TCG Planning

Kembla Grange Waste Recovery Facility
Air Quality Assessment

April 2015

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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)

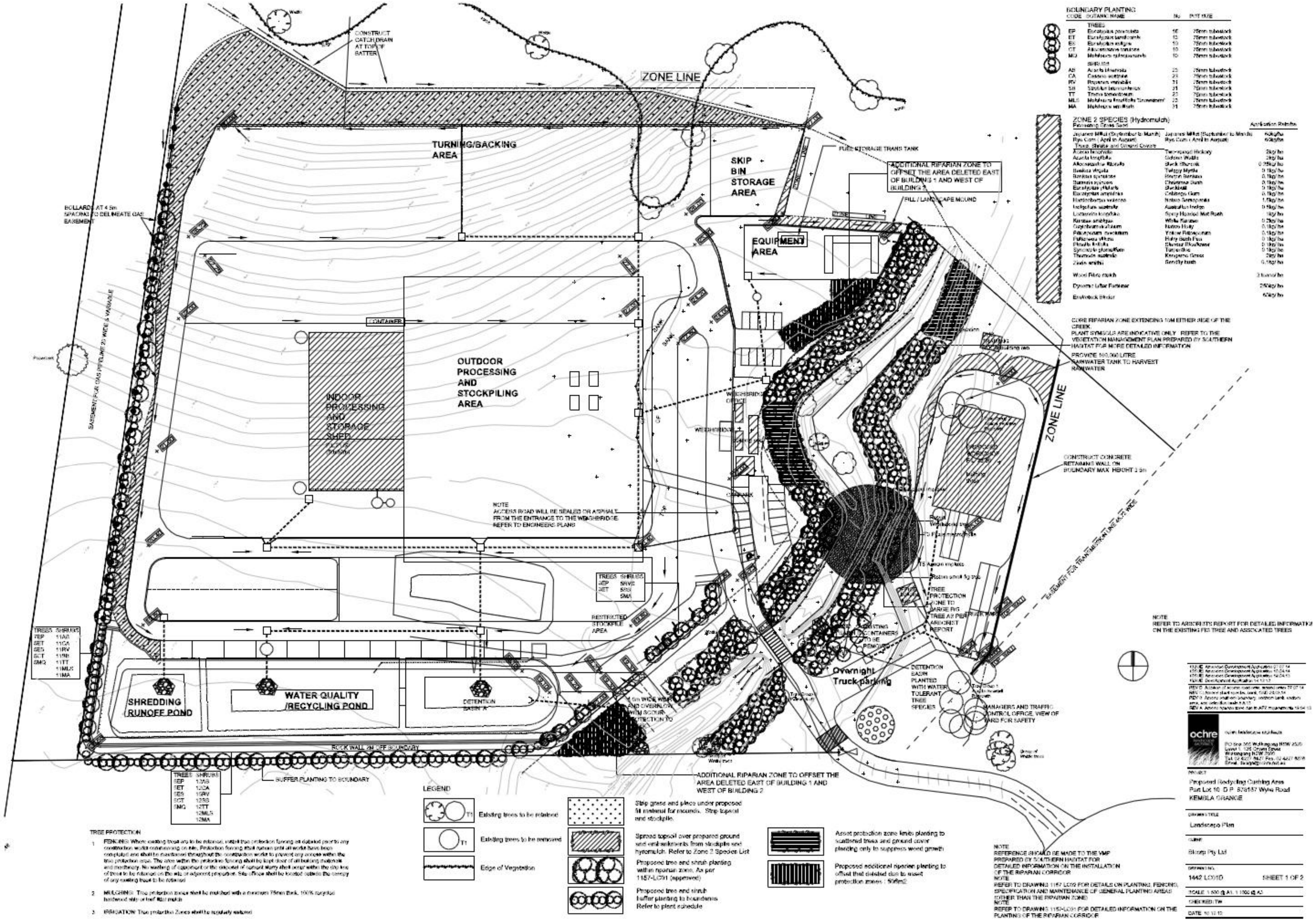

Figure 2 – Site landscape plan

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. The Patrick Autocare facility is located immediately south of the site and another car storage facility is located at 17 Reddalls Road.

Sensitive receivers surrounding the WRF are identified in Table 1 and shown in Figure 3. The office at Patrick Autocare has been assumed to be at the northern end of the buildings onsite and is considered conservative.

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
Patrick Autocare	06	66 West Dapto Road

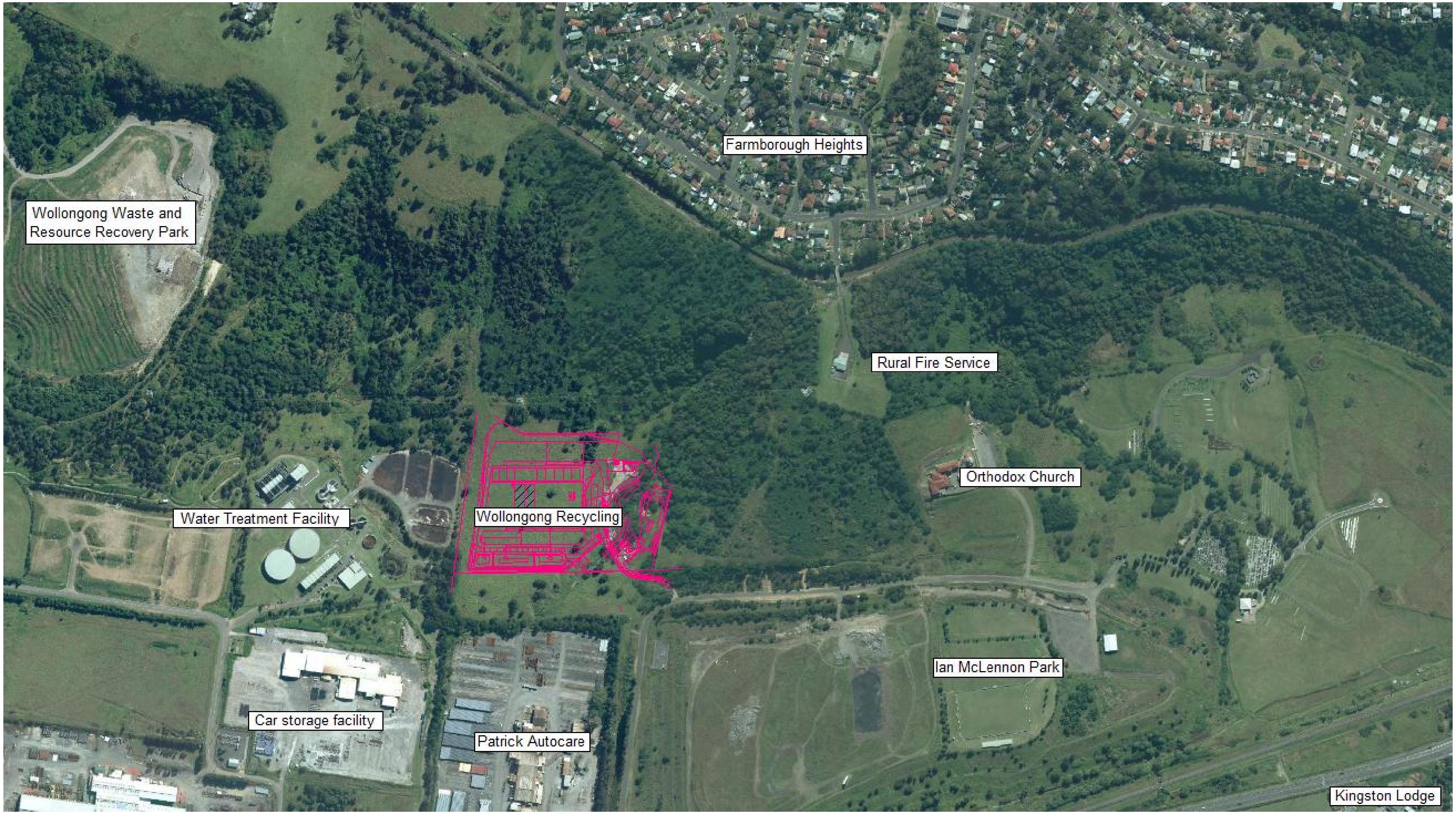

Figure 3 – Air quality sensitive receivers

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.

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

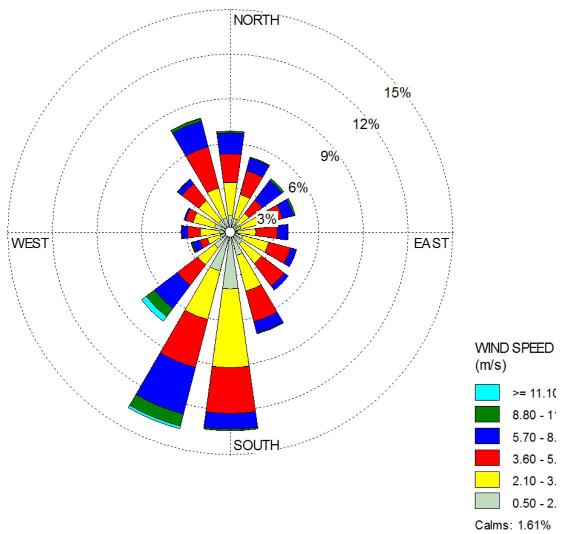
The effect of wind on odour dispersion patterns can be examined using the general wind climate and atmospheric stability class distributions. The general wind climate at a site is most readily displayed by means of wind rose plots, giving the incidence of winds from different directions for various wind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

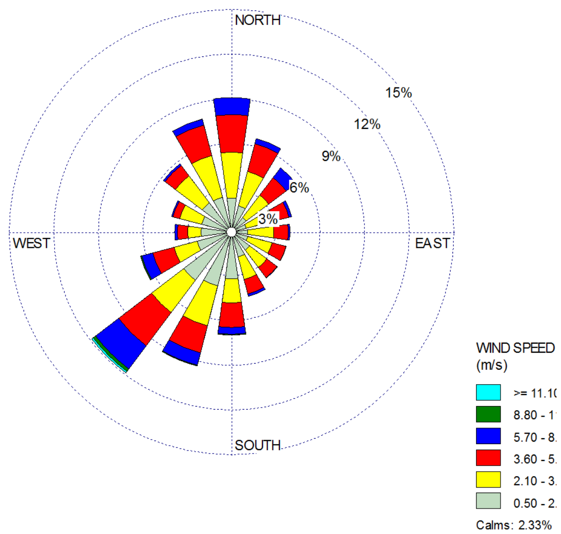


Figure 4 – Validation of meteorology

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.

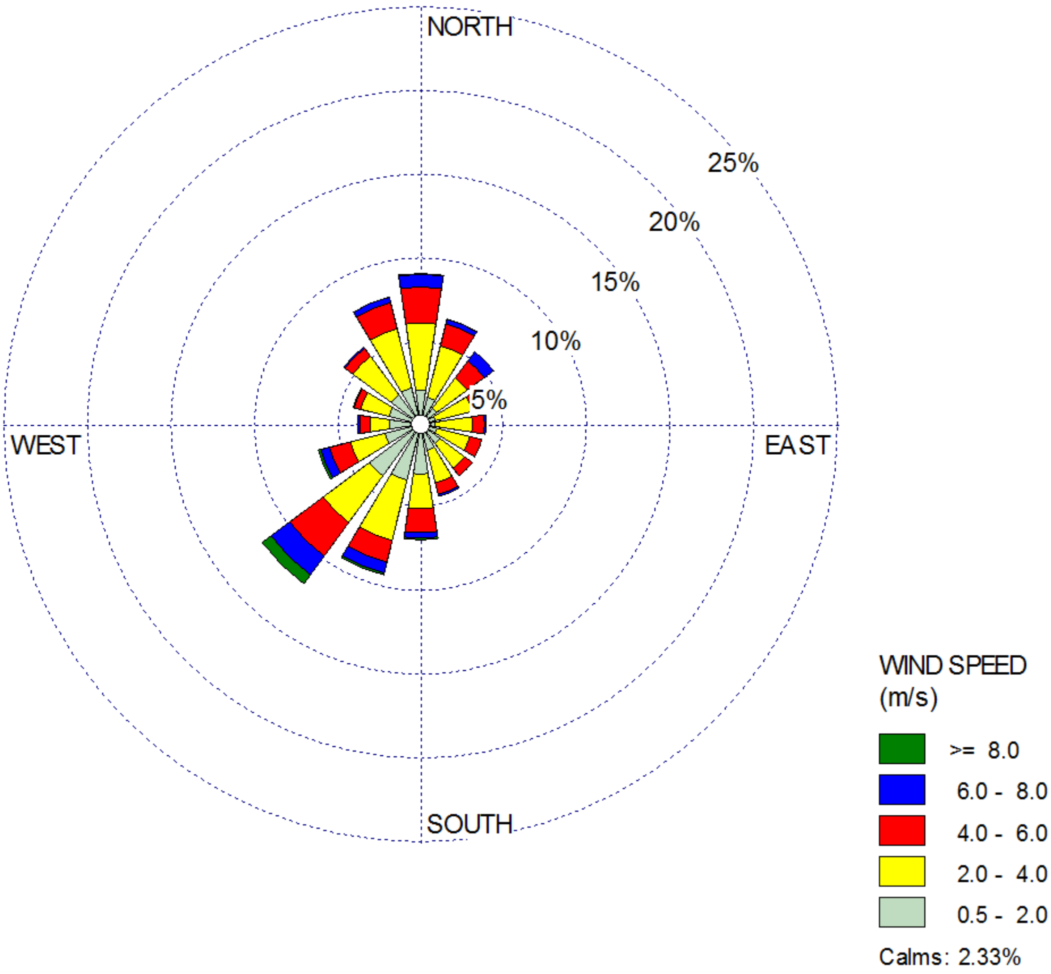


Figure 5 – Annual wind rose (from CALMET 2009)

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.

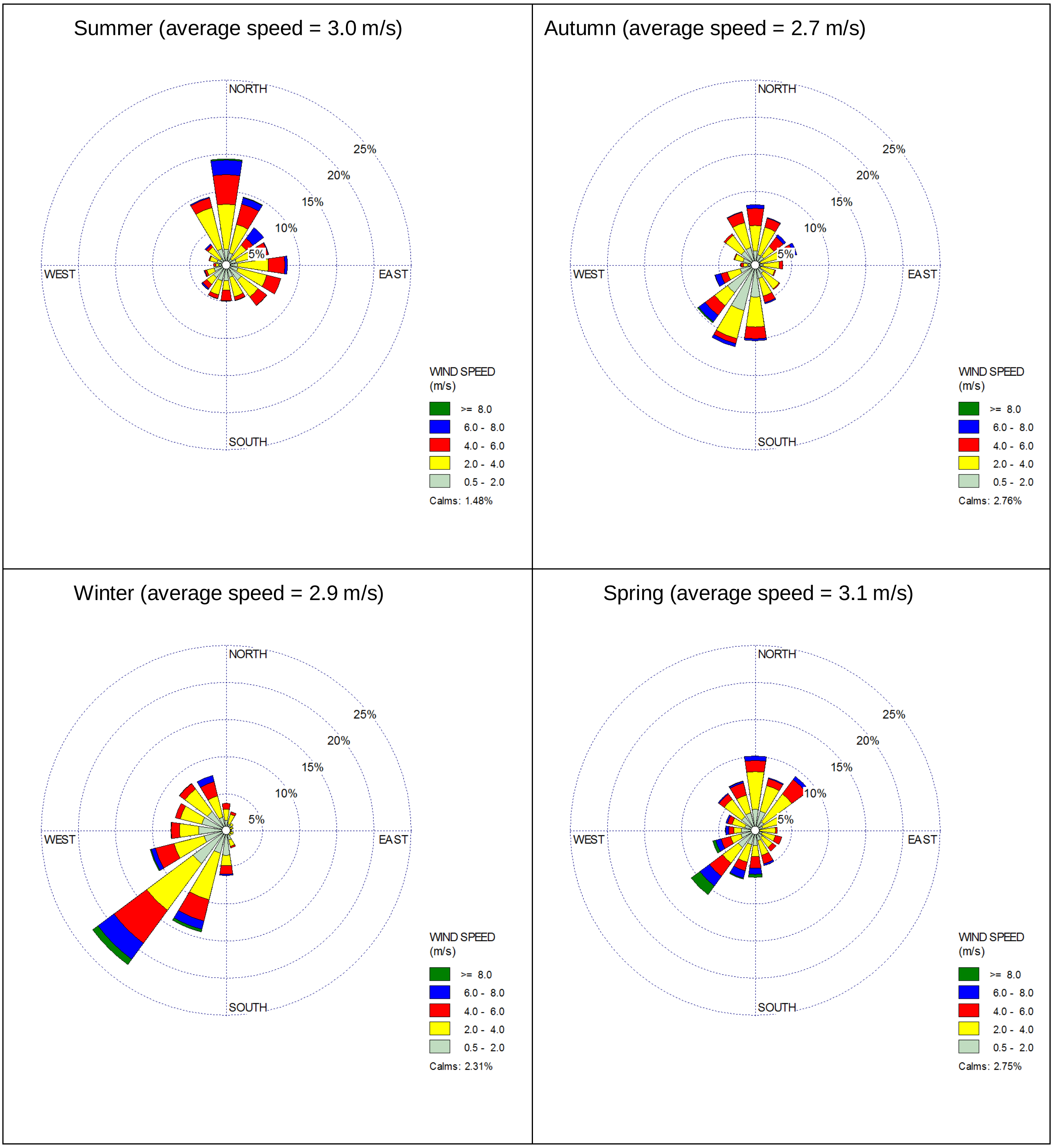


Figure 6 – Seasonal wind roses (from CALMET 2009)

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.

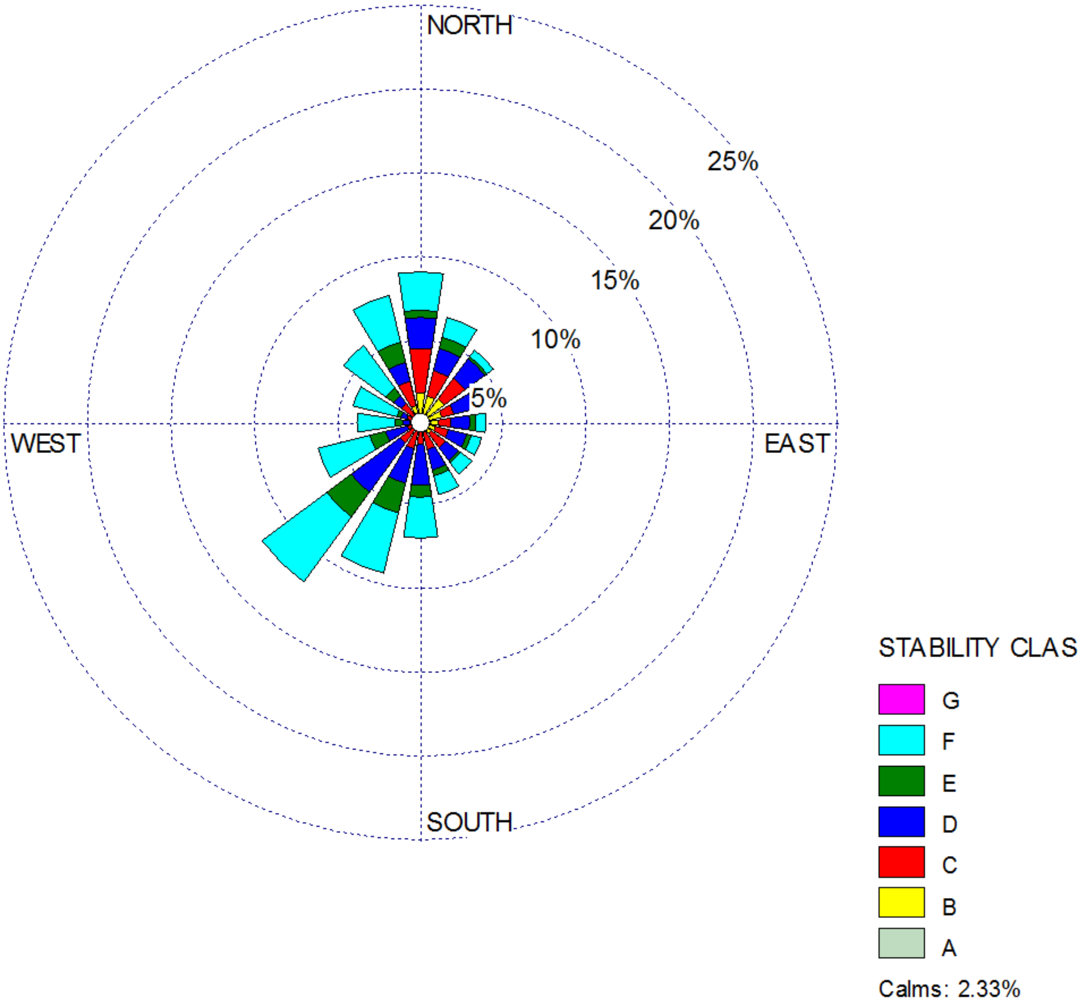


Figure 7 – Annual stability rose (from CALMET 2009)

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

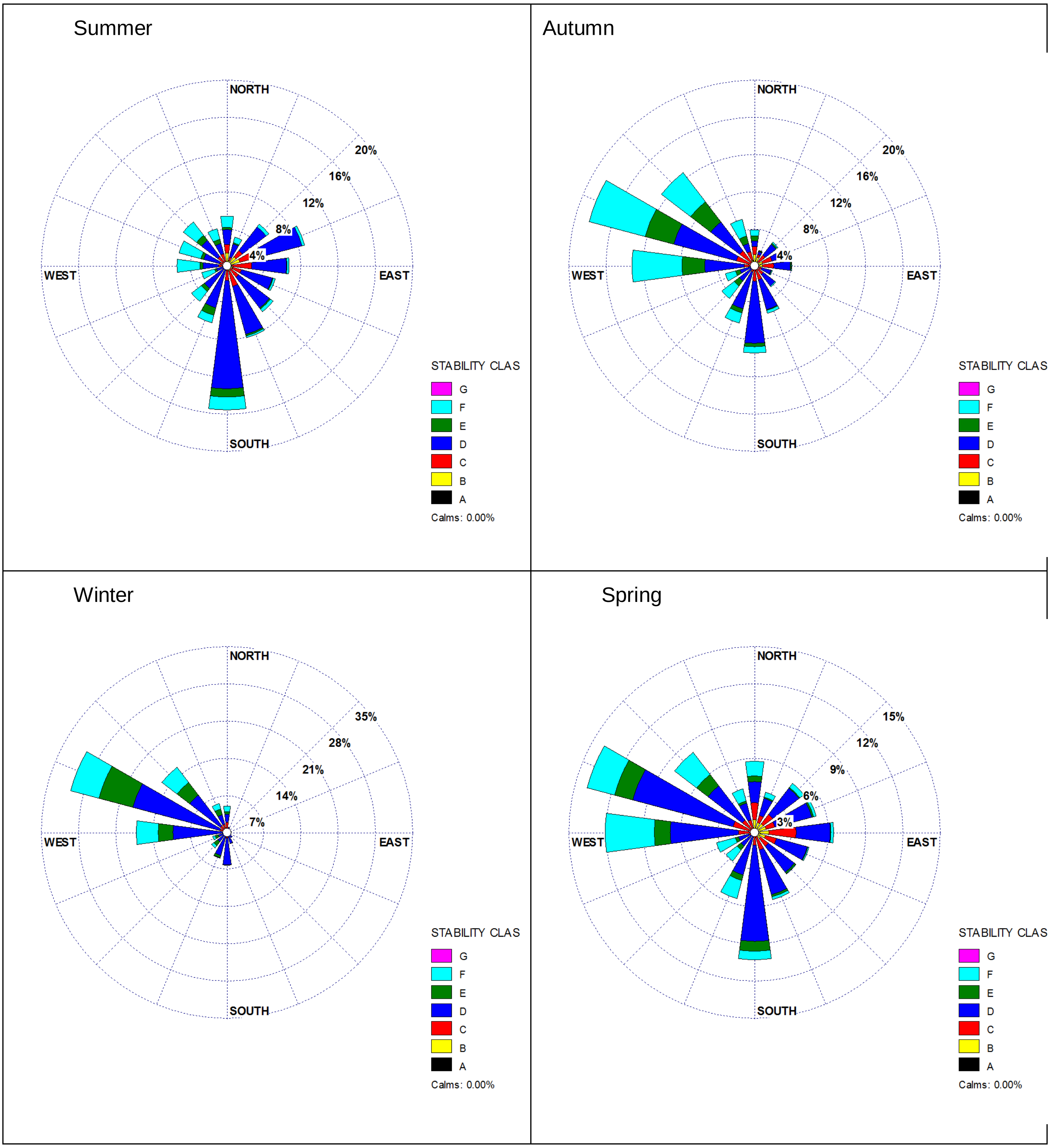


Figure 8 – Seasonal stability roses (from CALMET 2009)

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

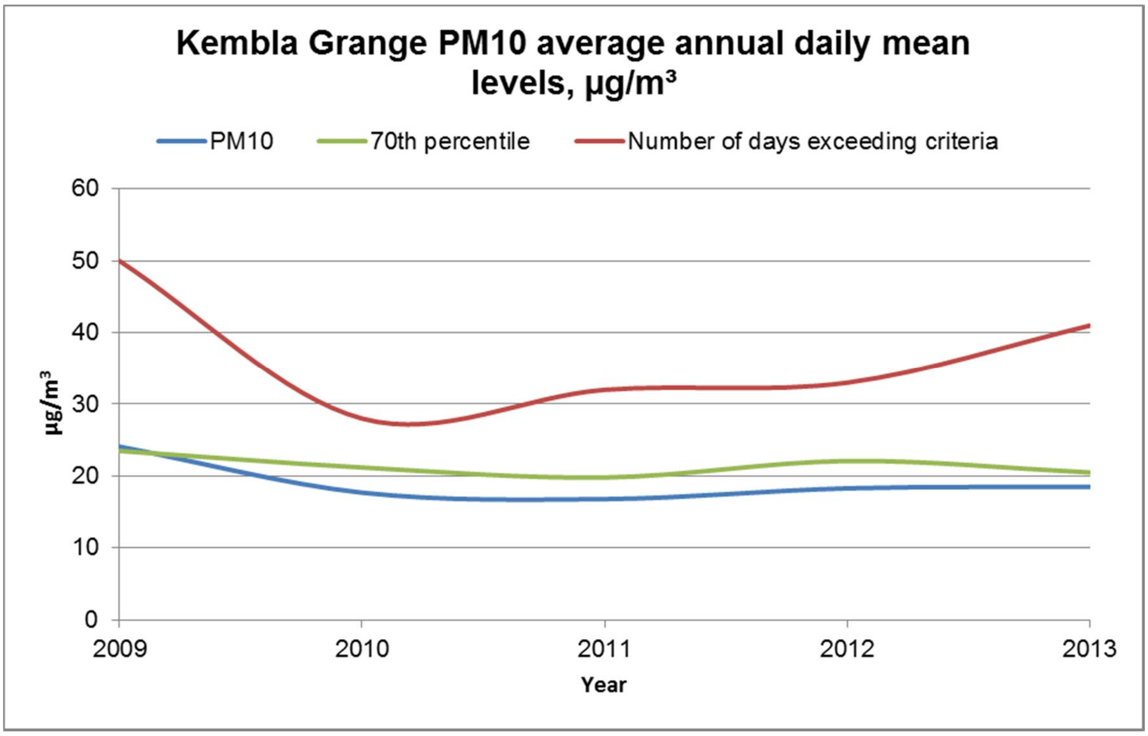


Figure 9 – Albion Park PM10 average annual daily mean levels, µg/m³

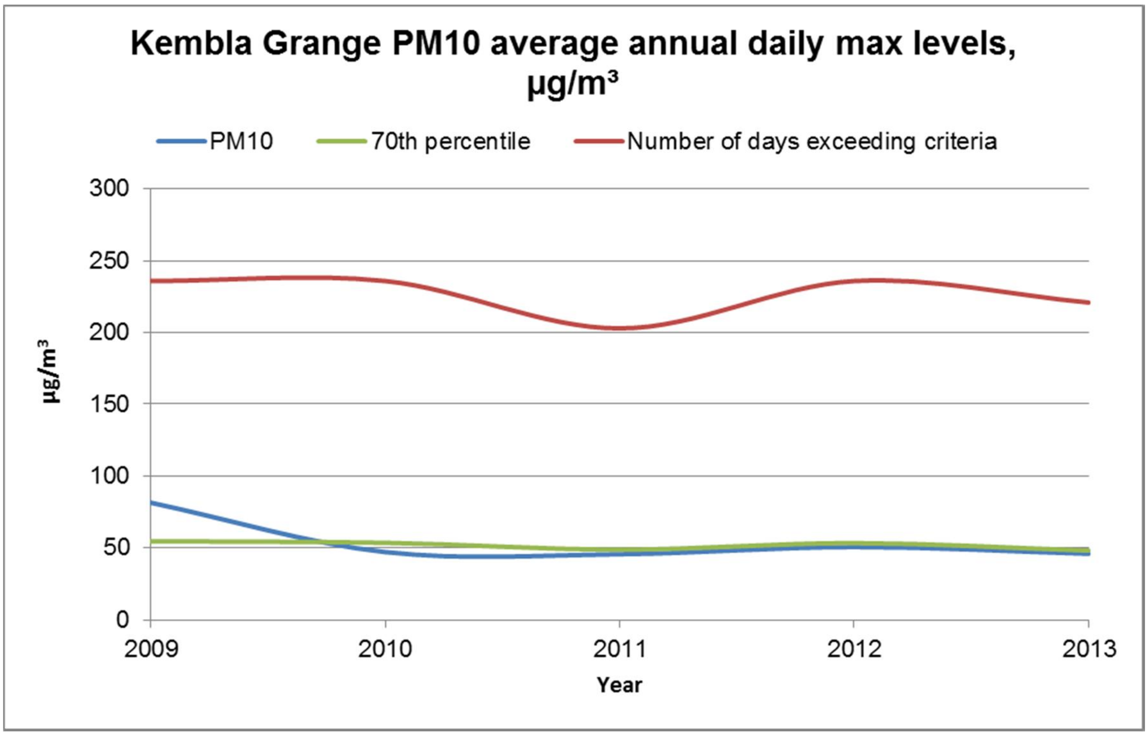


Figure 10 – Albion Park PM10 average annual daily max levels, µg/m³

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. Dust deposition criteria is primarily used to protect against amenity nuisance impacts and is relevant for the car storage facilities to the south and south west of the site.

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.

The Patrick Autocare site is located directly south of the site. There is no residential area in this immediate area meaning the risk of odour impact is low. Worst case odour impacts typically occur in the night time period when there will less people, if any, at work. Section 3.5 of the Patrick Autocare Vehicle Storage Facility- Stage 2 Statement of Environmental Effects (Cardno, March 2014) states that *"Once operational, a total of approximately 25 staff will be working on the site. Staff would be split between two shifts, with a maximum of 25 employees on site at any one time."*

Table 7.5 of the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* advises a 5 OU impact assessment criteria for complex mixtures of odorous air pollutants for an affected community of approximately 30 people. Hence, an odour criterion of 5 OU has been used for the Patrick Autocare Vehicle Storage Facility in this assessment.

The 5 OU impact assessment odour criteria has also been applied to the Rural Fire Service building located to the north east of the site. This site is only occupied occasionally by fewer than 30 staff.

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.

Chemical dust suppressant of the access road (from the site office into the site) and the Level 2 watering (>2L/m^2/hr) for the truck turning/backing area has been assessed as a mitigation option and is 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
Crusher with mitigation	0.2	0.02	kg/t	One crusher, 20.4 tonnes per hour	2.04	0.22	0.7
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 (Level 2 water)	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
Dump Truck – travelling on unpaved roads with mitigation (chemical dust suppression)	0.975	0.2895	kg/VKT	Average of 20 dump trucks per hour. Haul route 400 metres. Equals 8 km per hour total travel.	3.12	0.93	0.29
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:

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[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.

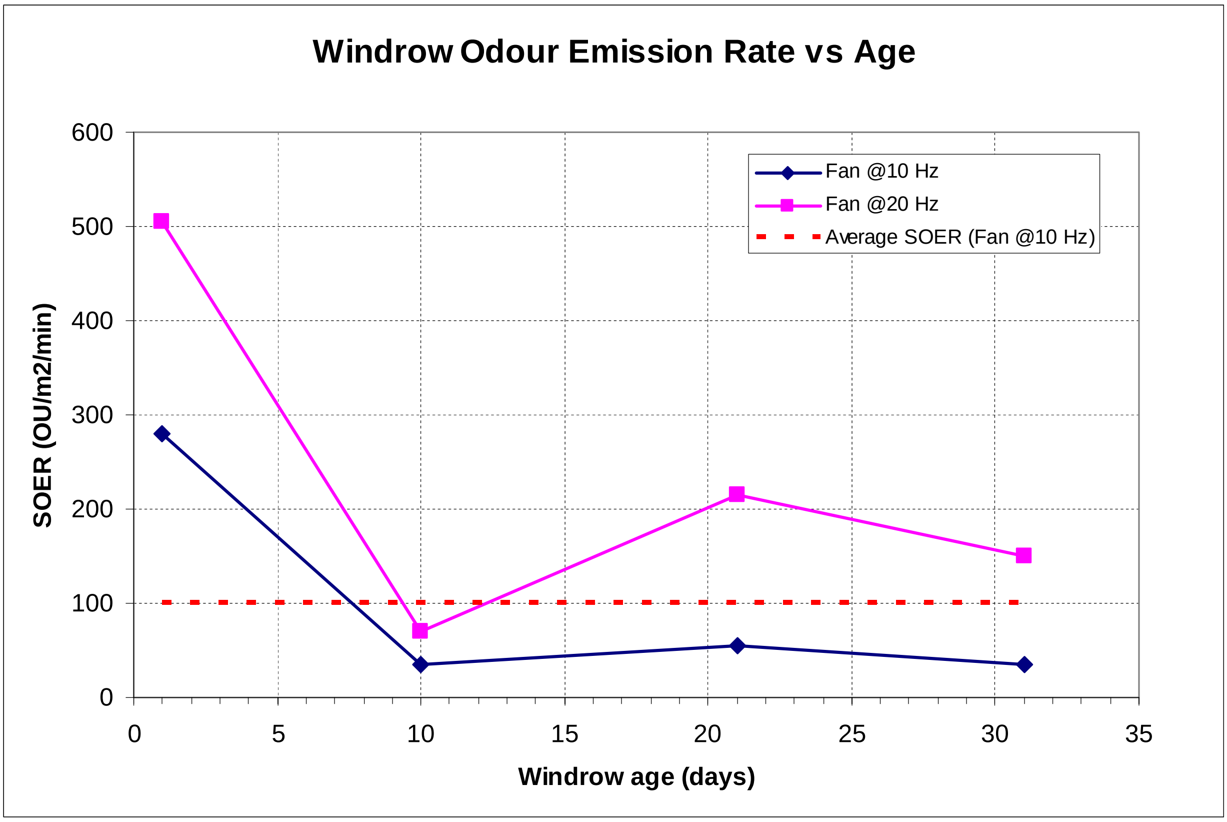

Figure 12 – Windrow Odour Emission Rate vs Age

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.

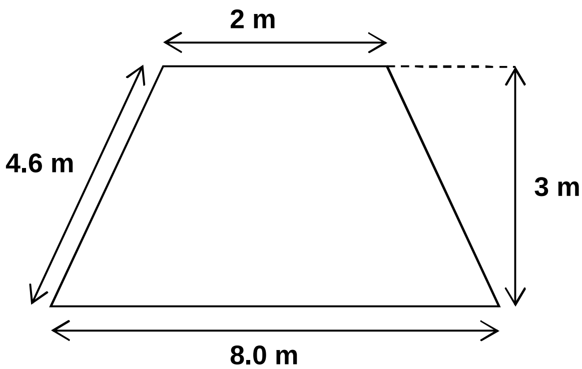

Figure 13 – Current typical windrow geometry

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 99^{th} 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
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**

5. Air quality dispersion modelling

5.1 The model

Atmospheric dispersion modelling was conducted to predict the maximum ground level concentrations of dust (TSP and PM_{10}) resulting from emissions to air from the WRF. Dust deposition rates were also predicted. The predicted ground level concentrations (GLC) and dust deposition rates were then assessed against the relevant criteria.

Dispersion modelling of emissions to air requires the selection of an appropriate model and then the selection of three general types of input. These are:

- Hourly site-specific or site representative meteorological data for a period of not less than one year. The meteorological data file used in this assessment is discussed in Section 2.
- Source characterisation (which includes emission rate inventory and source geometry) as detailed in Section 4.
- Model configuration – in which the various model settings are selected to best characterise the physical processes specific to this site and to make best use of the available emissions and meteorological data.

The source characterisation and model configuration are detailed below under relevant section headings.

Ausplume version 6.0 is a regulatory approved dispersion model and was used in this assessment. The use of Ausplume at this site is considered very conservative, with the steep terrain and heavy vegetation between the source and nearby receivers. Dust and odour emissions would require additional energy to be dispersed up the hill and therefore in this instance the predictions to the north of the site may be conservative.

5.2 Source characterisation

5.2.1 Mobile and Fixed Plant

Processing and mobile equipment, such as the crushers, screens, loaders, haul trucks and an excavator have been modelled as individual ‘volume’ sources using the corresponding emission rates and characteristics presented in Table 7 and Table 10. The details of modelled sources are provided in Table 11.

Table 11 – Dust source Characteristics

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Screen	2.8	3.5	5
Crusher	2.8	3.5	5
Loader	1.2	1.5	3
Excavator	1.2	1.5	3
Dump truck (dumping)	1.2	1.5	3
Reclaimer	1.2	1.5	3
Bulldozer	1.2	1.5	3

The significant dust generating activities will be located in the outdoor processing and stockpiling area indicated in Figure 14 below. Dust from trucks entering and exiting the site has been assumed to be emitted from the access road from the weighbridge into the vehicle turning and backing area.

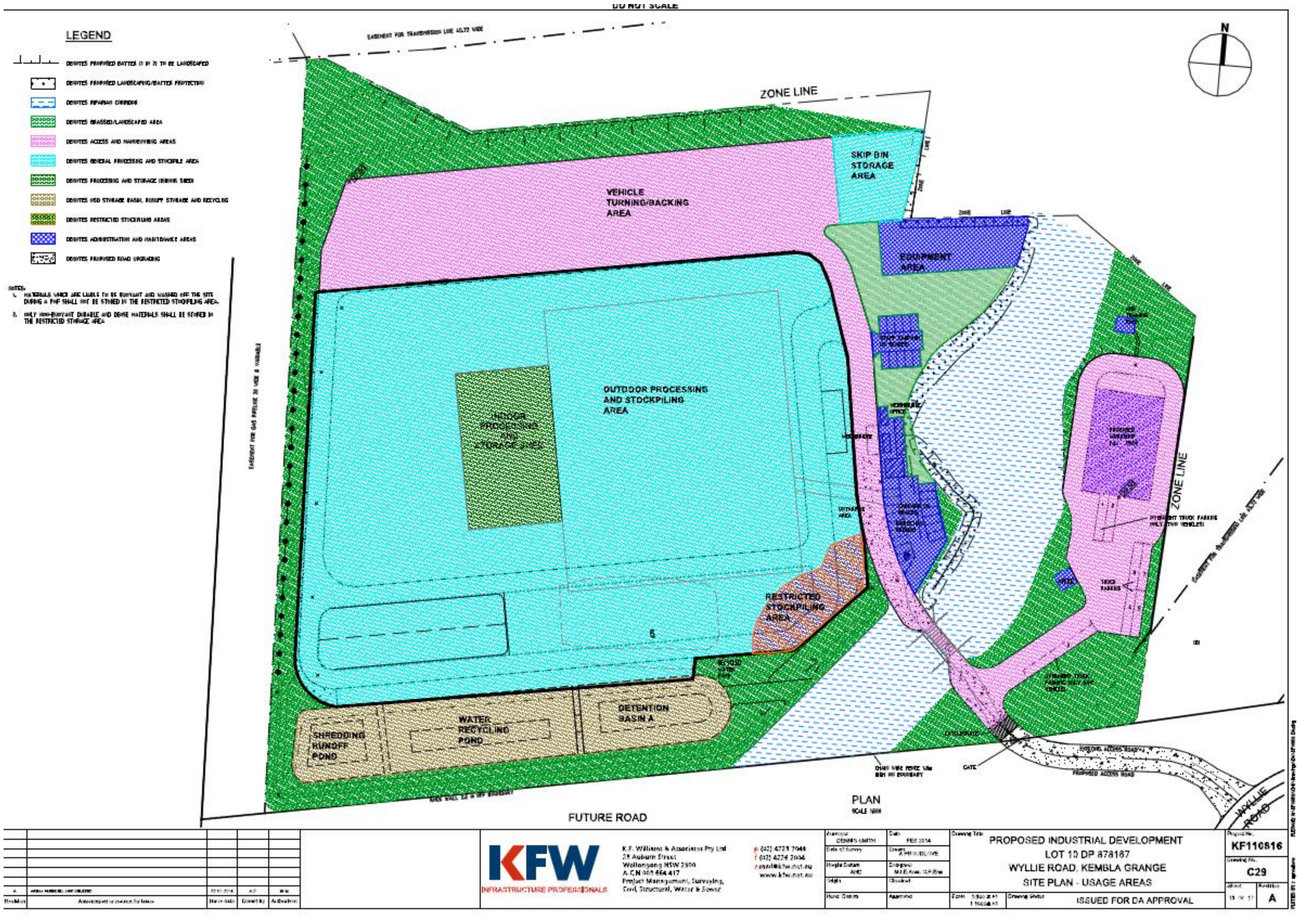

Figure 14 – Locations of emission sources

5.3 Dust Deposition

Dust deposition parameters have been set[5] as provided in Table 12. No site specific data was provided however due to the range of materials to be processed at the site dust particle parameters are believed to be conservative.

Table 12 – Dust Deposition Parameters

Fraction No.	Mass Fraction	Particle Size (micron)	Particle Density (g/cm^3)
1	0.052	1.8	2.6
2	0.140	4.0	2.6
3	0.223	8.0	2.6
4	0.322	17.0	2.6
5	0.263	31.0	2.6

5.4 Model Configuration

Key components of the Ausplume model configuration used in this assessment are as follows:

- Ground level concentrations (GLC) were predicted over a 2 km by 2 km receptor grid, with a grid resolution of 100 m.
- Dry depletion was included in the PM_{10}, $PM_{2.5}$ and TSP and dust deposition model runs.
- Irwin's 'Rural' wind profile exponents were used.
- Horizontal dispersion was parameterised according to equations for the Pasquill-Gifford curves.
- A roughness height of 0.8 m ('Rolling Rural') was used to represent the land features that surround the site. This is the dense forest and steep escapement to the north of the site

Further detail on the Ausplume configuration can be found in the Ausplume output file attached in Appendix A.

5.4.1 Odour Peak to mean calculations

The *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* states that peak to mean values are applied to the emissions from the sources in order to estimate the peak concentration. Peak to mean values are required as the evaluation of odour impacts requires the estimation of short or peak concentrations on the time scale of less than one second. Dispersion model predictions however are typically valid for averaging periods of 1 hour and longer. Thus in order to predict peak concentrations a ratio between extreme short term concentration and longer-term averages were used as defined in the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (refer Table 6.1). The far field peak to mean values were applied to the area and point sources at the site.

5.4.2 Building ventilation

As discussed in Section 4.2 the significant odour sources will be enclosed in a building maintained at negative air pressure. At this stage there is no detailed information on the ventilation system. As a conservative measure, GHD has modelled all odour sources at the

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[5] Based on data provided in the NSW Minerals Council Technical Paper: Particulate Matter and Mining Interim Report, 2000.

building location assuming no enclosure in place. One mitigation option has also been assessed:

- All air from the enclosed building is released into the atmosphere via a stack.

Once more details of the building ventilation are known, a more detailed assessment can be undertaken to determine appropriate sizing and flow rates.

6. Assessment of impacts

6.1 Dust

A summary of the predicted results from dispersion modelling are presented in Table 13 for the 6 identified receivers. To be conservative, the receptor location for dust deposition has been assumed to be at the northern boundary of the Patrick Autocare property.

Maximum predicted ground level concentrations and deposition rates at the six receivers have been added to the adopted background levels to determine the cumulative impact, which can then be compared against the NSW assessment criteria and are discussed below. Exceedances above the assessment criteria have been bolded in black.

GHD are not aware of any formal complaints regarding dust emissions from the current site operations.

6.1.1 PM_{10}

Results show that the predicted 24 hour PM_{10} dust concentration of 74.6 $\mu g/m^3$ at Receiver 1 (Fairloch Avenue) will exceed the criteria of 50 $\mu g/m^3$ without mitigation. The predicted dust levels also exceed the criteria at Receiver 3, 5 and 6.

In order to meet the criteria mitigation options have been assessed in Section 7.

All other receivers are predicted to be within the PM_{10} criteria.

6.1.2 TSP

The predicted TSP concentrations meet the relevant criteria at all receivers.

6.1.3 Dust deposition

Results show that the dust deposition levels are predicted to exceed the annual dust deposition criteria of 4 g/m^2/month at Receiver 6.

Table 13 – Maximum predicted dust impact at sensitive receivers

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
Receiver 1: 57 Fairloch Avenue, Farmborough Heights						
PM_{10}	24-hour	µg/m^3	53.3	21.3	**74.6**	50
$PM_{2.5}$	24-hour	µg/m^3	16.6	6.6	23.2	-
PM_{10}	Annual	µg/m^3	4.2	21.3	25.5	30
TSP	Annual	µg/m^3	12.9	42.6	55.5	90
Dust deposition	Annual	g/m^2/month max. total	1.3	2	3.3	4
Receiver 2: Ian McLennan Park						
PM_{10}	24-hour	µg/m^3	24.1	21.3	45.4	50
$PM_{2.5}$	24-hour	µg/m^3	7.6	6.6	14.2	-
PM_{10}	Annual	µg/m^3	1.3	21.3	22.6	30
TSP	Annual	µg/m^3	3.8	42.6	46.4	90
Dust deposition	Annual	g/m^2/month max. total	0.2	2	2.2	4
Receiver 3: Macedonian Orthodox Church						
PM_{10}	24-hour	µg/m^3	37.9	21.3	**59.2**	50
$PM_{2.5}$	24-hour	µg/m^3	11.8	6.6	18.4	-
PM_{10}	Annual	µg/m^3	1.7	21.3	23.0	30
TSP	Annual	µg/m^3	5.1	42.6	47.7	90
Dust deposition	Annual	g/m^2/month max. total	0.3	2	2.3	4
Receiver 4: Kingston Lodge						
PM_{10}	24-hour	µg/m^3	6.8	21.3	28.1	50
$PM_{2.5}$	24-hour	µg/m^3	2.2	6.6	8.8	-
PM_{10}	Annual	µg/m^3	0.4	21.3	21.7	30
TSP	Annual	µg/m^3	1.2	42.6	43.8	90
Dust deposition	Annual	g/m^2/month max. total	0.05	2	2.05	4
Receiver 5: Rural Fire Service						
PM_{10}	24-hour	µg/m^3	38.8	21.3	**60.1**	50

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
$PM_{2.5}$	24-hour	µg/m^3	12.1	6.6	18.7	-
PM_{10}	Annual	µg/m^3	3.8	21.3	25.1	30
TSP	Annual	µg/m^3	11.4	42.6	54.0	90
Dust deposition	Annual	g/m^2/month max. total	1.1	2	2.1	4
Receiver 6: Patrick Autocare*						
PM_{10}	24-hour	µg/m^3	96.7	21.3	**118**	50
$PM_{2.5}$	24-hour	µg/m^3	30.1	6.6	36.7	-
PM_{10}	Annual	µg/m^3	6.6	21.3	27.9	30
TSP	Annual	µg/m^3	19.2	42.6	61.8	90
Dust deposition	Annual	g/m^2/month max. total	9.1	2	**11.1**	4

* Note for Patrick Autocare PM10, PM2.5 and TSP have been predicted at the nearest building. Deposited dust has been predicted at the ***boundary*** of the site.

6.2 Dust mitigation

Dust emissions from the site are predicted to potentially exceed the NSW assessment criteria without mitigation. An analysis of dust emission rates shows that the haul trucks are the primary source of dust. In order to reduce these dust emissions, mitigation in the form of watering the access roads with chemical dust suppressants has been assessed. Watering of the access road (from the site office into the site) and truck turning/backing area with chemical dust suppressants has been assessed as a mitigation option and most likely to provide the necessary mitigation. Crushing activities were also found to be a large contributor to dust emissions. Wet suppression systems (such as spray nozzles) have also been assessed as appropriate mitigation[6] in order to provide the necessary mitigation. A site watering system has also been assumed ensuring that all significant dust generating activities will be managed.

Predicted dust emissions with mitigation at the sensitive receivers are presented in Table 14. Figure 15 shows the maximum predicted 24-hour PM_{10} ground level concentration (GLC) contours for WRF operations with mitigation, Figure 16 shows the maximum predicted annual TSP ground level concentration (GLC) contours for WRF operations with mitigation and Figure 17 shows the predicted annual dust deposition contours for WRF operation with mitigation.

To be conservative, the receptor location for dust deposition has been assumed to be at the northern boundary of the Patrick Autocare property. The results show compliance at all of the surrounding sensitive receptors, which would also include any receptors located further away from the site including 17 Reddalls Road.

[6] Based on data provided in the US EPA AP-42 Mineral Products Industry Section 11.19.2 (2003)

Table 14 - Maximum predicted dust impact at sensitive receivers with mitigation measures

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
Receiver 1: 57 Fairloch Avenue, Farmborough Heights						
PM_{10}	24-hour	µg/m^3	14.5	21.3	35.8	50
$PM_{2.5}$	24-hour	µg/m^3	6.4	6.6	13.0	-
PM_{10}	Annual	µg/m^3	1.1	21.3	22.4	30
TSP	Annual	µg/m^3	2.3	42.6	44.9	90
Dust deposition	Annual	g/m^2/month max. total	0.3	2	2.3	4
Receiver 2: Ian McLennan Park						
PM_{10}	24-hour	µg/m^3	5.9	21.3	27.2	50
$PM_{2.5}$	24-hour	µg/m^3	2.5	6.6	9.1	-
PM_{10}	Annual	µg/m^3	0.3	21.3	21.6	30
TSP	Annual	µg/m^3	0.7	42.6	43.3	90
Dust deposition	Annual	g/m^2/month max. total	0.04	2	2.04	4
Receiver 3: Macedonian Orthodox Church						
PM_{10}	24-hour	µg/m^3	9.2	21.3	30.5	50
$PM_{2.5}$	24-hour	µg/m^3	4	6.6	10.6	-
PM_{10}	Annual	µg/m^3	0.4	21.3	21.7	30
TSP	Annual	µg/m^3	0.9	42.6	43.5	90
Dust deposition	Annual	g/m^2/month max. total	0.06	2	2.06	4
Receiver 4: Kingston Lodge						
PM_{10}	24-hour	µg/m^3	1.6	21.3	22.9	50
$PM_{2.5}$	24-hour	µg/m^3	0.7	6.6	7.3	-
PM_{10}	Annual	µg/m^3	0.1	21.3	21.4	30
TSP	Annual	µg/m^3	0.2	42.6	42.8	90
Dust deposition	Annual	g/m^2/month max. total	0.01	2	2.01	4
Receiver 5: Rural Fire Service						

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
PM_{10}	24-hour	µg/m^3	10.2	21.3	31.5	50
$PM_{2.5}$	24-hour	µg/m^3	4.5	6.6	11.1	-
PM_{10}	Annual	µg/m^3	0.9	21.3	22.2	30
TSP	Annual	µg/m^3	1.9	42.6	44.5	90
Dust deposition	Annual	g/m^2/month max. total	0.2	2	2.2	4
Receiver 6: Patrick Autocare*						
PM_{10}	24-hour	µg/m^3	28	21.3	49.3	50
$PM_{2.5}$	24-hour	µg/m^3	11.8	6.6	18.4	-
PM_{10}	Annual	µg/m^3	1.6	21.3	22.9	30
TSP	Annual	µg/m^3	7.1	42.6	49.7	90
Dust deposition	Annual	g/m^2/month max. total	1.8	2	3.8	4

* Note for Patrick Autocare PM10, PM2.5 and TSP have been predicted at the nearest building. Deposited dust has been predicted at the ***boundary*** of the site.

Figure 15 – Predicted – Cumulative PM_{10} 24-hour Average Concentration (with mitigation) µg/m^3

Figure 16 – Predicted – Cumulative TSP Annual Average Concentration (with mitigation) μg/m^3

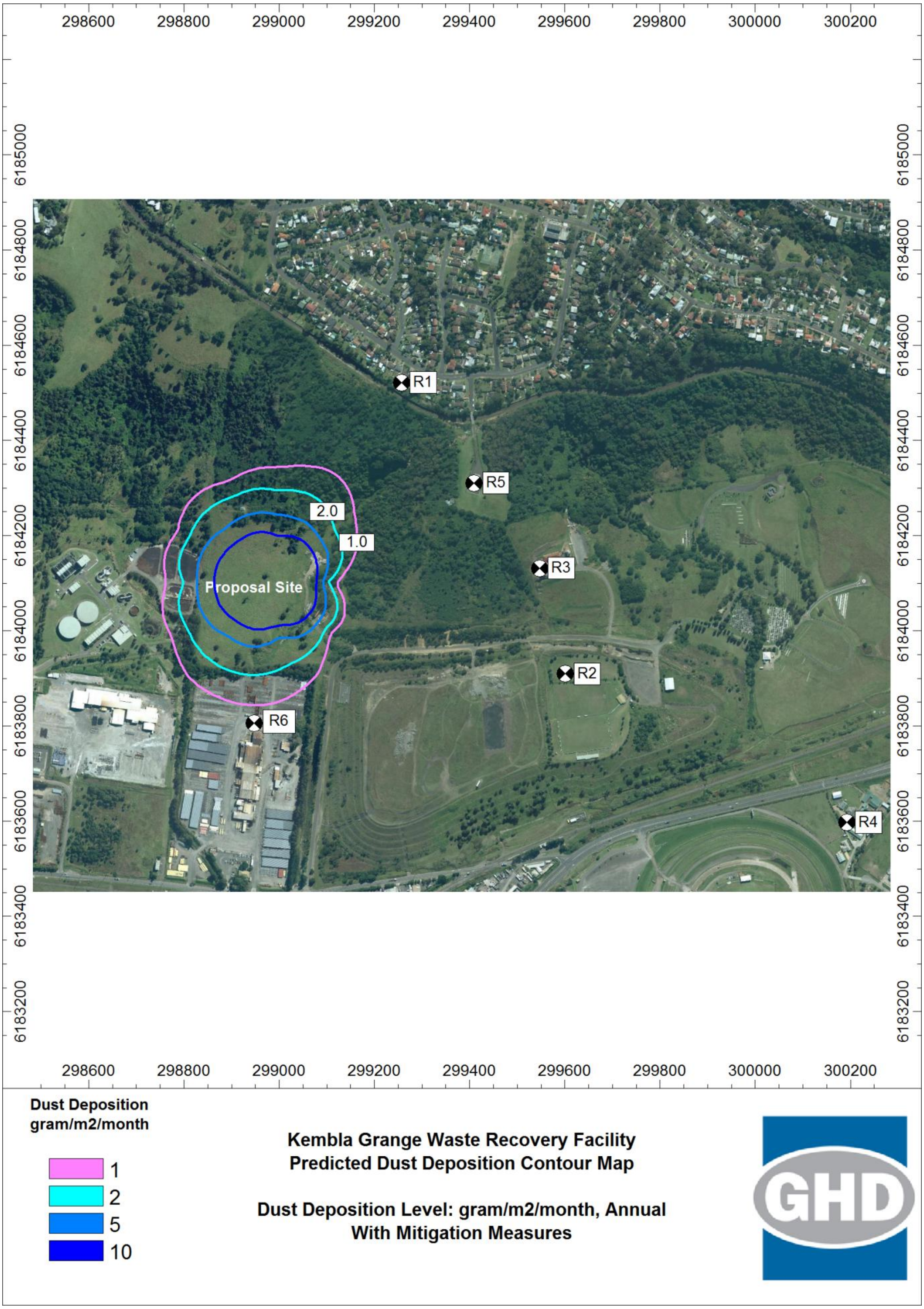

Figure 17 – Predicted –Annual dust deposition (with mitigation) $g/m^2/month$

6.3 Odour

6.3.1 Predicted peak impact as discrete receivers

All odour sources have been assumed to be located as per Figure 14, with no building ventilation or emission controls in place. This is considered a worst-case scenario.

For the nominated discrete receptors near the site i.e. closest residents on Fairloch Avenue Road and church on Wyllie Road (see Figure 3) the predicted peak 99th percentile (1-hour average) odour levels were assessed..

The highest predicted concentrations are at 57 Fairloch Avenue which is approximately 400 m from the proposal. Slightly lower concentrations would be expected at the church on Wyllie Road.

The compliance to the 2 OU criterion is to be taken as the 88th highest value in the top 100 values for the receptor. The 88th highest value for each receptor is given in Table 15. The predicted odour impact exceeds the criteria at R1 (residences on Fairloch Avenue). The predicted values do not exceed the criteria at the Patrick Autocare sensitive receptor, however the 5 OU criteria is exceeded in the northern half of the site.

The predicted levels at the receivers on Fairloch Avenue are considered conservative considering the ground based emission sources and the heavily vegetated hill behind the site. A plot of the predicted peak 99th percentile odour impact from the site is shown in Figure 18.

In order to meet the criteria mitigation options have been assessed in Section 6.4.

Table 15 – Predicted peak odour impact at receptors (OU) – no mitigation

Residence	R1	R2	R3	R4	R5	R6
Proposal (OU)	**2.6**	1.1	1.5	0.4	2.1	3.8
Criteria (OU)	2	2	2	2	5	5

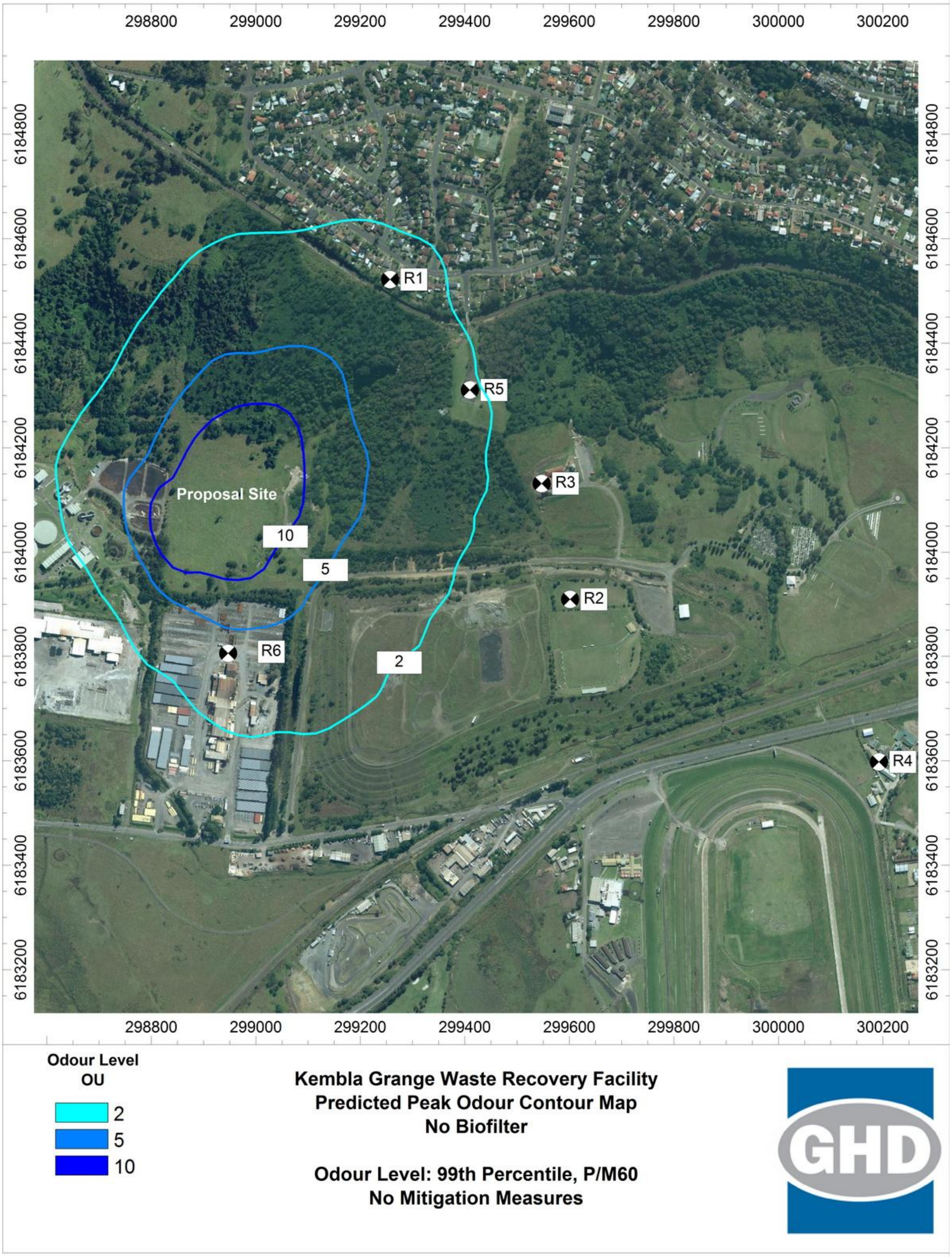

Figure 18 – Predicted Peak Odour Contour Map, OU

6.4 Odour Mitigation

Odour emissions from the site are predicted to exceed the NSW assessment criteria without mitigation. The largest odour contributors from the site are the activities proposed to be enclosed within the building. The following scenario has been assessed:

- All air from the ventilated enclosed building is released untreated into the atmosphere via a stack

GHD has assumed that the total air flow rate through the WRF ventilation system would be approximately 45,000 m^3 per hour. This represents three building air exchanges (approximate building volume is 15,000 m^3) that flow through the odour control system and then exhaust stack or directly through an exhaust stack. The parameters assumed in this assessment are presented in Table 16. The actual building ventilation requirements will need to be confirmed during the design stage.

Table 16 – Building ventilation system parameters

Parameter	AWT Building
Building height	10 m
Stack height above roof line	2 m
Exit velocity	6.25 m/s
Exit temperature	35 degrees C
Stack diameter	2 m
Building dimensions	30 m x 50 m
Building downwash algorithm	PRIME

The odour emission inventory for the mitigation scenario is presented in Table 17.

Table 17 – Emission inventory for building with exhaust stack for untreated air

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
Matured stockpile	429	0.6	250	2.4
Leachate pond	780	0.3	234	2.2
Building stack			3845	36.8
Total			**10436**	**100.0**
Non-Operating Hours				
Green waste stockpile – Receival	92	4.0	366	7.8
Matured stockpile	429	0.6	250	5.3
Leachate pond	780	0.3	234	5
Building stack			3845	81.9
Total			**4329**	**100.0**

6.4.1 Predicted peak impact as discrete receivers

The predicted odour impact at receivers for the mitigation scenario is presented below. The results in Table 18 assume that the building is maintained at negative air pressure with all untreated air being released through a stack on the roof as per Table 16. Results show compliance with the criteria at all receivers. Odour contours are provided in Figure 19.

Table 18 – Predicted peak odour impact at receptors (OU) – with building ventilation system

Residence	R1	R2	R3	R4	R5	R6
Proposal (OU)	1.1	0.6	0.7	0.3	0.9	1.7
Criteria (OU)	2	2	2	2	5	5

Given that the predicted odour impact complies with the criteria without treatment of ventilated air, an odour control system is not recommended and may only be required if the measured odour levels exceed the predicted odour levels once the site is operational.

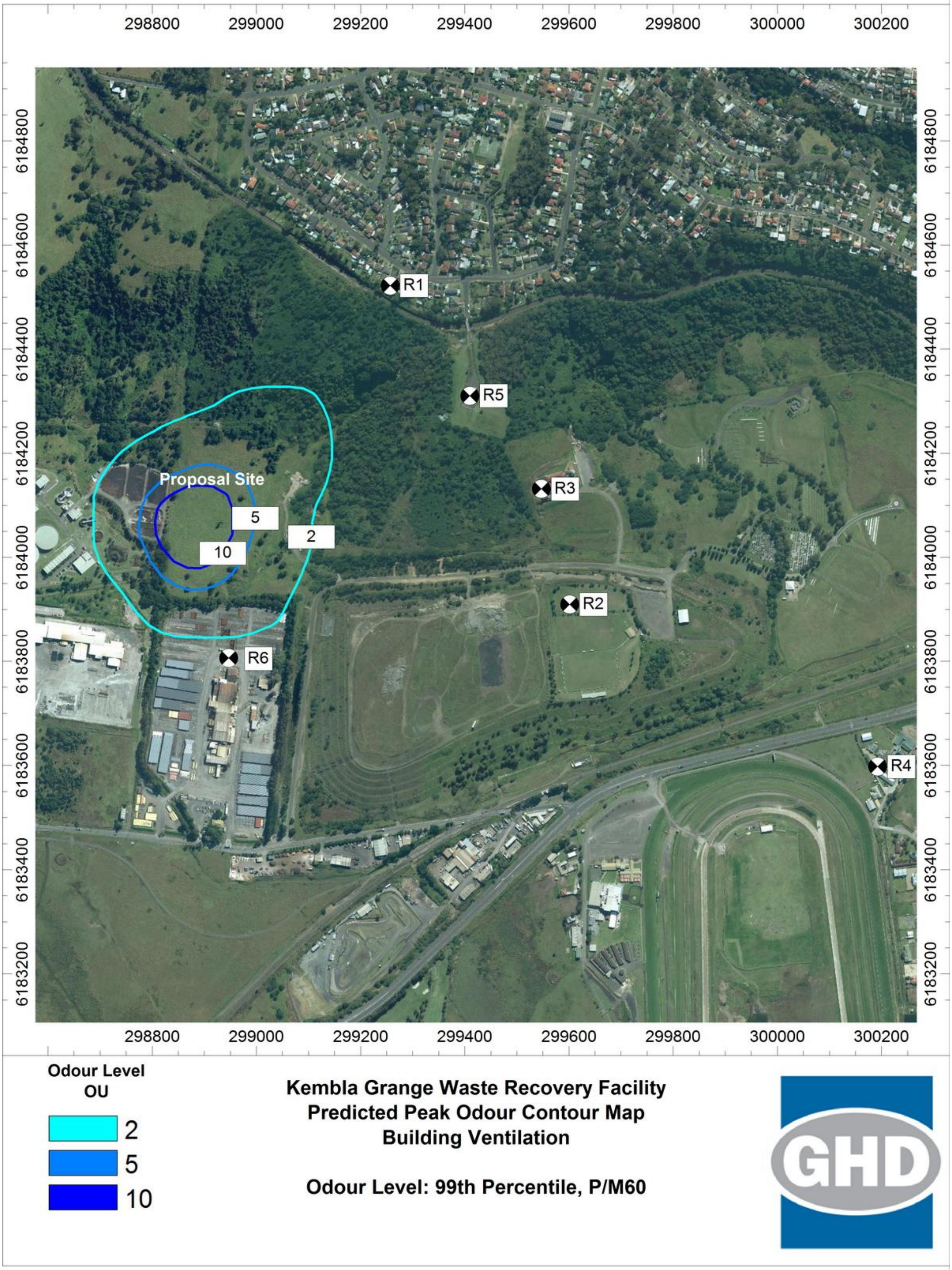

Figure 19 – Predicted Peak Odour Contour Map, OU with building ventilation

7. Management and mitigation

7.1 Access Roads

Dust dispersion modelling identified that trucks operating on unsealed surfaces are the primary source of dust. In order to control the primary source of dust, and to meet the project criteria, chemical dust suppressant spraying should be undertaken on the unsealed access road from the site office into the site. This should be undertaken as per the supplier's requirements. Regular water spraying should also be undertaken as required during daytime weather conditions that assist dust dispersion (dry and windy) towards receivers.

7.2 General Dust Mitigation measures

While general site operations are not expected to exceed air quality goals at nearby private receptors, the following mitigation measures are recommended.

- Water material prior to it being loaded for haulage, where appropriate.
- Water truck turn around and reversing areas with at least 2L/m^2/hr as required to control dust emissions. Any other areas that are visible sources of dust to be appropriately watered until dust impact is no longer an issue.
- Water the main access roads with chemical dust suppressants. Chemical dust suppressants generally only need be applied every few months however should be used as per the manufacturers' specifications and as needed. Additional dust suppression shall be applied if dust from the road is visibly observed to be leaving the site boundary.
- A dust suppression system is to be installed and operated for the crushing plant. The system shall be operated as per manufacturers' specification and used whenever dust from the crusher has the potential to be transported offsite in the direction of sensitive receptors.
- Aim to minimise the size of storage piles where possible.
- Limit cleared areas of land and clear only when necessary to reduce fugitive dust emissions.
- Control on-site traffic by designating specific routes for haulage and access and limiting vehicle speeds to below 25 km/hr.
- All trucks hauling material should be covered before exiting the site and should maintain a reasonable amount of vertical space between the top of the load and top of the trailer.
- Material spillage on sealed roads should be cleaned up as soon as practicable.
- A rumble-strip at the interface of the sealed road and the unsealed access road should be considered.
- Excavating operations conducted in areas of low moisture content material should be suspended during high wind speed events or water sprays should be used.

7.3 Odour mitigation measures

The odour modelling shows that odour emissions from the site without odour controls in place have the potential to exceed the 2 OU odour criteria at the nearby sensitive receivers. GHD has assessed a mitigation option for odour management onsite, and recommends that a ventilation system be designed that keeps the building under negative pressure at all times during operation. The air should be discharged in a manner that suitably disperses odour.

One suitable option to further reduce the odours from the site is an odour control system that is designed to treat all air from the building ventilation system.

The following odour mitigation measures are recommended:

- Design and installation of an appropriate building ventilation system at negative pressure at all times during operation
- A site odour management plan be developed prior to commissioning
- Minimise the onsite storage times of organic material prior to processing
- If the chosen composting process allows, cover the matured compost stockpiles to help reduce the ingress of water and reduce odour
- If the leachate pond is a significant source of odour, investigate the use of aerators. Aerators can be installed in the leachate pond in order to minimise odour, enhance biological degradation and encourage evaporation
- Validation sampling of odour from any key odour discharge points after commissioning
- Annual odour sampling of building ventilation stack
- If required, treat all air in an odour control system prior to discharge

8. Conclusion

An operational air quality impact assessment has been undertaken with consideration given to the *Approved methods for the modelling and assessment of pollutants in NSW* (DEC, 2005).

The results of the air quality impact assessment for the operation of the proposed WRF have led to the following conclusions:

- Based on the assumptions made in this assessment, predicted odour levels from proposed green waste composting without mitigation do not comply with the 2 OU criteria at receptors in Farmborough Heights.
- Based on the assumptions made in this assessment, predicted odour levels from the proposed green waste composting will comply with the criteria if the WRF building is kept at negative pressure and all air is released into the atmosphere via a stack.
- Based on the assumptions made in this assessment, 24-hour PM_{10} concentration levels (without mitigation) from site operations are not expected to comply with the adopted criteria at private Receiver R1. Annual average PM_{10} and TSP concentration levels, as well as monthly deposition rates are expected to readily comply with the adopted dust criteria. 24-hour 24-hour PM_{10} concentration levels (without mitigation) from site operations are also not expected to comply with the adopted criteria at Receivers R3, R5 and R6
- Dust mitigation measures in the form of chemical dust suppressants on the access roads Level 2 water sprays on the truck turning and backing areas are predicted to reduce dust emissions resulting in compliance with the adopted criterion at all receivers.
- Crushing activities were also found to be a large contributor to dust emissions. Wet suppression systems (such as spray nozzles) have also been adopted as part of the dust mitigation requirements for the site.
- Weather conditions that cause maximum dust impact are generally consistent winds in the direction of the nearest sensitive receivers throughout the daytime period outside of rain events.
- Trucks on unsealed surfaces were identified as the most significant source of dust emissions on the site and provide the greatest contribution to off-site dust impact. Therefore, during times of consistent adverse weather conditions (dry and winds), operations of these items should be reduced, or water sprays should be used in order to minimise potential impacts.
- The application of standard dust mitigation measures will also assist to minimise potential impacts from general site operations.

Appendices

Appendix A - Sample Ausplume output file

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Concentration or deposition Concentration
Emission rate units OUV/second
Concentration units Odour_Units
Units conversion factor 1.00E+00
Constant background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless overridden by met. file) 0.000
Anemometer height 10 m
Roughness height at the wind vane site 0.300 m
Use the convective PDF algorithm? No
Averaging time for sigma-theta values 60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.800m
Adjustment for wind directional shear None

PLUME RISE OPTIONS

Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed Category	Stability Class A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035

2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES

Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES

1 hour

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SOURCE CHARACTERISTICS

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STACK SOURCE: BIOFT

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
298931	6184103	0m	12m	2.00m	35C	6.3m/s

______ Effective building dimensions (in metres) ______

Flow direction	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
Effective building width	38	45	51	55	58	59	58	54	50	55	57	59
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	55	58	58	58	55	51	46	38	30	38	45	51
Along-flow distance from stack	-27	-28	-28	-28	-27	-25	-22	-19	-15	-19	-23	-26
Across-flow distance from stack	0	0	0	0	1	1	1	1	1	1	1	1

Flow direction	130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°
Effective building width	58	55	51	45	38	30	38	45	51	55	58	59
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	55	58	59	57	55	50	55	58	59	58	55	51
Along-flow distance from stack	-28	-29	-30	-30	-28	-26	-29	-30	-30	-30	-29	-26
Across-flow distance from stack	1	1	1	1	1	0	0	0	0	0	-1	-1

Flow direction	250°	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°	360°
Effective building width	58	55	50	55	57	58	58	56	51	45	38	30
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	45	38	30	38	45	51	55	58	59	58	55	50
Along-flow distance from stack	-23	-20	-15	-19	-23	-26	-27	-28	-29	-28	-27	-24
Across-flow distance from stack	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0

Emission rates by stability and wind speed, in OUV/second:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability B:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability C:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability D:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability E:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability F:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: G4

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298931	6184057	0m	4	0m	4m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298931	6184057	2	298947	6184057
3	298946	6184040	4	298931	6184040

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability B:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability C:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability D:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability E:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability F:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: POND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298858	6184023	0m	5	0m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298858	6184023	2	298854	6184006
3	298858	6184004	4	298882	6184004
5	298882	6184023			

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00

Stability B:	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00
Stability C:	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00
Stability D:	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00
Stability E:	9.20E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01
Stability F:	9.20E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01	9.20E-01

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: RAWGW

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298876	6184057	0m	4	0m	4m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298876	6184057	2	298880	6184057
3	298880	6184039	4	298876	6184039

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01
Stability B:	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01
Stability C:	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01
Stability D:	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01
Stability E:	1.10E+01	1.10E+01	1.10E+01	1.10E+01	1.10E+01	1.10E+01
Stability F:	1.10E+01	1.10E+01	1.10E+01	1.10E+01	1.10E+01	1.10E+01

No gravitational settling or scavenging.

VOLUME SOURCE: SHREDD

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
298879	6184063	0m	3m	1m	1m

Emission rates by hour of day in OUV/second:

1	0.00E+00	2	0.00E+00	3	0.00E+00	4	0.00E+00
5	0.00E+00	6	0.00E+00	7	1.32E+04	8	1.32E+04
9	1.32E+04	10	1.32E+04	11	1.32E+04	12	1.32E+04
13	1.32E+04	14	1.32E+04	15	1.32E+04	16	1.32E+04
17	1.32E+04	18	1.32E+04	19	0.00E+00	20	0.00E+00
21	0.00E+00	22	0.00E+00	23	0.00E+00	24	0.00E+00

No gravitational settling or scavenging.

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RECEPTOR LOCATIONS

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	299257	6184522	0.0	2.0					

METEOROLOGICAL DATA : Met for 299,193mE 6,184,118mN from CALMET output job

1 Peak values for the 100 worst cases (in Odour_Units)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	7.90E+00	07,10/08/09	(299257, 6184522, 2.0)
2	7.36E+00	07,06/05/09	(299257, 6184522, 2.0)
3	5.63E+00	07,24/06/09	(299257, 6184522, 2.0)
4	3.88E+00	07,12/05/09	(299257, 6184522, 2.0)
5	3.50E+00	07,04/05/09	(299257, 6184522, 2.0)
6	3.48E+00	07,19/08/09	(299257, 6184522, 2.0)
7	3.40E+00	18,06/07/09	(299257, 6184522, 2.0)
8	3.18E+00	07,01/05/09	(299257, 6184522, 2.0)
9	3.06E+00	07,05/06/09	(299257, 6184522, 2.0)
10	2.91E+00	07,06/07/09	(299257, 6184522, 2.0)
11	2.61E+00	07,09/05/09	(299257, 6184522, 2.0)
12	2.45E+00	18,13/05/09	(299257, 6184522, 2.0)
13	2.21E+00	07,02/05/09	(299257, 6184522, 2.0)
14	1.96E+00	07,18/06/09	(299257, 6184522, 2.0)
15	1.81E+00	07,26/05/09	(299257, 6184522, 2.0)
16	1.75E+00	07,07/05/09	(299257, 6184522, 2.0)
17	1.71E+00	07,06/06/09	(299257, 6184522, 2.0)
18	1.71E+00	07,15/06/09	(299257, 6184522, 2.0)
19	1.71E+00	07,18/08/09	(299257, 6184522, 2.0)
20	1.68E+00	07,12/06/09	(299257, 6184522, 2.0)
21	1.66E+00	07,17/08/09	(299257, 6184522, 2.0)
22	1.53E+00	07,17/05/09	(299257, 6184522, 2.0)
23	1.41E+00	07,29/07/09	(299257, 6184522, 2.0)
24	1.39E+00	18,27/05/09	(299257, 6184522, 2.0)
25	1.35E+00	07,08/08/09	(299257, 6184522, 2.0)
26	1.13E+00	18,13/07/09	(299257, 6184522, 2.0)
27	1.08E+00	07,28/03/09	(299257, 6184522, 2.0)
28	1.02E+00	07,19/07/09	(299257, 6184522, 2.0)

29	1.02E+00	07,23/06/09	(299257, 6184522,	2.0)
30	9.21E-01	22,27/11/09	(299257, 6184522,	2.0)
31	8.94E-01	02,19/05/09	(299257, 6184522,	2.0)
32	8.93E-01	05,10/08/09	(299257, 6184522,	2.0)
33	8.90E-01	03,19/10/09	(299257, 6184522,	2.0)
34	8.84E-01	02,10/08/09	(299257, 6184522,	2.0)
35	8.83E-01	02,14/07/09	(299257, 6184522,	2.0)
36	8.80E-01	03,21/03/09	(299257, 6184522,	2.0)
37	8.33E-01	23,06/05/09	(299257, 6184522,	2.0)
38	8.31E-01	07,06/09/09	(299257, 6184522,	2.0)
39	8.29E-01	02,17/04/09	(299257, 6184522,	2.0)
40	8.10E-01	07,27/05/09	(299257, 6184522,	2.0)
41	7.87E-01	01,28/12/09	(299257, 6184522,	2.0)
42	7.77E-01	23,22/06/09	(299257, 6184522,	2.0)
43	7.69E-01	18,02/08/09	(299257, 6184522,	2.0)
44	7.53E-01	17,06/07/09	(299257, 6184522,	2.0)
45	7.42E-01	22,12/04/09	(299257, 6184522,	2.0)
46	7.40E-01	05,14/12/09	(299257, 6184522,	2.0)
47	7.32E-01	21,22/06/09	(299257, 6184522,	2.0)
48	7.32E-01	07,16/07/09	(299257, 6184522,	2.0)
49	7.30E-01	01,12/05/09	(299257, 6184522,	2.0)
50	7.30E-01	04,21/01/09	(299257, 6184522,	2.0)
51	7.16E-01	06,27/06/09	(299257, 6184522,	2.0)
52	7.16E-01	22,29/09/09	(299257, 6184522,	2.0)
53	7.14E-01	05,19/08/09	(299257, 6184522,	2.0)
54	7.00E-01	03,05/06/09	(299257, 6184522,	2.0)
55	6.99E-01	07,29/05/09	(299257, 6184522,	2.0)
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60	6.58E-01	01,04/11/09	(299257, 6184522,	2.0)
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63	6.27E-01	05,20/12/09	(299257, 6184522,	2.0)
64	6.25E-01	03,28/03/09	(299257, 6184522,	2.0)
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83	5.52E-01	23,23/04/09	(299257, 6184522,	2.0)
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95	5.15E-01	22,29/12/09	(299257, 6184522,	2.0)
96	5.12E-01	08,04/06/09	(299257, 6184522,	2.0)
97	5.11E-01	08,07/07/09	(299257, 6184522,	2.0)
98	5.07E-01	21,06/04/09	(299257, 6184522,	2.0)
99	5.05E-01	04,04/05/09	(299257, 6184522,	2.0)
100	5.04E-01	04,25/05/09	(299257, 6184522,	2.0)

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4	P Pandey	E Smith		E Milton		10/07/2014
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