Appendix G

Air Quality Impact Assessment

Advanced Environmental Dynamics

Specialist Consultants

GREENSPOT RAVENSWORTH

GREENHOUSE GAS, ODOUR, AND DUST ASSESSMENTS

Report # 957002

Prepared for:

Bettergrow Pty Ltd

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9 August 2019

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Project Title	**Project / Report Number**
Greenspot Ravensworth Greenhouse Gas, Odour and Dust Assessments	957002

Authors	**Date**
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Revision	**Description**	**Date**
0	Draft Report	21/03/2019
1	Final	29/05/2019
2	Final	09/08/2019

Key Words	**Classification**
Odour, Dust, Greenhouse Gas, Management, Composting	Proprietary

Executive Summary

Advanced Environmental Dynamics Pty Ltd was commissioned by Bettergrow Pty Ltd to undertake greenhouse gas, odour and dust assessments of the expansion of the Greenspot Ravensworth composting and nutrient recycling facility (the Project) located at 74 Lemington Road, Ravensworth, New South Wales (NSW).

The Project site is located in a remote area which includes a number of active open cut mines. The nearest sensitive receptor is located at Camberwell, approximately 7 km to the southeast.

Project Background

Bettergrow are proposing to expand the current operations at the site from 76,000 tonnes per annum (tpa) to 200,000 tpa which will facilitate the increased composting of available organic material and allow for material not needed for mine rehabilitation to be sold for off-site use.

The main waste types and materials to be accepted at the site will include those which are currently in use:

- *Urban wood residues;*
- *Paper crumble;*
- *Wastewater from Bayswater mine Void 4;*
- *Natural organic fibrous material;*
- *Coal ash;*
- *Biosolids; and*
- *Garden waste*

with the addition of:

- *Drill mud process water; and*
- *Food and Garden Organics (FOGO).*

Composting will take place using both traditional windrow methods as well as forced aeration.

Greenhouse Gas Assessment

The current level of greenhouse gas emissions have been verified via direct measurement to be below the level of detection (Geotech GEM5000 Landfill Gas Analyser). With on-site electricity generation via a small petrol generator or solar power with battery backup, the

greenhouse gas assessment was limited to Scope 1 emissions associated with the consumption of diesel fuel.

Results of the GHG assessment suggest that emissions associated with the Project will be immaterial, contributing less than 0.0001% to the annual national total.

Odour Assessment

Odour from the Project may be associated with the processing and handling of the 200,000 tonnes of organic material. The site currently operates under a Composting Management Plan which outlines a number of odour management strategies and operational procedures (ZBE, 2016).

A single conservative odour scenario was considered based on peak volumes of material. Specific odour emission rates were based on on-site measurements supplemented by publically available information when required.

Based on the 99th percentile 1-second average concentration of odour, results of the odour dispersion modelling have not highlighted any issues with undetectable levels of odour (i.e. less than 1.0 OU) predicted at the nearest sensitive receptor location.

Dust Assessment

The assessment of the impact of dust focused on wheel generated dust due to truck movements on the approximately 6 km unsealed road from Lemington Road to the Project site. Although the haul road has multiuser access, this assessment has only included the explicit modelling of Project-related dust emissions.

Two dust emission scenarios were considered based on average and peak number of truck movements per day to the Project site.

Results of the dust assessment did not highlight any issues at the nearest sensitive receptor location.

Final Comments

Results of the greenhouse gas, odour and dust assessments for the Greenspot Ravensworth composting and nutrient recycling facility expansion has not highlighted any issues.

Results of both the odour and dust assessment suggest that current management practices will be sufficient to meet regulatory criteria.

Details of the site's current management strategies and operational procedures can be found in the Ravensworth Facility's Composting Management Plan (ZBE, 2016).

Table of Contents

Tables

Figures

Abbreviations

AED	Advanced Environmental Dynamics Pty Ltd
BoM	Bureau of Meteorology
c.	Circa (approximately)
CALMET	California Meteorological Model
CALPUFF	California Plume Dispersion Model
CER	Clean Energy Regulator
CH_4	Methane
CMP	Compost Management Plan
CO_2	Carbon dioxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEE	Department of the Environment and Energy
DEUS	Department of Energy Utilities and Sustainability
EPA	Environmental Protection Authority
ESAP	Energy Savings Action Plans
FO	Food organics
FOGO	Combined food organics and garden organics
GHG	Greenhouse gas
GO	Garden organics
LZE	LZ Environmental
MAF	Mobile Aerated Floor
NASA	National Aeronautics and Space Administration
N_2O	Nitrous oxide
NGA	National Greenhouse Accounts
NGER	National Greenhouse and Energy Reporting
NSW	New South Wales
OU	Odour units
P/M60	Peak to mean ratio based on one-hour average results
SOER	Specific odour emission rate
SRTM	Shuttle Radar Topography Mission

TAPM	The Air Pollution Model
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

Units

CO_{2-e}	Carbon dioxide equivalent
Gwh	Gigawatt hour
kwh	Kilowatt hour
m	metre
m^2	square meters
m^3	cubic meters
Mt	Mega tonnes
OU	Odour units
s	Second
t	tonnes
tpa	Tonnes per annum

1. Introduction

Advanced Environmental Dynamics Pty Ltd was commissioned by Bettergrow Pty Ltd (Bettergrow) to undertake greenhouse gas (GHG), odour and dust assessments of the expansion of the Greenspot Ravensworth composting and nutrient recycling facility (the Project) from 76,000 tonnes per annum (tpa) to 200,000 tpa.

This report contains a summary of the assessment methodologies and findings.

1.1 Current Operations

AED understands that Bettergrow (trading as Greenspot Hunter Valley) is seeking approval to expand its Ravensworth composting and nutrient recycling facility on Lot 10 DP1204457, 74 Lemington Road, Ravensworth, NSW (the site). The site is located approximately 20 km northwest of Singleton in the Hunter Valley, NSW and approximately 7 km northwest of Camberwell (Figure 1).

The site is located at Ravensworth No. 2 mine with an internal access road that connects the main part of the site to Lemington Road (Figure 2). The site is located on part of a capped open cut mining void which has been filled with ash from the Bayswater Power Station. The development footprint, including the existing approved composting facility is located in a graded hardstand area, surrounded by perimeter bunding.

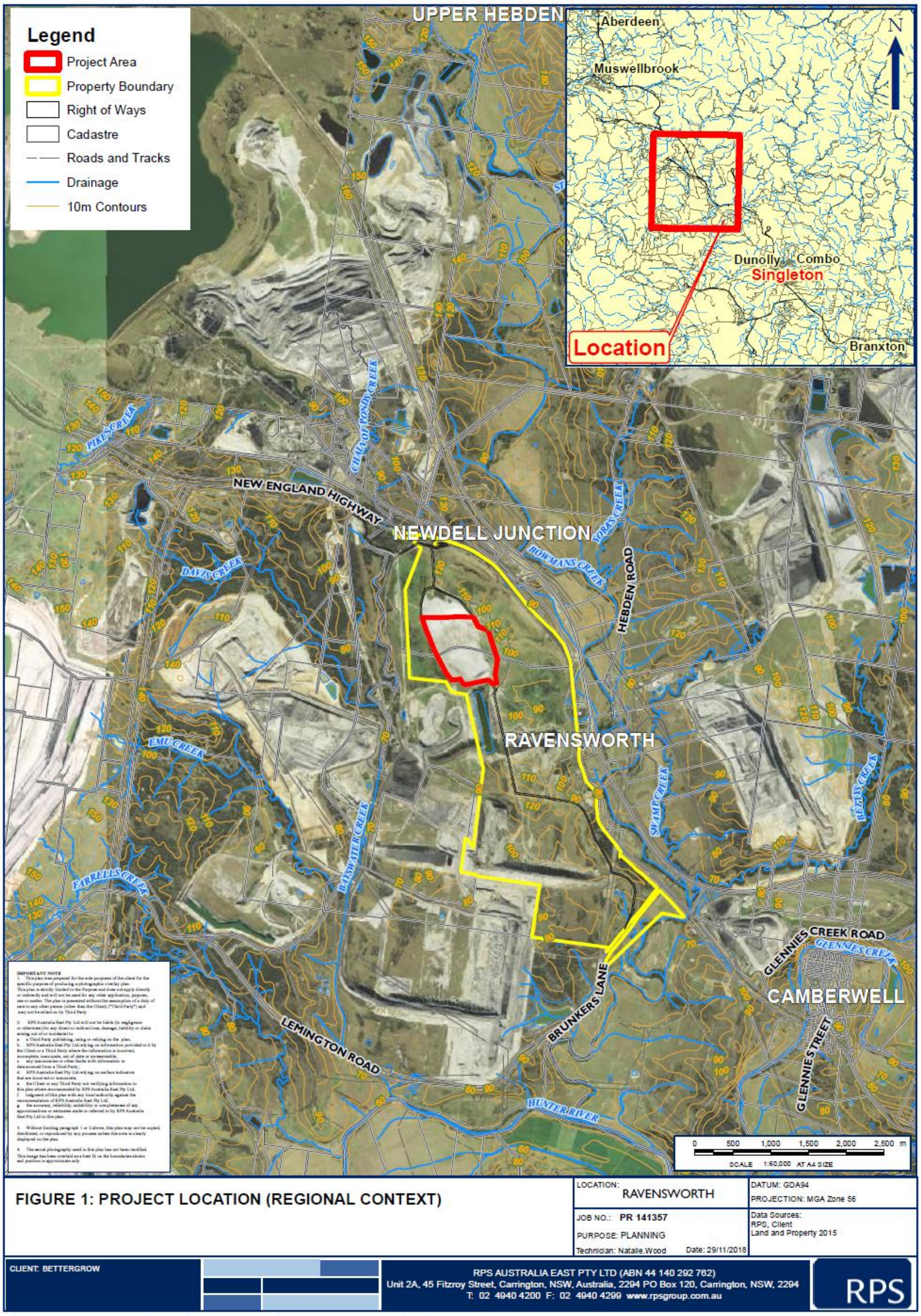
1.1.1 Current Site Use

The facility currently operates as follows:

- Hours of operation are from 06:00 to 18:00, Monday to Saturday
- Access is via the main entry gate off Lemington Road.
- Organic materials are unloaded to the existing hardstand areas for blending and processing.
- The hardstand covers approximately 16.58 hectares.
- Currently approved in-take streams comprise a mix of general solid waste (non-putrescible) and liquid waste which are limited to: Urban wood residues; Paper crumble; Wastewater from Bayswater mine Void 4; Natural organic fibrous material; Coal ash; Biosolids; and Garden waste

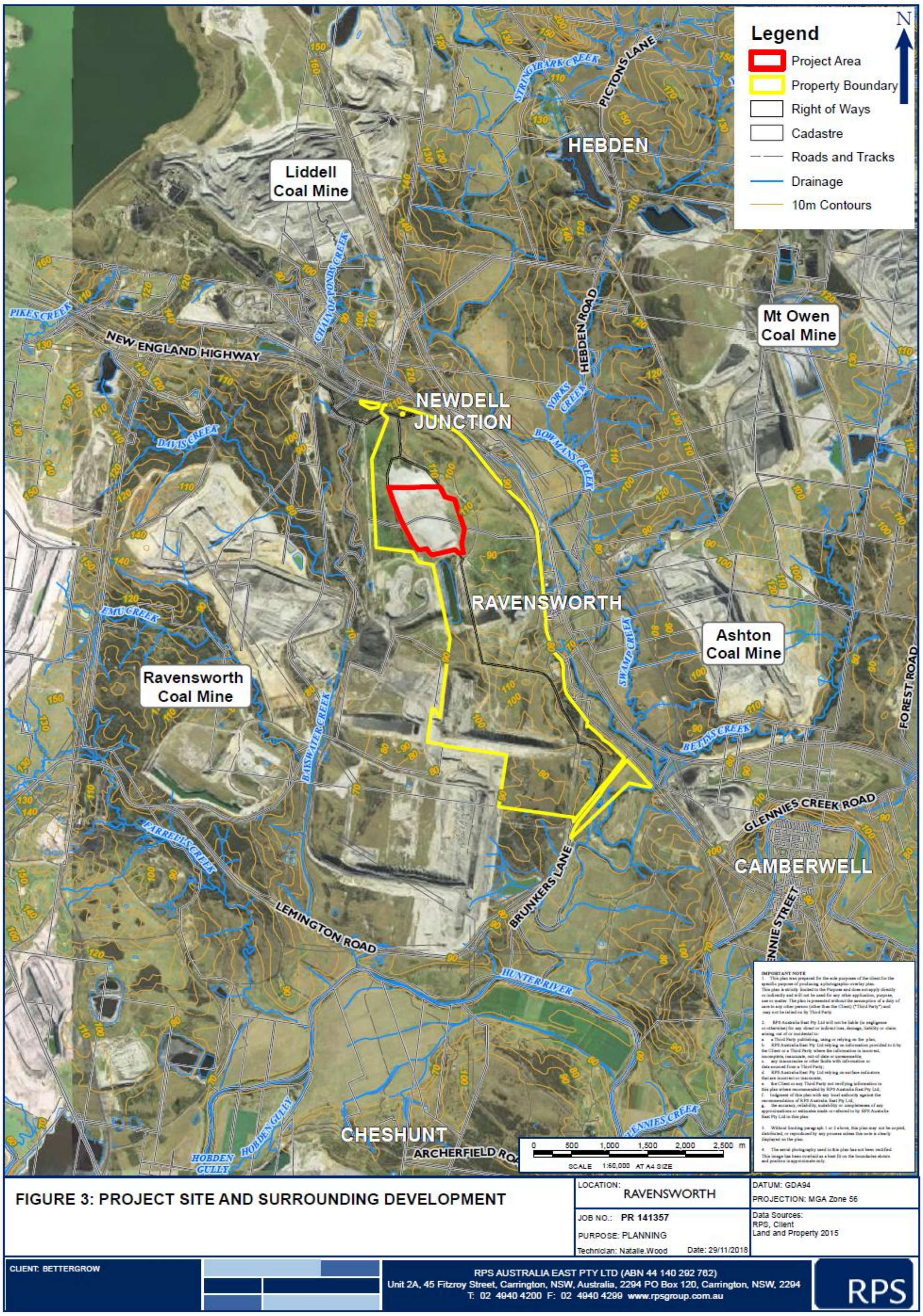
The existing approved operations are shown in Figure 3.

Figure 1: Site Location



Source: RPS

Figure 2: Site Access and Surrounding Development



Source: RPS

Figure 3: Approved Operations DA140/2016

Source: RPS

1.1.2 Surrounding Land Use

The development is located within an area that is dominated by coal mining and heavy industrial activities, including power generation and related activities. As such, the development is within a highly disturbed environment. The following land uses surround the development site (Figure 2):

- Liddell and Bayswater Power Station, including Lake Liddell to the north-west;
- Liddell Coal Operations to the north-west;
- New England Highway to the east;
- Ravensworth North Open-cut Coal Mine to the west; and
- Integra Coal Mine to the south-east.

It is additionally noted that Loop Organics have approval from Singleton Council (DA173/2016) for a composting facility on Lot 10, DP: 1204457, 74 Lemington Road, Ravensworth, NSW with a capacity of 55,000 tpa. The location of Loop Organics relative to the Project Site is depicted in Figure 4.

Figure 4: Location of Loop Organics to the South of the Project Site

Figure 5: Layout of the Loop Organics Facility

It is noted that in relation to odour from Loop Organics, the facilities Environmental Protection Licence states:

L5 Potentially offensive odour

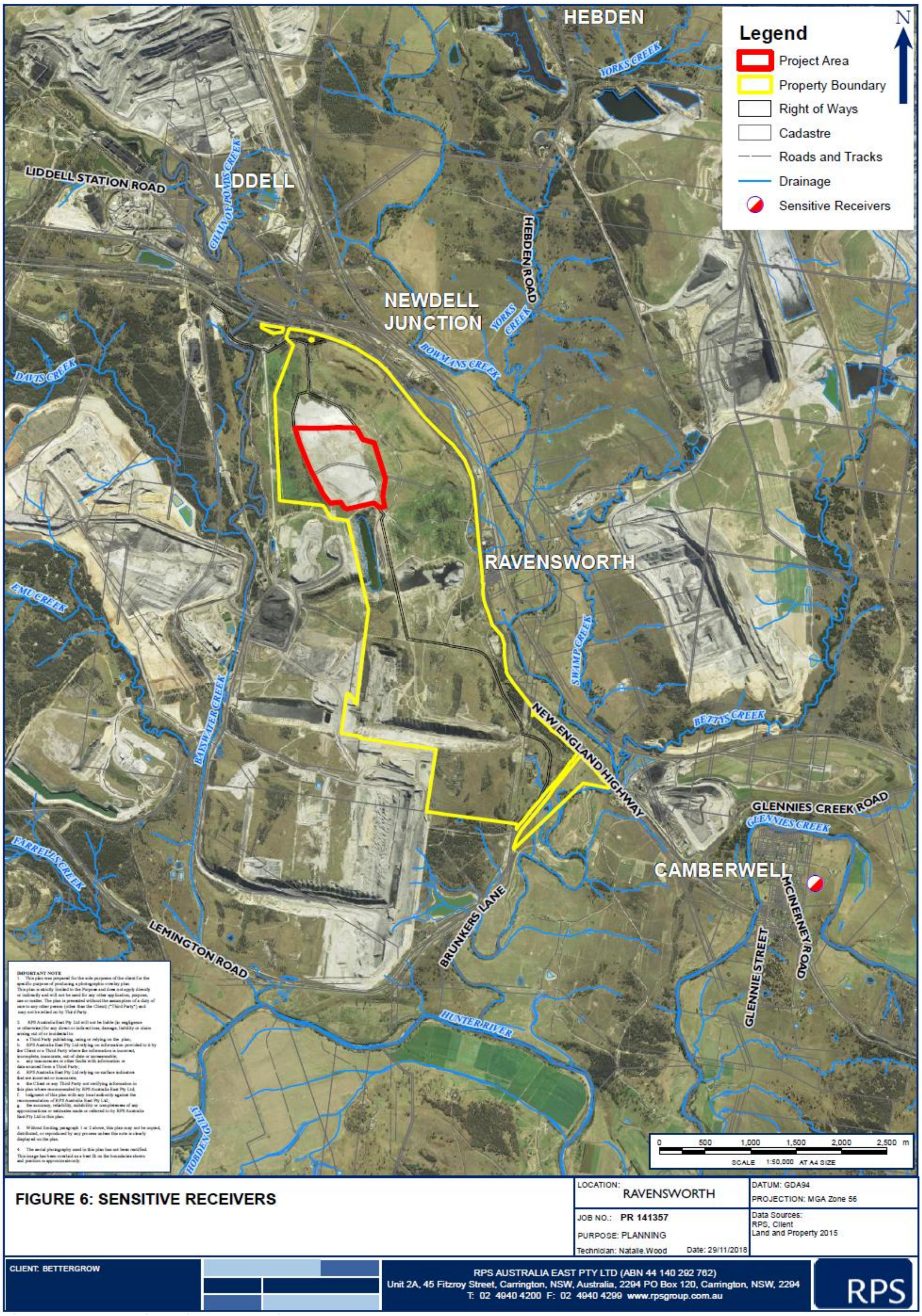
L.5.1 No condition of this licence identifies a potentially offensive odour for the purpose of section 129 of the Protection of the Environment Operations Act 1997

Note: Section 129 of the Protection of the Environment Operations Act 1997, provides that the licensee must not cause or permit the emission of any offensive odour from the premises but provides a defence if the emission is identified in the relevant environmental protection licence as the potentially offensive odour and the odour was emitted in accordance with the conditions in licence directed at minimising odour.

1.1.3 Sensitive Receptor Locations

The closest sensitive receivers to the development are a number of private rural residential properties at Camberwell Village (Figure 6) which is approximately 7 km to the southeast.

Figure 6: Sensitive Receptor Locations

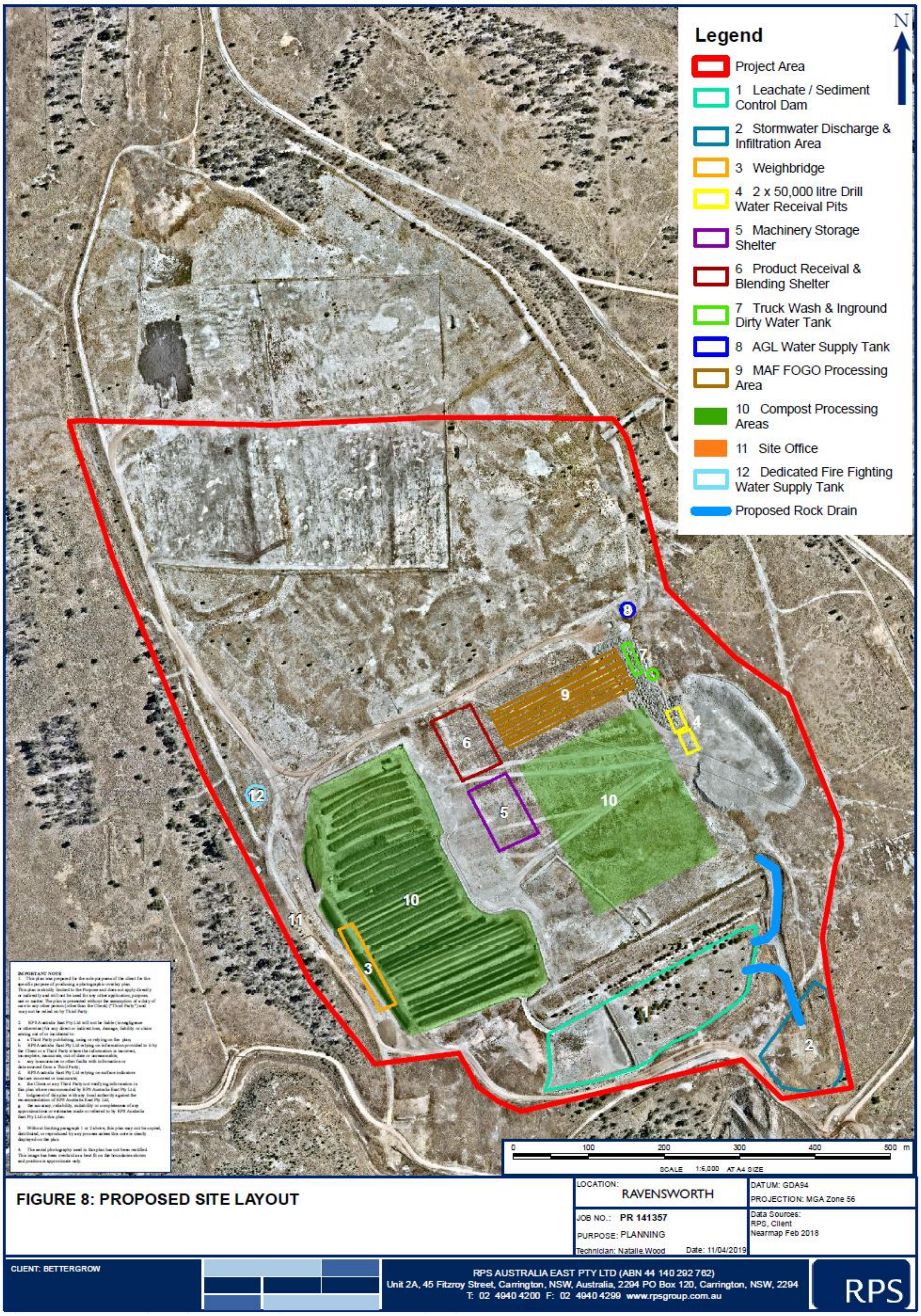


2. Project Description

Bettergrow are proposing to expand the current composting operations from 76,000 tpa to 200,000 tpa. The Project includes the following components that are relevant to this assessment (Figure 7):

- Receive a total of up to 200,000 tpa of organics;
- Transfer of the composted material for use in rehabilitation as per existing approval;
- Sale of a portion of the finished compost for off-site use;
- Upgrading of a proportion of the hardstand area and installation of a forced aeration composting system suitable for the management and composting of other organics including a combined food organic and garden organic (FOGO) resource stream.
- Installation of partially covered hard stand areas for the receival and blending of incoming organics including FOGO;
- Installation of a dedicated trailer wash bay;
- Installation of two 50,000 litre recycled drill water storage tanks for the storage and re-use of recycled water. This recycled water will be used in the organics composting process and for dust supression on roads onsite; and
- Expansion of the existing leachate/stormwater dam.

Figure 7: Proposed Site Layout



2.1 Project Construction

It is anticipated that construction activities will occur during the hours of 07:00 to 17:00 Monday to Friday and 08:00 to 13:00 on Saturdays.

Construction related vehicle movements are estimated to peak at 10 per day.

Based on the remoteness of the site and the scale of activities during the construction phase of the Project, no significant impacts of dust and/or odour is anticipated to occur at the nearest sensitive receptor location. Thus potential impacts associated with the construction phase of the Project have not been considered further.

2.2 Project Operations

The future operation of the facility including the Stage 2 development will parallel current operations (Section 1.1.1).

Of particular interest are those aspects of the operations that pertain to the greenhouse gas, odour and/or dust assessments. A description of the composting activities is provided in the following section. Additional information will be provided in the relevant sections of this report.

2.2.1 Composting

The main waste types and materials to be accepted at the site will include those listed in Section 1.1.1 (i.e.) which are currently in use, i.e.:

- Urban wood residues;
- Paper crumble;
- Wastewater from Bayswater mine Void 4;
- Natural organic fibrous material;
- Coal ash;
- Biosolids; and
- Garden waste

with the addition of:

- Drill mud process water; and
- Food and Garden Organics (FOGO).

Generally, the composting operations will involve the following key components:

- Biosolids received at the site will be immediately blended with garden organics and placed into windrows for pasteurisation and turning;
- Windrows will be frequently turned with either a front-end loader, or a specialised windrow turner to ensure they remain aerobic and that pasteurisation of all products is achieved. Windrows may initially be covered with previously composted material to act as an odour filter or odour neutralising agents may be used to aid the process;
- Mixed organic material will continue to be composted in windrows and will be turned to maintain aerobic conditions. On windy days, water may be sprayed over the compost or biosolids to prevent dust generation during the turning of windrows. The moisture content of windrows will be monitored and adjusted as required to maintain a moisture content of 45% to 50% w/w during composting;
- Dimensions of open windrows would be typically 2.5m high x 4m wide x 150m long;
- The composting process is expected to take approximately 8 weeks, after which maturation will occur. Compost must be dried to a moisture content of approximately 35% w/w or less. Finished compost material will be sorted and may be screened and blended with other ingredients to create the required final product. Final compost material will be loaded onto trucks using a front-end loader;
- The existing hardstand processing pad area will be used for the storage and processing of up to 200,000 tpa of composted material; and
- Water from the leachate dam may be used for irrigation or for use in the composting process. This may include wetting of hardstand pads and wetting of dry solid wastes to control the moisture content of windrows.

3. Greenhouse Gas Assessment

3.1 Legislative Framework

3.1.1 National Greenhouse and Energy Reporting Act 2007 and Supporting Legislation

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) and its associated regulations established the framework for a national greenhouse gas and energy reporting system in Australia.

The *National Greenhouse and Energy Reporting (NGER) Scheme 2007* was established by the NGER Act as a national framework for reporting and distributing information pertaining to greenhouse gas emissions, energy production, energy consumption as well as other information under NGER legislation. The objectives of the NGER Scheme are to (DEE, 2017):

- Inform policy making and the Australian public;
- Meet Australia's international reporting obligations; and
- Provide a single national reporting framework for energy and emissions reporting.

The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* provides methods and criteria for calculating greenhouse gas emissions and energy data under the NGER Act and is updated annually.

The National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (NGER Technical Guidelines) have been developed in order to assist stakeholders understand and apply the NGER (Measurement) Determination 2008.

3.1.2 Energy Efficiency Opportunities

The Department of Energy Utilities and Sustainability (DEUS, 2005) requires that NSW sites designated by the Minister as using over 10 GWh in electricity per annum prepare Energy Savings Action Plans (ESAPs).

As the facility will not use electricity from the grid, the site will not be required to prepare ESAPs.

3.2 Greenhouse Gas Emissions Inventory Methodology

The GHG emissions inventory for the Project is based on the accounting and reporting principles detailed within the *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard Revised Edition* (WBCSD & WRI). The protocol was first established in 1998 to develop internationally accepted accounting and reporting standards for GHG emissions from companies.

The Greenhouse Gas Protocol defines direct and indirect emissions through the concept of emission Scopes.

- **Scope 1:** Direct GHG emissions. Direct GHG emissions occur from sources that are owned or controlled by a company. For example emissions from combustion in owned or controlled boilers, furnaces or vehicles.
- **Scope 2:** Electricity indirect GHG emissions. This accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated but the emissions are allocated to the organisation that owns or controls the plant or equipment where the electricity is consumed.
- **Scope 3:** Other Indirect GHG emissions. This is an optional reporting category that allows for the treatment of all other indirect GHG emissions resulting from a company's activities, which occur from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation of product by contractors; use of sold products and services; and employee business travel and commuting.

3.2.1 Calculation Approach

The GHG emission inventory for the Project is based on the methodology detailed in the Greenhouse Gas Protocol (WBCSD & WRI) and the relevant emission factors in the National Greenhouse Accounts (NGA) Factors (DEE, 2017a).

There are several GHGs including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). However, to simplify inventory accounting, a single unit of measurement, the carbon dioxide equivalent ($CO_{2\text{-}e}$) is used. This unit of measure accounts for the various global warming potentials of non-CO_2 gases as specified by DEE (2017a).

3.2.2 Emission Factors

The National Greenhouse Accounts Factors (DEE, 2017a) provides emission factors for a variety of activities. Those for Scope 1 emissions associated with the Project are summarised in Table 1 with factors for Scope 2 emissions included in Table 2.

Table 1: Scope 1 Emission Factors: Consumption of Liquid Fuel for Transport (DEE, 2017a)

Category	Fuel Type	Energy Factor (GJ/Kl)	EF (kg CO_2-e/GJ)		
			CO_2	CH_4	N_2O
General transport	Diesel oil	38.6	69.9	0.10	0.5
Post-2004 vehicles	Diesel oil	38.6	69.9	0.01	0.5
Heavy Vehicles - Euro iv	Diesel oil	38.6	69.9	0.06	0.5
Heavy Vehicles - Euro iii	Diesel oil	38.6	69.9	0.10	0.5
Heavy vehicles - Euro i	Diesel oil	38.6	69.9	0.20	0.5

Table 2: Scope 2 Emission Factors: Consumption of Electricity (DEE, 2016a)

Category	State	Units
Electricity Use	NSW	Kg CO_{2-e}/kwh

3.2.3 Emissions of GHG during Composting

In order to confirm the materiality (or otherwise) of emissions of GHG's during composting, direct measurement was undertaken of emissions of carbon dioxide, methane and nitrous oxide from a variety of samples on site as summarised in Table 3.

Table 3: Results from GHG Sampling at the Ravensworth Facility (22/11/2018)

Sample Location	Description	Carbon Dioxide (CO_2) (%)	Methane (CH_4) (%)	Nitrous Oxide (N_2O) (PPM)
		Geotech GEM5000 Landfill Gas Analyser	Geotech GEM5000 Landfill Gas Analyser	ISO 21258
		±2%	±2%	±5%
BG 1	Organic Sample, windrow SP1, fresh green waste	<0.1	<0.01	<0.1
BG 2	Five week old compost windrow No 26, 3:1 mix (3 parts green organic + 1 part biosolids	<0.1	<0.01	<0.1
BG 3	Product sample Windrows No 13/14 3:1 Mix (3 parts green organic + 1 part biosolids)	<0.1	<0.01	<0.1
BG 4	Freshly opened compost windrow No. 23/2	<0.1	<0.01	<0.1
BG 5	One-week old compost windrow, test windrow, 3:1 mix (3 parts green organic + 1 part biosolids	<0.1	<0.01	<0.1
BG 6	Biosolids sample windrow 3020 (20/11/2018)	<0.1	<0.01	<0.1

3.2.4 Materiality

Materiality is a concept used in accounting and auditing to minimise time spent verifying amounts and figures that do not impact a company's accounts or inventory in a material way. The exact materiality threshold that is used in GHG emissions accounting and auditing is subjective and dependant on the context of the site and the details of the inventory.

All emissions that originate within the boundary are included in the inventory unless they are excluded on materiality grounds. Information is considered to be material if, by its inclusion or exclusion it can be seen to influence any decisions or outcomes. On the other hand, emissions are assumed to be immaterial if they are likely to account for less than (say) five per cent of the overall emissions profile.

The following emissions are not included in the inventory for this project on the basis of materiality:

- Based on the results from the GHG emissions sampling that was undertaken on site (Table 3) the inventory does not consider emissions associated with composting; and

- The consumption of unleaded petrol (ULP) which is limited to c. 1,500 litres per annum.

3.3 Greenhouse Gas Emission Sources

The Greenspot Ravensworth Facility does not consume electricity from the grid. Instead, a small petrol generator is currently used to generate electricity for the site office (consuming an estimated 1,500 litres per annum under peak operating conditions). Electricity for the weigh bridge facility will be generated using solar power with battery backup.

Thus, greenhouse gas emissions associated with the Project are limited to the consumption of fuel, and in particular the consumption of diesel fuel in mobile plant including: three loaders, 1 excavator, 1 windrow turner, 1 water cart and 1 trommel. Approximately 139,000 litres per annum of diesel will be consumed on site.

A breakdown of the estimated fuel consumption under peak conditions is provided in Table 4.

Table 4: Fuel Consumption

Activity	Fuel Type	Diesel (litres)
Loaders	Diesel	76,500
Excavators	Diesel	22,500
Windrow Turner	Diesel	25,000
Water Cart	Diesel	5,000
Trommel	Diesel	10,000
Site Total (per annum)		**139,000**
Generator	Petrol	1,500
Site Total (per annum)		**1,500**

3.4 Greenhouse Gas Emissions

3.4.1 Scope 1 Emissions

Based on the use of the worst-case Scope 1 emission factors for the consumption of diesel fuel (Table 1) and an annual total of 139,000 litres of diesel fuel consumed on site, Scope 1 emissions associated with diesel consumption are estimated to be 379.3 tonnes of CO_{2-e} per annum (Table 5).

Table 5: Scope 1 Emissions: Diesel Consumption

Activity	Diesel (litres)	CO_2	CH_4	N_2O	Total
		t CO2-e	t CO2-e	t CO2-e	t CO2-e
Loaders	76,500	206.4	0.6	1.8	**208.8**
Excavators	22,500	60.7	0.2	0.5	**61.4**
Windrow Turner	25,000	67.5	0.2	0.6	**68.2**
Water Cart	5,000	13.5	0.0	0.1	**13.6**
Trommel	10,000	27.0	0.1	0.2	**27.3**
Site Total (per annum)	**139,000**	**375.0**	**1.1**	**3.2**	**379.3**

3.4.2 Scope 2 Emissions

As the site does not consume electricity, there are no Scope 2 emissions associated with the Project.

3.4.3 Total Greenhouse Gas Emissions

The total Scope 1 and Scope 2 emissions of greenhouse gases per annum associated with site activities is estimated to be 379.3 tonnes of $CO_{2\text{-}e}$.

3.4.4 Comparison with National Total

Australia's annual total emissions for the year to September 2017 were estimated to be 557.7 megatonnes (Mt) of $CO_{2\text{-}e}$ (DEE, 2018). A breakdown of Australia's emissions by sector is provided in Table 6. A comparison of the Project emissions with those of the waste sector suggests that the Project will contribute an additional 0.003% to this sector and an additional 0.0001% to the annual national total (excluding land use, land use change and forestry).

Table 6: National Greenhouse Gas Inventory, Year to September 2018, (DEE, 2018)

Sector	Emissions (Mt $CO_{2\text{-}e}$)
Energy - Electricity	180.4
Energy - Stationary excluding electricity	101.6
Energy - Transport	101.3
Energy - Fugitive	57.3
Industrial processes and product use	34.7
Agriculture	70.3
Waste	12.1
Total excluding land use, land use change and forestry	**557.7**
land use, land use change and forestry	-21.7
Total including land use, land use change and forestry	**536.0**

3.5 Mitigation and Management Strategies

Although the scale of GHG emissions associated with the Project are minimal, opportunities to further reduce GHG emissions should be considered whenever possible/practicable. Potential mitigation and management strategies that could assist in reducing greenhouse gas emissions through improved energy efficiencies include (but may not be limited to):

- Use of building materials for walls, floors, roofs, that provide insulation and aid in reduced energy costs;
- Maximisation of natural ventilation and use of inverter air conditioning systems;
- Use of natural lighting;
- Use of light sensors to minimise lighting related electricity usage;
- Use of high efficiency lighting;
- Whenever practicable, vehicles to leave site with full loads to reduce the number of traffic movements and diesel consumption; and
- All vehicles/plant and machinery will be turned off when not in use and regularly serviced to ensure efficient operation.

4. Odour Assessment Methodology

4.1 Odour Assessment Criteria

Assessment criteria related to complex odorous emissions (as measured in odour units OU) as prescribed in NSW (2005) is dependent on the scale of the affected population with criterion ranging from 2 OU to 7 OU (Table 7). In general, which assessment criterion is appropriate will depend on the extent of the population that is predicted to be impacted upon (i.e. exposed to an odour impact greater than 2 OU).

Due to the remoteness of the site and the scale of the operations, it was anticipated that there would be no receptor locations affected by odour at levels above 2 OU based on a nose-response-time (i.e. 1-second) average 99th percentile.

Table 7: Population Based Odour Criteria (NSW, 2005)

Table 7.5: Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile) (EPA 2001)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

4.2 Material Handling and Odour Sources

Based on information provided by the proponent, it is understood that the following handling of potentially odorous material will occur on site:

- **Raw Biosolids:** There will be no stockpiling of raw biosolids. All incoming biosolids will be immediately blended with garden organics and placed into windrows to commence the composting process. Active windrows being managed by the windrow turner are approximately 2 metres in height and 5 metres wide in a trapezoidal shape with a flat top. Active windrows managed by excavator and loader can be up to 3 metres in height and potentially 7 metres wide again in a trapezoidal shape.

- **Garden Organics:** The majority of the garden organics will upon receipt on site be immediately blended with either biosolids and managed as described above or with food waste and placed onto the aerated pad area for forced aerated composting. The food and green windrow size will be approximately 2 to 2.5 metres high and 5 metres at the base again in a trapezoidal shape.
- **Food Organics:** All incoming FOGO (Garden organics containing food waste) directly from kerbside collection will be immediately placed onto the forced aerated floor composting area in windrows 2 to 2.5 metres high as described above.
- The **product receival shed** if required will only be used for the temporary storage of products prior to blending. Any potentially odorous material temporarily stored in the intake streams shed will be covered with finished compost to control any potential fugitive odour release.

4.2.1 Windrows and Stockpiles

At any given time, at maximum capacity of 200,000 tonnes per year, there may be up to 50,000 tonnes of composting material in windrows and 25,000 tonnes of finished product ready for campaign despatch.

The 50,000 tonnes in windrows would constitute 30 rows at 100m long by 5 metres wide and 2 metres high and 15 rows double the volume, 100 metres long.

The 25,000 tonnes of finished stabilised, screened and blended compost in stockpile windrows of approximately 5,000 tonnes each up to 8 metres in height with a surface area of approximately 3,000 m^2.

4.3 Odour Emissions Inventory

As noted in Section 1, the key odorous emission sources associated with activities include:

- Material composting in windrows;
- Finished product;
- Leachate water contained in the storage dam; and
- Potential odour associated with the short term storage of intake streams in the semi-enclosed receival shed.

Specific odour emission rates (SOERs) based on odour sampling undertaken at the Ravensworth Composting facility are summarised in Table 10. Since the facility does not currently undertake composting using forced aeration, relevant information was sourced from data presented in AED (2015) and was used to estimate the potential increase in odour emissions associated with forced aeration (Table 9). Finally, SOERs for intake streams that do not form part of the current operations (i.e. FOGO) was sourced from publically available information (Table 10).

Table 8: Specific Odour Emission Rates – Composting

Sample Location	Description	SOER[1] (ou.m3/m2/s)
BG 1	Organic Sample, windrow SP1, fresh green waste	0.027
BG 2	Five week old compost windrow No 26, 3:1 mix (3 parts green organic + 1 part biosolids	0.03
BG 3	Product sample Windrows No 13/14 3:1 Mix (3 parts green organic + 1 part biosolids)	0.032
BG 4	Freshly opened compost windrow No. 23/2	0.041
BG 5	One-week old compost window, test window, 3:1 mix (3 parts green organic + 1 part biosolids	0.045
BG 6	Biosolids sample windrow 3020 (20/11/2018)	0.553
Note (1): Results based on flux hood odour sampling undertaken at the Ravensworth Facility on 22/11/2018.		

Table 9: Specific Odour Emission Rates – Composting (AED, 2015)

Sample #	Sample	Description	Age	SOER
			(weeks)	(ou.m3/m2/s)
20	Fresh shredded green waste		0	0.266
11	P7	Uncovered (not aerated)	6	0.1
13	P7	Uncovered (aerated)	6	0.22
12	P8	Uncovered (not aerated)	7	0.065
14	P8	Uncovered (aerated)	7	0.133
Note (1): Based on data that was reported in support of the Greenspot Recycling Park Odour Assessment (AED Report # 959511). Prepared for Bettergrow Pty Ltd. Dated 13/09/2015.				

Table 10: Specific Odour Emission Rates (literature)

Odour Source	SOER $(OUm^3/((m^2))(sec)$
Green waste (shredded, uncovered)	2.37[1]
Solid food processing wastes	2.5-5.0
Note (1): GHD Pty Ltd, 2003: Camden Soil Mix Composting and Recycling Facility Local Environmental Study – Air Quality Assessment.	

4.4 Odour Emission Scenarios

Due to the remoteness of the site and the scale of the proposed operations, a single conservative odour scenario was considered based on peak volumes of material.

The SOERs adopted for the existing composting pad (ECP, Figure 8) were based on site-specific measurements (Table 8) for recently turned and unturned composting windrows.

Based on the information provided in Table 9, a factor of 2 was applied to the SOERs for the ECP and used to represent potential SOERS for activities associated with the aerated composting pads (ACP).

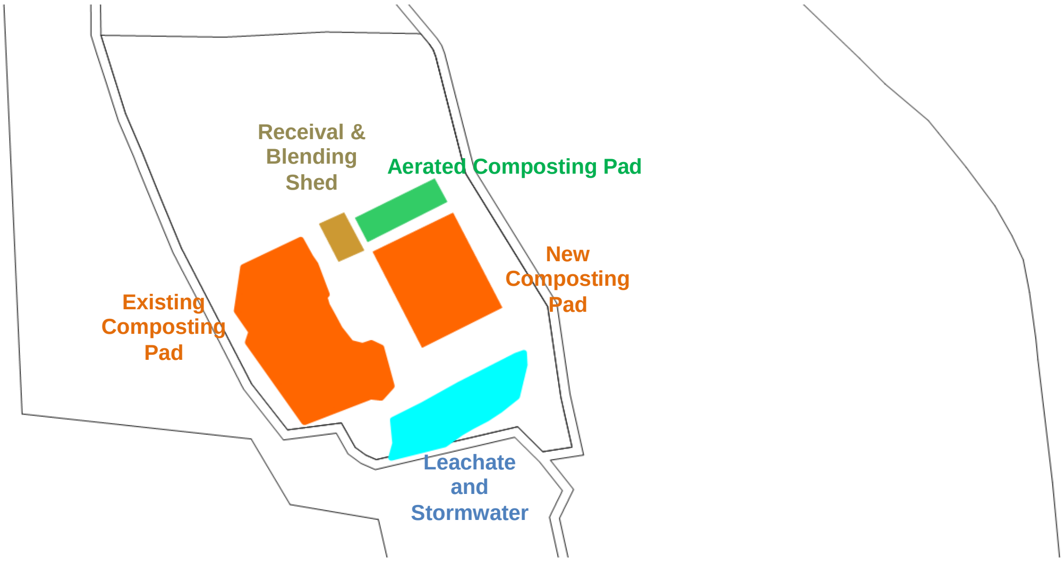
The SOERs for the receival & blending shed as well as for the leachate/stormwater dam were adopted from the information summarised in Table 10.

Table 11: Odour Emission Scenario

Source ID	Description	Surface Area (m2)	SOER ($OUm^3/((m^2))(sec)$)		Odour Emission Rate	
			During Working Hours	Outside working hours	During Working Hours OU/s	Outside Working Hours OU/s
Aerated Composting Pad	Aerated composting	10,800	0.072[(2)]	0.068[(2)]	772	734
Existing Composting Pad + New Composting Pad	Composting	34,560	0.034[(1)]	0.034[(1)]	1,175	1,175
	Freshly turned compost	8,640	0.041[(1)]	0.034[(1)]	354	294
	Product	12,000	0.032[(1)]	0.032[(1)]	384	384
Receival & Blending	Area	200	5.00[(3)]	0.00	1000	0
Leachate Pond	Area	19,800	1.00[(1)]	1.00[(1)]	19,800	19,800

Notes:
(1) Based on site-specific odour sampling results (Table 8).
(2) Based on site-specific odour sampling results scaled by a factor of 2 to account for the potential increased odour emission rate associated with forced aeration (Table 8, Table 9).
(3) Based on publically available information (Table 10).

Figure 8: Location of Odour Emission Sources



4.5 Summary of the Odour Dispersion Modelling Methodology

This odour assessment has been undertaken in consideration of and/or in accordance with:

- (NSW DEC, 2005)*: Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC).
- *Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (DEC).*
- *Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (DEC).*

Additionally it is noted:

- Odour dispersion modelling has been undertaken using a combination of the US EPA approved CALMET/CALPUFF modelling system (Scirer, 2000a) with numerically simulated upper air data based on TAPM. Regional, three-dimensional wind fields that are used as input into the dispersion model were prepared using a combination of The Air Pollution Model (TAPM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Hurley, 2008), and CALMET, the meteorological pre-cursor for CALPUFF (Scirer, 2000b).
- A total of three years of hourly meteorology was developed corresponding to years 2015, 2016 and 2017.

- Odour emission sources have been represented in the dispersion model using area sources (Figure 8). A summary of the applied odour emission rate is provided in Table 11.

- When applying a peak to mean ratio to the results of the dispersion model which is based on hourly averages, consideration was given to Table 6.1 of the NSW DEC (2005) which is reproduced below as Table 12.

  It is important to note that the concept of 'near-field' and 'far-field' is as much a property of the receiver as it is the source. It is the distance between the source and the receiver that will determine whether or not the receptor is located within the near-field or far-field influences of the source region. This is further complicated by the fact that the determination of whether or not a receptor lies within the far-field or near-field region may be influenced by atmospheric stability. Thus, even in circumstances of flat-terrain, the application of these peak-to-mean ratios is not necessarily straight-forward.

  It is further noted, that the values of the peak-to-mean ratio included in Table 12 are considered representative for flat terrain. Thus for this assessment, a conservative approach was adopted whereby a peak to mean ratio of 2.5 has been applied to all receptor locations under all atmospheric stability class conditions (Table 12, highlighted cell).

Table 12: Peak-to Mean Ratios for Flat Terrain (Source: NSW DEC (2005))

Table 6.1: Factors for estimating peak concentrations in flat terrain (Katestone Scientific 1995 and 1998)

Source type	Pasquill–Gifford stability class	Near-field P/M60*	Far-field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A–F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A–F	2.3	2.3
Volume	A–F	2.3	2.3

* Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

Additional information pertaining to the technical set up of the models is provided in Appendix A and Appendix C. Presented in Appendix B is a summary of the site-specific meteorology developed for the study region.

4.6 Results from the Odour Modelling

4.6.1 Interpretation of Odour Impacts

Presented in Table 13 is the maximum 99^{th} percentile 1-second average concentration of odour that is predicted to occur at the nearest sensitive receptor location. Results of the odour modelling suggest that there will be no perceptible odour at the nearest receptor location (i.e. Camberwell) due to the Project with the maximum odour impact predicted to be less than 1 OU. Note that the minimum perceptible level of odour is 1.0 OU and the strictest regulatory criterion is 2 OU.

Table 13: Results for the 99^{th} Percentile 1-Second Average Concentration of Odour

Scenario	Project Capacity	Meteorological Year	Camberwell (OU)
1	Peak	2015	<0.1
		2016	<0.1
		2017	<0.1

4.6.2 Contour Plots

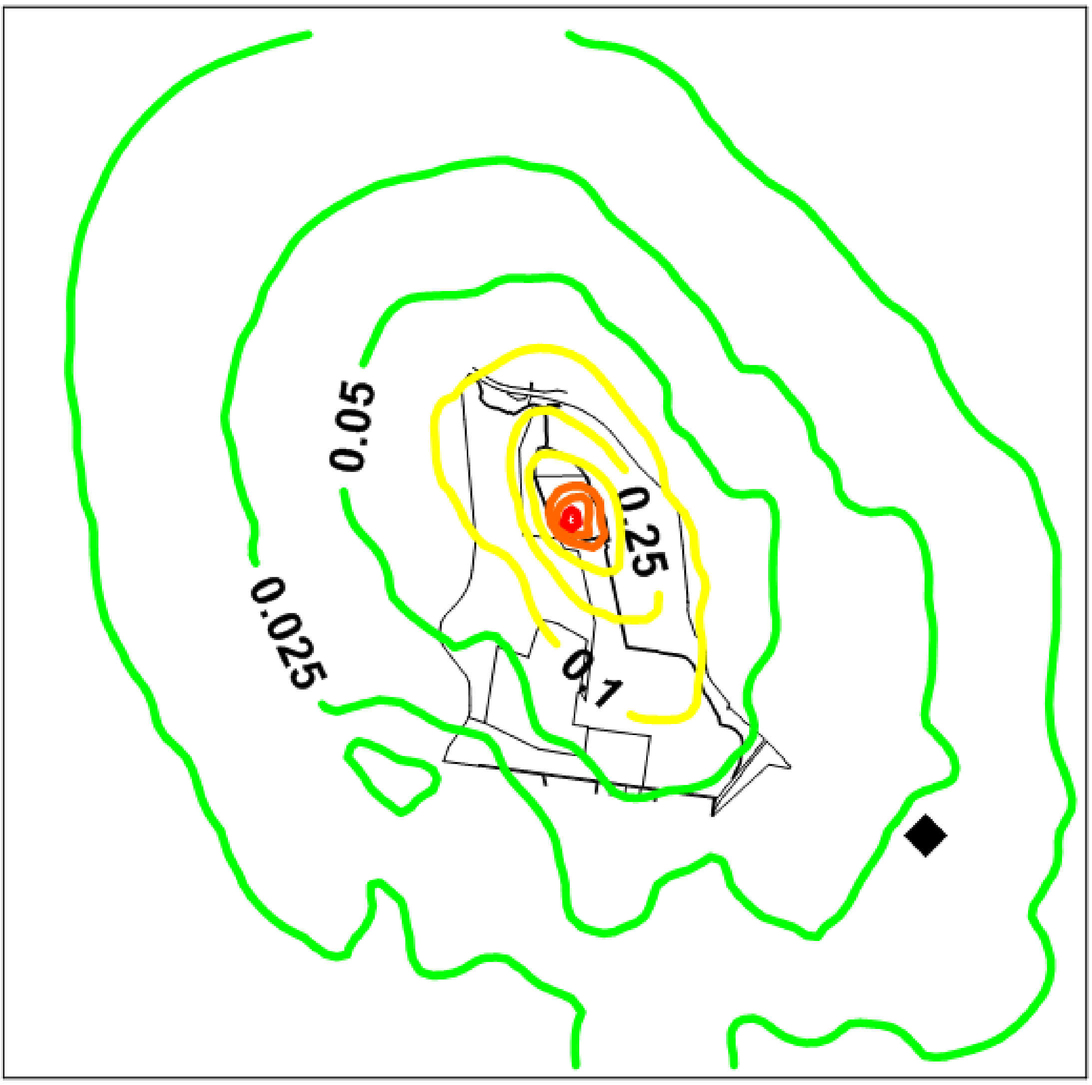
When interpreting results presented as contour plots, it is important to note that the figure does not represent a snapshot at any given time. Instead, it presents the 99^{th} percentile 1-second odour concentration at each location in the study region which for each receptor may occur at different times of the year and under different atmospheric conditions.

Presented in Figure 9 through Figure 11 are contour plots of the 99^{th} percentile, 1-second average concentration of odour as predicted using the CALPUFF dispersion model for meteorological years 2015 through 2017 for the peak tonnage scenario. Note that the contours are colour coded with:

- green contours associated with an odour concentration less than 0.1 OU,
- yellow contours for values between 0.1 OU and 1.0 OU,
- orange contours for values between 1.0 OU and 2.0 OU and
- red contours for values over the minimum regulatory criterion of 2 OU.

In general, no significant issues are indicated by the results of the dispersion modelling at any off-site location.

Figure 9: Peak Tonnage Scenario: The 99th Percentile 1-Second Average Concentration of Odour (OU) based on Meteorology for 2015

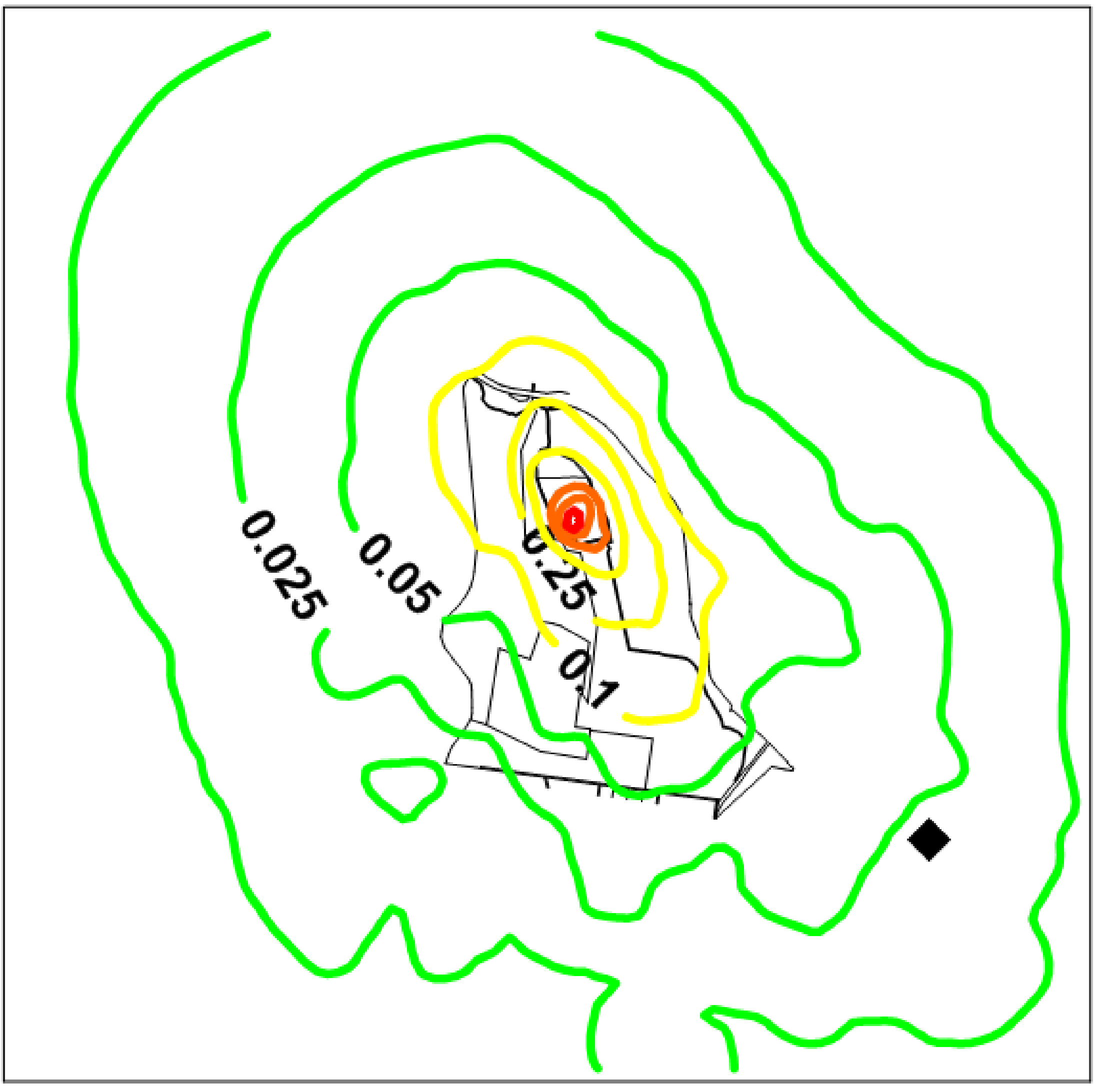


Scenario: As labelled		**Sources included:** All sources	
Pollutant:	Odour	Averaging Period:	1-second
Background-level:	N/A	Rank:	99th percentile based on 2015 meteorology
Project Goal:	7 OU	Contour level(s):	0.001, 0.0025, 0.005 (green), 0.1, 0.25, 0.5 (yellow), 1, 1.5 (orange), 2 (red) OU

Figure 10: Peak Tonnage Scenario: The 99th Percentile 1-Second Average Concentration of Odour (OU) based on Meteorology for 2016

Scenario: As labelled		**Sources included:** All Sources	
Pollutant:	Odour	Averaging Period:	1-second
Background-level:	N/A	Rank:	99th percentile based on 2016 meteorology
Project Goal:	7 OU	Contour level(s):	0.001, 0.0025, 0.005 (green), 0.1, 0.25, 0.5 (yellow), 1, 1.5 (orange), 2 (red) OU

Figure 11: Peak Tonnage Scenario: The 99th Percentile 1-Second Average Concentration of Odour (OU) based on Meteorology for 2017



Scenario: As labelled		**Sources included:** All Sources	
Pollutant:	Odour	Averaging Period:	1-second
Background-level:	N/A	Rank:	99th percentile based on 2017 meteorology
Project Goal:	7 OU	Contour level(s):	0.001, 0.0025, 0.005 (green), 0.1, 0.25, 0.5 (yellow), 1, 1.5 (orange), 2 (red) OU

4.7 Odour Management

The potential for odour-related impacts to off-site receptors will be managed through the adopted odour reduction measures that form part of the site's Composting Management Plan (CMP) (LZE, 2016). In particular it is noted that Section 11.1.2 *Odour Management*, Section 11.2.1 *Stormwater Management*, Section 11.2.2 *Basin Water Health and Management*, and Section 12. *Management Procedures*, of the CMP (LZE, 2016) include references to odour management strategies to be implemented on site as/if required to minimise the potential for off-site odour impacts.

4.7.1 Results of the Dispersion Modelling and Implications for Odour Management

Results of the dispersion modelling suggest that the proposed odour mitigation measures associated with the operation of the Project will be sufficient to manage odour impacts at off-site locations.

4.8 Cumulative Impacts of Odour

As noted in Section 1.1.2, a second composting facility operated by Loop Organics is located to the south of the Bettergrow Ravensworth facility with the potential for 55,000 tpa. Both composting facilities utilise a common entrance on Lemington Road.

Due to the scale of the predicted impacts of odour associated with composting activities at the Bettergrow Facility, and since the Loop Organics Environmental Protection Licence requires that the facility be operated in a manner deigned to minimise the risk of offensive odour, cumulative impacts of odour have not been explicitly modelled as they are expected to be minimal.

5. Dust Assessment

5.1 Ambient Air Quality Objectives

Assessment criteria related to dust as prescribed in NSW DEC (2005) include dust deposition, total suspended particulates (TSP) and particulate matter with an aerodynamic radius less than 10 micrometres (PM_{10}) (Table 7).

As particulate matter with an aerodynamic diameter less than 2.5 microns ($PM_{2.5}$) is of interest to the National Environmental Protection Council (NEPC) the associated advisory levels as noted in the National Environment Protection Measure (NEPM) Ambient Air Quality (AAQ) are included in the table for completeness.

Table 14: Impact Assessment Criteria (NSW, 2005)

Pollutant	Averaging Period	Project Goal	Source
TSP	Annual	90 µg/m^3	NHMRC (1996)
PM_{10}	24 hour	50 µg/m^3	NEPC (1998)
	Annual	30 µg/m^3	EPA (1998)
$PM_{2.5}$	24 hour	25 µg/m^3	NEPM - advisory
	Annual	8 µg/m^3	NEPM - advisory
Dust deposition	Monthly(1)	2 mg/m^2/day	NERDDC (1988)
	Monthly(2)	4 mg/m^2/day	NERDDC (1988)

Note (1): Maximum increase in deposited dust levels
(2): Maximum total deposited dust level

In relation to the operation of the Ravensworth Facility, as a result of the high moisture content of both the composting material and final product, it is wheel generated dust on unsealed roads that is the primary emission source of dust associated with the Project. Thus the focus of this assessment is on the larger size particulate ranges and in particular PM_{10}, TSP and dust deposition.

Since combustion-type emission sources are more likely to contribute to impacts in the particle size range of $PM_{2.5}$ or less, results for $PM_{2.5}$ associated with the Project have not been developed.

5.2 Existing Air Quality

The nearest dust monitoring location to the Ravensworth facility is the NSW Office of Environment and Heritage's (OEH) Camberwell monitoring station (Figure 12). The Camberwell monitoring station was commissioned in 2011. With respect to particulate matter, PM_{10} and $PM_{2.5}$ are measured at this location (NSW OEH, 2017) i.e. TSP is not measured.

The NSW OEH *Air Quality Statements (e.g. NSW OEH 2015)* note that Camberwell is a small community monitoring station which is not suitable for assessing performance against the NEPM standards.

Figure 12: Location of the Camberwell Monitoring Station relative to the Project site

Presented in Table 15 is a summary of the 24-hour average and annual average concentration of PM_{10} and $PM_{2.5}$ at the Camberwell monitoring station for 2015, 2016 and 2017 (NSW OEH, 2015, 2016, and 2017).

Exceedences of the ambient air criterion of 50 µg/m^3 for the 24-hour average concentration of PM_{10} is a frequent occurrence at this location with 11 to 33 exceedences days per year recorded during the three year period 2015 through 2017.

Monitoring data suggest that air quality at this location is significantly impacted upon by surrounding mining operations.

Table 15: Summary of the 24-Hour Average and Annual Average Concentration of PM_{10} and $PM_{2.5}$ during 2015, 2016 and 2017 (NSW OEH, 2015, 2016, 2017)

Region	Station	Year	PM10					PM2.5				
			Average annual	Max Daily avg	Date	Days above standard		Average annual	Max Daily avg	Date	Days above standard	
						(a)	(b)				(a)	(b)
Upper Hunter	Camberwell	2015	22.0	**86.7**	6/5	**11**	*	7.2	23.9	10/3	0	0
		2016	24.5	**65.7**	23/5	**11**	*	7.5	21.1	8/5	0	0
		2017	**27.4**	**101.5**	13/9	**33**	*	7.4	24.7	12/2	0	0

Notes (1) : Levels above standards are shown in bold
(2): Days above standard are divided into (a) non-exceptional and (b) exceptional events. Exceptional events are those related to dust storms, fires etc.
(3): Camberwell is a Small Upper Hunter Air Quality Monitoring Network community monitoring station which is not suitable for assessing performance against NEPM standards

5.2.1 Estimates of the Background-Level of PM_{10}

In theory, background-levels of pollutants are the concentrations that would occur in the absence of anthropogenic emission sources. In practice, the practicalities and limitations associated with the establishment of an ambient air monitoring stations means that they are rarely sited at locations which are not influenced to some degree by anthropogenic emission sources.

Estimating background-levels is further complicated by the fact that in reality background-levels will be spatially and temporally varying as the emission rate of pollutants from natural sources are often functions of a number of factors including for example, frequency of rain, wind speed, atmospheric stability etc.

Additionally it is noted that in general, an air quality assessment requires an estimate of the existing (or current) air quality environment as opposed to background (i.e. naturally occurring) levels of pollutants. Here we define existing air quality to include all current (and potentially approved) emission sources whether or not they are explicitly modelled as part of the assessment.

In NSW, the treatment of how to incorporate estimates for existing levels of pollutants depends on the assessment type (i.e. Level 1 – screening, or Level 2 – refined) (NSW EPA, 2005). For a Level 1 assessment, the maximum recorded concentration obtained at a ‘representative’ monitoring location is added to the maximum predicted concentration based on project-related emission sources. Based on the information contained in Table 15, a Level

1 background estimate for the Camberwell monitoring location based on a maximum recorded 24-hour average concentration of PM_{10} will exceed the assessment criteria of 50 µg/m^3.

For a Level 2 assessment (NSW EPA, 2005), a time series of measured dust levels (representing the background-level) is combined with a time series of modelled dust levels from which a resultant maximum concentration is determined. This latter approach is considered to be a more accurate representation of the temporal variability of naturally occurring dust levels. In general however, representative time series of measurements are typically limited and alternate approaches to the representation of the current air quality environment may require consideration.

For example, it is noted that the Victorian EPA recommend the use of the 70th percentile as an estimate for the background-level. However as noted above, the application of a single value (in this case the 70th percentile) does not account for the temporal and spatial variability of dust levels within the study region. Based on the summary of monitoring results from the Camberwell monitoring station, the average 75th percentile 24-hour average concentration of PM_{10} over the three year period 2015 through 2017 is c.31 µg/m^3. The Victorian EPA approach is not as restrictive as the NSW Level 1 approach of the use of the maximum recorded concentration at the appropriate averaging period though equally spatially and temporally limited in its representation.

For this assessment, the focus of the presentation of results is on Project-only impacts (i.e. in isolation of natural and other local emission sources). However, the interpretation of results in consideration of the aforementioned discussion in relation the various approaches that may be adopted to represent estimates of current dust levels will be discussed.

5.3 Dust Assessment Methodology

5.3.1 Dust Emission Sources

The key dust emission source associated with the facility is vehicle movements on the unsealed internal haul road (Figure 13).

As there are minimal light vehicle movements (e.g. due to staff and visitors) the focus of the dust assessment has been on the movement of heavy trucks that deliver waste streams and/or remove product from site. A breakdown of heavy vehicle movements during the operational phase of the Project is provided in Table 16 and Table 17 for average and peak operating scenarios.

Table 16: Peak and Average Heavy Vehicle Movements

Vehicle Type	Hydro Exc & Drill Mud				Paper Crumble				Biosolids				GO and comingled Food and GO			
	Average		Peak		Average		Peak		Average		Peak		Average		Peak	
	in	out	in	out	in	out	in	out	in	out	in	out	in	out	in	out
Truck and Dog					1.5	1.5	2	2	3	3	4	4	5	5	9	9
Semi Tippers & Walking Floors													7	7	9	9
19m B' Doubles													4	4	6	6
Semi Tippers	2	2	3	3												
Semi liquid tankers	1	1	2	2												

Table 17: Peak and Average Heavy Vehicle Movements (continued)

Vehicle Type	Compost Out				Recycled Water				Ash & Timber				Total Truck Movements	
	Average		Peak		Average		Peak		Average		Peak			
	in	out	in	out	in	out	in	out	in	out	in	out	Average	Peak
Truck and Dog	3	3	5	5					2	2	2	2	29	44
Semi Tippers & Walking Floors											1	1	14	20
19m B' Doubles	5	5	7	7									18	26
Semi Tippers													4	6
Semi liquid tankers					3	3	4	4					8	12
												Total	**73**	**108**

Figure 13: Location of Dust Emission Sources along Haul Route

5.3.2 Dust Emissions Scenario

Two dust emissions scenarios have been considered based on average and peak vehicle movements:

- **Peak Scenario:** Considers the emission of dust based on 108 heavy vehicle movements per day during normal operating hours.
- **Average Scenario:** Considers the emission of dust based on 73 heavy vehicle movements per day during normal operating hours.

A conservative approach has been adopted whereby it has been assumed that the daily throughput for both scenarios occurs 365 days per year in order to capture the maximum range of meteorological conditions. This approach will be more representative of possible risks of adverse dust impacts on the 24 hour time scale with results for the annual averages biased upwards.

Additionally it is noted, that since the dust emission factors are based on vehicle weight, a conservative approach has been adopted for which it has been assumed that all vehicles arrive and leave full.

5.3.3 Dust Emissions Inventory

Estimates for dust emission rates have been sourced from the National Pollutant Inventory Emissions Estimation Technique Manual for Mining version 3.1 (NPI EETM) dated January 2012 (NPI EETM, 2012). The NPI EETM (2012) includes a number of options for emission factors including default values (to be used in the absence of site specific information) as well as emission factor formulas.

A summary of the heavy vehicle information is provided in Table 18 with dust emission factors and dust emission rates provided in Table 19 and Table 20 respectively.

Table 18: Heavy Vehicle Information

Vehicle Type	Truck Mass (tonnes) (used in modelling)	Truck Mass (tonnes)	
		Tare	Gross
Truck and Dog	57.5	18	57.5
Semi Tippers & Walking Floors	43.5	14.6	43.5
19m B' Doubles	62.5	26.4	62.5
Semi Tippers	43.5	14.6	43.5
Semi liquid tankers	62.5	26	62.5

Table 19: Dust Emission Factor Options (NPI EETM, 2012)

Vehicle Type	Uncontrolled Emission Factor (kg/KVT)(1)		Control (%)	controlled Emission Factor (kg/KVT)	
	TSP	PM10		TSP	PM10
Truck and Dog	2.657	0.662	75%	0.664	0.166
Semi Tippers & Walking Floors	2.344	0.584	75%	0.586	0.146
19m B' Doubles	2.759	0.688	75%	0.690	0.172
Semi Tippers	2.344	0.584	75%	0.586	0.146
Semi liquid tankers	2.759	0.688	75%	0.690	0.172

Note (1): A silt content of 4.3% based on USE EPA AP42 Table 11.9.3 has been assumed.

Table 20: Dust Emission Rates

Activity	Units	Average		Peak	
		TSP	PM10	TSP	PM10
Haul Road length	km	5.3	5.3	5.3	5.3
Wheel Generated Dust	kg/VKT/Day	47.7	11.9	70.7	17.6
	kg/day	251	63	372	93

5.3.4 Summary of the Dust Dispersion Modelling Methodology

This dust assessment has been undertaken in consideration of:

- (NSW DEC, 2005)*: Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC).

Additionally it is noted:

- Dust dispersion modelling has been undertaken using a combination of the US EPA approved CALMET/CALPUFF modelling system (Scirer, 2000a) with numerically simulated upper air data based on TAPM. Regional, three-dimensional wind fields that are used as input into the dispersion model were prepared using a combination of The Air Pollution Model (TAPM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Hurley, 2008), and CALMET, the meteorological pre-cursor for CALPUFF (Scirer, 2000b).
- A total of three years of hourly meteorology was developed corresponding to 2015, 2016 and 2017.
- Dust emission sources have been represented in the dispersion model using volume sources with emission rates as summarised in Table 20.
- A conservative approach has been adopted whereby it has been assumed that peak or average tonnages of bulk landscaping supplies has passed through the facility 365 days per year. This approach has been adopted in order to capture the widest range of meteorological conditions that may lead to worst case impacts. A reduced estimate for the annual average dust emission rate could have been developed however, as the more conservative approach has not highlighted any issues, a refinement of the methodology to include an annual average estimate of emissions of dust from the facility has not been undertaken. Note that the assumption of 365 days per year rate will bias (upwards) the results for the annual average concentration of TSP and PM_{10} as well as the monthly average dust deposition.

- As the shortest averaging period associated with the ambient air objectives is 24 hours, the estimated mass of dust generated from material handling is assumed to be evenly spread over operating hours.

Additional information pertaining to the technical set up of the models is provided in Appendix A and Appendix C. Presented in Appendix B is a summary of the site-specific meteorology developed for the study region.

5.4 Results from the Dispersion Modelling

5.4.1 Interpretation of Dust Impacts

Presented in Table 13 are the results of the dispersion modelling at the location of the nearest receptor i.e. Camberwell for the peak and average scenarios (Section 5.3.2).

As the haul route is a shared corridor with other users, the site boundary has not been defined to include the haul road. Therefore, presenting Project-only results based on 'outside the site boundary' was not considered representative of potential impacts to off-site receptors. Thus, for the purposes of assessing potential impacts of dust from the Project, a table of results for the Camberwell community combined with contour plots are presented. It is noted however, that results are presented for the Ravensworth facility in isolation. Since the results do not include an estimate of background levels they are not directly comparable with the impact assessment criteria presented in Table 7. As discussed in Section 5.2.1, estimating background levels is complicated.

Recall that a Screening Level 1 approach involves the adding of the maximum recorded concentration to the results of the dispersion modelling. Independent of the magnitude of the predicted impact from the facility, a Level 1 approach will lead to an exceedence of the impact assessment criteria for the 24 hour average concentration of PM_{10} as maximum levels of PM_{10} recorded at the Camberwell monitoring station exceeded 50 µg/m^3 during 2015, 2016 and 2017 which correspond to each of the three meteorological years modelled.

This limitation noted, results of the dispersion modelling highlights that Project-related dust emission sources will be immaterial at the nearest off-site receptor location i.e. Camberwell.

The dust mitigation measures included in site's CMP (LZE, 2016) are considered sufficient.

Table 21: Results from the Dust Dispersion Model – Ravensworth Facility in Isolation

Scenario	Vehicle Movement Scenario	Pollutant (units)	Averaging Period	Meteorological Year	Project Only Maximum Camberwell (g/m2/month)	Assessment Criteria (total including background)
1	Peak (108 truck movements /day)	TSP (μg/m³)	Annual(1)	2015	0.4	90
				2016	0.4	90
				2017	0.3	90
		PM_{10} (μg/m³)	24 hour	2015	1.6	50
				2016	1.6	50
				2017	1.5	50
			Annual(1)	2015	0.2	30
				2016	0.2	30
				2017	0.2	30
		Dust Deposition (g/m²/month)	Monthly(1)	2015	<0.1	2.0/4.0(3)
				2016	<0.1	2.0/4.0(3)
				2017	<0.1	2.0/4.0(3)
2	Average (63 truck movements /day)	TSP (μg/m³)	Annual(2)	2015	0.2	90
				2016	0.3	90
				2017	0.2	90
		PM_{10} (μg/m³)	24 hour	2015	1.1	50
				2016	1.0	50
				2017	1.0	50
			Annual(2)	2015	0.1	30
				2016	0.1	30
				2017	0.1	30
		Dust Deposition (g/m²/month)	Monthly(2)	2015	<0.1	2.0/4.0(3)
				2016	<0.1	2.0/4.0(3)
				2017	<0.1	2.0/4.0(3)

Note (1): Assumes peak movements 365 days per year
(2): Assumes average movements 365 days per year
(3): Assessment criterion is: Project only contribution not to exceed 2 g/m²/month with total (including background) not to exceed 4 g/m²/month.
(4): Reported results are conservative as they are based on vehicle movements at the specified daily rate 365 days per year.

5.4.2 Contour Plots

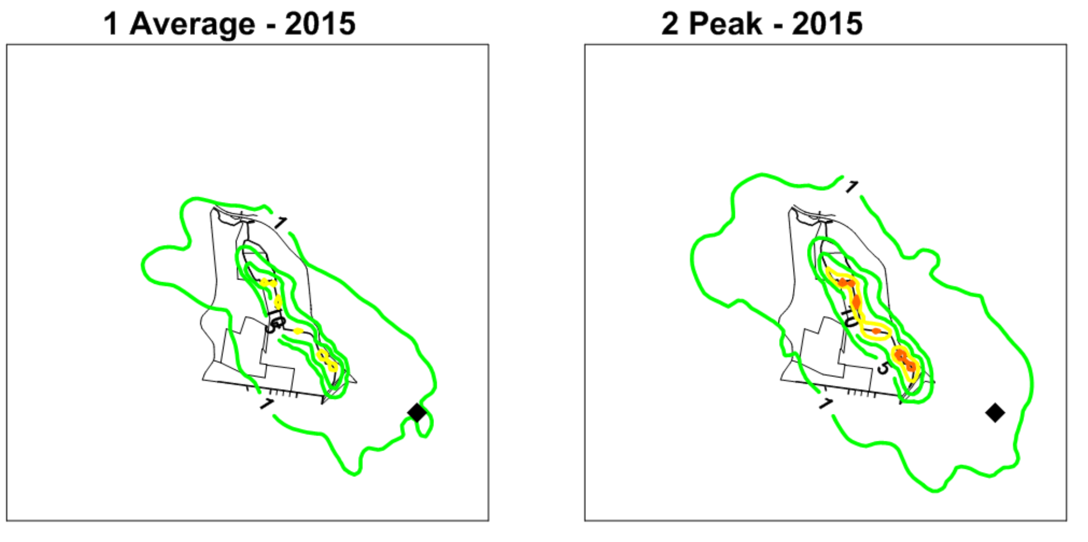
When interpreting results presented as contour plots, it is important to note that the figure does not represent a snapshot at any given time. Instead, it presents the maximum concentration at each location in the study region which for each receptor may occur at different times of the year and under different atmospheric conditions.

Presented in Figure 14 through Figure 16 are contour plots of the maximum 24-hour average concentration of PM_{10} predicted using the CALPUFF dispersion model for meteorological years 2015 through 2017 for the two scenarios modelled.

Note that the results are presented for the Ravensworth facility in isolation and do not include an estimate of background levels. Thus the results presented are not directly comparable with the impact assessment criteria presented in Table 7.

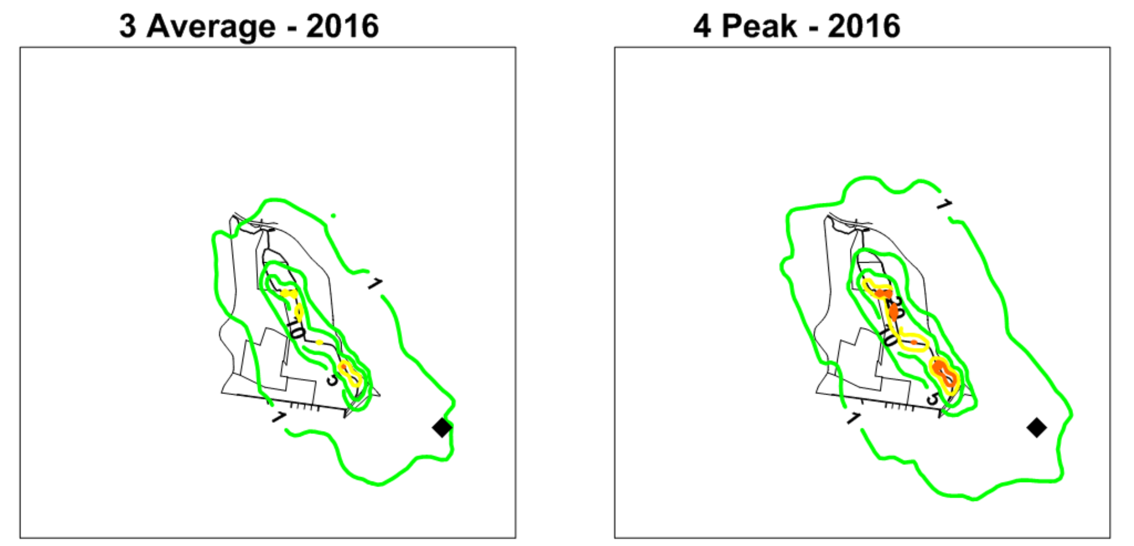
In general, no significant issues are indicated by the results of the dispersion modelling at any off-site location for the scenarios considered.

Figure 14: Ravensworth in Isolation: Maximum 24 Hour Average Concentration of PM_{10} based on 2015 Meteorology



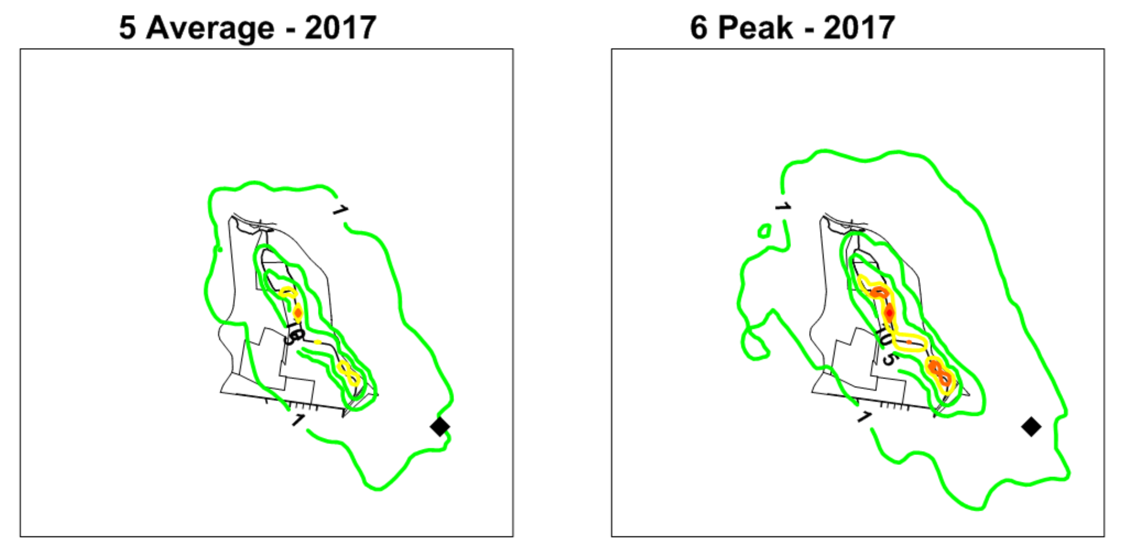
Scenario: Peak and Average		**Sources included:** Vehicle Movements	
Pollutant:	PM_{10}	Averaging Period:	24-hour
Background-level:	Not included	Rank:	maximum
Project Goal:	50 µg/m^3	Contour level(s):	1,5,10, 20, 30, 40 and 50 µg/m^3

Figure 15: Ravensworth in Isolation: Maximum 24 Hour Average Concentration of PM_{10} based on 2016 Meteorology



Scenario: Peak and Average		**Sources included:** Vehicle Movements	
Pollutant:	PM_{10}	Averaging Period:	24-hour
Background-level:	Not included	Rank:	maximum
Project Goal:	50 µg/m^3	Contour level(s):	1,5,10, 20, 30, 40 and 50 µg/m^3

Figure 16: Ravensworth in Isolation: Maximum 24 Hour Average Concentration of PM_{10} based on 2017 Meteorology



Scenario: Peak and Average		**Sources included:** Vehicle Movements	
Pollutant:	PM_{10}	Averaging Period:	24-hour
Background-level:	Not included	Rank:	maximum
Project Goal:	50 $\mu g/m^3$	Contour level(s):	1,5,10, 20, 30, 40 and 50 $\mu g/m^3$

5.5 Dust Management

The potential for dust-related impacts to off-site receptors will be managed through the adopted dust reduction measures that form part of the site's Composting Management Plan (CMP) (LZE, 2016). In particular it is noted that Section 11.1.1 *Dust and Particulate Management*, Section 12.4.2.4 *Hardstand Pads* and Section 12. *Management Procedures*, of the CMP (LZE, 2016) include references to dust management strategies to be implemented on site as/if required to minimise the potential for off-site dust impacts.

5.5.1 Results of the Dispersion Modelling and Implications for Dust Management

Results of the dispersion modelling suggest that the proposed dust mitigation measures associated with the operation of the Project will be sufficient to manage dust impacts at off-site locations.

6. Summary

AED has conducted greenhouse gas, odour and dust assessments of the Greenspot Ravensworth composting and nutrient recycling facility expansion project.

Due to the remoteness of the facility and the nature and extent of proposed composting activities, there were no issues identified in relation to emissions of greenhouse gases, odour or dust.

In summary, results of the odour and dust assessment suggest that the current mitigation measures and management strategies will be sufficient to comply with regulatory requirements for odour and dust.

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Appendix A Development of Numerically Simulated Meteorological Fields

Dispersion modelling typically requires a meteorological dataset representative of the local airshed on an hourly timescale. Parameters required include wind speed, wind direction, temperature, atmospheric stability and mixing height. In general, meteorological observations recorded by weather stations include hourly wind speed, wind direction, temperature, rainfall and humidity. However additional parameters like atmospheric stability class and mixing height are difficult to measure and are often generated through the use of meteorological models.

A.1 TAPM

The meteorological model 'The Air Pollution Model' (TAPM) developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) was used to predict initial three-dimensional meteorology for the local airshed. TAPM is a prognostic model used to predict three dimensional meteorological observations, with no local inputs required. The model predicts meteorological dataset consisting of parameters like wind speed, wind direction, temperature, water vapour, cloud, rain, mixing height, atmospheric stability classes etc. that are required for dispersion modelling.

Additionally TAPM includes the option to assimilate local observations (of wind speed and wind direction) in order to nudge the predicted solution towards the observed records. For this assessment, only the upper air data of TAPM is used in CALMET i.e. data assimilation functionality of TAPM was not used.

Technical details of the model equations, parameterisations and numerical methods are described in the technical paper by Hurley (2008).

The details of the TAPM configuration are summarised in Table 22.

Table 22: TAPM Configuration

Parameter	Units	Value
TAPM version	-	v4.0.5
Years modelled	-	2015, 2016 & 2017
Grid centre	Lat, Lon (Degrees)	-32° 26', 151° 2'
Number of nested grids	-	4
Grid dimensions (nx, ny)	-	25,25
Number of vertical grid levels (nz)	-	25
Grid 1 spacing (dx, dy)	Km	30,30

Parameter	Units	Value
Grid 2 spacing (dx, dy)	Km	10,10
Grid 3 spacing (dx, dy)	Km	3,3
Grid 3 spacing (dx, dy)	Km	1,1
Local hour	-	GMT + 10
Local Met Assimilation	-	No
Surface vegetation database	-	Default TAPM V4 database at 3-minute grid spacing (Australian vegetation and soil type data provided by CSIRO Wildlife and Ecology.
Terrain database	-	Default TAPM V4 database at 9-second grid spacing (Australian terrain height data from Geoscience Australia)

A.2 CALMET

CALMET (version 6.334) was used to simulate meteorological conditions for the local airshed. CALMET is a diagnostic three dimensional meteorological pre-processor for the CALPUFF modelling system (developed by Earth Tech, Inc.).

Prognostic output from TAPM was used as input into the CALMET model. Using high resolution geophysical datasets, CALMET then adjusts the initial guess field for the kinematic effects of terrain, slope flows, blocking effects and 3-dimensional divergence minimisation as well as differential heating and surface roughness associated with different land uses across the modelling domain.

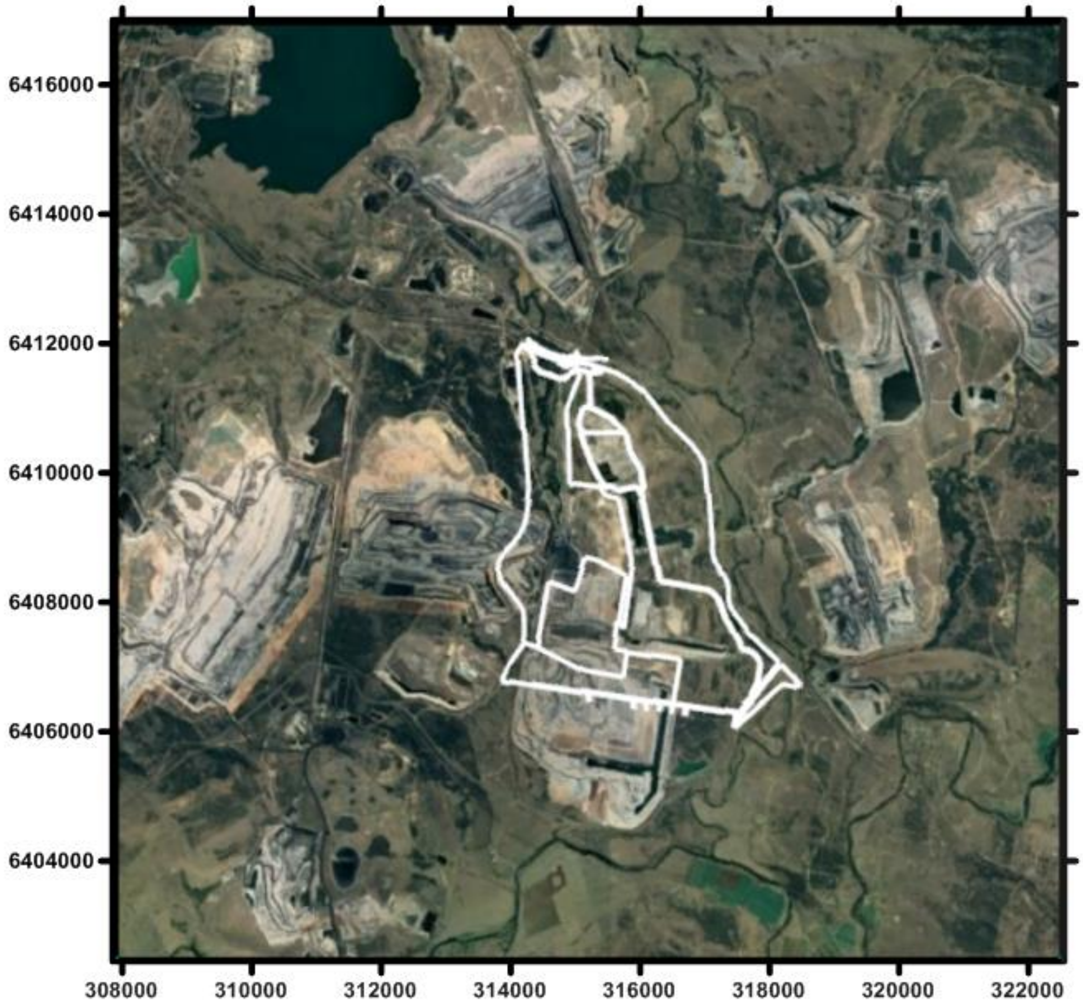
A single resolution CALMET grid was developed to derive meteorological fields at 150 m resolution. The domain size and grid resolution are specified in Table 4. The extent of the domains is shown in Figure 17.

Table 23: CALMET Domain Specifications

CALMET Grid Resolution	Domain Size	Number of Nodes	Grid Spacing (m)
150 m	14.7 km x 14.55 km	99 x 98	150 x 150

The development of the CALMET grid requires input datasets along with the control file where the CALMET run parameters are specified. These input datasets include geophysical data and synoptic wind fields. The CALMET inputs are discussed in detail in the following sections.

Figure 17: Areal Extent of CALMET Domain

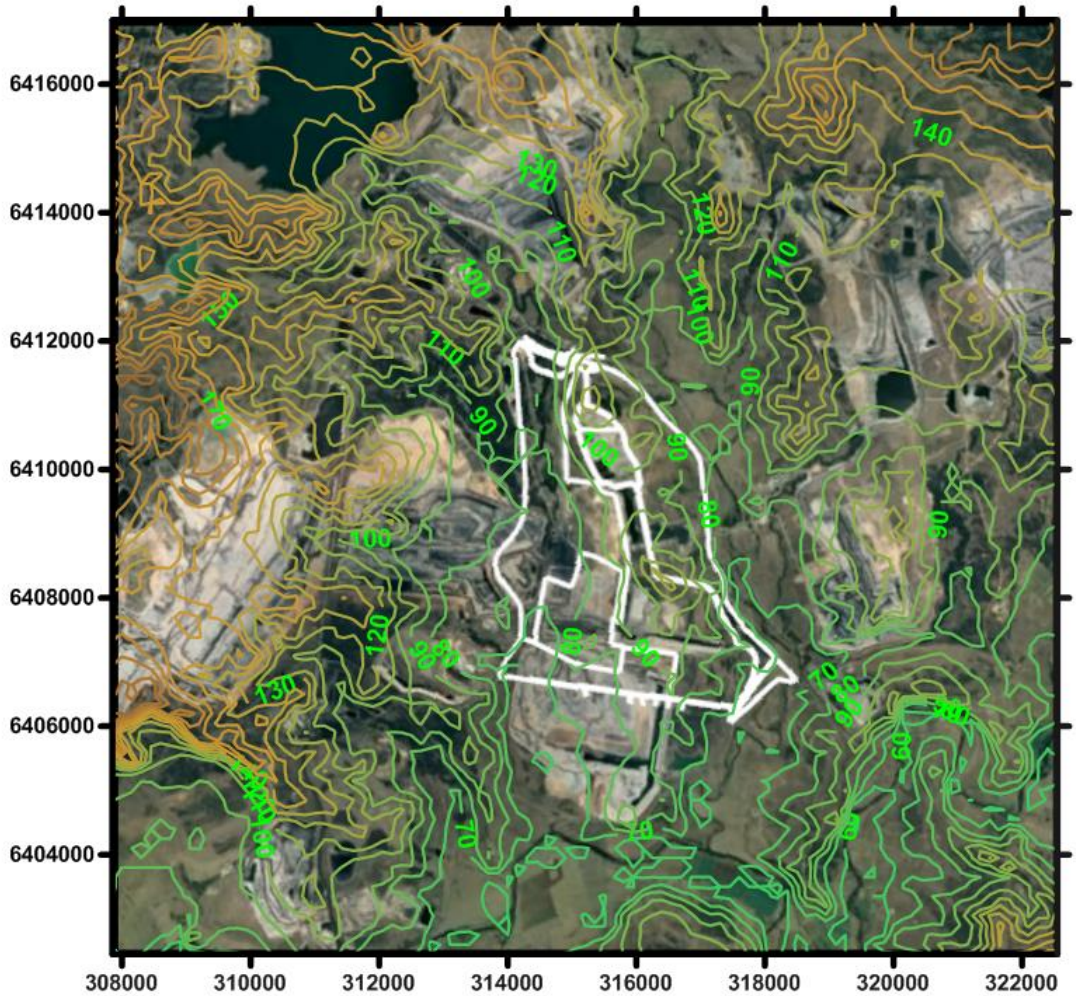


A.2.1 The CALMET Grid

Geophysical dataset

The terrain for the 150 m resolution CALMET grid was extracted from 3-arc second (90m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000. Terrain data at 150 m resolution is depicted in Figure 18.

Figure 18: Terrain data for CALMET Geophysical Dataset



The land use or land cover data for the modelling domain was derived manually using aerial imagery. The Geotechnical parameters for the land use classification were adopted from a combination of closest CALMET and AERMET land use categories.

User defined land use classification and geotechnical parameters used in CALMET are presented in Table 24 and Figure 19.

Figure 19: User Defined Land Use Categories for CALMET Modelling domain

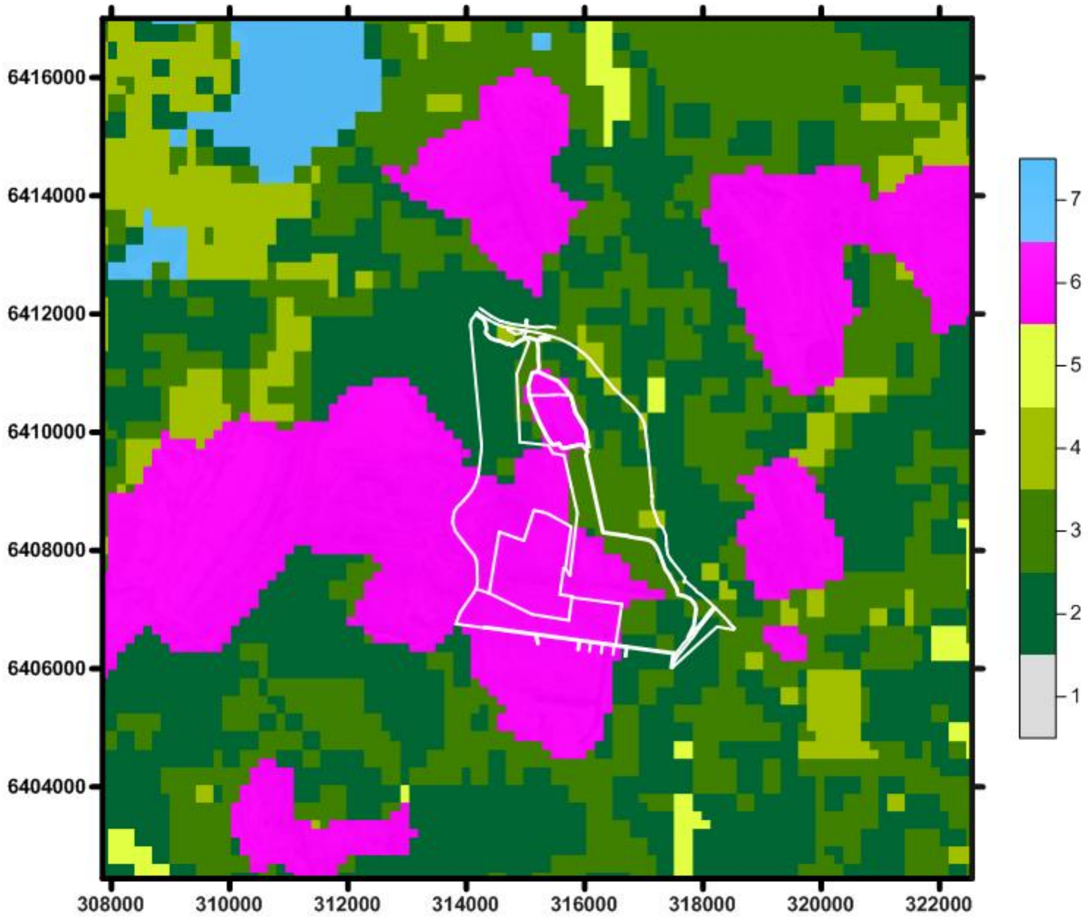


Table 24: Geotechnical Parameters for User Defined CALMET Land Use Classification

CALMET User defined Category	ESA category	Aermet Category	Surface roughness (a)	Bowen ratio (a)	Albedo (a)	Soil heat flux parameter (b)	Anthropogenic heat flux (b)	Leaf Area Index (b)
1	17 Artificial surfaces and associated areas (Urban areas >50%)	Low intensity residential	0.54	0.8	0.16	0.25 (Calmet – Urban)	0	0.2 (Calmet – Urban)
2	3 Closed to open (>15%) broadleaved evergreen or semi-deciduous forest (>5m)	Mixed Forest	1.3	0.3	0.14	0.15 (Calmet – Forestland)	0	6 (modified from Calmet – Forestland,

CALMET User defined Category	ESA category	Aermet Category	Surface roughness (a)	Bowen ratio (a)	Albedo (a)	Soil heat flux parameter (b)	Anthropogenic heat flux (b)	Leaf Area Index (b)
	5 Open (15-40%) broadleaved deciduous forest/woodland (>5m)							7)
3	9 Mosaic forest or shrubland (50-70%) / grassland (20-50%) 10 Mosaic grassland (50-70%) / forest or shrubland (20-50%) 11 Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m) 12 Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses) 2 Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20-50%)	Shrubland (Non-arid)	0.3	1	0.18	0.15 (Calmet – Forestland)	0	4.5 (average of modified Calmet forestland (above) and agriland un-irrigated)
4	13 Sparse (<15%) vegetation	Grassland / Herbaceous	0.1	0.8	0.18	0.15 (Calmet – Rangeland)	0	0.5 (Calmet – Rangeland)
5	1 Mosaic cropland (50-70%) / vegetation (grassland/shrubland/forest) (20-50%) 0 Rainfed croplands	Small grains	0.15	0.5	0.2	0.15 (Calmet – Agri land irrigated)	0	3 (Calmet – Agri land irrigated)
6	------------------------------	Quarries/strip mine/gravel	0.3	1.5	0.2	0.15 (Calmet – Barren)	0	0.05 (Calmet – Barren)
7	Water Bodies	Open water	0.001	0.1	0.1	1 (Calmet – small water body)	0	0 (Calmet – small water body)
8		Bare rock /sand/clay non-arid	0.05	1.5	0.2	0.15 (Calmet – Barren)	0.0	0.05 (Calmet – Barren)

(a) EPA (2008) , *AERSURFACE User's Guide*, developed by the Air Quality Modelling Group, USEPA office of Air Quality Planning and Standards.
(b) CALPUFF version 6, USER guide.

CALMET Configuration

Note that the 1 km TAPM grid was used as input into the CALMET model as the initial guess field. Details of the CALMET configuration are presented in Table 25.

Table 25: CALMET Configuration

Parameter	Units	Value
CALMET version	-	V6.334
Years modelled	-	2015, 2016 & 2017
No. X grid cells (NX)	-	99
No. Y grid cells (NY)	-	98
Grid spacing (DGRIDKM)	Km	0.150
X coordinate (XORIGKM)	Km	307.850
Y coordinate (YORIGKM)	Km	6402.450
No. of vertical layers (NZ)	-	10
Number of surface stations	-	0
Number of upper air stations	-	0
Land use database	-	Manually generated land use based on aerial imagery
Terrain database	-	10 m contour data as provided by RPS
Minimum overland mixing height (ZIMIN)	m	50
Maximum overland mixing height (ZIMAX)	m	3000
UTC time zone (ABTZ)	Hours	UTC+1000

Appendix B Existing Meteorological Environment

B.1 Wind Roses

Numerically simulated wind fields (CALMET) for the three-year period (2015 through 2017) were developed for the study area. The wind rose for the three-year period is presented in Figure 20. Predominant winds are from the northwest and southeast.

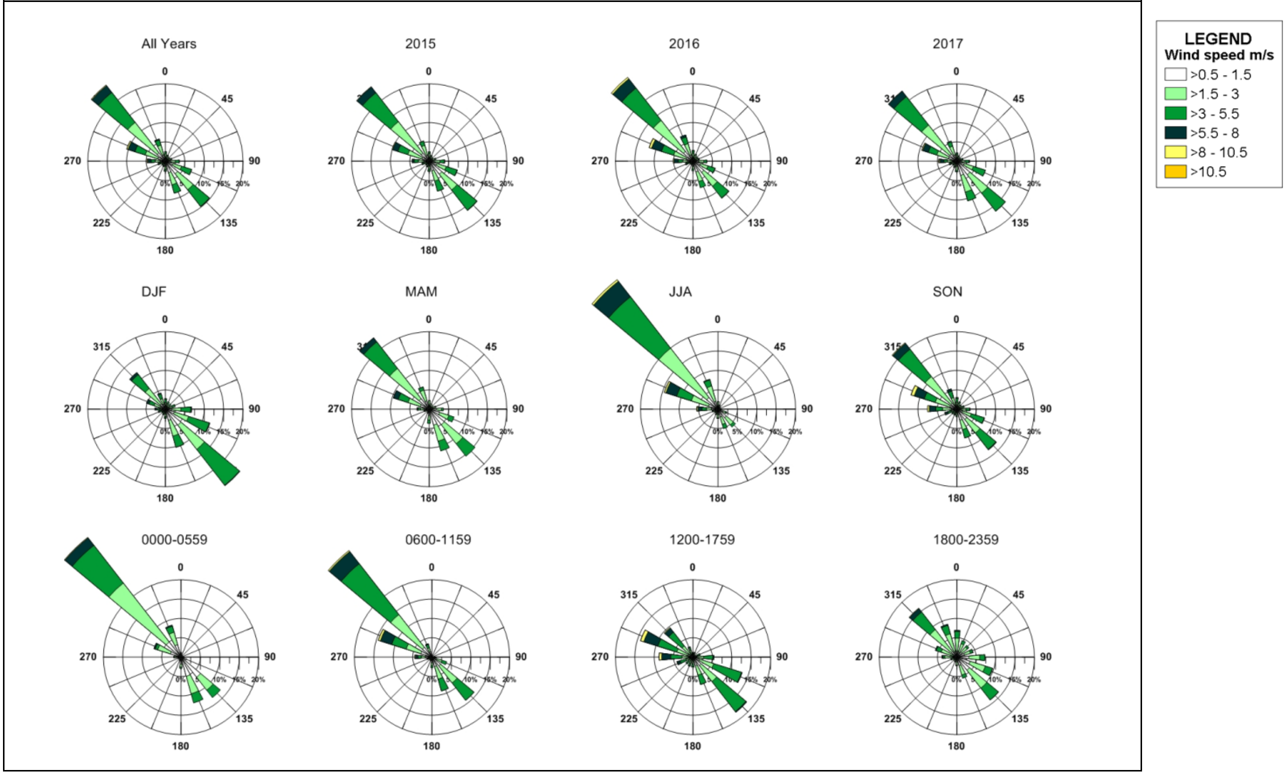
There is significant seasonality suggested by the middle row of wind roses. During summer months the winds are most frequently from the southeast, whilst strong north westerly winds occur most frequently during the winter.

Variability of the winds as a function of the time of day is indicated by the wind roses in the bottom row of the figure(s).

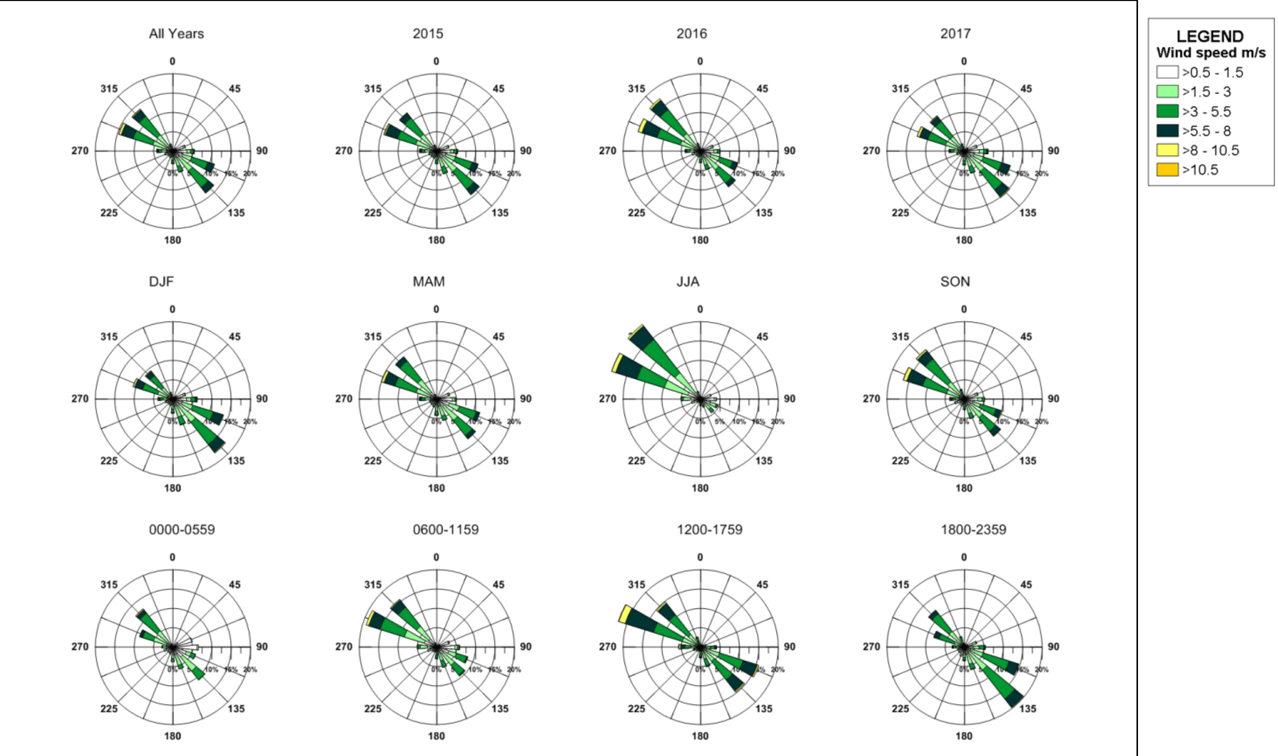
The wind roses for the Camberwell monitoring station are similar to those for the project site with predominantly southeast/northwest winds highlighted.

Figure 20: Wind Roses – All, Annual, Seasonal, Hour of Day (CALMET: 2015-2017)

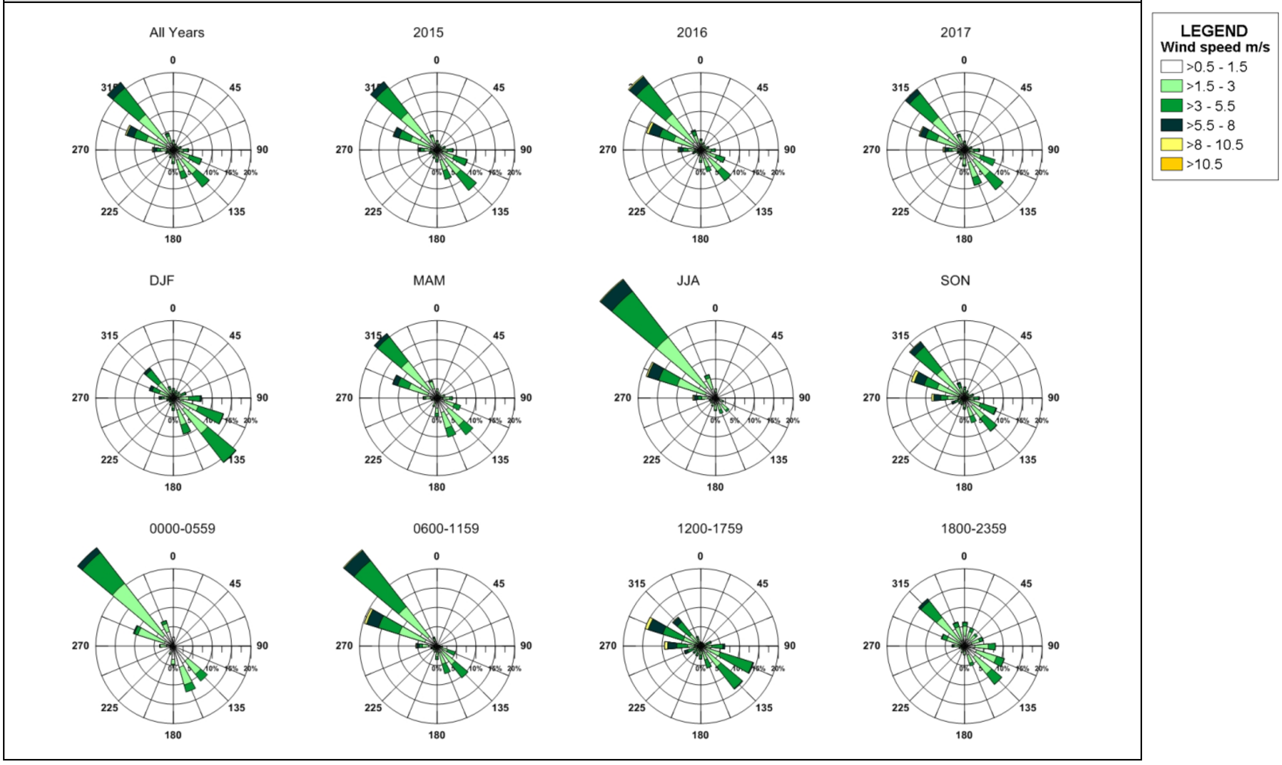
Project Site (CALMET)



Camberwell (NSW OEH)



Camberwell (CALMET)



Presented in Table 26, Table 27 and Figure 21 is a comparison of the monthly average 09:00 and 15:00 temperature based on numerically simulated data (i.e. CALMET) and observational data (NSW OEH, Camberwell). In general, the numerically simulated data slightly under estimates both the 09:00 and the 15:00 monthly average temperature.

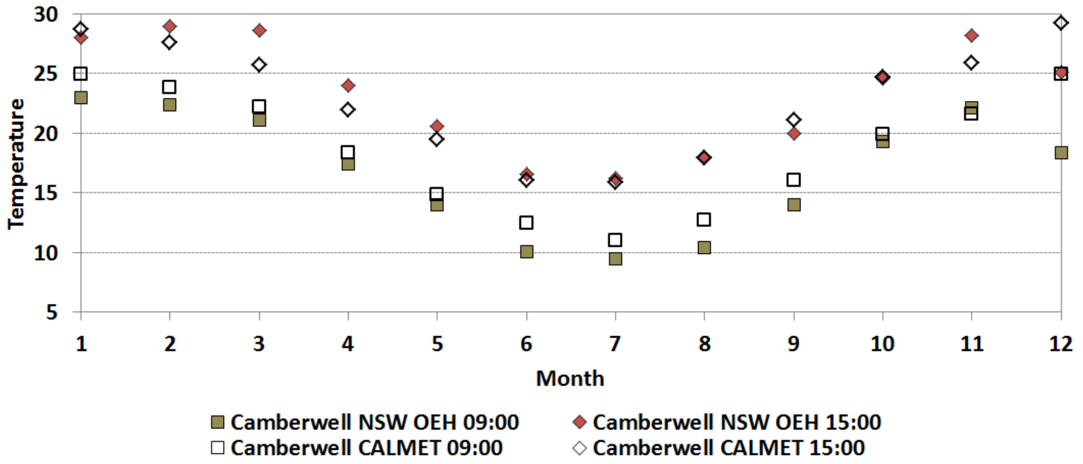
Table 26: CALMET generated Monthly Average Temperatures for Camberwell

Month	Month	Hour	Average Temp @ 09:00	Month	Hour	Average Temp @ 15:00
Jan	1	9	24.9	1	15	28.7
Feb	2	9	23.8	2	15	27.6
Mar	3	9	22.2	3	15	25.7
Apr	4	9	18.3	4	15	21.9
May	5	9	14.9	5	15	19.5
Jun	6	9	12.4	6	15	16.1
July	7	9	11.0	7	15	15.8
Aug	8	9	12.7	8	15	17.9
Sep	9	9	16.0	9	15	21.1
Oct	10	9	19.9	10	15	24.7
Nov	11	9	21.6	11	15	25.9
Dec	12	9	24.9	12	15	29.3

Table 27: Monthly Average Temperatures from the (NSW OEH) Camberwell Monitoring Station

Month	Month	Hour	Average Temp @ 09:00	Month	Hour	Average Temp @ 15:00
Jan	1	9	23.0	1	15	28.0
Feb	2	9	22.4	2	15	29.0
Mar	3	9	21.1	3	15	28.6
Apr	4	9	17.4	4	15	24.0
May	5	9	14.0	5	15	20.6
Jun	6	9	10.1	6	15	16.6
July	7	9	9.5	7	15	16.2
Aug	8	9	10.4	8	15	17.9
Sep	9	9	14.0	9	15	20.0
Oct	10	9	19.3	10	15	24.6
Nov	11	9	22.1	11	15	28.2
Dec	12	9	18.4	12	15	25.1

Figure 21: Monthly Average 09:00 and 15:00 Temperature based on CALMET output and NSW OEH Data from the Camberwell Monitoring Station



B.2 Stability Classes

Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly and instead it must be inferred from available data, either measured or numerically simulated.

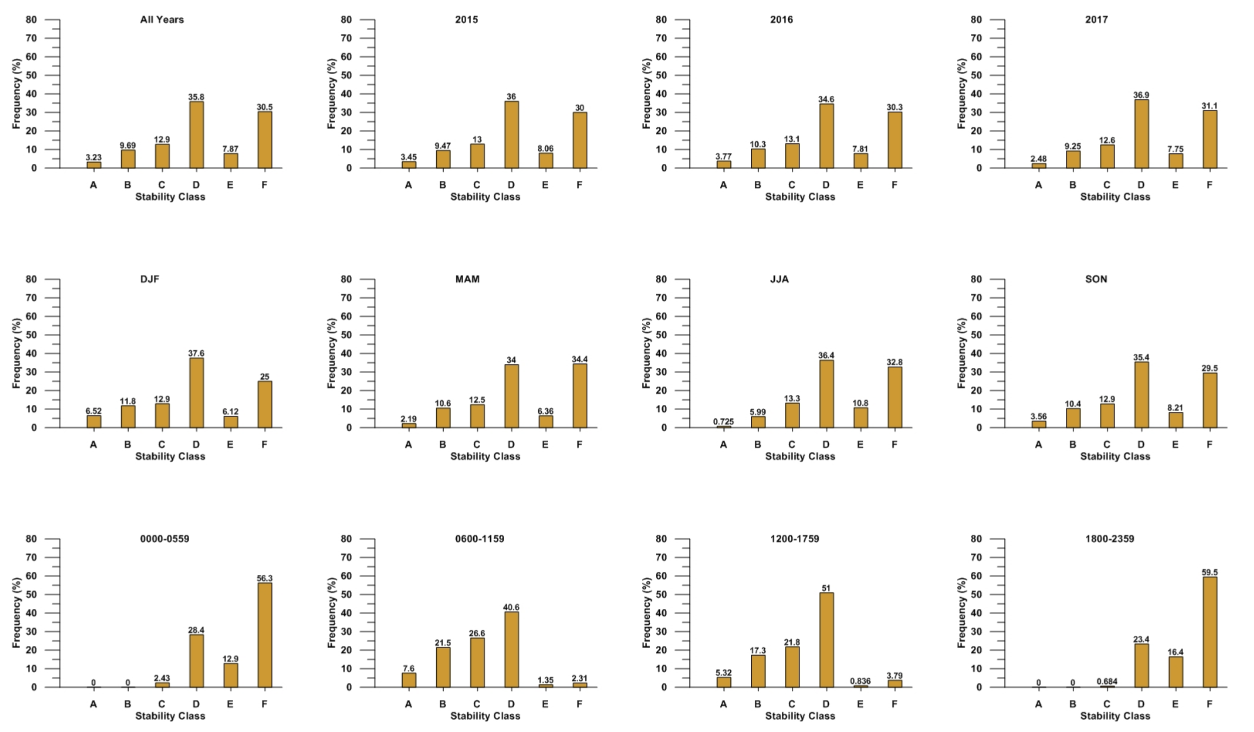
The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data for three years (2015 through to 2017) is presented in Figure 22. Stability class D and F are predicted to occur most frequently indicating that the dominant conditions are stable, with little diffusion. The frequency of strongly convective (unstable) conditions at the study area, represented by stability class A, is relatively low at four per cent of hours during the three years simulated.

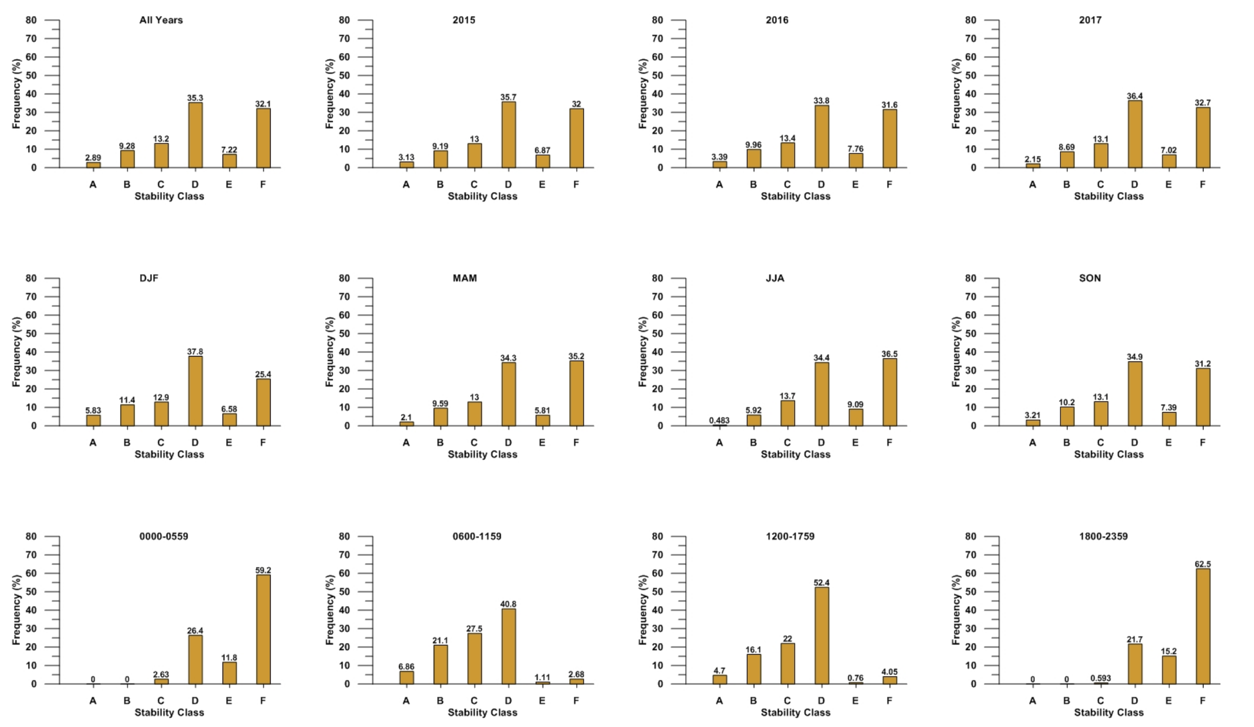
Seasonal and hourly variability is highlighted by the breakdown of stability class frequency in the middle and lower rows of the figure respectively. Not surprisingly, stable conditions are most frequent during the night time and early morning hours.

Figure 22: Frequency of Stability Classes

Project Site (CALMET 2015-2017)



Camberwell (CALMET 2015-2017)



Appendix C Dispersion Modelling Methodology

This appendix presents an overview of the dispersion modelling methodology.

C.1 Dispersion Model

Odour and dust dispersion modelling was undertaken using the US EPA approved CALPUFF model for three years of meteorological conditions at 0.15 km resolution wind fields developed using CALMET. General run control parameters and technical options that were selected are presented in Table 28. Defaults were used for all other options.

Table 28: CALPUFF Configuration

Parameter	Units	Value
CALPUFF version	-	V6.42
Years modelled	-	2015, 2016 & 2017
No. X grid cells (NX)	-	99
No. Y grid cells (NY)	-	98
Grid spacing (DGRIDKM)	Km	0.15
X coordinate (XORIGKM)	Km	307.850
Y coordinate (YORIGKM)	Km	6402.450
No. of vertical layers (NZ)	-	10
UTC time zone (XBTZ)	Hours	UTC+1000
Model Time step	sec	3600
Method used to compute dispersion coefficient (MDISP)	-	2 (internally calculated sigma v, sigma w using micrometeorology)
Computational grid size and resolution	-	Identical to CALMET grid
Discrete receptors modelled	-	2187
Discrete receptors height above ground	m	1.5
Wet deposition	-	False
Dry deposition	-	True (dust)

C.2 Discrete Project Receptors

A total of 2187 receptor locations were included in the CALPUFF model. A single sensitive receptor location corresponding to the township of Camberwell was included (Figure 23). Gridded receptors at 150 m and 350 m spacing were included for the production of contour plots (Figure 24).

Figure 23: Sensitive Receptor Location

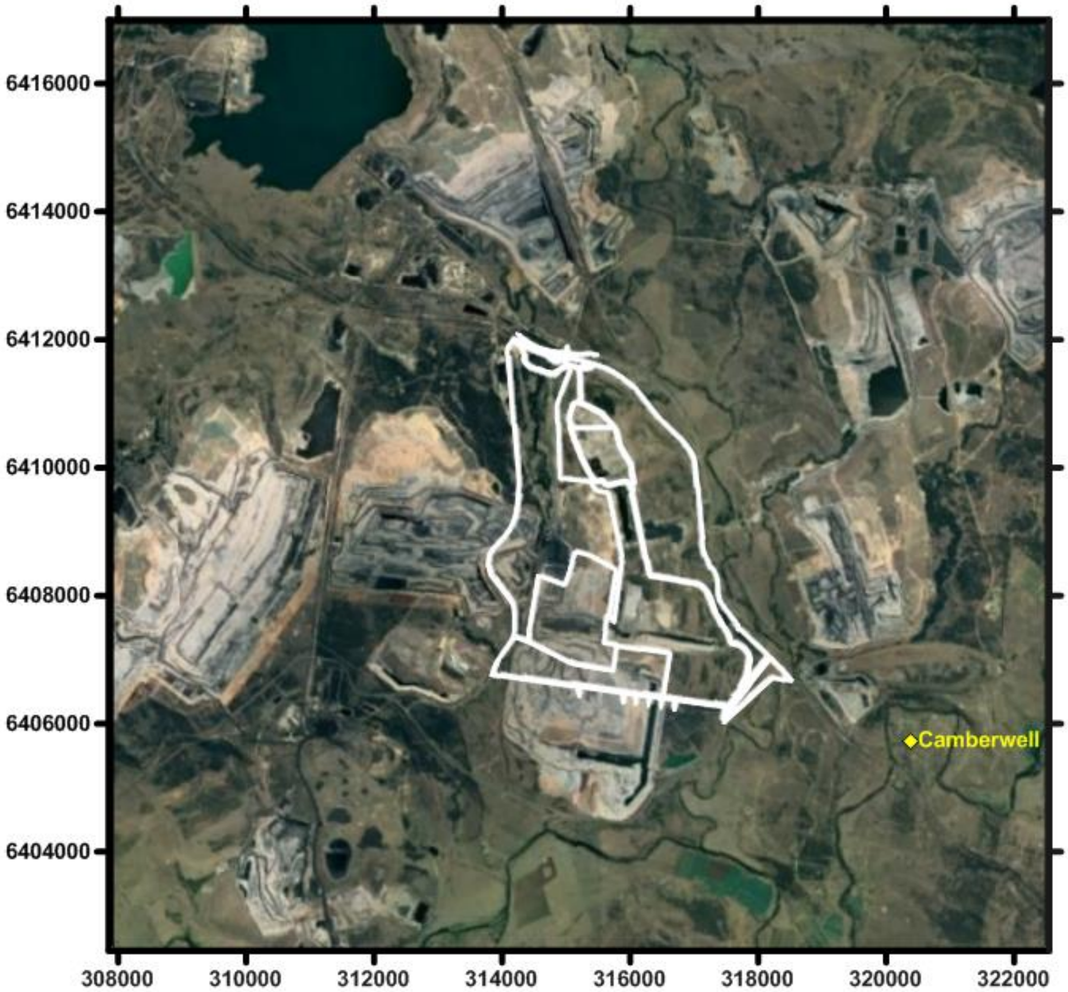


Figure 24: Discrete Receptor Locations (for production of contour plots)