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Outline Planning Consultants Pty Ltd

Gunnedah Waste Facility

Air Quality & Greenhouse Gas Assessment

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EXECUTIVE SUMMARY

Vipac Engineers and Scientists Ltd (Vipac) has been commissioned by Outline Planning Consultants Pty Ltd to conduct an Air Quality Impact Assessment in support of the proposed waste facility within a zoned industrial area on Lots 1 and 2 in Deposited Plan 1226992 at No.16 Torrens Road Gunnedah, in the Gunnedah LGA (the Project). MacKellar Excavations Pty Ltd, who currently operate their headquarters from the site at No. 16 Torrens Road, seek development consent for a waste facility handling up to 250,000 tonnes per annum of waste.

The overall approach to the assessment follows the guidance from *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* and the *Optimum CALPUFF modelling guidance for NSW* as follows:

- An emissions inventory of TSP, PM10, PM2.5, and deposited dust for the proposed Project was compiled using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology for the Project.
- Estimated emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model.
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria as part of the impact assessment. Air quality controls are applied to reduce emission rates where applicable.

As summarised in Table ES-1, the results of the modelling have shown that the TSP, PM2.5 and dust deposition predictions comply with the relevant criteria and averaging periods at all sensitive receptors. The annual average PM10 predictions also comply with criteria and the 24 hour average PM10 predictions are slightly above (51.95 µg/m^3 compared with 50 µg/m^3). The exceedance is driven by the elevated background conservatively adopted for the assessment (51.7 µg/m^3), which is already above the criteria. No additional exceedances of the criteria are predicted to occur as a result of the proposed waste facility activities and that best management practices will be implemented to minimise emissions as far as is practical. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required.

A greenhouse gas assessment has also been undertaken for the Project. This assessment determines the carbon dioxide equivalent (CO_2-e) emissions from the Project according to international and Federal guidelines. The estimated maximum annual operational phase emissions (2,842 tonnes CO_2-e) represent approximately 0.0005% of Australia's latest greenhouse inventory estimates of 532.5 MtCO_2-E (2019).

Annual greenhouse gas rates are expected to be below 25,000 t CO_2-e and therefore this Project will not trigger NGER reporting requirements.

It is therefore concluded that air quality should not be a constraint to proposed waste facility.

Table ES-1: Summary of Results

Pollutant	Averaging Period	Criteria	Maximum Prediction at Any Receptor		Compliant
			In isolation	Cumulative	
TSP	Annual	90 µg/m³	2.07 µg/m³	40.37 µg/m³	✓
PM10	24 Hour	50 µg/m³	12.90 µg/m³	51.95 µg/m³	×
	Annual	25 µg/m³	1.01 µg/m³	16.31 µg/m³	✓
PM2.5	24 Hour	25 µg/m³	2.79 µg/m³	20.39 µg/m³	✓
	Annual	8 µg/m³	0.22 µg/m³	7.82 µg/m³	✓
Dust Deposition	Monthly Total	4 g/m²/month	0.07 g/m²/month	2.18 g/m²/month	✓
	Monthly Increase	2 g/m²/month	0.07 g/m²/month	0.07 g/m²/month	✓

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1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) has been commissioned by Outline Planning Consultants Pty Ltd to conduct an Air Quality Impact Assessment in support of the proposed waste facility within a zoned industrial area on Lots 1 and 2 in Deposited Plan 1226992 at No.16 Torrens Road Gunnedah, in the Gunnedah LGA (the Project). MacKellar Excavations Pty Ltd, who currently operate their headquarters from the site at No. 16 Torrens Road, seek development consent for a waste facility handling up to 250,000 tonnes per annum of waste.

The purpose of this assessment is to assess the potential impacts of air pollutants generated from the Project and to provide recommendations to mitigate any potential impacts that might have an effect on any sensitive receptors.

The assessment has been carried out in accordance with the NSW Environment Protection Authority's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

2 PROJECT DESCRIPTION

2.1 OVERVIEW

The waste facility will accept up to 250,000 tonnes per annum waste material. The proposed development includes separating and sorting, processing or treating, temporary storage, or transfer or sale of recovered resources. The recycled materials able to be produced include soils and mulched material suitable for landscaping or rehabilitation and road-base. The proposed waste stream (largely excavated materials) will be stockpiled. No materials are land-filled or otherwise disposed anywhere within the site.

The key operational components of the expanded waste facility would include:

- Receipt of waste, with manual and mechanical sorting of waste material.
- Mechanical processing of waste using the processing equipment in an enclosed Unloading and Processing Shed in northern sector of the site (to help shield/limit noise to neighbouring properties).
- Recovery of recyclables through a manual picking line, including timber, and building materials. Transferral of processed waste into temporary storage bays in the hardstand area.
- Storage of asbestos waste in a secured, enclosed facility.
- Any waste which cannot be recycled or re-processed would be sent to an approved landfill.

The waste facility can utilise other existing facilities already owned and used by MacKellar group of companies, including but not limited to diesel fuel tanks, office and staff amenities, parking, and stormwater detention, as well as crushing and screening plant - the latter from MacKellar Excavations' Mount Mary quarry operation. If air quality is an issue, the waste facility would ensure that all waste processing activities, including tipping of incoming waste, would occur indoors within an enclosed processing building. This waste facility includes suitable dust suppression and sprinkler systems.

Details of the plant and equipment that will be used during the operational phase of the proposed facility are provided in

Table 2-1: Proposed Plant and Equipment

Description	No. of Units	Location
Cat 972M Loader	1	Outside
Cat 972M Loader	1	Inside Processing Building
Trommel (516R Anaconda)	1	Inside Processing Building
Watercart	1	Outside

Forklift	1	Outside
Dump Truck (Cat 745)	1	Outside
Waste Truck (Large)	1	Inside Processing Building
Weigh Bridge Motor	1	Outside
Crusher (Lippmann Jaw)	1	Inside Processing Building
Wash Bay	1	Outside

2.2 SITE LOCATION

The Project Site comprises Lots 1 and 2 DP 1226992 at No.16 Torrens Road, Gunnedah, having a combined area of approximately 2.77ha. All of the site is zoned IN1 General Industrial. Within the Allgayer Drive industrial subdivision are the following uses:

- GB Auto industrial, located on the opposite side of Allgayer Drive from the project site.
- Further north, on the opposite side of Allgayer Drive, is an industrial building housing CJC Drilling.
- Further north again, on the opposite side of Allgayer Drive, is an industrial building and covered work/storage area housing ACS Equip, a business associated with water bore inspections, cleaning and maintenance.
- Further north again, on the opposite side of Allgayer Drive, are industrial buildings, a shed and covered work/storage area housing Pirtek, a business providing fluid transfer solution products and services.
- To the north of the project site, but on the western side of Allgayer Drive, is an Expressway Spares industrial building. The company provides spare parts and equipment to earthmoving and mining industries in the region.

Figure 2-1 shows the proposed site plan.

Figure 2-1 - Project Site Plan

2.3 SITE ACCESS

Access to the Project Site is directly from Torrens Road, with side access to an industrial subdivision road, Allgayer Drive. Torrens Road then connects with Quia Road and thence to Kamilaroi Highway. All roads are bitumen sealed. The proposed waste facility will generate additional traffic and on site car parking demands. The primary traffic impact on local roads will be waste truck delivery movements. The haulage route for truck traffic entering and leaving the waste facility will be Torrens Road and Quia Road back to the Kamilaroi Highway (and vice versa).

As detailed in the accompanying Traffic Report (Ref: 01-20-AJD), the Kamilaroi Highway is approximately 9 metres wide, with a single (3.5m) lane in either direction and sealed shoulders. Torrens road is an industrial standard rural road. Between the project site and Quia Road, Torrens Road is 7m wide (2 x 3.5m) with variable width shoulders. Allgayer Drive is also an industrial standard road, and is 13m wide (2 x 3.5m) with kerb and gutters on both sides. Quia Road is a sealed rural road. The road has a 6-7m wide bitumen seal on an 8-9m wide gravel formation. Quia Road is generally 2 lanes (each 3-3.5m wide) in either direction with sealed or gravelled shoulders. The roadway has previously been approved as a haul road for local quarries.

2.4 OPERATIONAL HOURS

The proposed waste facility seeks to operate during the following hours;

- Monday to Saturday (excluding public holidays) - 7.00am to 6.00pm

Note – the operation of heavy machinery is only able to occur between 7:00am to 5:00pm Monday to Friday. No waste facility operations are undertaken on Sundays or public holidays. Construction hours would be 7:00am to 5:00pm, Monday to Friday, and 8:00am to 1:00pm on Saturdays.

3 POLLUTANTS OF CONCERN

The main emissions to air from the waste facility operations are caused by wind-borne dust, vehicle usage, materials handling and transfers.

Dust is a generic term used to describe fine particles that are suspended in the atmosphere. The dust emissions considered in this report are particulate matter in various sizes:

- 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.

As the proposed waste facility is with no putrescible waste accepted, the offsite odour impact is likely to be negligible. As a result, Vipac has solely considered the offsite dust and particulate impact.

4 REGULATORY FRAMEWORK

4.1 NATIONAL LEGISLATION

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}). A revision to the Measure was issued in 2003 with the inclusion of advisory $PM_{2.5}$ standards. The Air NEPM requires the State's governments to monitor air quality and to identify potential air quality problems.

4.2 STATE LEGISLATION AND GUIDELINES

4.2.1 DEPARTMENT OF ENVIRONMENT AND CONSERVATIONS APPROVED METHODS

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW Environment Protection Authority, 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.

4.3 PROJECT CRITERIA

The applicable criteria selected for this assessment are presented in *Table 4-1*.

Table 4-1: 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
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

5 EXISTING ENVIRONMENT

5.1 LOCAL SETTING

Figure 5-1 shows the location of project site, the land zones, the nearest rural dwellings and surrounding developments.

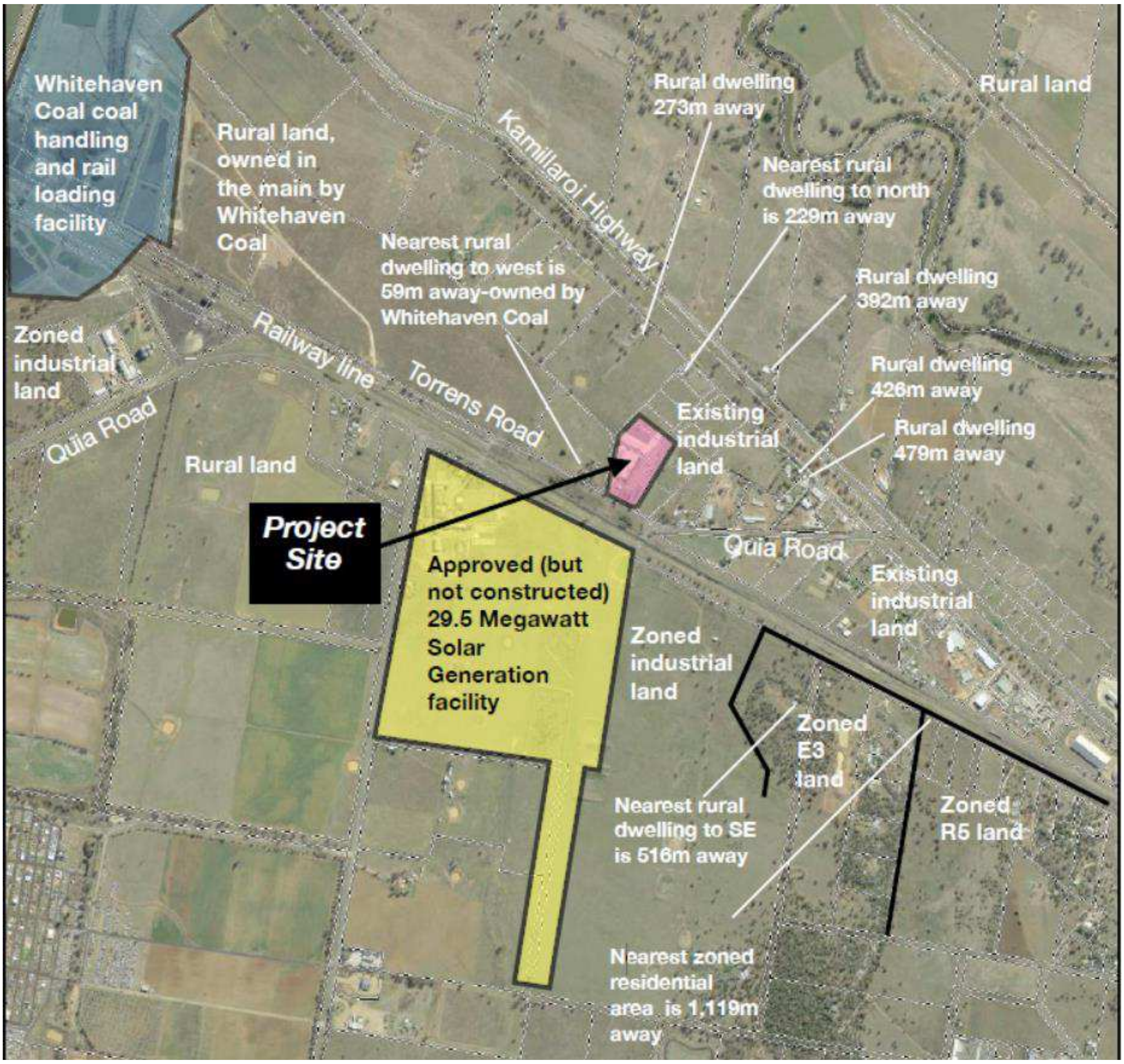


Figure 5-1: Project Site and Surrounding Developments

5.2 SENSITIVE RECEPTORS

There are six rural dwellings within 500m of the project site. The Whitehaven Coal dwelling is the closest sensitive ‘rural dwelling’ receiver, 59m to West of the waste facility site. Whitehaven have indicated their support for the project so this receptor will not be considered as a sensitive receptor in this assessment. The nearest sensitive receptors (SR) considered in this report are the following:

- R1 - Residential: 10193 Kamilaroi Highway, located 229m to the north-east of the proposed waste facility.
- R2 - Residential: 10221 Kamilaroi Highway, located 273m to the north of the proposed waste facility.
- R3 - Residential: 10176 Kamilaroi Highway, located 392m to the north-east of the proposed waste facility.
- R4 - Residential: 211 Mathias Road, located 426m to the east of the proposed waste facility.
- R5 - Residential: 207 Mathias Road, located 479m to the east of the proposed waste facility.

Figure 5-2 shows the location of the proposed waste facility and the nearest sensitive receptors.

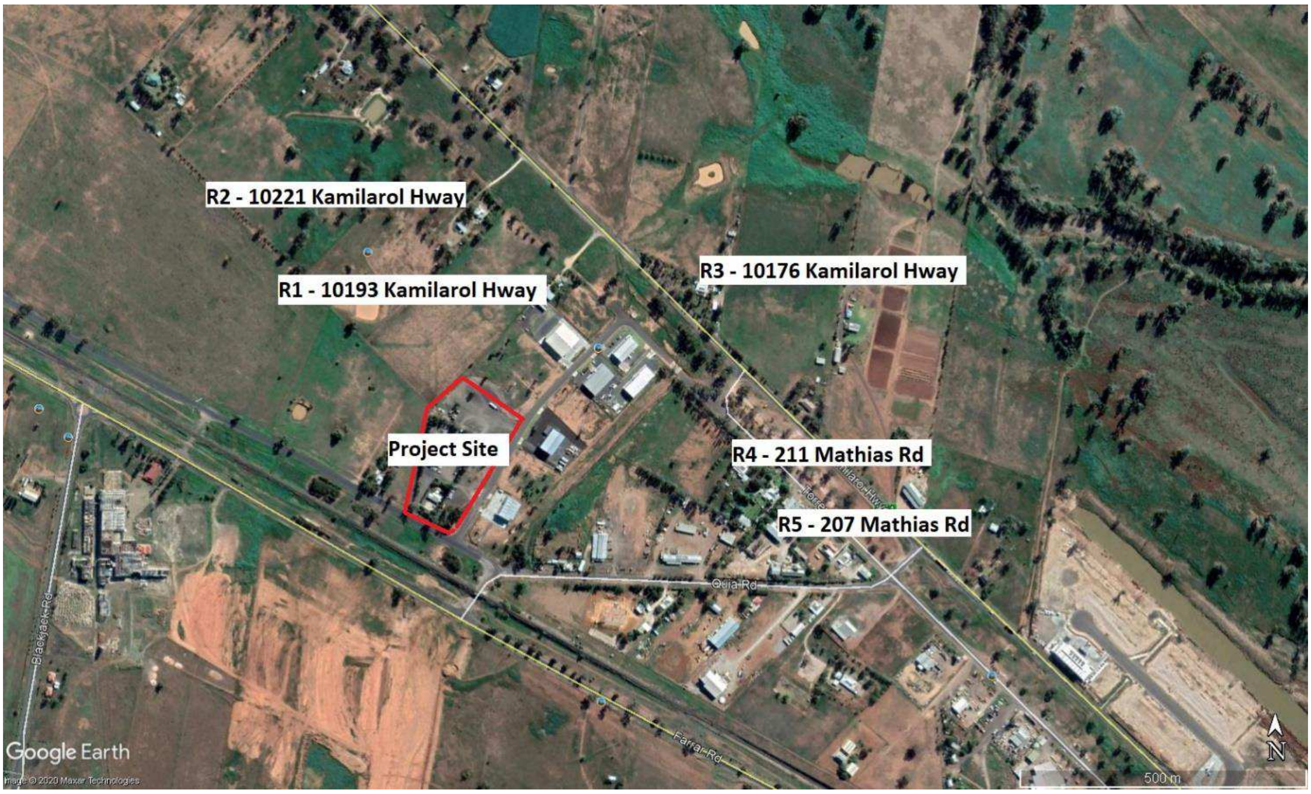


Figure 5-2 - Project Site and Nearest Receptors

5.3 DISPERSION METEOROLOGY

5.3.1 REGIONAL METEOROLOGY

The nearest Bureau of Meteorology (BOM) station with long term data is at Gunnedah Pool (Site number 055023), located approximately 4 km southeast of the Project site. This monitoring station has recorded data since 1876 and a summary of the climate is presented in Table 5-1.

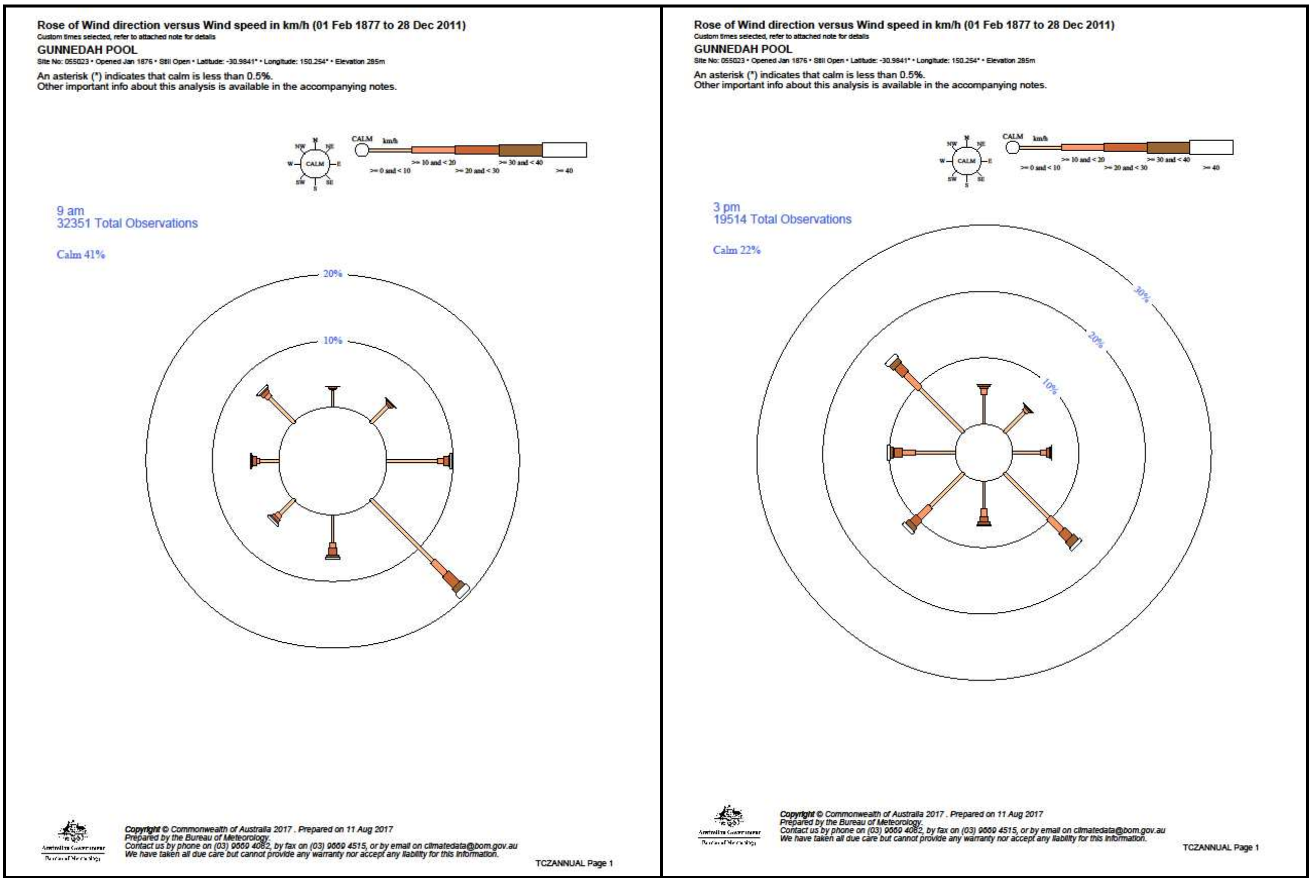
The long term mean temperature range is between 3°C and 34°C with the coldest month being July and the hottest months being December to March. On average, most of the annual rainfall is received between December and February. Rainfall is lowest between April and September, with a low mean annual rainfall of 621 mm. Rainfall reduces the dispersion of air emissions and therefore the potential impact on visual amenity and health.

Table 5-1: Long-term weather data for Gunnedah Pool [BOM]

Month	Temperature		Rainfall		9 am Conditions			3 pm Conditions		
	Max (°C)	Min (°C)	Mean Rain Days	No. of Days ≥ 1 mm	Temp (°C)	RH (%)	Wind Speed (km/h)	Temp (°C)	Mean RH (%)	Wind Speed (km/h)
Jan	34.0	18.4	70.6	5.5	25	61	7.6	31.2	43	9.6
Feb	32.9	18.1	66.1	5.0	23.8	65	8.3	30.3	45	9.1
Mar	30.7	15.8	48.9	4.0	22.1	65	8.1	28.7	44	9.4
Apr	26.4	11.4	36.6	3.4	18.3	67	6.7	24.9	46	8.7
May	21.3	7.1	42.0	4.0	13.3	73	5.8	20.0	51	7.5
Jun	17.6	4.3	44.0	4.8	9.8	79	5.8	16.7	55	8.8
Jul	16.9	3.0	41.5	4.7	8.8	77	5.3	15.8	53	9.8
Aug	18.9	4.2	40.9	4.7	10.9	71	5.8	17.7	48	10.6
Sep	22.8	7.0	40.2	4.5	15.0	65	6.7	21.3	44	10.9
Oct	26.7	10.8	54.2	5.3	19.1	61	7.9	24.5	43	10.4
Nov	30.3	14.2	61.4	5.6	22.1	59	7.8	27.7	40	11.0
Dec	32.9	16.8	69.6	6.0	24.4	58	7.3	30.2	40	10.3
Annual	**26**	**10.9**	**615.7**	**57.5**	**17.7**	**67**	**6.9**	**24.1**	**46**	**9.7**

A review of the number of rainfall days per year at Gunnedah shows that on average rainfall, is recorded on 57.5 days per year and the number of days where rainfall is ≥ 1 mm is 16% of the annual rainfall days are ≥ 1 mm.

The long term wind roses recorded daily at the Gunnedah station at 9am and 3pm are provided in Figure 5-3. Winds are shown to be primarily from the southeast at 9am and from the northwest and southeast directions at 3pm. Stronger winds (>40km/hr or >11.1m/s) occur infrequently mostly from the southeast.



Location: **Gunnedah BoM Station**	**Data Period:** **1876 to 2011**	**Data Type:** **Measured Data**

Figure 5-3: Annual wind roses for Gunnedah Weather Station (1876 to 2011)

5.3.2 LOCAL METEOROLOGY

5.3.2.1 INTRODUCTION

A three dimensional meteorological field was required for the air dispersion modelling that includes a wind field generator accounting for slope flows, terrain effects and terrain blocking effects. The Air Pollution Model, or TAPM, is a three-dimensional meteorological and air pollution model developed by the CSIRO Division of Atmospheric Research and can be used as a precursor to CALMET which produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables for each hour of the modelling period. The TAPM-CALMET derived dataset for 12 continuous months of hourly data from the year 2016 and approximately centred at the proposed Project has been used to provide further information on the local meteorological influences. Details of the modelling approach are provided in Section 6.

5.3.2.2 WIND SPEED AND DIRECTION

The wind roses from the TAPM-CALMET derived dataset for the year 2016 are presented in Figure 5-4 and Figure 5-5 for the Project site. Figure 5-4 shows that the dominant wind direction is from SE and W during spring, SE during the summer months. In autumn, the winds are primarily from the SE direction. Overall, winds from the S and N are infrequent which is likely indicative of the influences on wind flow from the elevated terrain in these directions.

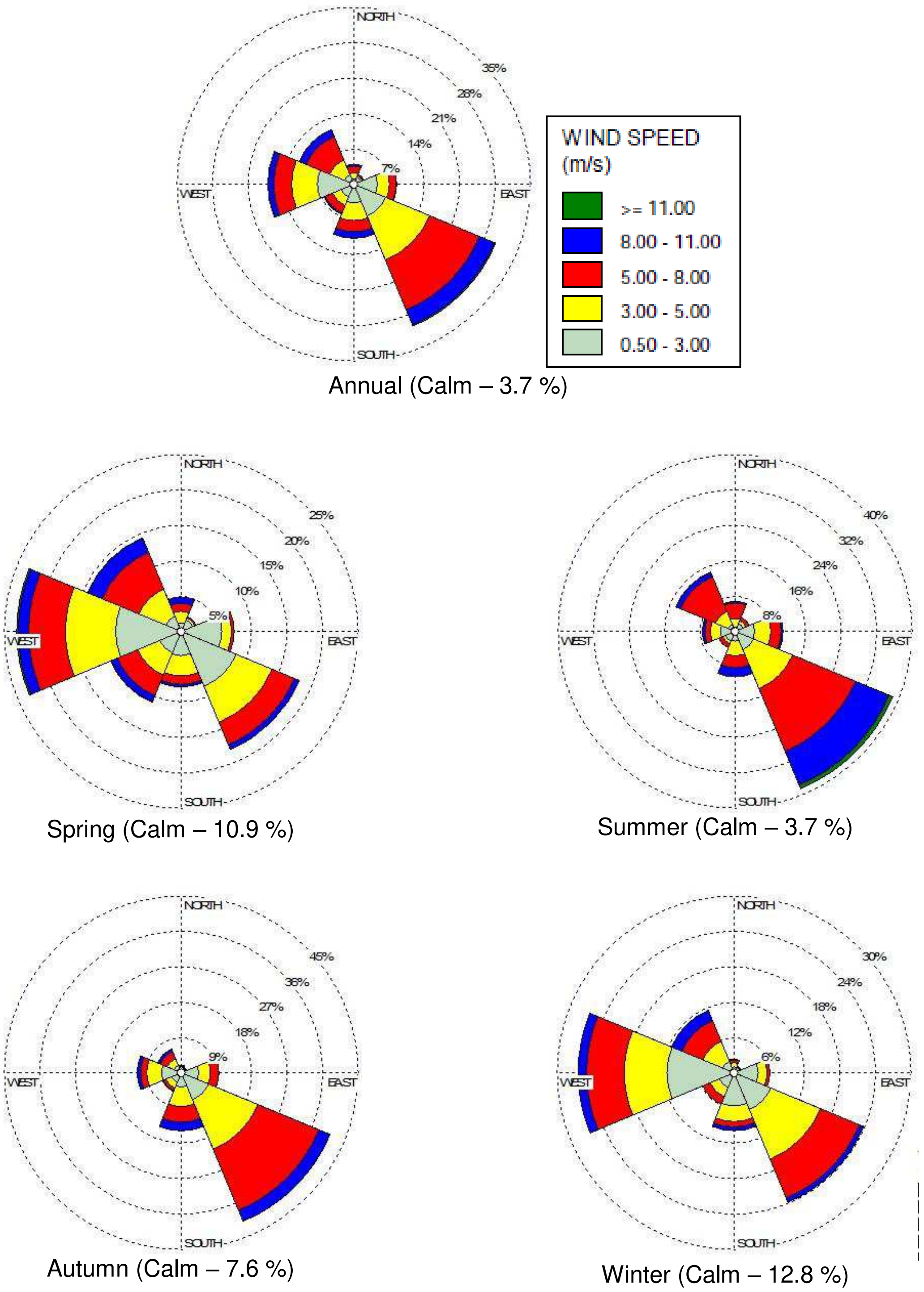
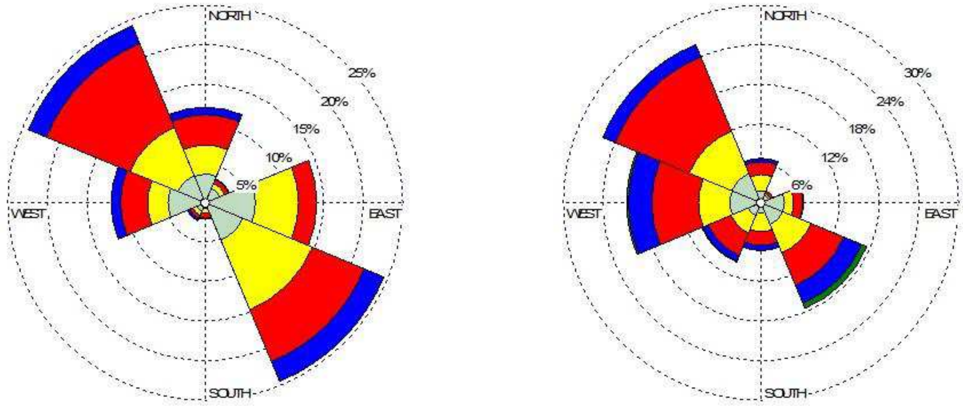


Figure 5-4: Site-specific wind roses by season for the TAPM-CALMET derived dataset, 2016

Figure 5-5 shows the wind roses for the time of day during the year for 2016. It can be seen that there are more frequent and stronger winds from the west during the afternoon periods.



9am (Calm – 5.0 %) 3pm (Calm – 3.8 %)

Figure 5-5: Site-specific wind roses by time of day for the TAPM-CALMET derived dataset, 2016

A comparison of the wind roses at 9am and 3pm hours for the TAPM-CALMET derived dataset (Figure 5-5) at the Project site was also undertaken with the BOM long-term wind roses at Gunnedah (Figure 5-3). There are similarities between the wind roses from BOM and derived dataset, most notably the dominance of winds from the NW and SE in both datasets.

A windrose report for hourly data collected at the Gunnedah Quarry Products Site from 12/11/2018 to 12/11/2019 is also provided for comparison in Figure 5-6. As shown in the figure, winds from the SE are dominant which is consistent with the TAPM-CALMET derived annual data windrose (Figure 5-4).

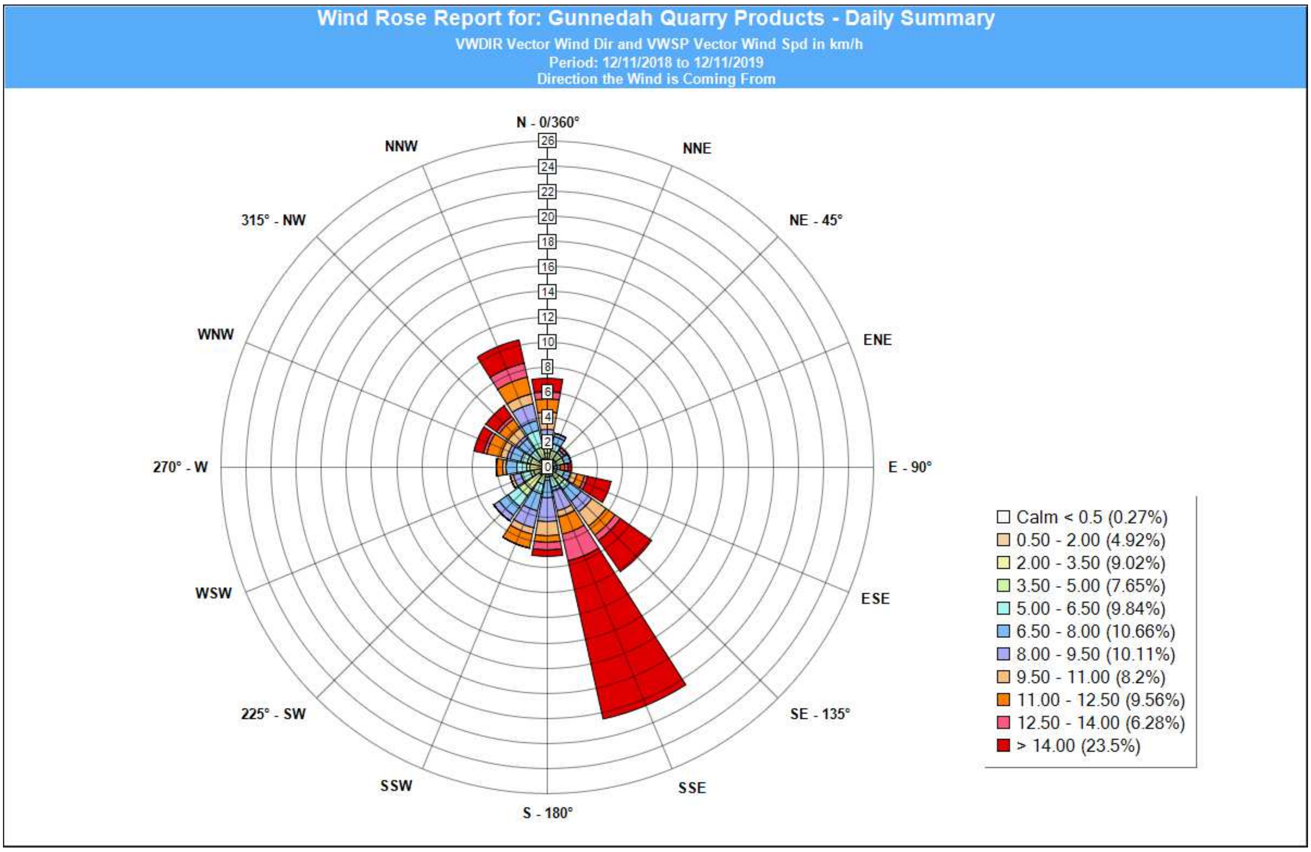


Figure 5-6: Windrose report for Gunnedah Quarry Products 11/2018 to 11/2019

In addition, as specified in the Approved Methods (2016), a comparison of the modelled data wind rose generated (as close as possible to Tamworth) for 2016 is provided with the most recent five years of measured data at the NSW EPA monitoring station in Tamworth. As shown in Figure 5-7, the modelled data is consistent with the measured data for the past five years.

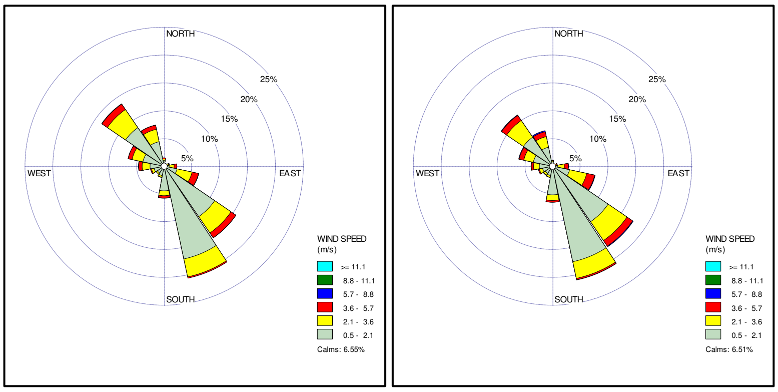


Figure 5-7: Wind roses comparison of modelled 2016 data (left) with Tamworth measured data (right)

5.3.2.3 ATMOSPHERIC STABILITY

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion of pollutants. 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 in various air dispersion models. The frequency of occurrence for each stability class for 2016 is shown in Figure 5-8.

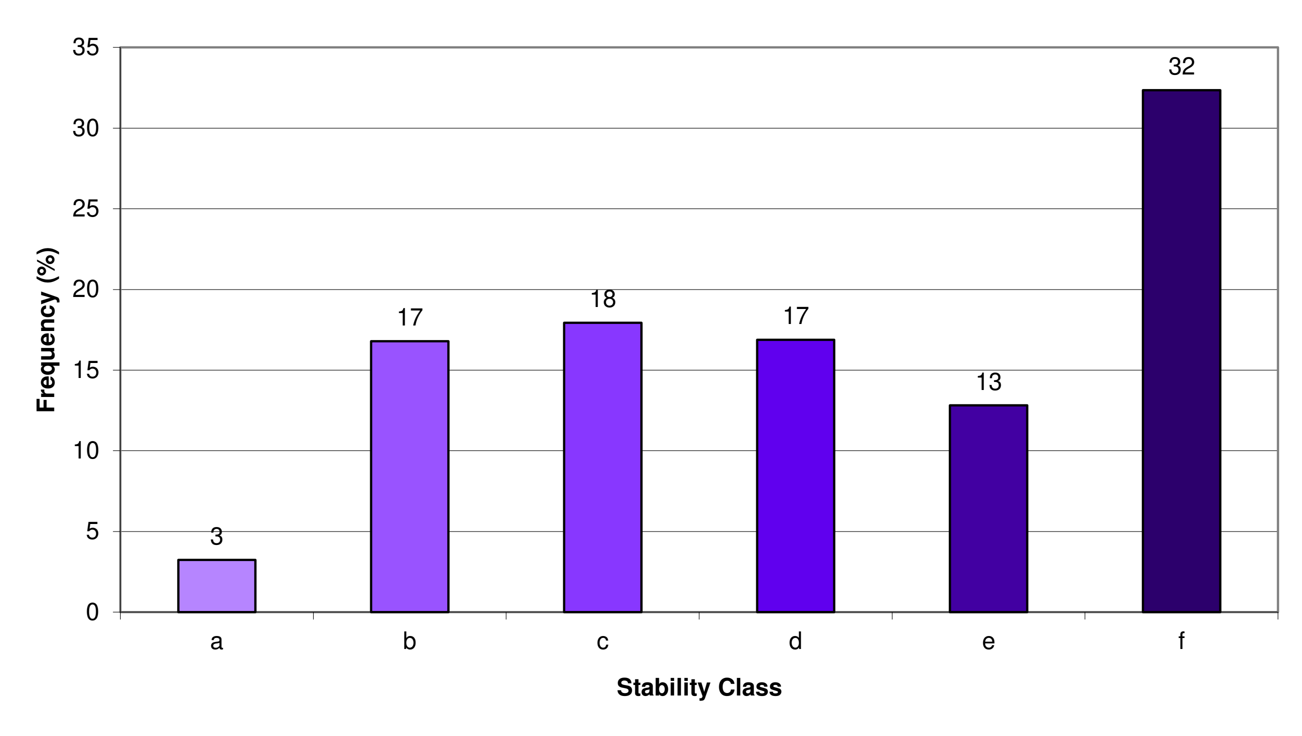


Figure 5-8: Stability class frequency for the TAPM-CALMET derived dataset, 2016

5.3.2.4 MIXING HEIGHT

Mixing height refers to the height above ground within which particulates or other pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and particulate dispersion is limited to within this layer.

Diurnal variations in mixing depths are illustrated in Figure 5-9. 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.

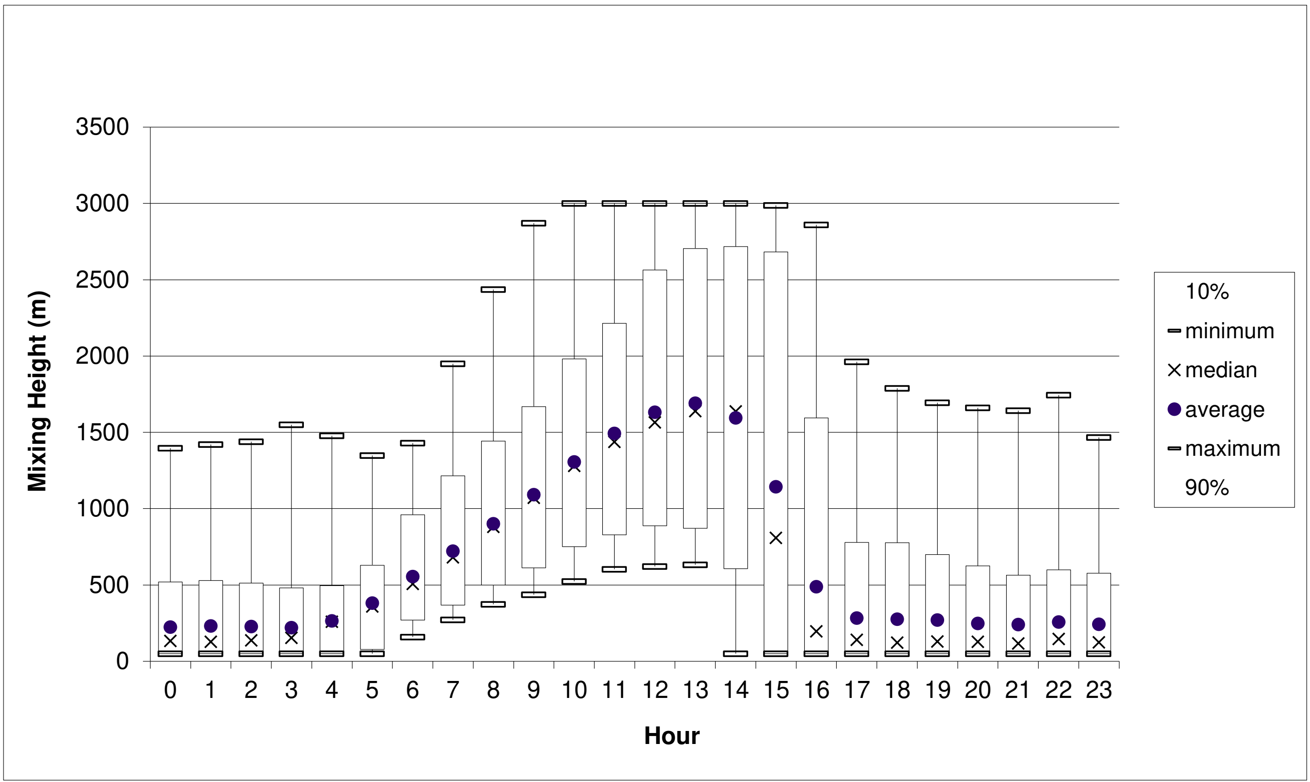


Figure 5-9: Mixing height for the TAPM-CALMET derived dataset, 2016

5.4 EXISTING AIR QUALITY

An extensive network of NATA-accredited air quality monitoring stations which use Standards Australia methods, where available is operated by the NSW EPA. The closest monitoring site to the Project site is at Tamworth, approximately 70 km to the east. The Tamworth air quality monitoring station is located in Hyman Park, off Robert Road and Vue Street in the rural service town of Tamworth on the north-west slopes. Of the pollutants of interest, PM10 and PM2.5 are measured at the Tamworth site. Where available, the maximum 24 hour average data collected at this site for 2016 is outlined in Table 5-2 for a Level 1 Assessment as specified in the Approved Methods (2016). Individual 24-hour average predicted PM_{10} concentration paired in time with the corresponding 24-hour concentration within the adopted 2016 monitoring dataset to obtain total impact at each receptor is provided for a Level 2 Assessment. In addition, annual average concentration data are adopted for the background levels of pollutants requiring assessment for these periods (e.g. PM2.5 and PM10).

Where unavailable, a conservative assumption is adopted. For example, annual TSP background is derived as 2.5 x measured PM10 based on data collected around Australian mines (ACARP, 1999). No dust deposition data is available, however the results of dust deposition monitoring undertaken at similar locations in central Queensland have been utilised. The average dust deposition from monitoring at these locations is 33 mg/m^2/day. This is likely to be typical of annual average dust fallout in rural regions although higher levels may exist in the vicinity of local sources. Therefore, the average background deposition rate for the air quality impact assessment in relation to the Project has been assumed to be double the nominated monitoring result, that is 2.0 g/m^2/month (67 mg/m^2/day). This methodology is consistent with the Approved Methods, which specifies criteria of 2 g/m^2/month without background and 4 g/m^2/month including background.

As shown in Table 5-2, the maximum measured 24 hour average PM_{10} is already above the relevant criteria of 50 µg/m³.

Table 5-2: Assigned Background Concentrations

Parameter	Air Quality Criteria	Period	Maximum Measured	Adopted Background	Comments
TSP	90 µg/m³	**Annual**	38.3 µg/m³	38.3 µg/m³	Conservative assumption
PM_{10}	50 µg/m³	**24 Hour**	51.7 µg/m³	Varies	NSW EPA Measurement
	25 µg/m³	**Annual**	15.3 µg/m³	15.3 µg/m³	
$PM_{2.5}$	25 µg/m³	**24 Hour**	17.6 µg/m³	17.6 µg/m³	NSW EPA Measurement
	8 µg/m³	**Annual**	7.6 µg/m³	7.6 µg/m³	
Dust Deposition	2 g/m²/month	**Month**	-	-	-
	4 g/m²/month	**Month**	2 g/m²/month	2 g/m²/month	Conservative assumption

6 METHODOLOGY

The overall approach to the assessment follows the guidance from *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Department of Environment & Conservation, 2016) and the *Optimum CALPUFF modelling guidance for NSW* (Barclay & Scire, 2011).

The air quality impact assessment has been carried out as follows:

- An emissions inventory of TSP, PM_{10}, $PM_{2.5}$, and deposited dust for the Project activities was derived using National Pollutant Inventory (NPI) and United States Environmental Protection Agency (USEPA) AP-42 emissions estimation methodology.
- Estimated emissions data was used as input for air dispersion modelling. The modelling techniques were based on a combination of The Air Pollution Model (TAPM) prognostic meteorological model (developed by CSIRO), and the CALMET model suite used to generate a three dimensional meteorological dataset for use in the CALPUFF dispersion model (see Figure 6-1).
- The atmospheric dispersion modelling results were assessed against the air quality assessment criteria described in Section 4.3 as part of the impact assessment.

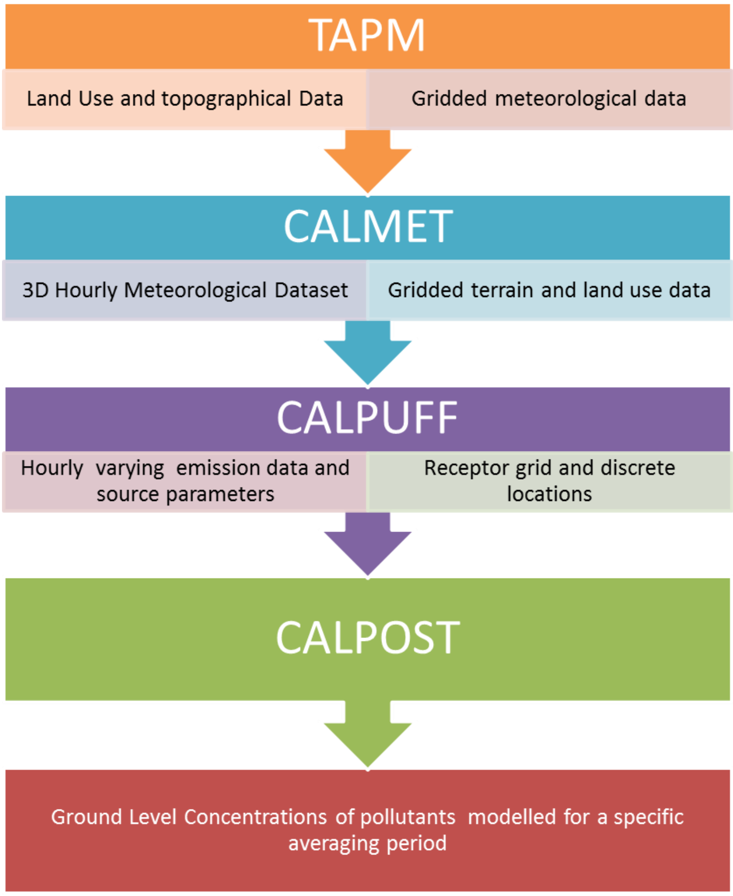


Figure 6-1: Overview of Modelling Process

6.1 EMISSIONS INVENTORY

Activities associated with the proposed operations have the potential to generate dust emissions. Potential dust emissions may be generated during the material loading/unloading, transport on-site, processing/sorting material and windblown dust generated from exposed areas and stockpiles.

As outlined in Section 2, many of the potential dust generating activities including unloading, sorting, partial storage and mechanical processing of waste are proposed in an enclosed Unloading and Processing Shed which will be fitted with dust suppression sprinklers thereby minimising dust emissions to the surrounding air environment. Furthermore, the proposed transportation routes will all be sealed which would also significantly decrease any dust generated by vehicle movements. In both cases, a conservative estimation of emissions is adopted. For example, a control factor derived from that specified for the miscellaneous transfer and handling within an enclosure in the National Pollutant Inventory Emissions Estimation Technique Manual for Mining Version 3.1 (NPI EET Mining) of 70% is applied to relevant activities within the shed and 75% to vehicle movements on unsealed roads controlled by water sprays (NPI EET Mining). These control factors were conservatively adopted to reflect the potential for dust generation within the shed that may be released through open doors and potential dust lift off from the sealed roads.

Estimated emissions for these sources are summarised in Table 6-1. Further details including the activity data and emissions estimation methodology are provided in Appendix A.

Table 6-1: Emissions Input Data Adopted for the Modelling

Activity	Emission Rate (g/s)			Control Factor (%)
	TSP	PM_{10}	$PM_{2.5}$	
Processing Shed				
Sorting	0.200	0.096	0.021	70% for enclosure
Crushing	0.120	0.040	0.003	70% for enclosure 50% for water sprays
Unloading at processing	0.005	0.002	0.0005	70% for enclosure
Stacking stockpiles	0.167	0.080	0.018	-
Wind Erosion - Stockpile	0.002	0.0008	0.0002	50% for water sprays 30% for wind breaks
Hard Stand				
Vehicle movements (HDV)[1]	0.116	0.034	0.002	75% for water sprays 44% for controlled speeds < 40 km/h
Vehicle movements (LDV)	0.029	0.010	0.001	
Stacking stockpiles	0.334	0.160	0.035	-
Wind erosion - Stockpiles	0.002	0.001	0.0002	50% for water sprays 30% for wind breaks
Total	**0.975**	**0.424**	**0.081**	

1 includes within the processing shed

6.2 SOURCE EMISSION LOCATIONS

Sources associated with the Waste Facility emissions were modelled at the locations shown in Figure 2-1.

6.3 AIR DISPERSION MODELLING

6.3.1 TAPM

A 3-dimensional dispersion wind field model, CALPUFF, has been used to simulate the impacts from the 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' (Barclay and Scire, 2011) 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.

TAPM was configured as follows:-

- Centre coordinates – 30˚ 58.5 S, 150˚ 10.5 E;
- Dates modelled – 30th December 2015 to 31st December 2016 (2 start-up days);
- Four nested grid domains of 30 km, 10 km, 3 km and 1 km;
- 41 x 41 grid points for all modelling domains;
- 25 vertical levels from 10 m to an altitude of 8000 m above sea level;
- Data assimilation using measured meteorological data from the Bureau of Meteorology Station at Gunnedah Airport; and
- The default TAPM databases for terrain, land use and meteorology were used in the model;

6.3.2 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.

6.3.3 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 5 km while the minimum radius of influence was set as 0.1 km. The terrain data incorporated into the model had a resolution of 1 arc-second (approximately 30 m) in accordance with the *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'*.

6.3.4 OTHER MODELLING INPUT PARAMETERS

6.3.4.1 PARTICLE SIZE DISTRIBUTION

CALPUFF requires particle distribution data (geometric mass mean diameter, standard deviation) to compute the dispersion of particulates (**Table 6-2**).

Table 6-2: Particle size distribution data

Particle size	Mean particle diameter (µm)	Geometric standard deviation (µm)
TSP	15	2
PM10	4.88	1
PM2.5	0.89	1

7 ASSESSMENT OF IMPACTS

This section presents the results of the air quality impact assessment for predicted ground level concentrations of TSP, PM10 and PM2.5 and dust deposition for the proposed operation of the Waste Facility.

The results of the dispersion modelling include individual sensitive receptor and contour plots that are indicative of ground-level concentrations and deposition. 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 cumulative impact (incremental plus background) for the 100^{th} percentile (i.e. maximum value) in units as per the criterion and time periods.

7.1 TSP

The predicted annual average TSP is presented in **Table 7-1**.

The model predictions for TSP are well below the criteria of 90 µg/m^3. TSP emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. A contour plot is presented in ***Appendix B***.

Table 7-1: Predicted Annual Average TSP Concentrations

ID	Receptor	Predicted Annual Average TSP Concentrations (µg/m^3)	
		Incremental	Cumulative
R1	10193 Kamilarol Hway	2.07	40.37
R2	10221 Kamilarol Hway	1.53	39.83
R3	10176 Kamilarol Hway	0.74	39.04
R4	211 Mathias Rd	0.99	39.29
R5	207 Mathias Rd	0.81	39.11
Criteria		**90**	

7.2 PM10

The maximum predicted 24 hour (including maximum measured background of 51.7 µg/m^3) and annual average (including measured annual background of 15.3 µg/m^3) PM10 are presented in

Table 7-2.

As shown in

Table 7-2, the model predictions for annual average PM10 are below the criteria of 25 µg/m^3. The model predictions for cumulative 24 hour average PM10 are above the criteria of 50 µg/m^3. As noted in Section 5.4, the measured 24 hour background PM10 of 51.7 µg/m^3 is already above the criteria of 50 µg/m^3. It is also noted that

Table 7-2 shows the worst case scenario such that the maximum predicted 24 hour PM10 concentration from the Project for the year is summed with the maximum measured 24 hour background.

Further investigation of the contemporaneous measured background and predicted data is therefore undertaken in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. **Table 7-3** provides the maximum cumulative concentrations at each receptor including contemporaneous background concentrations and associated number of exceedances of the criteria for the modelled year. As shown in **Table 7-3**, only one exceedance of the 24 hour average PM10 criteria (50 µg/m^3) is predicted at each of the receptors modelled. This exceedance corresponds to the date of the elevated measured background of 51.7 µg/m^3 on 31/1/16. Furthermore, the contribution of the waste facility emissions to the cumulative PM10 is negligible (maximum - 0.25 µg/m^3) on this day and does not contribute to any additional exceedances of the relevant criteria. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required.

The 24 hour and annual average PM_{10} emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in ***Appendix B***.

Table 7-2: Predicted 24 Hour and Annual Average PM10 Concentrations

ID	Receptor	Predicted 24 Hour Average PM10 Concentrations (µg/m^3)		Predicted Annual Average PM10 Concentrations (µg/m^3)	
		Incremental	Cumulative	Incremental	Cumulative
R1	10193 Kamilarol Hway	12.90	64.60	1.01	16.31
R2	10221 Kamilarol Hway	10.06	61.76	0.75	16.05
R3	10176 Kamilarol Hway	5.09	56.79	0.36	15.66
R4	211 Mathias Rd	4.60	56.30	0.46	15.76
R5	207 Mathias Rd	4.04	55.74	0.38	15.68
Criteria		**50**		**25**	

Table 7-3: Predicted Cumulative 24 Hour Average PM10 Concentrations and Number of Exceedances

ID	Receptor	Predicted Cumulative 24 Hour Average PM10 Concentrations (µg/m^3)		Number of Exceedances
		Incremental	Cumulative	
R1	10193 Kamilarol Hway	0.25	51.95	1
R2	10221 Kamilarol Hway	0.14	51.84	1
R3	10176 Kamilarol Hway	0.06	51.76	1
R4	211 Mathias Rd	0.09	51.79	1
R5	207 Mathias Rd	0.07	51.77	1
Criteria		**50**		

7.3 PM2.5

The maximum predicted 24 hour (including maximum measured background of 17.6 µg/m3) and annual average (including measured annual background of 7.6 µg/m3) PM2.5 are presented in **Table 7-4**.

The model predictions for 24 hour average and annual average PM2.5 are below the criteria of 25 µg/m^3 and 8 µg/m^3. The 24 hour and annual average PM2.5 emissions from the proposed Project are not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in ***Appendix B***.

Table 7-4: Predicted 24 Hour and Annual Average PM2.5 Concentrations

ID	Receptor	Predicted 24 Hour Average PM2.5 Concentrations (µg/m^3)		Predicted Annual Average PM2.5 Concentrations (µg/m^3)	
		Incremental	**Cumulative**	**Incremental**	**Cumulative**
R1	10193 Kamilarol Hway	2.79	20.39	0.22	7.82
R2	10221 Kamilarol Hway	2.16	19.76	0.17	7.77
R3	10176 Kamilarol Hway	1.12	18.72	0.08	7.68
R4	211 Mathias Rd	0.91	18.51	0.10	7.70
R5	207 Mathias Rd	0.79	18.39	0.08	7.68
Criteria		**25**		**8**	

7.4 DUST DEPOSITION

The maximum predicted monthly average dust deposition are presented in **Table 7-5**.

The model predictions for incremental and cumulative monthly average dust deposition are well below the criteria of 2 g/m^2/month and 4 g/m^2/month. Dust deposition from the proposed Project is not predicted to adversely impact upon the sensitive receptors. Contour plots are provided in ***Appendix B***.

Table 7-5: Predicted Monthly Average Dust Deposition

ID	Receptor	Predicted Monthly Average Dust Deposition (g/m^2/month)	
		Incremental	**Cumulative**
R1	10193 Kamilarol Hway	0.18	2.18
R2	10221 Kamilarol Hway	0.15	2.15
R3	10176 Kamilarol Hway	0.10	2.10
R4	211 Mathias Rd	0.15	2.15
R5	207 Mathias Rd	0.13	2.13
Criteria		**2**	**4**

8 GREENHOUSE GAS

8.1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Outline Planning Consultants to prepare a greenhouse gas assessment for the Project.

This assessment determines the carbon dioxide equivalent (CO_2-e) emissions from the Project according to international and Federal guidelines.

8.2 BACKGROUND

Greenhouse gases are a natural part of the atmosphere; they absorb and re-radiate the sun's warmth, and maintain the Earth's surface temperature at a level necessary to support life. Human actions, particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing, are increasing the concentrations of the greenhouse gases. This is the enhanced greenhouse effect, which is contributing to warming of the Earth.

Greenhouse gases include water vapour, carbon dioxide (CO_2), methane, nitrous oxide and some artificial chemicals such as chlorofluorocarbons (CFCs). Water vapour is the most abundant greenhouse gas. These gases vary in effect and longevity in the atmosphere, but scientists have developed a system called Global Warming Potential to allow them to be described in equivalent terms to CO_2 (the most prevalent greenhouse gas) called equivalent carbon dioxide emissions (CO_2-e). A unit of one tonne of CO_2-e (t CO_2-e) is the basic unit used in carbon accounting. An emissions inventory, or 'carbon footprint', is calculated as the sum of the emission rate of each greenhouse gas multiplied by the global warming potential.

8.3 LEGISLATION OVERVIEW

The *Commonwealth National Greenhouse and Energy Reporting Act 2007* (NGER Act) established a national framework for corporations to report greenhouse gas emissions and energy consumption. The NGER Act requires corporations to submit an annual report in energy consumption, energy production and greenhouse gas emissions, if any of the following thresholds are met:

- The facility consumes more than 100 terajoules of energy in a financial year or emits greenhouse gases above 25,000 tonnes CO_2-e (facility threshold); and
- All Australian facilities collectively consume more than 200 terajoules of energy in a financial year or emit greenhouse gases above 50,000 tonnes CO_2-e (corporate threshold).

A facility is defined as an activity, or a series of activities (including ancillary activities), if it involves the production of greenhouse gas emissions, the production of energy or the consumption of energy; and forms a single undertaking or enterprise and meets the requirements of the regulations.

8.4 METHODOLOGY

The Department of Industry, Science, Energy and Resources (formerly Department of the Environment and Energy (DotEE)) monitors and compiles databases on anthropogenic activities that produce greenhouse gases in Australia. The DotEE has published greenhouse gas emission factors for a range of anthropogenic activities. The DotEE methodology for calculating greenhouse gas emissions is published in the National Greenhouse Accounts (NGA) Factors workbook (DotEE, 2019). This workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported, as defined by the NGA Factors Workbook is determined by whether the activity is within the organisation's boundary (Scope 1 – Direct Emissions) or outside the organisation's boundary (Scopes 2 and 3 – Indirect Emissions). The scopes are described as follows:

- Scope 1 Emissions: Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.);
- Scope 2 Emissions: Indirect emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed; and
- Scope 3 Emissions: Indirect emissions for organisations that:
  a. Burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or
  b. Consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Scope 1 emissions include those from fuel use by vehicles, coal burnt in boilers and methane from wastewater systems. Scope 2 emissions are from any purchased electricity. Scope 3 emissions are from the emissions resulting from the energy required to manufacture products such as diesel and equipment.

The definition, methodologies and application of Scope 3 emission factors are currently subject to international discussions and have the potential to cause much confusion. Large uncertainty exists in the accurate quantification of these emissions.

Emission factors used in this assessment have been derived from either the DotEE, site-specific information or from operational details obtained from similar emission sources.

The majority of the emission factors used in this report have been sourced from the NGA Factors Workbook (DotEE, 2019) as indicated in Table 8-1.

Table 8-1: Emission Factors

Scope	Emission Source	Emission Factor	Source
1	Combustion emissions from ULP (stationary)	2.38 t CO_2-e / kL	NGA Factors Workbook, 2019
	Combustion emissions from diesel (stationary)	2.68 t CO_2-e / kL	NGA Factors Workbook, 2019
	Combustion for transport (general)	2.69 t CO_2-e / kWh	NGA Factors Workbook, 2019

For this assessment Scope 1 and Scope 2 emissions have been calculated in accordance with the NGA Factors Workbook methodology.

8.5 QUANTIFICATION OF EMISSIONS

Table 8-2 outlines the estimated greenhouse gas emissions for the operational phase of the Project. The following assumptions have been made for this assessment:

- The operational equipment list is in accordance with that specified in Table 2-1;
- It is estimated that 12 trucks are required to allow for worst case activities of 112 laden and unladen trips per day (as per Traffic Impact Assessment Report, Streetwise Road Safety & Traffic Services)
- 10 operational staff travelling approximately 6 km round-trip in 10 vehicles per day; and
- Electricity purchased from the grid would be minimal.

Table 8-2: Estimated Greenhouse Gas Emissions (CO_2-e tonnes)

		Annual Emissions (t CO_2-e)
Emission Source	**Scope**	**Operation**
Staff Movements	1 (direct)	20.3
Equipment	1 (direct)	463.0
Haulage	1 (direct)	2358.8
		2842.1

8.6 SUMMARY AND CONCLUSION

The results of the assessment of greenhouse gas emissions from the Project may be summarised as follows:

- During the operational phase the annual emissions are projected to be 2,842 tonnes CO_{2-e}, which is below the threshold of reporting of 25,000 tonnes CO_{2-e}. Therefore this Project will not trigger NGER reporting requirements; and
- The estimated maximum annual operational phase emissions (2,842 tonnes CO_2-e) represents approximately 0.0005% of Australia's latest greenhouse inventory estimates of 532.5 MtCO_2-E (2019).

9 CONCLUSION

An Air Quality Impact Assessment in support of the proposed waste facility within a zoned industrial area on Lots 1 and 2 in Deposited Plan 1226992 at No.16 Torrens Road Gunnedah, in the Gunnedah LGA has been undertaken to assess the potential impacts of air pollutants generated by the proposed waste facility and to provide recommendations to mitigate any potential impacts that might have an effect on any sensitive receptors.

The assessment has been carried out in accordance with the NSW Environment Protection Authority's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

As summarised in **Table 9-1**, the results of the modelling have shown that the TSP, PM2.5 and dust deposition predictions comply with the relevant criteria and averaging periods at all sensitive receptors. The annual average PM10 predictions also comply with criteria and the 24 hour average PM10 predictions are slightly above (51.95 µg/m³ compared with 50 µg/m³). The exceedance is driven by the elevated background conservatively adopted for the assessment (51.7 µg/m³), which is already above the criteria. No additional exceedances of the criteria are predicted to occur as a result of the proposed waste facility activities and that best management practices will be implemented to minimise emissions as far as is practical. As specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, under these circumstances no additional assessment is therefore required.

A greenhouse gas assessment has also been undertaken for the Project. This assessment determines the carbon dioxide equivalent (CO_2-e) emissions from the Project according to international and Federal guidelines. The estimated maximum annual operational phase emissions (2,842 tonnes CO_2-e) represent approximately 0.0005% of Australia's latest greenhouse inventory estimates of 532.5 MtCO_2-E (2019).

Annual greenhouse gas rates are expected to be below 25,000 t CO_2-e and therefore this Project will not trigger NGER reporting requirements.

It is therefore concluded that air quality should not be a constraint to proposed waste facility.

Table 9-1: Summary of Results

Pollutant	Averaging Period	Criteria	Maximum Prediction at Any Receptor		Compliant
			In isolation	Cumulative	
TSP	Annual	90 µg/m³	2.07 µg/m³	40.37 µg/m³	✓
PM10	24 Hour	50 µg/m³	12.90 µg/m³	51.95 µg/m³	×
	Annual	25 µg/m³	1.01 µg/m³	16.31 µg/m³	✓
PM2.5	24 Hour	25 µg/m³	2.79 µg/m³	20.39 µg/m³	✓
	Annual	8 µg/m³	0.22 µg/m³	7.82 µg/m³	✓
Dust Deposition	Monthly Total	4 g/m²/month	0.07 g/m²/month	2.18 g/m²/month	✓
	Monthly Increase	2 g/m²/month	0.07 g/m²/month	0.07 g/m²/month	✓

Appendix A EMISSIONS ESTIMATION METHODOLOGY

The major air emission from surface 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) provides 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.

$PM_{2.5}$ emission factors were derived from the ratio of $PM_{2.5}$ to TSP published in the relevant US AP42 Chapter tables. Table A-1 summarises the $PM_{2.5}$ to TSP ratio adopted for the emissions estimations.

Table A-1: Ratio of PM2.5 to TSP ratio adopted for the emissions estimations

Source	Ratio $PM_{2.5}$/TSP
Crushing	0.022
Truck loading	0.105
Front End Loaders	0.105
Wheel generated dust	0.017
Wind erosion	0.105

In the absence of measured physical parameters such as moisture and silt content, the default emission factors for all of the various operations as specified in Table 2 of the National Pollutant Inventory Emission Estimation Technique Manual for Mining (January 2012) have been conservatively adopted (Table A-2). Table A-3 outlines the activity data applied in the emissions estimation.

Table A-2: Source type Emission Factors applied

Source type	TSP Emission factor	PM_{10}/TSP ratio	Units
Wind erosion:			
stockpiles/ haul roads	0.4	0.5	kg/ha/h
Handling:			
Loading stockpiles	0.004	0.42	kg/t
FEL on waste	0.025	0.48	kg/t
Trucks dumping overburden	0.012	0.35	kg/t
Loading to trucks	0.0004	0.42	kg/t
Crushing	0.03	0.3	kg/t
Wheel generated dust:			
HDV	4.23	0.3	kg/VKT
LDV	0.94	0.35	kg/VKT

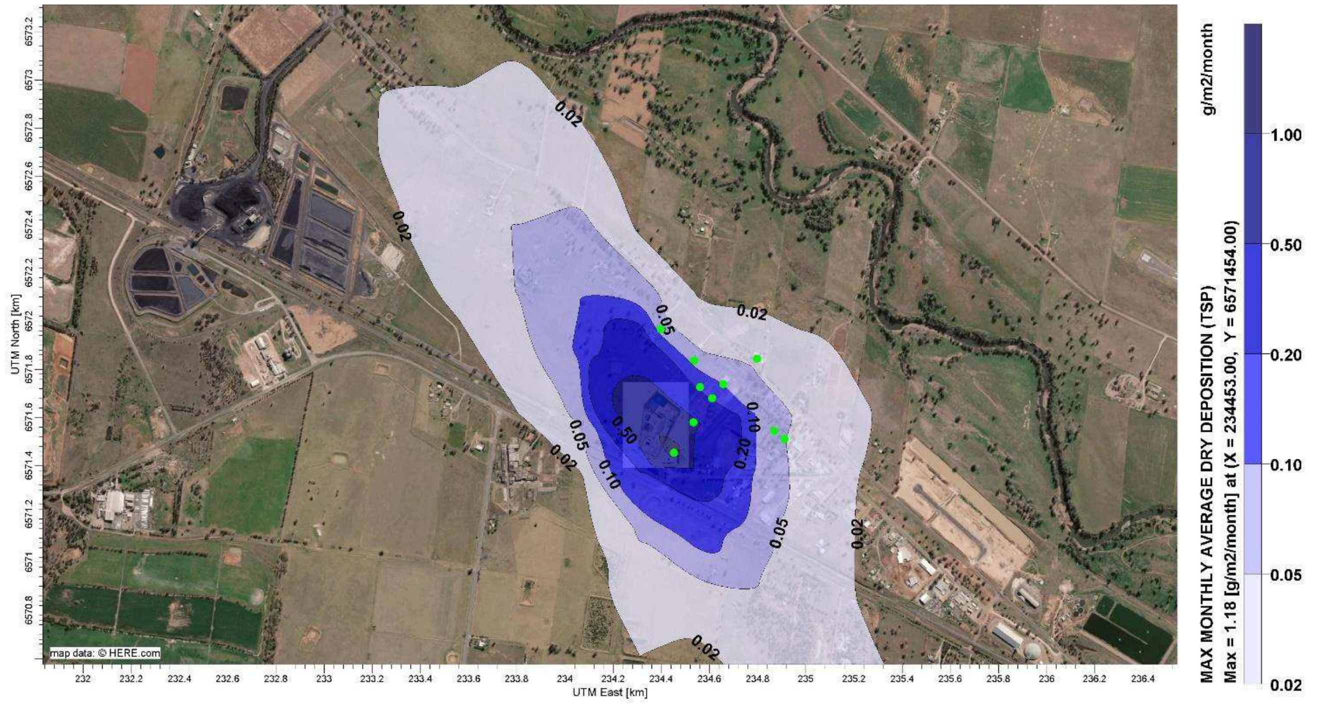
Table A-3: Parameters applied in emissions estimation

Parameter ID	Value	Units	Description	Data source
Hours	50	hours/week	Hours of operation	client supplied
Days	260	Days/year	Hours of operation	client supplied
W	46	t	Truck capacity	client supplied
Waste received	250,000	t/y	Waste received	client supplied
Haul	0.7	VKT/hr	HDV Hauling	estimated
Haul	0.8	VKT/hr	LDV Hauling	estimated

Appendix B CONTOUR PLOTS

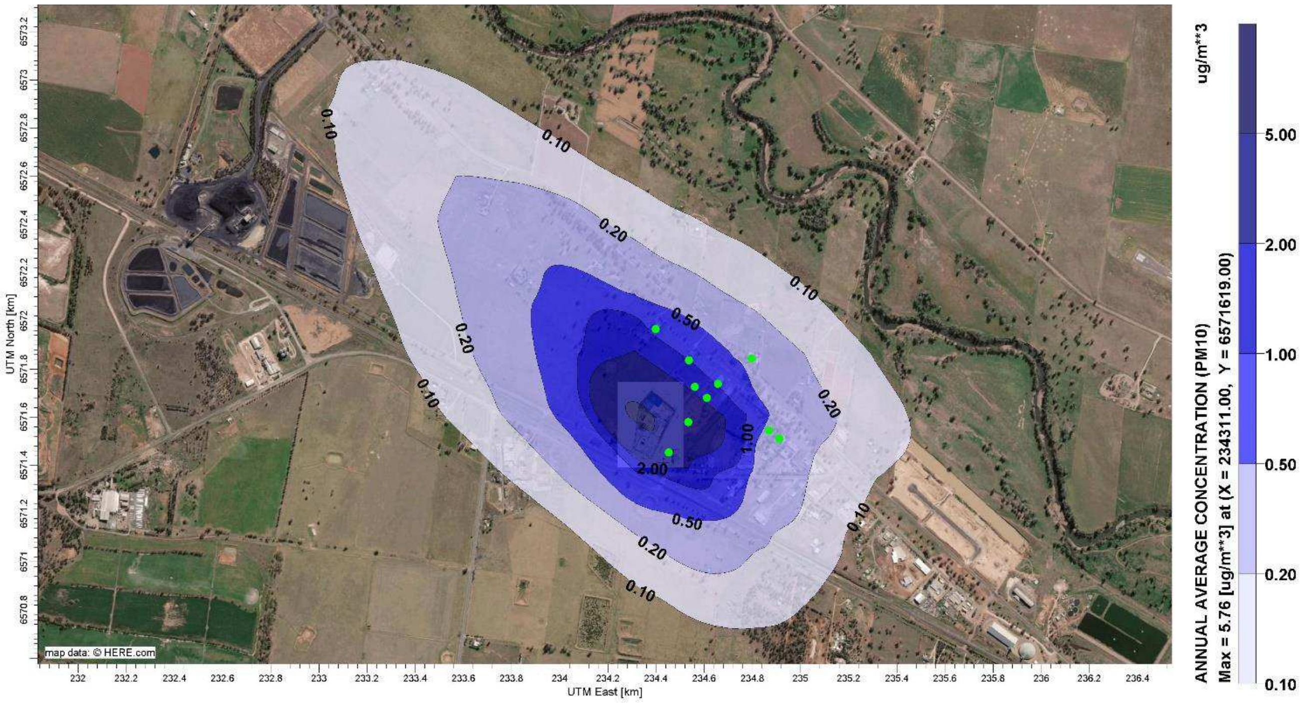
The contour plots are created from the predicted ground-level concentrations at the network of gridded receptors within the modelling domain at frequent intervals. These gridded values are converted into contours using triangulation interpolation in the CALPOST post-processing software within the CALPUFF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



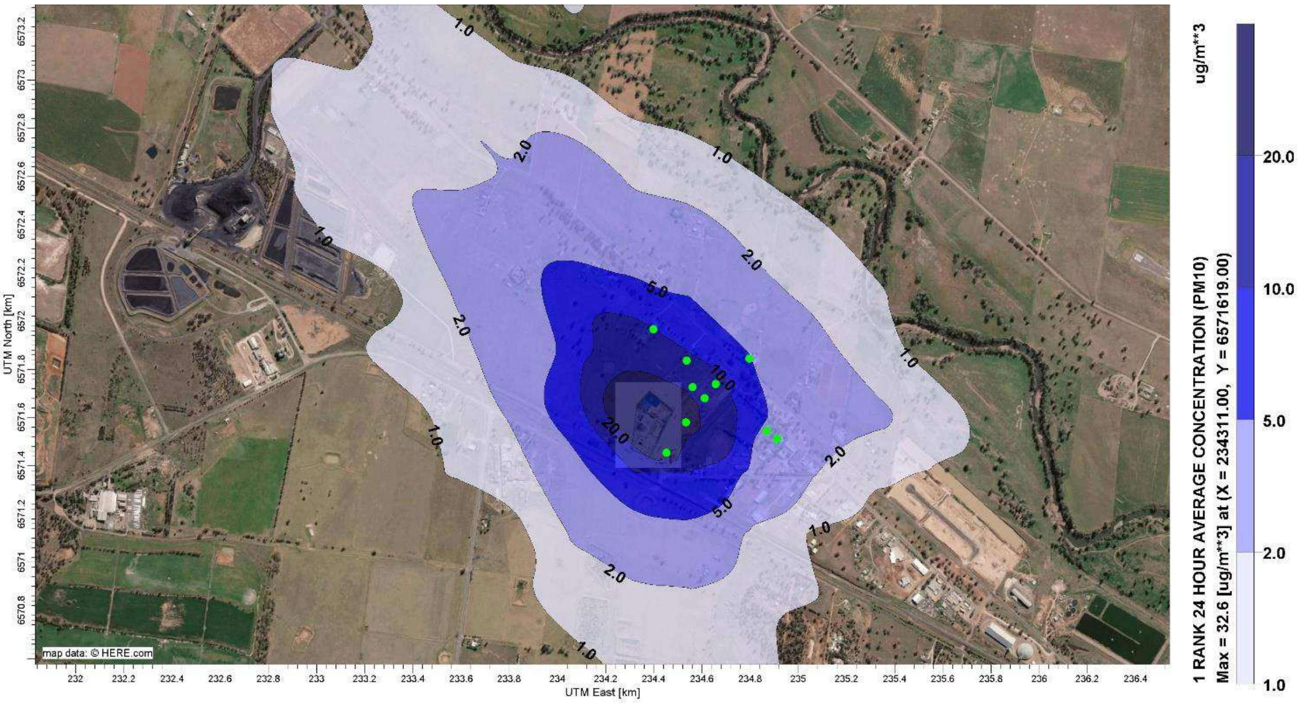
Pollutant:	Averaging Period:	Percentile:	Criteria:
Dust Deposition	Month	100th	2 g/m^2/month

Comment:
Incremental



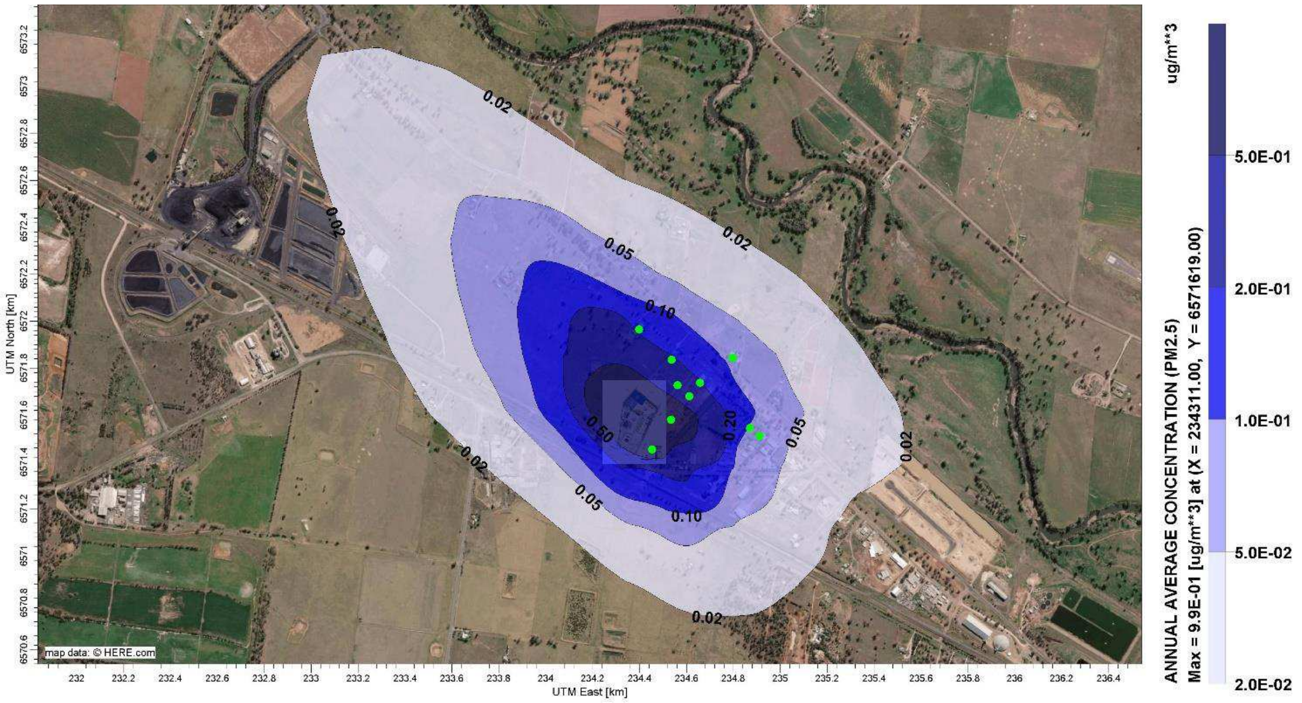
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10}	Annual	100th	25 µg/m^3

Comment:
Project Emissions



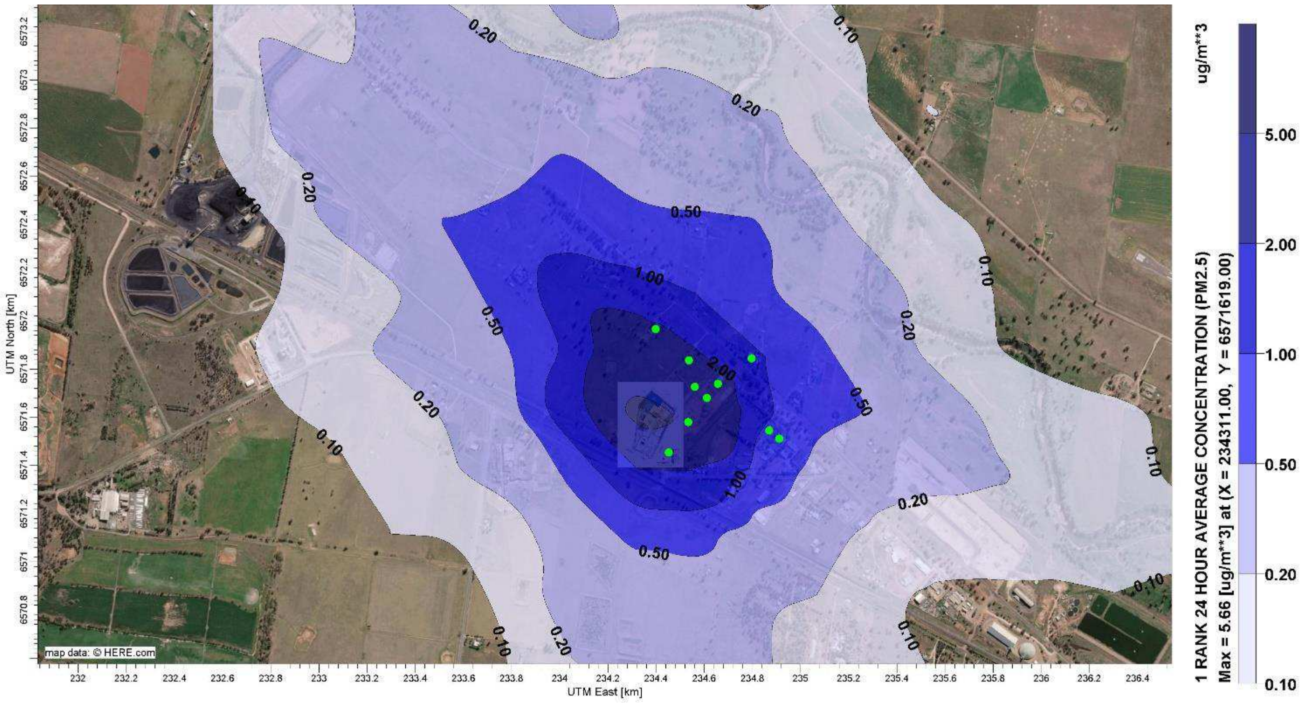
Pollutant:	Averaging Period:	Percentile:	Criteria:
PM_{10}	24 Hour	100th	50 µg/m^3

Comment:
Project Emissions



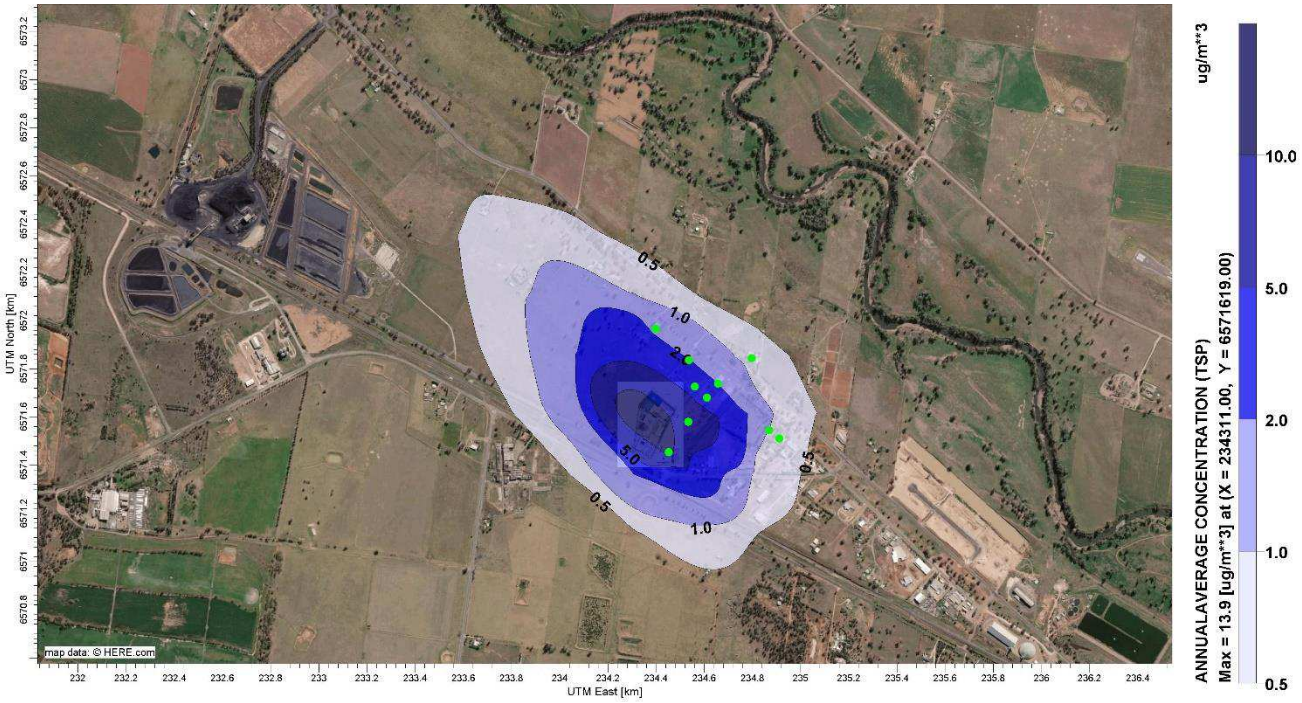
Pollutant:	Averaging Period:	Percentile:	Criteria:
$PM_{2.5}$	Annual	100th	8 μg/m³

Comment:
Project Emissions



Pollutant: PM$_{2.5}$	Averaging Period: 24 Hour	Percentile: 100th	Criteria: 25 µg/m^3

Comment:
Project Emissions



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

Comment:
Project Emissions