



Mount Alexander Shire Council  
Castlemaine Landfill  
Odour and Buffer Assessment

May 2016



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# 1. Introduction

GHD was engaged by the Mount Alexander Shire Council (MASC) to conduct an odour and buffer assessment for the Castlemaine Landfill at Sluicers Road, Castlemaine, Victoria. The landfill accepts kerbside putrescible waste from council kerbside rubbish bins. The current facility accepts 3,000 tonnes per year.

As part of the Diamond Gully Structure Plan (DGSP), a 200 m exclusion buffer was recommended for the landfill, with areas outside of this buffer identified for future residential use. However, the EPA Victoria (EPA) objected to the 200 m buffer on the basis that it considers a 500 m buffer should apply, with any reduction being dependent on odour modelling. The Planning Panel C56 has subsequently recommended that the DGSP be revised to include the 500 m landfill buffer as recommended by EPA.

Air quality associated with the landfill has the potential to be the major environmental issue. Generally, odour poses the critical constraint with respect to the available separation distance to nearby residences.

This report comprises odour modelling and an odour environmental risk assessment based on site-specific operations, with the purpose to assess whether it is appropriate to reduce the 500 m buffer to allow future residential development closer to the landfill. EPA has accepted the methodology proposed by GHD for this assessment<sup>1</sup>.

The assessment was conducted with reference to:

- State Environment Protection Policy – Air Quality Management (SEPP – AQM)
- EPA Publication 1509, Broiler Farm Odour Environmental Risk Assessment, November 2012

This report should be read in conjunction with the limitations presented in section 1.1 and the assumptions provided in section 1.2 and elsewhere in the report.

## 1.1 Scope and limitations

This report has been prepared by GHD Pty Ltd (GHD) for the Mount Alexander Shire Council (Council) and may only be used and relied on by Council for the purpose agreed between GHD and Council as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Council 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.

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<sup>1</sup> EPA Memo from Gavin Fisher, Air Quality Scientist, 8 February 2016

The opinions, conclusions and any recommendations in this report are based on explicit assumptions made by GHD, described in section 1.2 and throughout the body of this document, and limitations of the modelling software CALPUFF. GHD disclaims liability arising from any of the assumptions being incorrect. GHD has prepared this report based on information provided by Council 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.

## 1.2 Assumptions

The major assumptions used in this assessment are as follows:

- Meteorological data was synthesised for upper atmospheric conditions from the CSIRO prognostic model TAPM (The Air Pollution Model) for the year 2012 at a horizontal spatial resolution of 1 km.
- The coarse 1 km resolution meteorology was refined to a spatial resolution of 400 m using the diagnostic model CALMET V 5. CALMET was configured in “No Obs” mode.
- The odour dispersion modelling using the NSW EPA and US EPA approved regulatory Gaussian puff dispersion model CALPUFF V 5, was considered appropriate for the location and approved for use in this project by EPA.
- The emissions inventory and dispersion modelling is based on data measured on site at the Castlemaine Landfill under normal operations by Ektimo emission testing consultants. Actual measurements are dependent on site conditions at the time of measurement and these conditions may change. GHD does not accept any responsibility for updating the measurements, modelling or reporting after measurements have been taken.
- Odour emissions from the major sources of odour were modelled as both variable emission and fixed area sources in CALPUFF with appropriate dispersion characteristics.

## 1.3 Report structure

This report:

- Describes the operations of the current facility
- Describes the site-representative meteorological data
- Assesses the separation distance of the facility
- Presents the results of odour dispersion modelling for the facility using CALPUFF for normal operations and for selected plausible upset scenarios
- Presents a summary of the results and draws conclusions as to the off-site odour impact
- Presents the results of the odour environmental risk assessment (OERA) based on the outcomes of the dispersion modelling
- Recommends the appropriate buffer distance to apply to the landfill
- Outlines the limitations of the analyses and conclusions presented

## 2. Site location and context

### 2.1 Site location

Figure 1 shows the location of the facility in Castlemaine, Victoria. It is located approximately 120 km northwest from Melbourne and is approximately 2.5 km southwest from the town centre of Castlemaine.

The land uses surrounding the sites include:

- Residential (southeast, east)
- Light industrial and sewage treatment plant (north)
- Vacant land (west, southwest)
- A quarry (west)

The local sewage treatment plant (operated by Coliban Water) is located 140 m to the northeast, while a former quarry, (now rock wholesaler) is located approximately 120 m to the west.

#### 2.1.1 Nearby rural residences

The nearest existing dwelling is one single residential property (R6 ) located approximately 90 m south west of the site boundary and a historic homestead (unoccupied) on the corner of Diamond Gully Road and Sluicers Road, approximately 150 m from the property boundary (R5). The nearest existing multiple dwelling residential development is located off Honeycomb Road, approximately 250 m to the southeast . Other than the R5 and R6, there are no other residential properties located within 200 m of the landfill. Seventeen residences were identified in proximity to the facility as shown in Figure 1. These residences qualify as sensitive receptors, as defined by EPA Victoria (EPA VIC, 2014), which includes residential premises, childcare centres, pre-schools, primary schools, education centres or informal outdoor recreation sites.

The DGSP consists of 182 hectares which is located immediately west of the existing Sluicers Road landfill site with the majority of the proposed area to be used for residential uses.

### 2.2 Current operations

The landfill was constructed in 1995 and has an area of approximately nine hectares. The landfill's estimated lifespan is 30 years with a planned total airspace of 533,400 m<sup>3</sup>. The site is an EPA licensed site (EP Licence ES2449) that consists of the landfill, a waste transfer station and recycling area (including a resale area). The landfill is licenced to accept:

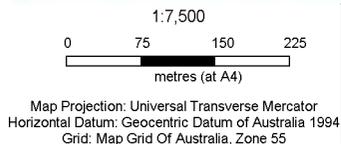
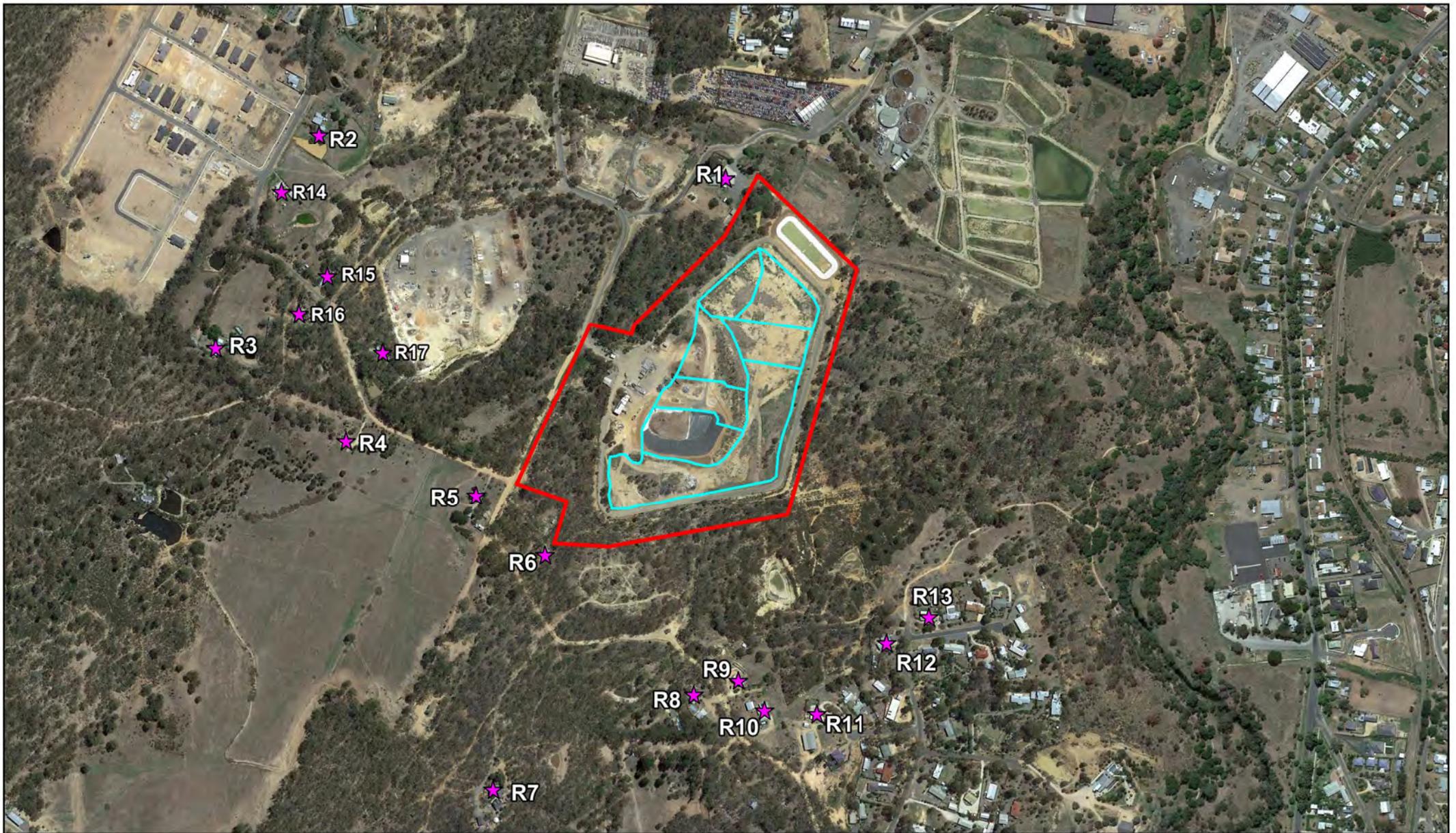
- Solid inert waste
- Putrescible wastes
- Asbestos waste of domestic origin
- Pneumatic automatic tyres shredded into pieces less than 250 mm in all diameters
- Category C prescribed industrial waste (PIW)

The landfill throughput is approximately 3,000 tonnes/year<sup>2</sup>. On average, there are three truckloads of waste delivered daily (Monday to Friday) with the majority arriving between 10 am and 12 pm. The tipping face is left uncovered between 10 am and 2 pm daily (Monday to Friday) with an average area of 10 m x 10 m.

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<sup>2</sup> Based on the amount of waste delivered by Wheelie Waste in 2015

Wastes are deposited at the tipping face daily and are covered at the end of each day's operations by 150 mm of soil/compost. At the end of each week, all wastes are covered with a layer of soil 300 mm thick.



LEGEND	
	Site Boundary
	Sensitive Receptors
	Cells



Mount Alexander Shire Council  
Castlemaine Landfill - Odour and Buffer Assessment

Job Number | 31/33897  
Revision | B  
Date | 13/05/2016

Site Location

Figure 1

## 3. Meteorology

### 3.1 Climate and topography

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. There is a substantial distance to the nearest meteorological observation data at Redesdale (BoM), with Redesdale located over 30 kilometres to the east and significant intervening drainage lines in between.

The initial site visit by GHD established that there was no on-site anemometer, however it was observed that the Castlemaine WWTP, located some 450 m to the north-northeast, had an anemometer installed onsite. Enquiries were made to Coliban Water and a five-year dataset of wind speed wind direction and temperature was made available. Unfortunately, detailed examination of that data showed that the recorded data was influenced by the wake of the building adjacent to the anemometer mast. The effect was to distort the pattern of wind direction and it was decided that the data could not be relied on for the odour modelling.

In this situation where there is a lack of site-representative data, the approach is to synthesise a 12 month meteorological dataset using TAPM and CALMET.

The selected model year of 2012 was chosen based on the following considerations:

- A recent year no older than a decade
- Avoid the strong multi-year La Nina event of 2010-11<sup>3</sup>
- Exclude excessively wet or dry years/months
- A 'normal' monthly pattern of rainfall – a strong correlation of recorded monthly totals against corresponding monthly long-term medians (correlation coefficient > 0.70)
- Annual rainfall within ~30% of median (70% to 130%)

### 3.2 TAPM modelling

The prognostic model TAPM (The Air Pollution Model by CSIRO) was used to derive the initialising atmospheric conditions around the site for input into CALMET. TAPM was set up according to the specifications in Table 1. The period for the year 2012 was selected for modelling based on the representativeness of the year, according to the above criterion.

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<sup>3</sup> From: <http://www.bom.gov.au/climate/enso/lnlist/index.shtml>

"The 2010–11 La Niña event consisted of two peaks over successive summers; the 2010–11 peak was one of the strongest on record, comparable in strength with the events of 1917–18, 1955–56 and 1975–76. In October and December 2010, and February and March 2011, monthly Southern Oscillation Index values were the highest on record (records commenced in 1876). 2010 and 2011 were the third-wettest and second-wettest calendar years on record for Australia, with 703 mm and 708 mm respectively, both well above the long-term average of 465 mm.

Table 1 TAPM model parameters

Parameter	Value
Modelled Year	2012
Domain centre	UTM: 55 S 250,610 m E, 5,892,795 m N Latitude = 37°5' S Longitude = 144°12' E
Number of vertical levels	25
Number of Easting Grid Points	41
Number of Northing Grid Points	41
Outer Grid Spacing	30,000 m x 30,000 m
Number of Grid Levels	4
Grid Level Horizontal Resolution	Level 1 – 10,000 m Level 2 – 3,000 m Level 3 – 1,000 m

However, GHD has found from previous studies that TAPM does not predict light wind conditions as well as CALMET. These meteorological conditions give rise to the upper percentile odour impacts, (i.e. top 0.1 per cent), and are critical for the correct prediction of odour impact.

Upon completion of the broad scale TAPM modelling runs, a CALMET simulation was set up to run for the year 2012, combining the three dimensional gridded data output from the TAPM model and using the CALTAPM conversion utility available with CALMET. This approach is consistent with NSW OEH (2011) guidance documentation.

### 3.3 CALMET modelling

CALMET (version 5.8) is the 3D meteorological model pre-processor to the CALPUFF (version 5.8) 3D puff based dispersion model. CALMET includes a diagnostic wind field generator, with algorithms to generate slope flows, kinematic terrain effects (wind channeling), terrain blocking effects (stagnation) and also divergence minimisation (mass consistency) over spatially varying land uses and types.

CALMET also includes separate micrometeorological models to characterise both the overland and over water atmospheric boundary layers. The sub-models each formulate the evolution of spatially varying temperature profiles and the heights of the different mixed layers both over water and overland, and at the Thermal Internal Boundary Layer (TIBL) interface between them through a process of upwind spatial averaging. They also generate parameters that characterise the atmospheric stability within and above these layers. This meteorological, micro-meteorological and land use information is passed to the CALPUFF dispersion model so that the manner in which emission plumes are transported and dispersed in the atmosphere can be assessed.

The US EPA approved version of CALMET (Version 5.8) was used to resolve the wind field at the site to a 400 m spatial resolution. The application of CALMET for this purpose is an approved modelling approach in New South Wales Approved Methods, (Department of Environment and Conservation, 2005) with model guidance documentation provided (Office of Environment and Heritage, 2011).

All CALMET settings were selected as per the CALPUFF guidance document OEH (2011) for “Hybrid” mode, except for the following:

- Kinematic effects were computed (IKINE = 1)
- O’Brien adjustment for vertical velocity smoothing (IOBR = 1)
- Observations were input, to account for onsite meteorological measurements

The undulating nature of the terrain means that hills and valleys create flow divergence and convergence as the wind moves around the natural obstacles. A better representation of the vertical velocity was required (by setting IKINE =1) to maintain mass consistency and to more accurately represent the situations of “plume diversion” around elevated terrain.

The TERRAD variable was set to a value of 10.0 km based on an inspection of the terrain elevations in the immediate vicinity of the site, according to OEH (2011) guidance.

The CALMET model parameters are summarised in Table 2 with the full input file in Appendix C.

Table 2 Summary of CALMET model parameters

Parameter	Value
Mode	No observations (No Obs)
UTM Zone	55 S
Southwest corner	Easting: 238.610 km Northing: 5880.795 km
Domain Size	60 x 60 at 0.4 km resolution (24.0 km x 24.0 km)
Modelled Year	2012
Number of vertical levels	11
Vertical Levels (m)	20, 40, 60, 90, 120, 180, 250, 500, 1000, 2000, 3000
CALMET Settings for Obs Mode (OEH, 2011)	TERRAD = 5.0 km Kinematic Effects O’Brien Vertical Velocity Adjustment

### 3.1 Regional climate and prevailing meteorology

The local climate at the landfill site is influenced by the 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 terrain surrounding the site is shown in Figure 2, with the site in blue and the meteorological grid in CALMET at spacing of 400 metres. The grid extends 24 kilometres in all directions from the site and influences local wind patterns as described in the following sections.

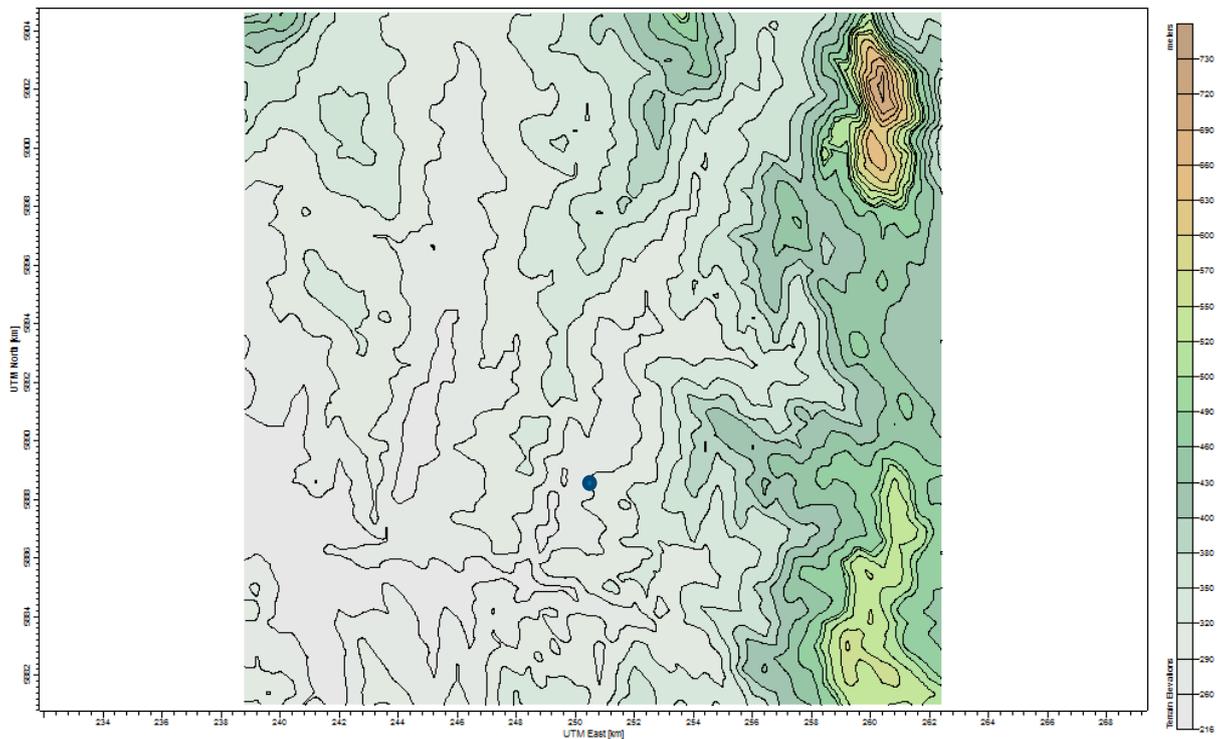


Figure 2 Local terrain surrounding the site

### 3.1.1 Wind pattern

The local meteorology largely influences the pattern of offsite odour impact on receptors. The effect of wind on odour dispersion patterns can be examined using the wind and stability class distributions at the site from the dataset that is produced by CALMET. The winds at a site are displayed by means of wind rose and stability rose plots, giving the distribution of winds and the wind speeds from these directions as well as the distribution of the stability classes.

The features of particular interest in this assessment are: (i) the dominant wind directions and (ii) the relative incidence of stable light wind conditions that yield minimal mixing, which defines peak impacts from ground-based sources.

### 3.1.2 Annual and seasonal variation in wind

#### **Annual**

The average wind rose for the entire data period is shown in Figure 3 and indicates the following features at the landfill site:

- Annual average wind speed of 3.0 m/s
- Winds are most prevalent from the north and north-northwest, southwest and south
- Winds are least prevalent from the east and northwest
- Light winds (shown in black) are more prevalent from the south and north
- Drainage flows occurring during night-time stable conditions are dominated by Campbells Creek

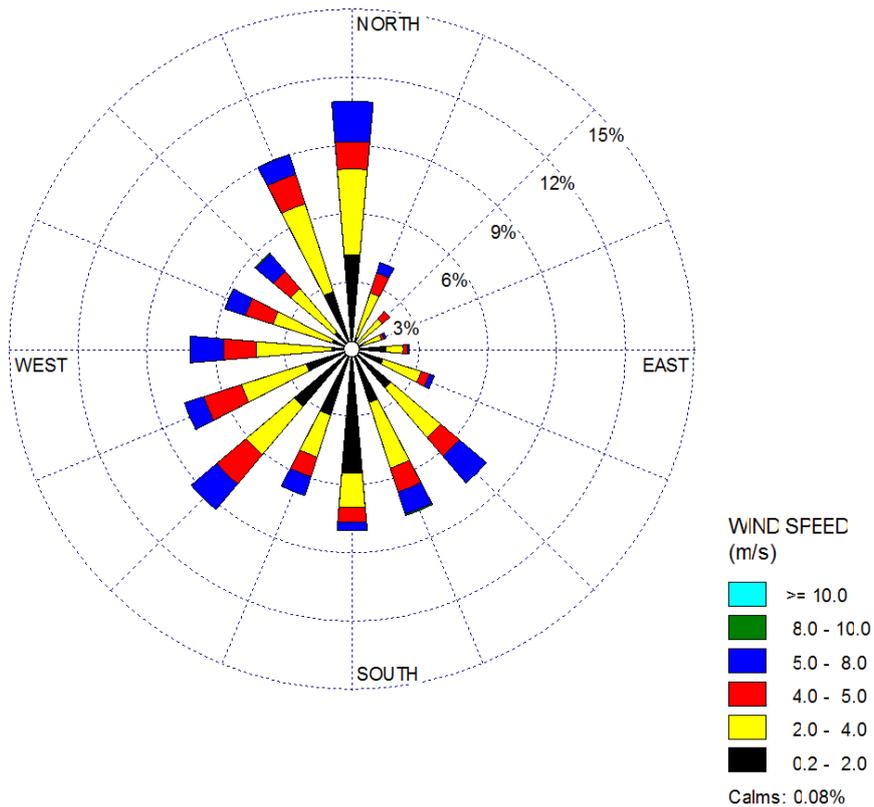
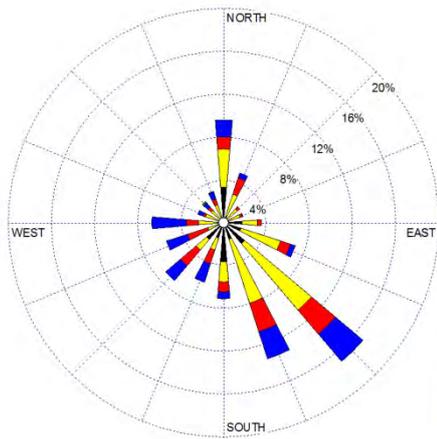


Figure 3 Annual wind rose – Landfill site (CALMET)

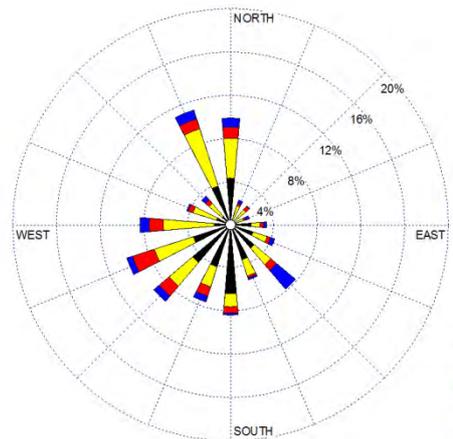
### Seasonal

The seasonal variation within the annual pattern is shown by seasonal wind roses in Figure 4. There are several significant seasonal features:

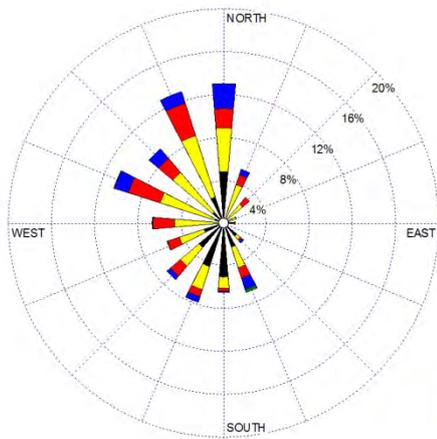
- In summer, winds are predominantly from the southwest and northeast, with strongest winds from the southwest
- In winter, the dominance of the southerlies winds is still evident, but a higher incidence of winds is observed from the north. Average wind speed is also lower than that of summer
- In spring and autumn, the lighter southerly winds remain dominant along with stronger winds from the southwest, but with a higher incidence of stronger westerly winds peaking in spring
- Light southerly winds (aligning to the Campbell Creek valley axis) predominate in all seasons but are most marked in spring and autumn



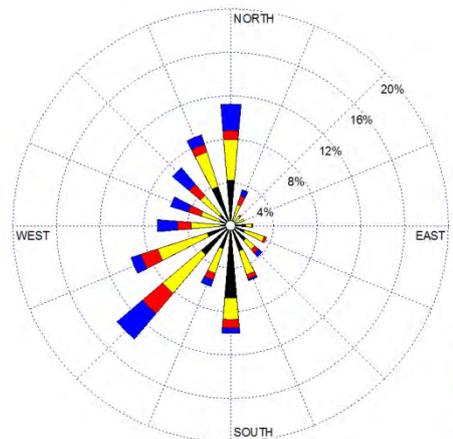
Summer – average speed 3.4 m/s



Autumn - average speed 2.6 m/s



Winter - average speed 3.0 m/s



Spring - average speed 3.0 m/s

Figure 4 Seasonal wind roses – Landfill Site (CALMET)

### 3.2 Pattern of atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere. For a landfill, odour emissions will have greatest impact downwind during stable conditions, reducing to a minimum impact during unstable conditions.

There are six Pasquill–Gifford classes (A-F) used to describe atmospheric stability and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and solar insolation are used to define the stability category as shown in Table 3, and as these parameters vary diurnally, there is a corresponding variation in the occurrence of each stability category. Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table 3 Stability Category Relationship to Wind Speed, and Stability Characteristics

Stability Category	Wind Speed Range (m/s) <sup>a</sup>	Stability Characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud
D	≥6	Neutral atmospheric conditions. Occur during the day or night with stronger winds. Or during periods of total cloud cover, or during the twilight period
E	3.4 – 5.4 <sup>b</sup>	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds
F	0 – 3.3 <sup>b</sup>	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds
<p>a. Data sourced from the Turner's Key to the P-G stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am)</p> <p>b. Assumed to only occur at night, during Net Radiation Index categories of –2.</p>		

Figure 5 shows the frequency of stability class for all hours from the model-generated dataset. The following trends were observed from Figure 5:

- Unstable atmospheres (A, B and C class stabilities) occur about 34.1 per cent of the time
- Stable E and F atmospheric conditions are predicted to be the most frequent at the site, with stability class F contributing to over 45.6 per cent of all conditions. The slightly stable atmosphere (E class) occurs for 9.1 per cent of the year, mostly occurring as a transition from neutral D class conditions to stable F class conditions

Figure 5 shows that the majority of stable winds (annually) are from the south, along with south-southwest and south-southeast.

The directional incidence of poor dispersion is focussed to the north, north-northwest and south (including southwest and southeast) and therefore, the zone of odour impact will be extended in these directions.

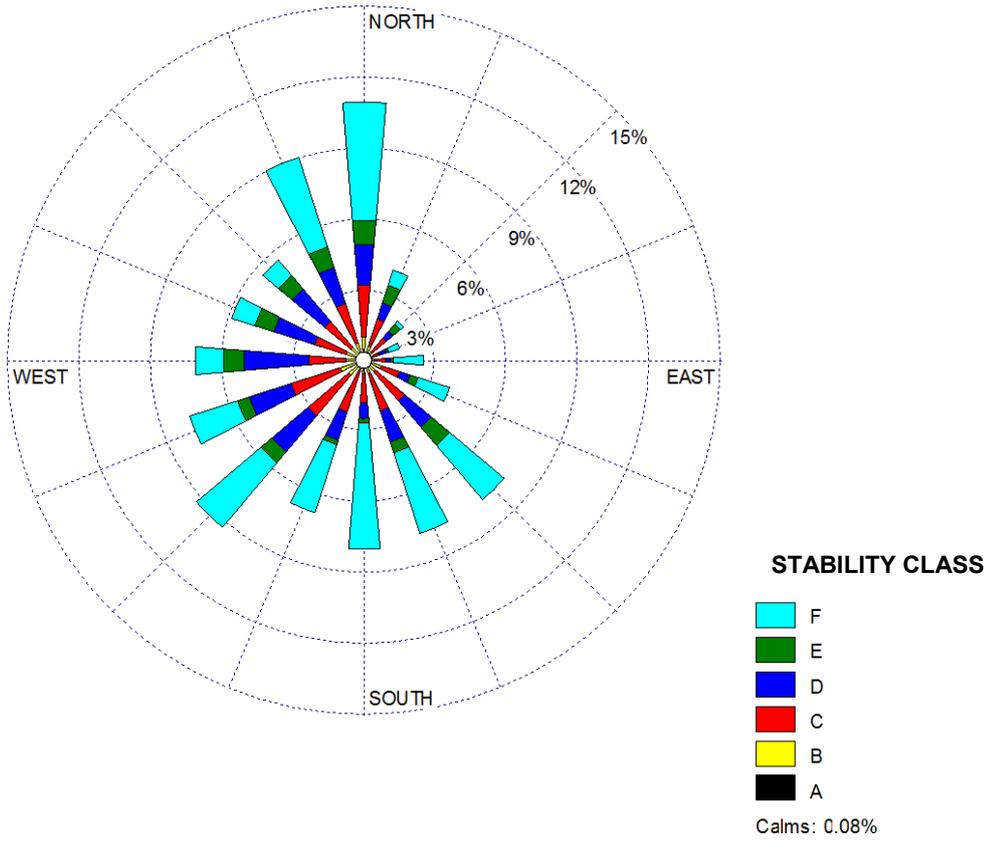


Figure 5 Annual stability rose for the Landfill Site (CALMET)

## 4. Environmental Guidelines

### 4.1 Air quality criteria

In Victoria and under the Environment Protection Act 1970, emissions from existing, new or proposed stationary emission sources are regulated by provisions in the State Environment Protection Policy (Air Quality Management) (SEPP-AQM) (Victorian Government, 2001). The EPA Victoria (EPA) criterion for a scheduled premises source requires that the predicted maximum ground level concentration (GLC) must not exceed the design criterion for the relevant pollutant listed in Schedule A of the SEPP-AQM. The predicted maximum concentration is taken to be the 99.9<sup>th</sup> percentile concentration using an averaging time of one hour or less, as appropriate.

The predicted peak GLC for each identified pollutant is assessed by dispersion modelling. Schedule A of the SEPP-AQM lists odour as an unclassified indicator for amenity and sets the following design criteria (refer to Table 4). Odour from the landfill facility is a potential critical indicator.

Table 4 Design criterion for gaseous boiler emissions

Indicator	Exceedance %	Averaging Period	Design Criterion	Location
General Odour	99.9 percentile	3 minute	1 odour unit	At site boundary
Odour (industries involving intensive animal husbandry and sited in an area of low density of sensitive land uses)	99.9 percentile	3 minute	5 odour units	

Whilst a landfill does not fall under the classification 'industries involving intensive animal husbandry', EPA Victoria have in the past accepted five odour units as the criterion at the site boundary for landfill facilities, and as such this value has been adopted for the report assessment. The site location does meet the criterion of a low density of sensitive land uses in the vicinity as shown in Figure 1.

### 4.2 Victorian Buffer Guidelines

Buffer distances have been used in Victoria since 1977 as a simple planning device to provide separation between industries with potential for odorous (or dusty) emissions and sensitive land uses.

A sensitive land use is defined as “any land uses which require a particular focus on protecting the beneficial uses of the air environment relating to human health and wellbeing, local amenity and aesthetic enjoyment, for example residential premises, child care centres, pre-schools, primary schools, education centres or informal outdoor recreation sites”. In Victoria, the EPA publish recommended separation distance guidelines (EPA Publication 1518), where it is understood that the separation is set to minimise offsite impact on sensitive land uses arising from unintended, industry generated odour and dust emissions. That is, an external buffer is not to be used to prevent off-site impacts under routine operations. Equipment failure, accidents and abnormal weather conditions are recognised as some of the causes that may result in increased odour and dust emissions. EPA Publication 1518 notes that the terms ‘buffer’ and ‘separation distance’ have been used interchangeably, however the guideline adopts the term ‘separation distance’ to mean the space between industrial land uses and sensitive land uses.

The buffers are to be scribed as per EPA Guidelines Method 1 (Rural Method). This method requires that the separation distance be measured from the activity boundary of the industry to the activity boundary of the sensitive land use, i.e. this activity boundary of the industry is a convex polygon containing the activities of the industry.

The guidelines also enlarge the definition of ‘sensitive land use’ to include ‘informal outdoor recreation sites’. This term is not itself defined within EPA Publication 1518, however enquiries to EPA<sup>4</sup> have led to the definition adopted in Victorian Planning Schemes where under *Definitions, Clause 74*, informal outdoor recreation is defined as:

*Land open to the public and used by non-paying persons for leisure or recreation, such as a cycle track, picnic or barbecue area, playground, and walking or jogging track.*

EPA Publication 1518 includes landfills under ‘Waste Management’, and refers to EPA Publication 788.1, *Best Practice Environmental Management - Siting, Design, Operation and Rehabilitation of Landfills* (the Landfill BPEM).

The Landfill BPEM states that “appropriate buffer distances must be maintained between the landfill and sensitive land uses (receptors) to protect those receptors from any impacts resulting from a failure of landfill design or management or abnormal weather conditions. These failures might constitute discharge from the site of potentially explosive landfill gas, offensive odours, noise, litter and dust. Features that could be adversely affected by landfilling operations include surface waters, buildings and structures and airports. Buffer areas are not an alternative to providing appropriate management practices, but provide for contingencies that may arise with typical management practices”.

Section 4 of the Landfill BPEM classifies landfills by the waste streams accepted into two types:

- **Type 2**, including:
  - Putrescible (municipal) waste, solid inert waste and fill material
  - Category C prescribed industrial waste
- **Type 3** comprising solid inert waste and fill material.

The required buffer distances are specified based upon landfill type and these are summarised in Table 5.

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<sup>4</sup> EPA Pers. comm. J. Frayne

Table 5 Required buffer distances specified by the Landfill BPEM

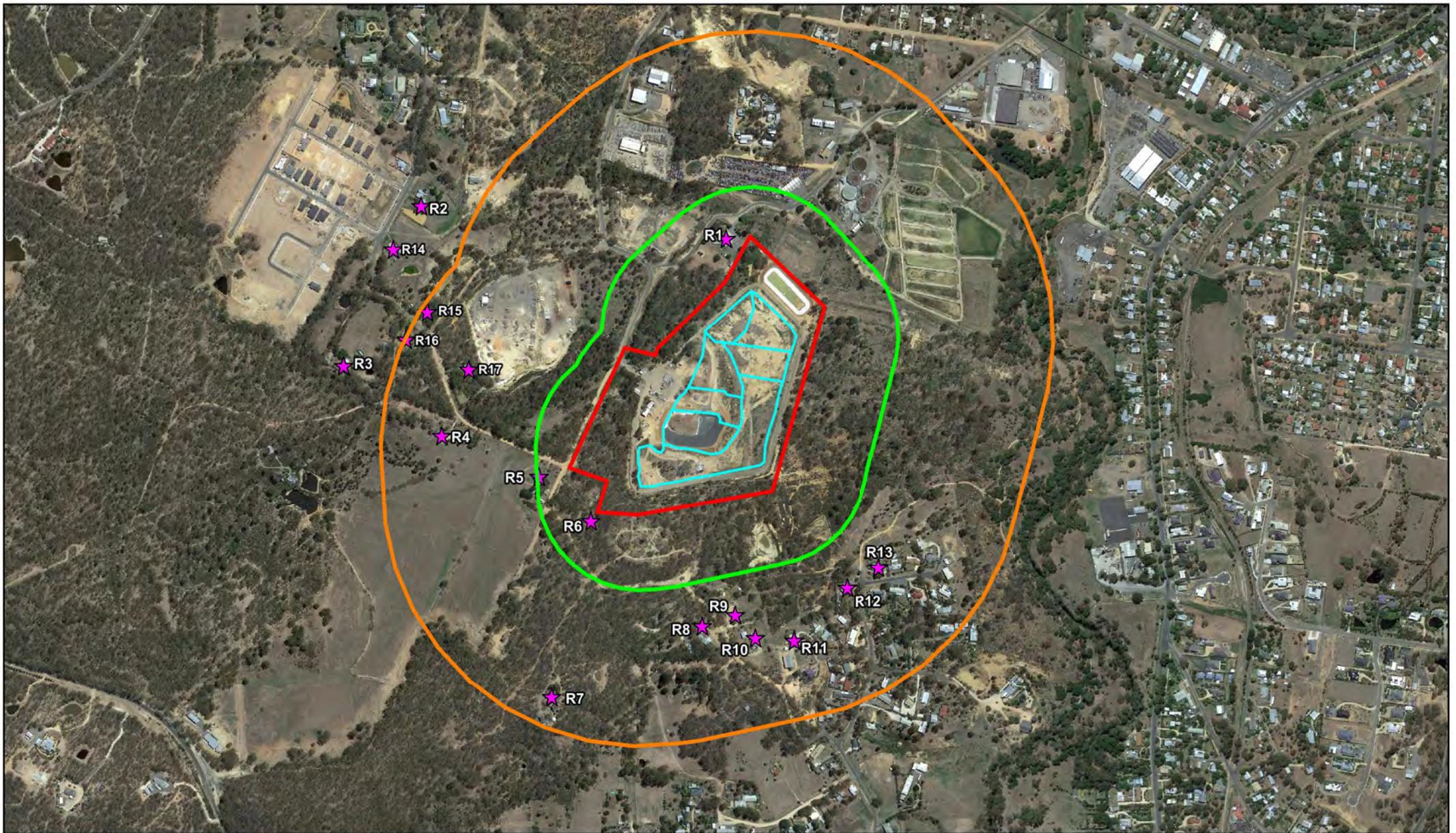
Landfill Type	Required Buffer Distances
Type 2	100 m from surface waters 500 m from building or structures 1500 m from aerodrome for piston propeller-driven aircraft 3000 m from an aerodrome for jet aircraft
Type 3	100 m from surface waters 200 m from building or structures 1500 m from aerodrome for piston propeller-driven aircraft 3000 m from an aerodrome for jet aircraft

#### 4.2.1 Application to Castlemaine Landfill

The current landfill is classified as Type 2, thus a buffer distance of 500 m from buildings or structures apply. At the Castlemaine facility, this default buffer was subsequently recommended to be replaced by a 200 m separation distance based on the outcomes of a qualitative assessment in 2009<sup>5</sup> and the recommendations from a Section 53V Environmental Audit in 2012<sup>6</sup>. The 500 m and 200 m buffer around the existing landfill are plotted in Figure 6.

<sup>5</sup> Meinhardt Report for Mount Alexander Shire Council, Castlemaine Existing and Former Landfills – Qualitative Risk Assessment, October 2009

<sup>6</sup> Nolan Consulting Report for Mount Alexander Shire Council, Section 53 Environmental Audit of development encroaching on Castlemaine Landfill buffer, December 2012



1:10,000  
 0 100 200 300  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



LEGEND	
	Site Boundary
	Cells
	Sensitive Receptors
	500 m Buffer
	200 m Buffer



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Default Buffers

Figure 6

#### 4.2.2 Variation to default buffer

The 500 m buffer recommended by EPA is the default buffer for putrescible landfills and has been set based on the experience of EPA field staff when landfill odour complaints are made at a given site. The factors to consider when considering a variation to the default value are: (i) the throughput of the landfill, and (ii) the local meteorology at the landfill site. Given the throughput at the Castlemaine facility is significantly lower than the Melbourne metropolitan landfills (viz. 3,000 tpa compared to 100,000 to 300,000 tpa) then the default buffer can be reduced. Where the local meteorology gives directions of poor dispersion towards existing or proposed residential developments then the buffer may need to be extended. In contrast, in the direction of good dispersion, the buffer may be able to be reduced. The influence of meteorology will be taken into account via the site specific modelling to obtain the process specific buffer.

#### Derating of 500 m buffer to account for throughput

Drawing on the Waste Management Association of Australia *National landfill Survey* (WMAA 2007), Australia has at least 459 landfills of sufficient capacity to be licensed to receive waste. Three landfill categories are identified namely small, medium and large as shown in Table 6.

Table 6 Landfill Size-Classes<sup>1</sup>

Category	Annual Tonnage Received
Small	Less than 10,000 tonnes/year (not including open, unattended, or unlicensed tips)
Medium	Greater than 10,000 tonnes/year and less than 100,000 tonnes/year
Large	Greater than 100,000 tonnes/year

<sup>1</sup> Source: WMAA National Landfill Survey (WMAA 2007)

Table 7 gives the annual throughput for a number of landfills. From Table 7, it can be seen that the Castlemaine Landfill is a small example compared with other facilities around Victoria and metropolitan Melbourne.

Table 7 Classification of landfills on throughput<sup>1</sup>

Landfill	Throughput tonnes/yr
<b>Castlemaine</b>	<b>3,000</b>
Lakes Entrance	8,000
Bairnsdale	16,000
Hume	30,000
Ballarat	60,000
Wyndham	400,000

<sup>1</sup> <http://www.audit.vic.gov.au/publications/20140903-Landfills/20140903-Landfills.html>

The annual throughput of the Castlemaine Landfill is 3,000 tonne. Hence, given that the 500 m buffer is to provide amenity protection for large landfills, there is scope to allow for a reduction in buffer distance. Such a graded scale for buffer distance that is proportional to throughput is commonly done (e.g. Victorian Broiler Code, EPA Composting Guidelines).

As shown in Table 7, the size of landfills in Victoria can range from large metropolitan facilities with throughputs in excess of 100,000 tpa, down to much smaller rural with throughputs at 1500 tpa.

GHD has developed a method<sup>7</sup> to derate buffers to account for reduced scale of operations. A similar method is used in the current guideline to define buffer distances for wastewater treatment ponds as a function of equivalent population (refer to Table 6).

The aim of derating the buffer is to provide an equivalent degree of protection in the event of a process upset/malfunction – independent of the facility size. Small landfill operations will generate correspondingly smaller odour/dust emissions during an upset, therefore a smaller buffer is required to deliver the same degree of protection from disamenity. A smaller buffer avoids unnecessary sequestering of land from sensitive land uses were the standard default buffer to be applied.

In this case, Castlemaine Landfill is a small example of a landfill – 3,000 tpa, and the 500 m buffer should be de-rated in comparison to the larger examples in metropolitan Melbourne at greater than 100,000 tpa.

From Table 6, a large landfill can be considered to be above 1000,000 tpa (e.g. large metropolitan sites such as Wyndham and Boroondara) while a small landfill can be considered to have a throughput of approximately 1500 tpa. Then using the de-rating method<sup>7</sup>, the derating factor is calculated by the approximate square root of the capacity ratio. For the Castlemaine Landfill, the derated buffer is calculated as follows:

Derating factor:

$$\left[ \frac{3,000}{100,000} \right]^{0.54} = 0.15$$

Therefore, applying the derating factor to the 500 m buffer gives a reduced buffer of:

$$0.15 \times 500 = 75 \text{ m}$$

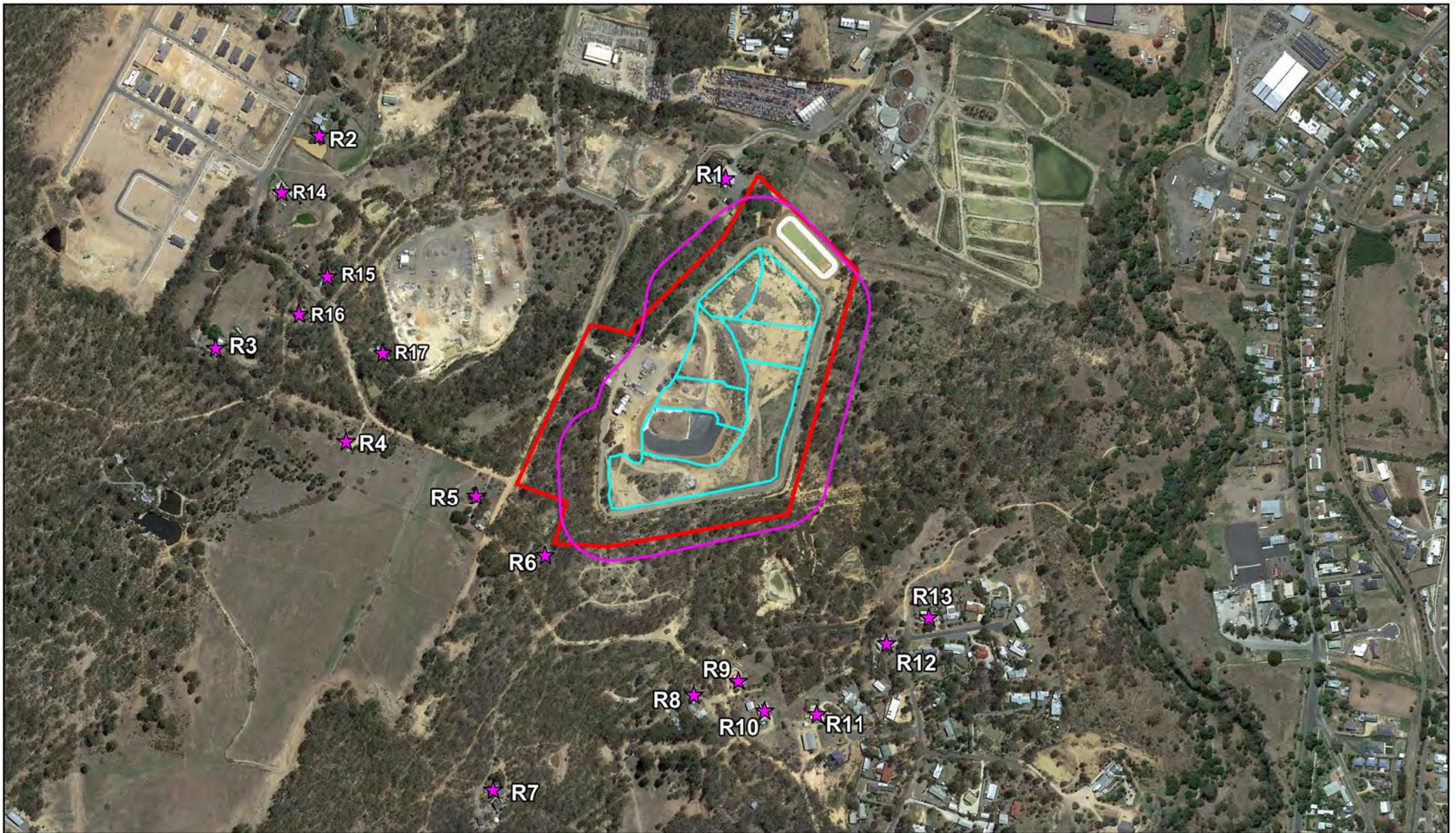
The 75 m buffer is shown in Figure 7 and shows that this buffer is significantly smaller than the 500 m and 200 m buffer respectively, with only nominal excursions outside the site boundary (20 m to 40 m) and no encroachment onto any current or future residential locations.

### Process-Specific Buffer

Separation distances are designed to minimise odour impact in the event of a process or operational upset, and the extent of the impact can therefore only be modelled for defined plausible upset scenarios. GHD has identified several such scenarios for this landfill and has modelled the consequent odour impact. The results were passed through an odour environmental risk assessment (OERA) to calculate the separation distance needed to obtain low risk at the buffer envelope (refer to section 7).

---

<sup>7</sup> Clarey P, Pollock T "Integrating Separation Distances with Dispersion Modelling" Enviro 04, 28 March – 1 April 2004, Darling Harbor, Sydney.



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



LEGEND	
	Site Boundary
	Cells
	Sensitive Receptors
	75 m De-rated buffer



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De-rated Buffer

Figure 7

## 5. Emission inventory

### 5.1 Landfill odour emission rates

Correspondence with EPA has indicated that they prefer onsite odour measurements to be collected at the Castlemaine site.

The direct methods of OER measurement for extended sources (such as use of flow-through hoods and isolation flux chambers) cannot readily be used to characterise odour emissions from a landfill tipping face as: (i) the operation of delivering loads to the tipping face by trucks and the moving of waste by swamp dozer would have to cease; and (ii) the emitting surface is highly heterogeneous and is very uneven, making the placement and sealing of hoods or chambers difficult. The indirect method of measuring the downwind plume odour levels along a transect at short range was adopted instead<sup>8</sup>. This method requires concurrent sampling at each station on the transect, and requires the atmospheric conditions (wind speed and atmospheric stability category) at the time of sampling to be measured/calculated. This method also requires dispersion modelling to be used to back-calculate the tipping face SOER.

While this method is clearly more cumbersome, it has the advantage of avoiding sub-sampling (i.e. the full plume width is sampled) and it represents source odour emissions from all of the component normal operations on the tip face.

#### 5.1.1 Source emission rate testing

GHD has obtained OER data from the Castlemaine Landfill to obtain site-specific source OERs applicable for current landfill operations. Odour testing was conducted by Ektimo on 7 April 2016. The testing involved sampling ambient odour levels along a transect of the odour plume downwind from the active tipping face, and taking concurrent measurement of local wind speed and direction. The odour levels in the samples from the transect stations were analysed by Ektimo in their Ringwood olfactometry facility. The methodology to calculate the SOER from the active tipping face was to match the measured downwind odour plume lateral profile by back-calculation, using a dispersion model with an initial estimate of the SOER. Successive iterations were made with adjusted values of SOER until the match of predicted to measured lateral odour profile was optimised. Transect measurements were made at three times during the day, so that the diurnal variation in OER could be characterised.

This method was used recently by GHD at the Werribee Landfill as part of the Wyndham Vale Buffer Study. An environmental audit under Section 53V of the Environment Protection Act 1970 was subsequently conducted of that work. The audit findings were accepted by EPA as appropriate to develop buffer/separation distances around the existing and proposed quarry, landfill and organic waste treatment sites in the Wyndham Vale and Werribee West areas.

Modelling of the current landfilling scenario was performed using the approved dispersion model, CALPUFF. The predicted offsite odour impact is presented as contours of 99.9<sup>th</sup> percentile odour levels.

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<sup>8</sup> M. Asimakis and T. Pollock, Review of odour emission rate measurements on active tipping face of landfills, CASANZ Conference 20 September 2015

## 5.1.2 Landfill tipping face

### **Test Schedule**

Three separate tests were conducted on 7 April 2016 during the morning (11 am), at midday (~1 pm) and the afternoon (~3 pm). The chosen times corresponded with:

1. 11 am – just after all waste for the day placed on tipping face
2. ~1 pm - two hours after all waste been placed
3. ~3 pm - tipping face, just after covering

The tipping face on 7 April 2016 was located within Cell 4. The Ektimo report in Appendix A and Appendix B shows the positions of the tipping face. Figure 8 displays some of the photos taken during the site visits over the day.

The test day was chosen by GHD for the occurrence of light wind conditions during the tests. Under these conditions, the downwind odour levels are at a maximum and the odour plume 'signal' is better defined.

Note that this monitoring was conducted during the cooler months when the temperature dependent OERs are lowest. However, it is generally the cooler months that lead to the highest off-site odour impact, despite the lowered OER, as these are the times of greatest incidence of poor dispersion and are therefore most likely to govern the maximum (99.9<sup>th</sup> percentile) predicted odour levels.

A description of the odour monitoring of the landfill tipping face is given below.

### **Sampling Programme**

Sampling of the downwind plume was conducted at four stations along a transect at short (~5-10 m) range from the downwind limit of the tipping face and parallel to the lee edge of the tipping face. In addition, an upwind station was used to measure background ambient odour levels directly upwind of the tipping face.

The placing of the transect lines and the sample positions was dependent on the wind direction at the time and the four locations were evenly spaced at a measured distance across the length of the tipping face. The locations were chosen so as not to interfere with operations at the tipping face.

The sampling in each test was conducted synchronously at all four stations downwind and at the one station upwind. The duration of sample collection was eight minutes and each sample drum was set at a height of 1.5 m above the ground. Local wind speed was measured using a portable weather station mounted on a 1.5 m mast within the clean fill depot at the top of Cell 4 and data was logged at ten minute intervals.



Looking south over Cell 4 (covered tipping face before placement of waste)



First load of waste ~10 am



Second load of waste ~10.15 am



Third load of waste ~10.45 am



Tipping face size (17 x 7.5 m) and transect set up for Test 1 at 11 am



Transect set up for Test 2 at ~1 pm



Figure 8 Photos of Castlemaine Landfill 7 April 2016

Further details of the sample measurements are given in the Ektimo report in Appendix A. Appendix B summarises the results of the back-calculation procedure.

The measured odour levels in Table 8 show that the downwind stations return values clearly above the upwind stations – i.e. the odour plume can be clearly distinguished against the background ambient odour levels. The morning surveys show an increase in plume odour levels compared to that measured in the afternoon – reflecting the effect of the waste being mixed and dumped, stirring up odour and settling down by the afternoon.

Table 8 Odour Emission Rate Survey – 7 April 2016

Source	Time (hr)	Temp °C	Atmospheric Conditions			Measured Odour Concentration (OU)	
			Speed m/s <sup>(a)</sup>	Direction (degrees)	Stability <sup>(b)</sup>	Average Concentration Downwind	Average Concentration Upwind
Open Tipping Face	1100	14.4	1.1	254	A	56	16
Open Tipping Face	1250	16.1	1.1	280	B	44	16
Covered Tipping Face	1450	17.8	0.5	207	B	24	16

a. Measured on transect at 1.5 m height above ground.

b. Pasquill- Gifford Classification.

The measurements of odour level upwind and downwind of the tipping face were then used in a back-calculation procedure as described in Appendix B. The back-calculation of SOER (specific odour emission rate, or OER/m<sup>2</sup>) for the municipal tipping face gave a morning value of 60 OUm/s, midday value of 29 OUm/s (both values after completion of waste dumping) and an afternoon value 6.0 OUm/s for when the tipping face had been covered.

#### ***Tipping face Source Odour Emission Rate***

Table 9 gives the tipping face SOERs at the landfill based on the site specific measurements for the current operations. The SOERs have been measured for the current tipping rate of 3,000 tonnes per annum with an average tipping face size of 128 m<sup>2</sup> (corresponding to a tipping face of size 17 m by 7.5 m).

Currently, the landfill receives waste from 9.30 am until 1.30 pm. Outside these hours, the active face is covered with a 150 mm layer of soil/compost, substantially reducing emissions to air.

A linear time variation in SOER was assumed between each pair of measurements. Outside the measurement times (but within tip operating times) the sources were assumed to 'plateau' at the same value as the nearest measurement.

Outside tip operating hours (i.e. 1.30 pm to 9.30 am) the sources are covered with soil and a nominal SOER equal to 10% of the peak measured value was adopted, based on the measurement of the tipping face once the covered material was placed.

Note that seasonal variation in the landfill tipping face SOER has not been accounted for, as odour sampling has been conducted during the autumn time only.

The OER data given in Table 9 for the current landfilling scenario has been calculated from data collected at the time of measurements.

Table 9 SOER Data for Municipal Tipping Face

Time, hr	SOER OUm/s
	Castlemaine, Current (3,000 tpa)
1	6
2	6
3	6
4	6
5	6
6	6
7	6
8	6
9	6
10	60
11	60
12	29
13	29
14	6
15	6
16	6
17	6
18	6
19	6
20	6
21	6
22	6
23	6
24	6

### 5.1.3 Landfill leachate pond

On 7 April 2016, sampling of the leachate pond system was also conducted using an Isolation Flux Chamber (IFC).

The leachate pond system consists of a single pond. The pond was partially filled and is used to collect the discharged leachate. Refer to Figure 8 for photos of the pond.

A single odour sample from an IFC was collected off the pond bank at the pump inlet point. A leachate pond SOER of 0.07 OUm/s was calculated from the IFC measurements. This SOER was applied to the emitting surface areas of the pond, which was calculated as 1,540 m<sup>2</sup> from the aerial imagery.

#### 5.1.4 Greenwaste pile odour emission rate

The back-calculation procedure used to calculate the specific odour emission rate (SOER) of the landfill tipping face and for the green waste pile, with the key difference being that a single downwind odour sample was taken at the estimated centre of the odour plume.

The dimensions and orientation of the greenwaste pile were taken from current site maps, as well as site measurements taken during the sampling programme.

The greenwaste pile was defined based on GPS measurements of its corners during the day. On 7 April 2016, the greenwaste was approximated by a rectangle area of 22 m x 13 m. The odour samples were taken on a downwind single point at right angles to the wind direction.

Table 10 SOER Data for Greenwaste Pile

Source	Time (Hr)	Temp °C	Atmospheric Conditions			Measured Odour Concentration (OU)	
			Speed m/s <sup>(a)</sup>	Direction (degrees)	Stability <sup>(b)</sup>	Average Concentration Downwind	Average Concentration Upwind
Tipping Face	1350	17	0.7	231	B	19	16

The back-calculation of SOER (specific odour emission rate, or OER/m<sup>2</sup>) was calculated to be 3 OUm/s.

#### 5.1.5 Summary of landfill source OERs

Table 11 compiles the component landfill source OERs for normal operations.

Table 11 Landfill Source Odour Emission rates

Source	Area, m <sup>2</sup>	SOER, OUm/s	OER, OUm <sup>3</sup> /s	Percentage of Total
Tipping face	127.5	60	7650	78.4
GW stockpile	286	7	2002	20.5
Leachate Pond	1540	0.07	108	0.1
Total			9760	100

Table 11 shows that the dominant odour source is the tipping face at ~ 80% of the all source total OER, with the compost stockpile contributing ~ 20%. The leachate pond OER is negligible compared to the other two sources.

## 5.2 Upset scenarios

Two upset scenarios have been considered for the landfill operations:

- Daytime operations with a larger tipping face than normal (double the size)
- Leachate pond overloading resulting in anaerobic conditions

### 5.2.1 Larger tipping face

A larger tipping face is possible in the event additional waste be delivered on a particular day. A doubling of the current operational tipping face was assumed at 34 m x 15 m.

### ***Anaerobic Leachate Pond***

Given the size of the landfill (3,000 tpa) and the area of the leachate pond, GHD considers the likelihood of the large leachate pond turning anaerobic due to overloading to be unlikely, therefore this event could be discarded as a plausible upset. Hence, the modelling of this scenario was not conducted.

## 6. Dispersion modelling

Dispersion modelling was conducted to predict the maximum offsite ground level odour concentrations resulting from odour emissions for; (i) the current normal operations scenario and (ii) one plausible upset scenario. In each case, the modelling placed the position of the tipping face at the worst case location i.e. the tipping face was placed closest to current/future receptors (that is, placed in the southwest corner of Cell 4).

It should be noted that, due to the mobile nature of the tipping operations at the landfill over the life of the site, direct assessment against fixed locations (such as the site boundary) do not necessarily give an indication of potential impact at all points in time. The predicted odour impact has been assessed for the landfilling location that is closest to the proposed future residents; however, the pattern of impact should be considered as mobile and can move around the site along the progressive position of the active tipping face during the life of Cell 4. This should give an indication of the maximum potential odour impact associated with future landfill operations.

The modelling is presented as predicted peak 3-minute averaged 99.9<sup>th</sup> percentile ground level odour contours and these are compared to the EPA odour design criterion contour at the existing nearby residences.

Note the modelling was undertaken assuming the landfill is operating seven days per week. Operations are currently confined to Monday to Friday, so that the predictions made in this section are conservative (i.e. an over-estimate the off-site odour impact).

Modelling was undertaken for normal operations and for the upset scenario as discussed in section 5.2.

### 6.1 Model

The odour dispersion modelling was conducted using the US EPA regulatory Gaussian puff model CALPUFF Version 5.8. CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model, which can simulate the effects of time and space, varying meteorological conditions on pollutant transport, chemical transformation and plume depletion. CALPUFF is a Regulatory Guideline model recommended by the US EPA, NSW Office of Environment and Heritage (OEH) and others, for a wide variety of applications including long-range transport, and on a case-by-case basis, for near-field applications involving complex flows and non-steady-state situations, such as in coastal applications, calm wind dispersion, stagnation, fumigation, complex terrain and recirculation situations (e.g. land-sea breezes). The model is suitable for source-receptor distances ranging from fence-line applications (tens of metres) to several hundred kilometres.

### 6.2 Model configuration and parameter selection

The following settings were used in the simulations:

- Model: CALPUFF Version 5.8
- The receptor grid was 12 km x 12 km, with a 100 m grid resolution
- 13 nearby residences were identified as discrete receptors
- Source odour emission rates were used as presented in section 5
- Meteorology was taken from the CALMET 2012 synthesised dataset
- Averaging time of one hour

- All CALPUFF settings were consistent with the OEH (2011) recommendations, except for use of observations from the met station
- The odour emissions from the tipping face, leachate pond and greenwaste pile were modelled as area sources. Refer to Appendix D for source parameter details.

### 6.3 Predicted peak off-site odour impact – normal operations

The predicted off-site peak (99.9<sup>th</sup> percentile) odour levels (1 OU, 2 OU and 5 OU) for the current landfill operations with the tipping face located closest to the proposed future residential area (southwest corner of Cell 4) are shown in Figure 9. The pattern of impact is seen to extend furthest in the north and south – reflecting the directions of poor dispersion (light stable winds) from the north and south.

Figure 9 shows the 1 OU level contour extends beyond the site boundary in all directions. This excursion extends 230 m south onto the Township Zoned land however not extending to the current rural residents, 130 m north onto Industrial and Public Use Zones, 80 m west and 120 m east onto Township Zone. Compliance to the 1 OU criterion for these locations is a SEPP (AQM) objective, even though this level cannot generally be detected against background odour in ambient conditions.

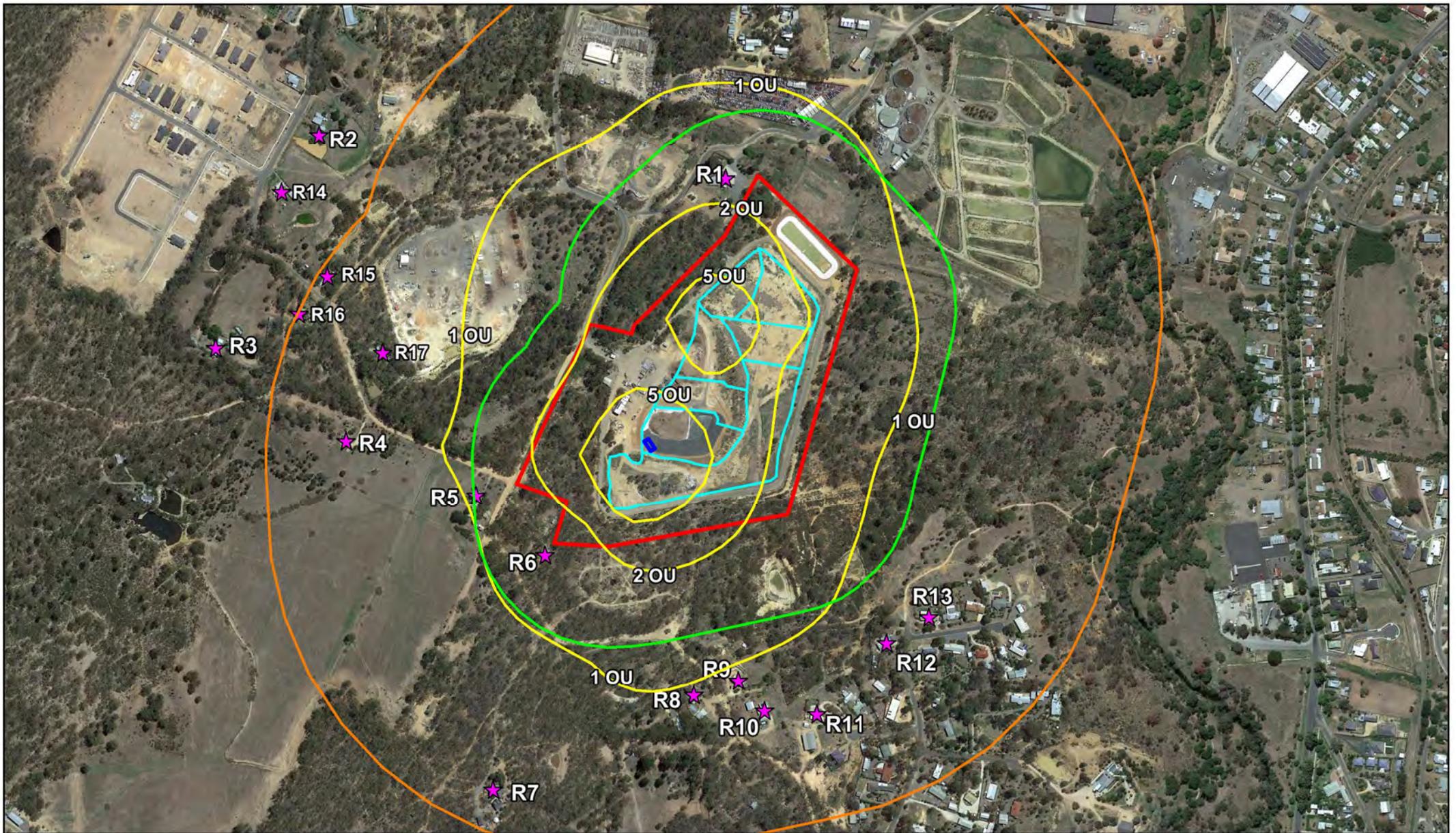
The 2 OU is mostly contained within the site boundary except for a marginal extrusion to the northwest approximately 70 m and south approximately 50 m.

The 5 OU level is generally taken as the level at which odour can be clearly distinguished against background, and if offensive, may lead to nuisance and resultant complaint. This level of odour was predicted to be contained entirely within the site boundary. The predicted extent of the 5 OU contour is well clear of any of the identified isolated residences, particularly those located south and west of the site.

#### *Implications for Site Buffer*

Figure 9 shows that the 500 m default buffer is significantly larger than the 1, 2 and 5 OU contours, while the 200 m buffer is closer in size to the 1 OU, with the 5 OU well within it. Setting a buffer to encompass the 1 OU contour would not allow sensitive land uses to be developed west of the plant as proposed in the Diamond Gully Structure Plan. However, this would not be appropriate given that the 1 OU level cannot generally be detected against background in ambient conditions. Setting such a buffer for this size landfill unnecessarily quarantines land from residential use, as there is no disamenity to be protected.

Setting a buffer to encompass the 5 OU contour, the level at which odour can be clearly distinguished under routine operations, would result in no external buffer from the site and would not constrain land to be developed for sensitive land use. Buffers are designed to minimise disamenity in the event of a malfunction/process upset, so that the modelling of an upset event, rather than routine operations, is required. This modelling is described in section 6.4.



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



LEGEND	
	Site Boundary
	Cells
	Sensitive Receptors
	Tipping face
	99.9%ile Odour Levels, 3 min avg.
	200 m Buffer
	500 m Buffer



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Predicted Odour Impact -  
 Normal Operations

Figure 9

## 6.4 Upset scenario

Figure 10 shows the predicted offsite peak (99.9<sup>th</sup> percentile) odour levels (1 OU, 2 OU and 5 OU) for the upset scenario, with doubling the size of tipping face, located closest to the proposed future residential area (southwest corner of Cell 4).

Note that the modelling has assumed that the upset condition is present for a complete year, so that the subsequent pattern represents the absolute worst-case scenario. To utilise these results, the probability of the upset event coupled with the probability of poor dispersion in the direction of the sensitive land use must be considered.

### *Pattern of Impact*

The pattern of impact is seen to extend furthest in the north and south, reflecting the directions of poor dispersion (light stable winds) from the north and south.

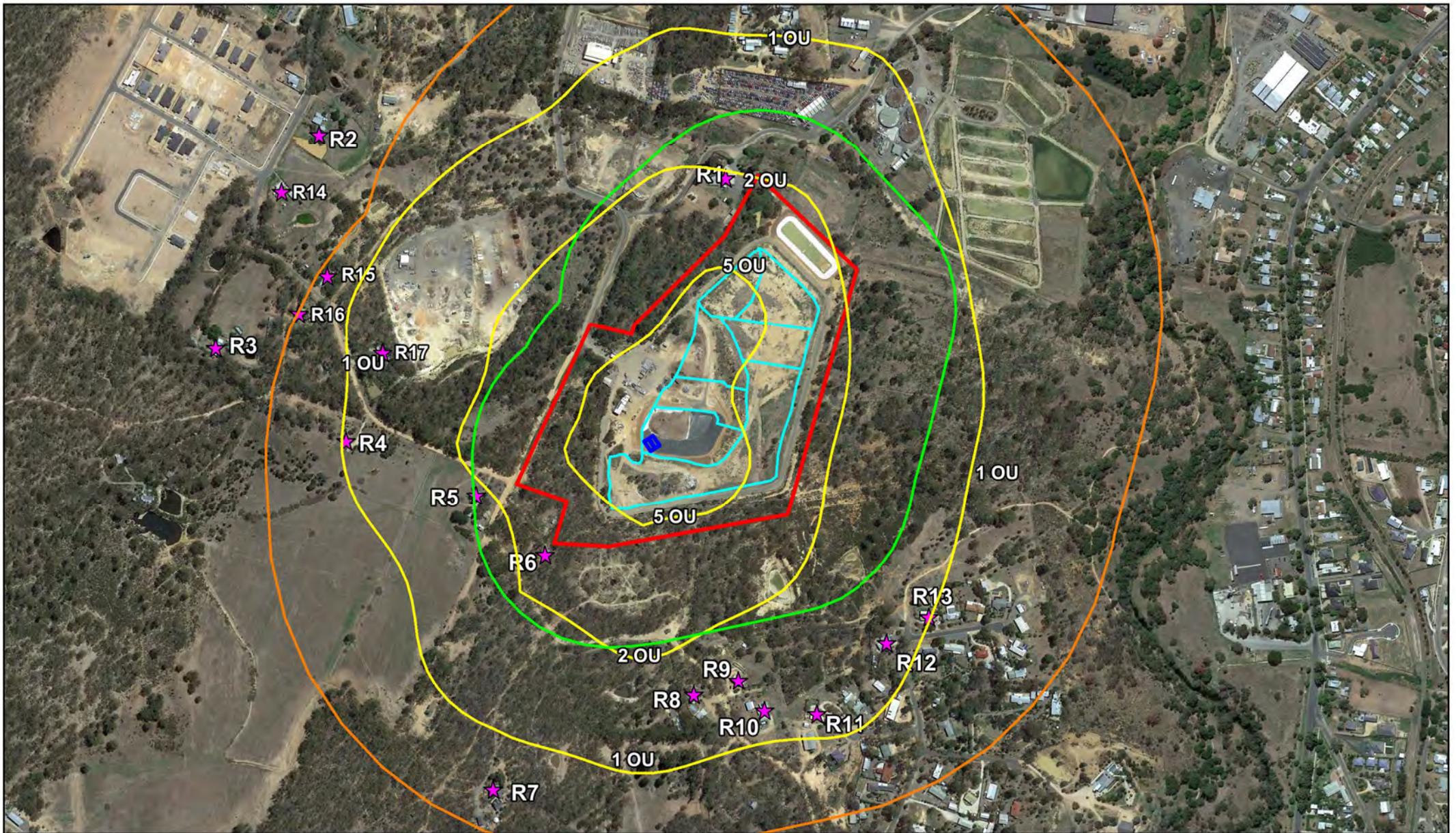
Figure 10 shows that the 1 OU level contour extends beyond the site boundary in all directions. This excursion extends 330 m south onto the Township Zoned land and includes approximately eight existing rural residents; 200 m north into Industrial and Public Use Zones; 250 m west and east into the Township Zone. The 2 OU level is fairly consistent in size with the 200 m buffer, while the 5 OU level is predicted to be within the site boundary. The predicted extent of the 5 OU contour is clear of any of the identified isolated residences, particularly those located south and west of the site.

### *Implications for Site Buffer*

Figure 10 shows that the 500 m default buffer is larger than the 1, 2 and 5 OU contours, while the 200 m buffer is closer in size to the 2 OU contour, with the 5 OU contour within it. Setting a buffer to encompass the 1 OU contour would be excessive, given this level cannot generally be detected against background in ambient conditions.

Setting a buffer to encompass the 5 OU contour, the level at which odour can be clearly distinguished, under upset operations would result in no buffer constraint for the site and would allow land to be developed for sensitive land use around the landfill.

As noted earlier, the upset scenario modelling does not account for the risk of odour impact. The SEPP (AQM) allows a risk assessment to be conducted in the event that design criteria can't be met and therefore assess the consequences of non-compliance. This is presented in section 7.



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



LEGEND	
<span style="border: 2px solid red; display: inline-block; width: 15px; height: 10px;"></span>	Site Boundary
<span style="border: 2px solid cyan; display: inline-block; width: 15px; height: 10px;"></span>	Cells
★	Sensitive Receptors
<span style="border: 2px solid yellow; display: inline-block; width: 15px; height: 10px;"></span>	99.9%ile Odour Levels, 3 min avg.
<span style="border: 2px solid green; display: inline-block; width: 15px; height: 10px;"></span>	200 m Buffer
<span style="border: 2px solid orange; display: inline-block; width: 15px; height: 10px;"></span>	500 m Buffer
<span style="border: 2px solid blue; display: inline-block; width: 15px; height: 10px;"></span>	Tipping face



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Predicted Odour Impact -  
 Upset Scenario (Doubling of tipping face) **Figure 10**

## 6.5 Predicted exposure at nearby residences – routine & upset conditions

Table 12 shows the predicted odour levels for the landfill (under routine and upset scenarios). Refer to Figure 1 for receptor locations.

Table 12 and Figure 2 show that receptor R1 is most exposed at 1.5 OU, followed by R6 and R5 at 1.3 OU and 1.1 OU respectively, while the least exposed receptors are R2 and R3 for routine operations.

It is clear that none of the receptors identified are predicted to exceed the EPA criterion of 5 OU for either scenario.

Table 12 Predicted peak (99<sup>th</sup> percentile, short term averaged) odour impact at nearby receptors

Receptor	Odour impact, OU, 99.9 percentile, 3 min average Normal Operations	Odour impact, OU, 99.9 percentile, 3 min average Upset Scenario
R1	1.5	2.0
R2	0.4	0.6
R3	0.3	0.6
R4	0.5	0.9
R5	1.1	1.8
R6	1.3	2.2
R7	0.5	0.7
R8	0.9	1.5
R9	0.9	1.4
R10	0.7	1.1
R11	0.7	1.1
R12	0.7	1.1
R13	0.6	0.9

# 7. Odour environmental risk assessment

## 7.1 Background

The SEPP (AQM) specifies design criteria for individual pollutants, where the design criterion is the concentration that is not to be exceeded in ambient air. In the case of odour, which is commonly a blend of odorous constituents rather than a single odorant, EPA specify criteria depending on the circumstance of release. Odour emissions from new licensed discharge points at a premises must be limited, so that the odour level in the downwind plumes at ground level does not exceed 1 OU at and beyond the premises boundary. This criterion can be exceeded onsite.

Odour emissions from existing premises must be managed, so that there are no offensive odours at residences or public open spaces adjacent to residences.

The SEPP (AQM) allows a risk assessment to be conducted in the event that design criteria can't be met, to assess the consequences of non-compliance. Where the emission is of a substance with a design criterion is based on health effects, the risk assessment will take the form of a Health Risk Assessment (HRA). Where the emission is an unclassified substance such as odour or nuisance dust, where the criterion is based on amenity, the risk assessment is will take the form of an Environmental Risk Assessment (ERA).

## 7.2 Approach to ERA for odour impact

The recent EPA Broiler Farm OERA<sup>9</sup> (Odour Environmental Risk Assessment) was issued as a discussion paper for comment. The paper presents a risk matrix to conduct an environmental risk assessment for broiler farms. In the absence of EPA guidance for environmental risk assessments for landfills and upon advice from the EPA, this Broiler Farm OERA has been applied by GHD to this assessment. The OERA risk matrix developed is presented as Table 13.

Table 13 Risk matrix in EPA broiler farm OERA

Frequency		Odour Concentration (OU CEN)			
Percentile	Occurrences (3 min av. time) per annum	15 +	10 -14	5 – 9	1 -4
99.9th	0 - 9	H	M	L	L
99.5th	10 - 44	H	H	M	L
98th	45 - 175	H	H	H	M
Outside 98th	>175	H	H	H	H

## 7.3 Risk descriptors

### 7.3.1 In the context of a broiler farm

The Broiler Code states that the OERA is not to describe an acceptable level of risk; rather this is up to the responsible authority (municipality). However, ERA formulations designed by GHD and VCAT in the past have used various risk weightings to assess the qualitative risk ranking into **high**, **medium**, **low** and in the case of GHD and VCAT<sup>10</sup>, **negligible**. EPA agreed that the implications of these rankings are as follows:

- **Low** – means the impact is acceptable and the farm can proceed

<sup>9</sup> EPA Publication No. 1509 "Broiler Farm Odour Environmental Risk Assessment", November 2012

<sup>10</sup> Victorian Civil and Administrative Tribunal (VCAT) in June 2011 (in relation to proceedings P1055/2010)

- **Medium** – means that mitigation is required before the farm can proceed. Relocation of sheds on the site, reduction in farm size or use of stub stacks are the only potentially viable options open to the proponent
- **High** – means that the site is unsuitable for the proposal

This understanding is also present in the Draft OERA.

#### 7.3.2 In the context of a landfill

While Council and stakeholders should further consider the odour frequencies and the assignment of risk levels in the context of land uses that can be considered to be sensitive and non-sensitive, the risk descriptors for a landfill can be considered to be as follows:

- Where there is **low** risk of odour impact, then this land may be developed for sensitive land uses such as residential housing, schools and hospitals
- Where there is a **medium** or **high** risk of odour impact, then developments may be limited to 'non-sensitive' land uses

#### 7.3.3 Scenarios assessed

The scenarios considered for the ERA are listed as follows:

- Normal Operations
- Upset Scenario with doubling of the area of the landfill tipping face

#### 7.3.4 Assessment methodology

Further processing of the outputs of the odour dispersion modelling assessment has been carried out to prepare odour event "frequency contours" (as opposed to contours of predicted maximum odour concentration shown in the dispersion modelling assessment). These frequency contours show the predicted number of exceedences of a certain odour concentration.

The frequency contours have been used to assess the risk of odour impact from landfilling operations, with reference to the EPA risk matrix (refer to section 7.2). From this, contours of predicted risk have been developed showing the extent of medium risk of odour impact associated with each of the selected scenarios. This 'risk contour' also takes into account the mobile nature of landfill tipping operations, whereas the modelling assumed a fixed location of the tipping face, the risk contours apply to the envelope of potential impact for all potential future tipping locations.

Due to the mobile nature of the tipping operations at the landfill over the life of the site, direct assessment against fixed locations, such as the site boundary, do not necessarily give an indication of potential impact at all points in time. The predicted 'risk contours' have been plotted for the approved future cells (including Cell 4 and 6A and 6B); the pattern of impact should be considered as mobile, i.e. it can be moved around the site to give an indication of maximum potential odour impact associated with future landfill operations. Thus, the tipping face source has been transposed to all corners within the area covered by future approved cells.

## 7.4 Outcomes of ERA for odour impact

The outcomes of the ERA are shown in Figure 11 and Figure 12. It is important to note the following context and assumptions when viewing the risk contours:

- The ERA and resulting risk contours rely upon the input data and model configuration adopted for the dispersion modelling assessment, and as such are subject to the scope and limitations of that assessment. In particular, the risk contours are based on hourly meteorological data for a particular historical dataset and future meteorological conditions may vary from those measured historically.
- The risk contours are associated with predicted odour impact for routine operation of the landfill and a sensitivity analysis has been conducted for an enlarged tipping face only. It is possible that there will be a greater risk of odour impact in the event of other process upsets/malfunctions.
- The risk contours are based on odour emission rate data for the active tipping face and leachate ponds that was obtained from the landfill at a fixed point in time; this data does not take into account any seasonal variability in landfill odour emissions rates. The odour emission rates associated with landfill operation may vary over time, and be dependent on factors such as the moisture content of the wastes (affected by rainfall), temperature, aerial extent of cells that have not been completed with effective capping and gas extraction systems in place; presence and effectiveness of gas extraction systems installed during the intermediate stages of the landfill, leachate level within the landfill, and nature of the wastes.
- Modelling has been undertaken for seven days per week, where in reality the landfill only operates five days week, thus the predicted results are conservative compared with the actual impacts expected.

With reference to the risk contours shown in Figure 11 and Figure 12, land situated outside of the medium risk (yellow) contour is considered to have a low risk of odour impact and should be developed for a sensitive land use in an urban setting (i.e. high density residential). As defined by the adopted risk matrix, low risk corresponds to an odour concentration of less than or equal to 9 OU, occurring no more frequently than nine times within a 12 month period.

Land inside the medium risk (yellow) contour has a higher frequency of odour events than for land within the low risk area and is considered to have medium to high risk of odour impact if it were to be developed for a sensitive land use (e.g. urban land developed for residential use).

Hence, it is the outer limit of the medium risk contour (or the inner limit of the low risk contour) that defines the separation required for a low risk of odour exposure to the residents.

### 7.4.1 Implications for the site

#### **Normal Operations**

Based on the predicted frequency odour assessment, the extent of the medium risk contour (refer to Figure 11), reduces the required buffer to less than 200 m to the southwest in the direction of the nearest proposed residential area a part of the Diamond Gully Structure Plan.

The medium risk contour for the current operations extends to encompass two existing sensitive receptors, while the medium risk contour extends approximately 50 m into the proposed residential area from the southwest corner of the landfill boundary.

GHD understands that no verified odour complaints have been received by EPA or Council in relation to the Castlemaine Landfill due to the current operations, which supports the prediction of low risk at the majority of nearby receptors. The absence of complaints does not necessarily mean that nearby residents do not register odour from the landfill from time to time, but it does suggest that the offensiveness of the odour is not sufficient to lodge a complaint, or that the existing sensitive land uses are outside the zone of potential impact.

### ***Upset Scenario***

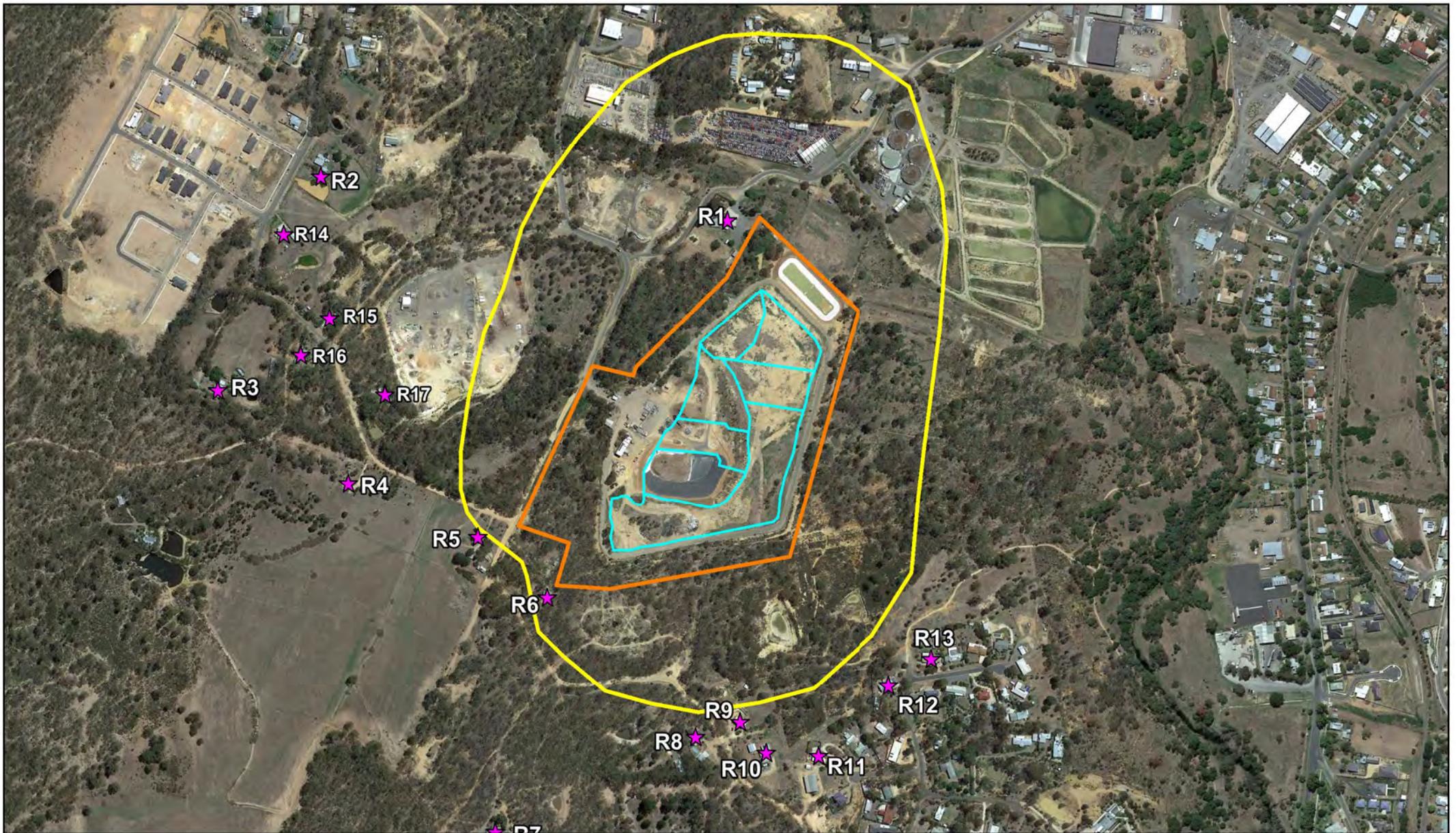
The extent of the medium risk contour with a tipping face double its normal size (refer to Figure 12), extends 150 m from the southwest corner of the landfill site boundary extending further in all directions, when compared to the medium risk contour for normal operations. This contour extends to encompass a greater amount of area to the southwest within the proposed residential area as part of the Diamond Gully Structure Plan. The sensitivity analysis has highlighted the requirement for Council to maintain an active tipping face size of approximately 10 x 10 m or less at all times.

The medium risk contour extends to encompass nine sensitive receptors, thus there would be a predicted increase in risk due to a larger tipping face. All other identified residences are predicted to remain at low risk.

### ***Probability of Upset Occurring***

The impact frequencies given in Table 13 are on the basis that the upset OER is occurring **all year**. In fact, such an event will be confined to infrequent and unpredictable occurrences. It is plausible to estimate an upper limit of five daily occurrences per year, so that the event frequencies given in the second column of Table 13 would reduce by the factor 365/5, or approximately **70 fold**. In other words, the risk reduces to **less than low** when the intermittency of the upset is taken into account.

The probability of the wind direction blowing in the direction of the proposed residential area within the DGSP is 7.8% of the time, so that the risk of this proposed residential area is further reduced to negligible, i.e. less than once in a lifetime occurrence.



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



**LEGEND**

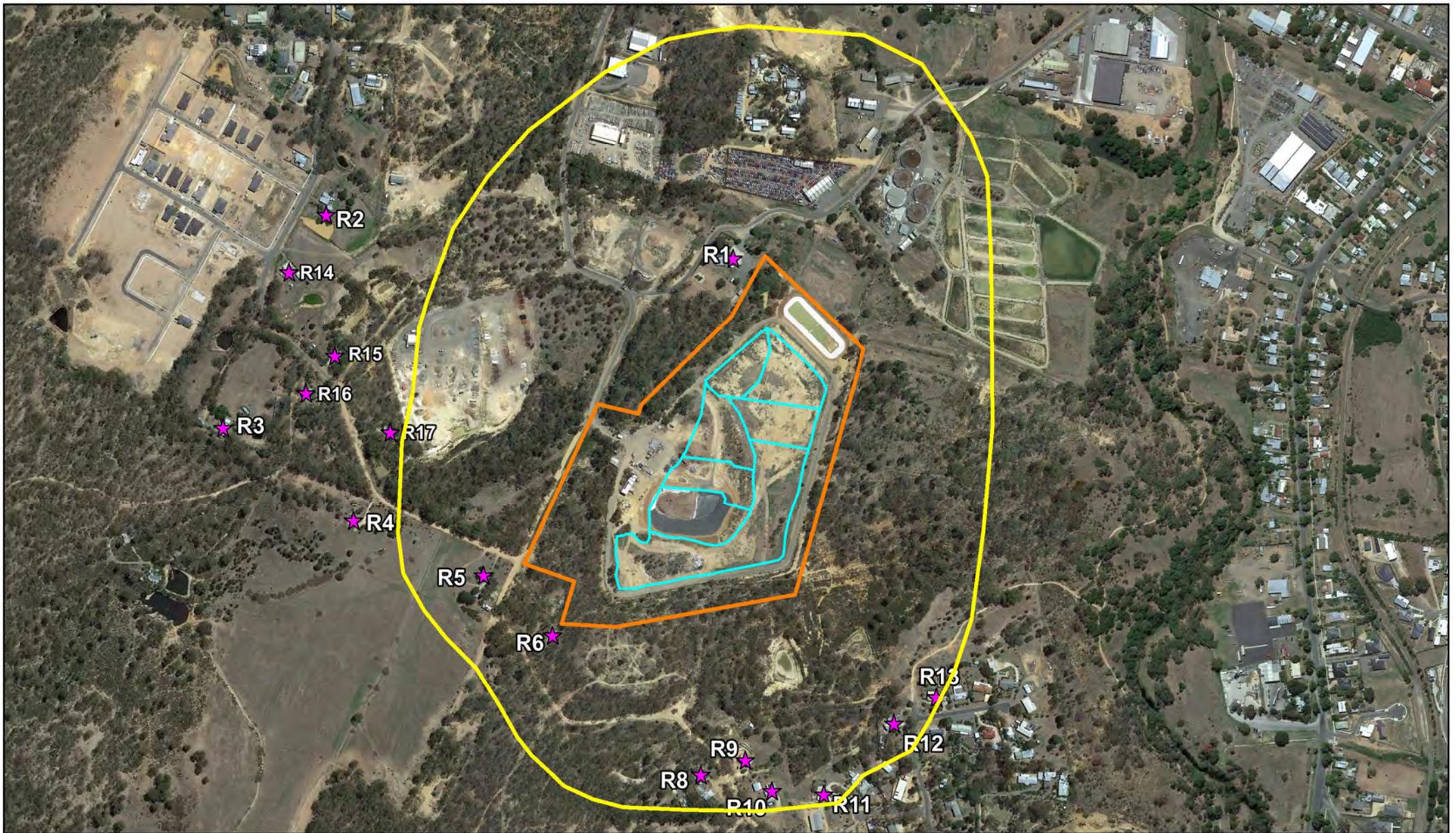
- Site Boundary
- Cells
- ★ Sensitive Receptors
- Tipping face
- Extent of Medium Risk



Mount Alexander Shire Council  
 Castlemaine Landfill - Odour and Buffer Assessment

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**Risk of Odour Impact (Normal Operations) Figure 11**



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



**LEGEND**

- Site Boundary
- Cells
- ★ Sensitive Receptors
- Tipping face
- Extent of Medium Risk



Mount Alexander Shire Council  
 Castlemaine Landfill - Odour and Buffer Assessment

**Risk of Odour Impact  
 (Upset - doubling of tipping face size)**

Job Number | 31/33897  
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 Date | 13/05/2016

**Figure 12**

## 8. Conclusions and recommendations

### 8.1 Conclusions

The modelling results indicate that under normal and upset operations, the landfill would produce no offsite odour impact at the nearest and proposed sensitive receptors within the DGSP, with the 5 OU contour contained within the site boundary.

In this modelling, a number of conservative assumptions were made including modelling estimates being on for all days of the week as opposed to only Monday to Friday. Actual peak odour levels are expected to be lower than those presented.

The predicted odour impact was assessed for the future landfilling location that is closest to the future residents.

The results of the dispersion modelling assessment show that:

- The application of the Victoria EPA buffer guidelines results in a default buffer of 500 m.
- When the size of the Castlemaine Landfill is compared to larger examples of landfills, the default buffer can be de-rated to 75 m.
- The main odour source is the tipping face at is approximately 80% of the site emissions.
- Under normal (routine) and upset operations, the landfill would produce no off-site odour impact at the nearest sensitive receptors (residences) with the 5 OU contour contained within the site boundary.
- The extent of the predicted odour contours towards the north and south reflects the direction of the local cool air drainage flow as defined by the local katabatic drainage flows along Campbells Creek.
- Under normal (routine) and upset operations, a 200 m buffer (as a maximum) would be more than adequate to avoid sensitive land uses being exposed to potential odour impact from future landfill operations, given the 5 OU contour level is contained within the boundary.
- It can be argued that a buffer less than 200 m may be adequate based on the risk of odour impact as discussed in section 8.2.

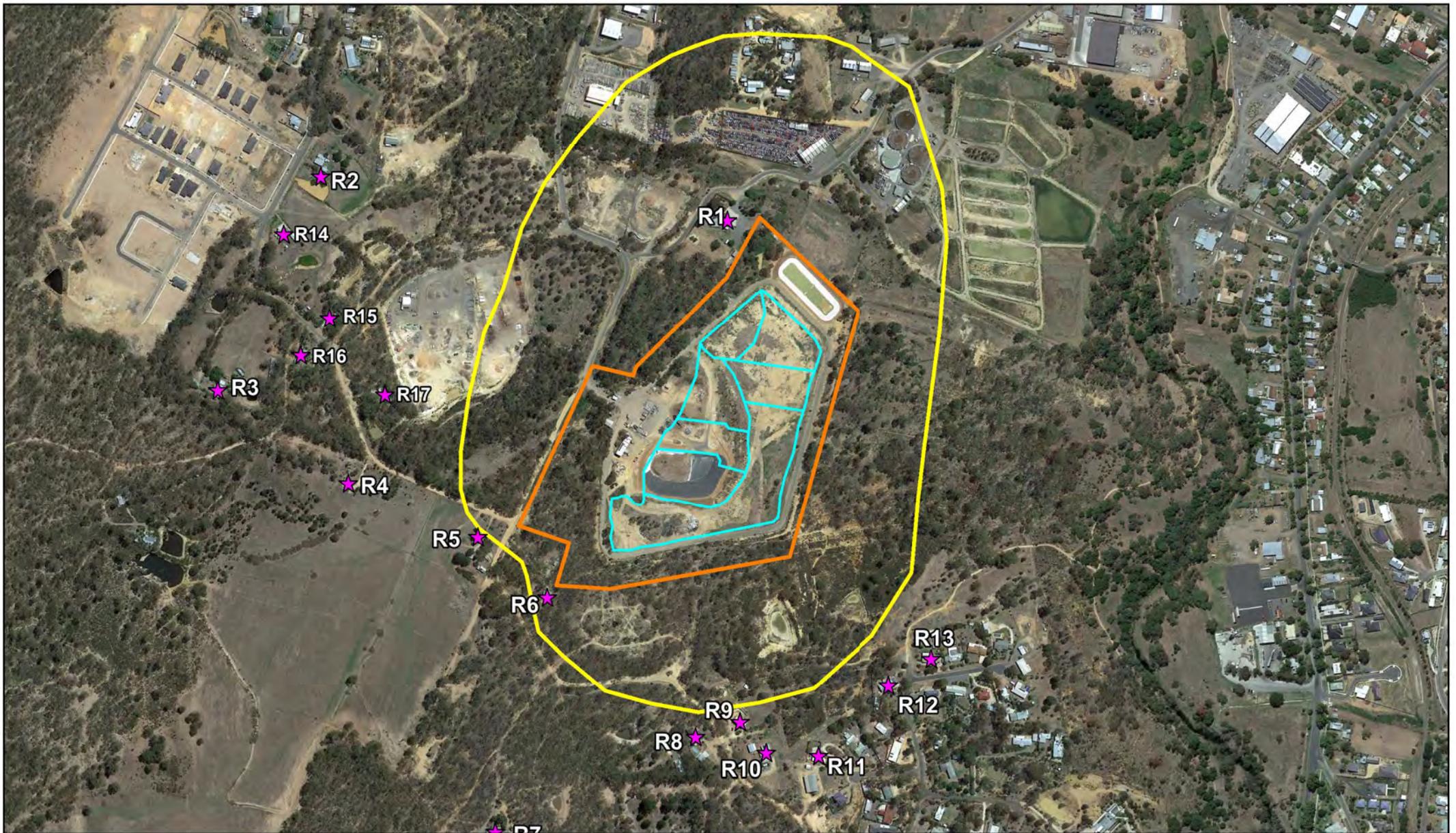
In comparing the predicted odour levels with complaint history, GHD understands that no odour complaints were received by EPA in relation to the landfill and likewise, there had been no complaints made to Council. The absence of complaints is consistent with the predictions of odour levels during normal and upset operations.

### 8.2 Recommendation

It is noted that the design criteria for odour (1 OU beyond the site boundary) usually cannot be met for landfills and other classes of industry (e.g. composters, wastewater treatment plants and waste transfer stations) without recourse to an uneconomic size of premises. In these cases, an ERA can be performed to establish the risk of odour impact at the nearest sensitive receptors.

As the EPA guidelines for external buffers are intended to minimise odour impact in the event of a process upset/malfunction or extreme weather conditions to avoid unacceptable odour impact, the landfill should be designed and operated in accordance with best practice and higher risk operational conditions avoided to minimise the potential for process upset/malfunction, so that normal operations impact the frequency and magnitude of odour levels external to the landfill.

Therefore, GHD recommend that the appropriate site-specific buffer to apply to the Castlemaine landfill is that defined by the medium risk contour (in yellow) for the normal operations of the landfill, refer to Figure 13 below. This buffer avoids unnecessary sequestering of land from sensitive land uses were the default buffer to be applied.



1:7,500  
 0 75 150 225  
 metres (at A4)

Map Projection: Universal Transverse Mercator  
 Horizontal Datum: Geocentric Datum of Australia 1994  
 Grid: Map Grid Of Australia, Zone 55



LEGEND	
	Site Boundary
	Cells
	Sensitive Receptors
	Tipping face
	Recommended site-specific buffer



Mount Alexander Shire Council  
 Castlemaine Landfill - Odour and Buffer Assessment

**Recommended site-specific buffer  
 for Castlemaine Landfill**

Job Number | 31/33897  
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 Date | 13/05/2016

Figure 13



# Appendices



# Appendix A – Ektimo report



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**Report Number R002635**

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**Castlemaine Landfill  
GHD, Melbourne**

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## Document Information

Client Name: GHD  
 Report Number: R002635  
 Date of Issue: 29 April 2016  
 Attention: Michael Asimakis  
 Address: L8, 180 Lonsdale Street  
 Melbourne VIC 3000  
 Testing Laboratory: Ektimo (ETC) ABN 74 474 273 172

## Report Status

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NATA Accredited Laboratory  
 No. 14601

Accredited for compliance with ISO/IEC 17025. NATA is a signatory to the ILAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports

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## 1 EXECUTIVE SUMMARY

Ektimo was engaged by GHD to perform odour monitoring at the Castlemaine Landfill located on Sluicers Road Castlemaine. Monitoring was conducted on 7 April 2016 in order to provide input data for a dispersion modelling assessment to be conducted by GHD.

Monitoring was performed as follows:

Location	Time Hrs	Status	Test Parameters	Methodology
Test 1: Active tipping face	1100	After receipt of 3 truckloads of waste	Odour concentration	4 point downwind traverse Singleton upwind sample
Leachate pond	1205	Quiescent surface	Odour flux rate	Isolation flux chamber
Test 2: Active tipping face	1252	Repeat test	Odour concentration	4 point downwind traverse
Green waste stock pile	1350	Static pile	Odour concentration	Singleton downwind sample
Test 3: Active tipping face	1444	After covering waste with temporary cover	Odour concentration	4 point downwind traverse Singleton upwind sample

All results are reported on a wet basis at STP. Unless otherwise indicated, the methods cited in this report have been performed without deviation.

The site layout and locations of the odour sources sampled are shown below:



The active tipping face was located in the north east corner of the active cell. Tests 1 and 2 were conducted at the active tipping face after receipt of three truckloads of general municipal waste. The approximate dimensions of the active tipping face are shown below:



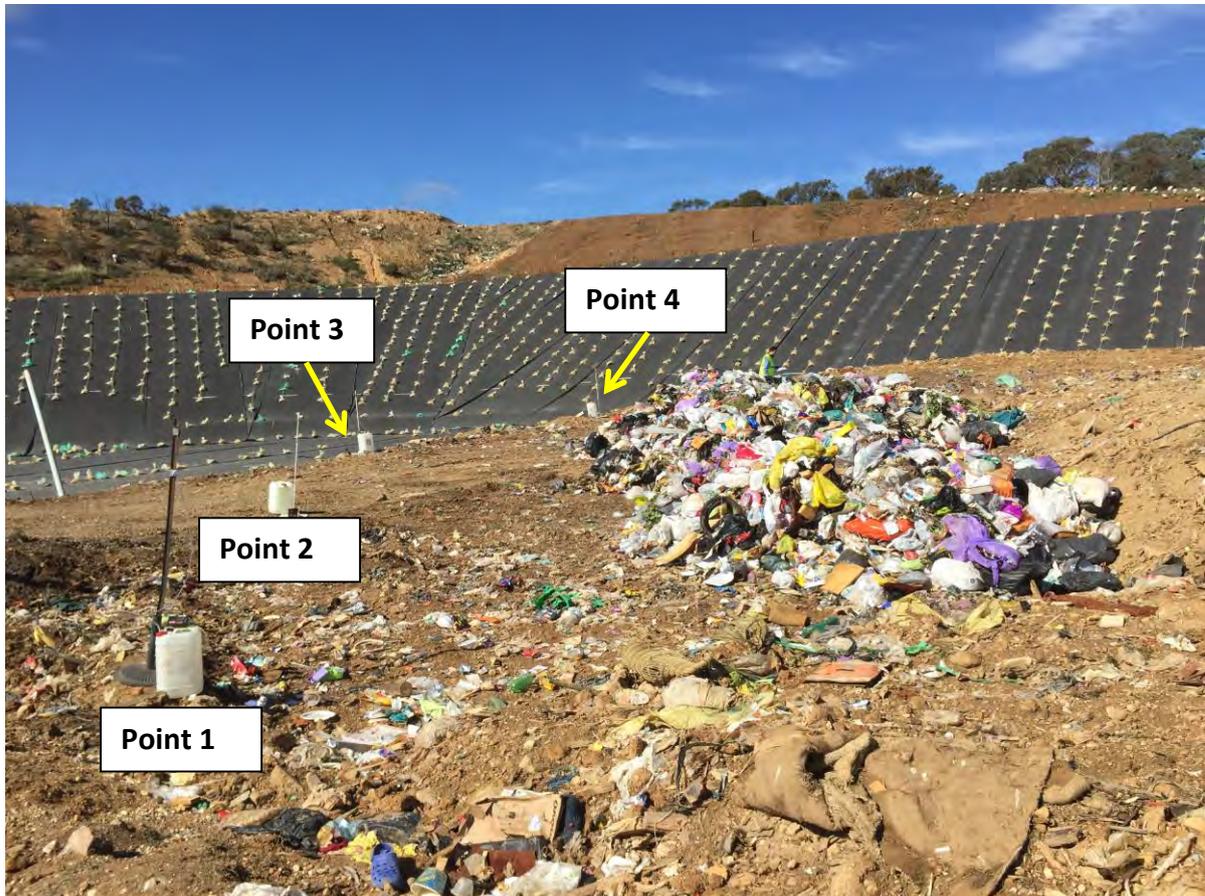
Test 3 was conducted at the active tipping face immediately after the received material was compressed and covered with temporary cover (clean fill). The following photographs show the process part way to completion.



## 2 RESULTS

### 2.1 Test 1: Active tipping face (1100 – 1108 hrs)

Tested 7 April 2016



Sample location	Distance from tipping face (m)	Sample ID	Dilution ratio	Odour concentration (ou)	Uncertainty 95% C.I. (ou)
R002624					
Test 1 Point 1	5.0	60	All sample gas	36	20 - 64
Test 1 Point 2	5.0	65	All sample gas	71	39 - 130
Test 1 Point 3	4.5	121	All sample gas	77	43 - 140
Test 1 Point 4	4.5	64	All sample gas	39	22 - 70
Test 1 Upwind		21	All sample gas	NR	-

	Butanol threshold (ppb)	Repeatability "r"	Repeatability "10r"	Accuracy "A"
R002624				
<b>Acceptance criteria</b>	<b>20-80</b>	<b>≤ 0.477</b>	<b>≤ 3.00</b>	<b>&lt; 0.217</b>
Current value	44	0.406	2.55	0.146

Sampling was conducted after the dumping of three truckloads of general municipal waste.

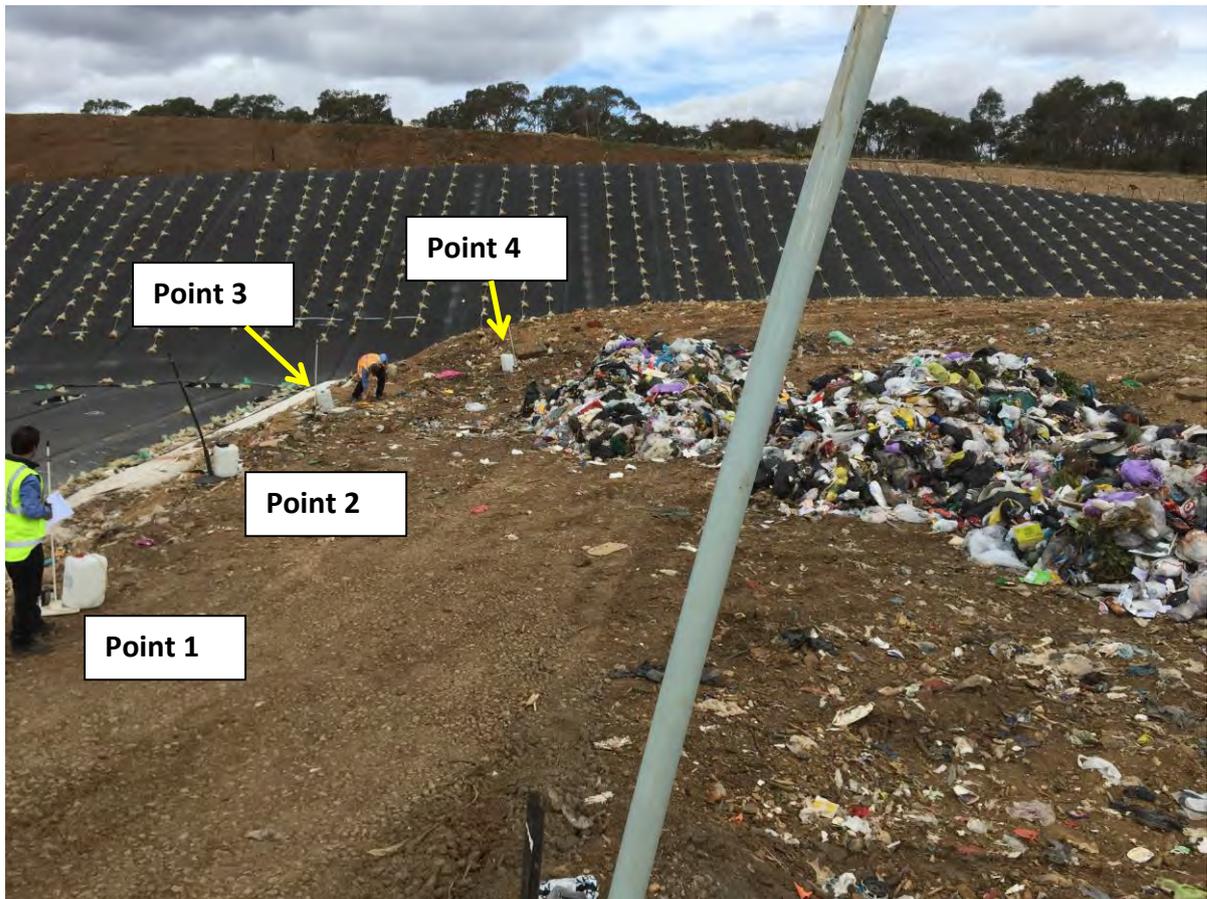
Downwind samples were collected simultaneously.

An upwind sample was collected to the west of the active tipping face at the same time as the downwind measurements. 260 ou was measured at this point. This was inconsistent with onsite observation and therefore disregarded and reported as a 'no result' (NR).

Odour samples were analysed on the same day as collection 1500 to 1700 hours.

**2.2 Test 2: Active tipping face (1252 – 1300 hrs)**

Tested 7 April 2016



Sample location	Distance from tipping face (m)	Sample ID	Dilution ratio	Odour concentration (ou)	Uncertainty 95% C.I. (ou)
R002624					
Test 2 Point 1	5.0	93	All sample gas	55	30 - 98
Test 2 Point 2	5.0	94	All sample gas	65	36 - 120
Tes 2 Point 3	5.0	136	All sample gas	30	17 - 54
Test 2 Point 4	5.0	28	All sample gas	27	15 - 49

	Butanol threshold (ppb)	Repeatability "r"	Repeatability "10r"	Accuracy "A"
R002624				
<b>Acceptance criteria</b>	<b>20-80</b>	<b>≤ 0.477</b>	<b>≤ 3.00</b>	<b>&lt; 0.217</b>
Current value	44	0.406	2.55	0.146

**Important note:** *The formal detection limit of the olfactometer determined according to AS4323.3 is 34 ou. Accordingly reported results less than the formal detection limit are estimates only.*

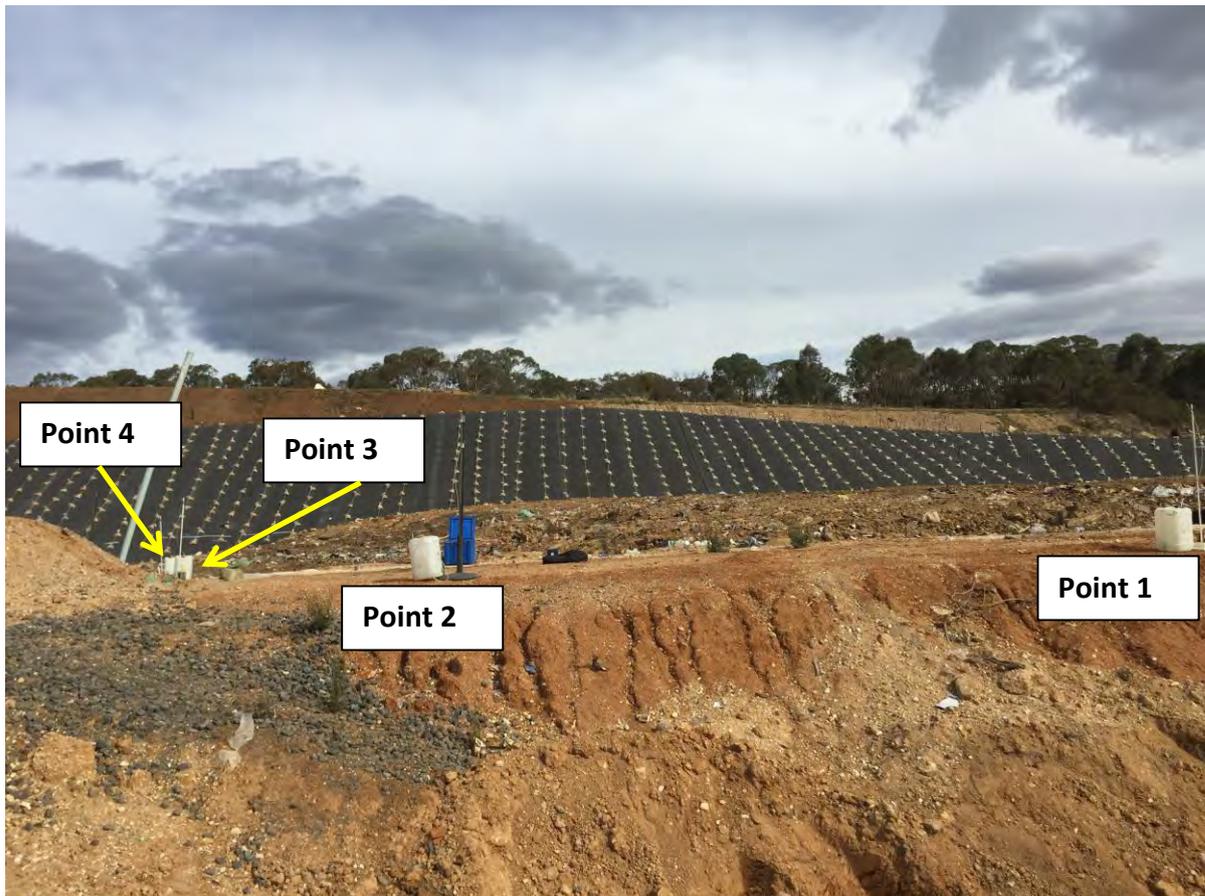
Test 2 sampling was conducted repeat testing conducted after test 1.

Downwind samples were collected simultaneously.

Odour samples were analysed on the same day as collection 1500 to 1700 hours.

### 2.3 Test 3: Active tipping face (1444 – 1452 hrs)

Tested 7 April 2016



Sample location	Distance from tipping face (m)	Sample ID	Dilution ratio	Odour concentration (ou)	Uncertainty 95% C.I. (ou)
R002635					
Test 3 Point 1	5.0	62	All sample gas	28	16 - 50
Test 3 Point 2	5.0	174	All sample gas	25	14 - 44
Test 3 Point 3	8.0	33	All sample gas	20	11 - 36
Test 3 Point 4	10.0	44	All sample gas	23	13 - 41
Test 3 Upwind	-	152	All sample gas	16	9.2 - 29

	Butanol threshold (ppb)	Repeatability "r"	Repeatability "10r"	Accuracy "A"
R002635				
<b>Acceptance criteria</b>	<b>20-80</b>	<b>≤ 0.477</b>	<b>≤ 3.00</b>	<b>&lt; 0.217</b>
Current value	42	0.400	2.51	0.163

**Important note:** *The formal detection limit of the olfactometer determined according to AS4323.3 is 34 ou. Accordingly reported results less than the formal detection limit are estimates only.*

Sampling was conducted immediately after the active tipping face had been covered with temporary cover.

Downwind samples were collected simultaneously.

An upwind sample was collected to the west of the active tipping face at the same time as the downwind measurements.

Odour samples were analysed on the same day as collection 1700 to 1830 hours.

## 2.4 Leachate pond (1205 – 1213)

Tested 7 April 2016



R002635 1	
Location	Leachate Pond
Date tested	7/04/2016
Location Description	Western bank (northern end)
Surface Description	Light brown water free of floating material
Area Classification	Agricultural
Sampling Method	AS4323.4
Equilibration time, hrs	1140 - 1205
Sample ID	90
Dilution ratio	Nil
Sampling time, hrs	1205 - 1213
<b>Odour concentration, ou</b>	<b>120</b>
<b>Odour flux rate, ou/m<sup>2</sup>/min</b>	<b>4.3</b>
Sweep Rate, L/min	4.70
Penetration Depth, mm	20
Static Pressure, Pa	<2
Surface temperature (°C)	15
Chamber temperature (°C)	19
Ambient temperature (°C)	14

R002624	Butanol threshold (ppb)	Repeatability "r"	Repeatability "10r"	Accuracy "A"
<b>Acceptance criteria</b>	<b>20-80</b>	<b>≤ 0.477</b>	<b>≤ 3.00</b>	<b>&lt; 0.217</b>
Current value	44	0.406	2.55	0.146

Odour samples were analysed on the same day as collection 1500 to 1700 hours.

## 2.5 Green waste stock pile (1350 – 1358)

Tested 7 April 2016



Sample location	Distance from stockpile (m)	Sample ID	Dilution ratio	Odour concentration (ou)	Uncertainty 95% C.I. (ou)
R002635 Green Waste Downwind	8.0	135	All sample gas	19	11 - 33

R002635	Butanol threshold (ppb)	Repeatability "r"	Repeatability "10r"	Accuracy "A"
<b>Acceptance criteria</b>	<b>20-80</b>	<b>≤ 0.477</b>	<b>≤ 3.00</b>	<b>&lt; 0.217</b>
Current value	42	0.400	2.51	0.163

**Important note:** *The formal detection limit of the olfactometer determined according to AS4323.3 is 34 ou. Accordingly reported results less than the formal detection limit are estimates only.*

Due to the variable nature of the wind direction during sampling, sample collection was conducted 'following the odour plume' in the area indicated by the yellow arrows on the photograph above.

Odour samples were analysed on the same day as collection 1700 to 1830 hours.

### 3 TEST METHODS

All sampling and analysis was performed by Ektimo unless otherwise specified. Specific details of the methods are available upon request

Parameter	Sampling Method	Analysis Method	Method Detection Limit	Uncertainty*	NATA Accredited	
					Sampling	Analysis
Odour (leachate pond)	AS4323.4	AS4323.4	analyte	analyte	✓	✓
Odour (grab samples )	AS 4323.3	AS 4323.3	30ou	not specified	✓	✓

### 4 QUALITY ASSURANCE/ QUALITY CONTROL INFORMATION

Ektimo (EML) and Ektimo (ETC) are accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants from industrial sources. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website [www.nata.com.au](http://www.nata.com.au).

Ektimo (EML) and Ektimo (ETC) are accredited by NATA (National Association of Testing Authorities) to ISO/IEC 17025. – General Requirements for the Competence of Testing and Calibration Laboratories. ISO/IEC 17025 requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Compliance Manager.

NATA is a member of APLAC (Asia Pacific Laboratory Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through the mutual recognition arrangements with both of these organisations, NATA accreditation is recognised world –wide.

A formal Quality Control program is in place at Ektimo to monitor analyses performed in the laboratory and sampling conducted in the field. The program is designed to check where appropriate; the sampling reproducibility, analytical method, accuracy, precision and the performance of the analyst. The Laboratory Manager is responsible for the administration and maintenance of this program.

## 5 DEFINITIONS

The following symbols and abbreviations may be used in this test report:

STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified.
Disturbance	A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter.
VOC	Any chemical compound based on carbon with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
TOC	The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives.
OU	The number of odour units per unit of volume. The numerical value of the odour concentration is equal to the number of dilutions to arrive at the odour threshold (50% panel response).
PM <sub>2.5</sub>	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm).
PM <sub>10</sub>	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm).
BSP	British standard pipe
NT	Not tested or results not required
NA	Not applicable
D <sub>50</sub>	'Cut size' of a cyclone defined as the particle diameter at which the cyclone achieves a 50% collection efficiency ie. half of the particles are retained by the cyclone and half are not and pass through it to the next stage. The D <sub>50</sub> method simplifies the capture efficiency distribution by assuming that a given cyclone stage captures all of the particles with a diameter equal to or greater than the D <sub>50</sub> of that cyclone and less than the D <sub>50</sub> of the preceding cyclone.
D	Duct diameter or equivalent duct diameter for rectangular ducts
<	Less than
>	Greater than
≥	Greater than or equal to
~	Approximately
CEM	Continuous Emission Monitoring
CEMS	Continuous Emission Monitoring System
DER	WA Department of Environment & Regulation
DECC	Department of Environment & Climate Change (NSW)
EPA	Environment Protection Authority
FTIR	Fourier Transform Infra Red
NATA	National Association of Testing Authorities
RATA	Relative Accuracy Test Audit
AS	Australian Standard
USEPA	United States Environmental Protection Agency
Vic EPA	Victorian Environment Protection Authority
ISC	Intersociety committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
APHA	American public health association, Standard Methods for the Examination of Water and Waste Water
CARB	Californian Air Resources Board
TM	Test Method
OM	Other approved method
CTM	Conditional test method
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
NIOSH	National Institute of Occupational Safety and Health
XRD	X-ray Diffractometry

# Appendix B – Back- Calculation procedure – SOER of landfill tipping face and greenwaste pile

## Introduction

The back calculation procedure used to calculate the specific odour emission rate (SOER) of the landfill tipping face involves selecting an SOER for the active tipping face to match the measured odour concentration in the downwind odour plume, with the concentration predicted by configuring an atmospheric dispersion model to simulate the conditions at the time of odour sampling. Sampling was conducted at three times through the cycle of active tipping and covering, on 7 April 2016.

### B1.2 Back-Calculation Procedure

The back calculation procedure requires a list of hourly values of temperature, wind speed, wind direction, atmospheric stability (Pasquill-Gifford stability categories) and mixing depth.

Onsite meteorological observations concurrent with odour sampling events were formatted for input into the dispersion model.

Preliminary simulations were conducted with the site representative stability to represent the actual time of measurements – these being the estimated range of stability observed on the sampling day, which ranged from category A to category B.

The meteorological input data is summarised in Table B1.

Table B1 Landfill Odour Emission Rate Survey – 7 April 2016

Date	Source	Time	Temp °C	Atmospheric Conditions		
				Speed m/s <sup>(b)</sup>	Direction (degrees)	Stability <sup>(a)</sup>
7 April 2016	Active Tipping Face	1100	14.4	1.1	254	A
	Active Tipping Face	1250	16.1	1.1	280	B
	Covered Tipping Face	1450	17.8	0.5	207	B

a. Pasquill – Gifford Classification (estimated by GHD meteorologist)

b. Measured on transect at 1.5 m height above ground.

### Model Settings

The model allows a number of options to be specified to configure the model to the Castlemaine Landfill site. Key components of the model configuration are summarised below:

- Ground level concentrations were predicted at discrete receptors that were set-up in the same position as each odour sample station on the sampling transect
- The terrain option was not selected as it has no effect on the dispersion of ground-based emissions
- Pasquill-Gifford horizontal dispersion curves were used
- A roughness height of 0.2 m was selected
- The averaging time selected for each simulation corresponds to the duration of each odour sampling event (eight minutes)
- The initial vertical spread of emissions was set at 0.4 m, while the height of the tipping face was set at 1.5 m

### B1.3 Source geometry

The dimensions and orientation of the municipal tipping face was based on current site maps, as well as site measurements taken during the sampling programme.

The municipal tipping face was defined on GPS measurements of the tipping face corners during the day. On 7 April 2016, the tipping face was approximated by a rectangle area of 7.5 m x 17 m (refer to Figures B2, B4 and B6).

### B1.4 Odour measurements

The odour samples were taken on a downwind transect at right angles to the wind direction and at four sample stations, refer to the yellow stars in Figures B1 to B3. In addition, a single upwind sample was taken to be representative of the ambient background odour level.

The mean measured odour concentrations over the transect for each monitoring event, corrected for the background odour, are given in Table B2. Sampling methods and results are detailed in the ETC report included as Appendix A.

### B1.5 Calculations

The equation used to calculate the SOER for each source was:

$$SOER_{(source)} = \text{measured } (OU_{tm}) / \text{predicted } (OU_{tm}) \times SOER_{(model)}$$

The model predictions and corresponding measured odour concentrations used to back calculate the SOER for each source are presented in Table G2.

To verify the results of the back calculation procedure, the average back calculation SOER was used to remodel each of the initial simulations. The results of these simulations are presented as odour plots in Figures B1, B2 B3, B4, B5 and B6.

The measured upwind odour concentrations have been subtracted from the downwind mean measured odour concentrations over each transect. Where the measured upwind sample was less than the non-detect (ND) Olfactometer level of 30 OU i.e. as calculated in AS/NZS 4323.3, the actual reading was used. In three of these cases, the actual reading was also a "less than", and consistent with statistical practice, the 50% ND was subtracted.

Table B2 SOER back-calculation data

Time	Discrete Receptor Location (MGA)		Odour Conc. (OU)				Average SOER (OU m/s)
	Easting	Northing	Measured	Measured Average	Predicted	Predicted Average	
1100 Hr <sup>1</sup>	250558	5892763	28	48	10	48	60
	250565	5892756	63		79		
	250570	5892750	69		87		
	250569	5892739	31		16		
1252 Hr <sup>2</sup>	250567	5892756	47	36	18	36	29
	250568	5892750	57		48		
	250570	5892744	22		57		
	250567	5892739	19		22		
1444 Hr <sub>3</sub>	250555	5892763	20	16	11	16	6
	250560	5892762	17		23		
	250567	5892760	12		18		
	250570	5892754	15		10		

Notes to Table C2:

1. Upwind concentration 16 OU (measured during test 3 at 1444-1452)
2. Upwind concentration 16 OU (measured during test 3 at 1444-1452)
3. Upwind concentration 16 OU (measured during test 3 at 1444-1452)

Figure B1 Test 1 - 11 am Odour Concentration - 8 Minute Average

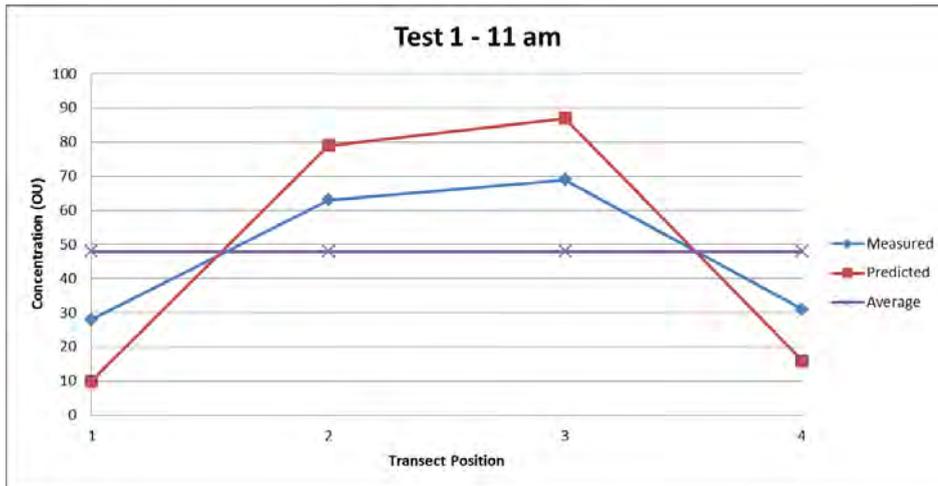


Figure B2 Test 1 - 11 am Predicted Odour Concentration - 8 Minute Average



Figure B3 Test 2 - 12.52 pm Odour Concentration - 8 Minute Average

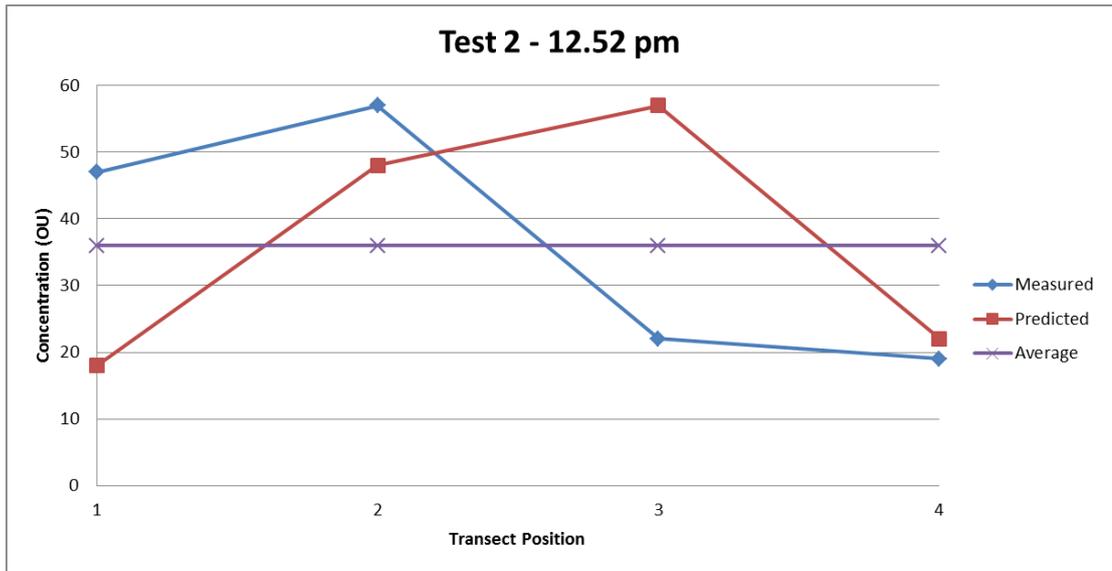


Figure B4 Test 2 - 12.52 pm Predicted Odour Concentration - 8 Minute Average



Figure B5 Test 3 -2.44 pm Odour Concentration - 8 Minute Average

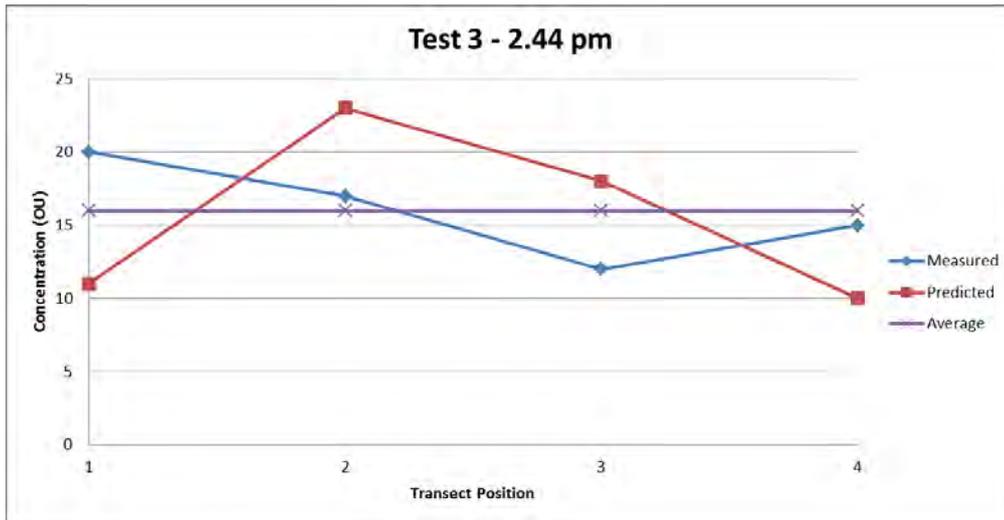


Figure B6 Test 3 -2.44 pm Predicted Odour Concentration - 8 Minute Average



## B1.6 Greenwaste Back Calculation Procedure

The back-calculation procedure used to determine the specific odour emission rate (SOER) of the landfill tipping face was also conducted for the green waste pile with the key difference being only one downwind transect was recorded.

The meteorological input data is summarised in Table B3 for the greenwaste pile.

Table B3 Greenwaste Odour Emission Rate Survey – 7 April 2016

Date	Source	Time	Temp °C	Atmospheric Conditions		
				Speed m/s <sup>(b)</sup>	Direction (degrees)	Stability <sup>(a)</sup>
7 April 2016	Greenwaste pile	1350	17	0.7	231	B

### Model Settings

The model allows a number of options to be specified to configure the model to the Castlemaine Landfill site. Key components of the model configuration are summarised below:

- Ground level concentrations were predicted at discrete receptors that were set-up in the same position as each odour sample station on the sampling transect
- The terrain option was not selected as it has no effect on the dispersion of ground-based emissions
- Pasquill-Gifford horizontal dispersion curves were used
- A roughness height of 0.2 m was selected
- The averaging time selected for each simulation corresponds to the duration of each odour sampling event (eight minutes)
- The initial vertical spread of emissions was set at 0.4 m, while the height of the greenwaste was set at 1.5 m

## B1.3 Source geometry

The dimensions and orientation of the greenwaste was based on current site maps, as well as site measurements taken during the sampling programme.

The greenwaste was defined based on GPS measurements of the corners during the day. On 7 April 2016, the greenwaste was approximated by a rectangle area of 22 m x 13 m (refer to Figure B7).

### Odour measurements

The odour samples were taken on a downwind single point at right angles to the wind direction (refer to the yellow star in Figure B7).

The measured odour concentration is given in Table B4.

## G1.5 Calculations

The equation used to calculate the SOER for each source was:

$$SOER_{(source)} = \text{measured } (OU_{tm}) / \text{predicted } (OU_{tm}) \times SOER_{(model)}$$

The model predictions and corresponding measured odour concentrations used to back-calculate the SOER for each source are presented in Table B4.

Table B4 Greenwaste SOER back-calculation data

Time	Discrete Receptor Location (MGA)		Odour Conc. (OU)				Average SOER (OU m/s)
	Easting	Northing	Measured	Measured Average	Predicted	Predicted Average	
1350 Hr <sup>1</sup>	250591	5892803	11	11	11	1 1	7

Notes to Table C2:

1. Upwind concentration 16 OU (measured during test 3 at 1444-1452)

Figure B7 Greenwaste Predicted Odour Concentration - 8 Minute Average



# Appendix C – CALMET input file

CMM2.inp

3133897 Castlemaine Landfill, TAPM MET 2012, NoOBS MODE  
 60x60 @ 400m grid Kinematic effects and O'Brien Included  
 20/04/2016 MA TERRAD = 5 - Geo file mods based on aerial. Excel Input Test.  
 ----- Run title (3 lines) -----

CALMET MODEL CONTROL FILE  
 -----

INPUT GROUP: 0 -- Input and Output File Names

Subgroup (a)

Default Name	Type	File Name
GEO. DAT	input	! GEODAT=L:\j obs\3133897\Cal met\geo\GEO. DAT!
SURF. DAT	input	* SRFDAT=L:\j obs\3133897\Cal met\met\surf. dat *
CLOUD. DAT	input	* CLDDAT= *
PRECIP. DAT	input	* PRCDAT= *
WT. DAT	input	* WTDAT= *
CALMET. LST	output	! METLST=L:\j obs\3133897\Cal met\CMM2. lst!
CALMET. DAT	output	! METDAT=L:\j obs\3133897\Cal met\CMM2. dat!
PACOUT. DAT	output	* PACDAT= *

All file names will be converted to lower case if LCFILES = T  
 Otherwise, if LCFILES = F, file names will be converted to UPPER CASE  
 T = lower case ! LCFILES = F !  
 F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

Number of upper air stations (NUSTA) No default ! NUSTA = 0!  
 Number of overwater met stations  
 (NOWSTA) No default ! NOWSTA = 0!

NUMBER OF PROGNOSTIC and IGF-CALMET FILES:

Number of MM4/MM5/3D. DAT files  
 (NM3D) No default ! NM3D = 1!  
 Number of IGF-CALMET. DAT files  
 (NIGF) No default ! NIGF = 0 !

! END!

Subgroup (b)

Upper air files (one per station)

Default Name	Type	File Name
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*
UP1. DAT	input	1 * UPDAT=UP_X. DAT * *END*

Subgroup (c)

Overwater station files (one per station)

Default Name	Type	File Name
SEA1. DAT	input	1 * SEADAT=SEA_449. DAT * *END*

Subgroup (d)

MM4/MM5/3D. DAT files (consecutive or overlapping)

Default Name	Type	File Name
MM51. DAT	input	1 ! M3DDAT=L:\j obs\3133897\Cal met\met\CALTAPM\2012. m3d! ! END!
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*
MM51. DAT	input	1 *M3DDAT=M3D_X. DAT * *END*

```

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MM51. DAT      input      1 *M3DDAT=M3D_X. DAT * *END*

```

-----  
Subgroup (e)

IGF-CALMET. DAT files (consecutive or overlapping)

```

-----
Default Name  Type      File Name
-----
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*
IGFn. DAT     input     1 * IGFDAT=CALMETO. DAT * *END*

```

-----  
Subgroup (f)

Other file names

```

-----
Default Name  Type      File Name
-----
DIAG. DAT     input     * DIADAT= *
PROG. DAT     input     * PRGDAT= *

TEST. PRT     output    * TSTPRT= *
TEST. OUT     output    * TSTOUT= *
TEST. KIN     output    * TSTKIN= *
TEST. FRD     output    * TSTFRD= *
TEST. SLP     output    * TSTSLP= *
DCST. GRD     output    * DCSTGD= *

```

- NOTES: (1) File/path names can be up to 70 characters in length  
(2) Subgroups (a) and (f) must have ONE 'END' (surrounded by delimiters) at the end of the group  
(3) Subgroups (b) through (e) are included ONLY if the corresponding number of files (NUSTA, NOWSTA, NM3D, NIGF) is not 0, and each must have an 'END' (surround by delimiters) at the end of EACH LINE

!END!

-----  
INPUT GROUP: 1 -- General run control parameters

```

Starting date:  Year (IBYR) -- No default      ! IBYR= 2012 !
                Month (IBMO) -- No default     ! IBMO= 1 !
                Day (IBDY) -- No default       ! IBDY= 1 !
                Hour (IBHR) -- No default      ! IBHR= 1 !

```

Note: IBHR is the time at the END of the first hour of the simulation  
(IBHR=1, the first hour of a day, runs from 00:00 to 01:00)

```

Base time zone (IBTZ) -- No default      ! IBTZ=-10 !
PST = 08, MST = 07
CST = 06, EST = 05

```

```

Length of run (hours) (IRLG) -- No default      ! IRLG= 8784 !

```

```

Run type (IRTYPE) -- Default: 1          ! IRTYPE= 1 !

```

```

0 = Computes wind fields only
1 = Computes wind fields and meteorological variables
  (u*, w*, L, zi, etc.)
(IRTYPE must be 1 to run CALPUFF or CALGRID)

```

```

Compute special data fields required
by CALGRID (i.e., 3-D fields of W wind
components and temperature)
in addition to regular          Default: T    ! LCALGRD = T !
fields? (LCALGRD)
(LCALGRD must be T to run CALGRID)

```

```

Flag to stop run after
SETUP phase (ITEST)          Default: 2    ! ITEST= 2 !
(Used to allow checking
of the model inputs, files, etc.)

```

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ITEST = 1 - STOPS program after SETUP phase  
 ITEST = 2 - Continues with execution of  
 COMPUTATIONAL phase after SETUP

Test options specified to see if  
they conform to regulatory  
values? (MREG)

No Default ! MREG = 0 !

0 = NO checks are made  
 1 = Technical options must conform to USEPA guidance  
     IMIXH -1 Maul-Carson convective mixing height  
           over land; OCD mixing height overwater  
     ICOARE 0 OCD delat method for overwater fluxes  
     THRESHL 0.0 Threshold buoyancy flux over land needed  
               to sustain convective mixing height growth

! END!

-----  
 INPUT GROUP: 2 -- Map Projection and Grid control parameters  
 -----

Projection for all (X,Y):  
 -----

Map projection  
(PMAP) Default: UTM ! PMAP = UTM !

UTM : Universal Transverse Mercator  
 TTM : Tangential Transverse Mercator  
 LCC : Lambert Conformal Conic  
 PS : Polar Stereographic  
 EM : Equatorial Mercator  
 LAZA : Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin  
(Used only if PMAP= TTM, LCC, or LAZA)

(FEAST) Default=0.0 ! FEAST = 0.000 !  
 (FNORTH) Default=0.0 ! FNORTH = 0.000 !

UTM zone (1 to 60)

(Used only if PMAP=UTM)  
 (IUTMZN) No Default ! IUTMZN = 55 !

Hemisphere for UTM projection?

(Used only if PMAP=UTM)  
 (UTMHEM) Default: N ! UTMHEM = S !  
 N : Northern hemisphere projection  
 S : Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin  
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)

(RLATO) No Default ! RLATO = ON !  
 (RLONO) No Default ! RLONO = OE !

TTM : RLONO identifies central (true N/S) meridian of projection  
       RLATO selected for convenience  
 LCC : RLONO identifies central (true N/S) meridian of projection  
       RLATO selected for convenience  
 PS : RLONO identifies central (grid N/S) meridian of projection  
       RLATO selected for convenience  
 EM : RLONO identifies central meridian of projection  
       RLATO is REPLACED by 0.ON (Equator)  
 LAZA: RLONO identifies longitude of tangent-point of mapping plane  
       RLATO identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection  
(Used only if PMAP= LCC or PS)

(XLAT1) No Default ! XLAT1 = ON !  
 (XLAT2) No Default ! XLAT2 = ON !

LCC : Projection cone slices through Earth's surface at XLAT1 and XLAT2  
 PS : Projection plane slices through Earth at XLAT1  
       (XLAT2 is not used)

-----  
 Note: Latitudes and longitudes should be positive, and include a  
 letter N, S, E, or W indicating north or south latitude, and  
 east or west longitude. For example,  
 35.9 N Latitude = 35.9N  
 118.7 E Longitude = 118.7E

Datum-region  
 -----

The Datum-Region for the coordinates is identified by a character  
string. Many mapping products currently available use the model of the

Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

## NIMA Datum - Regions(Examples)

```
-----
WGS-84   WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
NAS-C    NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
NAR-C    NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
NWS-84   NWS 6370KM Radius, Sphere
ESR-S    ESRI REFERENCE 6371KM Radius, Sphere
```

Datum-region for output coordinates  
(DATUM) Default: WGS-84 ! DATUM = WGS-84 !

## Horizontal grid definition:

-----  
Rectangular grid defined for projection PMAP,  
with X the Easting and Y the Northing coordinate

```
No. X grid cells (NX)      No default ! NX = 60 !
No. Y grid cells (NY)      No default ! NY = 60 !

Grid spacing (DGRI DKM)    No default ! DGRI DKM = 0.4 !
                           Units: km
```

Reference grid coordinate of  
SOUTHWEST corner of grid cell (1,1)

```
X coordinate (XORIGKM)     No default ! XORIGKM = 238.610 !
Y coordinate (YORIGKM)     No default ! YORIGKM = 5880.795 !
                           Units: km
```

## Vertical grid definition:

```
-----
No. of vertical layers (NZ) No default ! NZ = 11 !

Cell face heights in arbitrary
vertical grid (ZFACE(NZ+1)) No defaults
                           Units: m
! ZFACE = 0., 20., 40., 60., 90., 120., 180., 250., 500., 1000., 2000., 3000. !
```

! END!

-----  
INPUT GROUP: 3 -- Output Options

## DISK OUTPUT OPTION

```
Save met. fields in an unformatted
output file ? (LSAVE) Default: T ! LSAVE = T !
(F = Do not save, T = Save)

Type of unformatted output file:
(IFORMO) Default: 1 ! IFORMO = 1 !
1 = CALPUFF/CALGRID type file (CALMET.DAT)
2 = MESOPUFF-II type file (PACOUT.DAT)
```

## LINE PRINTER OUTPUT OPTIONS:

```
Print met. fields ? (LPRINT) Default: F ! LPRINT = F !
(F = Do not print, T = Print)
(NOTE: parameters below control which
met. variables are printed)

Print interval
(IPRINF) in hours Default: 1 ! IPRINF = 1 !
(Meteorological fields are printed
every 1 hours)
```

```
Specify which layers of U, V wind component
to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T) Default: NZ*0
! IUVOUT = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 !
-----
```

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Specify which levels of the W wind component to print  
 (NOTE: W defined at TOP cell face -- 11 values)  
 (IWOUT(NZ)) -- NOTE: NZ values must be entered  
 (0=Do not print, 1=Print)  
 (used only if LPRINT=T & LCALGRD=T)

-----  
 ! IWOUT = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 !  
 Defaults: NZ\*0

Specify which levels of the 3-D temperature field to print  
 (ITOUT(NZ)) -- NOTE: NZ values must be entered  
 (0=Do not print, 1=Print)  
 (used only if LPRINT=T & LCALGRD=T)

-----  
 ! ITOUT = 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 !  
 Defaults: NZ\*0

Specify which meteorological fields to print  
 (used only if LPRINT=T) Defaults: 0 (all variables)

Variable	Print ? (0 = do not print, 1 = print)	
! STABILITY	= 0	! - PGT stability class
! USTAR	= 0	! - Friction velocity
! MONIN	= 0	! - Monin-Obukhov length
! MIXHT	= 0	! - Mixing height
! WSTAR	= 0	! - Convective velocity scale
! PRECIP	= 0	! - Precipitation rate
! SENSHEAT	= 0	! - Sensible heat flux
! CONVZI	= 0	! - Convective mixing ht.

Testing and debug print options for micrometeorological module

Print input meteorological data and internal variables (LDB) Default: F ! LDB = F !  
 (F = Do not print, T = print)  
 (NOTE: this option produces large amounts of output)

First time step for which debug data are printed (NN1) Default: 1 ! NN1 = 1 !

Last time step for which debug data are printed (NN2) Default: 1 ! NN2 = 2 !

Print distance to land internal variables (LDBCST) Default: F ! LDBCST = F !  
 (F = Do not print, T = print)  
 (Output in .GRD file DCST.GRD, defined in input group 0)

Testing and debug print options for wind field module  
 (all of the following print options control output to wind field module's output files: TEST.PRT, TEST.OUT, TEST.KIN, TEST.FRD, and TEST.SLP)

Control variable for writing the test/debug wind fields to disk files (IOUTD) (0=Do not write, 1=write) Default: 0 ! IOUTD = 0 !

Number of levels, starting at the surface, to print (NZPRN2) Default: 1 ! NZPRN2 = 1 !

Print the INTERPOLATED wind components ? (IPR0) (0=no, 1=yes) Default: 0 ! IPR0 = 0 !

Print the TERRAIN ADJUSTED surface wind components ? (IPR1) (0=no, 1=yes) Default: 0 ! IPR1 = 0 !

Print the SMOOTHED wind components and the INITIAL DIVERGENCE fields ? (IPR2) (0=no, 1=yes) Default: 0 ! IPR2 = 0 !

Print the FINAL wind speed and direction fields ? (IPR3) (0=no, 1=yes) Default: 0 ! IPR3 = 0 !

Print the FINAL DIVERGENCE fields ? (IPR4) (0=no, 1=yes) Default: 0 ! IPR4 = 0 !

Print the winds after KINEMATIC effects are added ?

(IPR5) (0=no, 1=yes) CMM2.inp Default: 0 ! IPR5 = 0 !  
 Print the winds after the FROUDE NUMBER  
 adjustment is made ?  
 (IPR6) (0=no, 1=yes) Default: 0 ! IPR6 = 0 !  
 Print the winds after SLOPE FLOWS  
 are added ?  
 (IPR7) (0=no, 1=yes) Default: 0 ! IPR7 = 0 !  
 Print the FINAL wind field components ?  
 (IPR8) (0=no, 1=yes) Default: 0 ! IPR8 = 0 !

! END!

-----  
 INPUT GROUP: 4 -- Meteorological data options  
 -----

NO OBSERVATION MODE (NOOBS) Default: 0 ! NOOBS = 2 !  
 0 = Use surface, overwater, and upper air stations  
 1 = Use surface and overwater stations (no upper air observations)  
 Use MM4/MM5/3D.DAT for upper air data  
 2 = No surface, overwater, or upper air observations  
 Use MM4/MM5/3D.DAT for surface, overwater, and upper air data

NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

Number of surface stations (NSSTA) No default ! NSSTA = 0 !  
 Number of precipitation stations  
 (NPSTA=-1: flag for use of MM5/3D.DAT precip data)  
 (NPSTA) No default ! NPSTA = -1 !

CLOUD DATA OPTIONS

Gridded cloud fields:  
 (ICLOUD) Default: 0 ! ICLOUD = 3 !  
 ICLOUD = 0 - Gridded clouds not used  
 ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT  
 ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT  
 ICLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity  
 at 850mb (Teixera)

FILE FORMATS

Surface meteorological data file format  
 (IFORMS) Default: 2 ! IFORMS = 2 !  
 (1 = unformatted (e.g., SMERGE output))  
 (2 = formatted (free-formatted user input))  
 Precipitation data file format  
 (IFORMP) Default: 2 ! IFORMP = 2 !  
 (1 = unformatted (e.g., PMERGE output))  
 (2 = formatted (free-formatted user input))  
 Cloud data file format  
 (IFORMC) Default: 2 ! IFORMC = 2 !  
 (1 = unformatted - CALMET unformatted output)  
 (2 = formatted - free-formatted CALMET output or user input)

! END!

-----  
 INPUT GROUP: 5 -- Wind Field Options and Parameters  
 -----

WIND FIELD MODEL OPTIONS

Model selection variable (IWFCOD) Default: 1 ! IWFCOD = 1 !  
 0 = Objective analysis only  
 1 = Diagnostic wind module  
 Compute Froude number adjustment  
 effects ? (IFRADJ) Default: 1 ! IFRADJ = 1 !  
 (0 = NO, 1 = YES)  
 Compute kinematic effects ? (IKINE) Default: 0 ! IKINE = 1 !  
 (0 = NO, 1 = YES)  
 Use O'Brien procedure for adjustment  
 of the vertical velocity ? (IOBR) Default: 0 ! IOBR = 1 !  
 (0 = NO, 1 = YES)  
 Compute slope flow effects ? (ISLOPE) Default: 1 ! ISLOPE = 1 !  
 (0 = NO, 1 = YES)

Extrapolate surface wind observations  
to upper layers ? (IEXTRP) Default: -4 ! IEXTRP = 1 !  
(1 = no extrapolation is done,  
2 = power law extrapolation used,  
3 = user input multiplicative factors  
for layers 2 - NZ used (see FEXTRP array)  
4 = similarity theory used  
-1, -2, -3, -4 = same as above except layer 1 data  
at upper air stations are ignored

Extrapolate surface winds even  
if calm? (ICALM) Default: 0 ! ICALM = 0 !  
(0 = NO, 1 = YES)

Layer-dependent biases modifying the weights of  
surface and upper air stations (BIAS(NZ))

-1<=BIAS<=1  
Negative BIAS reduces the weight of upper air stations  
(e.g. BIAS=-0.1 reduces the weight of upper air stations  
by 10%; BIAS= -1, reduces their weight by 100 %)  
Positive BIAS reduces the weight of surface stations  
(e.g. BIAS= 0.2 reduces the weight of surface stations  
by 20%; BIAS=1 reduces their weight by 100%)  
Zero BIAS leaves weights unchanged (1/R\*\*2 interpolation)  
Default: NZ\*0  
! BIAS = 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0

Minimum distance from nearest upper air station  
to surface station for which extrapolation  
of surface winds at surface station will be allowed  
(RMIN2: Set to -1 for IEXTRP = 4 or other situations  
where all surface stations should be extrapolated)  
Default: 4. ! RMIN2 = 4.0 !

Use gridded prognostic wind field model  
output fields as input to the diagnostic  
wind field model (IPROG) Default: 0 ! IPROG = 14 !  
(0 = No, [IWFCOD = 0 or 1]  
1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]  
2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]  
3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]  
4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]  
5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]  
13 = Yes, use winds from MM5/3D.DAT file as Step 1 field [IWFCOD = 0]  
14 = Yes, use winds from MM5/3D.DAT file as initial guess field [IWFCOD = 1]  
15 = Yes, use winds from MM5/3D.DAT file as observations [IWFCOD = 1]

Timestep (hours) of the prognostic  
model input data (ISTEPPG) Default: 1 ! ISTEPPG = 1 !

Use coarse CALMET fields as initial guess fields (IGFMET)  
(overrides IGF based on prognostic wind fields if any)  
Default: 0 ! IGFMET = 0 !

#### RADIUS OF INFLUENCE PARAMETERS

Use varying radius of influence Default: F ! LVARY = T!  
(if no stations are found within RMAX1, RMAX2,  
or RMAX3, then the closest station will be used)

Maximum radius of influence over land  
in the surface layer (RMAX1) No default ! RMAX1 = 2 !  
Units: km

Maximum radius of influence over land  
aloft (RMAX2) No default ! RMAX2 = 2 !  
Units: km

Maximum radius of influence over water  
(RMAX3) No default ! RMAX3 = 2 !  
Units: km

#### OTHER WIND FIELD INPUT PARAMETERS

Minimum radius of influence used in  
the wind field interpolation (RMIN) Default: 0.1 ! RMIN = 0.1 !  
Units: km

Radius of influence of terrain  
features (TERRAD) No default ! TERRAD = 5.00 !  
Units: km

Relative weighting of the first  
guess field and observations in the  
SURFACE layer (R1) No default ! R1 = 3.00 !  
Units: km  
(R1 is the distance from an  
observational station at which the  
observation and first guess field are  
equally weighted)

Relative weighting of the first

CMM2.inp

guess field and observations in the layers ALOFT (R2) No default ! R2 = 3.00 !  
(R2 is applied in the upper layers in the same manner as R1 is used in the surface layer).  
Units: km

Relative weighting parameter of the prognostic wind field data (RPROG) No default ! RPROG = 0. !  
(Used only if IPROG = 1)  
Units: km

-----

Maximum acceptable divergence in the divergence minimization procedure (DIVLIM) Default: 5.E-6 ! DIVLIM= 5.0E-06 !

Maximum number of iterations in the divergence min. procedure (NITER) Default: 50 ! NITER = 50 !

Number of passes in the smoothing procedure (NSMTH(NZ))  
NOTE: NZ values must be entered  
Default: 2, (mxnz-1)\*4 ! NSMTH =  
2, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4 !

Maximum number of stations used in each layer for the interpolation of data to a grid point (NINTR2(NZ))  
NOTE: NZ values must be entered Default: 99, ! NINTR2 =  
99, 99, 99, 99, 99, 99, 99, 99, 99, 99, 99 !

Critical Froude number (CRITFN) Default: 1.0 ! CRITFN = 1.00 !

Empirical factor controlling the influence of kinematic effects (ALPHA) Default: 0.1 ! ALPHA = 0.1 !

Multiplicative scaling factor for extrapolation of surface observations to upper layers (FEXTR2(NZ)) Default: NZ\*0.0  
! FEXTR2 = 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0. !  
(Used only if IEXTRP = 3 or -3)

BARRIER INFORMATION

Number of barriers to interpolation of the wind fields (NBAR) Default: 0 ! NBAR = 0 !

Level (1 to NZ) up to which barriers apply (KBAR) Default: NZ ! KBAR = 12 !

THE FOLLOWING 4 VARIABLES ARE INCLUDED ONLY IF NBAR > 0

NOTE: NBAR values must be entered for each variable No defaults  
Units: km

X coordinate of BEGINNING of each barrier (XBBAR(NBAR)) ! XBBAR = 0. !  
Y coordinate of BEGINNING of each barrier (YBBAR(NBAR)) ! YBBAR = 0. !

X coordinate of ENDING of each barrier (XEBAR(NBAR)) ! XEBAR = 0. !  
Y coordinate of ENDING of each barrier (YEBAR(NBAR)) ! YEBAR = 0. !

DIAGNOSTIC MODULE DATA INPUT OPTIONS

Surface temperature (IDIOPT1) Default: 0 ! IDIOPT1 = 0 !  
0 = Compute internally from hourly surface observations or prognostic fields  
1 = Read preprocessed values from a data file (DIAG.DAT)

Surface met. station to use for the surface temperature (ISURFT) No default ! ISURFT = 1 !  
(Must be a value from 1 to NSSTA)  
(Used only if IDIOPT1 = 0)  
-----

Temperature lapse rate used in the computation of terrain-induced circulations (IDIOPT2) Default: 0 ! IDIOPT2 = 0 !  
0 = Compute internally from (at least) twice-daily upper air observations or prognostic fields  
1 = Read hourly preprocessed values from a data file (DIAG.DAT)

Upper air station to use for

```

                                CMM2.inp
the domain-scale lapse rate (IUPT) No default ! IUPT = -1 !
(Must be a value from 1 to NUSTA)
(Used only if IDIOPT2 = 0)
-----

Depth through which the domain-scale
lapse rate is computed (ZUPT) Default: 200. ! ZUPT = 200.0 !
(Used only if IDIOPT2 = 0) Units: meters
-----

Initial Guess Field Winds
(IDIOPT3) Default: 0 ! IDIOPT3 = 0 !
0 = Compute internally from
  observations or prognostic wind fields
1 = Read hourly preprocessed domain-average wind values
  from a data file (DIAG.DAT)

Upper air station to use for
the initial guess winds (IUPWND) Default: -1 ! IUPWND = -1 !
(Must be a value from -1 to NUSTA, with
-1 indicating 3-D initial guess fields,
and IUPWND>1 domain-scaled (i.e. constant) IGF)
(Used only if IDIOPT3 = 0)
-----

Bottom and top of layer through
which the domain-scale winds
are computed
(ZUPWND(1), ZUPWND(2)) Defaults: 1., 1000. ! ZUPWND= 1., 1000. !
(Used only if IDIOPT3 = 0, NOOBS>0 and IUPWND>0) Units: meters
-----

Observed surface wind components
for wind field module (IDIOPT4) Default: 0 ! IDIOPT4 = 0 !
0 = Read WS, WD from a surface
  data file (SURF.DAT)
1 = Read hourly preprocessed U, V from
  a data file (DIAG.DAT)

Observed upper air wind components
for wind field module (IDIOPT5) Default: 0 ! IDIOPT5 = 0 !
0 = Read WS, WD from an upper
  air data file (UP1.DAT, UP2.DAT, etc.)
1 = Read hourly preprocessed U, V from
  a data file (DIAG.DAT)

LAKE BREEZE INFORMATION

Use Lake Breeze Module (LLBREZE)
                                Default: F ! LLBREZE = F !

Number of lake breeze regions (NBOX) ! NBOX = 0 !

X Grid line 1 defining the region of interest ! XG1 = 0. !
X Grid line 2 defining the region of interest ! XG2 = 0. !
Y Grid line 1 defining the region of interest ! YG1 = 0. !
Y Grid line 2 defining the region of interest ! YG2 = 0. !

X Point defining the coastline (Straight line)
(XBCST) (KM) Default: none ! XBCST = 0. !

Y Point defining the coastline (Straight line)
(YBCST) (KM) Default: none ! YBCST = 0. !

X Point defining the coastline (Straight line)
(XECST) (KM) Default: none ! XECST = 0. !

Y Point defining the coastline (Straight line)
(YECST) (KM) Default: none ! YECST = 0. !

Number of stations in the region Default: none ! NLB = 0 !
(Surface stations + upper air stations)

Station ID's in the region (METBXID(NLB))
(Surface stations first, then upper air stations)
! METBXID = 0 !

```

! END!

-----  
INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters  
-----

## EMPIRICAL MIXING HEIGHT CONSTANTS

Neutral, mechanical equation (CONSTB)	Default: 1.41	! CONSTB = 1.41 !
Convective mixing ht. equation (CONSTE)	Default: 0.15	! CONSTE = 0.15 !
Stable mixing ht. equation (CONSTN)	Default: 2400.	! CONSTN = 2400. !
Overwater mixing ht. equation (CONSTW)	Default: 0.16	! CONSTW = 0.16 !
Absolute value of Coriolis parameter (FCORIOI)	Default: 1.E-4 Units: (1/s)	! FCORIOI = 1.E-4!

## SPATIAL AVERAGING OF MIXING HEIGHTS

Conduct spatial averaging (IAVEZI) (0=no, 1=yes)	Default: 1	! IAVEZI = 1 !
Max. search radius in averaging process (MNMDAV)	Default: 1 Units: Grid cells	! MNMDAV = 1 !
Half-angle of upwind looking cone for averaging (HAFANG)	Default: 30. Units: deg.	! HAFANG = 30. !
Layer of winds used in upwind averaging (ILEVZI) (must be between 1 and NZ)	Default: 1	! ILEVZI = 1 !

## CONVECTIVE MIXING HEIGHT OPTIONS:

Method to compute the convective mixing height (IMIXH)	Default: 1	! IMIXH = 1 !
1: Maul-Carson for land and water cells		
-1: Maul-Carson for land cells only - OCD mixing height overwater		
2: Batchvarova and Gryning for land and water cells		
-2: Batchvarova and Gryning for land cells only OCD mixing height overwater		
Threshold buoyancy flux required to sustain convective mixing height growth overland (THRESHL) (expressed as a heat flux per meter of boundary layer)	Default: 0.05 units: W/m3	! THRESHL = 0.05 !
Threshold buoyancy flux required to sustain convective mixing height growth overwater (THRESHW) (expressed as a heat flux per meter of boundary layer)	Default: 0.05 units: W/m3	! THRESHW = 0.05 !
Option for overwater lapse rates used in convective mixing height growth (ITWPROG)	Default: 0	! ITWPROG = 0 !
0: use SEA.DAT lapse rates and deltaT (or assume neutral conditions if missing)		
1: use prognostic lapse rates (only if IPRG>2) and SEA.DAT deltaT (or neutral if missing)		
2: use prognostic lapse rates and prognostic delta T (only if iprog>12 and 3D.DAT version# 2.0 or higher)		
Land Use category ocean in 3D.DAT datasets (ILUOC3D)	Default: 16	! ILUOC3D = 16 !
Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16 if MM4.DAT, typically iluoc3d = 7		

## OTHER MIXING HEIGHT VARIABLES

Minimum potential temperature lapse rate in the stable layer above the current convective mixing ht. (DPTMIN)	Default: 0.001 Units: deg. K/m	! DPTMIN = 0.001 !
Depth of layer above current conv. mixing height through which lapse rate is computed (DZZI)	Default: 200. Units: meters	! DZZI = 200. !
Minimum overland mixing height (ZIMIN)	Default: 50. Units: meters	! ZIMIN = 50.0 !
Maximum overland mixing height (ZIMAX)	Default: 3000. Units: meters	! ZIMAX = 3000.0 !
Minimum overwater mixing height (ZIMINW) -- (Not used if observed overwater mixing hts. are used)	Default: 50. Units: meters	! ZIMINW = 50.0 !
Maximum overwater mixing height (ZIMAXW) -- (Not used if observed)	Default: 3000. Units: meters	! ZIMAXW = 3000.0 !

overwater mixing hts. are used)

## OVERWATER SURFACE FLUXES METHOD and PARAMETERS

(ICOARE) Default: 10 ! ICOARE = 10 !  
 0: original deltaT method (OCD)  
 10: COARE with no wave parameterization (jwave=0, Charnock)  
 11: COARE with wave option jwave=1 (Oost et al.)  
 and default wave properties  
 -11: COARE with wave option jwave=1 (Oost et al.)  
 and observed wave properties (must be in SEA.DAT files)  
 12: COARE with wave option 2 (Taylor and Yelland)  
 and default wave properties  
 -12: COARE with wave option 2 (Taylor and Yelland)  
 and observed wave properties (must be in SEA.DAT files)

Coastal/Shallow water length scale (DSHELF)  
 (for modified z0 in shallow water)  
 ( COARE fluxes only)  
 Default: 0. ! DSHELF = 0. !  
 units: km

COARE warm layer computation (IWARM) ! IWARM = 0 !  
 1: on - 0: off (must be off if SST measured with  
 IR radiometer) Default: 0

COARE cool skin layer computation (ICOO) ! ICOOL = 0 !  
 1: on - 0: off (must be off if SST measured with  
 IR radiometer) Default: 0

## TEMPERATURE PARAMETERS

3D temperature from observations or  
 from prognostic data? (ITPROG) Default: 0 ! ITPROG = 2 !  
 0 = Use Surface and upper air stations  
 (only if N0OBS = 0)  
 1 = Use Surface stations (no upper air observations)  
 Use MM5/3D.DAT for upper air data  
 (only if N0OBS = 0,1)  
 2 = No surface or upper air observations  
 Use MM5/3D.DAT for surface and upper air data  
 (only if N0OBS = 0,1,2)

Interpolation type  
 (1 = 1/R ; 2 = 1/R\*\*2) Default: 1 ! IRAD = 1 !

Radius of influence for temperature  
 interpolation (TRADKM) Default: 500. ! TRADKM = 500. !  
 Units: km

Maximum Number of stations to include  
 in temperature interpolation (NUMTS) Default: 5 ! NUMTS = 5 !

Conduct spatial averaging of temp-  
 eratures (IAVET) (0=no, 1=yes) Default: 1 ! IAVET = 1 !  
 (will use mixing ht MNMDAV, HAFANG  
 so make sure they are correct)

Default temperature gradient  
 below the mixing height over  
 water (TGDEFB) Default: -.0098 ! TGDEFB = -0.0098 !  
 Units: K/m

Default temperature gradient  
 above the mixing height over  
 water (TGDEFA) Default: -.0045 ! TGDEFA = -0.0045 !  
 Units: K/m

Beginning (JWAT1) and ending (JWAT2)  
 land use categories for temperature  
 interpolation over water -- Make ! JWAT1 = 999 !  
 bigger than largest land use to disable ! JWAT2 = 999 !

## PRECIP INTERPOLATION PARAMETERS

Method of interpolation (NFLAGP) Default: 2 ! NFLAGP = 2 !  
 (1=1/R, 2=1/R\*\*2, 3=EXP/R\*\*2)  
 Radius of Influence (SIGMAP) Default: 100.0 ! SIGMAP = 100. !  
 (0.0 => use half dist. btwn  
 Units: km  
 nearest stns w & w/out  
 precip when NFLAGP = 3)  
 Minimum Precip. Rate Cutoff (CUTP) Default: 0.01 ! CUTP = 0.01 !  
 (values < CUTP = 0.0 mm/hr) Units: mm/hr

! END!

-----  
 INPUT GROUP: 7 -- Surface meteorological station parameters  
 -----

SURFACE STATION VARIABLES  
(One record per station -- 0 records in all)

1	2				
Name	ID	X coord. (km)	Y coord. (km)	Time zone	Anem. Ht. (m)

-----

1 Four character string for station name  
(MUST START IN COLUMN 9)

2 Six digit integer for station ID

!END!

-----  
INPUT GROUP: 8 -- Upper air meteorological station parameters  
-----

UPPER AIR STATION VARIABLES  
(One record per station -- 0 records in all)

1	2			
Name	ID	X coord. (km)	Y coord. (km)	Time zone

-----

1 Four character string for station name  
(MUST START IN COLUMN 9)

2 Five digit integer for station ID

!END!

-----  
INPUT GROUP: 9 -- Precipitation station parameters  
-----

PRECIPITATION STATION VARIABLES  
(One record per station -- 0 records in all)  
(NOT INCLUDED IF NPSTA = 0)

1	2		
Name	Station Code	X coord. (km)	Y coord. (km)

-----

1 Four character string for station name  
(MUST START IN COLUMN 9)

2 Six digit station code composed of state  
code (first 2 digits) and station ID (last  
4 digits)

!END!

# Appendix D – CALPUFF input file

3133897 Castlemaine Landfill Buffer  
 Odour Assessment Run 1  
 CMM2.DAT 2012 20/04/16 MA  
 ----- Run title (3 lines) -----

CALPUFF MODEL CONTROL FILE  
 -----

INPUT GROUP: 0 -- Input and Output File Names

Default Name	Type	File Name
CALMET.DAT	input	! METDAT =L: \j obs\3133897\Cal met\CMM2.DAT !
or		
ISCMET.DAT	input	* ISCDAT = *
or		
PLMMET.DAT	input	* PLMDAT = *
or		
PROFILE.DAT	input	* PRFDAT = *
SURFACE.DAT	input	* SFCDAT = *
RESTARTB.DAT	input	* RSTARTB= *
-----		
CALPUFF.LST	output	! PUFFLST =L: \j obs\3133897\Cal puff\CP01.lst !
CONC.DAT	output	! CONDAT =L: \j obs\3133897\Cal puff\CP01C.DAT !
DFLX.DAT	output	* DFDAT = *
WFLX.DAT	output	* WFDAT = *
-----		
VISB.DAT	output	* VISDAT = *
TK2D.DAT	output	* T2DDAT = *
RHO2D.DAT	output	* RHODAT = *
RESTARTE.DAT	output	! RSTARTE=L: \j obs\3133897\Cal puff\RESTARTE.DAT !

Emission Files

PTEMARB.DAT	input	* PTDAT = *
VOLEMARB.DAT	input	* VOLDAT = *
BAEMARB.DAT	input	* ARDAT = *
LNEMARB.DAT	input	* LNDAT = *

Other Files

OZONE.DAT	input	* OZDAT = *
VD.DAT	input	* VDDAT = *
CHEM.DAT	input	* CHEMDAT= *
H2O2.DAT	input	* H2O2DAT= *
HILL.DAT	input	* HILDAT= *
HILLRCT.DAT	input	* RCTDAT= *
COASTLN.DAT	input	* CSTDAT= *
FLUXBDY.DAT	input	* BDYDAT= *
BCON.DAT	input	* BCNDAT= *
DEBUG.DAT	output	* DEBUG = *
MASSFLX.DAT	output	* FLXDAT= *
MASSBAL.DAT	output	* BALDAT= *
FOG.DAT	output	* FOGDAT= *

All file names will be converted to lower case if LCFILES = T  
 Otherwise, if LCFILES = F, file names will be converted to UPPER CASE  
 T = lower case ! LCFILES = F !  
 F = UPPER CASE

NOTE: (1) file/path names can be up to 70 characters in length

Provision for multiple input files

Number of CALMET.DAT files for run (NMETDAT)  
 Default: 1 ! NMETDAT = 1 !

Number of PTEMARB.DAT files for run (NPTDAT)  
 Default: 0 ! NPTDAT = 0 !

Number of BAEMARB.DAT files for run (NARDAT)  
 Default: 0 ! NARDAT = 0 !

Number of VOLEMARB.DAT files for run (NVOLDAT)  
 Default: 0 ! NVOLDAT = 0 !

! END!

Subgroup (0a)

The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name	Type	File Name
--------------	------	-----------

none input \* METDAT= \* \*END\* CP01.INP

-----  
INPUT GROUP: 1 -- General run control parameters  
-----

Option to run all periods found  
in the met. file (METRUN) Default: 0 ! METRUN = 0 !

METRUN = 0 - Run period explicitly defined below  
METRUN = 1 - Run all periods in met. file

Starting date: Year (IBYR) -- No default ! IBYR = 2012 !  
(used only if Month (IBMO) -- No default ! IBMO = 1 !  
METRUN = 0) Day (IBDY) -- No default ! IDBY = 1 !  
Hour (IBHR) -- No default ! IBHR = 1 !

Base time zone (XBTZ) -- No default ! XBTZ = -10.0 !  
PST = 8., MST = 7.  
CST = 6., EST = 5.

Length of run (hours) (IRLG) -- No default ! IRLG = 8784 !

Number of chemical species (NSPEC)  
Default: 5 ! NSPEC = 1 !

Number of chemical species  
to be emitted (NSE) Default: 3 ! NSE = 1 !

Flag to stop run after  
SETUP phase (ITEST) Default: 2 ! ITEST = 2 !  
(Used to allow checking  
of the model inputs, files, etc.)  
ITEST = 1 - STOPS program after SETUP phase  
ITEST = 2 - Continues with execution of program  
after SETUP

Restart Configuration:

Control flag (MRESTART) Default: 0 ! MRESTART = 2 !

0 = Do not read or write a restart file  
1 = Read a restart file at the beginning of  
the run  
2 = Write a restart file during run  
3 = Read a restart file at beginning of run  
and write a restart file during run

Number of periods in Restart  
output cycle (NRESPD) Default: 0 ! NRESPD = 336 !

0 = File written only at last period  
>0 = File updated every NRESPD periods

Meteorological Data Format (METFM)  
Default: 1 ! METFM = 1 !

METFM = 1 - CALMET binary file (CALMET.MET)  
METFM = 2 - ISC ASCII file (ISCMET.MET)  
METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)  
METFM = 4 - CTDM plus tower file (PROFILE.DAT) and  
surface parameters file (SURFACE.DAT)  
METFM = 5 - AERMET tower file (PROFILE.DAT) and  
surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)  
(used only for METFM = 1, 2, 3)  
Default: 1 ! MPRFFM = 1 !

MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)  
MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

PG sigma-y is adjusted by the factor (AVET/PGTIME)\*\*0.2  
Averaging Time (minutes) (AVET) Default: 60.0 ! AVET = 60. !  
PG Averaging Time (minutes) (PGTIME)  
Default: 60.0 ! PGTIME = 60. !

! END!

-----  
INPUT GROUP: 2 -- Technical options  
-----

CP01.INP

Vertical distribution used in the near field (MGAUSS) Default: 1 ! MGAUSS = 1 !  
 0 = uniform  
 1 = Gaussian

Terrain adjustment method (MCTADJ) Default: 3 ! MCTADJ = 3 !  
 0 = no adjustment  
 1 = ISC-type of terrain adjustment  
 2 = simple, CALPUFF-type of terrain adjustment  
 3 = partial plume path adjustment

Subgrid-scale complex terrain flag (MCTSG) Default: 0 ! MCTSG = 0 !  
 0 = not modeled  
 1 = modeled

Near-field puffs modeled as elongated slugs? (MSLUG) Default: 0 ! MSLUG = 0 !  
 0 = no  
 1 = yes (slug model used)

Transitional plume rise modeled? (MTRANS) Default: 1 ! MTRANS = 1 !  
 0 = no (i.e., final rise only)  
 1 = yes (i.e., transitional rise computed)

Stack tip downwash? (MTIP) Default: 1 ! MTIP = 1 !  
 0 = no (i.e., no stack tip downwash)  
 1 = yes (i.e., use stack tip downwash)

Method used to simulate building downwash? (MBDW) Default: 1 ! MBDW = 1 !  
 1 = ISC method  
 2 = PRIME method

Vertical wind shear modeled above stack top? (MSHEAR) Default: 0 ! MSHEAR = 0 !  
 0 = no (i.e., vertical wind shear not modeled)  
 1 = yes (i.e., vertical wind shear modeled)

Puff splitting allowed? (MSPLIT) Default: 0 ! MSPLIT = 0 !  
 0 = no (i.e., puffs not split)  
 1 = yes (i.e., puffs are split)

Chemical mechanism flag (MCHEM) Default: 1 ! MCHEM = 0 !  
 0 = chemical transformation not modeled  
 1 = transformation rates computed internally (MESOPUFF II scheme)  
 2 = user-specified transformation rates used  
 3 = transformation rates computed internally (RIVAD/ARM3 scheme)  
 4 = secondary organic aerosol formation computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM) (Used only if MCHEM = 1, or 3) Default: 0 ! MAQCHEM = 0 !  
 0 = aqueous phase transformation not modeled  
 1 = transformation rates adjusted for aqueous phase reactions

Wet removal modeled? (MWET) Default: 1 ! MWET = 0 !  
 0 = no  
 1 = yes

Dry deposition modeled? (MDRY) Default: 1 ! MDRY = 0 !  
 0 = no  
 1 = yes  
 (dry deposition method specified for each species in Input Group 3)

Gravitational settling (plume tilt) modeled? (MTILT) Default: 0 ! MTILT = 0 !  
 0 = no  
 1 = yes  
 (puff center falls at the gravitational settling velocity for 1 particle species)

Restrictions:  
 - MDRY = 1  
 - NSPEC = 1 (must be particle species as well)  
 - sg = 0 GEOMETRIC STANDARD DEVIATION in Group 8 is set to zero for a single particle diameter

Method used to compute dispersion

```

CP01.INP
coefficients (MDISP)           Default: 3      ! MDISP = 2  !

  1 = dispersion coefficients computed from measured values
    of turbulence, sigma v, sigma w
  2 = dispersion coefficients from internally calculated
    sigma v, sigma w using micrometeorological variables
    (u*, w*, L, etc.)
  3 = PG dispersion coefficients for RURAL areas (computed using
    the ISCST multi-segment approximation) and MP coefficients in
    urban areas
  4 = same as 3 except PG coefficients computed using
    the MESOPUFF II eqns.
  5 = CTDM sigmas used for stable and neutral conditions.
    For unstable conditions, sigmas are computed as in
    MDISP = 3, described above. MDISP = 5 assumes that
    measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)   Default: 3      ! MTURBVW = 3  !
  1 = use sigma-v or sigma-theta measurements
    from PROFILE.DAT to compute sigma-y
    (valid for METFM = 1, 2, 3, 4, 5)
  2 = use sigma-w measurements
    from PROFILE.DAT to compute sigma-z
    (valid for METFM = 1, 2, 3, 4, 5)
  3 = use both sigma-(v/theta) and sigma-w
    from PROFILE.DAT to compute sigma-y and sigma-z
    (valid for METFM = 1, 2, 3, 4, 5)
  4 = use sigma-theta measurements
    from PLMMET.DAT to compute sigma-y
    (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)               Default: 3      ! MDISP2 = 3  !
(used only if MDISP = 1 or 5)
  2 = dispersion coefficients from internally calculated
    sigma v, sigma w using micrometeorological variables
    (u*, w*, L, etc.)
  3 = PG dispersion coefficients for RURAL areas (computed using
    the ISCST multi-segment approximation) and MP coefficients in
    urban areas
  4 = same as 3 except PG coefficients computed using
    the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                       Default: 0      ! MTAULY = 0  !
  0 = Draxler default 617.284 (s)
  1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)         -- e.g., 306.9

[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                       Default: 0      ! MTAUADV = 0  !
  0 = No turbulence advection
  1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)         -- e.g., 300

Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                         Default: 1      ! MCTURB = 1  !
  1 = Standard CALPUFF subroutines
  2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?   Default: 0      ! MROUGH = 0  !
(MROUGH)
  0 = no
  1 = yes

Partial plume penetration of
elevated inversion?               Default: 1      ! MPARTL = 1  !
(MPARTL)
  0 = no
  1 = yes

Strength of temperature inversion   Default: 0      ! MTINV = 0  !
provided in PROFILE.DAT extended records?
(MTINV)
  0 = no (computed from measured/default gradients)
  1 = yes

PDF used for dispersion under convective conditions?
                                  Default: 0      ! MPDF = 0  !
(MPDF)

```

CP01. INP

0 = no  
1 = yes

Sub-Grid TIBL module used for shore line? Default: 0 ! MSGTIBL = 0 !

(MSGTIBL)  
0 = no  
1 = yes

Boundary conditions (concentration) modeled? Default: 0 ! MBCON = 0 !

(MBCON)  
0 = no  
1 = yes, using formatted BCON.DAT file  
2 = yes, using unformatted CONC.DAT file

Note: MBCON > 0 requires that the last species modeled be 'BCON'. Mass is placed in species BCON when generating boundary condition puffs so that clean air entering the modeling domain can be simulated in the same way as polluted air. Specify zero emission of species BCON for all regular sources.

Individual source contributions saved? Default: 0 ! MSOURCE = 0 !

(MSOURCE)  
0 = no  
1 = yes

Analyses of fogging and icing impacts due to emissions from arrays of mechanically-forced cooling towers can be performed using CALPUFF in conjunction with a cooling tower emissions processor (CTEMISS) and its associated postprocessors. Hourly emissions of water vapor and temperature from each cooling tower cell are computed for the current cell configuration and ambient conditions by CTEMISS. CALPUFF models the dispersion of these emissions and provides cloud information in a specialized format for further analysis. Output to FOG.DAT is provided in either 'plume mode' or 'receptor mode' format.

Configure for FOG Model output? Default: 0 ! MFOG = 0 !

(MFOG)  
0 = no  
1 = yes - report results in PLUME Mode format  
2 = yes - report results in RECEPTOR Mode format

Test options specified to see if they conform to regulatory values? (MREG) Default: 1 ! MREG = 0 !

0 = NO checks are made  
1 = Technical options must conform to USEPA Long Range Transport (LRT) guidance

METFM	1 or 2
AVET	60. (min)
PGTIME	60. (min)
MGAUSS	1
MCTADJ	3
MTRANS	1
MTIP	1
MCHEM	1 or 3 (if modeling SOx, NOx)
MWET	1
MDRY	1
MDISP	2 or 3
MPDF	0 if MDISP=3 1 if MDISP=2
MROUGH	0
MPARTL	1
SYTDEP	550. (m)
MHFTSZ	0
SVMIN	0.5 (m/s)

! END!

-----  
INPUT GROUP: 3a, 3b -- Species list  
-----

-----  
Subgroup (3a)  
-----

The following species are modeled:

```

! CSPEC =          ODOR !          ! END!          CP01. INP

SPECIES           MODELED           EMITTED           Dry
NAME              (0=NO, 1=YES)      (0=NO, 1=YES)     DEPOSITED
(Limit: 12        (0=NO, 1=YES)      (0=NO, 1=YES)     (0=NO,
Characters        (0=NO, 1=YES)      (0=NO, 1=YES)     1=COMPUTED-GAS
in length)        (0=NO, 1=YES)      (0=NO, 1=YES)     2=COMPUTED-PARTICLE
                   (0=NO, 1=YES)      (0=NO, 1=YES)     3=USER-SPECIFIED)
OUTPUT GROUP
NUMBER
(O=NONE,
1=1st CGRUP,
2=2nd CGRUP,
3= etc.)

!          ODOR =          1,          1,          0,          0 !

! END!

```

Note: The last species in (3a) must be 'BCON' when using the boundary condition option (MBCON > 0). Species BCON should typically be modeled as inert (no chem transformation or removal).

-----  
Subgroup (3b)  
-----

The following names are used for Species-Groups in which results for certain species are combined (added) prior to output. The CGRUP name will be used as the species name in output files. Use this feature to model specific particle-size distributions by treating each size-range as a separate species. Order must be consistent with 3(a) above.

-----  
INPUT GROUP: 4 -- Map Projection and Grid control parameters  
-----

Projection for all (X, Y):  
-----

Map projection  
(PMAP)

Default: UTM ! PMAP = UTM !

UTM : Universal Transverse Mercator  
TTM : Tangential Transverse Mercator  
LCC : Lambert Conformal Conic  
PS : Polar Stereographic  
EM : Equatorial Mercator  
LAZA : Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin

(Used only if PMAP= TTM, LCC, or LAZA)  
(FEAST) Default=0.0 ! FEAST = 0.000 !  
(FNORTH) Default=0.0 ! FNORTH = 0.000 !

UTM zone (1 to 60)

(Used only if PMAP=UTM)  
(IUTMZN) No Default ! IUTMZN = 55 !

Hemisphere for UTM projection?

(Used only if PMAP=UTM)  
(UTMHEM) Default: N ! UTMHEM = S !  
N : Northern hemisphere projection  
S : Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin

(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)  
(RLATO) No Default ! RLATO = 0N !  
(RLONO) No Default ! RLONO = 0E !

TTM : RLONO identifies central (true N/S) meridian of projection  
RLATO selected for convenience  
LCC : RLONO identifies central (true N/S) meridian of projection  
RLATO selected for convenience  
PS : RLONO identifies central (grid N/S) meridian of projection  
RLATO selected for convenience  
EM : RLONO identifies central meridian of projection  
RLATO is REPLACED by 0.0N (Equator)  
LAZA: RLONO identifies longitude of tangent-point of mapping plane  
RLATO identifies latitude of tangent-point of mapping plane

Matching parallel (s) of Latitude (decimal degrees) for projection

(Used only if PMAP= LCC or PS)  
(XLAT1) No Default ! XLAT1 = 0N !  
(XLAT2) No Default ! XLAT2 = 0N !

LCC : Projection cone slices through Earth's surface at XLAT1 and XLAT2  
PS : Projection plane slices through Earth at XLAT1  
(XLAT2 is not used)

-----  
 Note: Latitudes and longitudes should be positive, and include a letter N, S, E, or W indicating north or south latitude, and east or west longitude. For example,  
 35.9 N Latitude = 35.9N  
 118.7 E Longitude = 118.7E

## Datum-region

-----  
 The Datum-Region for the coordinates is identified by a character string. Many mapping products currently available use the model of the Earth known as the World Geodetic System 1984 (WGS-84). Other local models may be in use, and their selection in CALMET will make its output consistent with local mapping products. The list of Datum-Regions with official transformation parameters is provided by the National Imagery and Mapping Agency (NIMA).

## NIMA Datum - Regions(Examples)

-----  
 WGS-84 WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)  
 NAS-C NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)  
 NAR-C NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)  
 NWS-84 NWS 6370KM Radius, Sphere  
 ESR-S ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates  
 (DATUM) Default: WGS-84 ! DATUM = WGS-84 !

## METEOROLOGICAL Grid:

Rectangular grid defined for projection PMAP,  
 with X the Easting and Y the Northing coordinate

No. X grid cells (NX)	No default	! NX = 60 !
No. Y grid cells (NY)	No default	! NY = 60 !
No. vertical layers (NZ)	No default	! NZ = 11 !
Grid spacing (DGRI DKM)	No default	! DGRI DKM = .4 !
	Units: km	

Cell face heights (ZFACE(nz+1))	No defaults
	Units: m
! ZFACE = .0, 20.0, 40.0, 60.0, 90.0, 120.0, 180.0, 250.0, 500.0, 1000.0, 2000.0, 3000.0 !	

Reference Coordinates  
 of SOUTHWEST corner of  
 grid cell (1, 1):

X coordinate (XORIGKM)	No default	! XORIGKM = 238.610 !
Y coordinate (YORIGKM)	No default	! YORIGKM = 5880.795 !
	Units: km	

## COMPUTATIONAL Grid:

The computational grid is identical to or a subset of the MET. grid.  
 The lower left (LL) corner of the computational grid is at grid point (IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.  
 The grid spacing of the computational grid is the same as the MET. grid.

X index of LL corner (IBCOMP) (1 <= IBCOMP <= NX)	No default	! IBCOMP = 10 !
Y index of LL corner (JBCOMP) (1 <= JBCOMP <= NY)	No default	! JBCOMP = 10 !
X index of UR corner (IECOMP) (1 <= IECOMP <= NX)	No default	! IECOMP = 50 !
Y index of UR corner (JECOMP) (1 <= JECOMP <= NY)	No default	! JECOMP = 50 !

## SAMPLING Grid (GRIDDED RECEPTORS):

The lower left (LL) corner of the sampling grid is at grid point (IBSAMP, JBSAMP) of the MET. grid. The upper right (UR) corner of the sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.  
 The sampling grid must be identical to or a subset of the computational grid. It may be a nested grid inside the computational grid.  
 The grid spacing of the sampling grid is DGRI DKM/MESH DN.

```

CP01.INP
Logical flag indicating if gridded
receptors are used (LSAMP)
(T=yes, F=no)          Default: T      ! LSAMP = T !

X index of LL corner (IBSAMP)
( IBCOMP <= IBSAMP <= IECOMP)  No default    ! IBSAMP = 20 !

Y index of LL corner (JBSAMP)
( JBCOMP <= JBSAMP <= JECOMP)  No default    ! JBSAMP = 20 !

X index of UR corner (IESAMP)
( IBCOMP <= IESAMP <= IECOMP)  No default    ! IESAMP = 40 !

Y index of UR corner (JESAMP)
( JBCOMP <= JESAMP <= JECOMP)  No default    ! JESAMP = 40 !

Nesting factor of the sampling
grid (MESHDN)
(MESHDN is an integer >= 1)   Default: 1     ! MESHDN = 4 !

```

! END!

-----

INPUT GROUP: 5 -- Output Options

-----

FILE	* DEFAULT VALUE	* VALUE THIS RUN
----	-----	-----
Concentrations (ICON)	1	! ICON = 1 !
Dry Fluxes (IDRY)	1	! IDRY = 0 !
Wet Fluxes (IWET)	1	! IWET = 0 !
2D Temperature (IT2D)	0	! IT2D = 0 !
2D Density (IRHO)	0	! IRHO = 0 !
Relative Humidity (IVIS)	1	! IVIS = 0 !
(relative humidity file is required for visibility analysis)		
Use data compression option in output file? (LCOMPRS)	Default: T	! LCOMPRS = T !

\*

0 = Do not create file, 1 = create file

QA PLOT FILE OUTPUT OPTION:

Create a standard series of output files (e.g.  
locations of sources, receptors, grids ...)  
suitable for plotting?

(IQAPLOT) Default: 1 ! IQAPLOT = 1 !  
0 = no  
1 = yes

DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

Mass flux across specified boundaries  
for selected species reported hourly?

(IMFLX) Default: 0 ! IMFLX = 0 !  
0 = no  
1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames  
are specified in Input Group 0)

Mass balance for each species  
reported hourly?

(IMBAL) Default: 0 ! IMBAL = 0 !  
0 = no  
1 = yes (MASSBAL.DAT filename is  
specified in Input Group 0)

LINE PRINTER OUTPUT OPTIONS:

Print concentrations (ICPRT) Default: 0 ! ICPRT = 1 !  
Print dry fluxes (IDPRT) Default: 0 ! IDPRT = 0 !  
Print wet fluxes (IWPRT) Default: 0 ! IWPRT = 0 !  
(0 = Do not print, 1 = Print)

Concentration print interval  
(ICFRQ) in hours Default: 1 ! ICFRQ = 8784 !  
Dry flux print interval  
(IDFRQ) in hours Default: 1 ! IDFRQ = 1 !  
Wet flux print interval  
(IWFRQ) in hours Default: 1 ! IWFRQ = 1 !

Units for Line Printer Output  
 (IPRTU) Default t: 1 ! IPRTU = 5 !  
 for Concentration for Deposition  
 1 = g/m\*\*3 g/m\*\*2/s  
 2 = mg/m\*\*3 mg/m\*\*2/s  
 3 = ug/m\*\*3 ug/m\*\*2/s  
 4 = ng/m\*\*3 ng/m\*\*2/s  
 5 = Odour Units

Messages tracking progress of run  
 written to the screen ?  
 (IMESG) Default t: 2 ! IMESG = 2 !  
 0 = no  
 1 = yes (advection step, puff ID)  
 2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)

SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

SPECIES /GROUP		--- CONCENTRATIONS ---		----- DRY FLUXES -----		----- WET FLUXES -----		
DISK?	SAVED ON DISK?	PRINTED?	SAVED ON DISK?	PRINTED?	SAVED ON DISK?	PRINTED?	SAVED ON DISK?	
!	0	!	1,	1,	0,	0,	0,	0,

Note: Species BCON (for MBCON > 0) does not need to be saved on disk.

OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

Logical for debug output  
 (LDEBUG) Default t: F ! LDEBUG = F !  
 First puff to track  
 (IPFDEB) Default t: 1 ! IPFDEB = 1 !  
 Number of puffs to track  
 (NPFDEB) Default t: 1 ! NPFDEB = 1 !  
 Met. period to start output  
 (NN1) Default t: 1 ! NN1 = 1 !  
 Met. period to end output  
 (NN2) Default t: 10 ! NN2 = 10 !

! END!

INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs

Subgroup (6a)

Number of terrain features (NHILL) Default t: 0 ! NHILL = 0 !  
 Number of special complex terrain  
 receptors (NCTREC) Default t: 0 ! NCTREC = 0 !  
 Terrain and CTSG Receptor data for  
 CTSG hills input in CTDM format ?  
 (MHILL) No Default t ! MHILL = 2 !  
 1 = Hill and Receptor data created  
 by CTDM processors & read from  
 HILL.DAT and HILLRCT.DAT files  
 2 = Hill data created by OPHILL &  
 input below in Subgroup (6b);  
 Receptor data in Subgroup (6c)  
 Factor to convert horizontal dimensions  
 to meters (MHILL=1) Default t: 1.0 ! XHILL2M = 1.0 !  
 Factor to convert vertical dimensions  
 to meters (MHILL=1) Default t: 1.0 ! ZHILL2M = 1.0 !  
 X-origin of CTDM system relative to  
 CALPUFF coordinate system, in Kilometers No Default t ! XCTDMKM = 0 !  
 (MHILL=1)  
 Y-origin of CTDM system relative to  
 CALPUFF coordinate system, in Kilometers No Default t ! YCTDMKM = 0 !  
 (MHILL=1)

! END !

-----  
Subgroup (6b)  
-----

1 \*\*  
HILL information

HILL 2 NO.	AMAX1 (m)	XC AMAX2 (m)	YC (km)	THETAH (deg.)	ZGRID (m)	RELIEF (m)	EXPO 1 (m)	EXPO 2 (m)	SCALE 1 (m)	SCALE (m)
----	----	----	----	-----	-----	-----	-----	-----	-----	-----

-----  
Subgroup (6c)  
-----

COMPLEX TERRAIN RECEPTOR INFORMATION

XRCT (km)	YRCT (km)	ZRCT (m)	XHH
-----	-----	-----	-----

1

Description of Complex Terrain Variables:  
 XC, YC = Coordinates of center of hill  
 THETAH = Orientation of major axis of hill (clockwise from North)  
 ZGRID = Height of the 0 of the grid above mean sea level  
 RELIEF = Height of the crest of the hill above the grid elevation  
 EXPO 1 = Hill-shape exponent for the major axis  
 EXPO 2 = Hill-shape exponent for the minor axis  
 SCALE 1 = Horizontal length scale along the major axis  
 SCALE 2 = Horizontal length scale along the minor axis  
 AMAX = Maximum allowed axis length for the major axis  
 BMAX = Maximum allowed axis length for the minor axis  
 XRCT, YRCT = Coordinates of the complex terrain receptors  
 ZRCT = Height of the ground (MSL) at the complex terrain Receptor  
 XHH = Hill number associated with each complex terrain receptor  
 (NOTE: MUST BE ENTERED AS A REAL NUMBER)

\*\*

NOTE: DATA for each hill and CTSG receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

-----  
INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases  
-----

SPECIES HENRY'S LAW COEFFICIENT NAME (dimensionless)	DIFFUSIVITY (cm**2/s)	ALPHA STAR	REACTIVITY	MESOPHYLL RESISTANCE (s/cm)
-----	-----	-----	-----	-----

! END!

-----  
INPUT GROUP: 8 -- Size parameters for dry deposition of particles  
-----

For SINGLE SPECIES, the mean and standard deviation are used to compute a deposition velocity for NINT (see group 9) size-ranges, and these are then averaged to obtain a mean deposition velocity.

For GROUPED SPECIES, the size distribution should be explicitly specified (by the 'species' in the group), and the standard deviation for each should be entered as 0. The model will then use the deposition velocity for the stated mean diameter.

SPECIES NAME	GEOMETRIC MASS MEAN DIAMETER (microns)	GEOMETRIC STANDARD DEVIATION (microns)
-----	-----	-----

! END!

-----  
INPUT GROUP: 9 -- Miscellaneous dry deposition parameters  
-----

Reference cuticle resistance (s/cm)  
(RCUTR) Default t: 30 ! RCUTR = 30.0 !  
Reference ground resistance (s/cm)  
(RGR) Default t: 10 ! RGR = 10.0 !  
Reference pollutant reactivity  
(REACTR) Default t: 8 ! REACTR = 8.0 !

Number of particle-size intervals used to  
evaluate effective particle deposition velocity  
(NINT) Default t: 9 ! NINT = 9 !

Vegetation state in unirrigated areas  
(IVEG) Default t: 1 ! IVEG = 1 !  
IVEG=1 for active and unstressed vegetation  
IVEG=2 for active and stressed vegetation  
IVEG=3 for inactive vegetation

! END!

-----  
INPUT GROUP: 10 -- Wet Deposition Parameters  
-----

Scavenging Coefficient -- Units: (sec)\*\*(-1)

Pollutant	Liquid Precip.	Frozen Precip.
-----	-----	-----

! END!

-----  
INPUT GROUP: 11 -- Chemistry Parameters  
-----

Ozone data input option (MOZ) Default t: 1 ! MOZ = 0 !  
(Used only if MCHEM = 1, 3, or 4)  
0 = use a monthly background ozone value  
1 = read hourly ozone concentrations from  
the OZONE.DAT data file

Monthly ozone concentrations  
(Used only if MCHEM = 1, 3, or 4 and  
MOZ = 0 or MOZ = 1 and all hourly O3 data missing)  
(BCKO3) in ppb Default t: 12\*80.  
! BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,  
80.00 !

Monthly ammonia concentrations  
(Used only if MCHEM = 1, or 3)  
(BCKNH3) in ppb Default t: 12\*10.  
! BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,  
10.00 !

Nighttime SO2 loss rate (RNITE1)  
in percent/hour Default t: 0.2 ! RNITE1 = .2 !

Nighttime NOx loss rate (RNITE2)  
in percent/hour Default t: 2.0 ! RNITE2 = 2.0 !

Nighttime HNO3 formation rate (RNITE3)  
in percent/hour Default t: 2.0 ! RNITE3 = 2.0 !

H2O2 data input option (MH2O2) Default t: 1 ! MH2O2 = 1 !  
(Used only if MAQCHEM = 1)  
0 = use a monthly background H2O2 value  
1 = read hourly H2O2 concentrations from  
the H2O2.DAT data file

Monthly H2O2 concentrations  
(Used only if MAQCHEM = 1 and  
MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)  
(BCKH2O2) in ppb Default t: 12\*1.  
! BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !

--- Data for SECONDARY ORGANIC AEROSOL (SOA) Option  
(used only if MCHM = 4)

The SOA module uses monthly values of:  
 Fine particulate concentration in ug/m<sup>3</sup> (BCKPMF)  
 Organic fraction of fine particulate (OFRAC)  
 VOC / NOX ratio (after reaction) (VCNX)  
 to characterize the air mass when computing  
 the formation of SOA from VOC emissions.  
 Typical values for several distinct air mass types are:

Month	1	2	3	4	5	6	7	8	9	10	11	12
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Clean Continental												
BCKPMF	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
OFRAC	.15	.15	.20	.20	.20	.20	.20	.20	.20	.20	.20	.15
VCNX	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
Clean Marine (surface)												
BCKPMF	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
OFRAC	.25	.25	.30	.30	.30	.30	.30	.30	.30	.30	.30	.25
VCNX	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.	50.
Urban - low biogenic (controls present)												
BCKPMF	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.	30.
OFRAC	.20	.20	.25	.25	.25	.25	.25	.25	.20	.20	.20	.20
VCNX	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.
Urban - high biogenic (controls present)												
BCKPMF	60.	60.	60.	60.	60.	60.	60.	60.	60.	60.	60.	60.
OFRAC	.25	.25	.30	.30	.30	.55	.55	.55	.35	.35	.35	.25
VCNX	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
Regional Plume												
BCKPMF	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.	20.
OFRAC	.20	.20	.25	.35	.25	.40	.40	.40	.30	.30	.30	.20
VCNX	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.	15.
Urban - no controls present												
BCKPMF	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
OFRAC	.30	.30	.35	.35	.35	.55	.55	.55	.35	.35	.35	.30
VCNX	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.

Default: Clean Continental  
 ! BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00 !  
 ! OFRAC = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15 !  
 ! VCNX = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,  
 50.00 !

! END!

-----  
 INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters  
 -----

Horizontal size of puff (m) beyond which  
 time-dependent dispersion equations (Heffter)  
 are used to determine sigma-y and  
 sigma-z (SYTDEP) Default: 550. ! SYTDEP = 5.5E02 !

Switch for using Heffter equation for sigma z  
 as above (0 = Not use Heffter; 1 = use Heffter  
 (MHFTSZ) Default: 0 ! MHFTSZ = 0 !

Stability class used to determine plume  
 growth rates for puffs above the boundary  
 layer (JSUP) Default: 5 ! JSUP = 5 !

Vertical dispersion constant for stable  
 conditions (k1 in Eqn. 2.7-3) (CONK1) Default: 0.01 ! CONK1 = .01 !

Vertical dispersion constant for neutral/  
 unstable conditions (k2 in Eqn. 2.7-4)  
 (CONK2) Default: 0.1 ! CONK2 = .1 !

Factor for determining Transition-point from  
 Schulman-Sci re to Huber-Snyder Building Downwash  
 scheme (SS used for Hs < Hb + TBD \* HL)  
 (TBD) Default: 0.5 ! TBD = .5 !  
 TBD < 0 ==> always use Huber-Snyder  
 TBD = 1.5 ==> always use Schulman-Sci re  
 TBD = 0.5 ==> ISC Transition-point

Range of land use categories for which

urban dispersion is assumed  
(IURB1, IURB2)

Default: 10 ! IURB1 = 10 !  
19 ! IURB2 = 19 !

Site characterization parameters for single-point Met data files -----  
(needed for METFM = 2, 3, 4, 5)

Land use category for modeling domain  
(ILANDUIN) Default: 20 ! ILANDUIN = 20 !

Roughness length (m) for modeling domain  
(ZOIN) Default: 0.25 ! ZOIN = .25 !

Leaf area index for modeling domain  
(XLAIIN) Default: 3.0 ! XLAIIN = 3.0 !

Elevation above sea level (m)  
(ELEVIN) Default: 0.0 ! ELEVIN = .0 !

Latitude (degrees) for met location  
(XLATIN) Default: -999. ! XLATIN = -999.0 !

Longitude (degrees) for met location  
(XLONIN) Default: -999. ! XLONIN = -999.0 !

Specialized information for interpreting single-point Met data files -----

Anemometer height (m) (Used only if METFM = 2, 3)  
(ANEMHT) Default: 10. ! ANEMHT = 10.0 !

Form of lateral turbulence data in PROFILE.DAT file  
(Used only if METFM = 4, 5 or MTURBVW = 1 or 3)  
(ISIGMAV) Default: 1 ! ISIGMAV = 1 !  
0 = read sigma-theta  
1 = read sigma-v

Choice of mixing heights (Used only if METFM = 4)  
(IMIXCTDM) Default: 0 ! IMIXCTDM = 0 !  
0 = read PREDICTED mixing heights  
1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)  
(XMXLEN) Default: 1.0 ! XMXLEN = 1.0 !

Maximum travel distance of a puff/slug (in  
grid units) during one sampling step  
(XSAMLEN) Default: 1.0 ! XSAMLEN = 1.0 !

Maximum Number of slugs/puffs release from  
one source during one time step  
(MXNEW) Default: 99 ! MXNEW = 99 !

Maximum Number of sampling steps for  
one puff/slug during one time step  
(MXSAM) Default: 99 ! MXSAM = 99 !

Number of iterations used when computing  
the transport wind for a sampling step  
that includes gradual rise (for CALMET  
and PROFILE winds)  
(NCOUNT) Default: 2 ! NCOUNT = 2 !

Minimum sigma y for a new puff/slug (m)  
(SYMIN) Default: 1.0 ! SYMIN = 1.0 !

Minimum sigma z for a new puff/slug (m)  
(SZMIN) Default: 1.0 ! SZMIN = 1.0 !

Default minimum turbulence velocities sigma-v and sigma-w  
for each stability class over land and over water (m/s)  
(SVMIN(12) and SWMIN(12))

Stab Class :	LAND						WATER					
	A	B	C	D	E	F	A	B	C	D	E	F
Default SVMIN :	.50	.50	.50	.50	.50	.50	.37	.37	.37	.37	.37	.37
Default SWMIN :	.20	.12	.08	.06	.03	.016	.20	.12	.08	.06	.03	.016

! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.370, 0.370, 0.370, 0.370,  
0.370, 0.370!  
! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120, 0.080, 0.060,  
0.030, 0.016!

Divergence criterion for dw/dz across puff  
used to initiate adjustment for horizontal  
convergence (1/s)  
Partial adjustment starts at CDIV(1), and  
full adjustment is reached at CDIV(2)  
(CDIV(2)) Default: 0.0, 0.0 ! CDIV = .0, .0 !

CP01.INP

Minimum wind speed (m/s) allowed for non-calm conditions. Also used as minimum speed returned when using power-law extrapolation toward surface (WSCALM)

Default: 0.5 ! WSCALM = .5 !

Maximum mixing height (m) (XMAXZI)

Default: 3000. ! XMAXZI = 3000.0 !

Minimum mixing height (m) (XMINZI)

Default: 50. ! XMINZI = 50.0 !

Default wind speed classes -- 5 upper bounds (m/s) are entered; the 6th class has no upper limit (WSCAT(5))

Default : ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8 (10.8+)

Wind Speed Class	1	2	3	4	5
	---	---	---	---	---
! WSCAT =	1.54,	3.09,	5.14,	8.23,	10.80 !

Default wind speed profile power-law exponents for stabilities 1-6 (PLX0(6))

Default : ISC RURAL values  
ISC RURAL : .07, .07, .10, .15, .35, .55  
ISC URBAN : .15, .15, .20, .25, .30, .30

Stability Class	A	B	C	D	E	F
	---	---	---	---	---	---
! PLX0 =	0.07,	0.07,	0.10,	0.15,	0.35,	0.55 !

Default potential temperature gradient for stable classes E, F (degK/m) (PTG0(2))

Default: 0.020, 0.035  
! PTG0 = 0.020, 0.035 !

Default plume path coefficients for each stability class (used when option for partial plume height terrain adjustment is selected -- MCTADJ=3) (PPC(6))

Stability Class	A	B	C	D	E	F
Default PPC :	.50,	.50,	.50,	.50,	.35,	.35
	---	---	---	---	---	---
! PPC =	0.50,	0.50,	0.50,	0.50,	0.35,	0.35 !

Slug-to-puff transition criterion factor equal to sigma-y/length of slug (SL2PF)

Default: 10. ! SL2PF = 10.0 !

Puff-splitting control variables -----

VERTICAL SPLIT  
-----

Number of puffs that result every time a puff is split - nsplit=2 means that 1 puff splits into 2 (NSPLIT)

Default: 3 ! NSPLIT = 3 !

Time(s) of a day when split puffs are eligible to be split once again; this is typically set once per day, around sunset before nocturnal shear develops. 24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00) 0=do not re-split 1=eligible for re-split (IRESPLIT(24))

Default: Hour 17 = 1  
! IRESPLIT = 0, 0 !

Split is allowed only if last hour's mixing height (m) exceeds a minimum value (ZISPLIT)

Default: 100. ! ZISPLIT = 100.0 !

Split is allowed only if ratio of last hour's mixing ht to the maximum mixing ht experienced by the puff is less than a maximum value (this postpones a split until a nocturnal layer develops) (ROLDMAX)

Default: 0.25 ! ROLDMAX = 0.25 !

HORIZONTAL SPLIT  
-----

Number of puffs that result every time a puff is split - nsplith=5 means that 1 puff splits into 5 (NSPLITH)

Default: 5 ! NSPLITH = 5 !

Minimum sigma-y (Grid Cells Units) of puff before it may be split (SYSPLITH)

Default: 1.0 ! SYSPLITH = 1.0 !

CP01. INP

Minimum puff elongation rate (SYSPLTH/hr) due to wind shear, before it may be split (SHSPLTH) Default: 2. ! SHSPLTH = 2.0 !

Minimum concentration (g/m<sup>3</sup>) of each species in puff before it may be split Enter array of NSPEC values; if a single value is entered, it will be used for ALL species (CNSPLTH) Default: 1.0E-07 ! CNSPLTH = 1.0E-07 !

Integration control variables -----

Fractional convergence criterion for numerical SLUG sampling integration (EPSSLUG) Default: 1.0e-04 ! EPSSLUG = 1.0E-04 !

Fractional convergence criterion for numerical AREA source integration (EPSAREA) Default: 1.0e-06 ! EPSAREA = 1.0E-06 !

Trajectory step-length (m) used for numerical rise integration (DSRISE) Default: 1.0 ! DSRISE = 1.0 !

Boundary Condition (BC) Puff control variables -----

Minimum height (m) to which BC puffs are mixed as they are emitted (MBCON=2 ONLY). Actual height is reset to the current mixing height at the release point if greater than this minimum. (HTMINBC) Default: 500. ! HTMINBC = 500.0 !

Search radius (km) about a receptor for sampling nearest BC puff. BC puffs are typically emitted with a spacing of one grid cell length, so the search radius should be greater than DGRI DKM. (RSAMPBC) Default: 10. ! RSAMPBC = 10.0 !

Near-Surface depletion adjustment to concentration profile used when sampling BC puffs? (MDEPBC) Default: 1 ! MDEPBC = 1 !  
 0 = Concentration is NOT adjusted for depletion  
 1 = Adjust Concentration for depletion

! END!

-----  
 INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters  
 -----

-----  
 Subgroup (13a)  
 -----

Number of point sources with parameters provided below (NPT1) No default ! NPT1 = 0 !

Units used for point source emissions below (IPTU) Default: 1 ! IPTU = 5 !  
 1 = g/s  
 2 = kg/hr  
 3 = lb/hr  
 4 = tons/yr  
 5 = Odour Unit \* m<sup>3</sup>/s (vol. flux of odour compound)  
 6 = Odour Unit \* m<sup>3</sup>/min  
 7 = metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (13d) (NSPT1) Default: 0 ! NSPT1 = 0 !

Number of point sources with variable emission parameters provided in external file (NPT2) No default ! NPT2 = 0 !

(If NPT2 > 0, these point source emissions are read from the file: PTEMARB.DAT)

! END!

-----  
 Subgroup (13b)  
 -----

POINT SOURCE: CONSTANT DATA<sup>a</sup>  
 -----

CP01. INP

Source No.	X (km)	Y (km)	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Vel. (m/s)	Exit Temp. (deg. K)	Bl dg. Dwash	Emi ssi on Rates
------------	-----------	-----------	---------------------	-----------------------	-----------------------	--------------------	------------------------	--------------	------------------

a  
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source (No default)  
X is an array holding the source data listed by the column headings (No default)  
SIGYZI is an array holding the initial sigma-y and sigma-z (m) (Default: 0., 0.)  
ZPLTFM is the platform height (m) for sources influenced by an isolated structure that has a significant open area between the surface and the bulk of the structure, such as an offshore oil platform. The Base Elevation is that of the surface (ground or ocean), and the Stack Height is the release height above the Base (not above the platform). Building heights entered in Subgroup 13c must be those of the buildings on the platform, measured from the platform deck. ZPLTFM is used only with MBDW=1 (ISC downwash method) for sources with building downwash. (Default: 0.0)  
FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent the effect of rain-caps or other physical configurations that reduce momentum rise associated with the actual exit velocity. (Default: 1.0 -- full momentum used)

b  
0. = No building downwash modeled  
1. = Downwash modeled for buildings resting on the surface  
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)  
NOTE: must be entered as a REAL number (i.e., with decimal point)

c  
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IPTU (e.g. 1 for g/s).

-----  
Subgroup (13c)  
-----

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH  
-----

Source No.	Effective building height, width, length and X/Y offset (in meters) every 10 degrees. LENGTH, XBADJ, and YBADJ are only needed for MBDW=2 (PRIME downwash option)
------------	---

a  
Building height, width, length, and X/Y offset from the source are treated as a separate input subgroup for each source and therefore must end with an input group terminator. The X/Y offset is the position, relative to the stack, of the center of the upwind face of the projected building, with the x-axis pointing along the flow direction.

-----  
Subgroup (13d)  
-----

POINT SOURCE: VARIABLE EMISSIONS DATA  
-----

Use this subgroup to describe temporal variations in the emission rates given in 13b. Factors entered multiply the rates in 13b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

IVARY determines the type of variation, and is source-specific:  
(IVARY) Default: 0  
0 = Constant  
1 = Diurnal cycle (24 scaling factors: hours 1-24)  
2 = Monthly cycle (12 scaling factors: months 1-12)  
3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)  
4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper

CP01.INP  
 5 = Temperature bounds (m/s) defined in Group 12  
 (12 scaling factors, where temperature  
 classes have upper bounds (C) of:  
 0, 5, 10, 15, 20, 25, 30, 35, 40,  
 45, 50, 50+)

-----  
<sup>a</sup>  
 Data for each species are treated as a separate input subgroup  
 and therefore must end with an input group terminator.

-----  
 INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters  
 -----

-----  
 Subgroup (14a)  
 -----

Number of polygon area sources with  
 parameters specified below (NAR1) No default ! NAR1 = 3 !

Units used for area source  
 emissions below (IARU) Default: 1 ! IARU = 5 !

- 1 = g/m\*\*2/s
- 2 = kg/m\*\*2/hr
- 3 = lb/m\*\*2/hr
- 4 = tons/m\*\*2/yr
- 5 = Odour Unit \* m/s (vol. flux/m\*\*2 of odour compound)
- 6 = Odour Unit \* m/min
- 7 = metric tons/m\*\*2/yr

Number of source-species  
 combinations with variable  
 emissions scaling factors  
 provided below in (14d) (NSAR1) Default: 0 ! NSAR1 = 1 !

Number of buoyant polygon area sources  
 with variable location and emission  
 parameters (NAR2) No default ! NAR2 = 0 !  
 (If NAR2 > 0, ALL parameter data for  
 these sources are read from the file: BAEMARB.DAT)

! END!

-----  
 Subgroup (14b)  
 -----

<sup>a</sup>  
 AREA SOURCE: CONSTANT DATA  
 -----

Source No.	Effect. Height (m)	Base Elevation (m)	Initial Sigma z (m)	Emission Rates
1!	SRCNAM = T1PF !			
1! X =	1.5,	279,	0.4,	1E00 ! ! END!
2!	SRCNAM = LEACH !			
2! X =	0.1,	287,	0.1,	7E-02 ! ! END!
3!	SRCNAM = GW !			
3! X =	1.5,	279,	0.4,	3E00 ! ! END!

-----  
<sup>a</sup>  
 Data for each source are treated as a separate input subgroup  
 and therefore must end with an input group terminator.

<sup>b</sup>  
 An emission rate must be entered for every pollutant modeled.  
 Enter emission rate of zero for secondary pollutants that are  
 modeled, but not emitted. Units are specified by IARU  
 (e.g. 1 for g/m\*\*2/s).

-----  
 Subgroup (14c)  
 -----

COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON  
 -----

Source No. Ordered list of X followed by list of Y, grouped by source <sup>a</sup>  
 -----

1 ! SRCNAM = T1PF !  
 1 ! XVERT = 250.517, 250.506, 250.512, 250.523!  
 Page 17

```

1      ! YVERT = 5892.703,      5892.716,      CP01.I.NP      5892.707!
!END!
2      ! SRCNAM =  LEACH !
2      ! XVERT = 250.761,      250.696,      250.710,      250.771!
2      ! YVERT = 5892.966,      5893.027,      5893.040,      5892.979!
!END!
3      ! SRCNAM =  GW !
3      ! XVERT = 250.567,      250.561,      250.579,      250.586!
3      ! YVERT = 5892.858,      5892.870,      5892.881,      5892.870!
!END!

```

-----  
a  
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

-----  
Subgroup (14d)  
-----

AREA SOURCE: VARIABLE EMISSIONS DATA<sup>a</sup>  
-----

Use this subgroup to describe temporal variations in the emission rates given in 14b. Factors entered multiply the rates in 14b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

IVARY determines the type of variation, and is source-specific:  
(IVARY) Default: 1

- 0 = Constant
- 1 = Diurnal cycle (24 scaling factors: hours 1-24)
- 2 = Monthly cycle (12 scaling factors: months 1-12)
- 3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
- 4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12)
- 5 = Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

```

1 ! SRCNAM = T1PF !
1 ! IVARY = 1 ! (24 Hours)
1 ! ODOR = 6, 6, 6, 6, 6, 6,
6, 6, 6, 60, 60, 29,
29, 6, 6, 6, 6, 6,
6, 6, 6, 6, 6 !
!END!

```

-----  
a  
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

-----  
INPUT GROUPS: 15a, 15b, 15c -- Line source parameters  
-----

-----  
Subgroup (15a)  
-----

Number of buoyant line sources with variable location and emission parameters (NLN2) No default ! NLN2 = 0 !

(If NLN2 > 0, ALL parameter data for these sources are read from the file: LNEARB.DAT)

Number of buoyant line sources (NLINES) No default ! NLINES = 0 !

Units used for line source emissions below (ILNU) Default: 1 ! ILNU = 1 !

- 1 = g/s
- 2 = kg/hr
- 3 = lb/hr
- 4 = tons/yr
- 5 = Odour Unit \* m\*\*3/s (vol. flux of odour compound)
- 6 = Odour Unit \* m\*\*3/min
- 7 = metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (15c) (NSLN1) Default: 0 ! NSLN1 = 0 !

Maximum number of segments used to model each line (MXNSEG) Default: 7 ! MXNSEG = 7 !

The following variables are required only if NLINES > 0. They are used in the buoyant line source plume rise calculations.

- Number of distances at which transitional rise is computed Default: 6 ! NLRISE = 6 !
- Average building length (XL) No default ! XL = .0 ! (in meters)
- Average building height (HBL) No default ! HBL = .0 ! (in meters)
- Average building width (WBL) No default ! WBL = .0 ! (in meters)
- Average line source width (WML) No default ! WML = .0 ! (in meters)
- Average separation between buildings (DXL) No default ! DXL = .0 ! (in meters)
- Average buoyancy parameter (FPRIMEL) No default ! FPRIMEL = .0 ! (in m\*\*4/s\*\*3)

! END!

-----  
Subgroup (15b)  
-----

BUOYANT LINE SOURCE: CONSTANT DATA  
-----

Source No.	Beg. X Coordinate (km)	Beg. Y Coordinate (km)	End. X Coordinate (km)	End. Y Coordinate (km)	Release Height (m)	Base Elevation (m)	Emission Rates
-----	-----	-----	-----	-----	-----	-----	-----

- a Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.
- b An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by ILNTU (e.g. 1 for g/s).

-----  
Subgroup (15c)  
-----

BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA  
-----<sup>a</sup>

Use this subgroup to describe temporal variations in the emission rates given in 15b. Factors entered multiply the rates in 15b. Skip sources here that have constant emissions.

- IVARY determines the type of variation, and is source-specific:  
(IVARY) Default: 0
- 0 = Constant
  - 1 = Diurnal cycle (24 scaling factors: hours 1-24)
  - 2 = Monthly cycle (12 scaling factors: months 1-12)
  - 3 = Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
  - 4 = Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12)
  - 5 = Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

- a Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters

-----  
Subgroup (16a)  
-----

Number of volume sources with parameters provided in 16b,c (NVL1)      No default !    NVL1 = 0 !

Units used for volume source emissions below in 16b      (IVLU)      Default: 1 !    IVLU = 5 !

1 =            g/s

2 =            kg/hr

3 =            lb/hr

4 =            tons/yr

5 =            Odour Unit \* m\*\*3/s (vol. flux of odour compound)

6 =            Odour Unit \* m\*\*3/min

7 =            metric tons/yr

Number of source-species combinations with variable emissions scaling factors provided below in (16c)      (NSVL1)      Default: 0 !    NSVL1 = 0 !

Number of volume sources with variable location and emission parameters      (NVL2)      No default !    NVL2 = 0 !

(If NVL2 > 0, ALL parameter data for these sources are read from the VOLEMARB.DAT file(s) )

!END!

-----  
Subgroup (16b)  
-----

VOLUME SOURCE: CONSTANT DATA<sup>a</sup>  
-----

X Coordinate (km)	Y Coordinate (km)	Effect. Height (m)	Base Elevation (m)	Initial Sigma y (m)	Initial Sigma z (m)	Emission <sup>b</sup> Rates
-----	-----	-----	-----	-----	-----	-----

<sup>a</sup> Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

<sup>b</sup> An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IVLU (e.g. 1 for g/s).

-----  
Subgroup (16c)  
-----

VOLUME SOURCE: VARIABLE EMISSIONS DATA<sup>a</sup>  
-----

Use this subgroup to describe temporal variations in the emission rates given in 16b. Factors entered multiply the rates in 16b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

IVARY determines the type of variation, and is source-specific:  
(IVARY)      Default: 1

0 =            Constant

1 =            Diurnal cycle (24 scaling factors: hours 1-24)

2 =            Monthly cycle (12 scaling factors: months 1-12)

3 =            Hour & Season (4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)

4 =            Speed & Stab. (6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12)

5 =            Temperature (12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

a  
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

-----  
INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information  
-----

-----  
Subgroup (17a)  
-----

Number of non-gridded receptors (NREC) No default ! NREC = 13 !  
!END!

-----  
Subgroup (17b)  
-----

NON-GRIDDED (DISCRETE) RECEPTOR DATA<sup>a</sup>  
-----

Receptor No.	X Coordinate (km)	Y Coordinate (km)	Ground Elevation (m)	Height Above Ground (m)	b
1 ! X =	250.614,	5893.099,	287.000,	1.500!	!END!
2 ! X =	250.020,	5893.145,	299.000,	1.500!	!END!
3 ! X =	249.879,	5892.833,	302.000,	1.500!	!END!
4 ! X =	250.073,	5892.705,	294.000,	1.500!	!END!
5 ! X =	250.264,	5892.632,	294.000,	1.500!	!END!
6 ! X =	250.367,	5892.549,	294.000,	1.500!	!END!
7 ! X =	250.301,	5892.209,	304.000,	1.500!	!END!
8 ! X =	250.589,	5892.354,	294.000,	1.500!	!END!
9 ! X =	250.653,	5892.377,	294.000,	1.500!	!END!
10 ! X =	250.693,	5892.334,	294.000,	1.500!	!END!
11 ! X =	250.769,	5892.331,	294.000,	1.500!	!END!
12 ! X =	250.869,	5892.436,	294.000,	1.500!	!END!
13 ! X =	250.930,	5892.475,	277.000,	1.500!	!END!

a  
Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

b  
Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

GHD

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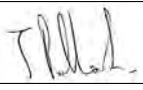
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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	M. Asimakis	T. Pollock		D. Kovacs		16/05/16

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