TCG Planning

Kembla Grange Waste Recovery Facility
Air Quality Assessment

July 2014

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1. Introduction

1.1 Purpose of this report

Wollongong Recycling and Building Supplies Facility (Wollongong Recycling) proposes to construct and operate a waste recovery facility (WRF) at Kembla Grange (referred to in this report as 'the proposal'). This report has been prepared by GHD Pty Ltd (GHD) to provide an assessment of air quality impacts of the proposal. This report has been conducted with consideration to the NSW Office of Environment and Heritage (OEH) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Department of Environment and Conservation* (August 2005) (*Approved Methods*).

1.2 Proposal overview

Wollongong Recycling proposes to build and operate a Waste Recovery Facility (WRF) which includes:

- The processing of up to 230,000 tonnes per annum of building and demolition waste, including brick, concrete, soils, timber, general and solid waste.
- Composting of up to 6,300 tpa of green waste.
- Waste storage and stockpile areas.
- Ancillary infrastructure including plant and equipment such as crushers, screens and front-end loaders.
- The expansion of the footprint of storage areas on site, thereby providing a more functional operational arrangement.

1.3 Location of the proposal

The subject site is located at No. 50 Wyllie Rd, Kembla Grange, also identified as Lot 10 DP 878167, as shown in Figure 1. The site is located within the Lake Illawarra catchment and covers approximately 21.7 hectares in area. The area covered by the proposed development is approximately 4.68 hectares.

The site is located on the northern side of Wyllie Road and contains cleared areas used for building material storage and recycling material, while the remainder of the site across the northern and eastern section remains vegetated. However, the site has undergone significant disturbance associated with historical broad scale vegetation clearing and disturbance to the land surface within the south western section of the site due to the use of the site as a resource recovery facility.

The site is bounded to the north by an existing ridgeline. The ground is steeply sloping from the south-eastern entrance from Wyllie Rd at approximately reference level (RL) 44 m Australian Height Datum (AHD) to a level platform located at the western part of the site at RL 21 m AHD. Within the site the landscape comprises the areas on the foot slopes of the Illawarra escarpment, local relief is approximately 30 - 100 m and slope gradients are up to 25%.

The current building material storage and recycling facility was approved pursuant to DA 2009/1153 on 29 April 2010, with Modification 2009/1153/A issued on 17 July 2012, granting approval to an increase in the annual tonnage to 29,999 tonnes. The current facility includes a number of stockpile areas, a dam, workshop, site office and two shipping containers.

A site landscape plan of the proposal is shown in Figure 2.

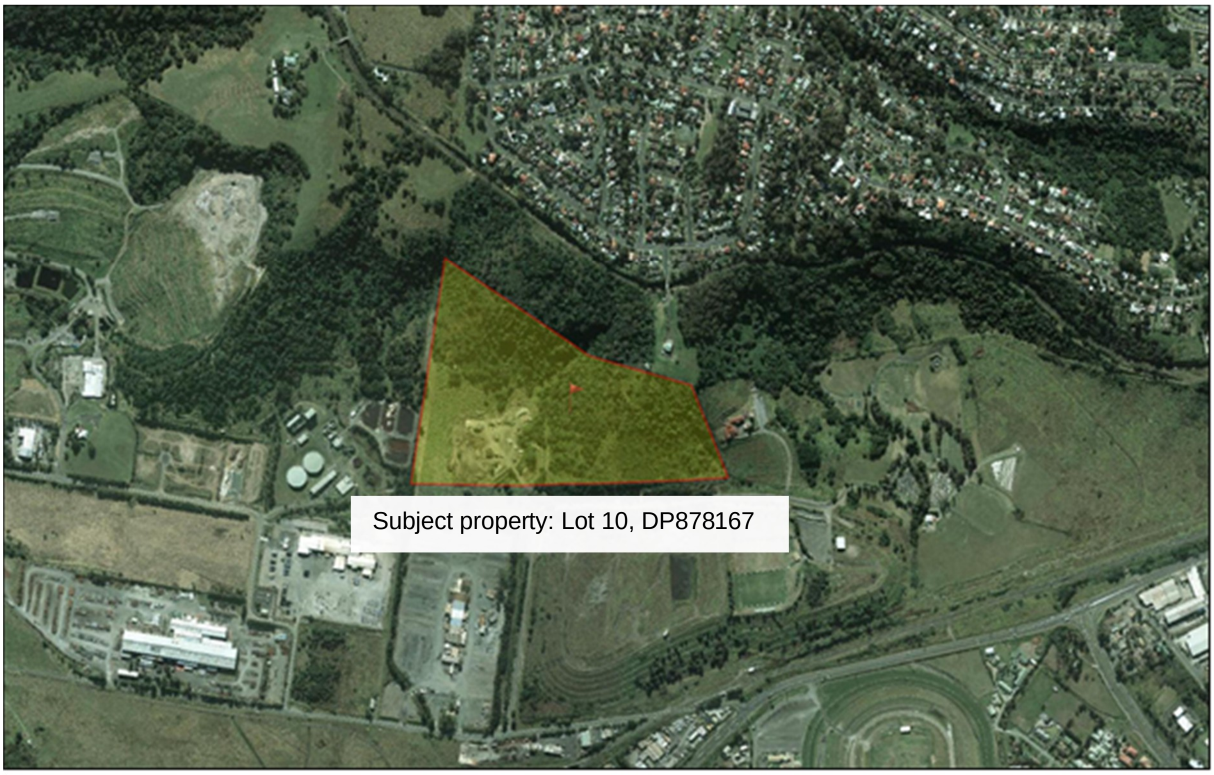

Figure 1 – Site location (Source: SIX Maps)

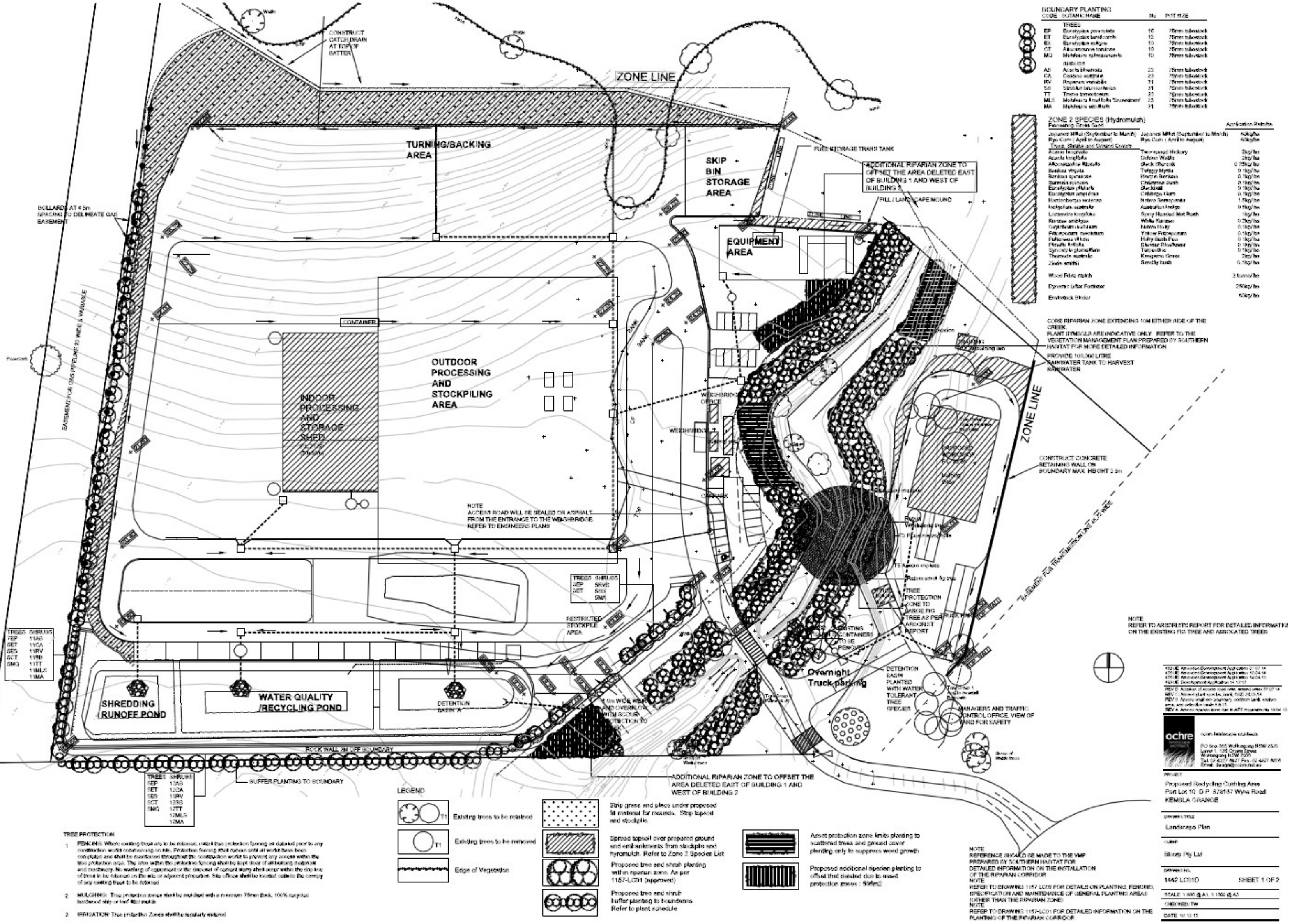

Figure 2 – Site landscape plan

1.4 Scope

The air quality assessment involved the following tasks:

- Initial review of project information provided by Bicorp covering the facility layout and the operational sequence, including any site layout plans and elevations.
- site visit to ascertain the local terrain and the nearest sensitive receptors / residences;
- An inventory was developed of source odour emission rates (OERs) for the facility from other GW facilities.
- Synthesise meteorological data for the site using TAPM and CALMET.
- Conduct a Level 2 modelling assessment to predict odour and dust impact (total suspended particles (TSP), PM_{10}, $PM_{2.5}$, dust deposition using NPI emission factors) at the nearest residences for existing and proposed scenarios.
- Determine if compliance to the OEH/EPA odour criterion is met.
- Reporting on the analyses conducted above.

1.5 Limitations

This report: has been prepared by GHD for TCG Planning and may only be used and relied on by TCG Planning for the purpose agreed between GHD and the TCG Planning as set out in section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than TCG Planning arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by TCG Planning and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Existing environment and meteorology

2.1 Sensitive receivers and land uses

Air quality sensitive receivers are defined based on the type of occupancy and the activities performed in the land use. Sensitive receivers are locations where people are likely to work or reside; this may be any of the following:

- Dwelling
- School
- Hospitals
- Office
- Public recreational area

A water treatment facility is located to the west of the site, together with other heavy industrial uses such as 24 hour pipe coating operations, and steel manufacturing. Other uses sited to the west of the site include a substation and storage facilities and the Wollongong Waste and Recovery Park (formerly known as the Whytes Gully Tip). To the east is the Macedonian Orthodox Church, vacant land, open space and the Wollongong Lawn Cemetery. Both adjacent uses are accessed via Wyllie Road.

To the north, buffered by bushland, is the residential neighbourhood of Farmborough Heights. The residences located to the north of the site are sited on an elevated rock shelf that is approximately 15 - 30 m up slope above the proposed development site. The nearest residences are approximately 500 m from the proposal. A vegetated buffer separates the closest residences to the north from the proposed development site.

To the south of the site opposite the Princes Highway is located residential housing of Kembla Grange, approximately 1 km from the proposal.

Sensitive receivers surrounding the WRF are identified in Table 1 and shown in Figure 3.

Table 1 – Air quality sensitive receivers

Receiver	Receiver ID	Receiver Address
Houses on Fairloch Avenue, Farmborough Heights	01	57 Fairloch Avenue, Farmborough Heights
Ian McLennan Park	02	Access off Wyllie Road
Macedonian Orthodox Church	03	11 Wyllie Road, Kembla Grange
Kingston Lodge	04	14A Kingston Town Dr, Kembla Grange
Farmborough Heights Rural Fire Brigade Station	05	Access off Bardess Crescent

Figure 3 – Air quality sensitive receivers

2.2 Regional climate and prevailing meteorology

The local climate is similar to that of the broader Wollongong region with warm to hot summers and cool to mild winters. The local climate at the Albion Park site is affected by broader regional patterns of synoptic pressure and wind with embedded weather systems.

Synoptic features vary in intensity and location according to the season. For instance, during summer a high-pressure belt is usually found over or just to the south of Australia, bringing warm weather while the subtropical easterlies cover most of the continent. In winter, the subtropical high-pressure belt is usually located further north over the continent, allowing westerly winds and occasional to frequent strong cold fronts to affect southern Australia.

The mean daily maximum temperatures range from 26 °C in summer to 17 °C in winter, and the mean daily minimum temperatures range from 17 °C in summer to 7 °C in winter. The area experiences significant diurnal and seasonal variations in meteorological conditions.

According to meteorological data, the average rainfall in the region is 919 mm (Bureau of Meteorology). Average monthly rainfall ranges from between 28 mm and 154 mm, and the driest months are in winter and early spring, with the higher rainfalls experienced between November and March.

2.3 Wind pattern

Local wind climate largely determines the pattern of off-site dust and odour impact. The characterisation of local wind patterns requires accurate site-representative hourly recordings of wind direction and speed over a period of at least a year. The nearest long term meteorological data available is from the BOM Albion Park AWS approximately 10 km to the south of the site and Port Kembla AWS approximately 10km east of the site. Due to the location of the site and the potential influence of the local terrain three dimensional meteorological data from the CALMET model was used. CALMET requires input from surface weather station networks and upper air stations. The regional-scale prognostic meteorological model, TAPM[1], was used to simulate the meteorology over the subject site with consideration to the DECC Approved Methods.

TAPM accesses databases of synoptic weather analyses from the Bureau of Meteorology. The model then provides the link between the synoptic large-scale flows and local climatology, which includes characterising such factors as local land use and topography, and their influence on atmospheric stability and mixing height.

TAPM was initially configured with a nested model grid coverage designed to capture:

- Broad scale synoptic flows;
- Regional to local scale wind channelling; and
- The influence of local land use.

The TAPM output was then passed to the CALMET model which is the 3D meteorological diagnostic model. The land use and terrain elevation information was derived from US Geological Survey and AusLig data, respectively, with adjustments based upon inspection of aerial photographs, topographical and land uses maps, and a site inspection. CALMET was used to produce hourly site-representative winds and micrometeorological information, which was used with the dispersion model to assess the impacts of the air pollutants on the surrounding land uses.

[1] Hurley, P. The Air Pollution Model (TAPM) version 3. CSIRO Atmospheric Research Paper No. 31, 2005

The effect of wind on odour dispersion patterns can be examined using the general wind climate and atmospheric stability class distributions. The general wind climate at a site is most readily displayed by means of wind rose plots, giving the incidence of winds from different directions for various wind speed ranges.

The features of particular interest in this assessment are: (i) the prevailing wind directions and (ii) the relative incidence of more stable light wind conditions (these define peak impacts from ground-based sources).

2.3.1 Validation of meteorological data

Wind field data from the CALMET model has been compared to the Port Kembla meteorological station approximately 10km to the east of the site. The wind roses are similar with both sites showing dominant winds from the south to southwest, and the north. The stronger coastal southerly winds at Port Kembla are more skewed from the west at the site due to the steep terrain adjacent the site that runs to the northeast.

Port Kembla AWS 2009 **CALMET at site 2009**

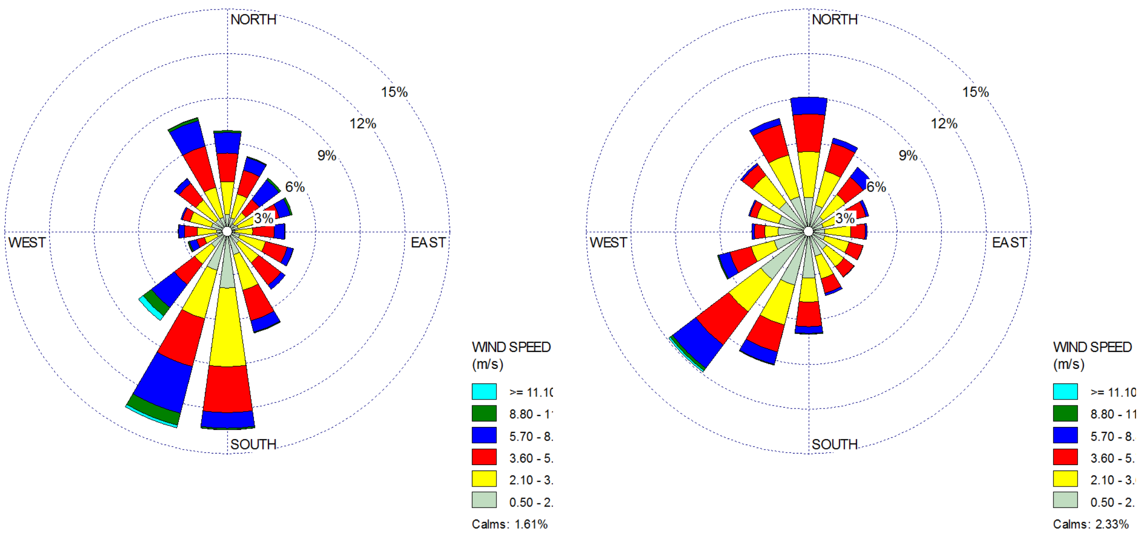

Figure 4 – Validation of meteorology

2.3.2 Annual wind rose

The average predicted annual wind rose for the site is shown in Figure 5 and indicates that predominant annual average wind directions are from the southwest quadrant and from the north. The annual average wind speed was 2.9 m/s. The observed wind speed distribution indicates that the largest proportion of high wind speeds (> 6 m/s) are from the south west, while the largest proportion of light winds (<2 m/s) are also from the southwest.

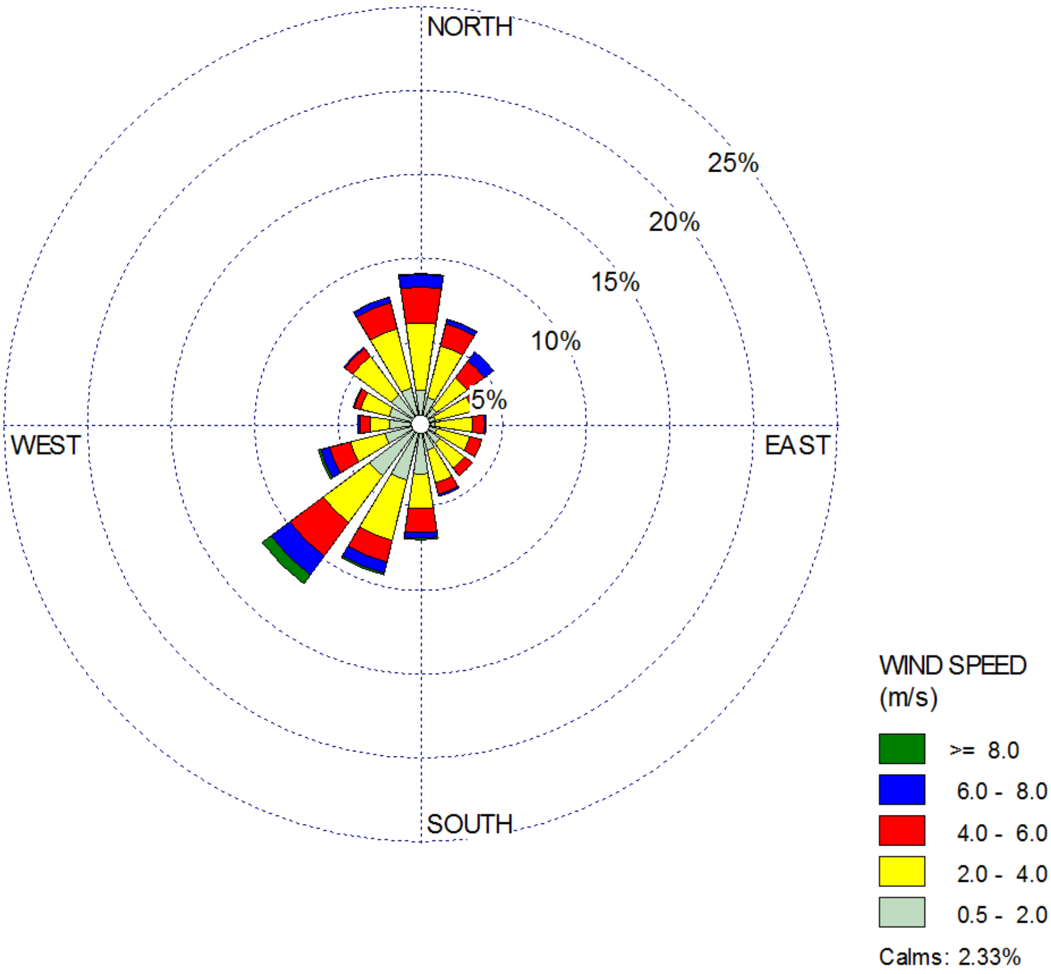

Figure 5 – Annual wind rose (from CALMET 2009)

2.3.3 Seasonal wind roses

The seasonal wind roses in Figure 6 indicate that:

- In winter, the winds are predominantly from the southwest. This observation reflects cool air drainage flows from the hills and mountains from the surrounding land in the west, as well as with the synoptic winter westerlies associated with the pre-frontal (stronger) winds; while
- In summer, the majority of stronger winds are from the north reflecting the synoptic sub-tropical ridge migrating to the south of this location during the warmer months of the year and the summertime sea breeze in the afternoon and evening.

Autumn and spring are transitional seasons with a mixture of both winter and summer observations, with peak incidences from the north and southwest.

The seasonal incidence of high winds (>6 m/s) is greatest in winter, and lowest in autumn, while the incidence of light (<2 m/s) winds is greatest in autumn.

The direction and high proportion of light winds in autumn and winter are predominantly westerly and south-westerly. These air flows are likely to be associated with high stability, and can be expected to define the directions of poorest dispersion for low lying odour emission sources. As the site is located inland with prominent stable winds from the west and southwest, the potential for odour impact is somewhat increased towards the east and northeast.

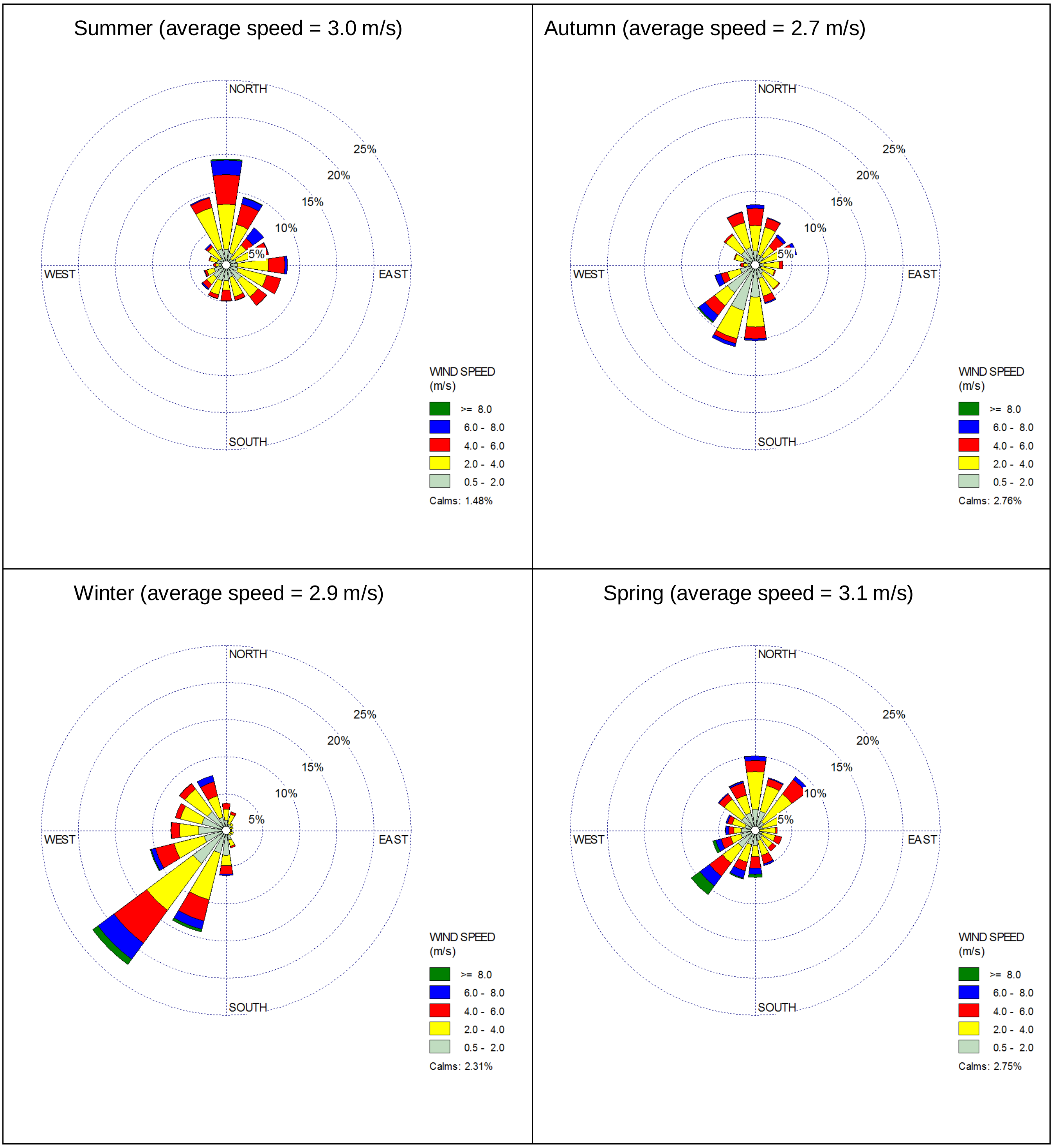

Figure 6 – Seasonal wind roses (from CALMET 2009)

2.4 Annual pattern and seasonal variation in atmospheric stability

In the Pasquill/Gifford atmospheric stability scheme, stability is classified into six classes A through F. The A, B and C stability classes represent strongly, moderately and slightly unstable atmospheres respectively. Under unstable conditions dispersion of emissions from near ground sources is good due to convectively vertical turbulent mixing. The stability category D denotes neutral atmospheric conditions (strong winds in moderate temperatures or lighter winds on overcast to partly cloudy days). Categories E and F denote slightly and moderately stable atmospheres when dispersion is poorest, as vertical mixing of air is suppressed Stable atmospheric conditions occur in the absence of strong gradient winds, and mostly on nights with clear skies. They are often associated with ground-based radiation force temperature inversions, sometimes with fog, mist or frost.

Neutral stability (D class) conditions generally occur most frequently and along with the prevailing wind direction can indicate the most common direction for potential odour impact. Under night-time E and F class conditions, odour emissions from ground based sources result in a downwind plume that is detectable to a greater distance than during the day with associated neutral or unstable atmospheric conditions. It is commonly these conditions that result in odour complaints at maximum range.

Figure 7 shows the stability rose for the entire data period. Neutral atmosphere (D) comprises 22.7% of incident time while the A, B and C class contribute unstable atmospheres 31.9% of the time and the stable E and F conditions contribute 43.1%. Figure 7 shows that the majority of stable winds are from the southwest.

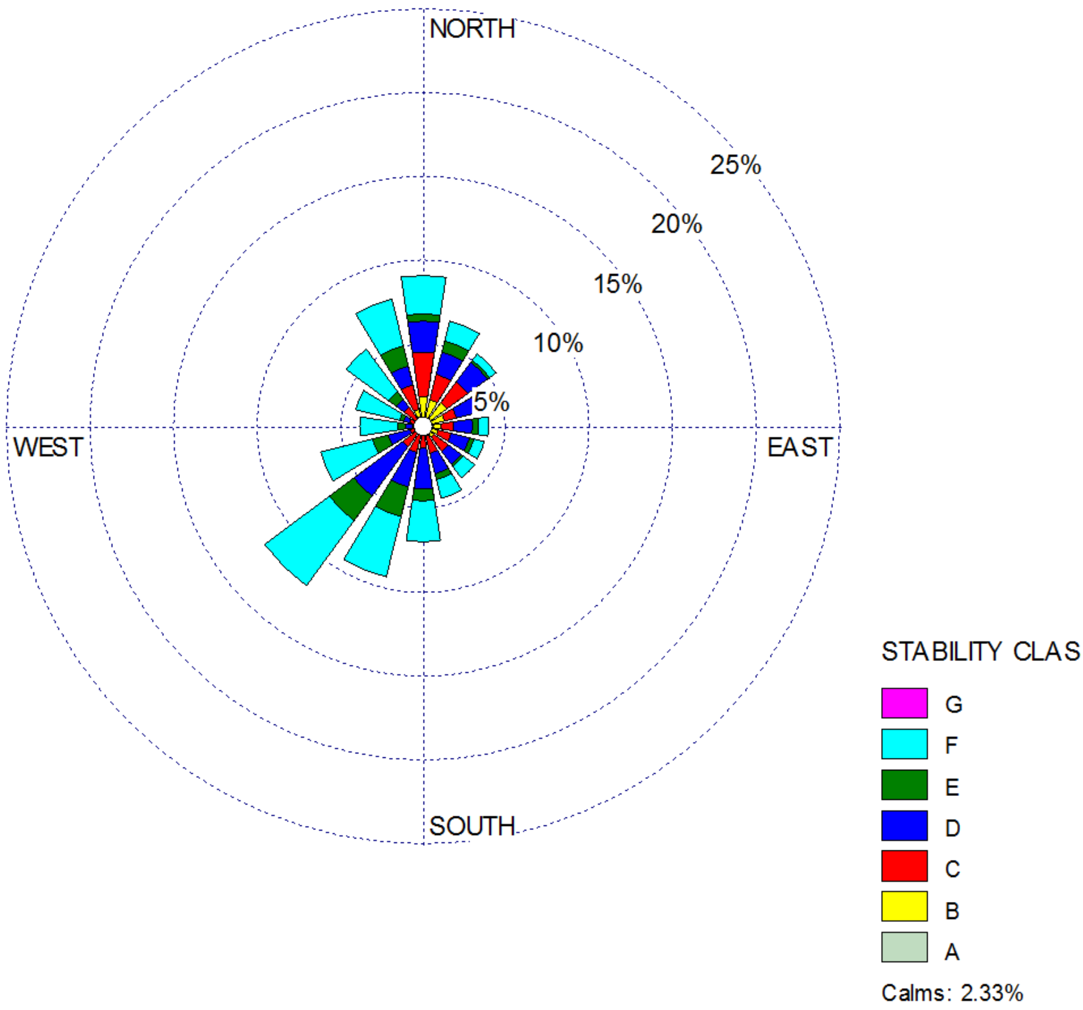

Figure 7 – Annual stability rose (from CALMET 2009)

Figure 8 shows the following seasonal variation trends in atmospheric stability:

- In Summer, neutral winds predominate from the south and east and stable from the west
- In Autumn, stable winds predominate from the west to northwest
- In Winter, stable winds predominate from the west to northwest
- In Spring, stable winds predominate from the western quadrants

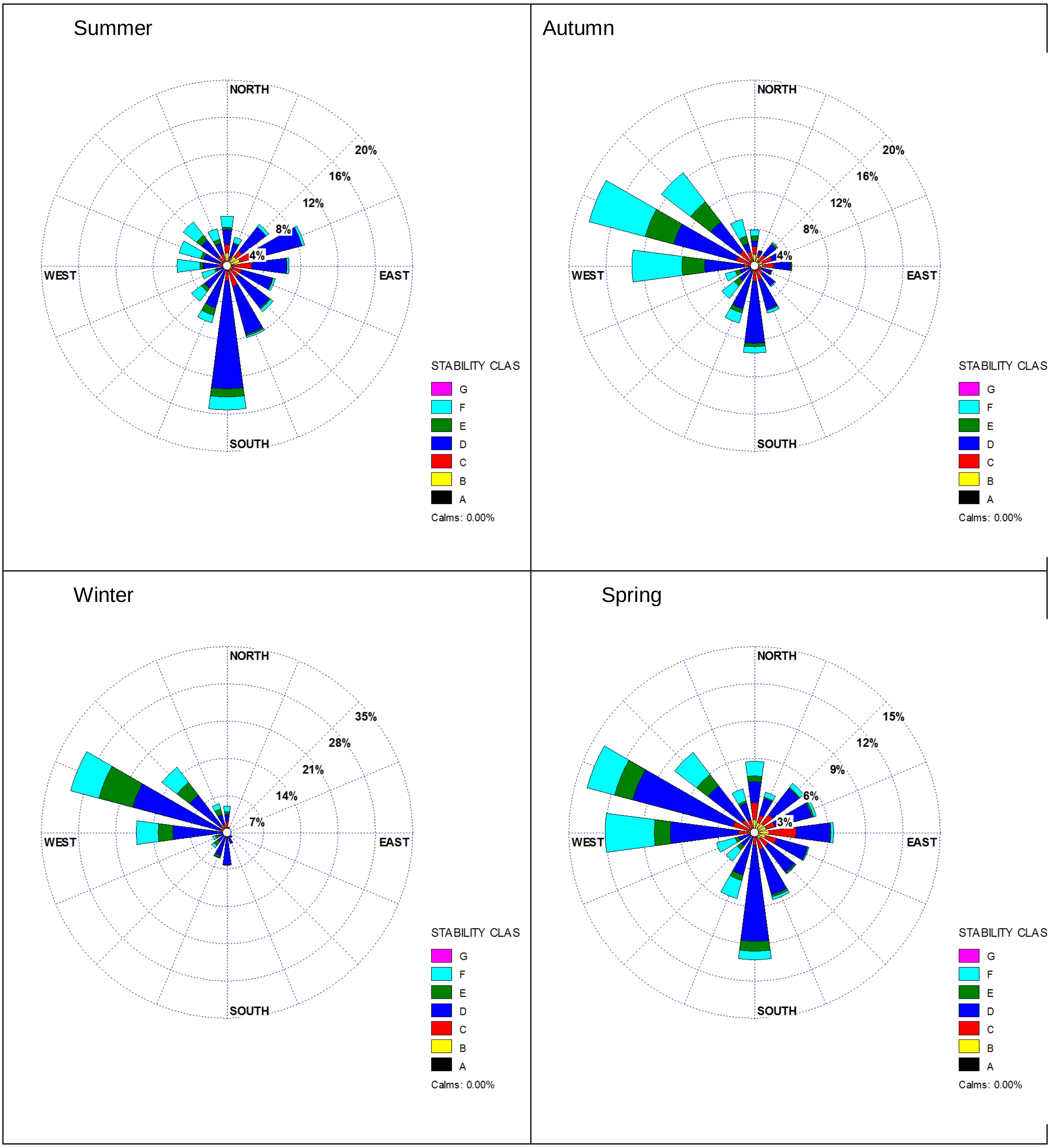

Figure 8 – Seasonal stability roses (from CALMET 2009)

2.5 Background air quality

The nearest existing EPA air quality monitoring station is at Kembla Grange in the Illawarra region in close proximity to the site. Air quality data from the Kembla Grange site was analysed for the last five years (2009 to 2013).

Annual PM_{10} averages for daily mean levels, daily max levels and number of days exceeding the criteria for Albion Park were calculated. The results are detailed in Table 2 and Table 3 and shown in Figure 9 and Figure 10. No other relevant air quality data is available in the area. The results show that the daily maximum PM_{10} levels exceed 50 µg/m³.

There is no $PM_{2.5}$ data available at the EPA Kembla Grange site, and for the purpose of this assessment a ratio of PM_{10} to $PM_{2.5}$ was obtained from the EPA Wollongong air quality monitoring station. The ratio of PM_{10} to $PM_{2.5}$ at Wollongong from 2009 to 2013 was 3.22.

For TSP, given a lack of measured background data, a TSP to PM_{10} ratio of 2:1 was assumed, giving a background value (70th percentile) of 42.6 µg/m^3.

Table 2 – Kembla Grange PM_{10} and $PM_{2.5}$ average annual daily mean levels, µg/m³

Year	Measured Annual mean PM_{10}	Assumed Annual mean $PM_{2.5}$	70th percentile PM_{10}	70th percentile $PM_{2.5}$
2009	24.1	7.5	23.5	7.3
2010	17.7	5.5	21.2	6.6
2011	16.8	5.2	19.8	6.1
2012	18.3	5.7	22.1	6.9
2013	18.5	5.7	20.5	6.4
Five yearly mean	19.1	5.9	21.3	6.7

Table 3 – Kembla Grange PM_{10} and $PM_{2.5}$ average annual daily max levels, µg/m³

Year	Measured Annual mean PM_{10}	Assumed Annual mean $PM_{2.5}$	70th percentile PM_{10}	70th percentile $PM_{2.5}$
2009	81.5	25.3	54.7	17.0
2010	47.2	14.7	53.6	16.6
2011	45.7	14.2	48.9	15.2
2012	50.7	15.7	53.4	16.6
2013	46.0	14.3	48.2	15.0
Five yearly mean	54.2	16.8	51.8	16.1

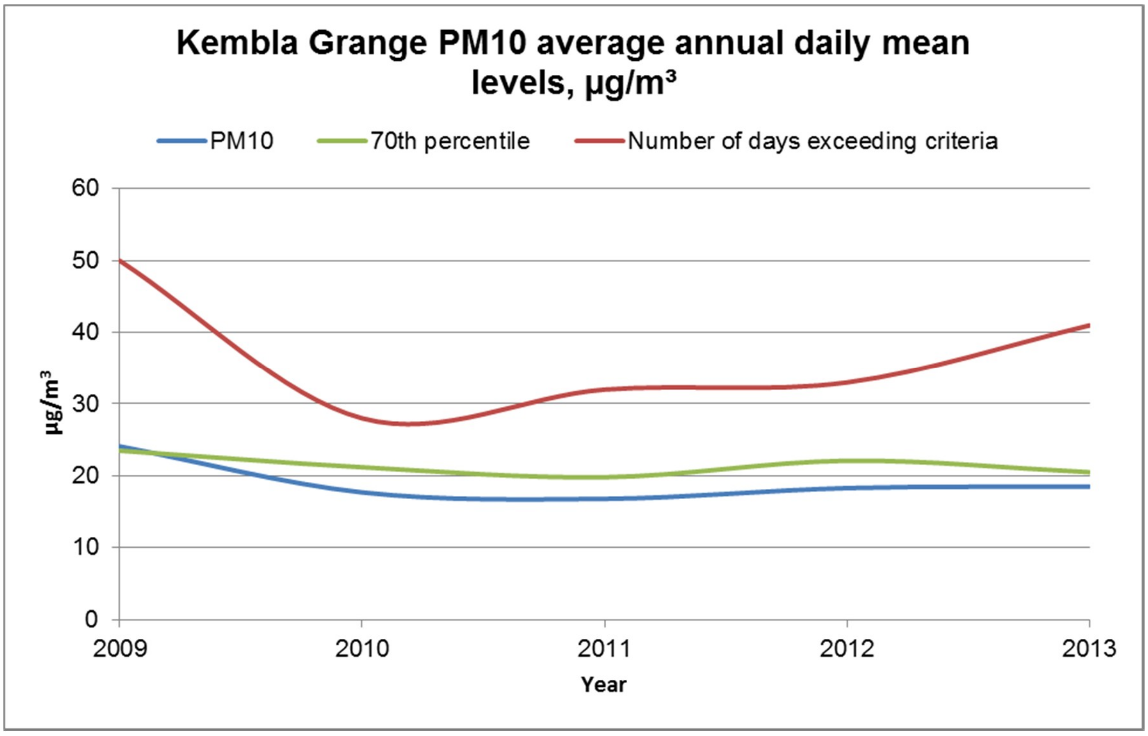

Figure 9 – Albion Park PM10 average annual daily mean levels, µg/m³

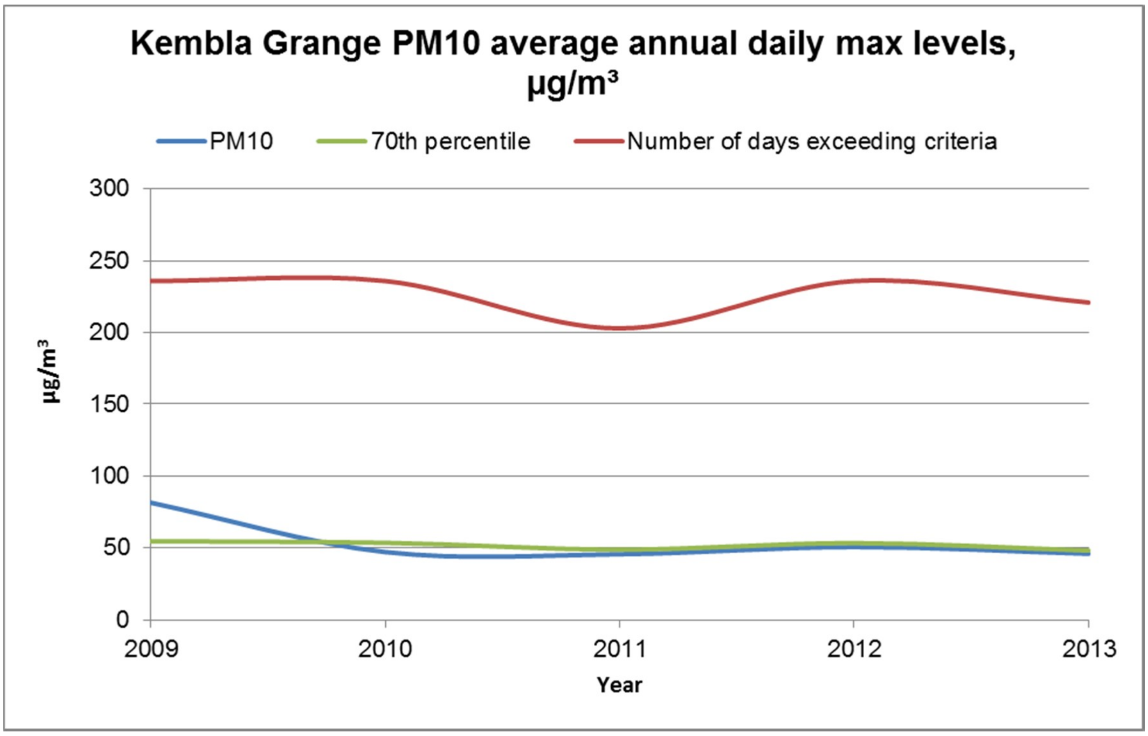

Figure 10 – Albion Park PM10 average annual daily max levels, µg/m³

2.6 Other sites nearby

There are other sites in the vicinity of the proposal that are sources of odour, including the Soilco site at 61 Reddalls Road (500 m to the west), Wollongong Waste and Recovery Park (over 500 m to the north west) and the Illawarra Water Filtration Plant (potable water). The nearby Soilco site and Wollongong Waste and Recovery Park undertake green waste composting however given the distance and the prevailing meteorology the potential for cumulative impacts at the nearby receivers on Fairloch Avenue and the Orthodox Church is considered minor. As can be seen in the meteorology in Section 2.3 and also the project odour prediction contours in Section 6.3 worst case odour dispersion is to the northeast and the south, meaning there is little chance for cumulative green waste odour impacts given that the proposal site is located to the east of these sites.

2.7 Complaint history

No odour or dust complaints were provided by Wollongong Recycling.

3. Air quality assessment criteria

This section considers the key guidelines/criteria which relate to and are relevant to the following potential impacts arising from green waste composting and landfilling, namely:

1. Odour; and
2. Dust.

3.1 Legislation

The *Protection of the Environment Operations Act 1997* (POEO Act) establishes, amongst other things, the procedures for issuing licences for environmental protection in relation to aspects such as waste, air, water and noise pollution control. The owner or occupier of premises engaged in scheduled activities is required to hold an environmental protection licence (EPL) and comply with the conditions of that licence.

The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. The operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act).

The POEO Act also addresses the issue of 'offensive odour' (section 129) and states it is an offence for scheduled activities to emit 'offensive odour'.

3.2 Guidelines

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales ('the Approved Methods') (DEC, 2005) lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW.

The *Technical framework for the assessment and management of odour from stationary sources in NSW* (DEC, 2006) introduces a system to help protect the environment and the community from the impacts of odour emissions while promoting fair and equitable outcomes for the operators of activities that emit odour.

3.3 Dust

Air quality impact assessment criteria are prescribed within the NSW Office of Environment and Heritage (OEH) *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Department of Environment and Conservation* (August 2005) (*Approved Methods*).

To ensure that dust environmental outcomes are achieved, emissions from the site must be assessed against the assessment criteria given in Table 4.

Table 4 – Assessment Criteria for PM_{10} and TSP

Pollutant	Averaging Period	Criteria
PM_{10}	24 hours	50 $\mu g/m^3$
	Annual	30 $\mu g/m^3$
TSP	Annual	90 $\mu g/m^3$
Dust deposition	Annual	2 g/m^2/month*

** Maximum Increment. Maximum cumulative impact of 4 g/m^2/month.*

The above criteria are provided as cumulative (incremental plus background) concentration levels.

3.4 Odour criteria

The Approved Methods defines odour criteria and then specifies how they should be applied in dispersion modelling to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impact is a subjective experience and has been found to depend on many factors, the most important of which are:

- The **F**requency of the exposure
- The **I**ntensity of the odour
- The **D**uration of the odour episodes
- The **O**ffensiveness of the odour
- The **L**ocation of the source.

These factors are often referred to as the FIDOL factors.

The odour criterion is defined to take account of two of these factors (**F** is set at 99th percentile; **I** is set at from 2 to 7 OU). The choice of criterion odour level has also been made to be dependent on the population of the affected area, and to some extent it could be said that population is a surrogate for location – so that the **L** factor has also been considered. The relationship between the criterion odour level **C** to affected population **P** is given below:

$$C = [\log P - 4.5] \div -0.6 \qquad \text{equation 1}$$

Table 5 lists the values of C for various values of affected populations as obtained using equation 1.

Table 5 – Odour criteria for the assessment of odour (DEC, 2005)

Population of affected community	Odour performance criteria (nose response odour certainty units at 99th percentile)
Single Residence (≤ ~2)	7
~ 10	6
~ 30	5
~ 125	4
~ 150	3
Urban (~2,000)	2

The criteria assumes that 7 OU at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be encountered. The criterion of 2 OU at the 99th percentile is considered to be acceptable for the whole population.

The criteria have also been specified at an averaging time of nominally 1 second. The choice of the short averaging time recognises that the human nose has a response time of less than 1 second, so that modelling of odour impact should allow for the short-term concentration fluctuations in an odour plume due to turbulence.

As the Ausplume dispersion model (used in this assessment) cannot predict concentrations for a 1 second average, a ratio between the 1 second peak concentration and 60 minute average concentration has been applied. This is known as the peak to mean ratio (PM60). PM60 is a function of source type, stability category and range (i.e. near or far-field), and values are tabulated in the Approved Methods.

3.5 Project odour criterion

The project site is immediately surrounded primarily by vegetated land to the north, and industrial land to the west. The community of Farmborough Heights is located approximately 500 m to the north. This population of Farmborough Heights is present adjacent the existing site, and with this density, equation 1 gives an odour criterion of 2 OU to apply to this project.

4. Estimated emissions

4.1 Dust

The air quality assessment focuses on dust, particulate matter being a significant emission to air from the site with potential for off-site impact. The fractions of interest assessed in this report are airborne concentrations of TSP and fine particulate matter as well as total deposited dust.

Activities at the site include receiving construction and demolition waste, crushing, screening, reclaiming, and transport of the processed material on and off-site.

The individual processes that generate significant amounts of particulate matter (dust) were identified to be:

- Crushing of materials (64,500 T) including:
  - Glass
  - Plasterboard
  - Ceramics
  - Brick
  - Concrete
  - Asphalt waste
  - Cured concrete waste
  - Waste accepted under NSW EPA resource redemption
- Screening of crushed waste and soils (114,500 T).
- Vehicle induced dust emissions in site area and haul road.
- Wind erosion of exposed unstable soil surfaces and localised stockpiles.

In the absence of any site specific data, emission rates from naturally wind-borne dust and mechanically induced dust were characterised using Emission Factors (EFs) provided in the National Pollutant Inventory (NPI) Emission Estimation Technique Manual (EETM) for Mining[2]. The techniques used to estimate emissions from mining operations are based primarily on activity rate (e.g. tonnes per hour).

Other air emissions such as combustion products (e.g. vehicle exhaust) will also be present within the site, however due to the small number of vehicles, the potential for impact from these emissions is negligible. Therefore, vehicle exhaust emissions have not been considered further in this assessment.

4.1.1 General site activities

It is understood that the site is to have a typical material throughput of up to 871 tonnes per weekday, which equates, on average, to 73 tonnes per hour (TPH) over a 12 hour day, 5 days per week). Throughputs on weekends would be typically 25% of a weekday and therefore not assessed separately.

Although it is not expected that the WRF will operate at 73 TPH consistently, this production rate has been chosen to represent a likely scenario to derive emission rates.

[2] National Pollutant Inventory (NP)I Emission Estimation Technique Manual for Mining, Version 3.1 January 2012.

Table 6 provides a summary of the WRF equipment considered in this assessment. It should be noted that of the total equivalent truck movements (494 per day), approximately 10% have been assumed to be light duty trucks as defined by NPI.

Table 6 – On-site Equipment Summary

Equipment Type	Number of Units
Screen (screens, conveyor)	1
Wheeled loader	2
Excavator	3
Bulldozer	1
Crusher	1
Mobile crusher	1
Shredder (one inside shed and one outside)	2
Water truck	1
Reclaimer	1
Delivery vehicles – single truck units and truck/dogs	247
Sales vehicles – single truck units and truck/dogs	247

The following assumptions were made in calculating the dust emission rates for WRF activities:

- Where there was more than one item of the same equipment, the total throughput was split between each item. For example, if there were two loaders operating at once, it was assumed that each loader would have half of the total throughput.
- The use of a water truck has been assumed not to generate dust emissions, as its use will act to suppress emissions. Therefore, the water truck has not been included in the emissions inventory.

The dust emissions inventory for the site (including with mitigation) is provided below in Table 7.

Level 2 watering (>2L/m^2/hr) of the access road (from the site office into the site) and the truck turning/backing area has been assessed as a mitigation option and most likely to provide the necessary mitigation.

Table 7 – Dust emission inventory

Equipment	Default TSP Emission Factor	Default PM_{10} Emission Factor	Unit	Application	TSP Emission Rate (kg/hr)	PM_{10} Emission Rate (kg/hr)	$PM_{2.5}$ Emission Rate (kg/hr)
Screen	0.08	0.06	kg/t	One mobile screen, 36.1 tonnes per hour	2.89	2.17	0.67
Loaders	0.025	0.012	kg/t	Two loaders, 36.3 tonnes per hour per loader	0.91	0.44	0.14
Excavator	0.025	0.012	kg/t	Three excavators, 24.2 tonnes per hour per excavator	0.61	0.29	0.09
Crusher	0.2	0.02	kg/t	One crusher, 20.4 tonnes per hour	4.08	0.41	0.13
Reclaimer	0.06	0.03	kg/t	One reclaimer, 20.4 tonnes per hour	1.22	0.61	0.19
Dump Truck - dumping	0.012	0.0043	kg/t	Dumping 36.1 tonnes per hour	0.43	0.16	0.05
Dump Truck – travelling on unpaved roads	3.901	1.158	kg/VKT	Average of 20 dump trucks per hour. Haul route 400 metres. Equals 8 km per hour total travel.	31.21	9.26	2.88
Dump Truck – travelling on unpaved roads with mitigation	0.975	0.2895	kg/VKT	Average of 20 dump trucks per hour. Haul route 400 metres. Equals 8 km per hour total travel.	7.80	2.32	0.72
Bulldozer with mitigation	4.25	1.03	kg/h/veh	One bulldozer 6 hours per day.	2.13	0.52	0.16
Wind Erosion	0.4	0.2	kg/ha/hr	Assuming stockpiles of various sizes located around the site	-	-	-

4.2 Odour

The following odour sources have been identified onsite:

- Raw green waste receival and shredding (outside of the building)
- Initial stage static compost pile (inside the building)
- Compost maturation windrows (inside the building)
- Compost matured product stockpiles (outside the building)
- Green waste leachate pond

The two main sources of odour from the proposal are the building and the green waste maturation area. As discussed in the Waste Management Plan (Benviron Group, June 2014) the initial stage static compost pile and maturation windrows will all be housed within an enclosed building maintained at negative air pressure.

Potential odour mitigation options are assessed in Section 6.4.

The raw green waste and matured product storage area will not be enclosed and odour emission rate (OER) data has been obtained from testing trial windrows that were formed from the composted product from Veolia's in-vessel facility at Dandenong, and which were set up at Veolia's Bangholme facility.

Green waste composting at the WRF has the potential to emit odours that may impact on the surrounding environment. Approximately 6,300 tpa of green waste is to be accepted onsite. No odour sampling data was available for the site and therefore odour emissions data from other similar sites have been used in this assessment. The data used is considered representative of a typical composting operation.

In order to predict the maximum potential odour impact associated with operation of the proposal, the identified odour emission sources will be characterised as follows:

- **Fugitive emissions and transfer points:** These sources have been characterised using data from other similar composting facilities;
- **Static Piles** The static piles of green waste have been characterised with reference to odour testing at an existing facility (ANL[3]);
- **Maturation Windrows:** Odour emission rate (OER) data has been obtained from testing of trial windrows that were formed from the composted product from Veolia's in-vessel facility at Dandenong, and which were set up at Veolia's Bangholme facility. The tests were conducted at different elapsed times during the 4-week maturation process, so that the combined odour emission rate from the windrow array could be quantified. The odour emission rates for windrow activities such as the formation and break apart of windrows were also characterised.

The output windrow OER from the in-vessel has been assumed to be similar to the output from the static green waste piles.

4.2.1 Static windrow emission rates

Given that on-site measurements were not available to GHD, the static windrow emission rates were sourced from a report on Odour Survey and Improvement Plan for ANL at Coldstream[5].

Odour monitoring was conducted on various windrows including:

[3] Report on Odour Survey and Improvement Plan for ANL – Sustainable Infrastructure Australia 29th March 2007.

- Green waste with added moisture – undisturbed;
- Green waste with added moisture – disturbed;
- one month old compost pile – undisturbed;
- one month old compost pile – disturbed;
- Three month old compost pile(s) – undisturbed;
- Three month old compost pile(s) – disturbed;
- Mature compost pile- undisturbed; and
- Mature compost pile- disturbed.

The following Table 8 gives the SOER's for the static green waste windrows at different ages.

Table 8 – Static stockpile SOERs

Green Waste - Source Description	SOER (OUm/s)
Static Windrows - 1 month	2.1
Static Windrows - 2 months	1.4
Static Windrows - up to 4 months old	0.8

4.2.2 Maturation windrow OER measurements – greenhouse enclosure method

Technique of measurement of windrow OER

SOER data for the maturation windrows was obtained from trial windrows set up at Bangholme, Victoria. The material for these windrows was taken from the in-vessel composting facility operated by Veolia (Natural Resource Systems (NRS)) in Dandenong. The OER measurements taken from the trial windrows are considered by GHD to be representative of the emissions from the compost that will be generated at the proposed operations at the WRF and Waste Facility. That is, the matured compost was a mixture of green waste and approximately 3-4% grease trap waste. Grease trap waste is not added at the proposed WRF meaning the emission rates are considered conservative.

Odour sampling of the trial windrows was conducted on three occasions by EML. The initial stage of testing involved sampling of a compost windrow by two methods:

- by using an isolation flux chamber at three points along the crest of the windrow; and
- by fully enclosing the windrow with a greenhouse frame and stretching an impermeable polyethylene sheet over the frame. The sheet extends both ends – at the exit, the sheet is drawn onto the housing of a 1.3 m axial fan with a variable speed controller, and the inlet is formed to a circular aperture at approximately 800 mm diameter. Figure 11 below shows the arrangement. To determine the windrow OER, samples of odour are taken at the inlet and outlet, and the air flowrate Q drawn by the fan is measured at the inlet. Windrow OER is calculated as OER = $(OU_{outlet} - OU_{inlet}) * Q$. This temporary enclosure is referred to here as the 'greenhouse' method.

Figure 11 – Enclosed windrow for odour sampling

Calculation of age-mean windrow SOER

Measurements of trial windrow OER were made at windrow 'ages' of 1, 10, 21 and 31 days, with fan speed settings at 10 Hz and 20 Hz (50 Hz representing a 100% fan flow rate of ~ $10m^3/s$). The results are presented in Figure 12, where the OER/m^2 of windrow surface – specific OER, or SOER is plotted against windrow age in days.

The results for the 10 Hz fan controller setting (giving an annular air speed of ~0.1 m/s) were assumed to be representative of light wind ambient conditions, and as such, an age-average SOER of 100 OUm/min for the maturation windrow array has been adopted for the odour modelling (see Figure 12). For ground level sources, dispersion under light stable winds generates maximum off-site impact, and experience has shown that any increase in emission rate as wind speed increases is more than off-set by the stability category changing to less stable settings. In other words, the increased dispersion as a consequence of the lessened stability more than outweighs the increased source emission rate as a result of increased wind stripping. As such, the effect of wind stripping was not accounted for in the model.

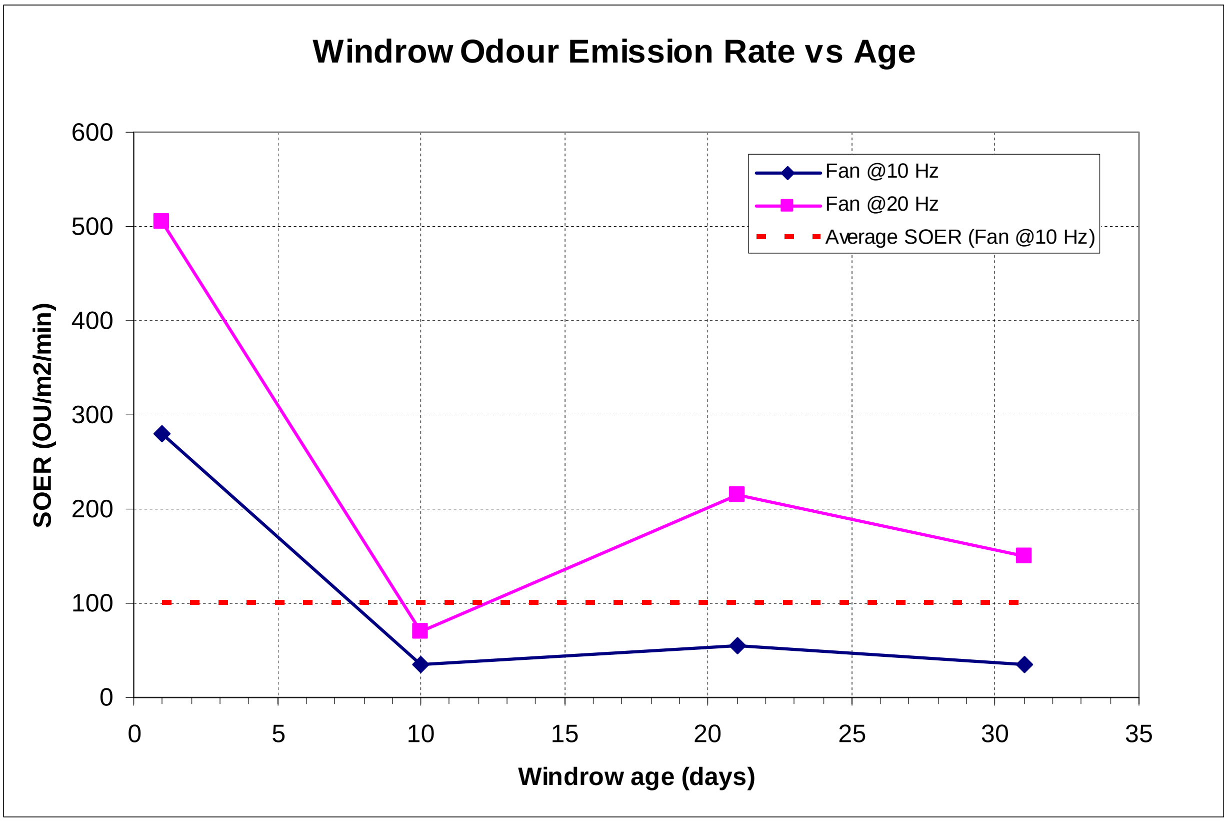

Figure 12 – Windrow Odour Emission Rate vs Age

Calculation of windrow array SOER

A trapezoidal windrow geometry was assumed, as indicated by Figure 13. Based upon this windrow geometry and the expected throughput for a 4 week on-site maturation, it was calculated that two windrows of approximately 21.5 m length would be present on site at any one time. The total exposed surface area of the windrows was calculated as approximately 508 m^2. Based on windrow parameters of width of 8 m and a height of 3 m, which equates to a cross-sectional area 15 m^2, the volume on site at any one time was calculated to be ~ 640 m^3. This equates to an approximate windrow length of 43 m. The ‘footprint’ area of the two windrow array was calculated to be 469 m^2.

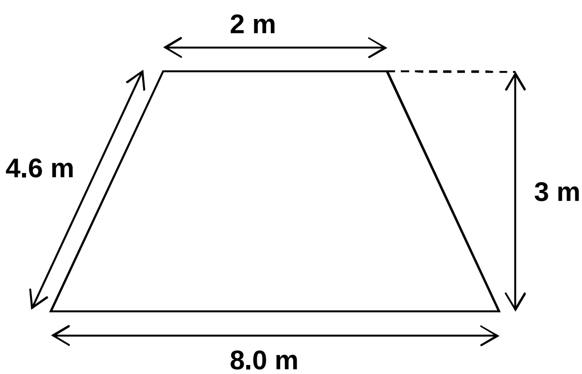

Figure 13 – Current typical windrow geometry

4.2.3 Matured stage

Matured compost from the proposal will be stored onsite in a designated area at the northern end of the landfill site. The proposed maximum amount of input waste has been assumed for this scenario and includes 4,740 t of green waste.

The total length of matured windrows at any one time has been calculated to be 33 m with a surface area of 429m^2 and a total ground area of 291 m^2.

4.3 Summary of OER inventory for all windrows

4.3.1 Quiescent windrows

Table 9 describes the separate windrow sources and their corresponding SOERs.

Note the static windrow emission data is from Isolation Flux Chamber (IFC) measurements which is known to be an under estimate of actual OER. The basis for accepting that IFC measurements under-estimate windrow OERs is described elsewhere[4].

The SOER data for static piles as given in Table 8 was based on the use of an IFC at Coldstream. To enable an estimate of the degree of under-estimation of SOER due to the use of an IFC for static piles, the mean SOER measured on the Bangholme trial windrow (obtained using a total enclosure) was taken to be the equivalent of the static piles at Coldstream. On that basis, the factor of increase to apply to the Coldstream static pile results is: (100/60) /0.8 = 2.1. Thus a factor of increase of 2.1 to account for the under-estimate of IFC has been applied to the static windrows at 1 month, 2 months old and 3 to 4 months old (see Table 9). In the absence of on-site measurements this may be an over-estimate.

Table 9 – Summary windrow SOERs

Green Waste - Source Description	Corrected SOER (OUm/s) to account for under-estimate of IFC
Static Windrows - 1 month	4.4
Static Windrows - 2 months	2.9
Static Windrows - 3 to 4 months old	1.7
Maturation Windrows	1.7
Matured Stockpile	0.6

Note that GHD has used 3 OUm/s for static windrows SOER as the average was taken from the windrows 1-3 months old.

Other assumptions used in the assessment were:

- 50% of the daily input of raw green waste sits at the receival area at any one time during operating hours;
- A 30% reduction in the mass of material at the maturation stage i.e. after static phases due to evolution of moisture and VOCs during the composting process; and
- The bulk density of composting material during the static phases is assumed at 0.33 t/m^3, increasing to 0.6 t/m^3 during maturation phase.

[4] Pollock T, Braun H "Odour Emission rate Measurements on Greenwaste Windrows" 19th Int. Clean Air & Env. Conf. 9-11 Sept 2009 , Perth WA.

4.3.2 Fugitive emissions and transfer points:

GHD holds a large database of odour emission rate measurements taken from odour sources associated with similar green waste composting operations to those proposed by Wollongong Recycling. This database has been collated principally by GHD (using the specialist firm Emission Testing Consultants (ETC) and also (in the case of the ANL Coldstream facility) by URS (using the olfactometry laboratory operated by EML). The GHD database comprises some 16 reports by ETC while the URS database is contained in URS's reports of March 2008 and August 2008 (URS 2008a, 2008b).

Receivals area/ shredder/pre-sort

An SOER for non-mulched green waste of 0.3 OU m/s was referenced from available data for Alternative Waste Treatment operations within NSW (Heggies, 2011). To account for some seasonal variability in the received green waste material, a conservative SOER of 1.0 OU m/s was adopted for the purpose of the odour modelling. In general, all of the material received would be contained within the building and on any one day, would be processed before the end of that day. As such, the odour modelling has assumed a pad containing approximately 8 tonnes of received material increasing to 10 tpa, with an emitting surface area of approximately 50 m^2 and 62 m^2 respectively. Emissions from this source are assumed to occur 8 hours/day, 7 days per week.

A dedicated shredder would be located at the receivals area where oversize material from the pre-sort screening operation would be processed.

This assessment has assumed that WRF will use a mobile slow speed shredder. GHD has assumed that the OER measured from the shredder used by ANL would be representative for this unit. Emissions are from the URS Report of 7 March 2008 (Table 3-1 and Appendix A (Section A.1)).

4.3.3 OER inventory

The OER's from the green waste piles and windrows plus turning contribution, fugitive and transfer point sources are summarised in Table 10 to enable a comparison of the component source contributions to the site OER.

Key points from Table 10 in terms of emission sources, the appropriateness of technology and proposed practices are as follows:

- The shredder dominates emissions at 55% of the total emissions during operating hours.
- The contribution from the static windrows is 28.7%.
- During non-operating hours (when poor dispersion occurs) the site OER reduces to ~ 41% of daytime values. Hence, any reduction of OER from daytime-only sources will not decrease the extent of the 99th percentile contour.
- In summary, the peak off-site impact is defined almost solely by the static and maturation windrows at night.

Table 10 – OER inventory for proposed operations

Source description	Emitting surface area (m^2)	SOER (OUm/s)	OER (OUm^3/s)	Percentage of OER (%)
Operating Hours				
Green waste stockpile – Receival	92	4.0	366	3.5
Shredder		-	5,741	55.0

Source description	Emitting surface area (m^2)	SOER (OUm/s)	OER (OUm^3/s)	Percentage of OER (%)
Static Windrows	1000	3	2999	28.7
Maturation windrows (with turning)	508	1.7	846	8.1
Matured stockpile	429	0.6	250	2.4
Leachate pond	780	0.3	234	2.2
Total			**10436**	**100.0**
Non-Operating Hours				
Green waste stockpile – Receival	92	4.0	366	7.8
Static windrows	1000	3	2999	63.9
Maturation windrows	508	1.7	846	18
Matured stockpile	429	0.6	250	5.3
Leachate pond	780	0.3	234	5
Total			**4329**	**100.0**