AIR QUALITY IMPACT ASSESSMENT
SANDY POINT QUARRY EPL VARIATION

Benedict Industries Pty Ltd

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Job Number 11100038G

Prepared by

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Benedict Industries (hereafter referred to as the Proponent) for the application to vary Environment Protection Licence (EPL 1924) for the Sandy Point Quarry at Menai, New South Wales (NSW) (hereafter referred to as the Project).

The Project seeks to increase the existing threshold for extractive activities, crushing, grinding and separating from 200,000 tonnes per annum (tpa) (EPL Conditions L5.1 and L5.2) up to 400,000tpa

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

- A background and description of the Project;
- A review of the existing meteorology and air quality environment of 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 NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

1.1 Preamble

Todoroski Air Sciences have previously prepared the *Air Quality Impact Assessment Proposed Inert Materials Recycling Activity in the Existing Sandy Point Quarry, Menai* (**Todoroski Air Sciences, 2016**). It is understood that the application for the proposed Inert Materials Recycling Activity is on hold with the existing quarrying activity ongoing.

This application is seeking only to modify the total amount of material that can be extracted and crushed, ground, or separated at the existing quarry.

This assessment applies a similar modelling methodology and approach used in the previous Air Quality Impact Assessment for the site (**Todoroski Air Sciences, 2016**) in order to allow direct comparisons to be made between the predicted levels and those in the previous application.

2 PROJECT BACKGROUND

2.1 Project setting

The Project is located on Heathcote Road approximately 0.5 kilometres (km) south of Picnic Point, approximately 0.8km southeast of Sandy Point and approximately 2km west of Alfords Point. The site is situated in a relatively isolated bushland setting, characterised by surrounding dense bushland. The Georges River is located to the north of the quarry and separates the residential areas to the north.

Figure 2-1 presents the location of the Project and the nearest sensitive receptor locations.

The nearest sensitive receptors are located approximately 0.5km and 0.8km to the north and north-northeast of the quarry boundary. The previously proposed Heathcote Ridge State Significant Site, included commercial, industrial and residential uses on undeveloped Gandangara Local Aboriginal Land Council land, is to the east. The concept plan for the development showed a band of commercial/industrial land approximately 180m wide adjacent to the quarry's eastern boundary with the nearest proposed residential land to be located on the far side of this commercial/industrial land (indicated by receptors R9, R10 and R11).

This proposal was scaled back and State Environmental Planning Policy Amendment (Heathcote Ridge West Menai) 2015 was gazetted for a smaller part of the original Heathcote Ridge State Significant Site. The smaller West Menai State Significant Site has been rezoned for low density residential uses. It is at least 3.5km south of the quarry so well outside the area that needs to be considered as part of an air quality assessment. We understand that there is no formal application for residential rezoning or development in the areas of Receptors R9, R10 and R11. However, these have still been assessed in consideration that there may be future applications to develop this area.

Figure 2-2 presents the terrain surrounding the Project. The site is relatively flat and is on a broad ridge surrounded by valleys formed by the river system.

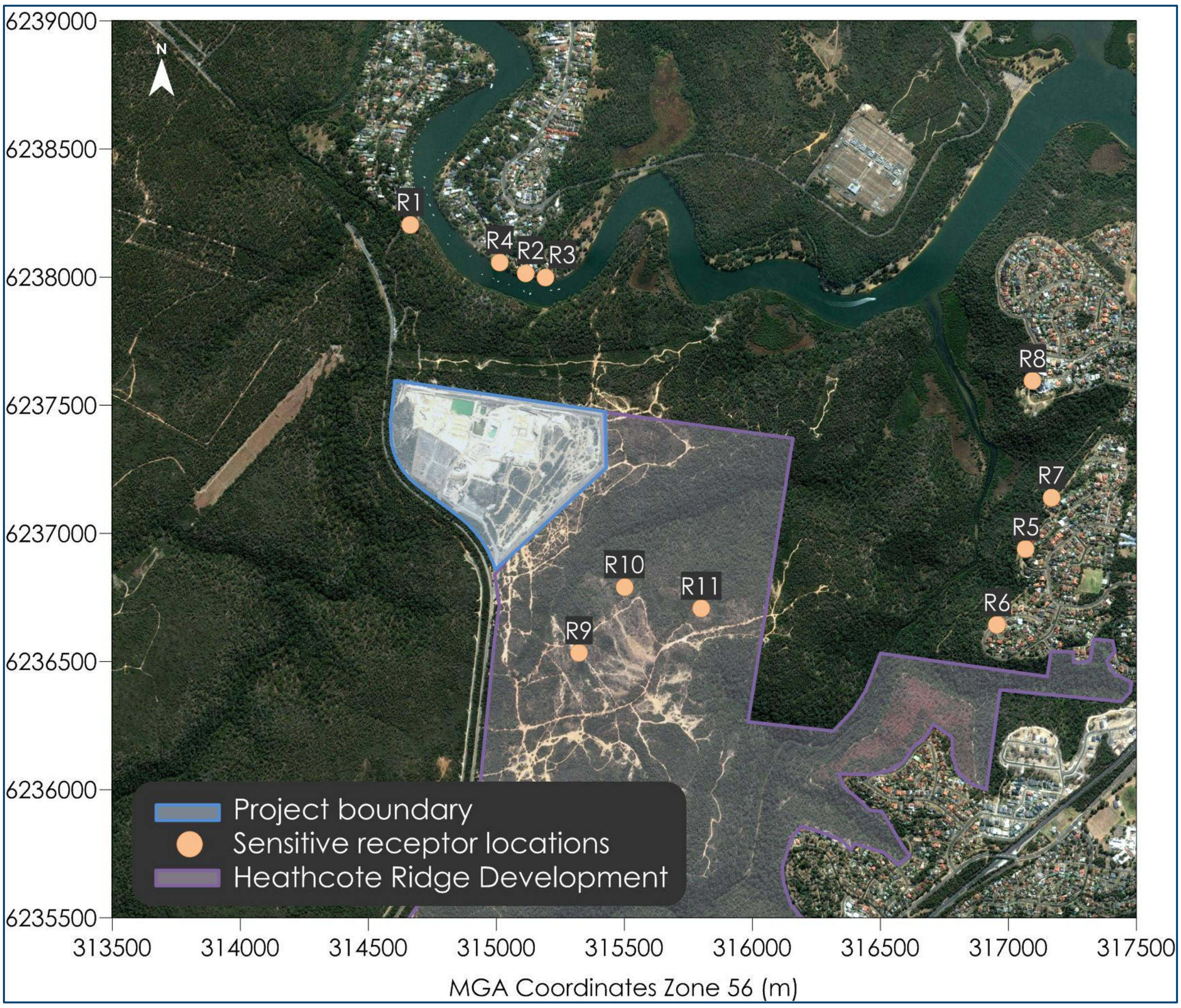

Figure 2-1: Site location

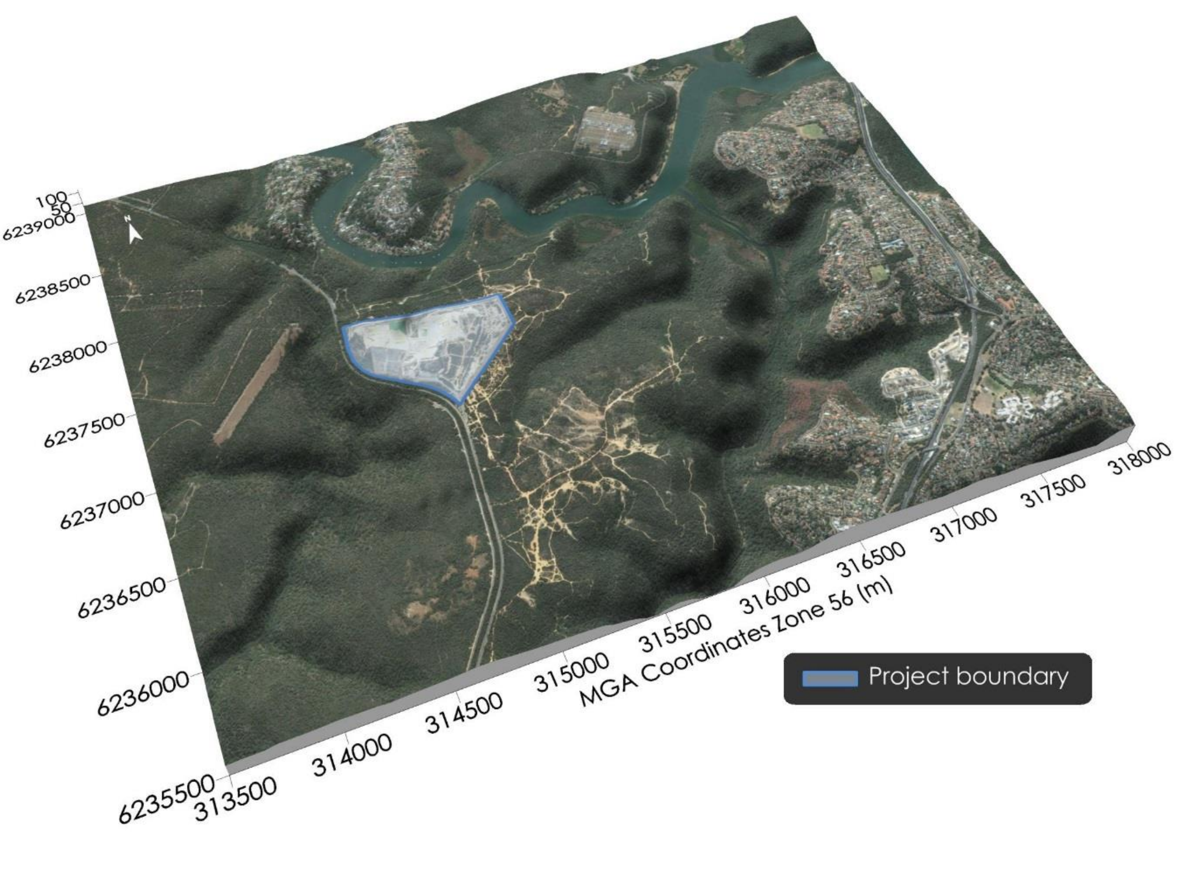

Figure 2-2: Representation of three-dimensional terrain surrounding the Project

2.2 Project description

The Sandy Point Quarry was established by Sutherland Shire Council in the late 1950's. It covers 38 hectares (ha) of mostly cleared land and sandstone is extracted by excavators after blasting and processed using sorting and screening equipment.

The Project seeks to increase the EPL threshold for quarry activity from 200,000tpa up to 400,000tpa using the existing methods of extraction and on-site processing facilities. The increase in production at the Project is anticipated to see an additional two truckloads per hour from the site.

Typical product from the Sandy Point Quarry includes rock spalls, gabion rock, select fill, road base and sands for the Sydney construction market.

Typical operating hours for extraction, processing and sales at the quarry are during the day (7am to 6pm) and morning shoulder periods (6am to 7am), six days per week, with no work on Sundays and public holidays. Additionally, on occasion processing may occur to 10pm on weekdays if demand requires.

3 AIR QUALITY CRITERIA

3.1 Preamble

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the potential air emissions generated by the Project and the applicable air quality criteria.

3.2 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.

3.2.1 NSW EPA impact assessment criteria

Table 3-1 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 criteria for particulates refers to the cumulative impact and not just the dust from the proposed modification. Consideration of background dust levels needs to be made when using these goals to assess potential impacts.

Table 3-1: NSW EPA air quality impact assessment criteria

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

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

4 EXISTING ENVIRONMENT

4.1 Local climatic conditions

Long-term climate data from the closest Bureau of Meteorology (BoM) station, Lucas Heights (ANSTO) (Site Number 066078), were analysed to characterise the local climate in the proximity of the Project. The Lucas Heights (ANSTO) weather station is located approximately 7km south-southwest of the Project.

Table 4-1 and **Figure 4-1** present a summary of data from the Lucas Heights (ANSTO) weather station collected over a 20 to 60 year period for the various meteorological parameters.

The data indicate that February is the hottest month with a mean maximum temperature of 26.0 degrees Celsius (°C) and July is the coldest month with a mean minimum temperature of 6.6°C.

Rainfall is higher during the warmer months of the year and declines during the colder months, with an annual average rainfall of 1005.1 millimetres (mm) over 87.4 days. The data indicate that March is the wettest month with an average rainfall of 119.1mm over 9.1 days and September is the driest month with an average rainfall of 50.5mm over 6.0 days.

Relative humidity is relatively constant across the year. Mean 9am relative humidity ranges from 63% in September to 74% in February. Mean 3pm relative humidity levels range from 51% in August to 63% in February and March.

Wind speeds during the warmer months show a greater spread between the 9am and 3pm conditions compared to the colder months. Mean 9am wind speeds range from 7.3 kilometres per hour (km/h) in April to 9.9km/h in August. Mean 3pm wind speeds range from 9.3km/h in May to 14.9km/h in December.

Table 4-1: Monthly climate statistics summary - Lucas Heights (ANSTO)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (°C)	25.9	26.0	24.7	22.3	18.9	16.2	15.8	17.2	19.5	21.6	23.4	25.7	21.4
Mean min. temp. (°C)	17.4	17.6	16.1	13.3	10.1	8.2	6.6	7.4	9.4	11.9	13.7	15.9	12.3
Rainfall													
Rainfall (mm)	96.4	104.8	119.1	92.8	75.6	105.0	53.1	69.8	50.5	70.4	91.3	77.6	1005.1
No. of rain days (≥1mm)	7.9	8.4	9.1	7.2	6.8	7.6	5.4	5.6	6.0	7.6	8.3	7.5	87.4
9am conditions													
Mean temp. (°C)	21.3	21.4	20.3	17.8	14.1	11.6	10.5	12.0	14.6	17.2	18.8	20.6	16.7
Mean R.H. (%)	72	74	73	70	72	73	68	65	63	64	66	67	69
Mean W.S. (km/h)	8.5	7.9	7.4	7.3	7.7	8.5	8.3	9.9	9.5	9.8	9.4	8.9	8.6
3pm conditions													
Mean temp. (°C)	24.2	24.3	23.1	21.0	17.7	15.2	14.8	16.0	18.0	19.6	21.5	23.7	19.9
Mean R.H. (%)	62	63	63	58	58	61	52	51	52	57	57	57	57
Mean W.S. (km/h)	13.7	12.5	11.1	10.4	9.3	9.8	10.5	12.6	13.2	13.1	14.1	14.9	12.1

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

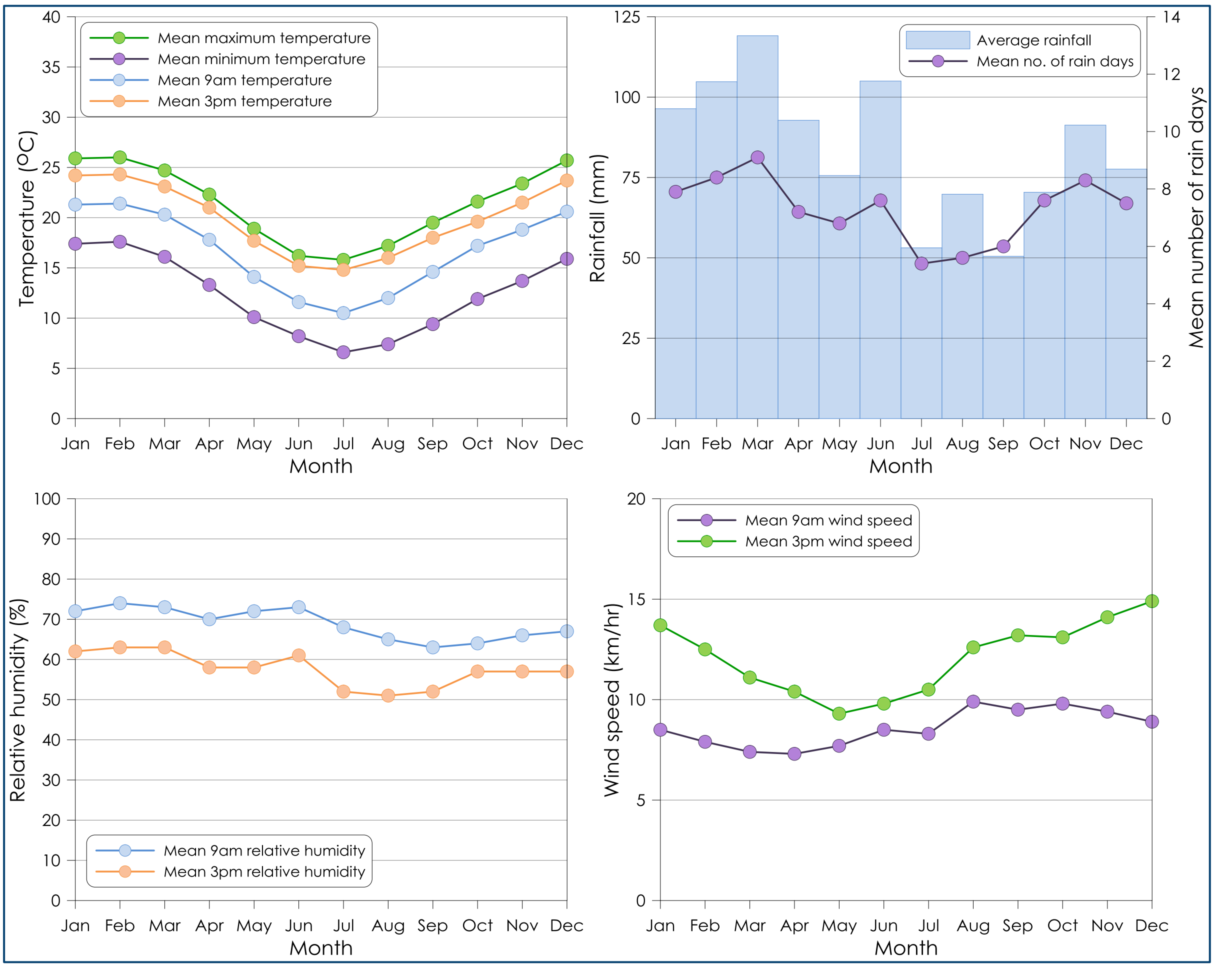

Figure 4-1: Monthly climate statistics summary - Lucas Heights (ANSTO)

4.2 Local meteorological conditions

Site specific meteorological data are not available to characterise the dispersion meteorology of the Project site and its surroundings. To generate the representative local meteorological data required for this assessment, the meteorological component of The Air Pollution Model (TAPM) was used in general accordance with the applicable NSW EPA guidelines (**NSW EPA, 2017**) for the 2010 calendar period.

TAPM predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analyses.

Figure 4-2 presents the annual and seasonal windroses (generated from TAPM output) for the Project site. On an annual basis, winds from the west and west-southwest are most frequent with a high proportion of winds from the south-southeast. In summer, winds from the southeast quadrant are predominant. Autumn and spring have a similar wind distribution to the annual distribution however spring experiences a higher proportion of winds from the northeast and east-northeast. In winter, westerly winds dominate in comparison to the other seasons. The annual average wind speed is 2.21m/s and the annual percentage of calms is 2.6%.

Table 4-2 presents a summary of the stability class distribution from the TAPM generated data. This distribution (Class A to Class F) is a measure of the turbulence of the atmosphere with Class A associated with highly unstable or turbulent conditions and Class F related to stable conditions, typically at night. The relatively high frequency of Class E and Class F combined (28%) suggests that emissions will disperse slowly for much of the time.

Table 4-2: Stability class distribution (TAPM - 2010)

Stability Class	Frequency of Stability Class Occurrence (%)
A	0.2
B	2.6
C	15.2
D	54.1
E	13.8
F	14.2

Figure 4-2: Annual and seasonal windroses - TAPM

4.3 Local air quality

Site-specific air quality monitoring data are not available to quantify existing airborne particulate matter concentrations at the site.

Monitoring data from the NSW Office of Environment and Heritage (OEH) Liverpool monitoring site which measures PM_{10} and $PM_{2.5}$ concentrations using a Tapered Element Oscillating Microbalance (TEOM) and a Beta Attenuation Monitor (BAM) have been used to characterise the ambient air quality. The NSW OEH monitor is located approximately 10km northwest of the Project.

As the Liverpool monitoring site is closer to traffic and industry, it is likely that the data would overestimate the actual background levels at the Project site. The data used therefore represent a conservative background level.

4.3.1 PM_{10} concentrations

A summary of the monthly PM_{10} monitoring data from 2008 to 2012 is presented in **Table 4-3**. The monitoring data show the annual average PM_{10} concentrations are below the 25µg/m^3 criterion for all years reviewed. The monthly maximum 24-hour average PM_{10} concentrations at this site exceeded the criterion of 50µg/m^3 on five occasions occurring during 2008, 2009 and 2011.

During November 2008, the site recorded a maximum 24-hour average PM_{10} concentration of 53.8µg/m^3, an investigation into the possible cause failed to determine the reason for this event however it may been due to a localised source as other EPA monitors in the area recorded lower levels.

During 2009, exceedences were recorded in April, September and November; these were most likely due to widespread dust storms occurring during these months in 2009.

During November 2011, the site recorded a maximum 24-hour average PM_{10} concentration of 68.8µg/m^3, an investigation into this event indicated a possible regional event as other nearby EPA monitors also recorded similar elevated readings.

Table 4-3: Summary of 24-hour PM_{10} monitoring from Liverpool monitoring site (µg/m^3)

Year / Month	2008		2009*		2010		2011		2012	
	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.
Jan	31.1	20.1	32.3	20.5	37.1	23.1	37.8	20.4	40.1	19.9
Feb	30.1	15	33.3	16.7	25.3	17.1	46.3	20.5	27.4	15.6
Mar	26	16.7	33.9	18.5	35.8	19.6	30.9	15.9	24.1	17.1
Apr	29.9	14	**117.4**	23.3	30.3	16.3	17.9	11.7	32.7	17.8
May	32.3	20.2	39.6	23.1	26.7	16.6	ND	ND	39.3	21.6
Jun	26.7	14.3	33.1	17.5	26.8	15.2	ND	ND	25.5	15.4
Jul	39.2	17.3	27	15.5	26.2	15	18.7	12.9	30.1	15.7
Aug	29.3	13.7	38.9	22.7	26.2	13.4	36.9	17.9	37.2	20.4
Sep	40.2	21.7	**1579.8**	79.4	32.2	16.4	46	21.5	38	21.6
Oct	ND	ND	42.7	17.8	24.2	15.5	32.8	18.3	42.5	23.6
Nov	**53.8**	20.1	109.3	31.1	41.1	17.6	**68.8**	21.9	39	23.8
Dec	34.1	19.9	40.7	21	30	18.6	22.2	15.6	36.7	23.9
Annual	**53.8**	**17.5**	**1579.8**	**25.6**	**41.1**	**17**	**68.8**	**17.7**	**42.5**	**19.7**

ND - no data

*Data affected by regional dust storms

4.3.2 $PM_{2.5}$ concentrations

A summary of the annual average $PM_{2.5}$ monitoring data from 2008 to 2012 is presented in **Table 4-4**. The monitoring data show the annual average $PM_{2.5}$ concentrations are on occasion above the 8µg/m^3 criterion.

As $PM_{2.5}$ particles are typically generated through combustion processes or as secondary particles formed from chemical reactions rather than through mechanical processes such as the abrasion and crushing of rock, the potential causes of the elevated annual average $PM_{2.5}$ levels are most likely due to local anthropogenic sources (such as motor vehicle exhaust and wood heaters) and also contributions from bushfire events.

Table 4-4: Summary of annual average $PM_{2.5}$ monitoring from Liverpool monitoring site (µg/m³)

Year	Liverpool
2008	6.5
2009	8.3
2010	6.3
2011	5.9
2012	8.5

4.3.3 TSP and deposited dust

There are no available site-specific TSP and deposited dust monitoring data. The EPA monitoring site does not measure these components. However, estimates of the background levels for the site are required to assess any potential impacts.

Estimates of the annual average background TSP concentrations have been determined from a relationship between measured PM_{10} concentrations. This relationship assumes that 40% of the TSP is PM_{10} and was established as part of a review of ambient monitoring data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**).

Applying this relationship with the annual average PM_{10} concentration of 17µg/m^3 from the Liverpool monitor, estimates an annual average TSP concentration of 42.5µg/m^3.

To estimate annual average dust deposition levels, a similar process to the method used to estimate TSP concentrations is applied. This approach assumes that a TSP concentration of 90µg/m^3 will have an equivalent dust deposition value of 4g/m^2/month.

This relationship indicates a background annual average dust deposition of 1.9g/m^2/month for the area surrounding the Project site.

4.3.4 Summary of background air quality levels

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

- PM_{10} concentrations: 17µg/m^3;
- $PM_{2.5}$ concentrations: 6.3µg/m^3;
- TSP concentrations: 42.5µg/m^3; and
- Deposited dust levels: 1.9g/m^2/month.

5 DISPERSION MODELLING APPROACH

5.1 Modelling methodology

Air dispersion modelling of the likely dust emission sources identified for the Project was conducted to predict potential air quality impacts in the surrounding environment.

The AUSPLUME dispersion model, in conjunction with a TAPM generated meteorological data file (described in **Section 4.2**), provides predictions of the ground level concentrations of PM_{10}, $PM_{2.5}$, TSP and dust deposition based on the dust emission estimations provided in the following section.

Dust emissions from each significant activity were represented by a series of volume sources and were included in the AUSPLUME 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.

As a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions was not applied.

5.2 Estimated dust emissions

The significant dust generating activities associated with operation of the Project are identified as: drilling and blasting, loading/unloading of material, vehicles travelling on-site, and windblown dust generated from exposed areas and stockpiles.

This assessment considers a worst-case scenario and applies conservative assumptions. For example, it has been assumed that wind erosion would occur from the entire site area, whereas the sealed and undisturbed parts of the site would generate little dust.

Dust emission estimations from each activity were determined using recognised Australian and US emission factors. **Table 5-1** presents the estimated TSP emissions for the operations. Where applicable, dust mitigation controls have been applied in emission estimation.

Further details regarding each of the emission estimation techniques applied to estimate the TSP emissions are provided in **Appendix A**, which also identifies the control effectiveness of the dust mitigation measures that have been applied in the emission estimation.

Table 5-1: Estimated dust emissions for the Project (kg/year)

Activity	TSP emission
Drilling sandstone material	211
Blasting sandstone material	68
Excavator removing sandstone material	573
Loading sandstone material to trucks	573
Hauling sandstone material to stockpile	3,170
Unloading sandstone material to stockpile	573
Loading sandstone material to crusher	573
Crushing sandstone material	240
Screening sandstone material	440
Unloading processed sandstone to stockpile	573
Rehandle materials and miscellaneous sources	573
Loading processed sandstone to trucks	573
Hauling processed sandstone off-site	5739
Wind erosion from active quarry area	41,084
Wind erosion from inactive quarry area	26,411
Wind erosion from vegetated quarry area	2,348
Total	**83,723**

6 DISPERSION MODELLING RESULTS

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 that were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) in the one year long modelling period. The predictions do not represent just one particular day, but a combination of days and is an overestimation of what would actually occur.

6.1 Dust concentrations

Figure 6-1 to **Figure 6-6** present isopleths of the spatial distribution of predicted incremental impacts associated with the operation of the Project.

Figure 6-7 to **Figure 6-10** present isopleths of the spatial distribution of predicted cumulative (total) impacts associated with the operation of the Project. The cumulative impact is defined as the modelled impact associated with the operation of the Project combined with the ambient background levels as determined in **Section 4.3.4**.

Table 6-1 presents the particulate dispersion modelling results at each receptor shown in **Figure 2-1**. The results show minimal incremental effects would arise at the receptor locations due to the Project.

Table 6-1: Particulate dispersion modelling results for discrete receptors

Receptor ID	$PM_{2.5}$ (µg/m³)		PM_{10} (µg/m³)		TSP (µg/m³)	DD (g/m²/mth)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	TSP (µg/m³)	DD (g/m²/mth)
	Project alone						Total impact			
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	25	-	50	-	-	2	8	25	90	4
R1	3.1	0.2	10.1	1.0	1.5	0.2	6.5	18.0	44.0	2.1
R2	2.4	0.2	16.6	1.1	1.8	0.2	6.5	18.1	44.3	2.1
R3	2.7	0.2	15.5	1.0	1.7	0.2	6.5	18.0	44.2	2.1
R4	2.9	0.2	16.0	1.1	1.8	0.3	6.5	18.1	44.3	2.2
R5	0.8	0.0	2.7	0.2	0.3	0.0	6.3	17.2	42.8	1.9
R6	0.9	0.0	3.8	0.2	0.2	0.0	6.3	17.2	42.7	1.9
R7	0.9	0.1	3.2	0.3	0.3	0.0	6.4	17.3	42.8	1.9
R8	1.3	0.1	5.8	0.4	0.4	0.1	6.4	17.4	42.9	2.0
R9	1.6	0.1	5.3	0.3	0.4	0.1	6.4	17.3	42.9	2.0
R10	3.4	0.1	10.8	0.6	0.8	0.1	6.4	17.6	43.3	2.0
R11	3.0	0.1	9.5	0.4	0.6	0.1	6.4	17.4	43.1	2.0

A range of conservative assumptions have been applied in the emissions inventory and modelling which would overestimate the likely levels of dust emissions. Even with a range of conservative assumptions applied, the dust dispersion modelling results show that there will be minimal impacts at nearby sensitive receptors.

This is clearly shown in the right hand side of **Table 6-1** where the background monitoring data collected at the NSW EPA Liverpool monitoring site is added to the predicted levels to assess potential cumulative impacts at the discrete receptors.

The predicted cumulative annual average PM_{10}, TSP and dust deposition levels would be below the relevant EPA criteria at all receptors.

The results show that the Project would make only a marginal difference to cumulative 24-hour PM_{10} levels at the nearest, most affected receptor locations and the potential future receptor locations in the proposed Heathcote Ridge development.

Cumulative 24-hour average PM_{10} requires more detailed assessment, which is presented in **Section 6.2**.

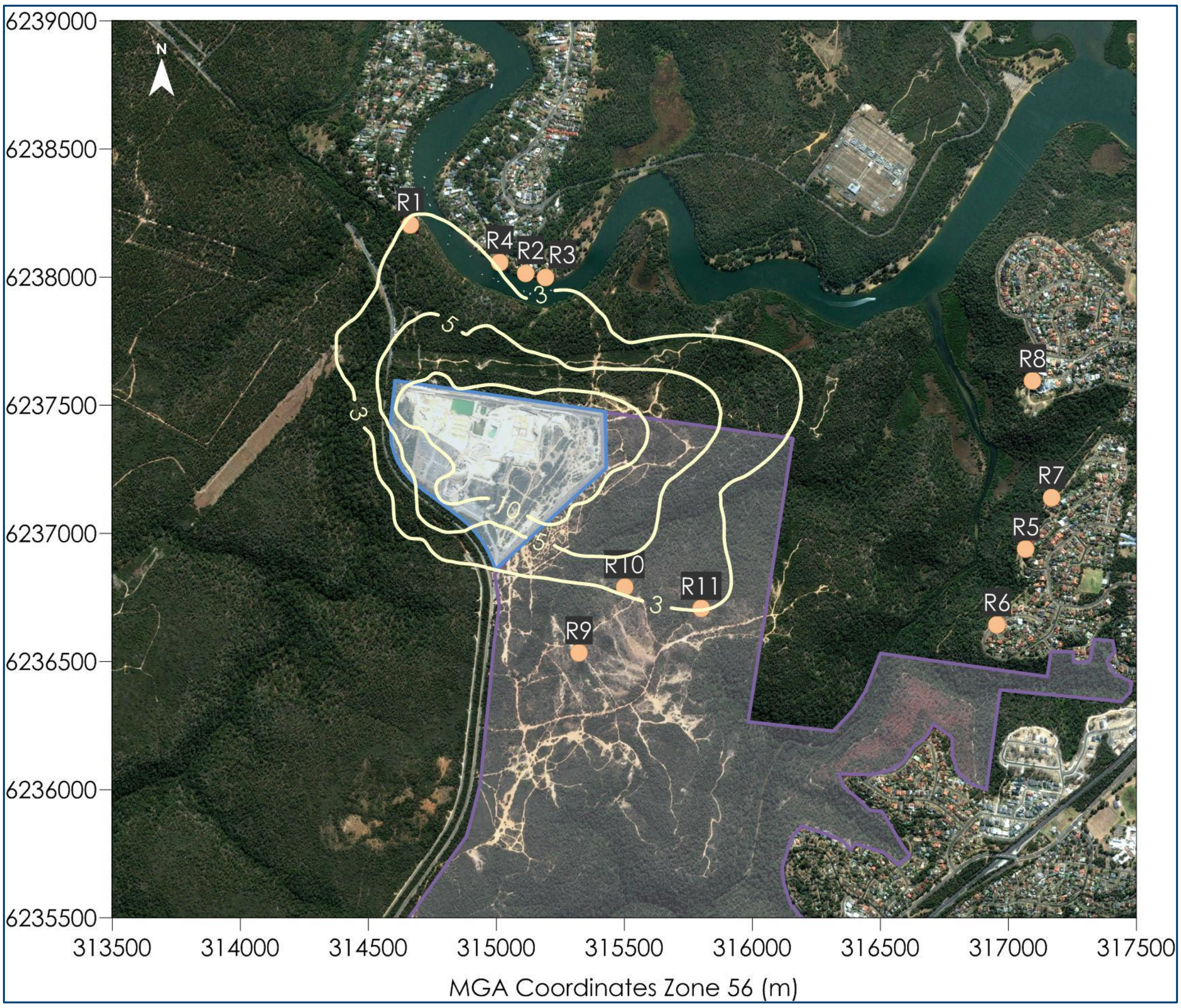

Figure 6-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations ($\mu g/m^3$)

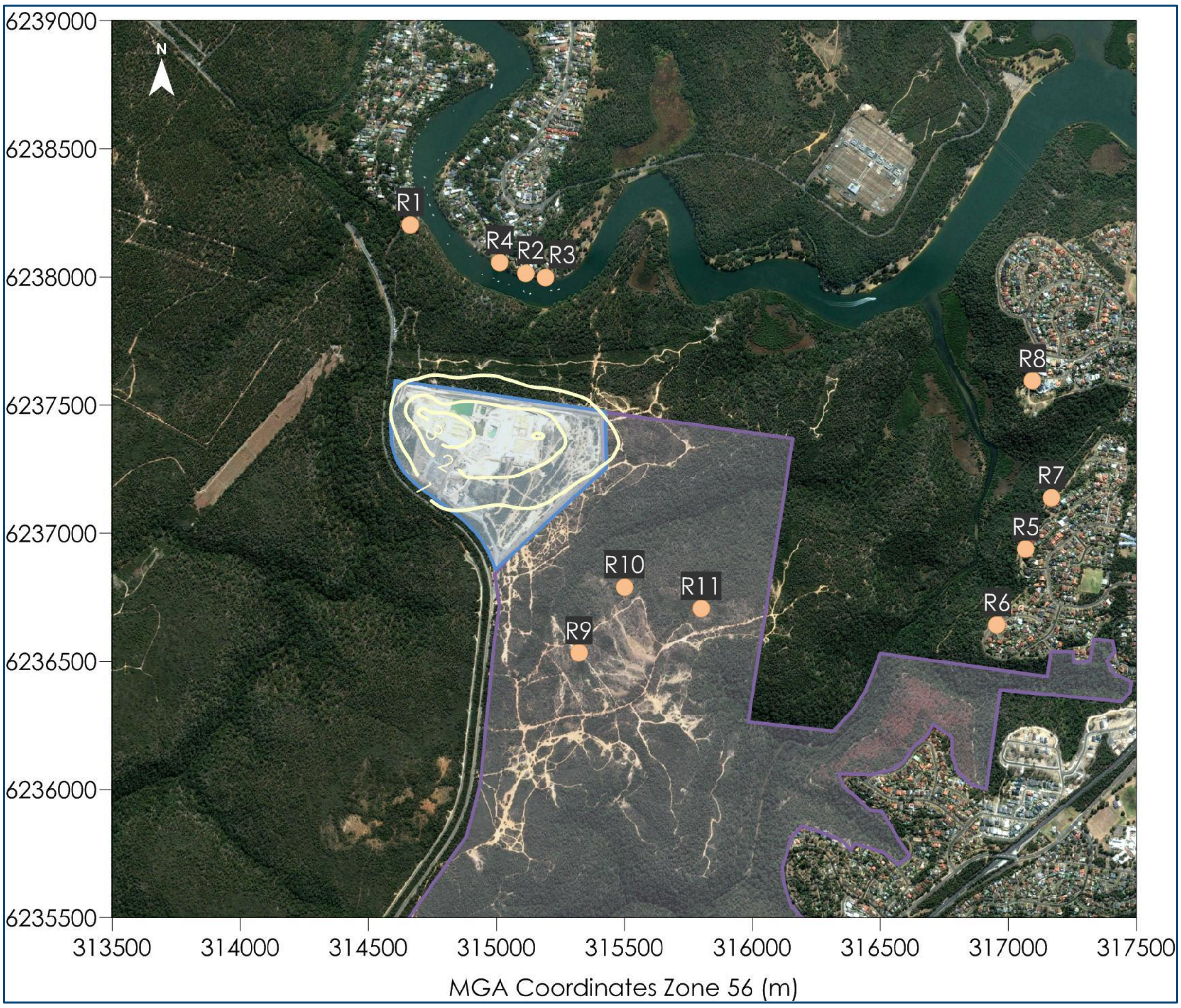

Figure 6-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

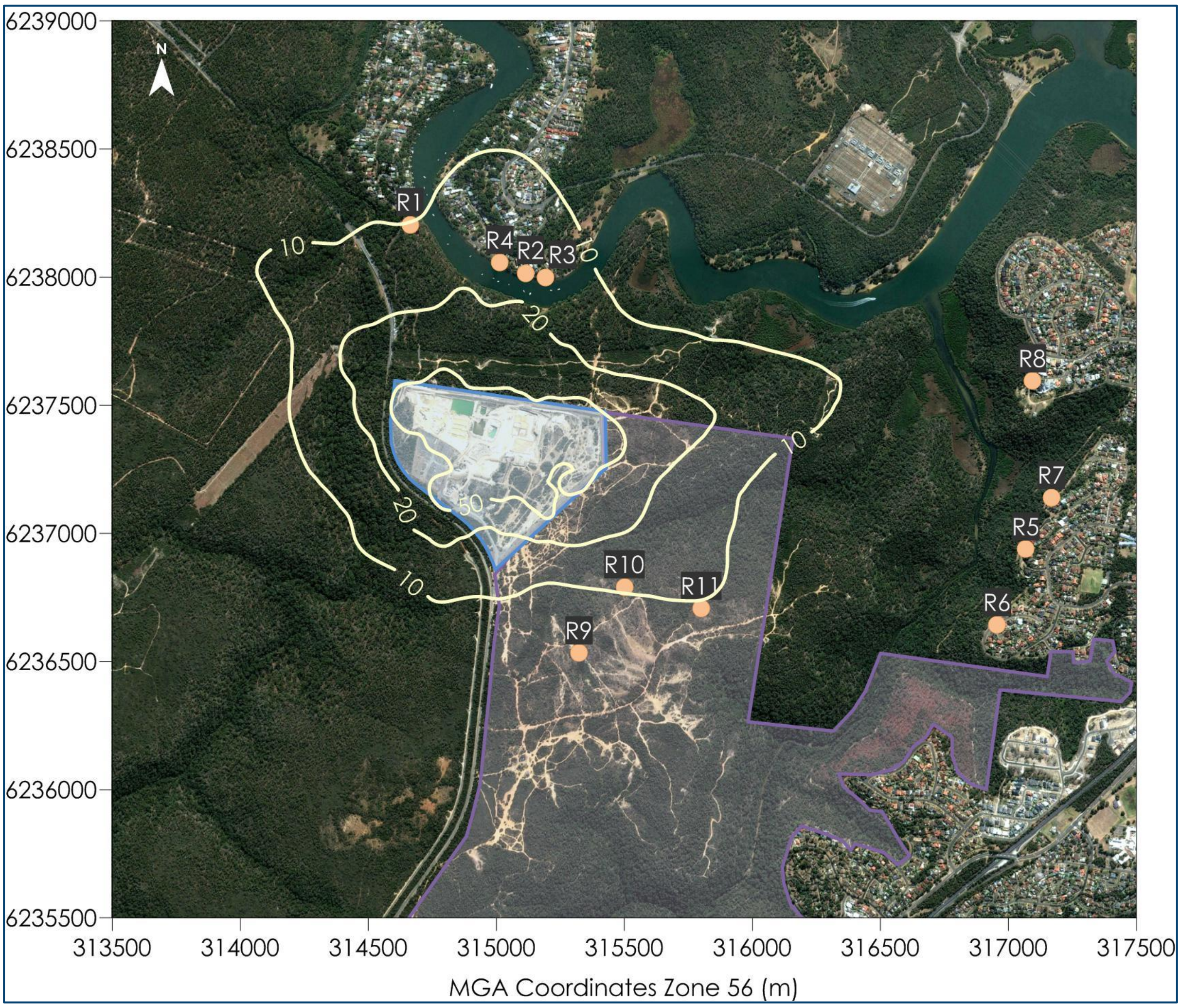

Figure 6-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

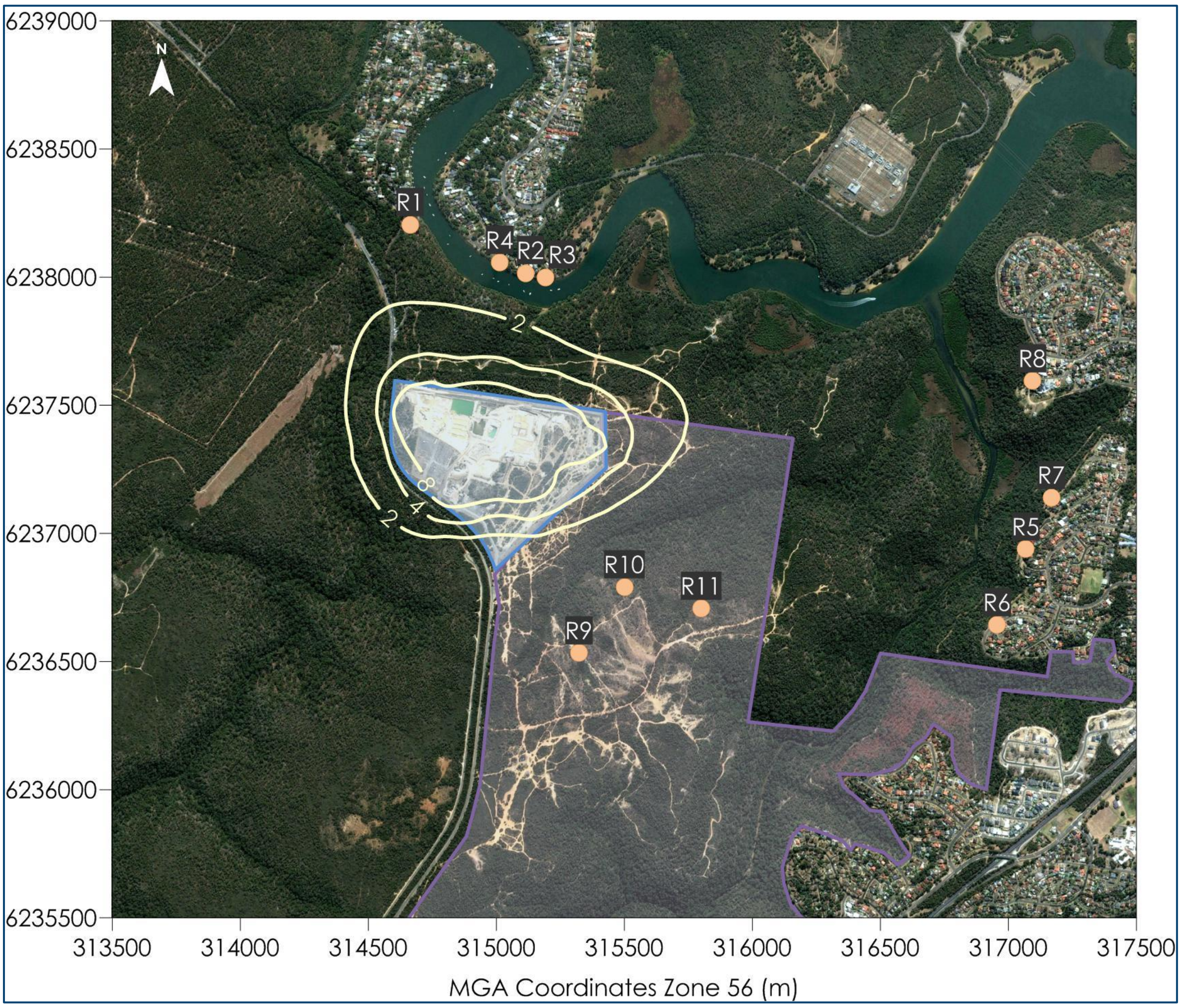

Figure 6-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

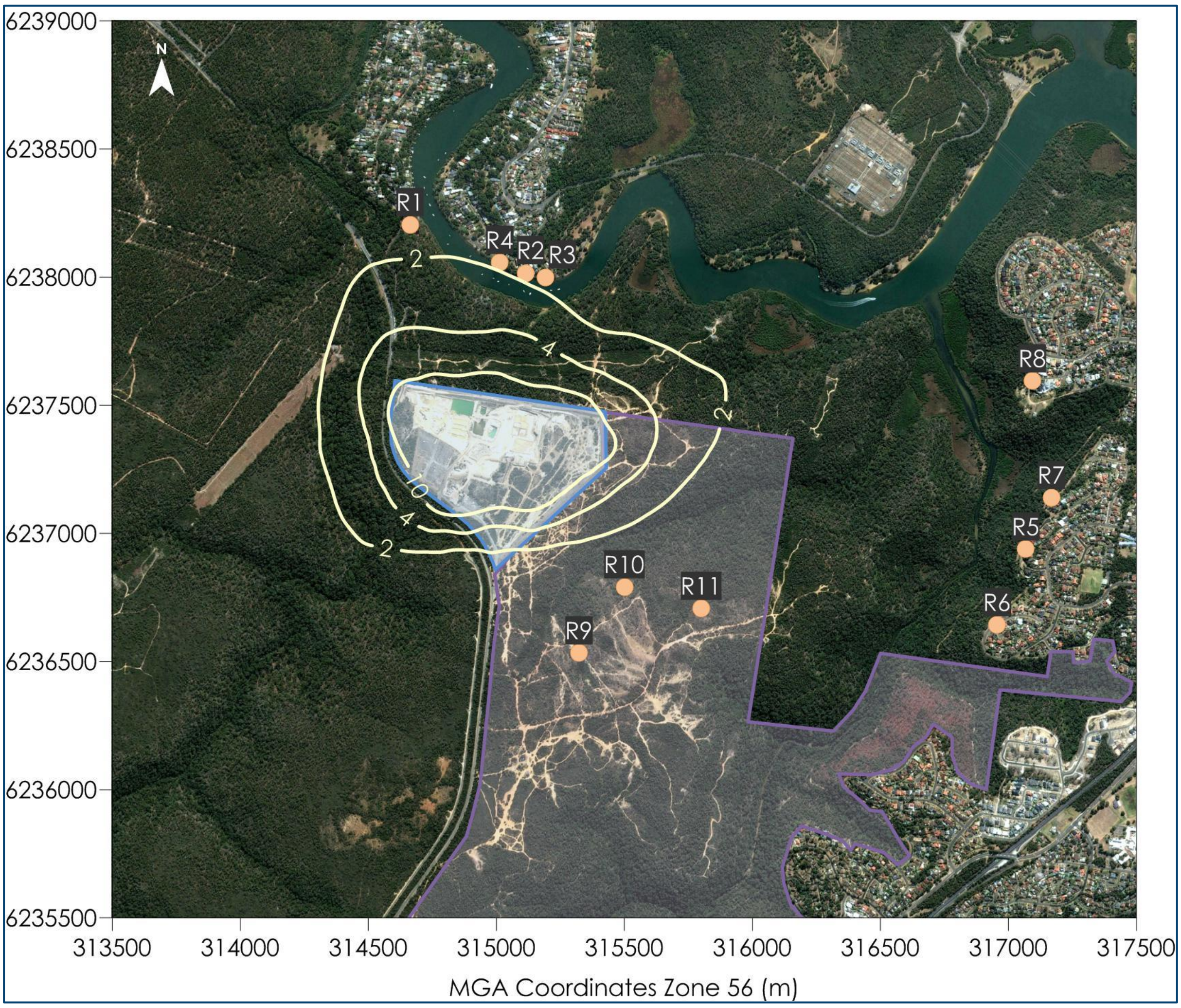

Figure 6-5: Predicted incremental annual average TSP concentrations (µg/m³)

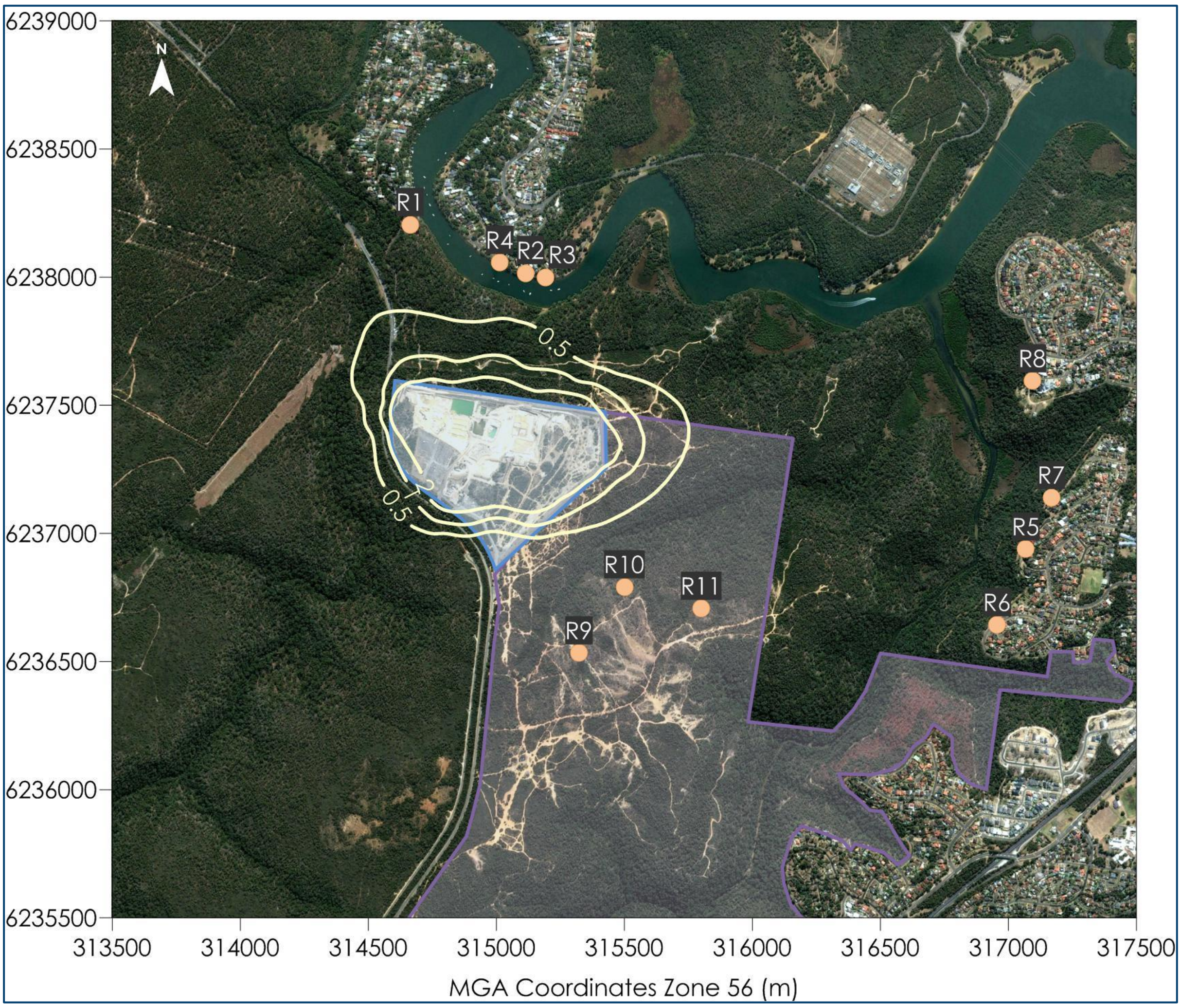

Figure 6-6: Predicted annual average dust deposition levels (g/m²/month)

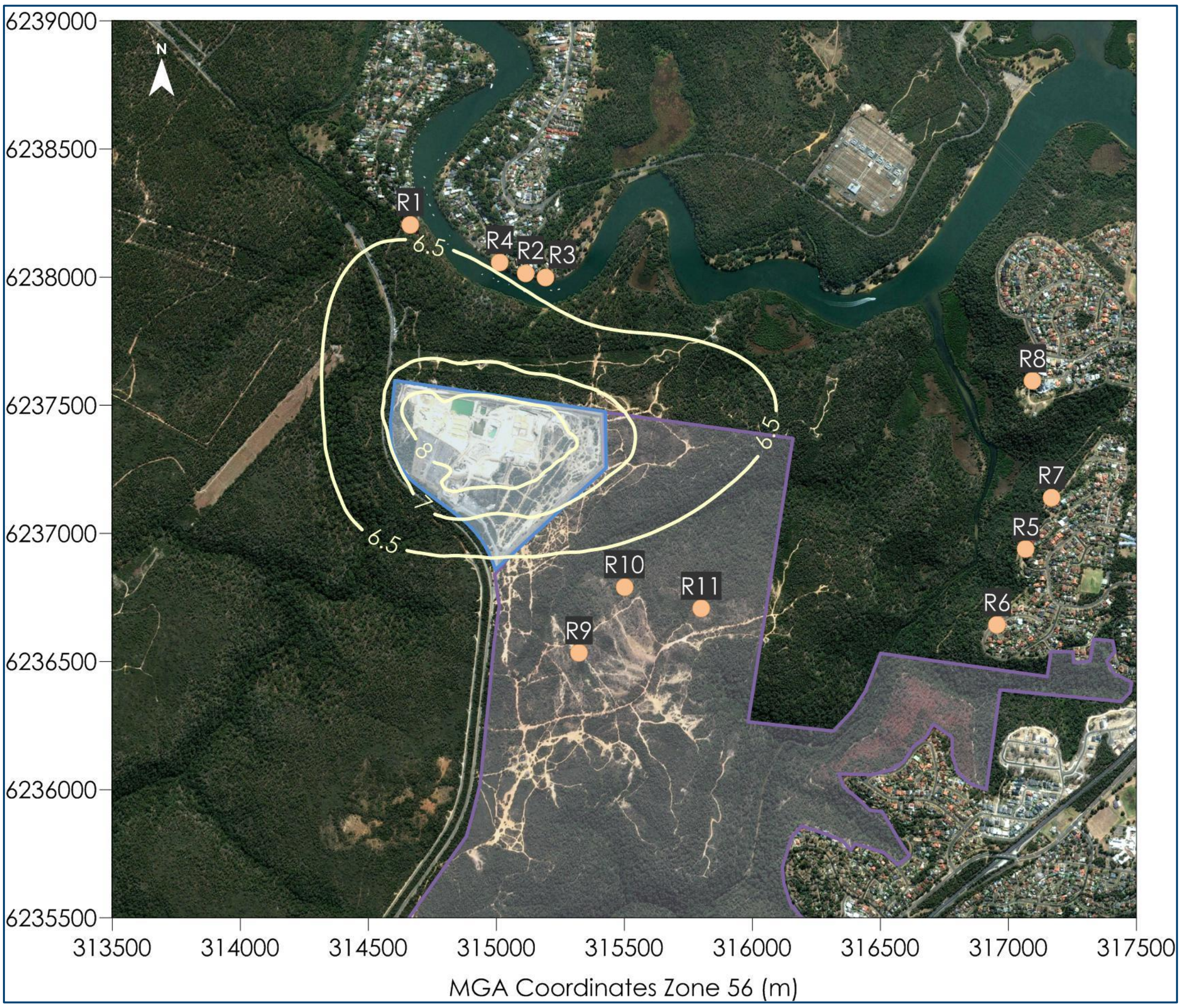

Figure 6-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

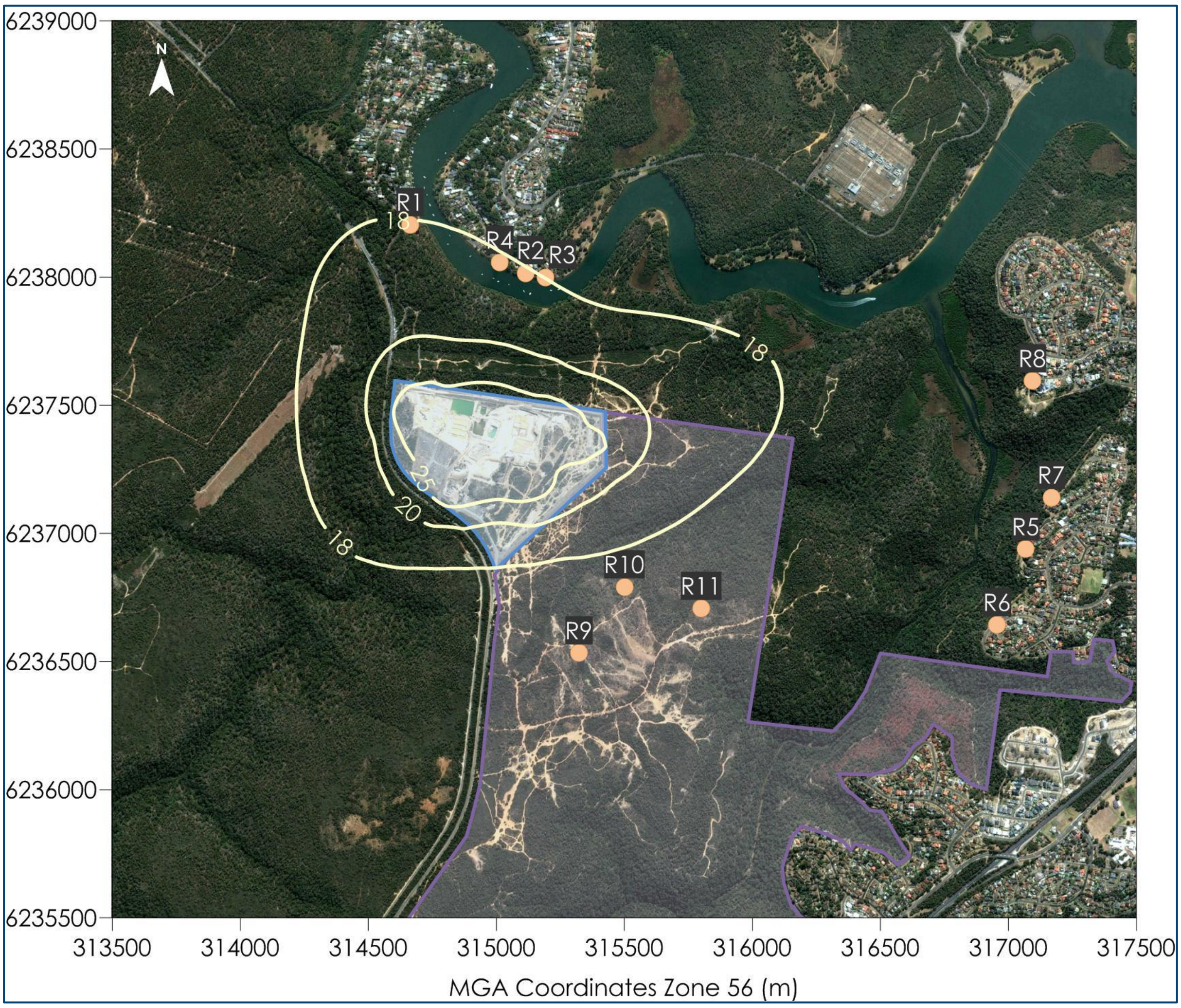

Figure 6-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

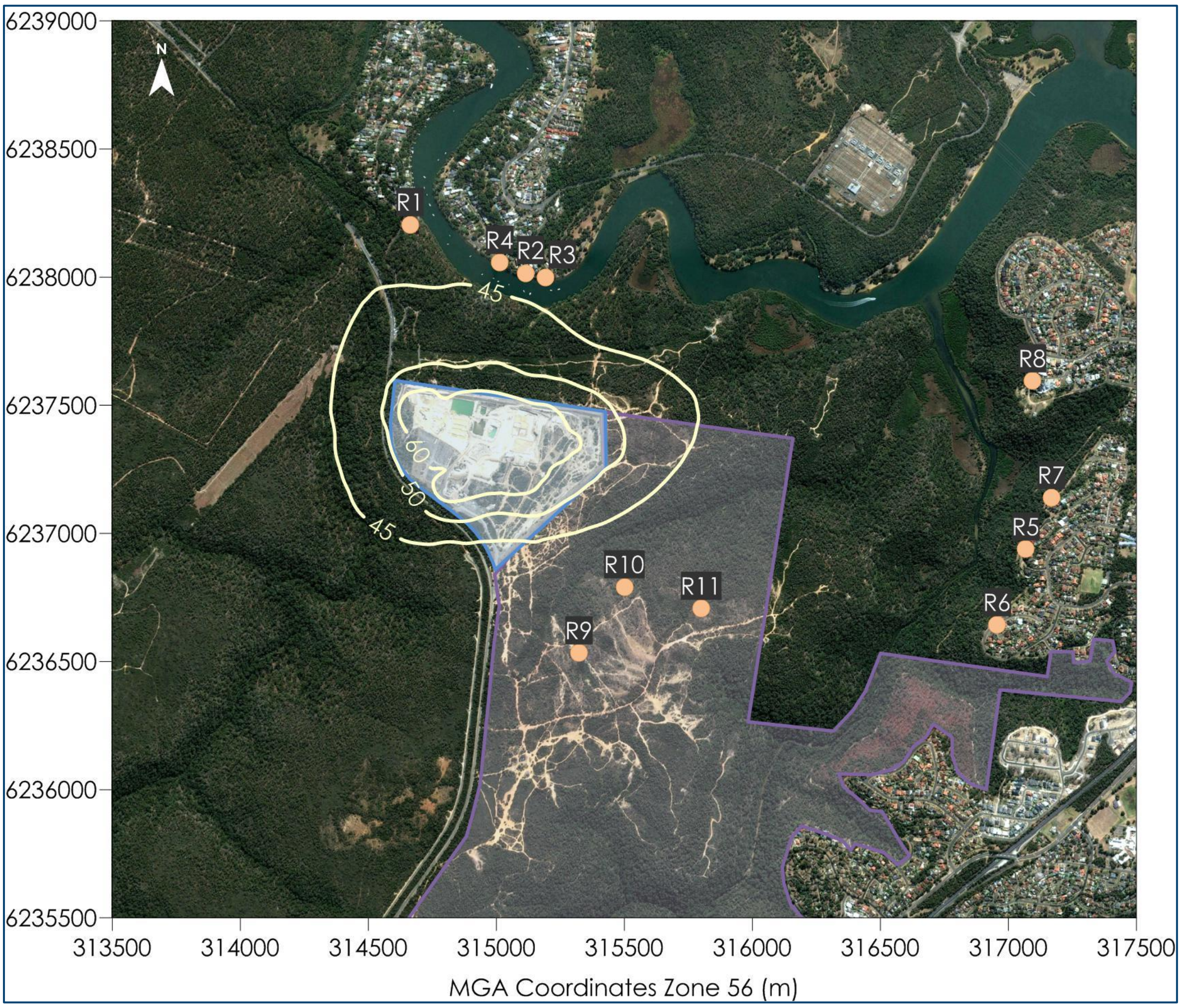

Figure 6-9: Predicted cumulative annual average TSP concentrations (µg/m³)

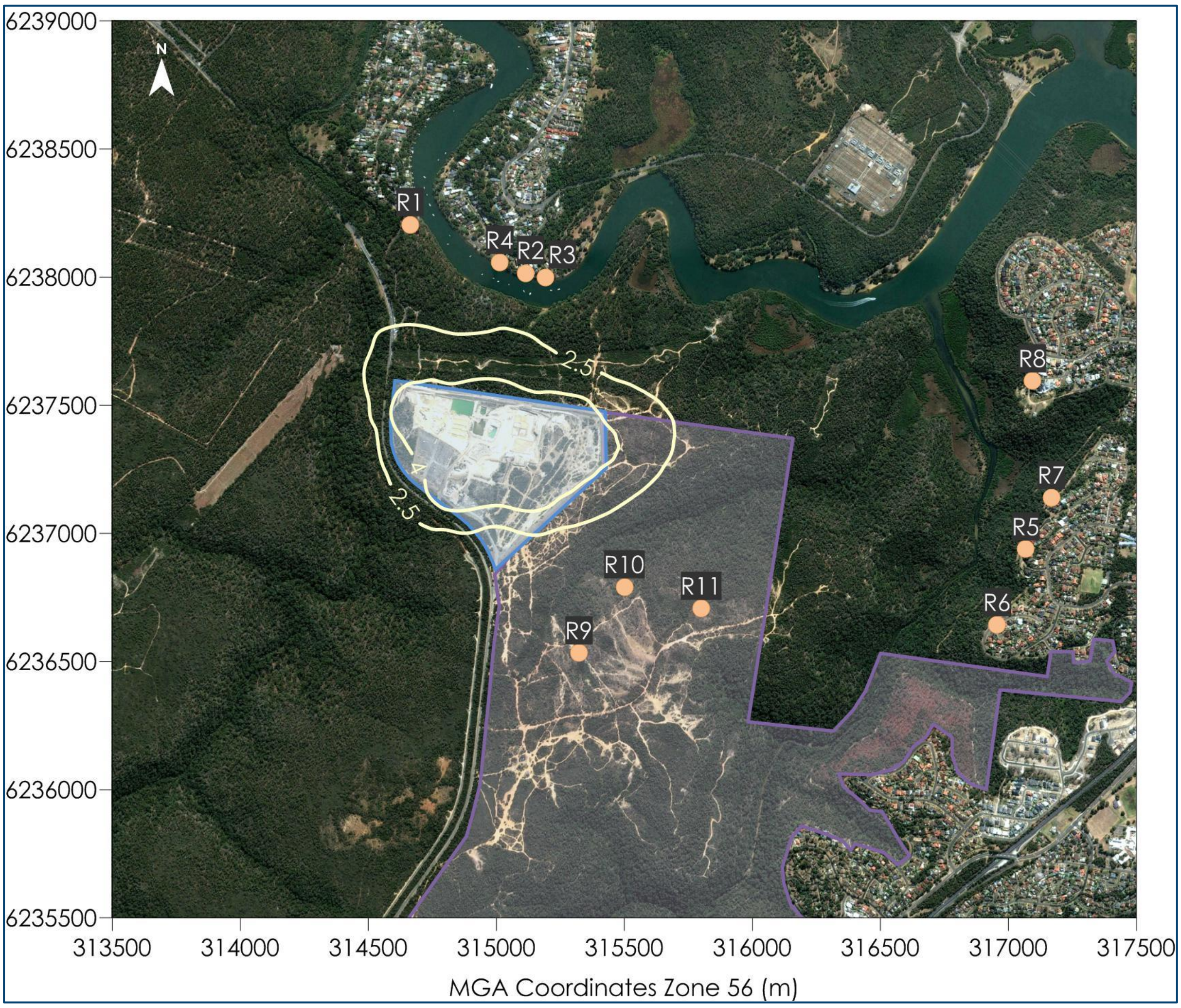

Figure 6-10: Predicted cumulative annual average dust deposition level (g/m^2/month)

6.2 Assessment of total (cumulative) 24-hour average PM_{10} and $PM_{2.5}$ concentrations

Assessment of cumulative 24-hour average PM_{10} and $PM_{2.5}$ impacts requires further and more detailed analysis of background conditions and the projected incremental impacts due to the Project.

Therefore, the NSW EPA contemporaneous assessment method as outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**) was applied to examine the potential maximum total (cumulative) 24-hour average PM_{10} impacts for the Project.

The method involves adding the predicted incremental impact of the Project to each day's measured background levels. This method accounts for the highly varying background dust level on any given day, and also the effects of the weather conditions on each day in regard to a Project's emissions.

Monitoring data from the NSW EPA monitoring site at Liverpool was used in this assessment. This would provide a conservative estimate as this monitor is located closer to traffic and industry, and it is likely that the data would overestimate the actual background levels at the Project.

The NSW EPA approach was applied at each individual receptor location. The background data were comprised of the measured levels at the nearest EPA monitoring station. In addition to this, the contribution that would arise from the Project was added to determine the total. This was done for each day of a full year. Detailed tables of the full assessment results for selected receptors are provided in **9Appendix B**.

Table 6-2 provides a summary of the findings from the contemporaneous assessment and presents the maximum number of additional days on which the 24-hour average PM_{10} and $PM_{2.5}$ criterion would be exceeded at the surrounding receptors due to the background dust levels, the Project.

Table 6-2: Summary of NSW EPA contemporaneous assessment

Receptor ID	Number of additional days above 24-hour average PM_{10} criterion	Number of additional days above 24-hour average $PM_{2.5}$ criterion
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0	0

As there are zero additional days on which impacts are predicted, in order to show a meaningful analysis of the potential effects on air quality of the Project, an examination of the potential PM_{10} dust levels on each day of the year relative to the background data was conducted at the two receptors. These are Receptor 2 located to the north and Receptor 10 representing the nearest area of the proposed new Heathcote Ridge development. It is important to note that no impacts are predicted to occur at these most affected locations.

Figure 6-11 and **Figure 6-12** present a time series plot of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations predicted to be experienced at Receptor 2 and Receptor 10 due to the Project (shown in bright pink in the figures). The grey bars show background levels.

These figures indicate that any measureable increase in dust levels from the Project would only occur on infrequent occasions at these receptors, and that the overall effect would be very low relative to the existing background levels.

Figure 6-11: Predicted 24-hour average PM_{10} concentrations for Receptor 2

Figure 6-12: Predicted 24-hour average PM_{10} concentrations for Receptor 10

7 DUST MITIGATION MEASURES

The activities at the Project will generate dust, therefore it is prudent to take reasonable and practicable measures to prevent or minimise dust emissions to the surrounding environment.

The Project will apply a range of mitigation measures to achieve a standard of operation consistent with current best practice for the control of dust emissions from such an operation.

A summary of the key dust controls that would be applied to the Project is presented in **Table 7-1**. Further details provided in **Appendix A** identify the control effectiveness of the proposed dust mitigation measures (where such controls can be factored into the emissions estimates).

Table 7-1: Best practice dust mitigation measures

Source	Control Procedure
Exposed areas	✦ Rehabilitate any unused quarry areas as soon as practicable. ✦ Use water sprays where feasible to minimise dust lift-off.
Traffic on unsealed roads	✦ Surface maintenance of unsealed roads. ✦ Watering of road surfaces and manoeuvring areas using permanent sprinkler system. ✦ Restrict vehicle speeds with speed limits. ✦ Trafficable areas clearly marked; vehicle movement restricted to these areas. ✦ Trafficable areas and vehicle manoeuvring areas maintained.
Stockpiles	✦ Watering of dusty stockpiles to minimise dust lift-off where required. ✦ Ensure that exceptionally dusty material is sufficiently wetted prior to handling. ✦ Minimise drop heights when unloading dusty material. ✦ Manual implementation of water sprays and/or water cart during dusty periods.
Handling and processing material	✦ Ensure that exceptionally dusty material is sufficiently moist prior to handling using water sprays where applicable. ✦ Minimise the distance fall of materials during loading and unloading. ✦ Modify operations during high dust generations periods if visible dust is crossing the quarry boundary.

8 SUMMARY AND CONCLUSIONS

This report has assessed the potential dust impacts associated with the proposed increase of the existing threshold for extractive activities, crushing, grinding and separating production at the Sandy Point Quarry.

Dispersion modelling with the AUSPLUME model was used to predict the potential of off-site dust impacts in the surrounding area due to the Project.

The assumptions used in the estimation of emissions and also in the approach to modelling are conservative, and therefore the predicted levels provide a conservative estimate of potential impact (i.e. the actual levels are expected to be lower than the predictions).

It is predicted that emissions of $PM_{2.5}$, PM_{10}, TSP and dust deposition will comply with the applicable assessment criteria at all existing and proposed future receptor areas and would therefore not lead to any unacceptable level of environmental harm or impact on the amenity of the area.

Nevertheless, the site will apply appropriate dust management measures to minimise the potential occurrence of excessive dust emissions from the site.

Overall, the assessment shows that the Project can operate without causing any discernible air quality impact at the sensitive receptors in the surrounding environment.

9 REFERENCES

Bureau of Meteorology (2019)

Climatic Averages Australia, Bureau of Meteorology website [*http://www.bom.gov.au/climate/averages*]

NSW EPA (2017)

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

NSW Minerals Council (2000)

"Technical Paper – Particulate Matter and Mining Interim Report".

SPCC (1983)

"Air Pollution from Coal Mining and Related Developments", State Pollution Control Commission.

Todoroski Air Sciences (2016)

"Air Quality Impact Assessment Proposed Inert Materials Recycling Activity in the Existing Sandy Point Quarry, Menai". Prepared by Todoroski Air Sciences for Benedict Industries Pty Ltd, April 2016.

US EPA (1985 and updates)

"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. Note this reference is now a web-based document.

Appendix A
Emission Inventory

<u>Emission Calculation</u>

The dust emissions from the proposed Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations 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 the US EPA AP42 Emission Factors (**US EPA, 1985 and Updates**) and the State Pollution Control Commission document "*Air Pollution from Coal Mining and Related Developments*" (**SPCC, 1983**).

The emission factor equations used for each dust generating activity are outlined in **Table A-1** below. Detailed emission inventory is presented in **Table A-2.**

Table A-1: Emission factor equations

Activity	Emission factor equation	Variable	Control	Source
Drilling	**EF = 0.59 kg/hole**	-	70% - dust suppression	US EPA, 1985
Blasting	**EF = 0.00022 x $A^{1.5}$ kg/blast**	A = average area of blast (m^2)	-	US EPA, 1985
Loading / emplacing material	**EF = k x 0.0016 x [$(U/2.2)^{1.3}$ / $(M/2)^{1.4}$] kg/tonne**	Ktsp = 0.74 U = wind speed (m/s) M = moisture content (%)	-	US EPA, 1985
Hauling on unsealed surfaces	**EF = $k(s/12)^a$ x $(W/3)^b$ lb/VMT**	K = 4.9 (lb/VMT) s = surface material silt content (%) W = average weight of vehicle (tons)	75% - watering trafficked areas	US EPA, 1985
Crushing material	**EF = 0.0027 kg/Mg**	-	-	US EPA, 1985
Screening material	**EF = 0.0125 kg/Mg**	-	-	US EPA, 1985
Wind erosion	**EF = 0.4 kg/ha/hour**	-	50% - watering 90% - avoidance and stabilisation	SPCC, 1983

Table A-2: Emissions Inventory

ACTIVITY	TSP emission	Intensity	Units	Emission Factor - TSP	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units	Variable 4	Units	Variable 5	Units	Variable 6	Units
Drilling sandstone material	211	1190	holes/yr	0.59	kg/hole											70	% Control
Blasting sandstone material	68	7	blasts/yr	9.72	kg/blast	1250	Area of blast m^2										
Excavator removing sandstone material	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Loading sandstone material to trucks	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Hauling sandstone material to stockpile	3,170	400,000	t/yr	0.032	kg/t	30	tonnes/load	30	GVM (t)	0.3	km	3.33	kg/VKT	9	S.C. %	75	% Control
Unloading sandstone material to stockpile	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Loading sandstone material to crusher	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Crushing sandstone material	240	400,000	t/yr	0.0006	kg/Mg												
Screening sandstone material	440	400,000	t/yr	0.0011	kg/Mg												
Unloading processed sandstone to stockpile	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Rehandle materials and miscellaneous sources	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Loading processed sandstone to trucks	573	400,000	t/yr	0.0014	kg/t	1.21	ave. of $(U/2.2)^{1.3}$	2	M.C. %								
Hauling processed sandstone off-site	5739	400,000	t/yr	0.057	kg/t	32	tonnes/load	33	GVM (t)	0.5	km	3.45	kg/VKT	9	S.C. %	75	% Control
Wind erosion from active quarry area	41,084	11.7	ha	0.4	kg/ha/hr	8760	hours										
Wind erosion from inactive quarry area	26,411	15.1	ha	0.4	kg/ha/hr	8760	hours									50	% Control
Wind erosion from vegetated quarry area	2,348	6.7	ha	0.4	kg/ha/hr	8760	hours									90	% Control
Total	**83,723**																

Appendix B

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

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

The background level is the total ambient measured level at the nearest monitoring station to the receptor assessed in each table.

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

The total is the sum of the background level and the predicted level.

Each table assesses one receptor. The left hand half of the table examines the cumulative impact during the periods of highest background levels and the right hand side of the table examines the cumulative impact during the periods of highest contribution from the Project.

Tables B-1 to **B-2** show the predicted maximum $PM_{2.5}$ and PM_{10} cumulative levels for Receptor 2 and **Tables B-3** to **B-4** show the predicted maximum $PM_{2.5}$ and PM_{10} cumulative levels for Receptor 10.

There are no days in the year assessed that have higher total levels than those shown in the tables.

The results show that:

1. No exceedance of the $PM_{2.5}$ and PM_{10} cumulative levels is predicted to arise due to the Project; and,
2. The contribution to dust levels from the Project are low on the days with the highest background level.

Table B-1: Cumulative 24-hour average $PM_{2.5}$ concentrations (µg/m³) - Receptor 2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment
27/03/2010	21.8	0.1	21.9	3/08/2010	4	2.4	6.4
27/11/2010	20.9	0.0	20.9	31/05/2010	3.2	2.4	5.6
20/03/2010	18.1	0.0	18.1	6/02/2010	1.6	2.3	3.9
26/03/2010	17.7	0.1	17.8	19/11/2010	5.9	1.9	7.8
23/04/2010	17.7	0.0	17.7	31/03/2010	1.4	1.2	2.6
28/04/2010	16.1	0.0	16.1	4/06/2010	2.6	1.2	3.8
1/09/2010	15.6	0.0	15.6	6/06/2010	2.7	1.2	3.9
21/03/2010	15.4	0.3	15.7	24/10/2010	2.8	1.2	4.0
29/06/2010	15.1	0.0	15.1	27/12/2010	3.6	1.0	4.6
28/03/2010	14.6	0.2	14.8	21/07/2010	7.7	1.0	8.7

ND – No data

Table B-2: Cumulative 24-hour average PM_{10} concentrations (µg/m³) - Receptor 2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment
27/11/2010	41.1	0.0	41.1	31/05/2010	10.2	16.6	26.8
21/01/2010	37.1	0.3	37.4	6/02/2010	5.6	8.5	14.1
27/03/2010	35.8	0.8	36.6	3/08/2010	11.2	8.3	19.5
12/01/2010	35.3	0.0	35.3	4/06/2010	9.4	7.7	17.1
13/01/2010	34.1	2.2	36.3	22/05/2010	10.4	7.6	18.0
21/03/2010	33.3	2.9	36.2	31/03/2010	7.5	7.4	14.9
20/03/2010	33.2	0.1	33.3	21/06/2010	19.3	7.3	26.6
25/01/2010	32.9	0.1	33.0	21/07/2010	16.9	7.2	24.1
26/03/2010	32.8	1.1	33.9	19/11/2010	21.7	6.8	28.5
20/01/2010	32.6	0.5	33.1	13/06/2010	16.2	6.7	22.9

Table B-3: Cumulative 24-hour average $PM_{2.5}$ concentrations (µg/m³) - Receptor 10

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment
27/03/2010	21.8	0.0	21.8	11/08/2010	2.5	3.4	5.9
27/11/2010	20.9	0.0	20.9	14/07/2010	1.2	2.6	3.8
20/03/2010	18.1	0.1	18.2	17/06/2010	4.8	2.0	6.8
26/03/2010	17.7	0.1	17.8	5/09/2010	1.6	2.0	3.6
23/04/2010	17.7	0.1	17.8	15/08/2010	3.5	1.5	5.0
28/04/2010	16.1	0.1	16.2	26/08/2010	2.4	1.5	3.9
1/09/2010	15.6	0.3	15.9	15/10/2010	1.9	1.5	3.4
21/03/2010	15.4	0.0	15.4	19/12/2010	2.9	1.4	4.3
29/06/2010	15.1	0.2	15.3	1/01/2010	6.1	1.2	7.3
28/03/2010	14.6	0.0	14.6	8/03/2010	3.2	1.2	4.4

Table B-4: Cumulative 24-hour average PM_{10} concentrations (µg/m³) - Receptor 10

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment	Measured background level	Predicted increment
27/11/2010	41.1	0.0	41.1	11/08/2010	6.5	10.5	17.0
21/01/2010	37.1	0.0	37.1	17/06/2010	12	9.4	21.4
27/03/2010	35.8	0.0	35.8	15/08/2010	8.9	8.3	17.2
12/01/2010	35.3	0.7	36.0	14/07/2010	6.5	8.1	14.6
13/01/2010	34.1	0.2	34.3	26/08/2010	8.7	8.0	16.7
21/03/2010	33.3	0.4	33.7	19/12/2010	12.3	7.0	19.3
20/03/2010	33.2	0.4	33.6	1/01/2010	11.8	6.9	18.7
25/01/2010	32.9	0.0	32.9	25/08/2010	11.3	6.1	17.4
26/03/2010	32.8	0.4	33.2	5/09/2010	6.4	5.5	11.9
20/01/2010	32.6	0.0	32.6	14/08/2010	13.6	4.9	18.5