/02/2015	**59.3**	0.2	0.2	0.0	0.0	0.0	0.0
17/03/2015	**59.2**	0.1	0.1	0.0	0.0	0.0	0.0
12/11/2015	**58.9**	0.1	0.1	0.0	0.0	0.0	0.0
9/12/2015	**58.8**	0.0	0.0	0.0	0.0	0.0	0.0
21/08/2015	**58.4**	0.3	0.3	0.0	0.0	0.0	0.0
28/10/2015	**58.4**	0.0	0.0	0.1	0.5	0.8	0.9
19/11/2015	**57.8**	0.0	0.1	0.0	0.1	0.3	0.3
28/11/2015	**57.2**	0.2	0.1	0.2	0.0	0.0	0.0
31/01/2015	**56.6**	0.0	0.0	0.0	0.2	0.3	0.4
5/12/2015	**55.5**	0.1	0.0	0.1	0.3	0.4	0.4
22/08/2015	**54.8**	0.0	0.0	0.0	0.0	0.0	0.0
8/10/2015	**54.7**	0.2	0.1	0.2	0.1	0.0	0.0
18/03/2015	**54.6**	0.0	0.0	0.0	0.0	0.0	0.0
4/03/2015	**54.4**	0.0	0.0	0.0	0.2	0.3	0.4
25/11/2015	**53.9**	0.0	0.1	0.0	0.1	0.1	0.1
13/02/2015	**53.8**	0.0	0.0	0.1	0.4	0.7	0.8
26/03/2015	**53.8**	0.0	0.0	0.0	0.0	0.0	0.0
3/10/2015	**53**	0.0	0.0	0.0	0.0	0.0	0.0
30/01/2015	**52.8**	0.0	0.0	0.0	0.0	0.1	0.1
11/02/2015	**52.8**	0.2	0.2	0.1	0.1	0.0	0.0

Ranked by Highest to Lowest Background Concentrations							
Date	Measured background level	Predicted increment					
		R1	R2	R3	R4	R5	R6
25/01/2015	**52.4**	0.0	0.0	0.0	0.0	0.0	0.0
10/12/2015	**52.2**	0.0	0.0	0.0	0.2	0.3	0.4
5/11/2015	**52.1**	0.0	0.1	0.0	0.0	0.0	0.0
23/11/2015	**51.5**	0.0	0.0	0.0	0.0	0.0	0.0
26/12/2015	**51.5**	0.0	0.1	0.0	0.0	0.0	0.0
19/08/2015	**51.3**	0.1	0.1	0.2	0.2	0.2	0.2
8/12/2015	**51.3**	0.1	0.1	0.0	0.0	0.0	0.0
22/11/2015	**51**	0.2	0.2	0.1	0.0	0.0	0.0
1/02/2015	**50.6**	0.0	0.0	0.0	0.3	0.6	0.7
20/01/2015	**50.3**	0.1	0.1	0.0	0.0	0.0	0.0
20/03/2015	**50.3**	0.0	0.0	0.0	0.0	0.0	0.0
14/04/2015	**50.1**	0.1	0.1	0.2	0.3	0.4	0.4

Table E-8: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R1

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	0.5	28.6
1/10/2015	49.8	0.1	49.9	29/06/2015	48	0.4	48.4
5/03/2015	49.6	0.0	49.6	23/07/2015	31	0.3	31.3
21/12/2015	49.6	0.0	49.6	4/04/2015	13.6	0.3	13.9
19/03/2015	49.5	0.0	49.5	21/08/2015	**58.4**	0.3	**58.7**
12/12/2015	49.4	0.0	49.4	2/04/2015	33.4	0.3	33.7
8/01/2015	48.8	0.1	48.9	15/07/2015	15.1	0.3	15.4
3/03/2015	48.7	0.1	48.8	20/09/2015	22.6	0.2	22.8
31/10/2015	48.3	0.1	48.4	20/07/2015	ND	0.2	0.2
29/06/2015	48	0.4	48.4	14/10/2015	35.1	0.2	35.3

ND – no data

Table E-9: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.1	49.9	18/05/2015	28.1	0.5	28.6
1/10/2015	49.8	0.2	50.0	13/06/2015	43.2	0.4	43.6
5/03/2015	49.6	0.0	49.6	29/06/2015	48	0.4	48.4
21/12/2015	49.6	0.0	49.6	2/04/2015	33.4	0.3	33.7
19/03/2015	49.5	0.0	49.5	23/07/2015	31	0.3	31.3
12/12/2015	49.4	0.0	49.4	21/08/2015	**58.4**	0.3	**58.7**
8/01/2015	48.8	0.1	48.9	4/04/2015	13.6	0.3	13.9
3/03/2015	48.7	0.1	48.8	19/10/2015	42.8	0.2	43.0
31/10/2015	48.3	0.1	48.4	15/04/2015	47.3	0.2	47.5
29/06/2015	48	0.4	48.4	13/12/2015	**64.9**	0.2	**65.1**

Table E-10: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R3

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	15/07/2015	15.1	0.5	15.6
1/10/2015	49.8	0.0	49.8	20/07/2015	ND	0.5	0.5
5/03/2015	49.6	0.0	49.6	4/04/2015	13.6	0.4	14.0
21/12/2015	49.6	0.0	49.6	2/05/2015	43.4	0.4	43.8
19/03/2015	49.5	0.1	49.6	29/06/2015	48	0.4	48.4
12/12/2015	49.4	0.0	49.4	12/06/2015	19.1	0.4	19.5
8/01/2015	48.8	0.0	48.8	23/07/2015	31	0.4	31.4
3/03/2015	48.7	0.1	48.8	18/05/2015	28.1	0.3	28.4
31/10/2015	48.3	0.0	48.3	19/09/2015	20.2	0.3	20.5
29/06/2015	48	0.4	48.4	31/07/2015	26.6	0.3	26.9

ND – no data

Table E-11: Cumulative 24-hour average PM10 concentration (µg/m³) – Receptor R4

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	12/06/2015	19.1	1.1	20.2
1/10/2015	49.8	0.0	49.8	31/07/2015	26.6	1.0	27.6
5/03/2015	49.6	0.0	49.6	18/05/2015	28.1	0.9	29.0
21/12/2015	49.6	0.0	49.6	15/07/2015	15.1	0.8	15.9
19/03/2015	49.5	0.2	49.7	9/07/2015	31.4	0.8	32.2
12/12/2015	49.4	0.3	49.7	22/02/2015	44.3	0.7	45.0
8/01/2015	48.8	0.0	48.8	20/02/2015	**70.5**	0.6	**71.1**
3/03/2015	48.7	0.0	48.7	23/02/2015	42.2	0.6	42.8
31/10/2015	48.3	0.0	48.3	3/12/2015	**61.3**	0.6	**61.9**
29/06/2015	48	0.3	48.3	31/03/2015	23.7	0.6	24.3

Table E-12: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R5

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	1.8	29.9
1/10/2015	49.8	0.1	49.9	12/06/2015	19.1	1.7	20.8
5/03/2015	49.6	0.0	49.6	9/07/2015	31.4	1.3	32.7
21/12/2015	49.6	0.0	49.6	20/02/2015	**70.5**	1.2	**71.7**
19/03/2015	49.5	0.3	49.8	15/07/2015	15.1	1.1	16.2
12/12/2015	49.4	0.5	49.9	3/12/2015	**61.3**	1.1	**62.4**
8/01/2015	48.8	0.0	48.8	23/02/2015	42.2	1.1	43.3
3/03/2015	48.7	0.0	48.7	31/07/2015	26.6	1.1	27.7
31/10/2015	48.3	0.0	48.3	22/02/2015	44.3	0.9	45.2
29/06/2015	48	0.3	48.3	5/02/2015	39.8	0.9	40.7

Table E-13: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
2/09/2015	49.8	0.0	49.8	18/05/2015	28.1	2.1	30.2
1/10/2015	49.8	0.1	49.9	12/06/2015	19.1	1.9	21.0
5/03/2015	49.6	0.0	49.6	20/02/2015	**70.5**	1.4	**71.9**
21/12/2015	49.6	0.1	49.7	9/07/2015	31.4	1.4	32.8
19/03/2015	49.5	0.4	49.9	23/02/2015	42.2	1.3	43.5
12/12/2015	49.4	0.6	50.0	3/12/2015	**61.3**	1.2	**62.5**
8/01/2015	48.8	0.0	48.8	15/07/2015	15.1	1.2	16.3
3/03/2015	48.7	0.0	48.7	21/03/2015	45.1	1.1	46.2
31/10/2015	48.3	0.0	48.3	3/02/2015	36.4	1.1	37.5
29/06/2015	48	0.2	48.2	5/02/2015	39.8	1.0	40.8