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Vipac Engineers & Scientists

Tattersall Lander PTY LTD

Bobs Farm Sand Mine

Air Quality Assessment

29N-14-0048-TRP-516792-4

Report Title: Air Quality Assessment **Job Title: Bobs Farm Sand Mine**	
DOCUMENT NO: 29N-14-0048-TRP-516792-4	**REPORT CODE:** TRP
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REVISION HISTORY

Revision No.	Date Issued	Reason/Comments
0	29 May 2015	Initial Issue
1	06 June 2016	Information Request
2	17 September 2018	Further Information Request
3	02 September 2019	Further Information Request
4	18 January 2021	Further Information Request

DISTRIBUTION

Copy No.______	**Location**	
1	Project	
2	Client (PDF Format)	Uncontrolled Copy
3		

KEYWORDS:

EXECUTIVE SUMMARY

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Tattersall Lander (Tattersall) to prepare an air quality impact assessment for the proposed sand mine (the 'Project') located near Bobs Farm, near Newcastle, New South Wales.

This Level 2 assessment predicts air pollutant concentrations in accordance with NSW guidelines and is based on computational modelling and determines controls where needed. The modelling is based on activity information provided by Tattersall Lander. The emission rates for individual mining activities were calculated in accordance with the National Pollutant Inventory (NPI) - *Emissions Estimation Technique (EET) Manual for Mining.*

The main air emissions from the proposed Sand Mine operations are caused by vehicle usage, materials handling and transfers associated with the haul roads, until the dredge operations begin.

In order to assess the impact of the proposed Sand Mine on the receiving environment, the incremental impact is quantified and added to existing background pollutant concentrations.

The results of the modelling have shown that during all Stages, the TSP, PM_{10} (annual), $PM_{2.5}$ (24 hour and annual), respirable crystalline silica and dust deposition predictions comply with the relevant criteria, as requested in the DGRs. In addition, RCS predictions also comply with the relevant criteria.

For most sensitive receptors the maximum 24-hour PM_{10} concentrations are driven by the background concentrations obtained from Newcastle monitoring station. The results have shown that the highest predicted concentrations will occur during Production Stage 2 (Year 3) for most sensitive receptors. This is a result of the increased throughput with dry mining.

Frequency analysis has identified that the highest number of days the PM_{10} 24-hour criteria will be exceeded is 1 day per annum at two receptors during all Stages except Production Stage 3 (Year 4 onwards).

Overall, the predicted levels comply with the incremental increase and the total dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Recommendations for the installation of a TEOM machine and weather station at the site have been outlined within this report. This would allow proactive dust controls measures to be enforced to reduce the likelihood of exceedances and complaints.

TABLE OF CONTENTS

1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Tattersall Lander (Tattersall) to prepare an Air Quality Impact Assessment for the proposed sand mine (the 'Project') located near Bobs Farm, near Newcastle, New South Wales.

The purpose of this assessment is to evaluate the potential impacts of air pollutants generated from the construction and operational stages of the project and to provide recommendations to mitigate any potential impacts that might have an effect on nearby sensitive receptors.

An updated technical report (the Bobs Farm Sand Mine Air Quality Assessment (Vipac Report Ref No. 29N-14-0048-TRP-516792-2) outlining the methodology and results of the air quality assessment was prepared by Vipac in September 2018 that addresses the Department of Planning and Environment's (DPE) concerns regarding the EIS. A revised document (Vipac Report Ref No. 29N-14-0048-TRP-516792-3) addresses the public submissions since received in relation to the air quality assessment. This document (Vipac Report Ref No. 29N-14-0048-TRP-516792-4) addresses the NSW Environmental Protection Authority (NSW EPA) comments and updates the associated technical report accordingly.

2 PROJECT DESCRIPTION

2.1 Site Location

The Bobs Farm site deposit is situated on the northern end of the Stockton Bight Dunal system, approximately 200 km north of Sydney, near Bobs Farm, NSW. The surrounding area is predominately zoned as rural with minimal primary production.

2.2 Proposed Operations

Bobs Farm Sand Project comprises:

- The establishment of a quarry to extract and process sand at a rate of approximately 750,000 tonnes per annum, from a total sand resource of approximately 8-10 million tonnes. The estimated life of the extraction process is 13 years;
- The construction of extractive materials processing and transport infrastructure;
- The transportation of extractive materials off-site via roads; and
- The rehabilitation of the site.

Table 2-1 provides an overview of the developmental stages during the Project life. A cross-section of the proposed Sand Mine presents the extent of each production stage in relation to the water table (between the blue and green lines), as shown in ***Figure 2-1***.

Table 2-1: Overview of Proposed Operations

Stage	Operational Year	Annual Throughput (tonnes)	Method	Location in Relation to Water Table
Initial Stage	Year 1	150,000	Stripping of topsoil & dry mining	Above
Production Stage 1	Year 2	250,000	Dry mining	Above (blue line in ***Figure 2-1***)
Production Stage 2	Year 3	450,000	Dry mining & wet production	Above and below (green line in ***Figure 2-1***)
Production Stage 3	Years 4 - 13	700,000	Wet production	Below (red line in ***Figure 2-1***)

The main activities of the Project will be the bulk handling of sand material, utilising mobile plant, general truck movements for the transport of the material to the plant where the sand is screened and washed before being de-watered and stockpiled. The final product will be transported, when necessary from site using trucks.

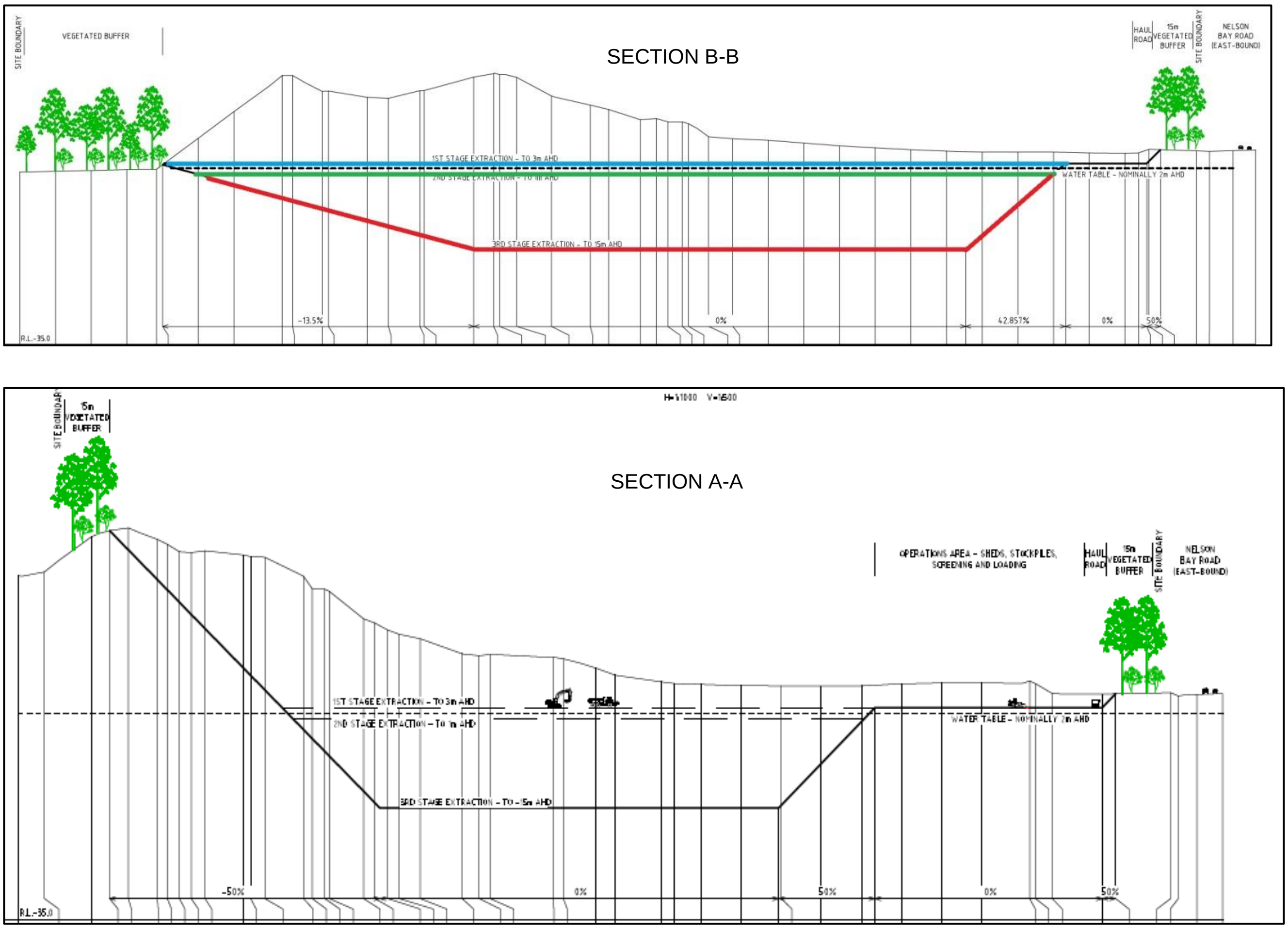


Figure 2-1: Production Stages (Section B-B and Section A-A) [Tattersall Lander]

2.3 Operational Hours

During construction of the proposed Sand Mine the proposed operating hours will be for 10 hours per day from 07:00 to 17:00.

During initial operation of the proposed Sand Mine the operating hours will commence as a single shift of 10 hours, from 06:00 – 16:00, with provision for an additional 10 hour shift if production and or sales demands require it. Production is based upon 11 months per year, 19 days per month and 8 hours per day.

Operational hours for both extraction, loading of vehicles and transportation of material are proposed to be Monday to Saturday – 06:00 to 18:00 only.

2.4 Equipment

The proposed equipment for the Project will comprise of core mobile plant which will change in quantity to reflect the product throughput and ancillary equipment. The proposed equipment includes:

- Excavators;
- Articulated dump truck (44 tonne capacity);
- Front end loaders;

- Conveyor;
- Screens and hoppers;
- Wash / recovery plant;
- Dredge (stage 3 only); and
- Road trucks.

2.5 Sensitive Receptors

A review of the area has identified several sensitive receptors within the locality of the Project. The approximate geographic coordinates of the closest sensitive receptors are presented in ***Table 2-2*** and ***Figure 2-2.***

Table 2-2: Sensitive Receptor Details

ID	Description	Universal Transverse Mercator Location (m)	
		X	Y
R1	756 Marsh Road	407267	6374127
R2	760 Marsh Road	407312	6374149
R3	774 Marsh Road	407345	6373909
R4	780 Marsh Road	407471	6374162
R5	Primary School	407332	6374083
R6	3679 Nelson Bay Road	407078	6373773
R7	698 Marsh Road	406802	6373679
R8	640 Marsh Road	406129	6373507
R9	614A Marsh Road	405905	6373164
R10	Port Stephens Avocado Farm	405930	6372951

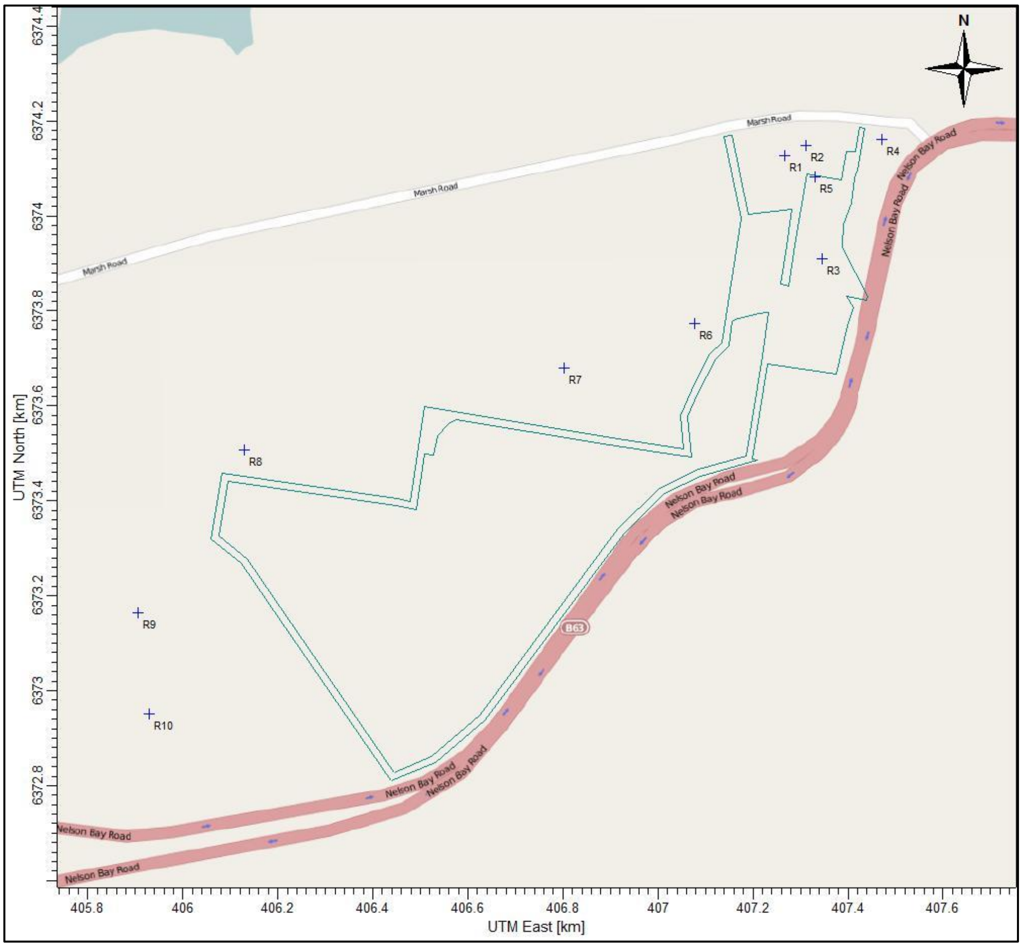


Figure 2-2: Sensitive Receptor Locations as Modelled

2.6 Local Topography

The Project is situated is approximately 2 km from Nelson Bay. The local topography as modelled is presented in ***Figure 2-3***.

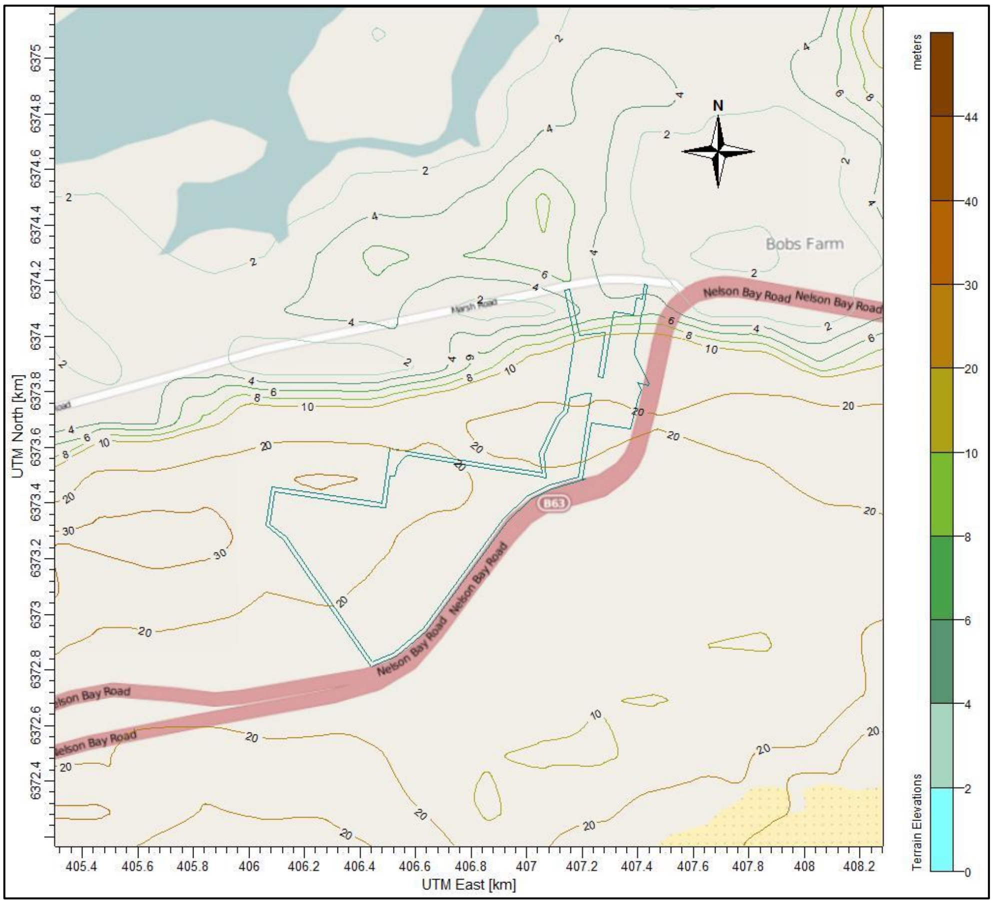


Figure 2-3: Local Topography

3 REGULATORY FRAMEWORK

3.1 National Legislation

3.1.1 National Environment Protection Measure for Ambient Air Quality

Australia's first national ambient air quality standards were outlined in 1998 as part of the National Environment Protection Measure for Ambient Air Quality (National Environment Protection Council , 1998).

The Ambient Air Measure (referred to as Air NEPM) sets national standards for the key air pollutants; carbon monoxide, ozone, sulfur dioxide, nitrogen dioxide, lead and particles (PM_{10} and $PM_{2.5}$). The Air NEPM requires the State's governments to monitor air quality and to identify potential air quality problems.

3.2 State Legislation and Guidelines

3.2.1 Department of Environment and Conservations (NSW) Approved Methods

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2016) detail both the assessment methodology and criteria for air quality assessments. Due to the type of industry and proximity to sensitive receptors, the requirements for a Level 2 assessment have been followed.

While the most recent update of the Approved Methods (2016) was published in January 2017 after the original air quality impact assessment was issued, the criteria within the updated Approved Methods have been used for this amended assessment.

3.2.2 Protection of the Environment Operations (Clean Air) Regulation 2010

The *Protection of the Environment Operations (Clean Air) Regulation 2010 (Clean Air Regulation)* (NSW Government) provides regulatory measures to control emissions from wood heaters, open burning, motor vehicles and fuels and industry. The operation of Project does not trigger any regulatory emissions relating to industry; however the emission requirements for goods vehicles must be adhered to.

3.2.3 Action for Air

Action for Air (Environmental Protection Authority, 1998) seeks to provide long-term ongoing emission reductions, however it does not target acute and extreme exceedances from events such as bushfires. The aim of Action for Air includes:

- Meeting the national air quality standards for six pollutants as identified in the Ambient Air-NEPM; and
- Reducing the population's exposure to air pollution and the associated health costs.

The six pollutants in the Ambient Air-NEPM are CO, NO_2, SO_2, lead, ozone and PM_{10}. The pollutant from the Project that is relevant to the Action for Air is PM_{10}. Action for Air aims to reduce air emissions to enable compliance with the Ambient Air-NEPM targets to achieve the aims described above, with a focus on motor vehicle emissions. The Project would address the aims of the Action for Air Plan by implementing reasonable and feasible mitigation measures to reduce dust (e.g. PM_{10}) emissions and continue to implement an air quality monitoring plan to assess the Project against the Ambient Air-NEPM goals.

3.3 Pollutants of Concern

The main emissions to air from mining operations caused by wind-borne dust, vehicle usage, materials handling and transfers. Fugitive air emissions can be estimated using emission factors combined with site-specific information such as the silt and moisture content of material being handled.

The Director General's Requirements (DGRs) for this Project were to assess:

- Total Suspended Particles (TSP) - Particulate matter with a diameter up to 50 microns;
- PM_{10} - Particulate matter less than 10 microns in size;
- $PM_{2.5}$ - Particulate matter less than 2.5 microns in size; and
- Dust Deposition – deposited matter that falls out of the atmosphere.

In addition, crystalline silica is a basic component of sand (soil, granite and many other minerals). Quartz is the most common form of crystalline silica. Cristobalite and tridymite are two other forms of crystalline silica. Only the respirable particles (<7 µm in aerodynamic diameter those which are capable of reaching the gas exchange region of the lungs) are considered when determining health effects of crystalline silica. Silicosis is generally considered a workplace risk.

Repeated and prolonged exposure to relatively high concentrations of crystalline silica can cause the disease known as silicosis. This respiratory disease is characterised by scarring and hardening of the lung tissue and it reduces the ability of the lungs to extract oxygen from the air.

3.4 Project Criteria

The DGRs for this Project requested that the "*cumulative impact does not result in an annual level greater than 30 µg/m³ of PM₁₀ for private dwellings*". As discussed in Section 3.2.1, the criteria specified in the Approved Methods have been updated since the original air quality impact assessment was issued. This includes the criteria for annual PM_{10} which is more stringent than the DGRs (i.e. 25 $\mu g/m^3$ compared with 30 $\mu g/m^3$). The criteria specified within the updated Approved Methods have therefore been used for this amended assessment.

The NSW Office of Environment and Heritage (OEH) have not detailed an impact assessment criterion for Respirable Crystalline Silica (RCS). The Victorian EPA has adopted an annual average (as $PM_{2.5}$) ambient assessment criterion for mining and extractive industries of 3 $\mu g/m^3$ (EPA Victoria, 2007). This criterion has been adopted for this assessment.

From all of the regulations the strictest applicable criteria have been selected for this assessment and are presented in ***Table 3-1***.

Table 3-1: Project Air Quality Goals

Pollutant	Basis	Criteria	Averaging Time	Source
TSP	Human Health	90 $\mu g/m^3$	Annual	Approved Methods
PM_{10}	Human Health	50 $\mu g/m^3$	24-hour	Approved Methods
	Human Health	25 $\mu g/m^3$	Annual	Approved Methods
$PM_{2.5}$	Human Health	25 $\mu g/m^3$	24-hour	Approved Methods
	Human Health	8 $\mu g/m^3$	Annual	Approved Methods
RCS	Human Health	3 $\mu g/m^3$	Annual	EPA Victoria
Dust deposition	Amenity	Maximum incremental increase of 2 g/m^2/month	Annual	Approved Methods
	Amenity	Maximum total of 4 g/m^2/month	Annual	Approved Methods

4 METHODOLOGY

Computational modelling of air dispersion is used to predict the maximum levels of air pollutants based on the local topography, weather conditions and emission rates for the various sources of pollutants. The maximum levels are compared with criteria provided in ***Table 3-1***. Air quality controls are applied to reduce emission rates when non-compliance is predicted.

4.1 Emission Estimation

The emission rates for individual activities were obtained from the National Pollutant Inventory (NPI) - *Emissions Estimation Technique (EET) Manual for Mining.* (Department of Sustainability, Environment, Water, Population and Communities, 2012). The NPI emission factors are derived from the USEPA AP-42 (see ***Appendix C***).

Emission factors can be used to estimate emissions of TSP and PM_{10} to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity (Department of Sustainability, Environment, Water, Population and Communities, 2012).

Emission factors are used to estimate a facility's emissions by the general equation:

$$E_{i\,(kg/yr)} = \left[A_{(t/h)} \times OP_{(h/yr)} \right] \times EF_{i\,I(kg/t)} \times \left[1 - \frac{CE_i}{100} \right]$$

Where:

$E_{i\,(kg/yr)}$ = Emission rate of pollutant

$A_{(t/h)}$ = Activity rate

$OP_{(h/yr)}$ = operating hours

$EF_{i\,I(kg/t)}$ = uncontrolled emission factor of pollutant

CE_i = overall control efficiency for pollutant

The equations and activity rates are presented in ***Appendix B***.

4.2 Air Dispersion Modelling

4.2.1 TAPM

A 3-dimensional dispersion wind field model, CALPUFF, has been used to simulate the impacts from Project. CALPUFF is an advanced non-steady-state meteorological and air quality modelling system developed and distributed by Earth Tech, Inc. The model has been approved for use in the '*Guideline on Air Quality Models*' (United States Environmental Protection Agency, 2005) as a preferred model for assessing applications involving complex meteorological conditions such as calm conditions.

To generate the broad scale meteorological inputs to run CALPUFF, this study has used the model The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO. The output from TAPM will be used to generate the appropriate meteorological data for the CALPUFF modelling system.

TAPM was configured as follows:-

- Centre coordinates – 32˚ 47.0 S, 152˚ 0.5 E;
- Dates modelled – 1st January 2013 to 31st December 2013;
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 25 x 25 grid points for all modelling domains;
- 20 vertical levels from 10 m to an altitude of 8000 m above sea level;
- The default TAPM databases for terrain, land use and meteorology were used in the model; and
- Wind data from Bureau of Meteorology weather station at Nelson Bay was assimilated into the model.

4.2.2 CALMET

CALMET is an advanced non-steady-state diagnostic three-dimensional meteorological model with micro-meteorological modules for overwater and overland boundary layers. The model is the meteorological pre-processor for the CALPUFF modelling system.

The CALMET simulation was run as No-Obs simulation with the gridded TAPM three-dimensional wind field data from the innermost grid. CALMET then adjusts the prognostic data for the kinematic effects of terrain, slope flows, blocking effects and three-dimensional divergence minimisation.

4.2.3 CALPUFF

CALPUFF is a non-steady-state Lagrangian Gaussian puff model. CALPUFF employs the three-dimensional meteorological fields generated from the CALMET model by simulating the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal.

Emission sources can be characterised as arbitrarily-varying point, area, volume and lines or any combination of those sources within the modelling domain.

The radius of influence of terrain features was set at 3 km while the minimum radius of influence was set as 0.1 km. The terrain data had a resolution of 3 arc-seconds (approximately 90 m). Most CALPUFF options remained at their default recommended values.

5 EXISTING CONDITIONS

5.1 Ambient Particulate Monitoring - PM_{10}

PM_{10} is not currently monitored for compliance in the vicinity of the proposed Sand Mine site. As a substitute, data is available from the Office of Environment and Heritage's (OEH) monitoring stations. Available data for 2013 has shown that the Newcastle monitoring station, located at Smith Street, approximately 29 km south west of the proposed Sand Mine was considered more representative than the other OEH monitoring stations.

In order to obtain an indication of likely PM_{10} concentrations in the region of the Project site, the daily-varying (24-hour average) PM_{10} concentrations recorded at this station in 2013 has been analysed;

- The highest 24-hour concentration was 69 µg/m³ on 17th October 2013, with four exceedances of the criteria during the year. The sixth highest value was 49.1 µg/m³;
- The annual average excluding the exceedances was 22.3 µg/m³; and
- The 90th percentile was 37.2 µg/m³ and the 70th percentile was 26.3 µg/m³.

Level 2 air quality assessments require ambient monitoring data for at least one year of continuous measurements should be used in the dispersion modelling process (Department of Environment & Conservation, 2005). The 24-hour average PM_{10} concentrations recorded at the Newcastle monitoring station for the period 1st January 2013 to 31st December 2013 are presented in ***Figure 5-1***.

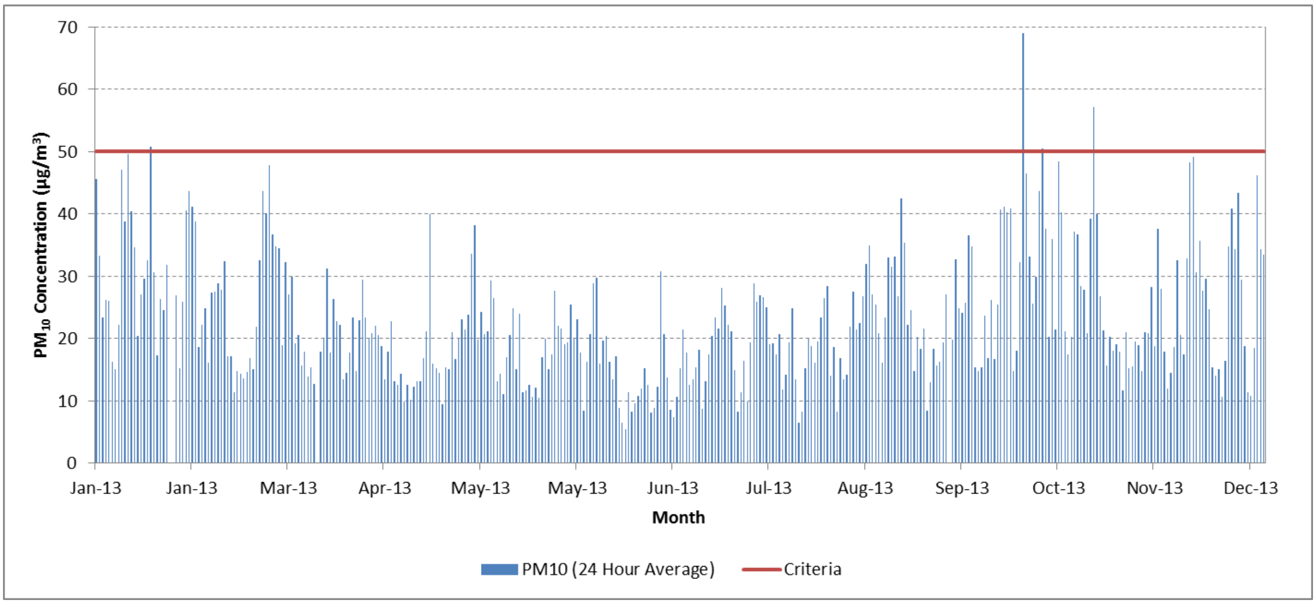


Figure 5-1: PM_{10} Concentrations at Newcastle [DECCW, 2013]

Figure 5-2 shows the distribution of the 24-hour PM_{10} concentration monitoring data. It can be seen that the 24% of PM_{10} 24-hour concentrations range 20-25 µg/m³.

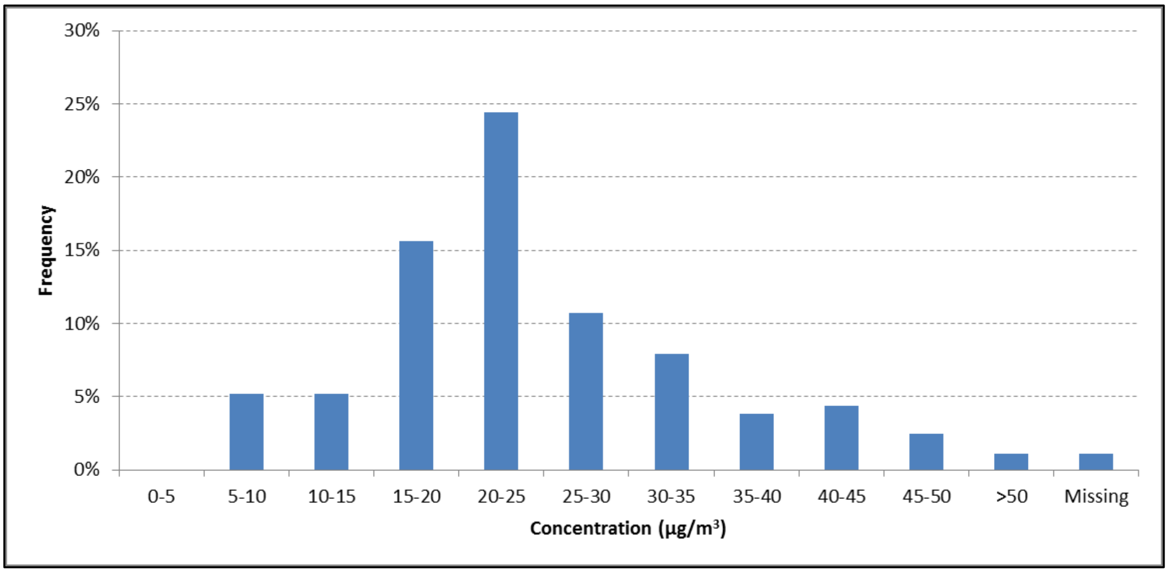


Figure 5-2: 24-Hour Average PM_{10} Concentration Distribution at Newcastle [DECCW, 2013]

5.2 Ambient Particulate Monitoring - $PM_{2.5}$

As with PM_{10}, $PM_{2.5}$ is not monitored in the vicinity of the Mine site, additionally $PM_{2.5}$ data was not available for the Newcastle monitoring station. As a substitute, data from the Wallsend monitoring station was used, this monitoring station is located 34 km south west of the site. In order to obtain an indication of likely $PM_{2.5}$ concentrations in the region of the Mine, the daily-varying (24-hour average) $PM_{2.5}$ concentrations recorded at this station in 2013 has been analysed;

- The highest 24-hour concentration was 37 µg/m^3 on the 19^{th} October 2013, with six exceedances of the criteria during the year. The second highest 24-hour concentration was 31.3 µg/m^3;
- The annual average excluding the one exceedance was 7.7 µg/m^3; and
- The 90^{th} percentile was 12.3 µg/m^3 and the 70^{th} percentile was 8.5 µg/m^3.

The 24-hour average $PM_{2.5}$ concentrations recorded at the Wallsend monitoring station for the period 1^{st} January 2013 to 31^{st} December 2013 are presented in Figure 5-3.

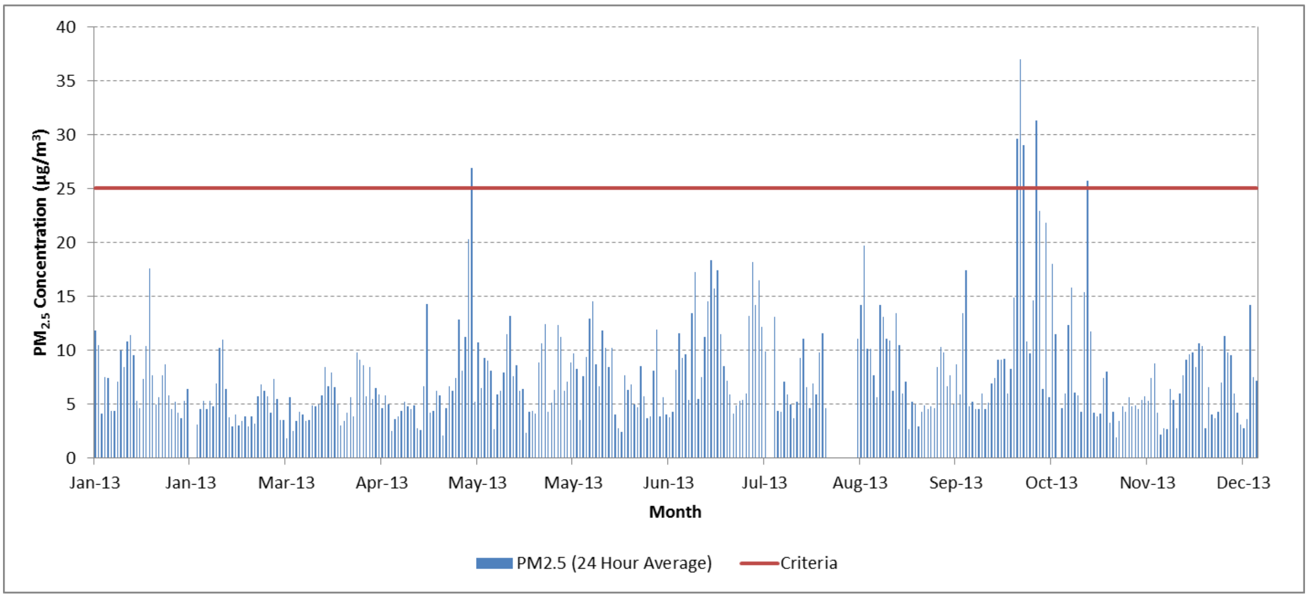


Figure 5-3: $PM_{2.5}$ Concentrations at Wallsend [DECCW, 2013]

5.2.1 TSP

TSP is not currently monitored in the vicinity of the proposed Sand Mine site. In this instance, TSP concentrations have been assumed to be twice those of the measured PM_{10} concentrations at Newcastle. It is noted that the PM_{10} sub-set is typically 50% of TSP mass in regions where road traffic is not the dominant particulate source (NSW Minerals Council, 2000).

5.3 Respirable Crystalline Silica

In lieu of any ambient air quality data of the background silica levels a report by Toxikos (2005) is referenced, which stated that data collected in Victoria estimated the respirable crystalline silica (RCS) annual average background concentration to be 0.7 µg/m^3. In the absence of any local data and in respect that this approach has been used previously in NSW, it has been assumed that the annual average background concentration of 0.7 µg/m^3 for RCS for the site is both reasonable and representative.

5.4 Project Assigned Background Concentrations

A summary of the assigned background concentrations used in this study are presented in

***Table* 5-1**. These background concentrations will be used to add to the predicted incremental impact from the Project to derive total concentrations:

- Individual 24-hour average predicted PM_{10} and $PM_{2.5}$ concentration will be paired in time with the corresponding 24-hour concentration within the adopted 2013 monitoring dataset to obtain total impact at each receptor; and
- Annual average PM_{10}, $PM_{2.5}$, TSP and monthly dust deposition will be assessed through the addition of the dataset average concentrations.

Table 5-1: Assigned Project Background Concentrations

Parameter	Air Quality Objective	Period	Applied Background	Comments
TSP	90 µg/m³	**Annual**	44.6 µg/m³	Double annual average PM_{10}
PM_{10}	50 µg/m³	**24-Hour**	Varies	Daily Newcastle Data for 2013
	25 µg/m³	**Annual**	22.3 µg/m³	Annual Average Newcastle Data
$PM_{2.5}$	25 µg/m³	**24 Hour**	Varies	Daily Wallsend Data for 2013
	8 µg/m³	**Annual**	7.7 µg/m³	Annual Average Wallsend Data
RCS	3 µg/m³	**Annual**	0.7 µg/m³	Toxicos, 2005
Dust Deposition	4 g/m²/month	**Month**	2.1 g/m²/month	Typical Values

6 METEOROLOGY

At the time this assessment was undertaken, there was no site specific meteorological data available for consideration.

Long term weather data has been obtained from the Bureau of Meteorology Nelson Bay Automatic Weather Station [AWS] Street (Site number 061054). The mean temperature range is between 8.9º and 27.3º with the coldest month being July and the hottest being January. The Rainfall in the region is variable, with most rainfall in the cooler months. On average, most of the annual rainfall is received between May and August. Rainfall is lowest between October and January, with a mean annual rainfall of 1,350 mm. The mean long-term weather data for the Bureau of Meteorology (BOM) Weather station at Nelson Bay is presented in ***Table 6-1.***

Table 6-1: Mean Long-term Weather Data for Nelson Bay [BOM 1968-2010]

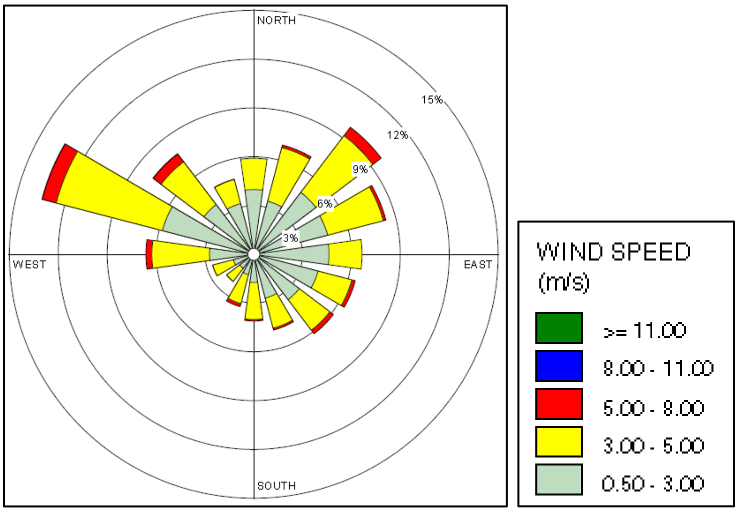
Month	Temperature		Rainfall (mm)	9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)		Temp (°C)	Cloud Cover (oktas)	Wind Speed (km/h)	Temp (°C)	Cloud Cover (oktas)	Wind Speed (km/h)
Jan	27.3	18.7	99.3	22.8	4.3	12.8	25.5	4.0	21.7
Feb	27.0	18.8	113.2	22.7	4.8	12.7	25.3	4.4	20.5
Mar	25.9	17.5	116.4	21.1	4.3	11.6	24.2	4.0	17.5
Apr	23.6	15.1	127.9	18.8	3.7	12.0	22.0	3.8	15.3
May	20.7	12.2	152.9	15.3	3.6	15.0	19.0	4.0	15.2
Jun	18.3	10.0	154.6	13.0	4.2	15.9	16.9	4.2	14.8
Jul	17.4	8.9	140.1	11.8	3.3	14.6	16.3	3.7	15.4
Aug	18.9	9.7	103.4	13.3	3.4	14.6	17.4	3.4	17.5
Sep	21.5	11.8	89.0	16.1	3.3	13.9	19.3	3.6	18.2
Oct	23.2	13.9	78.5	18.7	3.8	13.3	21.1	4.0	20.8
Nov	24.7	15.8	81.1	20.1	4.5	13.4	22.3	4.4	21.2
Dec	26.1	17.5	94.3	21.6	4.6	12.5	24.1	4.4	20.9
Annual	**22.9**	**14.2**	**1,350.7**	**17.9**	**4.0**	**13.5**	**21.1**	**4.0**	**18.2**

6.1 TAPM Meteorological Data

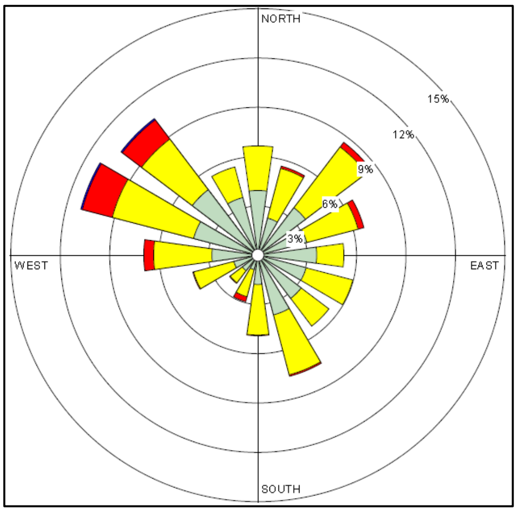
Meteorological data for the site was generated using meteorological data using The Air Pollution Model (TAPM) at the site for 2013, as discussed in ***Section 4***.

The wind roses are presented in ***Figure 6-1*** and show that winds blowing from the north-west are dominant in Spring, Autumn and Winter. These winds will carry the pollutants away from sensitive receptors, whilst during the summer months, the receptors R9 and R10 are likely to be affected due to north easterly winds.

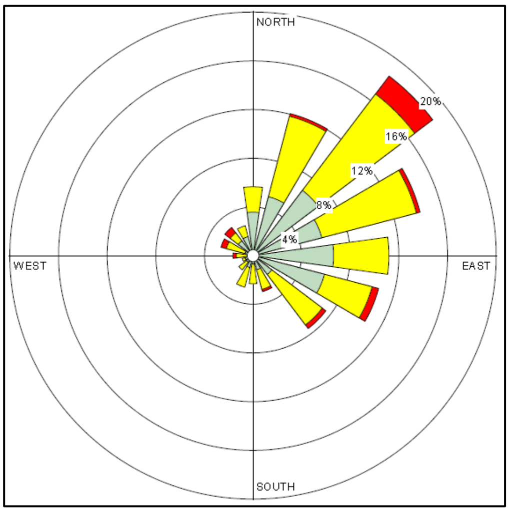
A comparison of the BOM wind roses and the TAPM generated wind roses at the BOM location are presented in ***Appendix B***.



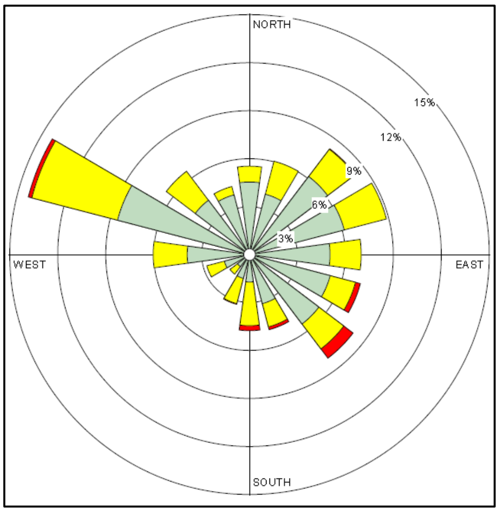
Annual (Calm – 0.39%)



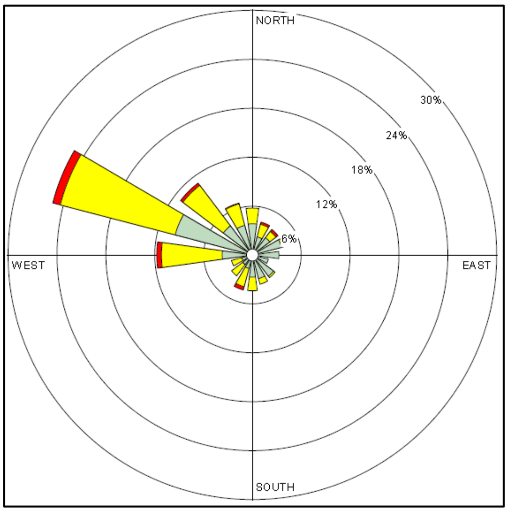
Spring (Calm – 0.37%)



Summer (Calm – 0.05%)



Autumn (Calm – 0.77%)



Winter (Calm – 0.36%)

Figure 6-1: Site-Specific Wind Roses by Season for 2013 [TAPM]

6.2 Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes (Stability Classes A to F), to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models. The frequency of occurrence for each stability class and the associated average wind speed for proposed development site for 2013 is detailed in ***Table* 6-2**. The data identifies that Stability Class D is most common; this stability class is indicative of neutral conditions neither enhancing nor impeding pollutant dispersion.

Table 6-2: Annual Stability Class Distribution Predicted [TAPM, 2013]

Stability Class	Description	Frequency of Occurrence (%)	Average Wind Speed (m/s)
A	Very unstable low wind, clear skies, hot daytime conditions	9.58%	2.3
B	Unstable clear skies, daytime conditions	15.55%	3.3
C	Moderately unstable moderate wind, slightly overcast daytime conditions	9.10%	3.6
D	Neutral high winds or cloudy days and nights	19.75%	3.0
E	Stable moderate wind, slightly overcast night-time conditions	13.68%	3.6
F	Very stable low winds, clear skies, cold night-time conditions	**32.35%**	2.6

6.3 Mixing Height

Mixing height is defined as the height of the layer adjacent to the ground over which an emitted or entrained inert non-buoyant tracer will be mixed (by turbulence) within a time scale of about one hour or less.

Diurnal variations in mixing depths are illustrated in ***Figure 6-2***. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

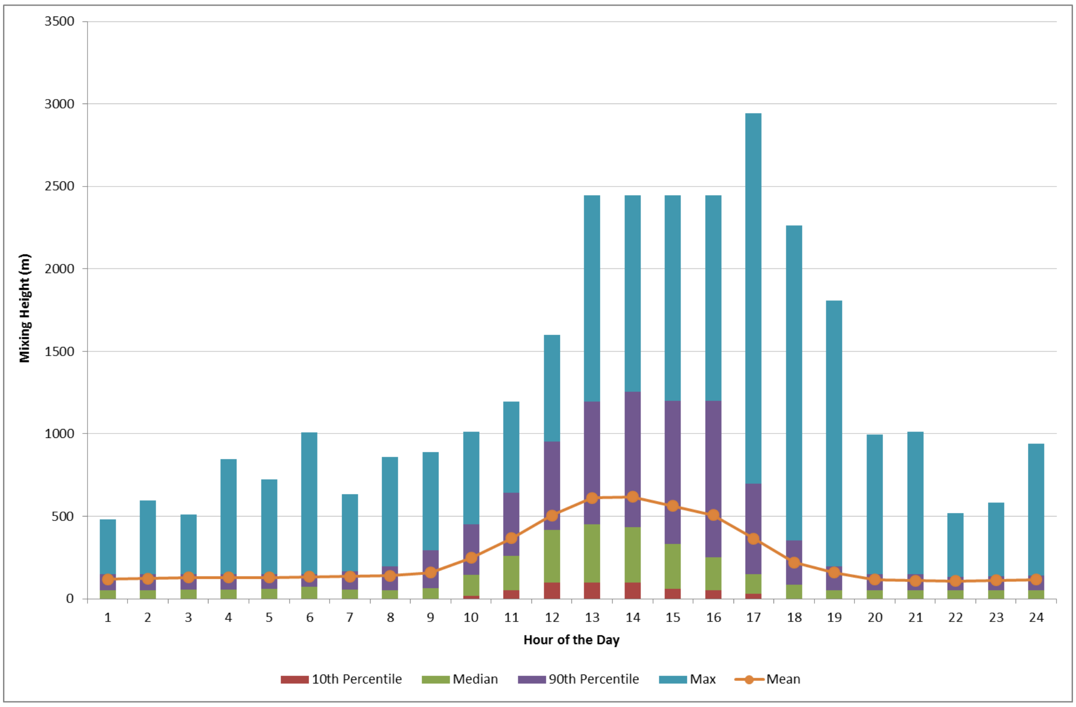


Figure 6-2: Mixing Height [TAPM, 2013]

7 SOURCES AND EMISSION ESTIMATION

This section provides information upon which the emission rates were derived using the equations and parameters detailed in ***Appendix C***.

7.1 Modelling Scenarios

Modelling for each stage has been undertaken for this assessment, as detailed in ***Section 2***:

- Initial Stage (Year 1) – due to the short duration of stripping of topsoil, the dry mining above the water table and processing activities (150,000 tonnes per annum) during this stage have been modelled;
- Production Stage 1 (Year 2) – dry mining above the water table and processing activities (250,000 tonnes per annum) during this stage have been modelled.
- Production Stage 2 (Year 3) – dry mining above and below the water table and processing activities (450,000 tonnes per annum) during this stage have been modelled; and
- Production Stage 3 (Years 4 onwards) – setting up of dredge operations, wet production and processing activities (700,000 tonnes per annum) have been modelled.

Each modelling scenario incorporates the following activities:

- Mining operations (mobile plant and truck loading);
- Haul road movements to processing area;
- Processing operations (vehicle movements, material unloading, screening, material transfers, stockpiling of materials);
- Wind generated emissions from stockpiles and pit floors; and
- Product loading to trucks.

The following assumptions have been made:

- Continuous 24-hour plant operation, 365 days per year. In reality this situation is unlikely to occur;
- One haul road will be paved and the remaining two haul roads will be covered with gravel; and
- Screens are enclosed.

Additional assumptions and equations are presented in ***Appendix B***.

7.2 Location of Sources

Figure 7-1 presents the proposed locations of the pits, stockpiles, and processing area. The location of sources remains constant throughput the life of the Project.

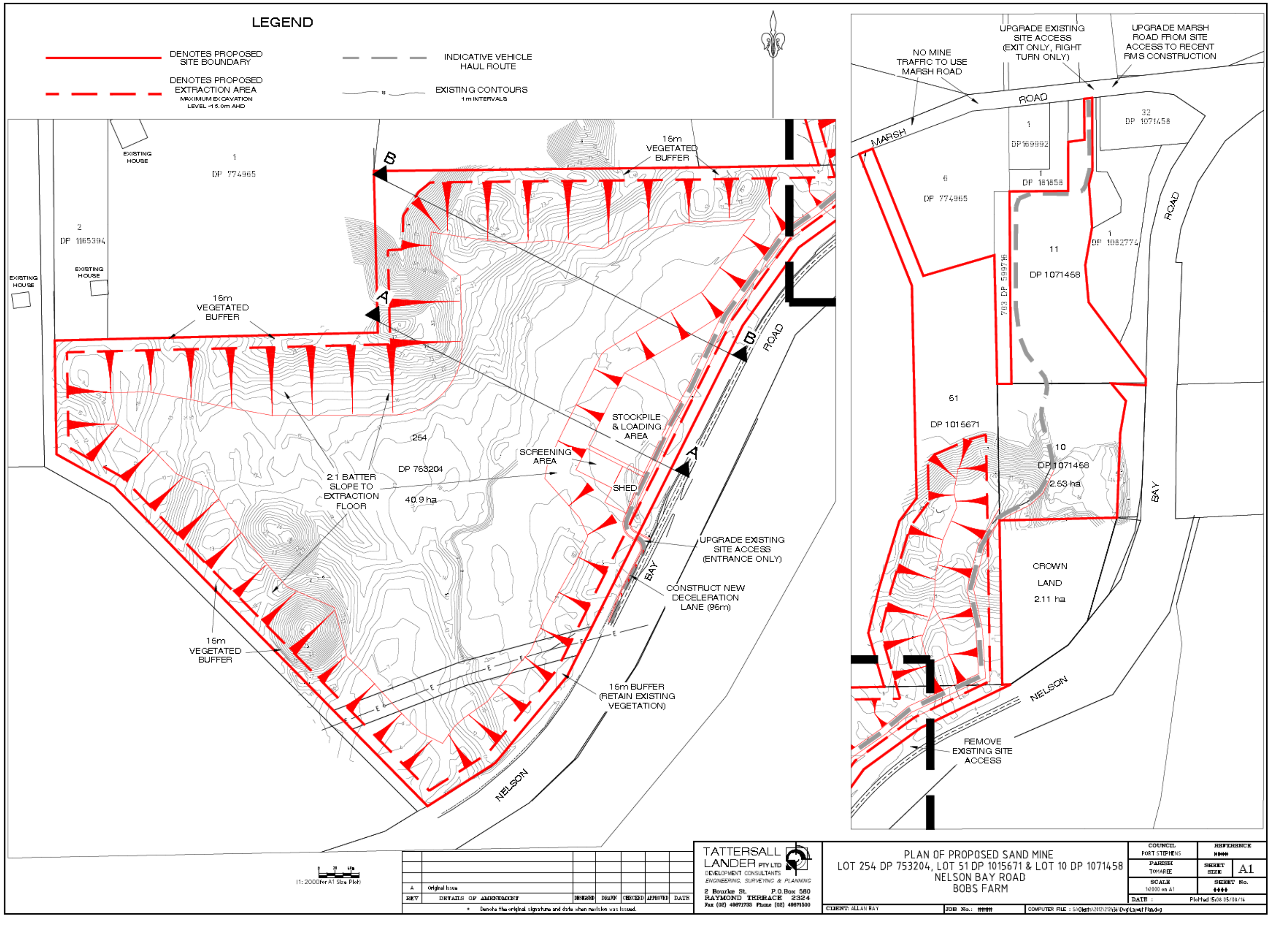


Figure 7-1: Location of Sources [Tattersall Lander]

18 January 2021

7.3 Emissions by Source

As discussed in ***Section 5.1***, the emission estimation for individual activities has been derived from NPI Emission Estimation Technique manuals and US EPA AP42 documentation. Where calculation methods require site-specific parameters, these have been provided by Tattersall Lander, as detailed in ***Appendix C***.

The annual calculated emissions for TSP, PM_{10} and $PM_{2.5}$ are presented in ***Table 7-1***, ***Table 7-2*** and ***Table 7-3*** for each source type and assessment stage. It should be noted that all sources are classed as fugitive and there are no point sources associated with this project.

Table 7-1: Calculated Annual TSP Emissions by Source for Each Assessment Stage (t/year)

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	6.65	11.10	9.99	1.58
Wind Erosion (pits)	1.17	1.17	0.59	0.12
Haul Truck Movements	15.54	25.91	46.65	0
Material Handling & Screening	0.08	0.14	0.25	0.39
Stockpiles	0.09	0.11	0.14	0.19
Product Movements	0.13	0.22	0.39	0.61

Table 7-2: Calculated Annual PM_{10} Emissions by Source for Each Assessment Stage (t/year)

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	3.19	5.32	4.79	0.75
Wind Erosion (pits)	0.59	0.59	0.29	0.06
Haul Truck Movements	3.96	6.60	11.89	0.00
Material Handling & Screening	0.04	0.07	0.12	0.18
Stockpiles	0.05	0.05	0.07	0.09
Product Movements	0.06	0.10	0.17	0.27

Table 7-3: Calculated Annual $PM_{2.5}$ Emissions by Source for Each Assessment Stage (t/year)

Fugitive Activities	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
Mining	0.70	1.17	1.05	0.17
Wind Erosion (pits)	0.09	0.09	0.04	0.01
Haul Truck Movements	0.40	0.66	1.19	0.00
Material Handling & Screening	0.002	0.003	0.005	0.01
Stockpiles	0.01	0.01	0.01	0.01
Product Movements	0.01	0.02	0.04	0.06

Table 7-1, ***Table 7-2*** and ***Table 7-3*** show an increase in emissions in relation to the increase in throughput for each stage. The emissions during Production Stage 2 clearly show the influence of the water table during mining and material handling activities. It is clear that the highest emission source is from the haul roads, until the dredge operations begin.

The efficiency controls applied are presented in ***Appendix C***.

7.4 Respirable Crystalline Silica

Emission rates for RCS were derived using the analysis report conducted by Geochempet Services on behalf of Quarry Mining Services Pty Ltd (QMS) at the site. The silica dioxide results for the nine blended sand samples range from 97.3wt% to 98.3wt% which is quite consistent across the sand samples. The particle size distribution for seven collected samples is listed in Table 7-4.

Table 7-4: Size Distribution for blended samples

Sample	Size Distribution (wt%)						
	Very Coarse	Coarse	Medium	Medium	Fine	Very Fine	Silt
	1.18mm	0.6mm	0.425mm	0.3mm	0.15mm	0.075mm	<0.075mm
BH3-BL-B1-CS	0	0	2	35	62	0	1
BH3-BL-B2-CS	0	0	1	40	58	1	0
BH3-BL-B3-CC	0	0	2	44	53	1	0
BH5-BL-B-CS	0	0	0	25	73	1	1
BH1-BL-G1-CC	0	2	10	40	48	0	0
BH3-BL-G-CS	0	0	3	25	71	1	0
BH1-BL-G1-CS	0	2	7	38	52	0	1

As shown in **Table 7-4**, the grainsizes range mainly between -0.6 and +0.15 mm but are generally concentrated in the -.425 to -0.15 mm in particle sizes and particles in the smallest size range of <0.075mm (or 75µm) are between 0 and 1% by mass.

However, in the absence of size specific silica content data we refer to a study undertaken by Getex Pty Ltd who were commissioned to take dust samples at Rocla's Calga Sand Quarry in April 2008 to determine both the maximum crystalline silica content (from ripping of the sandstone) and the crystalline silica content of the dust emissions from activities that do not involve ripping.

Ripping of the sandstone (using dozers) from its in-situ position is likely to produce dust emissions with the highest percentage of crystalline silica in the relevant size range. Samples of dust were taken at three locations outside a dozer while ripping sandstone in the lower parts of the quarry. The average crystalline silica content of the PM10 dust sampled was 90%.

Dust generated by the hauling of material is considered representative of the crystalline silica content of all sand on the haul roads and sand not subject to ripping. Samples of dust were taken at three locations outside a haul truck as it travelled along a haul route. The average crystalline silica content of this dust was 6%.

Nevertheless, an implausibly conservative estimate of 100wt% silica is adopted for this assessment.

8 IMPACT ASSESSMENT

This section presents the results of the air quality impact assessment for predicted ground level concentrations of TSP, PM_{10}, $PM_{2.5}$, and dust deposition for the proposed operations at varying Stages.

The results of the dispersion modelling include individual sensitive receptor and contour plots that are indicative of ground-level concentrations.

This Level 2 impact assessment requires the predictions to be presented as follows:

- The incremental impact of each pollutant as per the criterion units and time periods;
- The total impact (incremental plus background) for the 100^{th} percentile (i.e. maximum value) in units as per the criterion and time periods. For 24-hour average PM_{10} and $PM_{2.5}$ predictions, the contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Newcastle and Wallsend, as discussed in ***Section 6.3***.

8.1 TSP

The predicted incremental increase in annual average TSP is presented in ***Table 8-1*** for each assessment stage. It can be seen from ***Table 8-1*** that the incremental increase in annual average TSP will be less than 8 µg/m^3 at all sensitive receptor locations. The highest incremental increases will occur at Port Stephens Avocado Farm during Production Stage 2.

Table 8-1: Predicted Annual Average Incremental TSP Concentrations (µg/m^3)

Receptor	Predicted Annual Average Incremental TSP Concentrations (µg/m^3)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	0.2	0.4	0.6	0.0
760 Marsh Road	0.2	0.3	0.5	0.0
774 Marsh Road	0.3	0.5	0.8	0.0
780 Marsh Road	0.2	0.3	0.4	0.0
Primary School	0.2	0.3	0.6	0.0
3679 Nelson Bay Road	0.7	1.2	2.0	0.1
698 Marsh Road	2.5	4.1	7.1	0.2
640 Marsh Road	1.9	3.0	4.8	0.3
614A Marsh Road	2.3	3.8	6.3	0.2
Port Stephens Avocado Farm	2.8	4.7	7.9	0.2

When the annual average background concentration of 44.6 µg/m^3 is applied to the model productions, the total annual average TSP is predicted to be less than 53 µg/m^3, which is below the criterion of 90 µg/m^3. As such the TSP emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Appendix D***.

8.2 PM_{10}

8.2.1 24-Hour Average Concentrations

The daily PM_{10} results have been analysis in the following manner:

- Maximum total concentrations – these results are the overall maximum 24-hour concentrations at each receptor and associated number of exceedances of the criteria;
- Maximum incremental contemporaneous concentrations – these results are reviewed based on the highest impact from the Project. The daily results are added to the corresponding background concentrations as detailed in ***Section 5.1***.

Maximum Concentrations

Analysis of the daily predictions has identified the maximum 24-hour concentration at each receptor and the number of daily exceedances of the criteria. The maximum predicted 24-hour average PM_{10} is presented in ***Table 8-2*** for each assessment stage.

The results show that Port Stephens Avocado Farm will exceed the 50 µg/m³ criteria for one day during all Stages of the Project. During Production Stage 2 (Year 3) 640 Marsh Road will also experience and exceedance.

Table 8-2: Predicted Maximum Contemporaneous 24-Hour Average PM_{10} Concentrations (µg/m³)

Receptor	Predicted Max 24-Hour Average Contemporaneous PM_{10} Concentrations (µg/m³) with Background Concentrations in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
760 Marsh Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
774 Marsh Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
780 Marsh Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
Primary School	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
3679 Nelson Bay Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
698 Marsh Road	49.6 (0)	49.6 (0)	49.6 (0)	49.6 (0)
640 Marsh Road	49.6 (0)	49.6 (0)	**50.1 (1)**	49.6 (0)
614A Marsh Road	49.7 (0)	49.7 (0)	49.7 (0)	49.6 (0)
Port Stephens Avocado Farm	**50.1 (1)**	**50.5 (1)**	**50.9 (1)**	49.7 (0)

Figure 8-1 presents a graph of the number of exceedances per Stage at each sensitive receptor.

The maximum background concentration with exceedances removed (as discussed in ***Section 5.1***) was 49.6 µg/m³, which occurred on 11/01/2013. As this high value is close to the criteria, a review of the incremental increases on this date has been undertaken:

- During the Initial Stage (Year 1) one receptor, Port Stephens Avocado Farm, is predicted to exceed the criteria, this exceedance occurs on 11/01/2013;
- During Production Stage 1 (Year 2) one receptor, Port Stephens Avocado Farm, will exceed the criteria as a result of this high background concentration on 11/01/2013;
- During Production Stage 2 (Year 3) two receptors will exceed the criteria as a result of this high background concentration on 11/01/2013; and
- During Production Stage 3 (Year 4 onwards) no receptors will exceed the criteria.

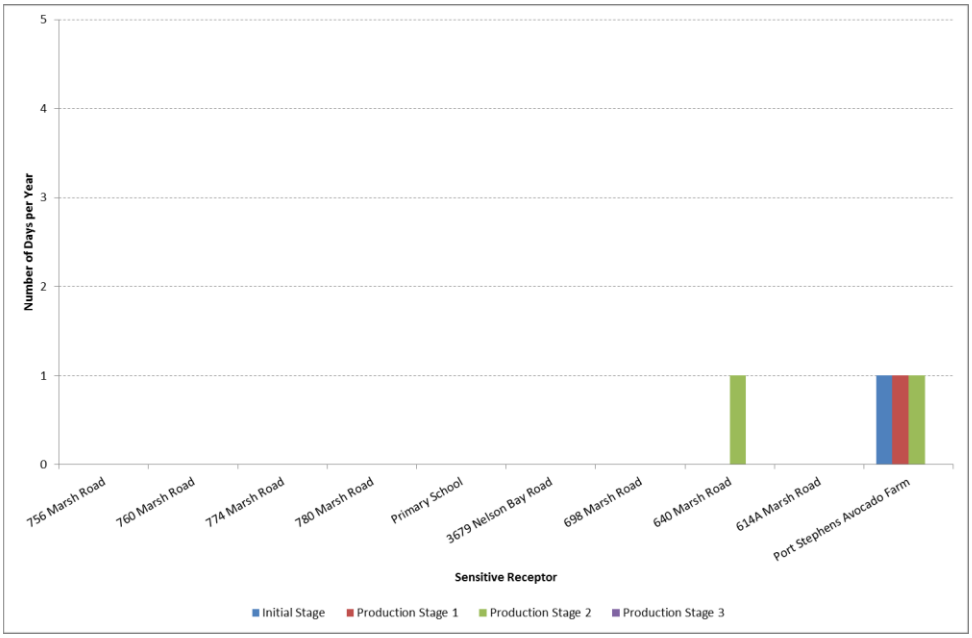


Figure 8-1: Number of Days the 24-Hour Average Contemporaneous Predictions Exceed the PM_{10} Criteria

Maximum Incremental Concentrations

The predicted contemporaneous 24-hour average PM_{10} is presented in ***Table 8-3*** for each assessment stage. The contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Newcastle as discussed in ***Section 5.1***. For each receptor location, the highest predicted incremental concentration occurs at different times, therefore the background concentrations vary. The incremental increase for each sensitive receptor is presented in ***Table 8-4***.

Table 8-3: Maximum Incremental Contemporaneous 24-Hour Average PM_{10} Concentrations (µg/m^3)

Receptor	Predicted Max 24-Hour Average Contemporaneous PM_{10} Concentrations (µg/m^3) with Background Concentrations in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	16.6 (15.2)	17.6 (15.2)	19.1 (15.2)	15.4 (15.2)
760 Marsh Road	13.3 (11.9)	14.2 (11.9)	15.6 (11.9)	12.1 (11.9)
774 Marsh Road	12.4 (10.2)	13.8 (10.2)	16.3 (10.2)	10.6 (10.2)
780 Marsh Road	16.4 (15.2)	17.2 (15.2)	18.6 (15.2)	15.4 (15.2)
Primary School	13.5 (11.9)	14.5 (11.9)	16.3 (11.9)	12.2 (11.9)
3679 Nelson Bay Road	15.6 (11.9)	18.0 (11.9)	22.2 (11.9)	12.5 (11.9)
698 Marsh Road	18.5 (10.6)	23.7 (10.6)	33.2 (10.6)	12.0 (10.6)
640 Marsh Road	18.6 (13.2)	22.1 (13.2)	27.2 (13.2)	12.8 (11.7)
614A Marsh Road	18.4 (13.6)	21.5 (13.6)	27.1 (13.6)	16.8 (16.1)
Port Stephens Avocado Farm	20.4 (13.7)	24.8 (13.7)	32.0 (13.7)	14.6 (13.7)

It can be seen from ***Table 8-4*** that:

- The increases in concentrations during each Stage of the Project reflect in the increase in throughput of the Mine, which the exception of Production Stage 3, where dredging operations commence;
- During all Stages of the Project, this highest incremental increases occur at 698 Marsh Road, with the maximum 24-hour increase of 22.6 µg/m^3 occurring during Production Stage 2 (Year 3); and
- During Production Stage 3 (Year 4 onwards) will have the lowest incremental increases due to the reduction in emissions as a result of the dredging operations.

Table 8-4: Predicted Max 24-Hour Incremental PM_{10} Concentrations (µg/m³)

Receptor	Predicted 24-Hour Average Incremental PM_{10} Concentrations (µg/m³)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	1.4	2.4	3.9	0.2
760 Marsh Road	1.4	2.3	3.7	0.2
774 Marsh Road	2.2	3.6	6.1	0.4
780 Marsh Road	1.2	2.0	3.4	0.2
Primary School	1.6	2.6	4.4	0.3
3679 Nelson Bay Road	3.7	6.1	10.3	0.6
698 Marsh Road	7.9	13.1	22.6	1.4
640 Marsh Road	5.4	8.9	14.0	1.1
614A Marsh Road	4.8	7.9	13.5	0.7
Port Stephens Avocado Farm	6.7	11.1	18.3	0.9

8.2.2 Annual Average

The PM_{10} annual average criterion of 25 µg/m³ has been adopted for this assessment. ***Table 8-5*** presents the predicted total PM_{10} concentrations at sensitive receptors for each assessment stage. Background PM_{10} concentration of 22.3 µg/m³ are included in the predictions.

Table 8-5: Predicted Total Annual Average PM_{10} Concentrations (µg/m³)

Receptor	Predicted Total Annual Average PM_{10} Concentrations with Background Concentrations in Brackets (µg/m³)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	22.4 (22.3)	22.5 (22.3)	22.5 (22.3)	22.5 (22.3)
760 Marsh Road	22.4 (22.3)	22.4 (22.3)	22.4 (22.3)	22.4 (22.3)
774 Marsh Road	22.4 (22.3)	22.5 (22.3)	22.5 (22.3)	22.5 (22.3)
780 Marsh Road	22.3 (22.3)	22.4 (22.3)	22.4 (22.3)	22.4 (22.3)
Primary School	22.4 (22.3)	22.4 (22.3)	22.4 (22.3)	22.4 (22.3)
3679 Nelson Bay Road	22.5 (22.3)	22.8 (22.3)	22.8 (22.3)	22.8 (22.3)
698 Marsh Road	22.9 (22.3)	24.1 (22.3)	24.1 (22.3)	24.1 (22.3)
640 Marsh Road	22.8 (22.3)	23.6 (22.3)	23.6 (22.3)	23.6 (22.3)
614A Marsh Road	22.9 (22.3)	24.0 (22.3)	24.0 (22.3)	24.0 (22.3)
Port Stephens Avocado Farm	23.0 (22.3)	24.3 (22.3)	24.3 (22.3)	24.3 (22.3)

It can be seen from ***Table 8-5*** that the total PM_{10} concentration will be less than the 25 µg/m³ criterion at all sensitive receptor locations. The highest annual average PM_{10} concentration is 24.3 µg/m³ which will occur at Port Stephens Avocado Farm during all Production Stages. As such the annual PM_{10} emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Appendix D***.

8.3 $PM_{2.5}$

8.3.1 24-Hour Average Concentrations

The daily $PM_{2.5}$ results have been analysed based on maximum total concentrations – these results are the overall maximum 24-hour concentrations at each receptor and associated number of exceedances of the criteria.

Maximum Concentrations

Analysis of the daily predictions has identified the maximum 24-hour concentration at each receptor and the background concentrations at the time of the maximum predictions. The maximum predicted 24-hour average $PM_{2.5}$ is presented in **Table 8-6** for each assessment stage. The maximum background concentration with exceedances removed (as discussed in ***Section 5.1***) was 23.5 µg/m³ for Production Stage 2 at 3679 Nelson Bay Road and 698 Marsh Road, which occurred on 24/10/2013. This is also the date on which the highest background of 22.9 µg/m³ was recorded.

The results show that there are no additional exceedances of the 24 hour $PM_{2.5}$ criteria (25 µg/m³) predicted at any modelled receptor.

Table 8-6: Predicted Maximum Contemporaneous 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

Receptor	Predicted Max 24-Hour Average Contemporaneous $PM_{2.5}$ Concentrations (µg/m³) with Background Concentrations in Brackets (µg/m³)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
760 Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
774 Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
780 Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
Primary School	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
3679 Nelson Bay Road	23.1 (0)	23.3 (0)	23.5 (0)	23 (0)
698 Marsh Road	23.1 (0)	23.3 (0)	23.5 (0)	23 (0)
640 Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
614A Marsh Road	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)
Port Stephens Avocado Farm	22.9 (0)	22.9 (0)	22.9 (0)	22.9 (0)

Maximum Incremental Concentrations

The predicted contemporaneous 24-hour average $PM_{2.5}$ is presented above for each assessment stage. The contemporaneous concentrations are the predicted pollutant concentrations added to the daily monitoring results from Wallsend as discussed in ***Section 5.1***. For each receptor location, the highest predicted incremental concentration occurs at different times, therefore the background concentrations vary. The incremental increase for each sensitive receptor is presented in **Table 8-7**.

Table 8-7: Maximum Incremental Contemporaneous 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

Receptor	Predicted Max 24-Hour Average Contemporaneous $PM_{2.5}$ Concentrations (µg/m³) with Background Concentrations in Brackets			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	8.4 (8.2)	8.5 (8.2)	8.7 (8.2)	8.2 (8.2)

760 Marsh Road	4.9 (4.7)	5 (4.7)	5.2 (4.7)	4.7 (4.7)
774 Marsh Road	3.1 (2.8)	3.2 (2.8)	3.5 (2.8)	2.9 (2.8)
780 Marsh Road	8.4 (8.2)	8.4 (8.2)	8.6 (8.2)	8.2 (8.2)
Primary School	4.9 (4.7)	5 (4.7)	5.2 (4.7)	4.7 (4.7)
3679 Nelson Bay Road	5.2 (4.7)	5.4 (4.7)	5.9 (4.7)	4.8 (4.7)
698 Marsh Road	5.2 (4.3)	5.8 (4.3)	6.9 (4.3)	4.6 (4.3)
640 Marsh Road	3.4 (2.7)	3.9 (2.7)	4.4 (2.7)	4.5 (4.3)
614A Marsh Road	4 (3.4)	4.4 (3.4)	4.9 (3.4)	4.6 (4.5)
Port Stephens Avocado Farm	6.4 (5.6)	7 (5.6)	7.8 (5.6)	5.7 (5.6)

8.3.2 Annual Average

The $PM_{2.5}$ annual average criterion of 8 µg/m³ has been adopted for this assessment. ***Table 8-5*** presents the predicted total $PM_{2.5}$ concentrations at sensitive receptors for each assessment stage. Background $PM_{2.5}$ concentration of 7.7 µg/m³ are included in the predictions.

Table 8-8: Predicted Total Annual Average $PM_{2.5}$ Concentrations (µg/m³)

Receptor	Predicted Total Annual Average $PM_{2.5}$ Concentrations with Background Concentrations in Brackets (µg/m³)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	7.71 (7.7)	7.71 (7.7)	7.72 (7.7)	7.70 (7.7)
760 Marsh Road	7.71 (7.7)	7.71 (7.7)	7.72 (7.7)	7.70 (7.7)
774 Marsh Road	7.71 (7.7)	7.72 (7.7)	7.73 (7.7)	7.70 (7.7)
780 Marsh Road	7.71 (7.7)	7.71 (7.7)	7.71 (7.7)	7.70 (7.7)
Primary School	7.71 (7.7)	7.71 (7.7)	7.72 (7.7)	7.70 (7.7)
3679 Nelson Bay Road	7.73 (7.7)	7.74 (7.7)	7.77 (7.7)	7.71 (7.7)
698 Marsh Road	7.78 (7.7)	7.83 (7.7)	7.91 (7.7)	7.71 (7.7)
640 Marsh Road	7.78 (7.7)	7.82 (7.7)	7.87 (7.7)	7.72 (7.7)
614A Marsh Road	7.79 (7.7)	7.84 (7.7)	7.91 (7.7)	7.71 (7.7)
Port Stephens Avocado Farm	7.80 (7.7)	7.87 (7.7)	7.95 (7.7)	7.71 (7.7)

It can be seen from **Table 8-8** that the total $PM_{2.5}$ concentration will be less than the 8 µg/m³ criterion at all sensitive receptor locations. The highest annual average $PM_{2.5}$ concentration is 7.95 µg/m³ which will occur at Port Stephens Avocado Farm during Production Stage 2. As such the annual $PM_{2.5}$ emissions from the Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Appendix D***.

8.4 Dust Deposition

The predicted incremental increase in monthly average dust deposition is presented in ***Table 8-9*** for each assessment stage. The assessment criterion for dust deposition is a maximum incremental increase of 2 g/m²/month. It can be seen from ***Table 8-9*** that the highest incremental increase in dust deposition is 0.3 g/m²/month, which will occur at 698 and 614A Marsh Road during Production Stage 2.

When the background dust deposition level of 2.1 g/m²/month is applied to the predictions detailed in ***Table 8-9***, the highest dust deposition monthly average is 2.4 g/m²/month, which complies with the total dust deposition criterion of 4 g/m²/month.

Overall, the predicted levels comply with the incremental increase and the total dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Table 8-9: Predicted Monthly Average Incremental Dust Deposition (g/m²/month)

Receptor	Predicted Annual Average Incremental Dust Deposition (g/m²/month)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	0.01	0.02	0.04	0.00
760 Marsh Road	0.01	0.02	0.03	0.00
774 Marsh Road	0.01	0.01	0.02	0.00
780 Marsh Road	0.01	0.01	0.02	0.00
Primary School	0.01	0.02	0.03	0.00
3679 Nelson Bay Road	0.04	0.06	0.10	0.01
698 Marsh Road	0.10	0.17	0.30	0.01
640 Marsh Road	0.06	0.10	0.15	0.01
614A Marsh Road	0.11	0.18	0.30	0.01
Port Stephens Avocado Farm	0.09	0.15	0.24	0.01

8.5 Respirable Crystalline Silica

The RCS annual average criterion of 3 µg/m³ has been adopted for this assessment. **Table 8-10** presents the predicted total RCS concentrations at sensitive receptors for each assessment stage. A background RCS of 0.7 µg/m³ is included in the predictions.

It can be seen from **Table 8-10**, that the highest future predicted RCS concentration is 0.95 µg/m³, which will occur during Production Stage 2 at the Port Stephens Avocado Farm.

Overall, the RCS concentration is below the criterion and is not expected to impact on the nearby sensitive receptors.

Table 8-10: Predicted Total Annual Average RCS Concentrations (µg/m³)

Receptor	Predicted Total Annual Average RCS Concentrations with Background Concentrations in Brackets (µg/m³)			
	Initial Stage	Production Stage 1	Production Stage 2	Production Stage 3
756 Marsh Road	0.71 (0.7)	0.71 (0.7)	0.72 (0.7)	0.70 (0.7)
760 Marsh Road	0.71 (0.7)	0.71 (0.7)	0.72 (0.7)	0.70 (0.7)
774 Marsh Road	0.71 (0.7)	0.72 (0.7)	0.73 (0.7)	0.70 (0.7)
780 Marsh Road	0.71 (0.7)	0.71 (0.7)	0.71 (0.7)	0.70 (0.7)
Primary School	0.71 (0.7)	0.71 (0.7)	0.72 (0.7)	0.70 (0.7)
3679 Nelson Bay Road	0.73 (0.7)	0.74 (0.7)	0.77 (0.7)	0.71 (0.7)
698 Marsh Road	0.78 (0.7)	0.83 (0.7)	0.91 (0.7)	0.71 (0.7)
640 Marsh Road	0.78 (0.7)	0.82 (0.7)	0.87 (0.7)	0.72 (0.7)
614A Marsh Road	0.79 (0.7)	0.84 (0.7)	0.91 (0.7)	0.71 (0.7)
Port Stephens Avocado Farm	0.80 (0.7)	0.87 (0.7)	0.95 (0.7)	0.71 (0.7)

8.6 Discussion of Results

The results of the modelling have shown that during all Stages, the TSP, PM_{10} (annual), $PM_{2.5}$ (24 hour and annual), and dust deposition predictions comply with the relevant criteria, as requested in the DGRs. In addition, RCS predictions also comply with the relevant criteria.

For most sensitive receptors the maximum 24-hour PM_{10} concentrations are driven by the background concentrations obtained from Newcastle monitoring station. The results have shown that the highest predicted concentrations will occur during Production Stage 2 (Year 3) for most sensitive receptors. This is a result of the increased throughput with dry mining.

Frequency analysis has identified that the highest number of days the PM_{10} 24-hour criteria will be exceeded is 1 day per annum at two receptors during all Stages except Production Stage 3 (Year 4 onwards).

9 MITIGATION & MONITORING

9.1 General Dust Control Measures

General dust control measures include:

- Minimise the potential for dust emissions from the product stockpile by either watering or screening, where practical;
- Minimise the potential for dust emissions from the haul roads by paving haul road three and applying low silt gravel to the remaining two haul roads. Water the haul roads when dust is visible especially during dry conditions;
- Maintain a wheel wash at the exit of Mine to remove dust from vehicle wheels. This will reduce the likelihood of dust visibly accumulating on the road.

An Air Quality Management Plan is provided in ***Appendix E***; this Management Plan outlines general practices which will reduce dust emissions from the operation of Project.

9.2 Air Monitoring Network

In the Director General Requirements (DGR's) for this Project, the EPA state that they are moving away from dust deposition monitoring due to a more proactive real-time data collection methods for PM_{10}. A cost/benefit analysis of Hi-Volume Sampling and Tapered Element Oscillating Microbalance (TEOM) is undertaken, as shown in ***Table 9-1***. Additionally, dust deposition monitoring has also been included to outline the differences in measurement techniques.

Table 9-1: PM_{10} Measurement Technique Cost Benefit Analysis

Measurement Technique	Benefits	Disadvantages	Australian Standard
Hi-Volume Sampler	The particulate concentration is calculated at a laboratory based on the total mass of the sample divided by the volume of air drawn through the filter paper.	Time resolution is limited to 24 hour and the results are only available several days after the measurement. Estimated precision - ±2 $\mu g/m^3$	AS/NZS 3580.9.6:2003
TEOM	Provide real-time data with short resolution (<1 hour) that can be used for proactive particulate control. Estimated precision - ±0.5 $\mu g/m^3$	High capital costs.	AS/NZS 3580.9.8-2001

Based on this assessment, consideration should be given to install and maintain a TEOM machine at the fence-line of the proposed Sand Mine. Additionally, the installation of a meteorological station would be beneficial to provide more accurate wind conditions.

The installation of a TEOM and weather station will allow proactive dust management techniques to be employed to reduce the likelihood of complaints and exceedances. Any equipment must be installed, maintained and sited in accordance with (Department of Environment & Conservation, 2007).

10 CONCLUSION

The purpose of this air quality assessment is to evaluate the potential impacts of pollutants generated from the stages of the proposed Bobs Farm Sand Mine and to provide recommendations to mitigate and minimise any potential impacts that might have an effect on nearby sensitive receptors.

The main air emissions from the proposed Sand Mine operations are caused by vehicle usage, materials handling and transfers associated with the haul roads, until the dredge operations begin.

In order to assess the impact of the proposed Sand Mine on the receiving environment, the incremental impact is quantified and added to existing background pollutant concentrations.

Vipac has used daily particulate monitoring data from NSW EPA site at Newcastle (Smith Street) in the PM_{10} predictions. For the purposes of accurate predictions, the modelling simulated different Stages of the project as outlined in ***Section 7***.

The results of the modelling have shown that during all Stages, the TSP, PM_{10} (annual), $PM_{2.5}$ (24 hour and annual) and dust deposition predictions comply with the relevant criteria, as requested in the DGRs. In addition, RCS predictions also comply with the relevant criteria.

For most sensitive receptors the maximum 24-hour PM_{10} concentrations are driven by the background concentrations obtained from Newcastle monitoring station. The results have shown that the highest predicted concentrations will occur during Production Stage 2 (Year 3) for most sensitive receptors. This is a result of the increased throughput with dry mining.

Frequency analysis has identified that the highest number of days the PM_{10} 24-hour criteria will be exceeded is 1 day per annum at two receptors during all Stages except Production Stage 3 (Year 4 onwards).

Overall, the predicted levels comply with the incremental increase and the total dust deposition criteria and therefore dust is not expected to be a nuisance for sensitive receptors.

Recommendations for the installation of a TEOM machine and weather station at the site have been outlined in ***Section 9***. This would allow proactive dust controls measures to be enforced to reduce the likelihood of exceedances and complaints.

11 BIBLIOGRAPHY

Bohn. R, C. T. (1978, March). Fugitive Emissions from Integrated Iron and Steel Plants. Missouri, United States: Midwest Research Institute.

Department of Environment & Conservation. (2005). *Approved Methods for the Modelling and Assessment of Air Pllutants in New South Wales.* Sydney: Department of Environment & Conservation (NSW).

Department of Environment. (2014). *National Greenhouse Accounts (NGA) Factors Workbook.* Canberra: Department of Environment.

Department of Sustainability, Environment, Water, Population and Communities. (2012). *National Pollution Inventory - Emission Estimation Technique Manual for Mining Version 3.1.* Canberra: Commonwealth of Australia.

Department of the Environment. (2013). *National Inventory Report 2012 - Volume 1.* Canberra: Department of the Environment.

Environmental Protection Authority. (1998). *Action for Air.* Sydney: Environmental Protection Authority (NSW).

EPA Victoria. (2007). *Protocol for Environmental Management - Mining and Extractive Industries.* Melbourne: EPA Victoria.

National Environment Protection Council . (1998). *National Environment Protection (Ambient Air Quality) Measure.* Canberra: NEPC.

NSW Government. (n.d.). Protection of the Environment Operations (Clean Air) Regulation 2010.

NSW Minerals Council. (2000). *Particulate Matter in Mining.* Sydney: NSW Minerals Council.

SLR. (2012). *Somersby Quarry Extension - Air Quality Assessment (Revision 2).* Cessnock: SLR.

Toxikos (2005) Health Risk Assessment of Crystalline Silica from Alex Fraser's proposed Recycling/Transfer Station of Construction Waste, Clarinda", Prepared by Toxikos Pty Ltd, February 2005, TR080105 RF.

United States Environmental Protection Agency. (2005). *Revision to the Guidance on Air Quality Models: Adoption of a Preferred General Purpose Dispersion Model and Other Revisions; Final Rule.* Washington: United States Environmental Protection Agency.

WRAP. (2006). *Background Document for Revisions to Fine Fraction Ratios Used fro AP-42 Fugitive Dust Emission Factors.* Colorado: WRAP.

APPENDIX A: GLOSSARY

Ambient Monitoring	Ambient monitoring is the assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air.
AWS	Automatic Weather Station
BOM	Bureau of Meteorology
Carbon Dioxide Equivalent	A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (expressed as CO_2-e).
Conveyor	Mechanical handling equipment (which may include a belt, chain or shaker) used to move materials from one location to another.
Deforestation	Conversion of forested lands for non-forest uses.
Deposited Matter	Any particulate matter that falls from suspension in the atmosphere
Dust	Generic term used to describe fine particles that are suspended in the atmosphere. The term is nonspecific with respect to the size, shape and chemical composition of the particles.
Embodied energy	Energy consumed by all of the processes associated with the production of a building, from the mining and processing of natural resources to manufacturing, transport and product delivery.
Emissions	Release of a substance (usually a gas) into the atmosphere.
Emissions Factor	Unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams emitted per litre of fossil fuel consumed).
EPA	Environmental Protection Authority (NSW)
Fluorinated Gases	Powerful synthetic greenhouse gases such that are emitted from a variety of industrial processes.
Fluorocarbons	Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).
Fugitive Dust	Dust derived from a mixture of not easily defined sources. Dust is commonly derived from such non-point sources such as vehicular traffic on unpaved roads, materials transport and handling
Global Warming Potential	Measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to carbon dioxide.
Greenhouse Gas (GHG)	Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.
Haul Roads	Roads used to transport extracted materials by truck around a mine/quarry site
Hydrocarbons	Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

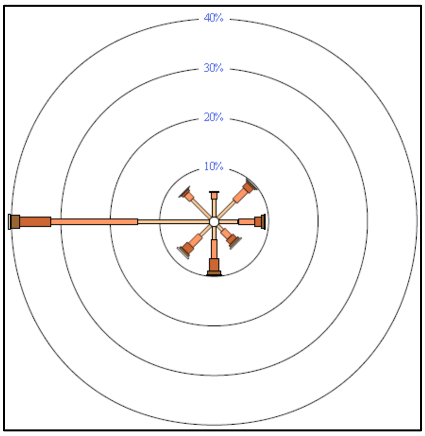
Hydrochlorofluorocarbons	Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons.
Hydrofluorocarbons (HFCs)	Compounds containing only hydrogen, fluorine, and carbon atoms. HFCs are emitted as by-products of industrial processes and are also used in manufacturing.
Methane (CH_4)	A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 25 times that of carbon dioxide (CO_2).
mg	Milligram (g × 10^{-3})
Micron	Unit of measure µm (metre × 10^{-6})
Nuisance Dust	Dust which reduces environmental amenity without necessarily resulting in material environmental harm. Nuisance dust generally comprises particles greater than 10 micrograms.
OEH	Office of Environment & Heritage (NSW)
Overburden	Material of any nature that overlies a deposit of useful materials
PM_{10}	Particulate matter less than 10 microns in size
TSP	Total Suspended Particles is particulate matter with a diameter up to 50 microns
µg/m^3	Micrograms per cubic metre

APPENDIX B: COMPARISON OF TAPM WIND ROSES AND BOM STATIONS

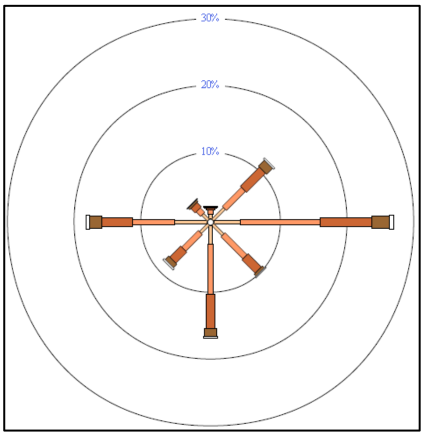
Vipac used TAPM to generate wind roses at the nearby BOM weather stations (Nelson Bay (061054) located 14.1 km east and 8.2 km north of the Project site to determine the suitability of the meteorological data.

The wind speed of the BoM wind roses are is km/h whereas the TAPM generated wind rose is in m/s. It should be noted that the scale of the TAPM wind rose has been adjusted be representative of the BoM scale, allowing easier comparison.

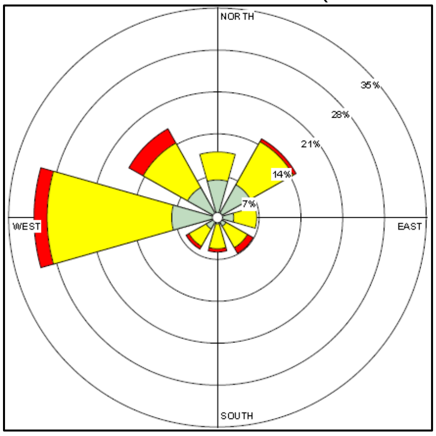
A review of the BoM met station wind roses and the generated data has been undertaken. The 9 am wind rose for the research centre for 2013 was compared to the BoM long-term wind rose. It can be seen that the wind directions are very similar, with TAPM slightly overestimating the north westerlies and north easterlies in the morning. During the afternoon the south easterlies are overestimated whilst the westerlies are underestimated.



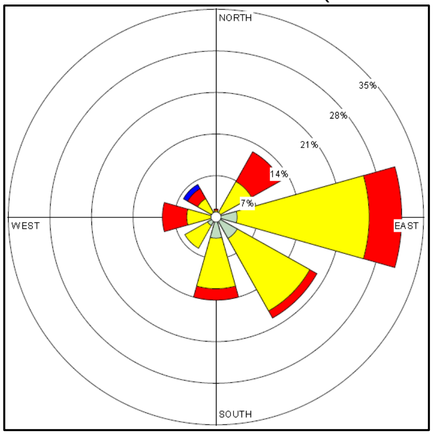
Annual BoM Wind Rose at 0900 (Calms – 5%)



Annual BOM Wind Rose at 1500 (Calms – 2%)



Annual TAPM Wind Rose at 0900 (Calms – 1%)



Annual TAPM Wind Rose at 1500 (Calms – 1%)

A wind rose comparison for each month was undertaken and the monthly wind roses were relatively comparable in wind speed and direction. As such, the TAPM weather data used in this assessment is considered representative of the site.

APPENDIX C: EQUATIONS FOR ESTIMATING EMISSIONS

C.1 EMISSION RATES

The major air emission from mining is fugitive dust. Emission factors can be used to estimate emissions of TSP, PM_{10} and $PM_{2.5}$ to the air from various sources. Emission factors relate the quantity of a substance emitted from a source to some measure of activity associated with the source. Common measures of activity include distance travelled, quantity of material handled, or the duration of the activity.

The National Pollutant Inventory Emission Estimation Technique Manual for Mining (January 2012) provide the equations and emission factors to determine the emissions of TSP and PM_{10} from mining activities. These emission factors incorporate emission factors published by the USEPA in their AP-42 documentation. Tables C-1 to C-4 summarise the source type emission factors applied for each operational year. Where site specific data is available, the equations outlined in the Manual are used to derive emission factors.

Table C-1: Source type Emission Factors applied – Year 1

Source type	TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	Units	Controls applied
Wind erosion:					
stockpiles	0.009	-	0.5	kg/ha/h	No control
pit	0.009	-	0.5	kg/ha/h	No control
Handling:					
Excavators/FEL on overburden	0.025	-	0.48	kg/t	No control
Loading to trucks	0.0004	-	0.42	kg/t	No control
Stockpile loading	-	0.0001	0.5	kg/t	No control
Wheel generated dust:					
Unpaved roads - loaded	-	3.53	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Unpaved roads - unloaded	-	2.62	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Materials Handling					
Conveyors	-	0.00052	0.48	Kg/t	
Product Movement					
Loading to trucks	0.0004	-	0.42	kg/t	No control
Stockpile loading	-	0.0001	0.5	kg/t	No control

Table C-2: Source type Emission Factors applied – Year 2

Source type	TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	Units	Controls applied
Wind erosion:					
stockpiles	0.009	-	0.5	kg/ha/h	No control
pit	0.009	-	0.5	kg/ha/h	No control
Handling:					
Excavators/FEL on overburden	0.025	-	0.48	kg/t	No control
Loading to trucks	0.0004	-	0.42	kg/t	No control
Stockpile loading	-	0.0001	0.5	kg/t	No control
Wheel generated dust:					
Unpaved roads - loaded	-	3.53	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Unpaved roads - unloaded	-	2.62	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Materials Handling					

Source type	TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	Units	Controls applied
Conveyors	-	0.00052	0.48	Kg/t	
Product Movement					
Loading to trucks	0.0004	-	0.42	kg/t	No control
Stockpile loading	-	0.0001	0.5	kg/t	No control

Table C-3: Source type Emission Factors applied – Year 3

Source type	TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	Units	Controls applied
Wind erosion:					
stockpiles	0.009	-	0.5	kg/ha/h	No control
pit	0.009	-	0.5	kg/ha/h	50% for area under water table
Handling:					
Excavators/FEL on overburden	0.025	-	0.48	kg/t	50% for area under water table
Loading to trucks	0.0004	-	0.42	kg/t	50% for area under water table
Stockpile loading	-	0.0001	0.5	kg/t	No control
Wheel generated dust:					
Unpaved roads - loaded	-	3.53	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Unpaved roads - unloaded	-	2.62	0.25	kg/VKT	30% for gravel roads, 90% for sealed roads
Materials Handling					
Conveyors	-	0.00052	0.48	Kg/t	
Product Movement					
Loading to trucks	0.0004	-	0.42	kg/t	No control
Stockpile loading	-	0.0001	0.5	kg/t	No control

Table C-4: Source type Emission Factors applied – Year 4

Source type	TSP Emission factor	Derived TSP Emission factor	PM_{10}/TSP ratio	Units	Controls applied
Wind erosion:					
stockpiles	0.009	-	0.5	kg/ha/h	No control
pit	0.009	-	0.5	kg/ha/h	90% for all under water table
Handling:					
Excavators/FEL on overburden	0.025	-	0.48	kg/t	95% for all wet
Loading to trucks	0.0004	-	0.42	kg/t	90% for all wet
Stockpile loading	-	0.0001	0.5	kg/t	No control
Wheel generated dust:					
Unpaved roads - loaded	-	3.53	0.25	kg/VKT	100%, dredge used to transfer material
Unpaved roads - unloaded	-	2.62	0.25	kg/VKT	100%, dredge used to transfer material
Materials Handling					
Conveyors	-	0.00052	0.48	Kg/t	
Product Movement					
Loading to trucks	0.0004	-	0.42	kg/t	No control

Excavation on Overburden

The default emission rates in the NPI EET for Mining have been used for this emission factor.

Loading Trucks

Emission rate for loading trucks is the default emissions rate in NPI EET for loading to trains.

Screening

The default emission rates in AP42 have been used for these emission factors.

Haul Roads

The dust emission rate from haul roads has been calculated using the following equation:

$$Emissions = \left(\frac{0.4536}{1.6093}\right) x\ k\ x \left(\frac{s_{(\%)}}{12}\right)^{\alpha} x \left(\frac{W_{(t)}}{3}\right)^{0.45} \text{ kg /VKT}$$

Where:

k = 4.9 for TSP, 1.5 for PM_{10}.

$s_{(\%)}$ = surface material silt content (4.8%)

W = mean vehicle weight (tons converted to tonnes)

a = 0.7 for TSP, 0.9 for PM_{10} and $PM_{2.5}$

Conveyors

The dust emission rate from conveyor transfer points has been calculated using the following equation:

$$Emissions = k\ x\ 0.0016\ \frac{(U/2.2)^{1.3}}{(M/2)^{1.4}} \text{ kg /transfer point}$$

Where:

k = 0.74 for TSP, 0.35 for PM_{10}, 15% of PM_{10} is $PM_{2.}$

U = mean wind speed (3.13 m/s)

M = material moisture content (5%)

Stockpile Loading and Unloading

Emission rate for dust from stockpile loading and unloading has been calculated using the following emission rates from AP42 11.19.2:

TSP = PM_{10} multiplied by 2

PM_{10} = 0.00005

$PM_{2.5}$ = 15% of PM_{10} is $PM_{2.5}$

Wind Erosion

The emission rate for dust from stockpile has been calculated using the following equation for TSP:

$$Emissions = 1.9\ x \left(\frac{s(\%)}{1.5}\right) x\ 365\ x \left(\frac{365-p}{235}\right) x \left(\frac{f(\%)}{15}\right) \text{kg /ha /yr}$$

Where:

$s_{(\%)}$ = silt content (10%).

P = number of days per year when rainfall is greater than 0.25 mm. A review of the TAPM metrological data has determined there are 161 days where rainfall is greater than 0.25 mm.

$f_{(\%)}$ = percentage of time that wind speed is greater than 5.4 m/s at the mean height of the stockpile. The frequency of wind speed >5.4 m/s has been determined to be 1.54%.

The fraction of PM_{10} in TSP is 50% and $PM_{2.5}$ is 15% of PM_{10}.

C.2 ACTIVITY OVERVIEW

Table C-5 summarises the activity data applied in the emissions estimation. Further details are provided in the subsequent sections.

Table C-5: Parameters applied in emissions estimation

Parameter ID	Value	Units	Description	Operational Year	Data source
Hours	12	hours/day	Hours of operation	All years	client supplied
Days	209	Days/year	Days of operation	All years	client supplied
W	44	t	Truck capacity		client supplied
Product extraction	150,000	t/y	Extracted product	Year 1 – all dry	client supplied
	250,000	t/y		Year 2 – all dry	
	450,000	t/y		Year 3 – 50% wet	
	700,000	t/y		Year 4 onwards – all wet	
Haul 1	6.92	VKT/day	haul for transport	Year 1	estimated
	11.54	VKT/day		Year 2	
	20.77	VKT/day		Year 3	
	32.31	VKT/day		Year 4	
Haul 2	2.95	VKT/day	haul for transport	Year 1	estimated
	4.92	VKT/day		Year 2	
	8.86	VKT/day		Year 3	
	13.78	VKT/day		Year 4	
Haul 3	0.12	VKT/day	haul for transport	Year 1	estimated
	0.20	VKT/day		Year 2	
	0.35	VKT/day		Year 3	
	0.55	VKT/day		Year 4	

Extraction Rates

The annual and daily extraction rates are detailed in Table C-6.

Table C-6: Extraction Rates Modelled

Activity	Modelling Scenario			
	Initial	Stage 2	Stage 3	Stage 4
Annual Extraction Rate (Mtpa)	150,000	250,000	450,000	700,000
Daily Extraction Rate (tonnes)	717	1,196	2,153	3,349

Silt Content

Silt content data for Bobs Farm was derived from borehole testing data. For topsoil, the silt content was 10% and the sand 2% based on testing data. Haul road silt content of 4.8% was obtained from AP42 13.2 for sand and gravel processing.

C.3 EFFICIENCY CONTROLS APPLIED

Haul Roads

Tattersall Lander confirmed that one haul road will be paved and the remaining two haul roads will be covered with gravel. The following efficiency controls have been applied:

- Paved road – 90% (Bohn. R, 1978)
- Gravel (low silt) covered roads – 30% (Bohn. R, 1978)

In-Pit Retention

The default reductions as detailed in the NPI EET for Mining were applied:

TSP = 50% reduction

PM_{10} = 5% reduction

Screening

Screens have been modelled at fully enclosed – 100% reduction

Water Table Influences

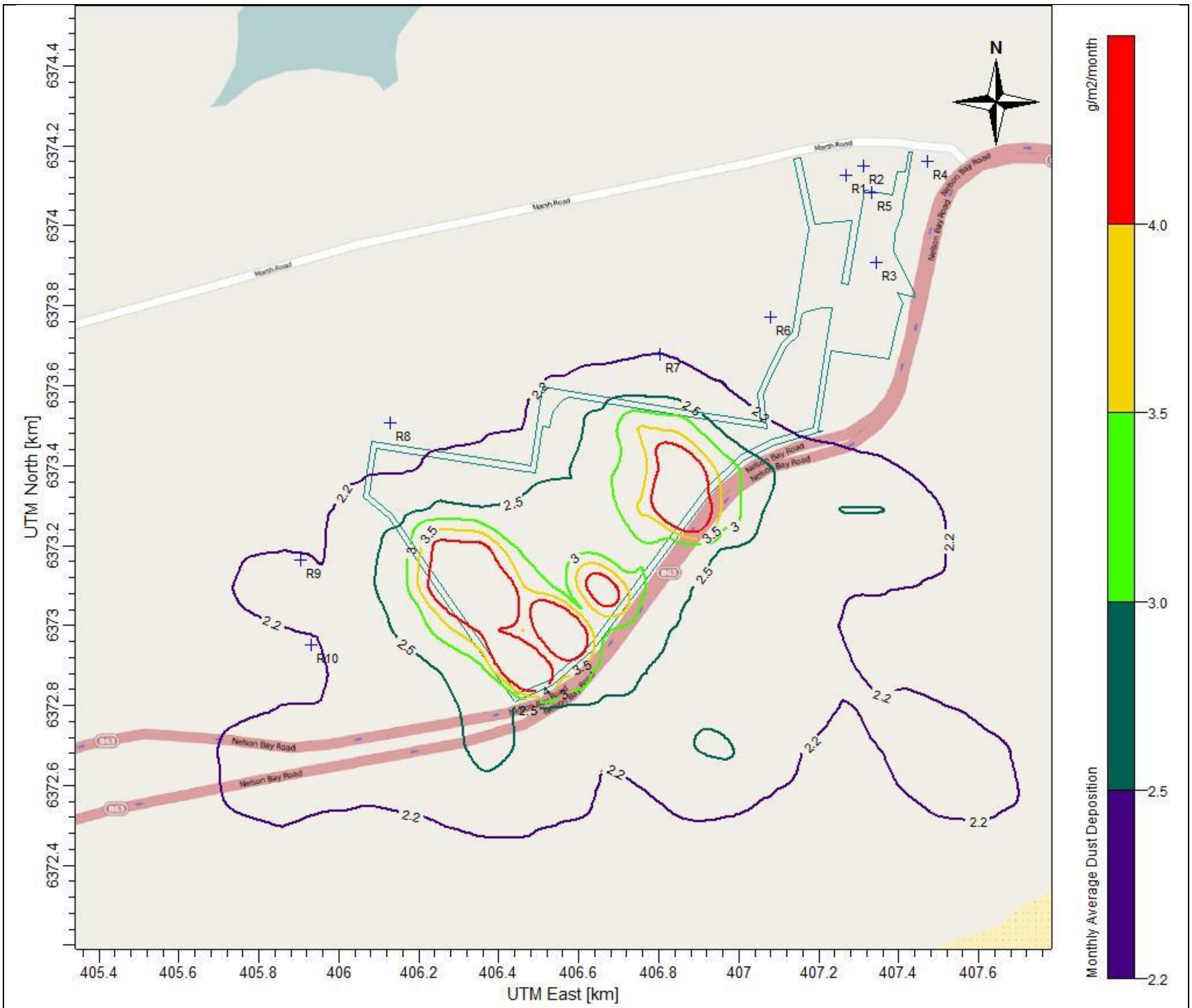
Where material is mined under the water table the following reductions have been applied:

- 50% to the in-pit emissions and material handling prior to de-watering. This is considered to be conservative.
- No reduction has been applied to the sellable product material.

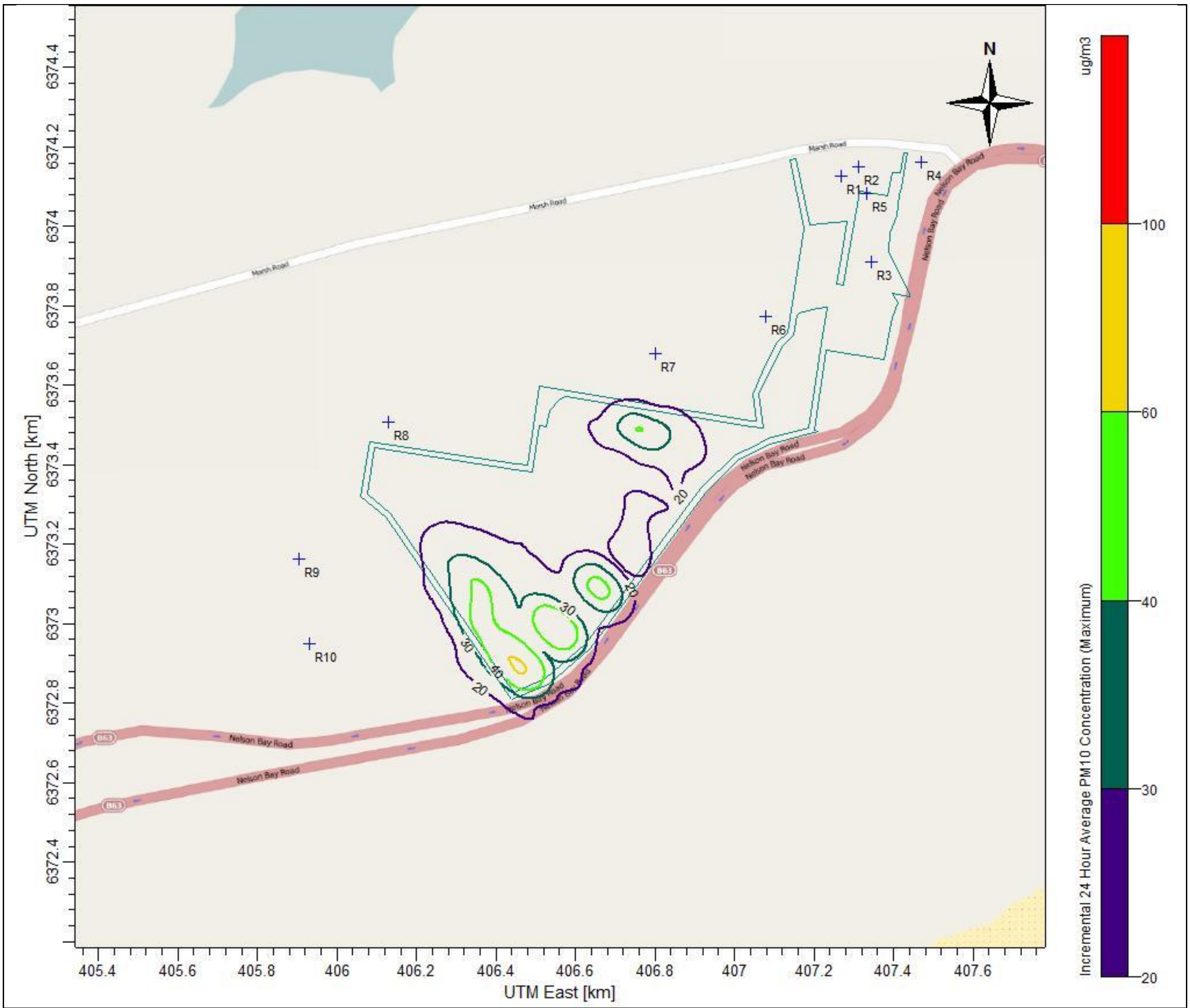
APPENDIX D: CONTOUR PLOTS

The contour plots are created from the predicted ground-level concentrations at the network of gridded receptors within the modelling domain at frequent intervals. These gridded values are converted into contours using triangulation interpolation in the CALPOST post-processing software within the CALPUFF View software (Version 7.2 - June 2014).

Contour plots illustrate the spatial distribution of ground-level concentrations across the modelling domain for each time period of concern. However, this process of interpolation causes a smoothing of the base data that can lead to minor differences between the contours and discrete model predictions.

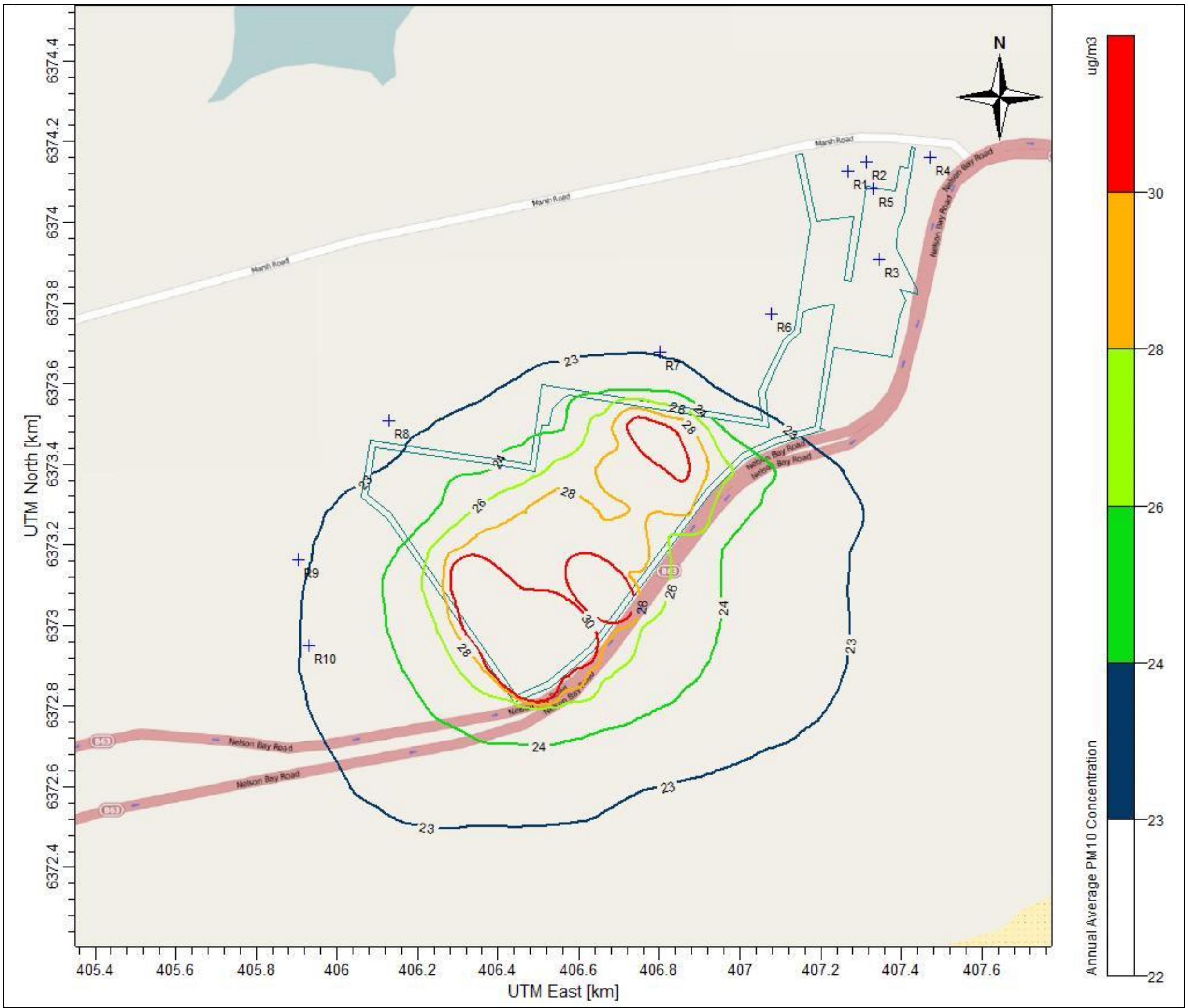


Pollutant: Dust Deposition	**Averaging Period:** Month	**Percentile:** 100th	**Criteria:** 4 g/m^2/month
Comment: Initial Stage - Year 1 Includes background of 2.1 g/m^2/month			



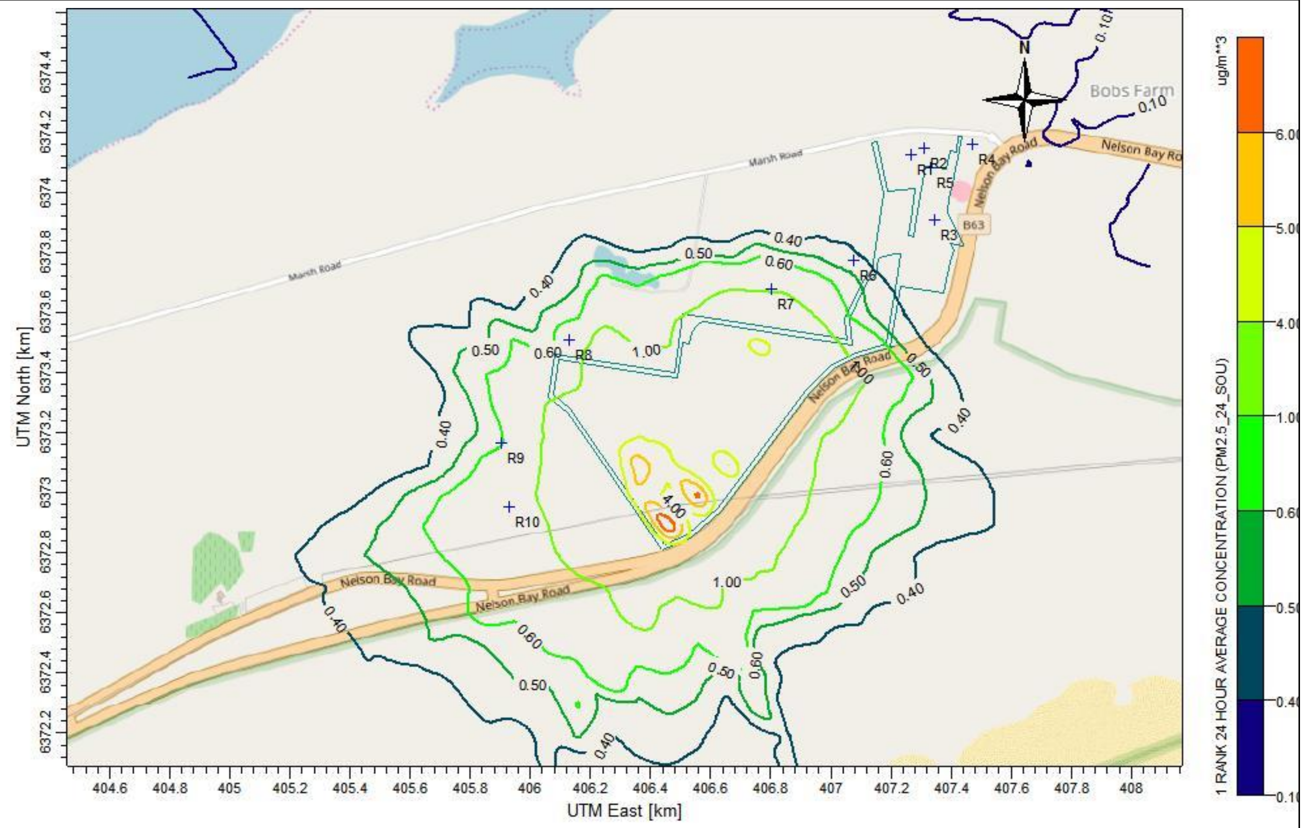
Pollutant: PM10 (Incremental)	Averaging Period: 24 hour	Percentile: 100th	Criteria: 50 µg/m³

Comment:
Initial Stage - Year 1



Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10} (Total)	Annual	100th	25 µg/m^3

Comment:
Initial Stage - Year 1
Includes background of 22.3 µg/m^3

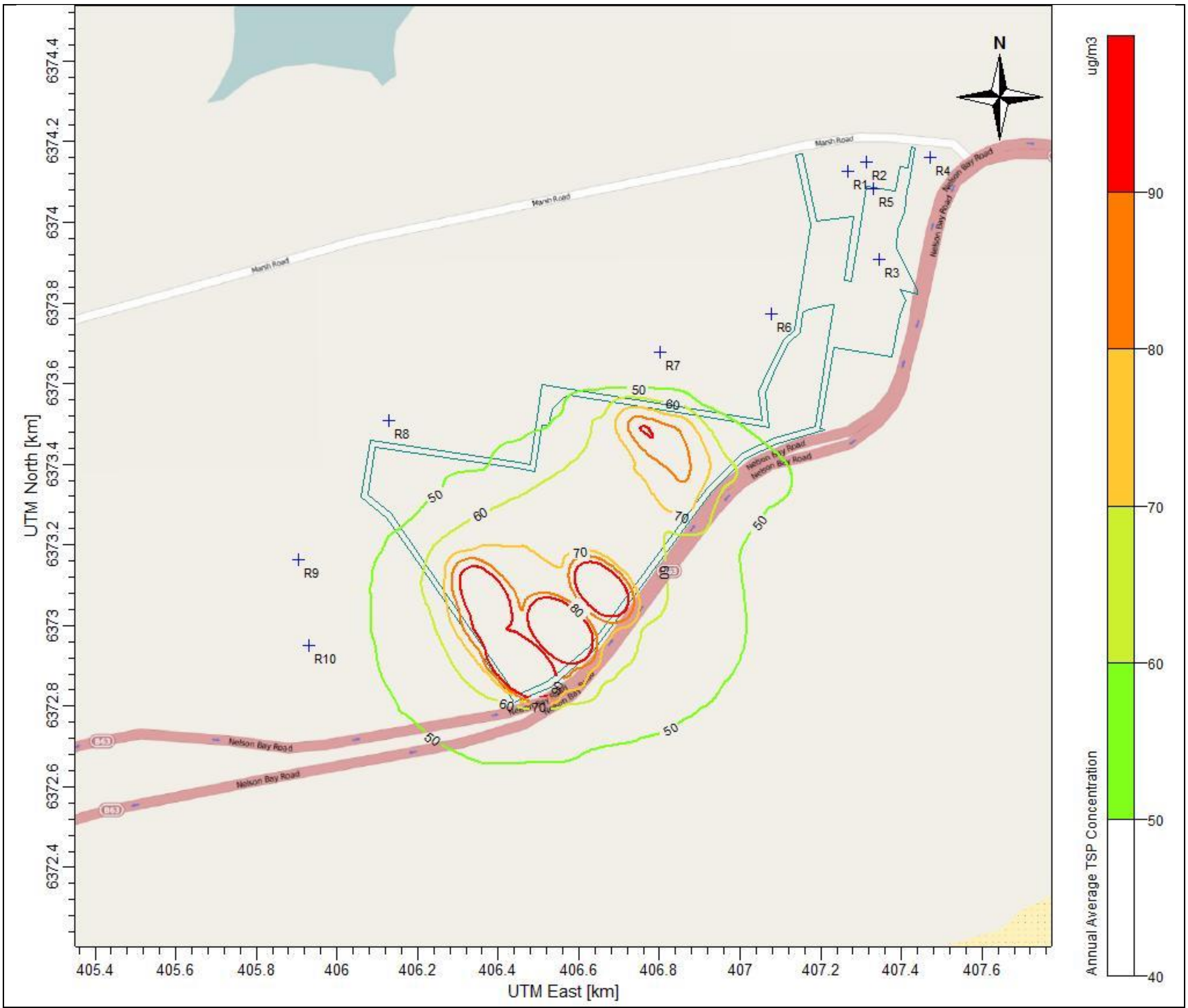


Pollutant: PM2.5 (Incremental)	Averaging Period: 24 hour	Percentile: 100th	Criteria: 25 µg/m3

Comment:
Initial Stage - Year 1

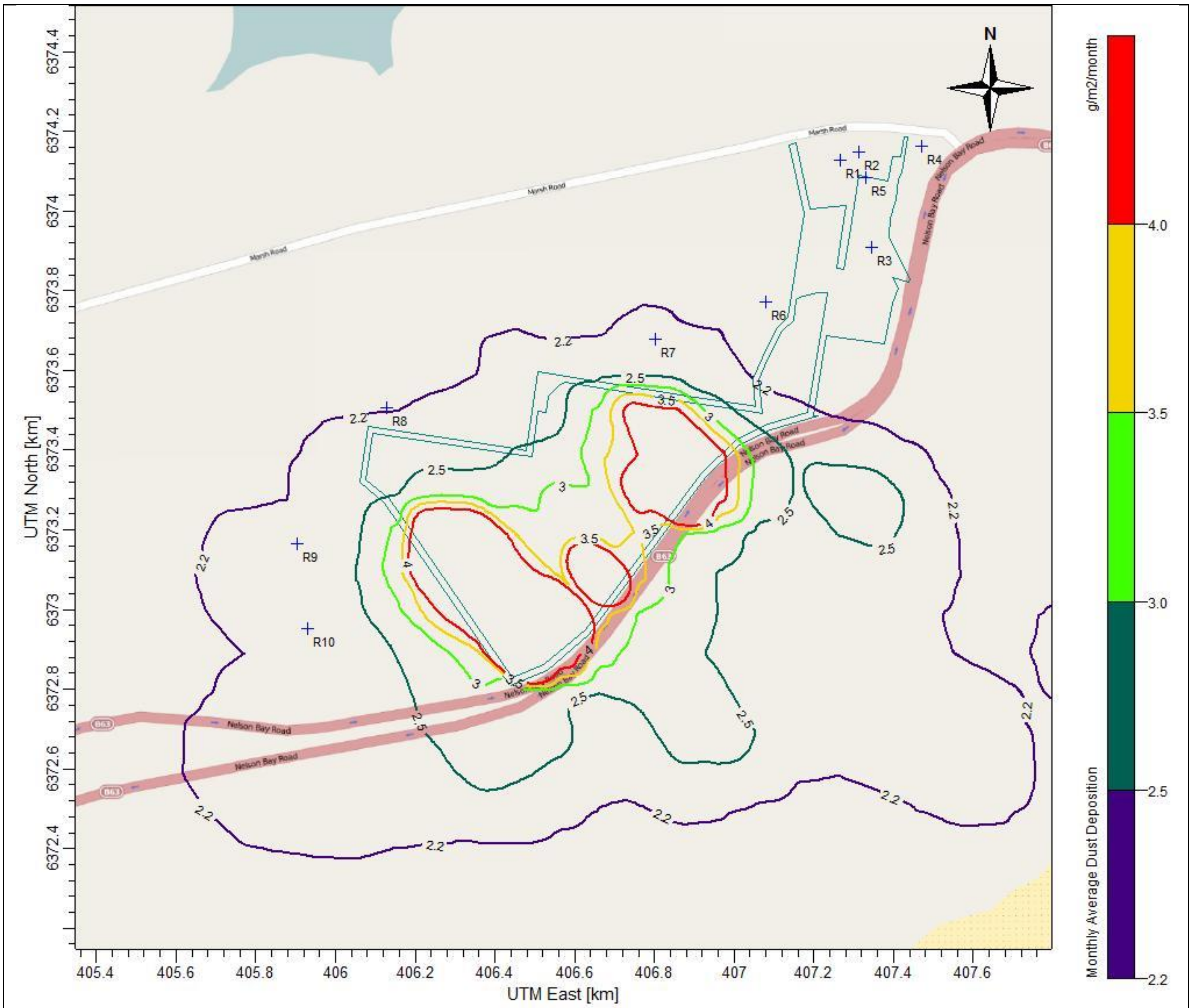
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$ (Total)	Annual	100th	8 µg/m^3

Comment:
Initial Stage - Year 1
Includes background of 7.7 µg/m^3



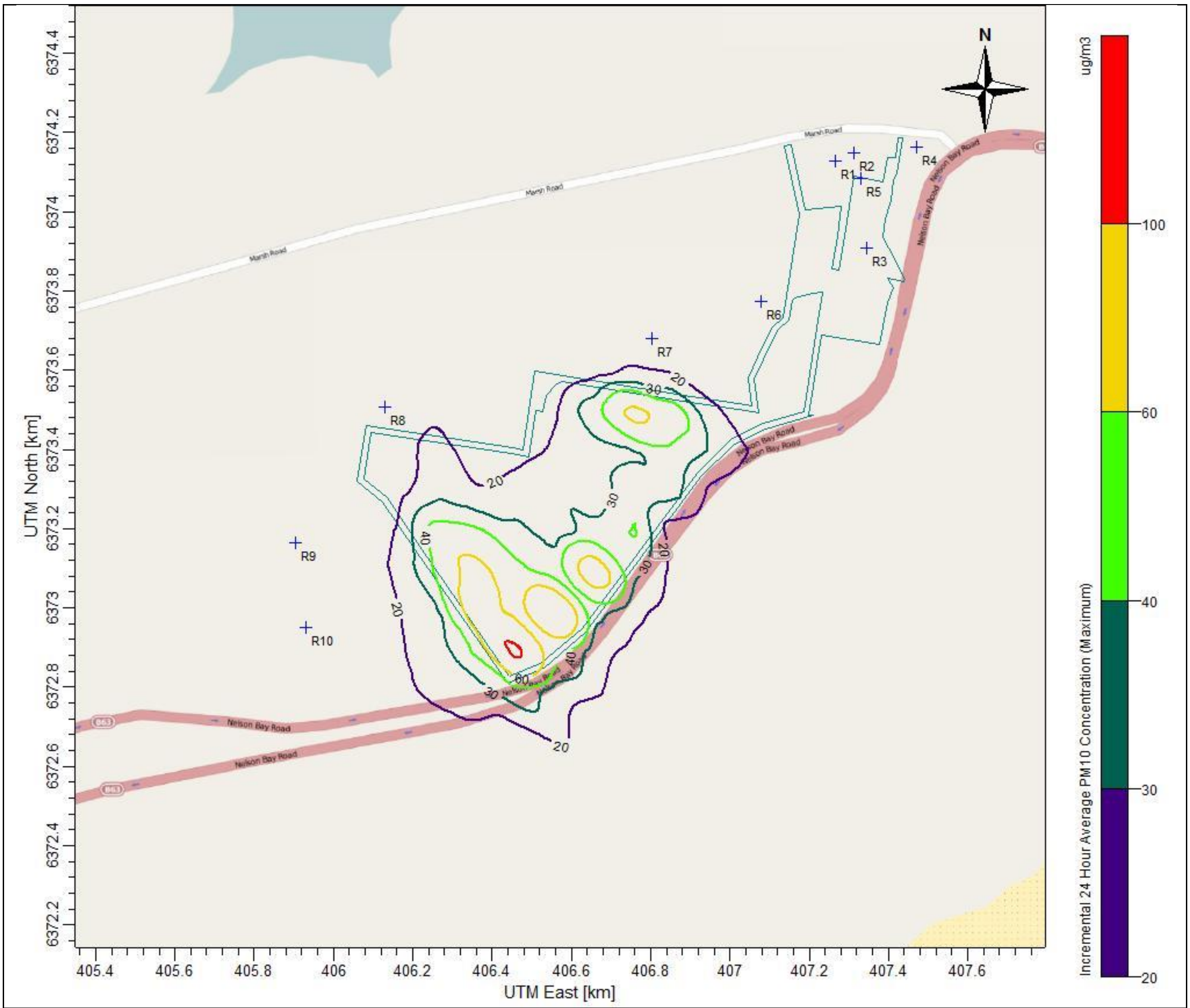
Pollutant:	Averaging Period:	Percentile:	Criteria:
TSP (Total)	Annual	100th	90 µg/m³

Comment:
Initial Stage - Year 1
Includes background concentration of 44.6 µg/m³



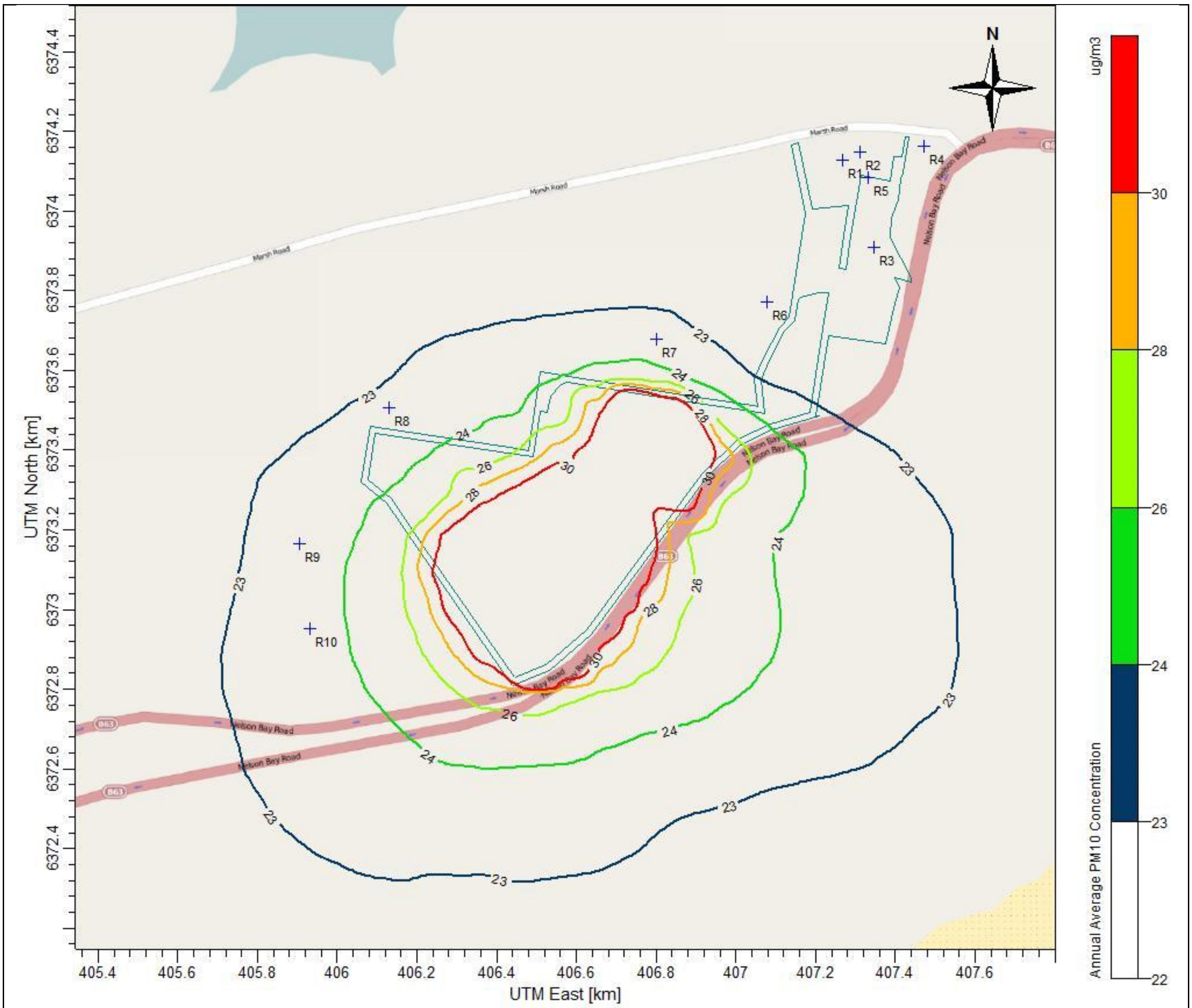
Pollutant: Dust Deposition	**Averaging Period:** Month	**Percentile:** 100th	**Criteria:** 4 g/m²/month

Comment:
Production Stage 1 – Year 2
Includes background of 2.1 g/m²/month



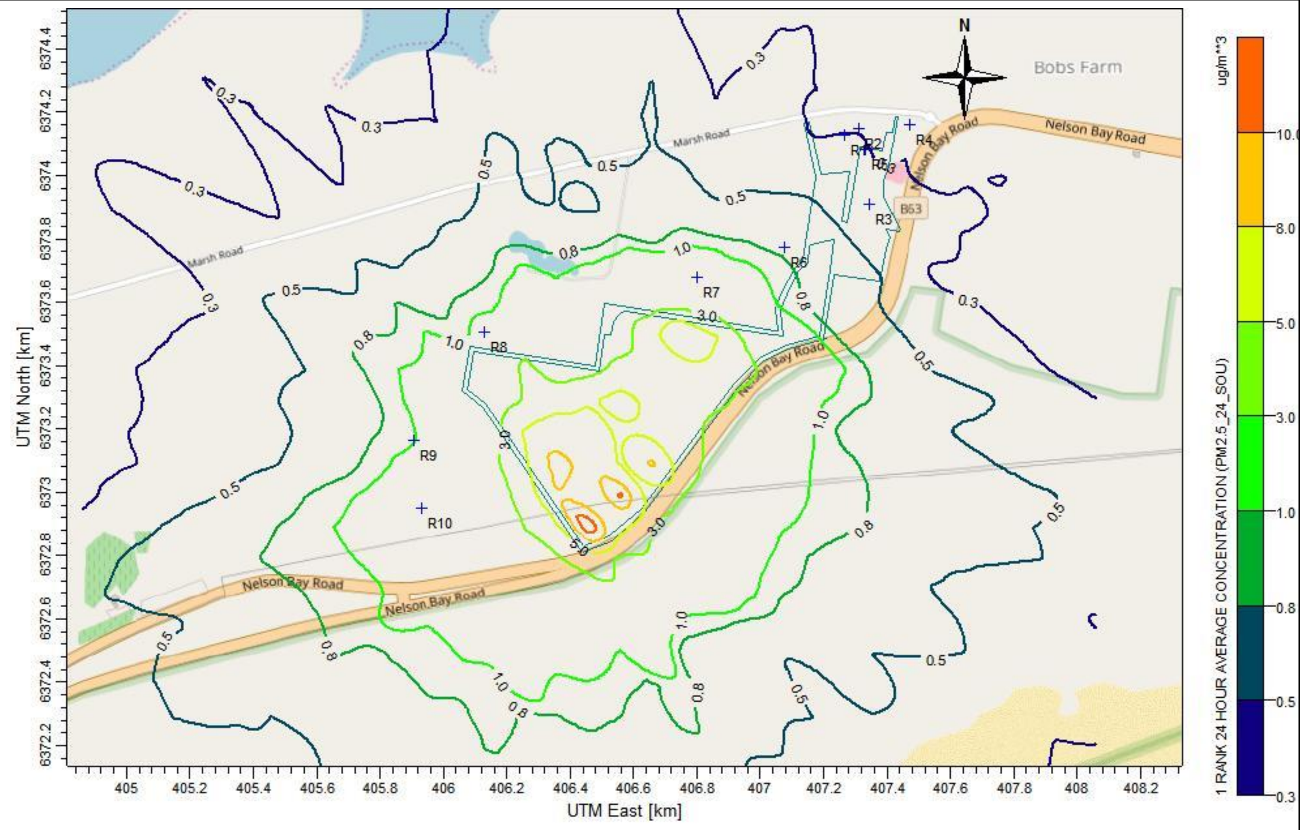
Pollutant: PM10 (Incremental)	**Averaging Period:** 24 hour	**Percentile:** 100th	**Criteria:** 50 µg/m^3

Comment:
Production Stage 1 – Year 2



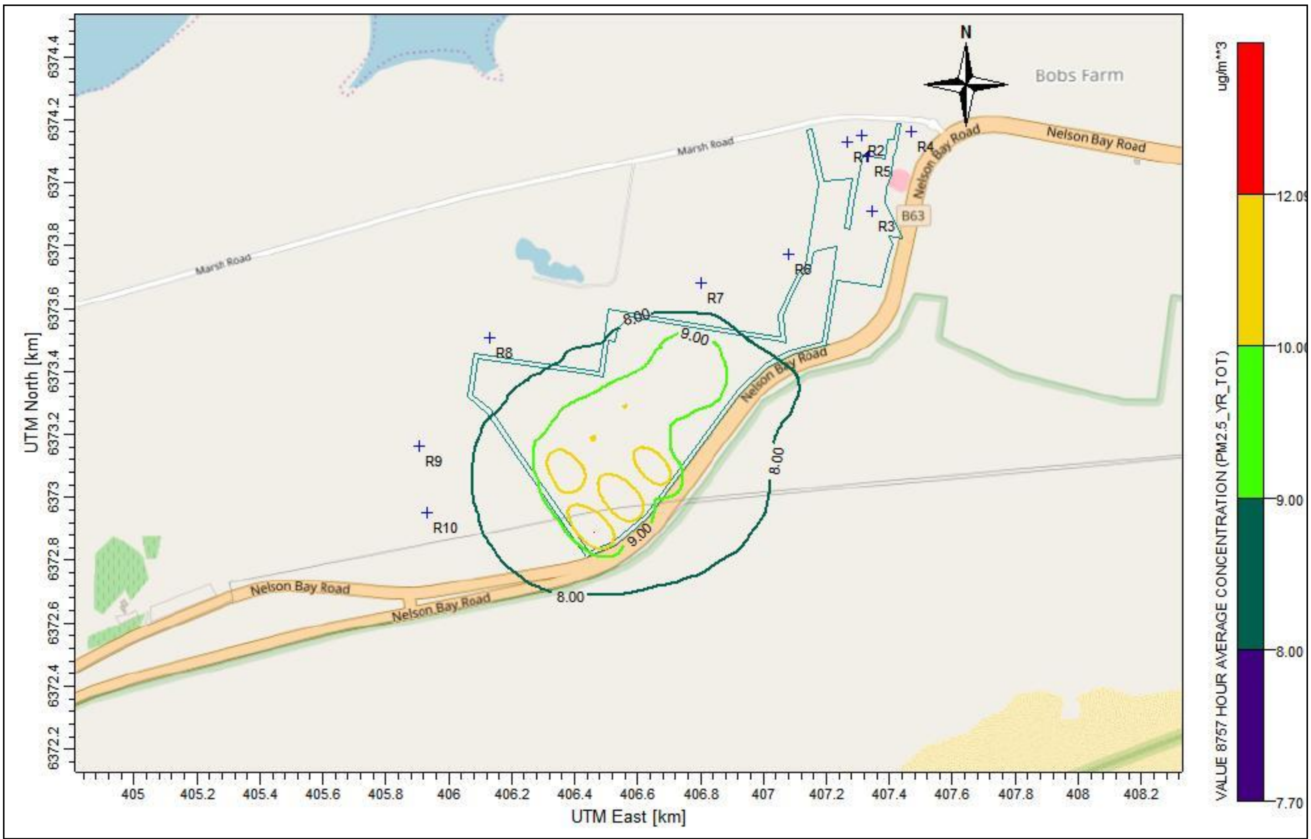
Pollutant: PM10 (Total)	**Averaging Period:** Annual	**Percentile:** 100th	**Criteria:** 25 µg/m³

Comment:
Production Stage 1 – Year 2
Includes background of 22.3 µg/m³



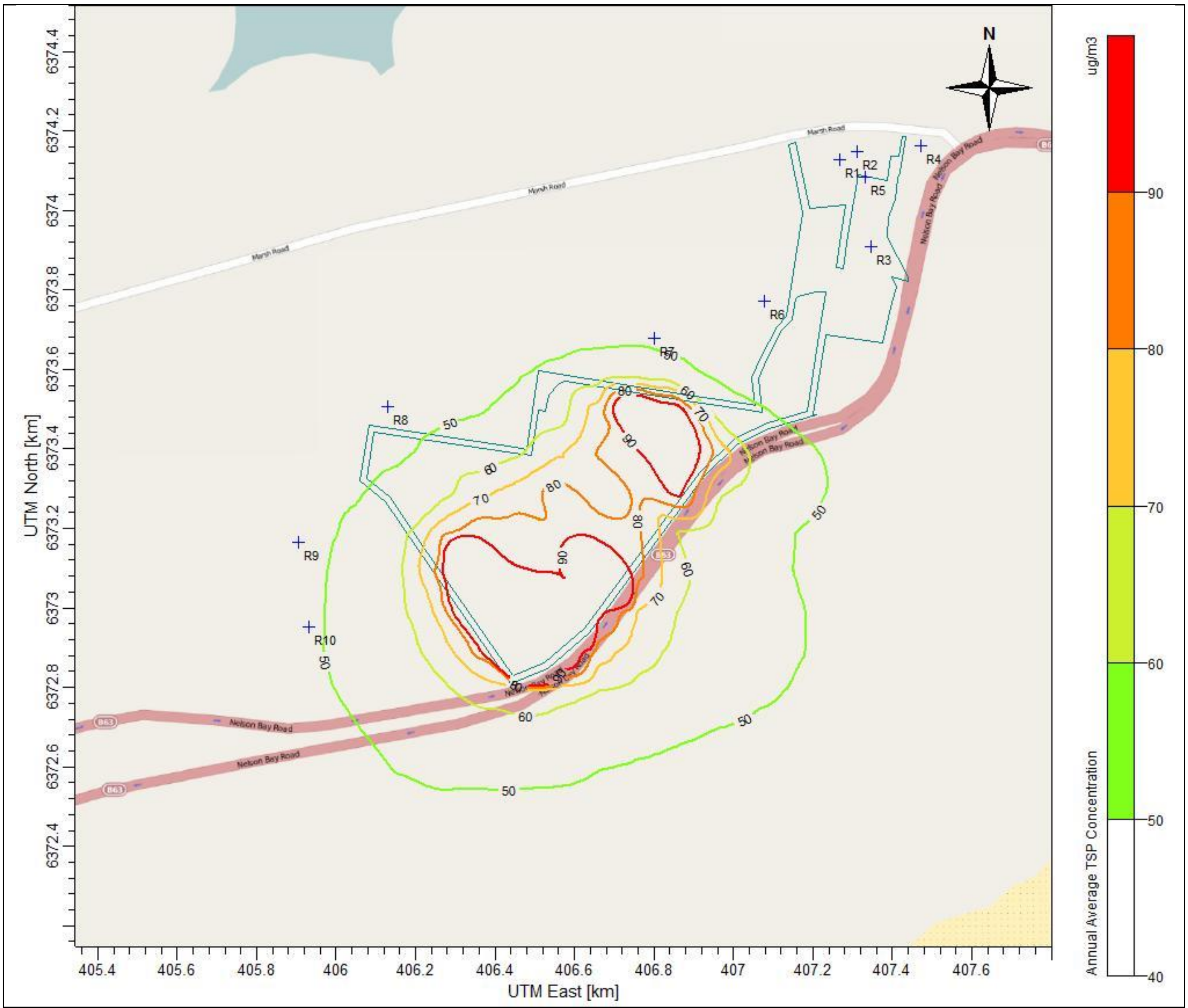
Pollutant: $PM_{2.5}$ (Incremental)	Averaging Period: 24 hour	Percentile: 100th	Criteria: 25 µg/m³

Comment:
Production Stage 1 – Year 2



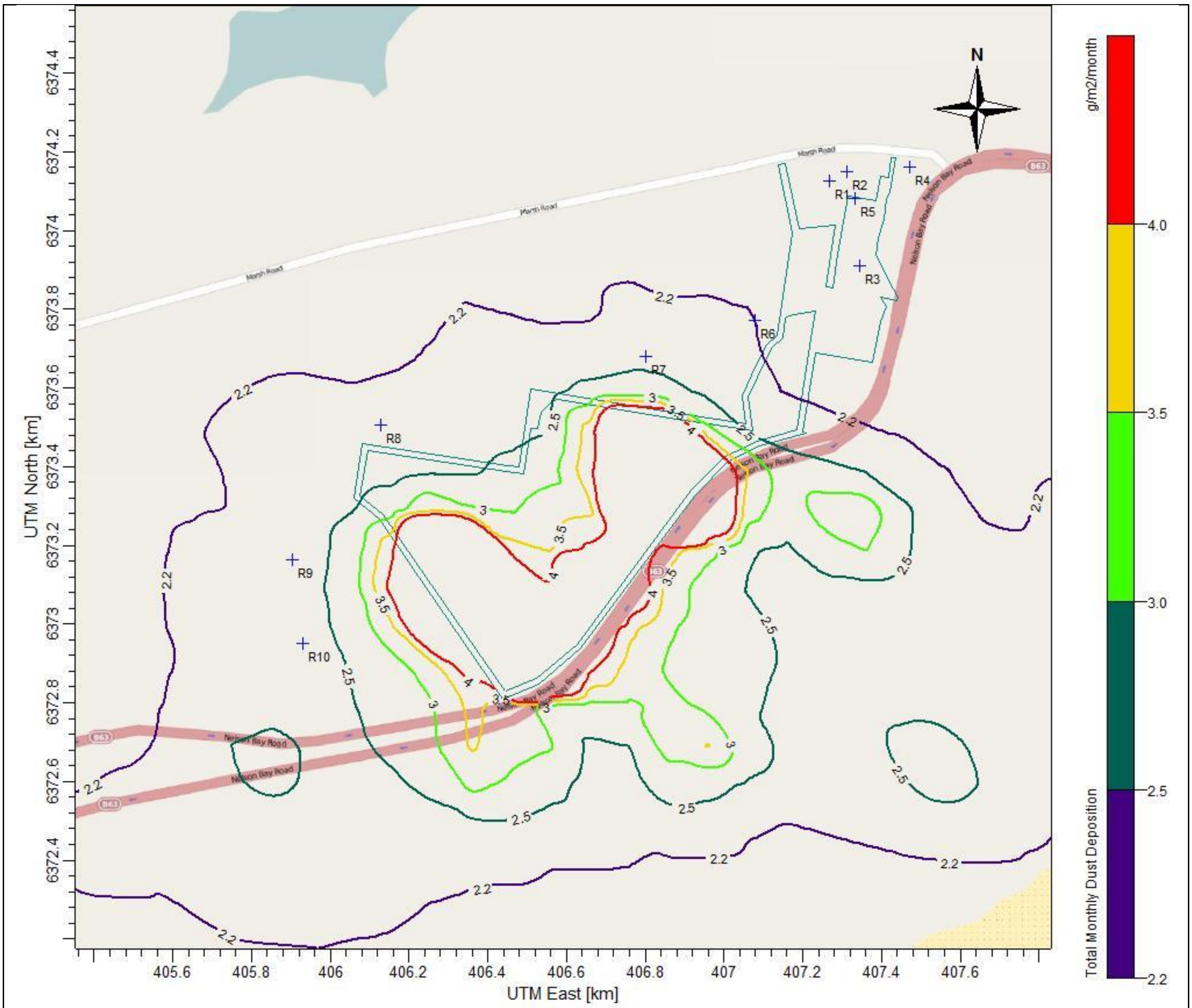
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$ (Total)	Annual	100th	8 µg/m^3

Comment:
Production Stage 1 – Year 2
Includes background of 7.7 µg/m^3



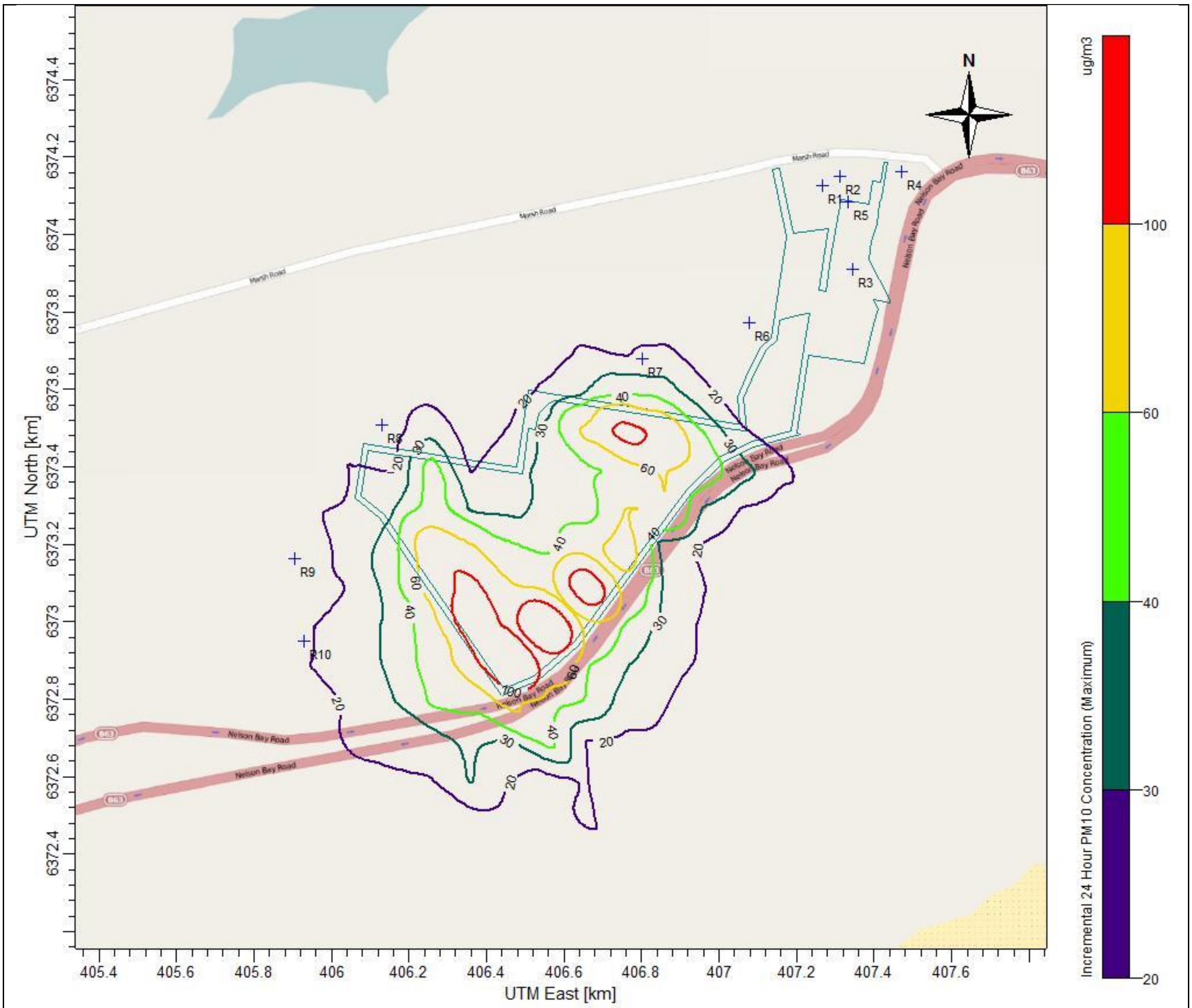
Pollutant:	**Averaging Period:**	**Percentile:**	**Criteria:**
TSP (Total)	Annual	100th	90 µg/m^3

Comment:
Production Stage 1 – Year 2
Includes background concentration of 44.6 µg/m^3



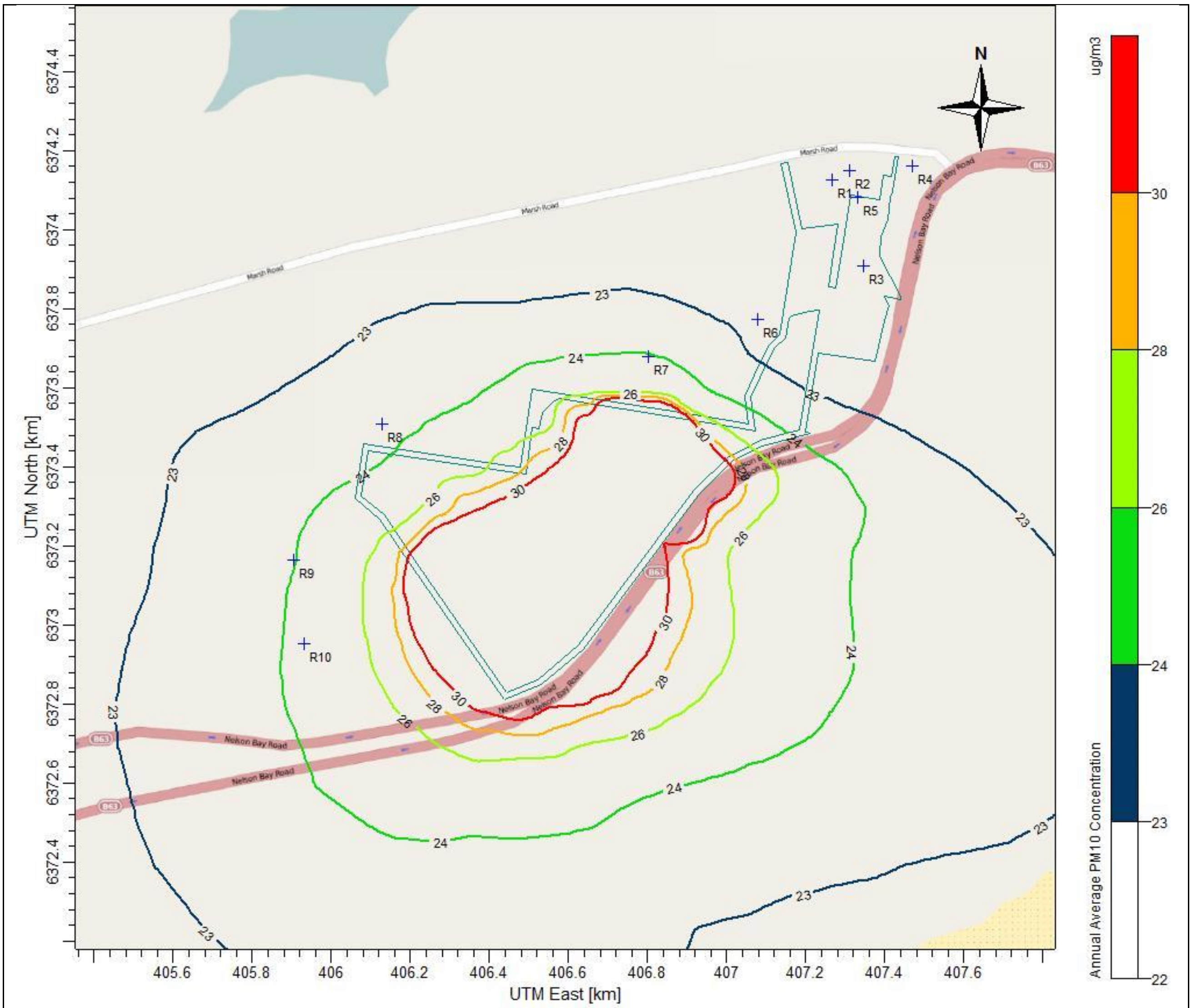
Pollutant: Dust Deposition	**Averaging Period:** Month	**Percentile:** 100th	**Criteria:** 4 g/m²/month

Comment:
Production Stage 2 – Year 3
Includes background of 2.1 g/m²/month



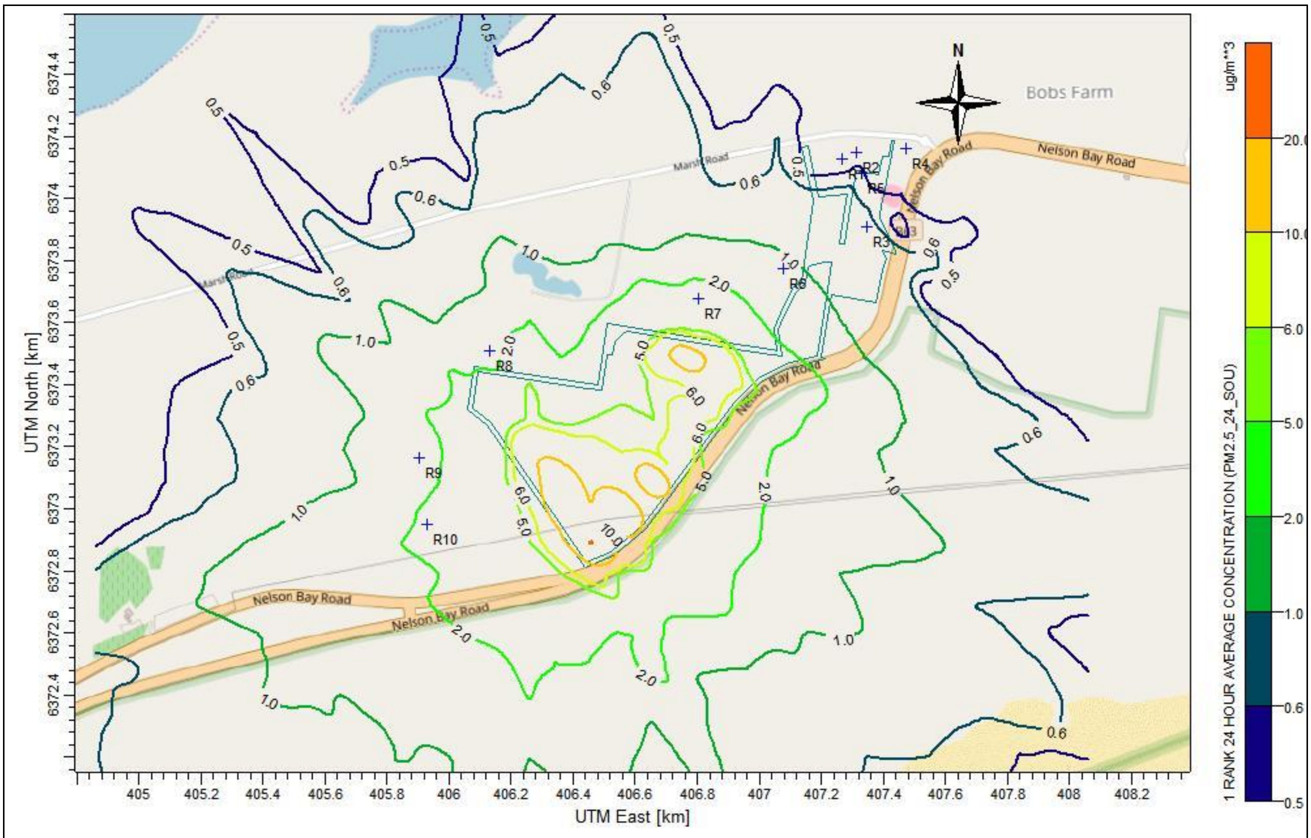
Pollutant: PM10 (Incremental)	Averaging Period: 24 hour	Percentile: 100th	Criteria: 50 µg/m³

Comment:
Production Stage 2 – Year 3



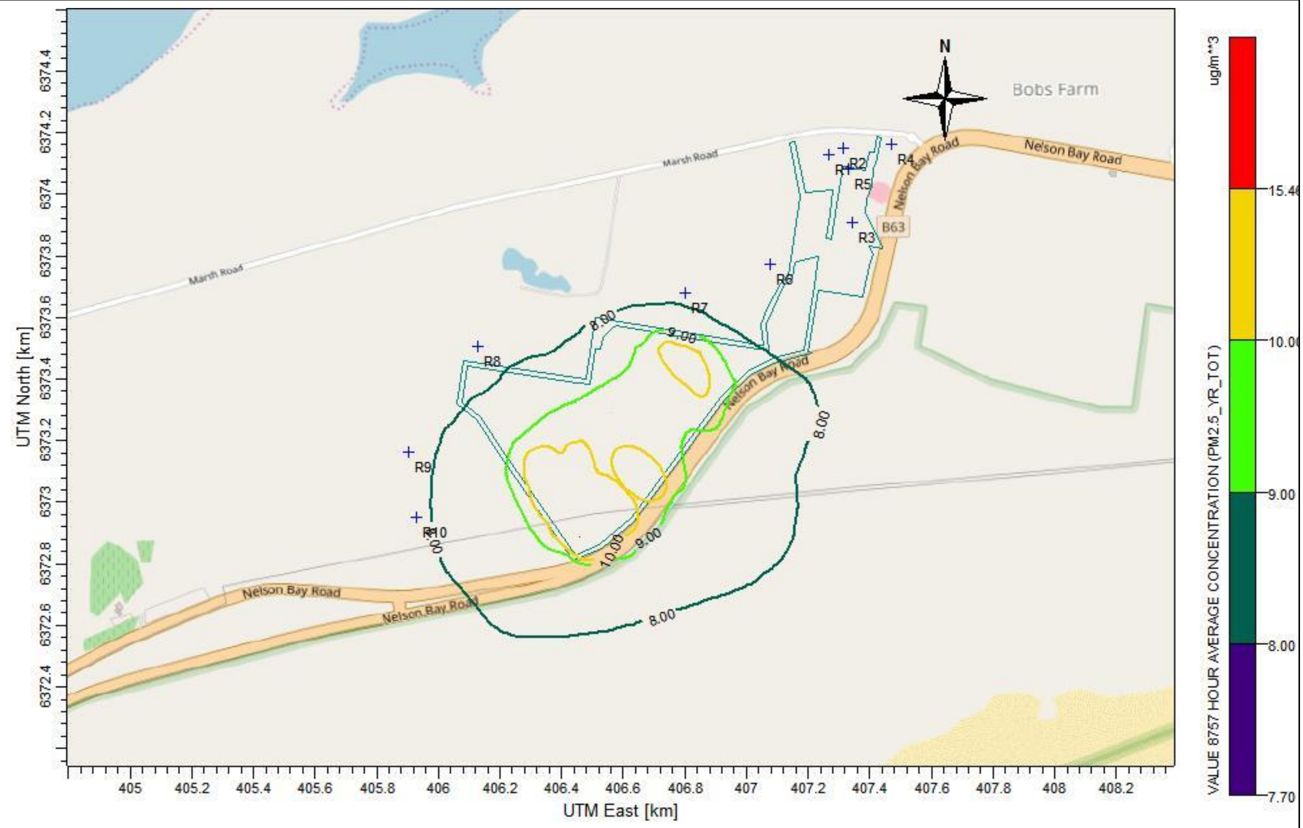
Pollutant:	**Averaging Period:**	**Percentile:**	**Criteria:**
PM_{10} (Total)	Annual	100th	25 µg/m^3

Comment:
Production Stage 2 – Year 3
Includes background of 22.3 µg/m^3



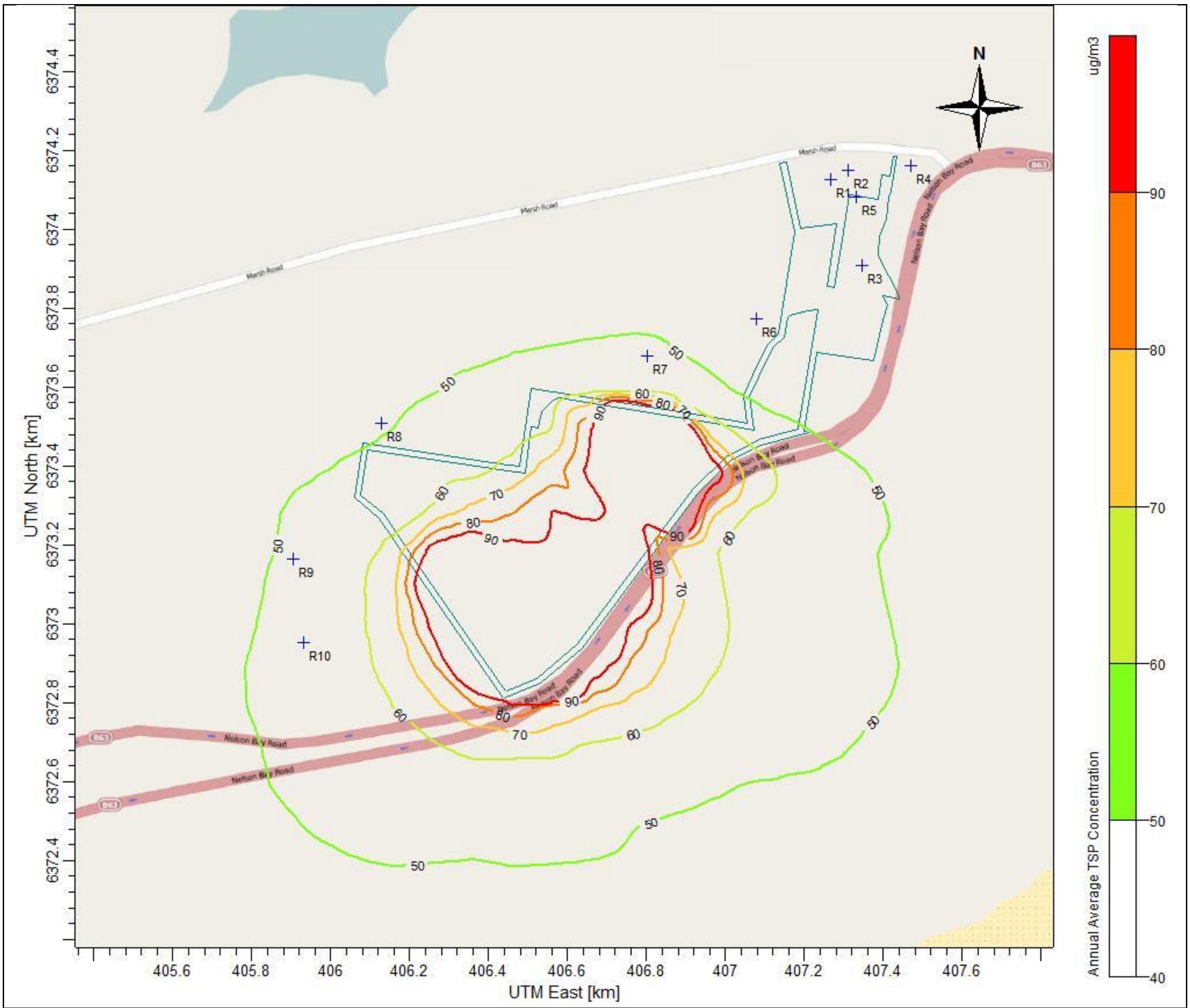
Pollutant: PM2.5 (Incremental)	**Averaging Period:** 24 hour	**Percentile:** 100th	**Criteria:** 25 µg/m3

Comment:
Production Stage 2 – Year 3



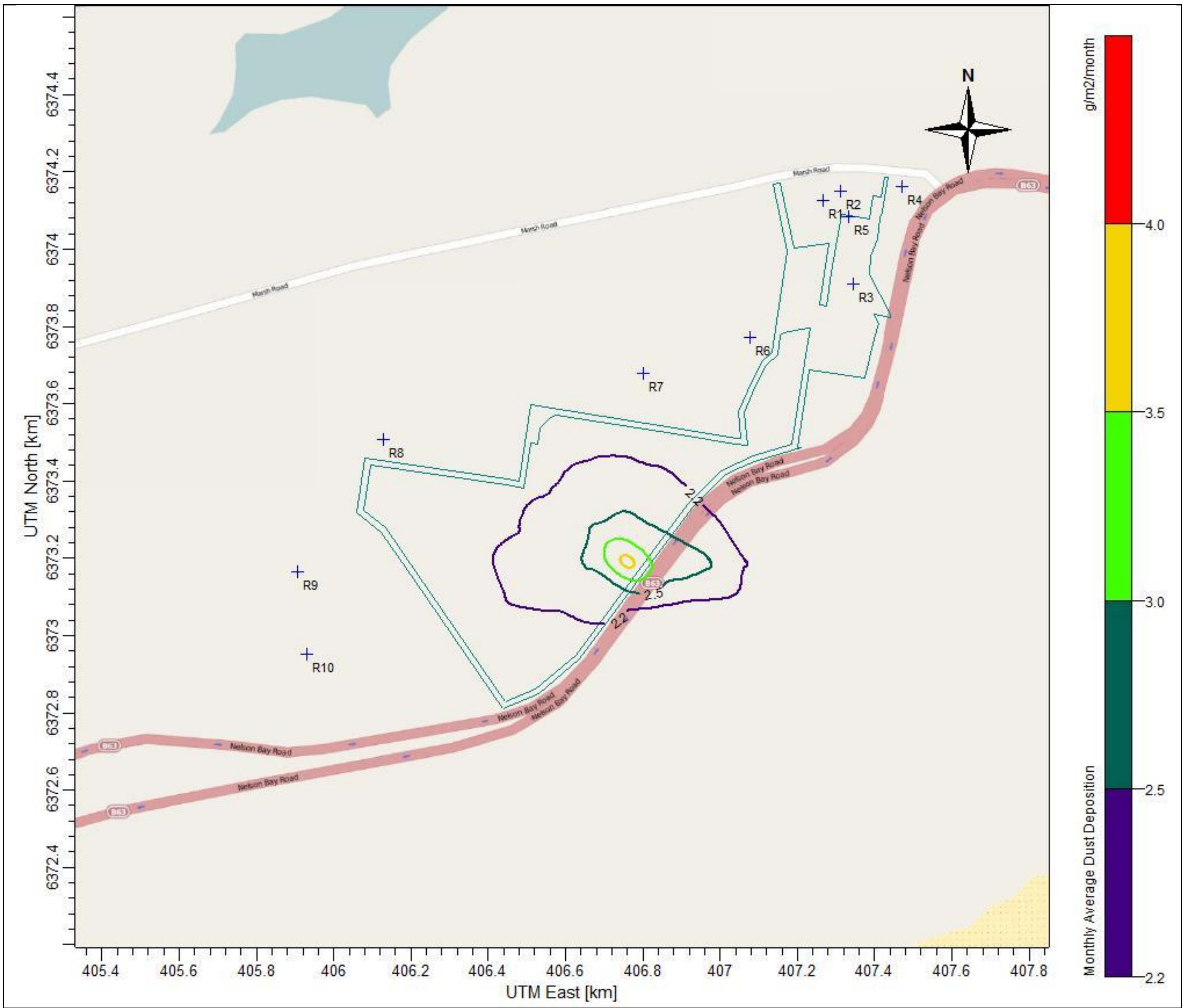
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$ (Total)	Annual	100th	8 µg/m^3

Comment:
Production Stage 2 – Year 3
Includes background of 7.7 µg/m^3



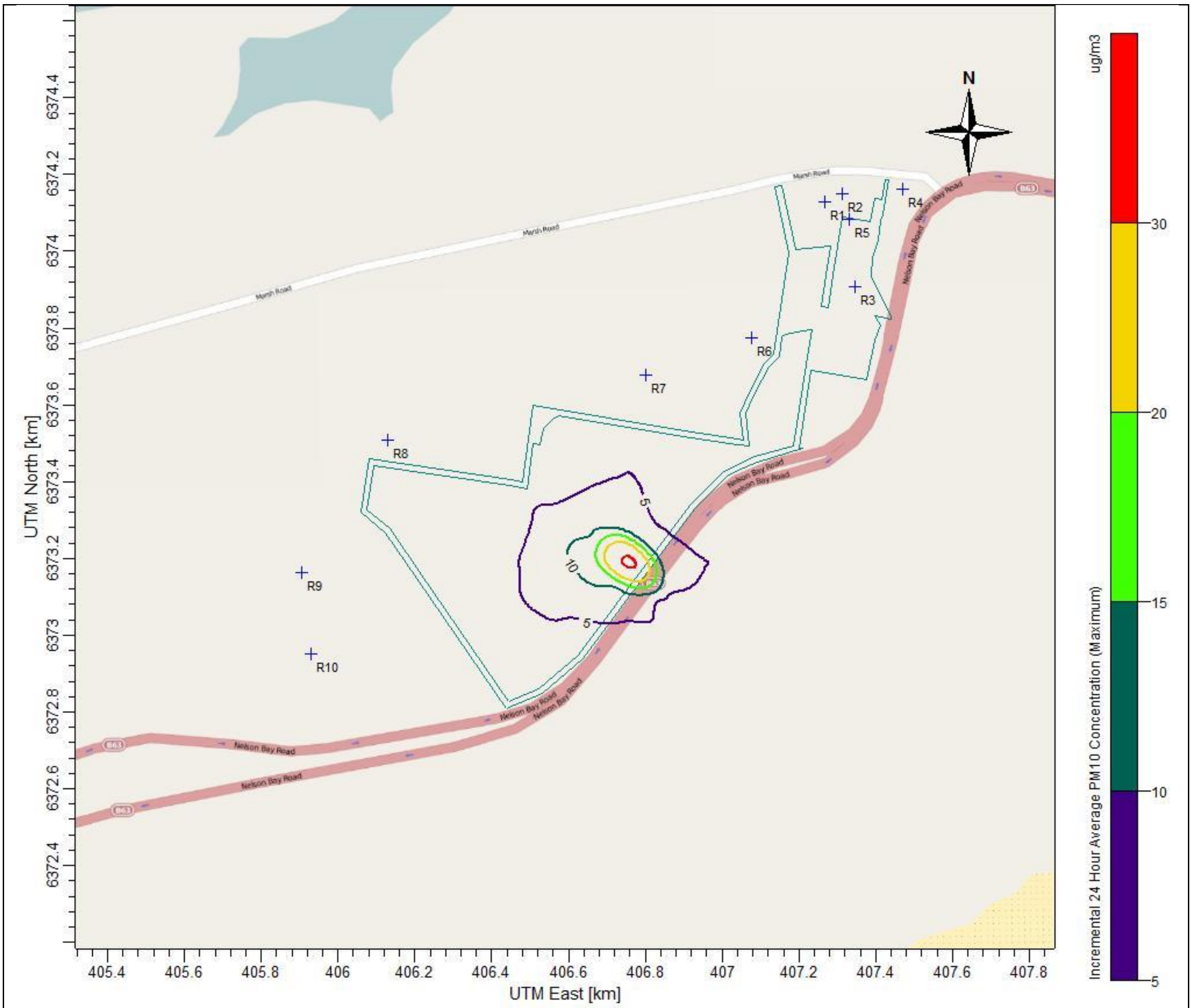
Pollutant:	Averaging Period:	Percentile:	Criteria:
TSP (Total)	Annual	100th	90 µg/m³

Comment:
Production Stage 2 – Year 3
Includes background concentration of 44.6 µg/m³



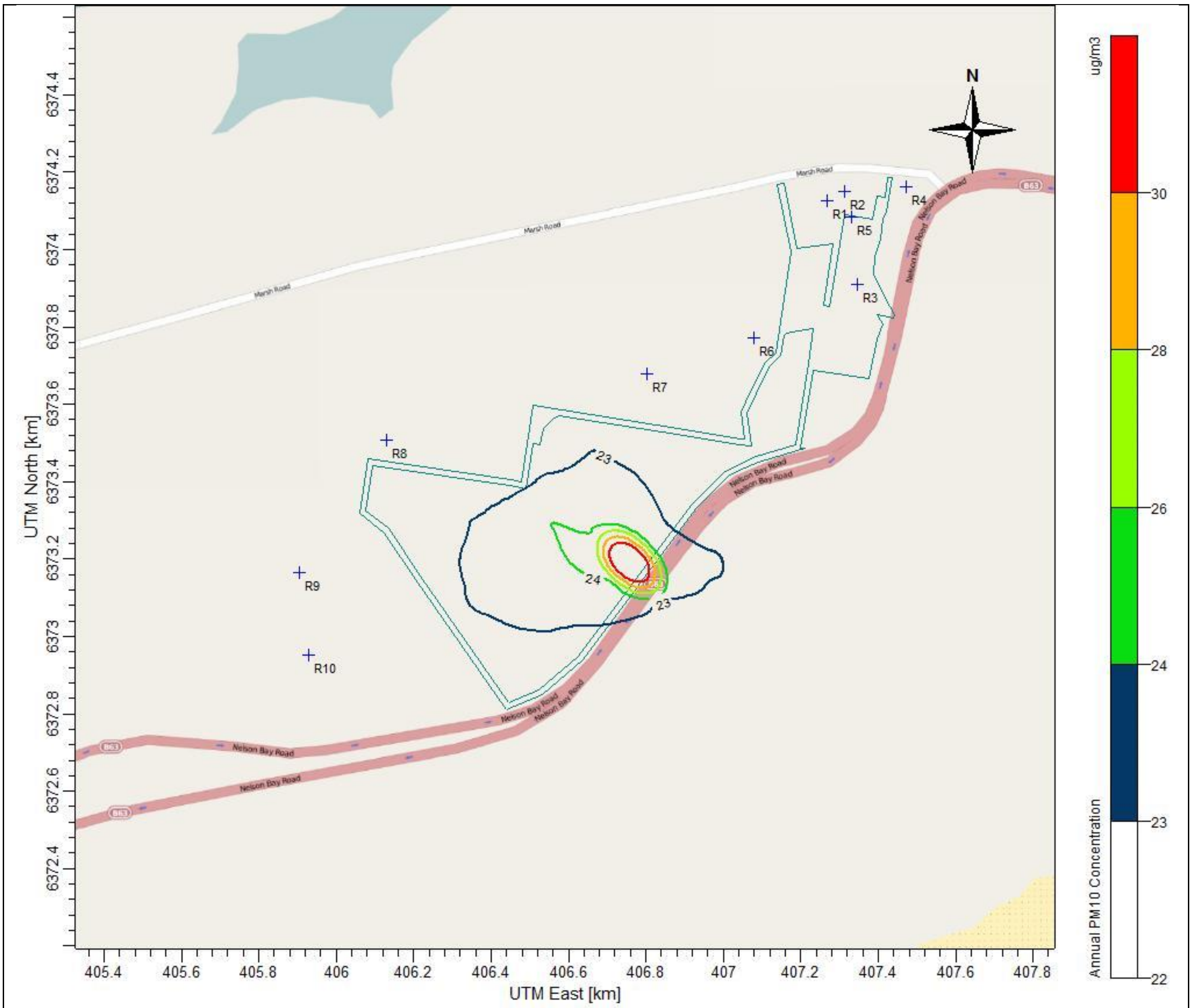
Pollutant: Dust Deposition	**Averaging Period:** Month	**Percentile:** 100th	**Criteria:** 4 g/m²/month

Comment:
Production Stage 3 – Year 4 onwards
Includes background of 2.1 g/m²/month



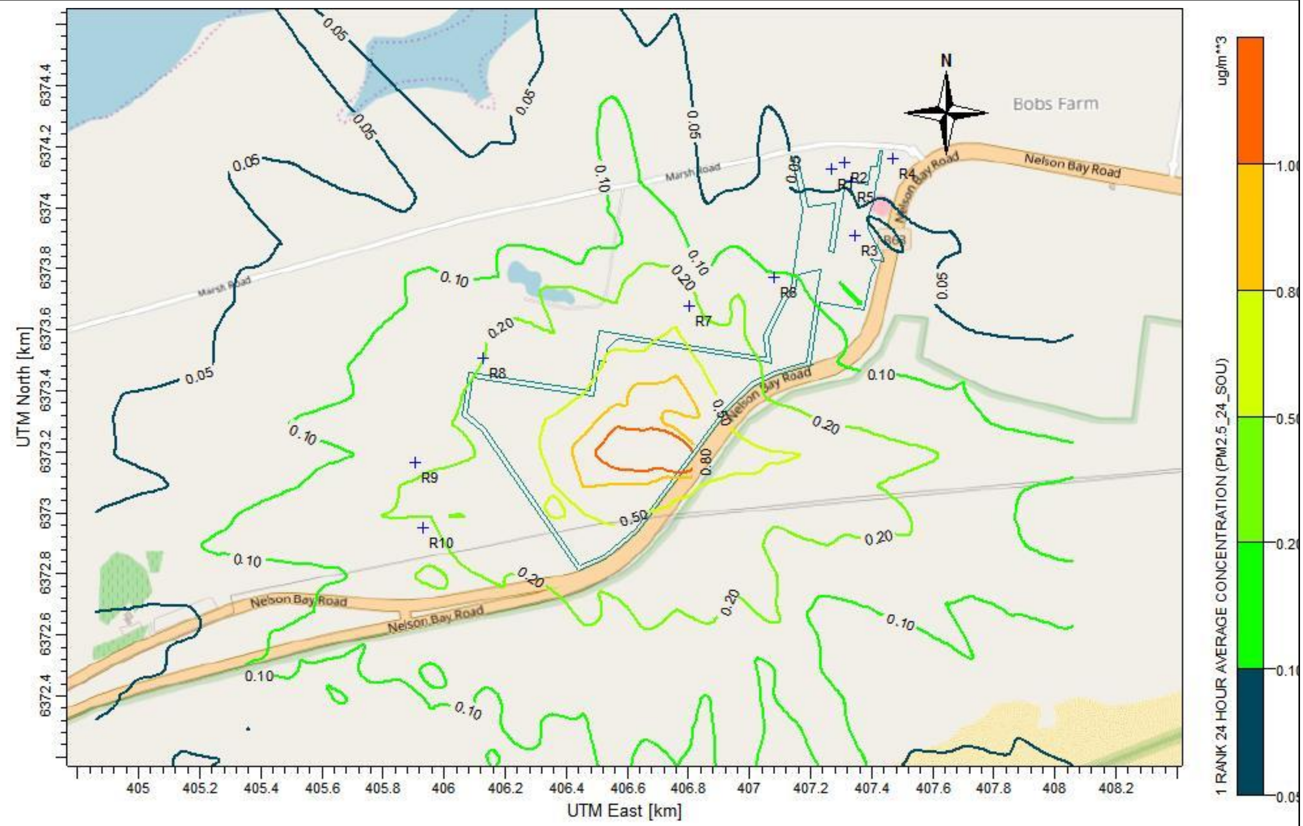
Pollutant: PM10 (Incremental)	**Averaging Period:** 24 hour	**Percentile:** 100th	**Criteria:** 50 µg/m³

Comment:
Production Stage 3 – Year 4 onwards



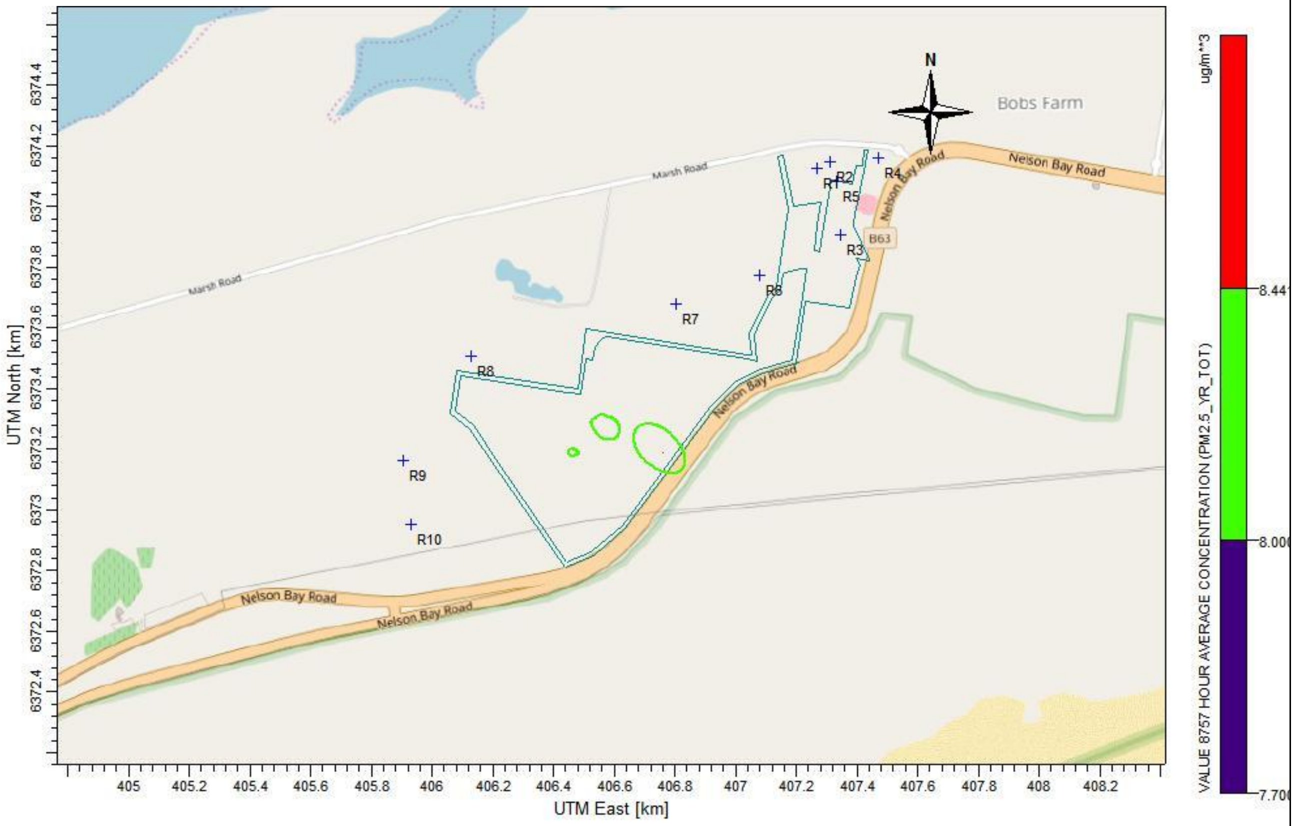
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10} (Total)	Annual	100th	25 µg/m³

Comment:
Production Stage 3 – Year 4 onwards
Includes background of 22.3 µg/m³



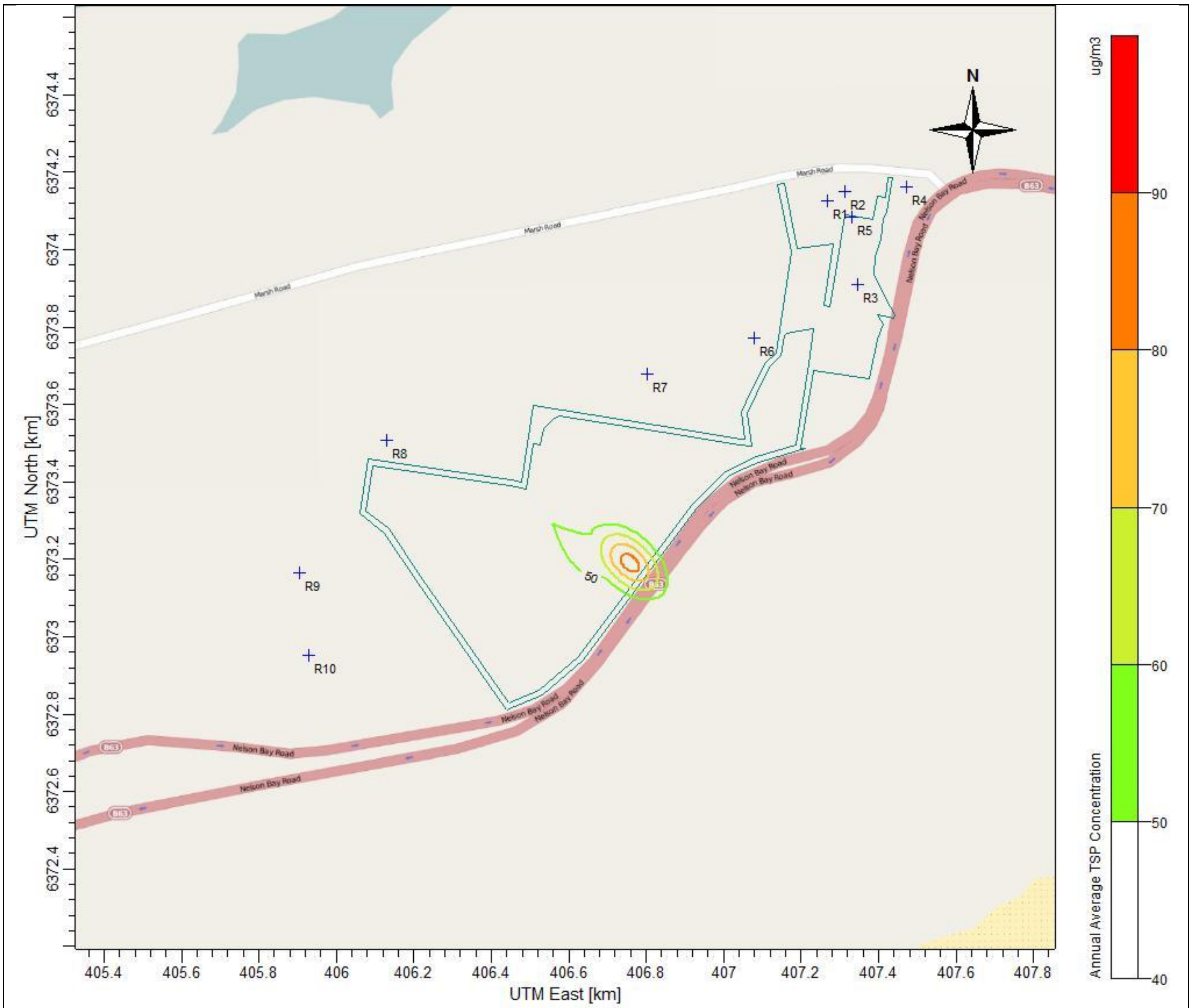
Pollutant: PM2.5 (Incremental)	Averaging Period: 24 hour	Percentile: 100th	Criteria: 25 µg/m³

Comment:
Production Stage 3 – Year 4 onwards



Pollutant: PM$_{2.5}$ (Total)	**Averaging Period:** Annual	**Percentile:** 100th	**Criteria:** 8 µg/m^3

Comment:
Production Stage 3 – Year 4 onwards
Includes background of 7.7 µg/m^3



Pollutant:	Averaging Period:	Percentile:	Criteria:
TSP (Total)	Annual	100th	90 µg/m³

Comment:
Production Stage 3 – Year 4 onwards
Includes background concentration of 44.6 µg/m³

APPENDIX E: AIR QUALITY MANAGEMENT PLAN

Purpose & Scope

The purpose of the Plan is to:

- Provide a description of the measures to be implemented to mitigate air quality impacts;
- To detail air quality monitoring requirement;
- Provide a mechanism for assessing air quality monitoring results against the relevant air quality impact assessment criteria; and
- Provide employees with a clear and concise description of their responsibilities in relation to air quality management during the operation of the Project.

Objectives

The Air Quality Management objectives of the Plan are to ensure that appropriate procedures and programs of work are in place to:

- Maintain an air quality monitoring system which can assess the air quality impact on surrounding sensitive receivers and performance against the legislative air pollution requirements;
- Detail the controls to be implemented to minimise dust generation from the site recognising that cumulative air quality is a key issue for the local community;
- Provide a mechanism to assess monitoring results against air quality impact assessment criteria to evaluate compliance;
- Manage air quality related community complaints in a timely and effective manner; and
- Provide management commitments and strategies for dealing with air quality related issues.

Compliance Assessment Protocol

In the event of an exceedance of the relevant pollutant criteria, the operator of the Project will investigate and report the exceedance and will also implement mitigating measures for future air quality impacting activities as necessary and will monitor all activities for effectiveness and improvement opportunities. Air quality data will be collected and assessed in conjunction with meteorological data to determine the Project contribution to recorded dust events.

Community Complaints

Community complaints management includes receipt of complaints, investigation, implementation of appropriate remedial action, and feedback to the complainant as well as communication to site management or personnel and notification to external bodies, such as the OEH.

Accountabilities

Specific roles and accountabilities for employees and contractors in relation to Air Quality Management Plan are outlined below.

Person Responsible	Responsibilities
Operations Manager	• Approve appropriate resources for the implementation of this Plan. • Ensure the effective implementation of strategies designed to reduce air quality impacts from the operation. • Ensure air quality issues are reported in accordance with legal requirements. • Authorise internal reporting requirements of this plan
Environment and Community Manager/Officer	• Provide that sufficient resources are allocated for the implementation of this program. • Identify air quality risks and impacts to the environment and assess resources required to mitigate identified risks and impacts within the site. • Ensure that the air quality management controls are implemented in accordance with this Plan. • Ensure that the results of monitoring are evaluated and reported to senior management and to relevant personnel for consideration as part of ongoing planning. • Ensure any potential or actual air quality is reported in accordance with legal requirements and the corporate standard. • Provide visible and proactive leadership in relation to the air quality management. • Ensure that operational changes consider the potential air quality impacts to adjacent private landowners • Ensure all reporting requirements are met and complies with internal and external monitoring standards, protocols and regulations. • Coordinate progressive rehabilitation to minimise disturbed areas. • Manage and maintain the air quality monitoring programs. • Ensure monitoring equipment is operated in accordance with relevant industry standards and protocols.
Managers, Supervisor, & Task Coordinators	• Provide that sufficient resources are allocated for the implementation of this Plan, as required. • Ensure adequate resources are budgeted for in relation to air quality • Ensure that operational changes consider the potential impacts of dust emissions from the Project on the surrounding environment. • Monitor team members and contractors carry out work appropriate monitoring and maintenance tasks. • Ensure any potential or actual air quality emissions are controlled. • Conduct daily inspections of the work area to monitor compliance with this plan. • Provide input to management on the adequacy and effectiveness of this plan. • Ensure the effective implementation of strategies designed to reduce air quality impacts from the Project. • Provide visible and proactive leadership in relation to air quality management. • Ensure personnel working at the operation are aware of the air quality management obligations.