Veolia (Australia) Pty Ltd

Woodlawn Bioreactor Expansion Project

Independent Odour Audit #3

December 2014

FINAL REPORT

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EXECUTIVE SUMMARY

In August 2014, Veolia (Australia) Pty Ltd engaged The Odour Unit Pty Ltd (TOU) to carry out an Independent Odour Audit of the Woodlawn Bioreactor Facility located at Collector Road, Tarago, NSW. This represents the third Independent Odour Audit conducted since June 2012 and consisted of fieldwork, reviewing, and reporting components.

The Audit requirements is detailed in *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill sites* for DA 10_0012. In addition to the pre-defined requirements, the Audit scope was extended to include the odour diary entries that have been logged by participating residents from the period of May 2014 to September 2014.

Pond sources

The sampled pond-based odour emissions sources in this Audit included: the leachate aeration dam (LAD) and Evaporation Dam 3 North (ED3N) Pond System. In addition, the Audit reviewed the Leachate Treatment Operational Manual and treated leachate quality data supplied by Veolia.

The key findings in the Audit for pond sources are as follows:

- A reduction of approximately 92% in odour emissions from the LAD since the previous 2013 Audit;
- A reduction of approximately 91% in odour emissions in the treated leachate stored in ED3N;
- The dark colour characteristics of the treated leachate stored in ED3N has no link to odour emission potential;
- The leachate quality in ED3N is suitable for mechanical evaporation;
- The LAD is a continuous treatment system that is now streamlined. Its performance is benchmarked against key monitoring targets recommended by

Veolia Water and have been identified in the Audit to result in leachate quality stored in ED3N to be virtually odour-free; and

- The benchmarked specific odour emission rates derived in this Audit showed close agreement with the values used in the EA model.

Non-pond sources

The sampled non-pond based odour emissions sources in this Audit included key areas in the Void including: the active tipping face; waste covered areas; and leachate recirculation system. The Audit also consisted of odour sampling and testing on the trial of organic compost biofilter-based cover material, which was a non-mandatory audit recommendation in the 2013 Independent Odour Audit (2013 IOA), and vent air emissions from a positive displacement air pump in the Void.

The key findings in the Audit for non-pond sources are as follows:

- The benchmarked specific odour emission rates derived in this Audit showed close agreement with the values in the EA model (excluding fugitive gas emissions from the Void);
- The biofilter medium trial in the Void indicated a 88% reduction in fugitive gas emissions from a known problematical area at a depth of 0.5 m under adequate moisture conditions;
- Fugitive gas emissions continue to be an on-going operational issues that is actively managed by the Site;
- The transportation operations of waste from the Crips Creek Intermodal Facility continue to be an insignificant source of odour emissions;
- The active tipping face area was found to be similar to that found in the 2013 IOA;
- The use of a water cart to suppress dust continues to be an on-going operating practice;
- The sampled pressure relief vent emission from a selected Airwell pump system operating in the Void indicated that seepage of landfill gas into the vent air

emission during a discharge interval is occurring. Preliminary advice from Veolia to the Audit is that the seepage effect is an indicator of the decline of a pumps performance over time; and

- The pump pressure relief vents have the potential to be a significant contributor to odour emissions from the Void, in the event that the odour concentration is higher than that measured in the Audit and/or the number of operating pumps in use increase in the future.

Odour diary analysis

The Odour Diary project is a joint initiative between TOU and Veolia in early-2014 and was completed and issued to the community in May/June 2014. The purpose of the Odour Diary is to collect real-time data on ambient odour levels at residential properties. Whilst not being an Audit requirement, the odour diaries are relevant to the discussion of the Audit as it provides a better understanding on the nature and likely source of odours that are emitted beyond the Site boundary and experienced by the community.

A total of 116 entries were collected from eight out of the twelve odour diaries distributed and subsequently analysed in this Audit. Based on the analysis undertaken, it can be concluded that odour impact is experienced by most of the participating entrants under calm to light wind conditions with westerly winds. The major odour characters detected were ‘Garbage’ (76% of entries) and ‘Rotten eggs’ (11% of entries), suggesting that the Void is the likely source based on field observations and experience gained by the audit team. No odour characters were logged that could be directly related to the pond sources at the Site. Approximately 88% of positive entries that detected and recorded garbage as the odour character ranked the odour intensity between 1 and 3 (i.e. very weak to distinct). The remaining 12% of positive entries ranked it as 4 (strong). The positive entries that detected and recorded rotten eggs as the odour character (i.e. 11%) ranked the odour intensity between 2 to 4 (i.e. weak to strong).

The odour diary analysis suggests that there is a need to validate the community’s ability to characterise between the various odours detected. Notwithstanding this shortcoming, the above findings appear consistent with the Field Ambient Odour Assessment (FAOA) surveys conducted by the audit team separate to the Audit. The FAOA surveys results indicated that garbage was the dominant odour character detected by the assessors at a distance from the Site and closet to the Tarago community. There was an instance of a rotten eggs odour character detected, which is a common characteristic of the presence of landfill gas, in a downwind area closet to the Site. No rotten egg character however was detected in areas closet to the Tarago community.

Audit Recommendations

Based on the outcomes from this Audit, the following mandatory and non-mandatory audit recommendations have been made.

Mandatory recommendations

The mandatory recommendations in this Audit are as follows:

- Continue to adequately maintain and manage the leachate management system to ensure it is operating in an optimum state and meeting the leachate quality targets recommended by Veolia Water. This will significantly attenuate the potential for odour generation from the leachate stored in ED3N;
- Improve Gas Capture within the Void and continue to implement the works as outlined in the 2012 Waste Infrastructure Plan. The gas capture efficiency should be continuously monitored and recorded and the surface of the Void monitored to determine effectiveness of capture within specific areas of the Void; and
- A mechanical evaporation protocol/procedure should be developed that provides advice on the conditions under which treated leachate can be mechanically evaporated.

Non-Mandatory Recommendations

The non-mandatory recommendations in this Audit are as follows:

- Expansion and continuation of the biofiltration medium trial to be used in areas where there is an identified risk of fugitive odour emissions from the Void surface;
- The development of a pilot-scale biofilter system to evaluate the effect of medium depth on landfill gas emissions. Based on the results in the preliminary biofilter trial, a suitable medium depth range to evaluate would be between 0.5 – 1.0 m;
- Repeating the odour monitoring of the generator exhaust stacks;
- The cause and extent of landfill gas seepage into the leachate recirculation pump air pressure relief streams should be investigated by Veolia; and
- Investigate the Site sulphur loading and develop a suitable protocol to optimise the dosing of iron (or other metal-based compounds) into waste to reduce the potential for hydrogen sulphide generation and emission.

In addition to the above recommendations, Veolia should continue the current community liaison program (including the Woodlawn Community Liaison Committee and the Tarago and District Progress Association Inc.) to notify affected/nearby residents of works and address concerns. Veolia should also continue to log odour complaints in the current odour complaints register and odour diary project.

CONTENTS

APPENDICES

1 INTRODUCTION

In August 2014, Veolia (Australia) Pty Ltd (Veolia) engaged The Odour Unit Pty Ltd (TOU) to carry out the third Independent Odour Audit (the Audit) of the Woodlawn Bioreactor Facility located at Collector Road, Tarago, NSW (the Site).

The specific scope of works for the Audit is detailed in *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill site* and enforced by *Section 75J* of the *Environmental Planning and Assessment Act 1979* as part of the project approval for the Woodlawn Waste Expansion Project.

1.1 WOODLAWN WASTE EXPANSION PROJECT BACKGROUND

In March 2010, Veolia issued an application to the Department of Planning & Infrastructure (DPI) seeking approval to increase the maximum throughput rate of the Woodlawn Bioreactor from 500,000 to 1.13 million tonnes per annum (tpa). Simultaneously, Veolia was also seeking to increase the maximum throughput rate of the nearby Crisps Creek Intermodal Facility (IMF) to 1.18 million tpa.

The proposal further entailed:

- Installing additional lighting at the Site;
- Extending the approved hours of operation at the Bioreactor and the IMF site;
- Increasing the number of truck movements transporting waste to the Bioreactor from the IMF; and
- Increasing the amount of waste transported to the Site by road from regional councils from 50,000 to 130,000 tpa.

Veolia received approval for the Woodlawn Waste Expansion Project on 16 March 2012.

1.2 OBJECTIVES

In accordance with the project approval requirements of *Condition 7* of *Schedule 4* in the *Specific Environmental Conditions - Landfill sites* (DA 10_0012), Veolia is required to carry out an Independent Odour Audit three months from the date of project approval and annually thereafter, unless otherwise agreed by the Director-General. The Independent Odour Audit (IOA) must:

a. *Consult with OEH and the Department;*
b. *Audit the effectiveness of the odour controls on-site in regard to protecting receivers against offensive odour;*
c. *Review the proponents' production data (that are relevant to the odour Audit) and complaint records;*
d. *Review the relevant odour sections of the Air Quality and Greenhouse Gas Management Plan for the project and assess the effectiveness of odour control;*
e. *Measure all key odour sources on-site including:*
    i. *consideration of wet weather conditions providing all raw data used in this analysis;*
    ii. *consideration of (but not limited to) all liquid storage area, active tipping faces, waste cover area, aged waste areas and recirculation of leachate onto waste in the Void;*
    iii. *a comparison of the results of these measurements against the predictions in the EA*
f. *Determine whether the project is complying with the requirements in this approval to protect receivers against offensive odour*
g. *Outline all reasonable and feasible measures (including cost/benefit analysis, if required) that may be required to improve odour control at the site and; and*
h. *Recommend and prioritise (mandatory and non-mandatory) recommendations for their implementations.*

This is the third IOA commissioned since the Woodlawn Waste Expansion project approval was granted.

1.3 COMPLIANCE WITH AUDIT OBJECTIVES

The Audit has been undertaken by TOU and endorsed by the Director-General of the DPI, and consists of the following:

- *Fieldwork:* collection of odour samples from key sources (as per *Condition 7 (e)),* recording of relevant field observations and measurements, and discussions with Veolia Woodlawn staff in regards to the operations of the Bioreactor. The odour emissions inventory developed in the previous Independent Odour Audits (IOA), including 2012 & 2013, was used by the audit team as a basis for the sampling program in the Audit;
- *Reviewing:* a comprehensive review of all new relevant assessments undertaken and documentation since the 2013 IOA. This includes:
    - Review of landfill gas capture since the previous Audit;
    - Leachate quality data;
    - Leachate treatment operation manual;
    - A guide to the operation of Woodlawn Bioreactor's treatment system for extracted leachate manual;
    - Odour complaints register and responses by Veolia;
    - Stack Emission Survey for Generators No. 2, 3 & 4; and
    - Bioreactor operations and system functions;
- *Reporting:* a comprehensive summary of all aspects of the Audit, complying with the Audit objectives specified in **Section 1.2.**

1.3.1 Additional work to Audit requirements

In May 2014 Veolia, in conjunction with TOU, published and distributed odour diaries to participating community members. In addition to the requirements specified in **Section 1.2,** the Audit scope was extended to include the odour diary entries that have been logged by participating residents from the period of May 2014 to September 2014.

This report summarises the Audit carried out by the auditors at the Site.

2 THE SITE

2.1 WOODLAWN BIOREACTOR FACILITY BACKGROUND

The Site is located 250 km south of Sydney, within the 6,000 hectare (ha) Woodlawn Eco-Precinct, in the Southern Tablelands near Goulburn in New South Wales. An aerial view of the Site as it currently stands is shown in **Figure 2.1.**

Prior to waste operations, Woodlawn operated as a base metals open-cut mine site during the 1970s and 1990s, processing copper, lead and zinc. Since September 2004, the mine void has been operated as an in-situ Bioreactor. Putrescible waste from the Sydney metropolitan area was historically received solely via rail from the Clyde Transfer Terminal, while waste from local regional areas has been received since early 2012.

Waste contained within the Bioreactor undergoes anaerobic decomposition, which is supplemented by leachate recirculation, resulting in the production of landfill gas (also referred to as landfill gas). The landfill gas, predominately rich in methane (CH_4) and carbon dioxide (CO_2), is continuously extracted from the Bioreactor and directly consumed via purpose built landfill gas-fired engines that form the Site's power plant. Each landfill gas-fired engine is capable of generating up to 1.065 Megawatt hours (MWh) of 'green' electricity. All electricity generated is exported to the main grid. This process is described in further detail in the **Section 2.2**.

Aside from generating 'green' electricity from waste at Woodlawn, Veolia is also undertaking mine rehabilitation works and has established innovative wind farm, aquaculture and horticulture projects within the Eco-Precinct. These undertakings are not relevant to the Audit and thus have been excluded.

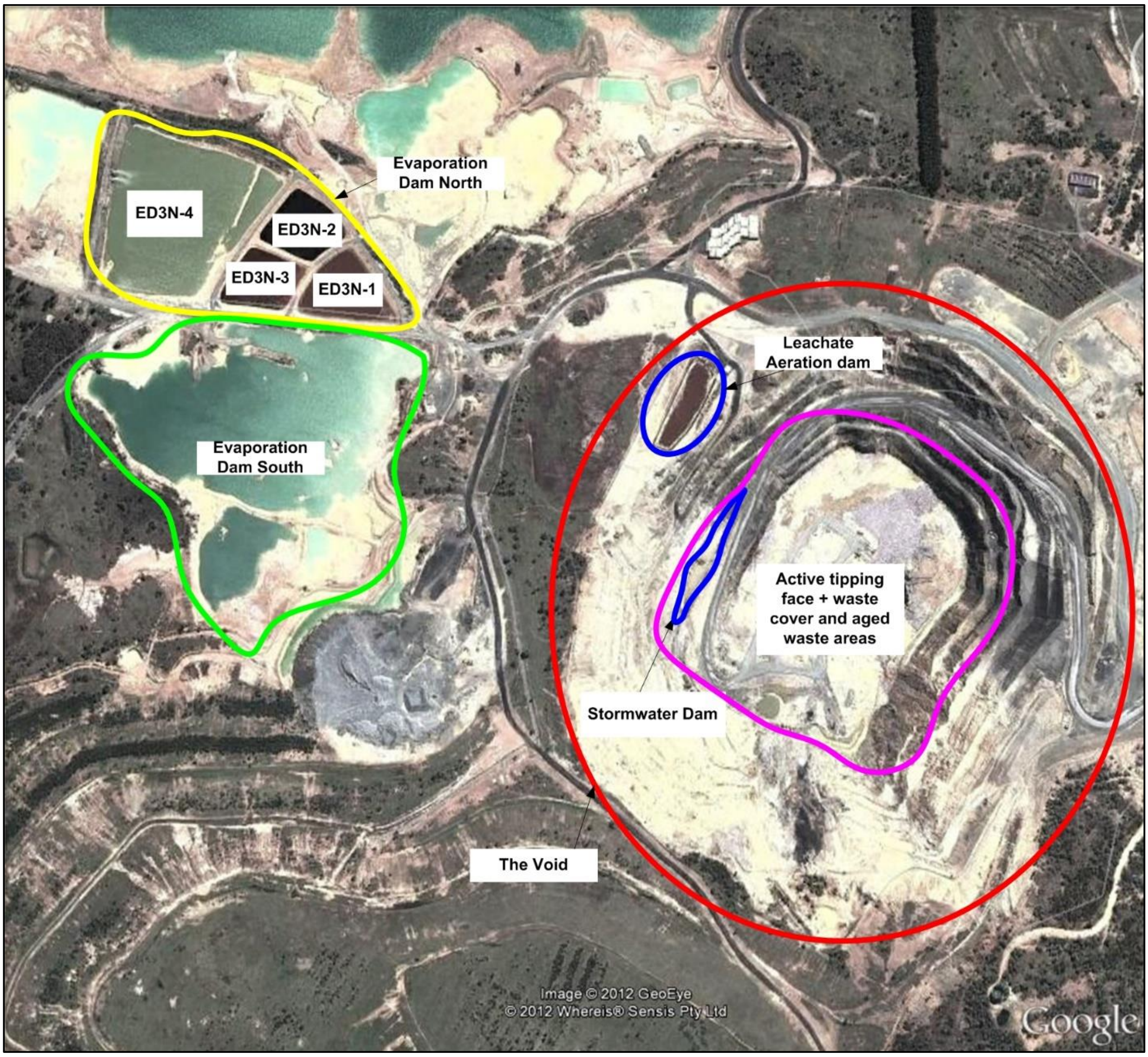


Figure 2.1 – An aerial view of the Site (**Image source:** Google Earth ®)

2.2 PROCESS OVERVIEW

The Site has approval to operate between 0600hrs to 2200hrs on Mondays to Saturdays, with no activities on Sundays, Good Friday or Christmas Day. For the purpose of this Audit, the operational processes at Woodlawn have been categorised under two primary management systems, namely:

1. The Bioreactor Waste Management System; and
2. The Leachate Management System

These management systems are described in concise detail in the **Sections 2.3 & 2.4.** Further details in regards to these systems are contained in the *Environmental Assessment Woodlawn Expansion Report* (EA) dated August 2010.

2.3 BIOREACTOR WASTE MANAGEMENT

At first glance, the Bioreactor layout appears to be a simple landfilling operation, consisting of the following:

- An active tipping face;
- Waste cover area;
- Aged waste area;
- A mobile tipping platform;
- A leachate recirculation system; and
- A gas extraction system.

On closer inspection, however, it is clear that there are complex operating procedures for the Bioreactor that result in a dynamic site layout that is able to vary with time and operational demands such as the requirement of covering areas of waste, setup of a gas extraction system at specified locations and the need for a leachate extraction/recirculation systems.

The Void layout and operations at the time of the Audit is shown in **Figure 2.2.**

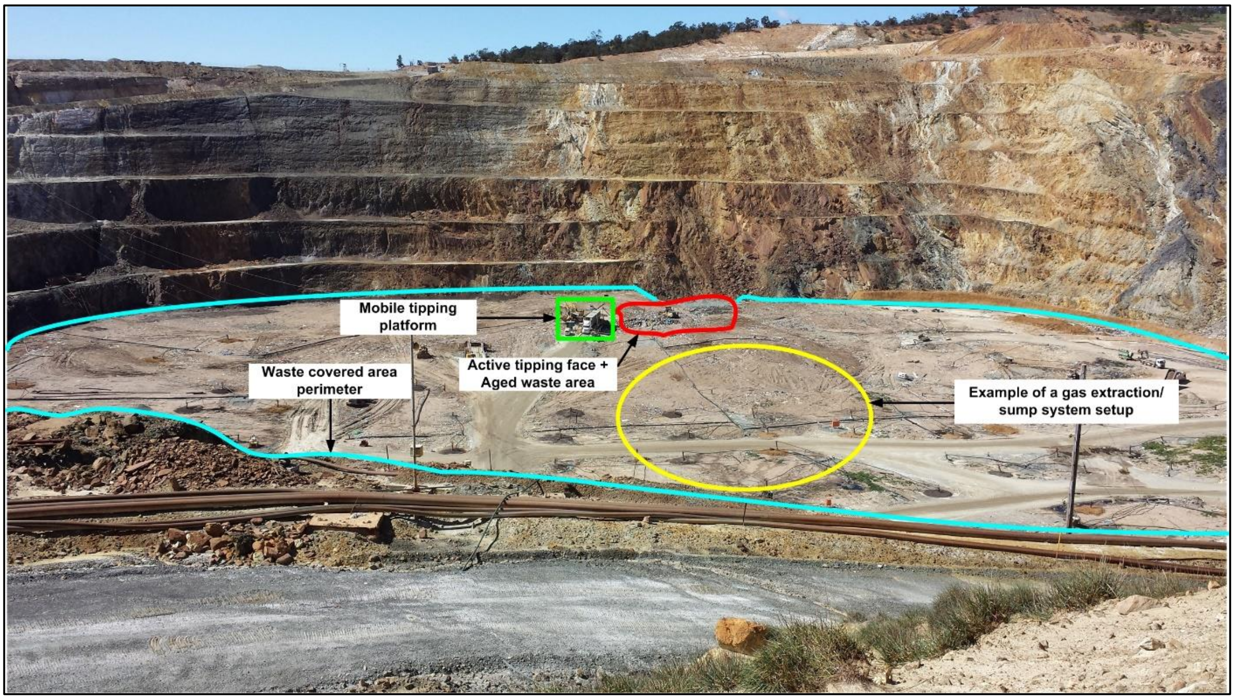


Figure 2.2 – Void Layout and operations as found on 1 October 2014

The current procedure for operating the Bioreactor involves the receival of putrescible waste transported to Woodlawn by rail from Sydney after being containerised at the Veolia Transfer Terminal situated in Clyde, NSW. The fully sealed containerised waste is received by the Crisps Creek Intermodal Facility and transported by a series of trucks to the Bioreactor, where waste is unloaded via a mobile tipping platform and subsequently transported by a dozer prior to compaction at the active tipping face area. The active tipping face area is progressively covered on a daily basis. As advised by Veolia in previous Audits, covering of the active tipping face is an ongoing operational process, although the area of exposed waste on a daily basis will vary depending on positioning in the Void, gas infrastructure and weather conditions. It was evident in this Audit that the size of the active tipping face was still well below the area size specified in the *EA Woodlawn Expansion Project (August 2010)*, discussed in further detail in **Section 7.2.1.5**.

It is understood by the Audit that the tipping process is supplemented by a hydrogen sulphide (H_2S) emission control measure which involves periodic in-situ addition of metal oxide (haematite and magnetite) to the waste as placed. Once a waste area is covered, leachate recirculation is promoted to optimise degradation rates and, in turn, encouraging the generation of landfill gas which is continuously extracted by the landfill gas infrastructure within the waste. The landfill gas collection system is constantly expanded to promote better gas capture as waste filling progresses around the Void.

2.3.1 Leachate recirculation

The main principle of leachate recirculation within the Void is to move leachate from aged waste areas, especially those that are in a more advanced stage of anaerobic decomposition, to new waste areas in order to enhance the waste decomposition process. This process has the effect of promoting higher and faster volumes of landfill gas generation within the Bioreactor. The current recirculation method is by direct injection into the waste area.

2.3.2 Landfill gas extraction

The operational management and instalment of landfill gas extraction infrastructure in the Void has been extensively described in *the Woodlawn Infrastructure Plan (WIP) Phase 1 - April 2012* (WIP 2012). The configuration during placement of waste on the surface of the Void and during waste lift is designed to ensure streamlined gas (and leachate) extraction. Landfill gas that is extracted is directed to a series of knock-out pots before flowing to the on-site cogeneration plant.

2.4 LEACHATE MANAGEMENT SYSTEM

The Leachate Management System (LMS) has been described in *Chapter 8* of the *EA Woodlawn Expansion Project (August 2010)*. It is a condition of the Site's Environmental Protection Licence (EPL) that no leachate (treated or untreated) is allowed to be directly discharged from site. The only means of volume reduction is through mechanical and/or natural evaporation processes. The Audit has found this is the continued practice at the Site.

According to *Chapter 8* in the *EA Woodlawn Expansion Project (August 2010)*, leachate (and any wastewater) generated at the Site is generated from (in order of highest contribution of total inflow):

- indirect rainfall (sides of the pit) (63%);
- groundwater inflow (21%);
- rainfall (direct onto waste) (13%);
- recirculated leachate (2%); and
- added water (water brought into Bioreactor, including water used to extinguish any landfill fires) (1%).

The key features of the LMS include the Evaporation Dam 3 North, Evaporation Dam 3 South, Leachate Aeration Dam and Storage Pond 7. Each of these features have been described in **Sections 2.4.1** to **2.4.4** respectively.

2.4.1 Evaporation Dam 3 North (ED3N)

ED3N pond system covers a total area of 3.6 hectares and is divided into four lagoons:

- *ED3N – 1:* contains treated leachate from the leachate aeration dam (LAD). The pond surface area as of the Audit is approximately 0.6 ha;
- *ED3N – 2:* receives treated leachate from the LAD. The pond surface area as of the Audit is approximately 0.55 ha;
- *ED3N – 3:* receives treated leachate from the LAD. On-site mechanical evaporators are available to promote evaporation but have not been used since the previous audit. The pond surface area as of the Audit is approximately 0.55 ha. Any overflow from this pond is directed to ED3N-1; and
- *ED3N – 4:* receives treated leachate overflow from ED3N–2 and ED3N-3. The pond surface area as of the Audit is approximately is 2.5 ha. Evaporators are available to promote evaporation which are controlled by wind direction and humidity.

2.4.1.1 Mechanical evaporation system

The mechanical evaporation system at the Site consists of five Turbomist ® evaporation pump units, three active and two spare, each capable of spraying 350 L/min of liquid into the air. These evaporator units are intended to only be operated under favourable wind directions (i.e. when wind direction favours air movement back over the dam) and when ambient relative humidity (RH) levels are less than 75%. Information provided by

Veolia indicates that approximately 20% to 30% of the pumped water is evaporated, depending upon ambient temperature and RH conditions. The evaporator units can be relocated to different areas within ED3N.

Veolia has indicated that they now intend on using the evaporator units as there is a growing need for volume reduction in the ponds to retrieve storage capacity. As cited in previous audits, the use of the evaporator units is an important part of volume reduction at the Site. This activity will be mainly undertaken in warmer months to maximise the evaporation potential. This is provided that the quality of the treated leachate stored in ED3N is assessed to be of suitable quality (discussed further in **Section 7.2.1.5**).

2.4.2 Evaporation Dam 3 South (ED3S)

ED3S contains stormwater runoff which is managed as acid mine drainage. The pond surface area is 6.7 ha.

2.4.3 Leachate Aeration Dam (LAD)

The LAD is located in the upper north-western edge of the Void and is an integral part of the LMS at the Site. Leachate from the Void is pumped directly to the LAD as required. Since the 2012 IOA, the LAD was upgraded from a batch-based wastewater treatment system to a continuous configuration. The upgraded system was commissioned in April 2013. **Figure 2.3** illustrates the current continuous treatment configuration for the LAD.

The LAD has a hydraulic retention time (HRT) of 33 days and is capable of continuous treatment of approximately 259,000 L/day of untreated leachate, equivalent to a current maximum treatment capacity of 3 L/s. The effluent from the LAD is dosed in-situ with a polymer before passing through a settling tank (known as the Woodlawn Aerated Leachate Treated Effluent Refiner or WALTER). The sludge from the settling tank is returned to the LAD and when required can be transported to the Void. Under this treatment configuration, the LAD requires desludging approximately every 2 - 5 months (as advised by Veolia Water). The sludge from the desludging process (and any excess sludge that is generated) is returned to the waste in the Bioreactor where it is buried and covered.

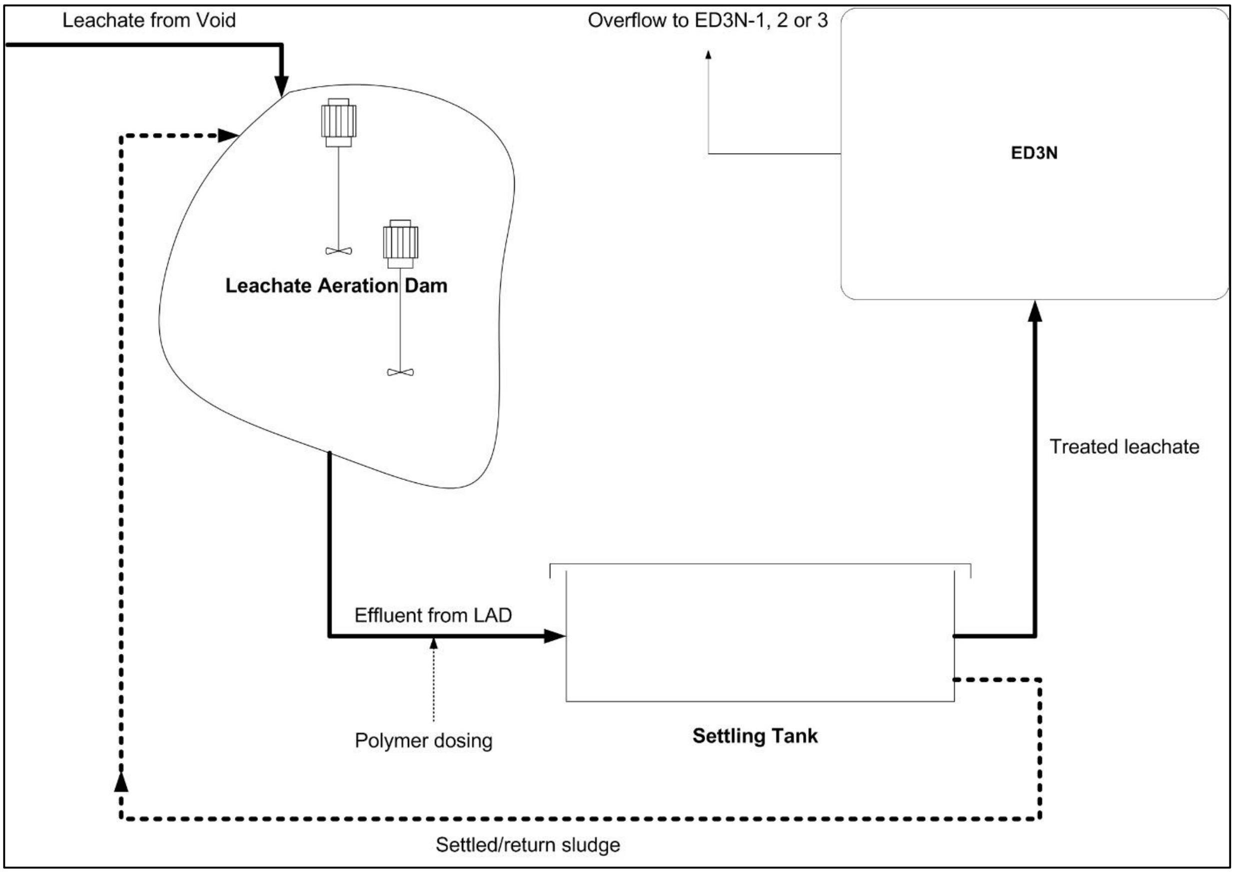


Figure 2.3 – Flow schematic of the current continuous leachate treatment system at the Site

2.4.4 Storage Pond 7 (inside the Void)

At the time of the Audit, Storage Pond 7 remains decommissioned (previously located in the Void). As a result, it has been excluded as a valid odour emission source for the purposes of this Audit. There are no stored leachate sources on the waste surface of the Void.

3 SAMPLING PROGRAM

As per *Condition 7 (e)* of *Schedule 4* in the *Specific Environmental Conditions - Landfill site,* this Audit measured all current and key sources at the Site. As previously highlighted **in Section 1.3**, the odour emissions inventory developed in the 2013 IOA by the audit team was used as a basis for the sampling program in the Audit.

A total collection of twenty eight samples, namely, twenty five gas samples and three liquid samples. The liquid samples, whilst not being a requirement for the purposes of this Audit, were collected from ED3N-2, ED3N-3 & ED3N-4 to provide a basic snapshot of the liquid odour potential of the lagoons contents of interest. The liquid samples were collected for subsequent odour concentration measurement using an in-house NATA-accredited Liquid Odour Concentration Determination Method (see **Section 4.3 & Appendix D** for details). This method is able to quantify the odour emissions caused by the natural or forced evaporation of odorous liquids (see **Section 7.2.1.5** for results).

The sampling program for the Audit has been summarised in **Table 3.1.** As shown**,** there are several key sampling locations at the Woodlawn Bioreactor Facility. This includes:

- The Bioreactor;
- ED3N System;
- The Landfill Gas System; and
- Other sources in Void.

The sampling program includes all key sources requested in *Condition 7 (e) of Schedule 4 in the Specific Environmental Conditions - Landfill site* with the following exceptions:

- *Consideration of wet weather conditions:* No rainfall was experienced during sampling. As a result, this Audit was unable to collect representative odour samples under wet weather conditions but considered the effects of wet weather in terms of the need to handle increased levels of leachate under wet weather conditions; and

- *Leachate recirculation:* Similarly to the 2012 IOA, the Audit was unable to observe and thus collect representative samples for this scenario. Since the EA was undertaken, Veolia has developed a leachate recirculation system that involves direct injection of leachate into the waste which eliminates the need for spraying over the surface. The audit team understands this will remain to be continued practice into the future. Therefore, no suitable access points for the collection of odour samples from this source will be possible.

No samples were collected from the Crisps Creek Intermodal Facility as waste transportation is a fully contained process until displacement of the waste contents into the Void. Similarly to the previous Audit, it has been determined by the Audit team that there are no valid odour emission sources from this operation that can be physically measured. As will be discussed in **Section 7.2.1.9**, the Crisps Creek Intermodal Facility is not considered to be a significant contributor to the Site's overall odour emissions profile.

Table 3.1 - Woodlawn Bioreactor Facility Sampling Program: 30 September 2014 – 2 October 2014		
Location	**Source Type**	**No. of samples collected**
The Bioreactor		
Active Tipping Face	Area source	2
Waste Covered Area		13
Leachate Aeration Dam		
Leachate Aeration Dam	Area source	2
ED3N Pond System		
ED3N - 1	Area source	2
ED3N - 2	Area Source (2) + Liquid odour measurement (1)	3
ED3N - 3	Area source (2) + Liquid odour measurement (1)	3
ED3N - 4	Area source (1) + Liquid odour measurement (1)	2
Landfill Gas System		
Gas engine inlet (i.e. landfill gas)	Point source	0
Other sources		
Positive displacement pump pressure relief vent	Point source	1
TOTAL		**28**

4 SAMPLING METHODOLOGY

The following sampling methodologies refers to the source type description presented in **Section 3** - **Table 3.1** source type description.

4.1 POINT SOURCE SAMPLING

4.1.1 Positive displacement pump pressure relief vent

The method used for collecting samples from the positive displacement pump pressure relief vent involved drawing the sample air through a polytetrafluoroethylene (PTFE), commercially known as Teflon ®, sampling tube into a single use, Nalophan sample bag. The air samples collated using this technique only involved the positive pressure on the discharge side of the vent where the sample was collected on the air vent discharge line.

4.2 AREA SOURCE SAMPLING METHOD

The objective of the area source sampling programme was to collect representative samples at various locations at the Site, and included both solid and liquid surface area sources. The area source sampling is undertaken using an apparatus known as an isolation flux hood (IFH). All sampling using the IFH is carried out according to the method described in the United States Environment Protection Agency (US EPA) technical report '*EPA/600/8-86/008*'. This method is also defined in Australian Standard AS/NZS4323.4. TOU's IFH adheres to the design specifications, materials of construction and supporting equipment that the US EPA report '*EPA/600/8-86/008*' defines. **Table 4.1** summarises the design specifications of the IFH.

Once the IFH apparatus is set up for sample collection, dry nitrogen gas (N_2) is then introduced into the hood at a sweep rate of 5 litres per minute.

Table 4.1 - IFH design specifications

Parameter	Value
Diameter (m)	0.406
Surface Area (m^2)	0.13
Volume (L)	30*

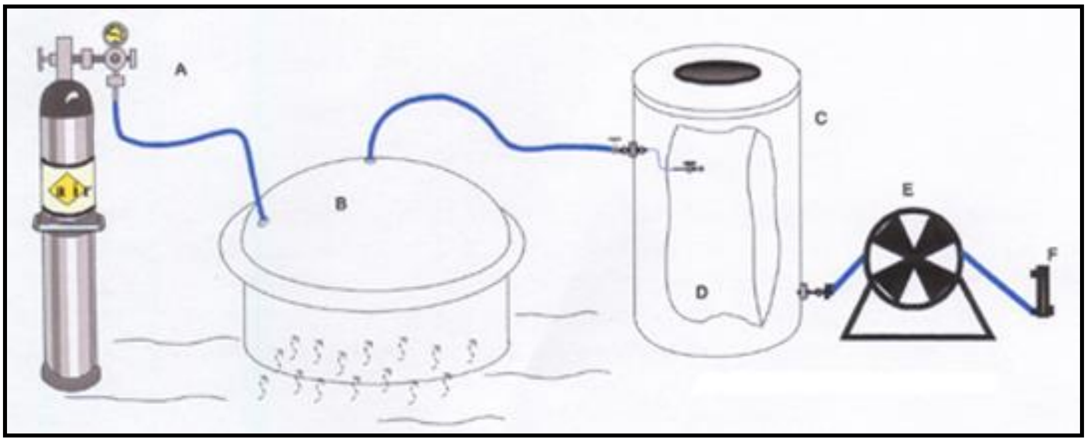
* When the skirt of the hood is immersed into the water or solid surface by the specified 25 millimetres

Area source samples are opened to the atmosphere resulting in wind being a major factor in the release of odorous pollutants from the surface and conveying the pollutant from the source to areas beyond the boundary of the Site. The IFH system is designed to simulate the mass transfer of odorous pollutants into the atmosphere, resulting in a controlled and consistent sampling environment. This is achieved by the flux of dry nitrogen sweep gas into the IFH, as it is positioned on the solid or liquid surface. On a liquid surface this is achieved by floating the IFH within an inflated tyre inner tube. The nitrogen gas then transports the odour from the surface in a similar manner to the wind, albeit at a very low sweep velocity. This odorous air is then sampled for subsequent odour testing.

As the IFH has a constant 5 litres per minute inflow of nitrogen gas to it, the sampling chamber remains under very slight positive pressure (less than 2 Pa) and produces a net outflow through the vent on top of the IFH, therefore eliminating any chance of contamination with external air from the atmosphere. The IFH's volume of 30 litres and the 5 litres per minute nitrogen sweep rate results in a gas residence time of 6 minutes. The standard method prescribes a minimum of four (4) air changes in order to achieve optimum purging and equilibrium in the hood, and hence a total of 24 minutes is allowed before sampling commences. The sample is then collected at a flow rate of approximately 2 litres per minute over a 5–10 minute period to obtain a 10–20 litre gas sample for analysis.

The method followed by the audit team is depicted in the schematic of the sampling equipment shown in **Figures 4.1 & 4.2**. The IFH is manufactured from acrylic resin to ensure it does not contribute to the odour sample. All other surfaces in contact with the sample are made from PTFE or stainless steel.

Figure 4.1 - Schematic Drawing of Sampling with the IFH

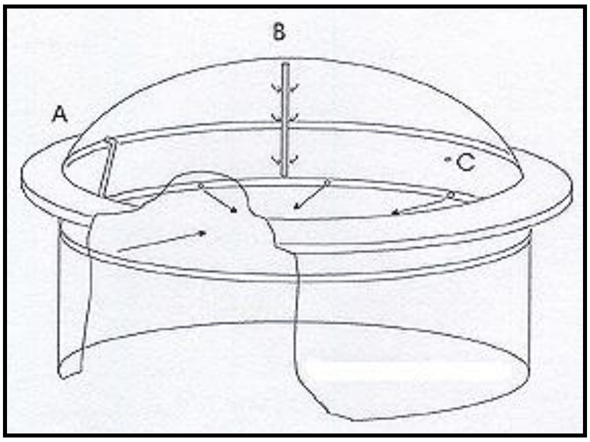


Source: Odotech - Odoflux IFH Manual

Key

A	Cylinder of medical air, nitrogen or any neutral gas.
B	IFH (detailed diagram shown in **Figure 4.2**)
C	Lung chamber (sampling drum)
D	Nalophan sampling bag
E	Sampling pump
F	Air flow meter

Figure 4.2 - Schematic of the IFH



Key

A	Inlet gas from gas cylinder.
B	Outlet to sample bag.
C	Additional gas outlet points for other sampling, or temperature and moisture monitoring.

Source: Odotech - Odoflux IFH Manual

The use of the IFH method enables a Specific Odour Emission Rate (SOER) to be calculated (ou.m^3/m^2/s). A SOER is a measure of odour released from a representative area unit. The SOER is multiplied by the area of the source to obtain an Odour Emission Rate (OER) (ou.m^3/s), or the total odour released from each source. This calculation is demonstrated in **Equation 4.1 & Equation** 4.2 below.

$$SOER\ (ou.m^3m^{-2}s^{-1}) = OC * \frac{Q}{A}$$ **Equation 4.1**

$$OER\ (ou.m^3s^{-1}) = SOER * area\ of\ source\ unit\ (m^2)$$ **Equation 4.2**

where

OC = odour concentration of compound from air in the chamber (ou)

Q = sweep gas volumetric flow rate into chamber (m^3/s)

A = sample source total surface area (m^2)

All area source samples collected in the Audit were collected using the area source sampling method.

4.2.1 Biofilter capping material trial

The trialling of biofilter capping material was a non-mandatory recommendation from the previous 2013 IOA to mitigate known fugitive odour emission sources, while continuing to improve gas collection at the Site. Veolia is trialling the biofilter capping material to complement existing cover material. It is intended that, if determined to be effective, the biofilter capping material may be used in the future as a contingency measure to assist in odour management at the Site.

Veolia has advised the Audit that placement of biofilter capping material has been placed in areas where perimeter cracking and areas of increased settlement has occurred. Other key areas have been targeted based on surface emissions monitoring and areas that are identified as potential sources of fugitive odour emissions. The biofilter capping material, which is being applied over existing capping material, is a mixture of oversized compost fractions, mulch and fines. This organic-based capping material is being used on the basis that a biofiltration-like effect could occur, which would result in the in-situ treatment of fugitive landfill gas emissions from the Bioreactor prior to discharge to atmosphere.

The biofilter capping material has been sampled at two different medium depths including 300 mm and 500 mm. These medium depths are currently being applied to cracks or known problematical area in the Bioreactor. The area source sampling method (described in **Section 4.2**) was used for the collection of gas samples for the trial in the Audit, and should be used in any future trials in the Bioreactor. Further details on the sampling for the trial is described in **Section 6.2.1.**

4.3 LIQUID ODOUR METHOD

4.3.1 Overview

The Liquid Odour Method (LOM) was developed by TOU for measurement of the odour release potential from process liquors, which is universally applicable to aqueous solutions containing odorous substances. In simple terms, it measures the odour released when an odorous liquid evaporates. It is directly relevant to the mechanical evaporation units in use at the Site for volume reduction of treated leachate (see **Appendix D** for details on methodology).

5 ODOUR CONCENTRATION MEASUREMENT METHOD

TOU's odour laboratory operates to the Australian Standard for odour measurement '*Determination of odour concentration by dynamic olfactometry'* (AS/NZS 4323.3:2001) which prescribes a method for sample analysis that provides quality assurance/quality control and ensures a high degree of confidence in the accuracy, repeatability and reproducibility of results.

The concentration of the gaseous odour samples were measured using a technique known as dynamic olfactometry. Dynamic olfactometry involves the repeated presentation of both a diluted gaseous odour sample and an odour-free air stream to a panel of qualified assessors through two adjacent ports on the olfactometer (known as the Odormat™). TOU utilises four (4) to six (6) trained assessors (or panellists) for sample analysis, with the results from four qualified panellists being the minimum allowed under the Australian Standard AS/NZS 4323.3:2001. For the Audit, four panelists were used.

The method for odour concentration analysis involves the odorous gas sample initially being diluted to the point where it cannot be detected by any member of the panel. The assessor's step- up to the olfactometer in turn, takes a sniff from each port, then choose which port contains the odour and enter their response. At each stage of the testing process, the concentration of the odorous gas is systematically increased (doubled) and re-presented to the panellist's. A round is completed when all assessors have correctly detected the presence of the odour with certainty. The odour is presented to the panel for three rounds and results taken from the latter two rounds, as stated in AS/NZS 4323.3:2001.

The results obtained give an odour measurement measured in terms of odour units (ou). One (1) ou is the concentration of odorous air that can be detected by 50% of members of an odour panel (persons chosen as representative of the average population sensitivity to odour). This process is defined within AS/NZS 4323.3:2001. The odour units can be subsequently multiplied by an emission rate or volumetric flow to obtain an

Odour Emission Rate (ou.m^3/s) or a SOER (ou. m^3/m^2/s) for area source samples collected using the IFH method (see **Section 4.2**).

5.1 ODOUR MEASUREMENT ACCURACY

The repeatability and odour measurement accuracy of the Odormat™ is determined by its deviation from statistically reference values specified in AS/NZS4323.3:2001. This includes calculation of instrumental repeatability (r), where r must be less than 0.477 to comply with the standard criterion for repeatability. Its accuracy (A) is also tested against the 95th percentile confidence interval, where A must be less than 0.217 to comply with the accuracy criterion as mentioned in the Standard.

The Odormat™ V05 was last calibrated in April 2014 and complied with all requirements set out in the AS/NZS4323.3:2001 (see **Appendix A** – Result sheets: *Repeatability and Accuracy*). The calibration gas used was 50 ppm n-butanol in nitrogen gas.

6 RESULTS

6.1 ODOUR TESTING AND H_2S CONCENTRATION MEASUREMENT RESULTS

This chapter is dedicated to addressing the following Audit requirement as outlined in **Section 1.2**, that is:

e. Measure all key odour sources on-site including:

i. consideration of wet weather conditions providing all raw data used in this analysis;

ii. consideration of (but not limited to) all liquid storage area, active tipping faces, waste cover area, aged waste areas and recirculation of leachate onto waste in the Void;

iii. a comparison of the results of these measurements against the predictions in the EA.

All key odour sources at the Site were measured in the Audit. This section has several tables presented, as follows:

- **Table 6.1** summarises the odour emission results obtained from the Audit and compares the results against the EA predictions;
- **Table 6.2** summaries the global mean SOER results derived in this Audit and compares these results to those derived in the previous IOAs in 2012 & 2013;
- **Table 6.3** summarises in-situ H_2S concentration measurement results undertaken on all collected samples in the Audit using a calibrated Jerome ® 631-X H_2S analyser (Jerome Analyser). The concentration results in this table have been presented in part per million (ppm) by volume; and
- **Table 6.4** summarises liquid odour measurement results.

In the following section (**Section 7**)**, Table 7.1** summarises the odour emission rates from emission sources amenable to quantitative measurements. These sources have been ranked in descending order. The results in **Table 7.1** do not include potential gas pathways and other fugitive emission sources from the waste surface, due to the difficulty in assigning an appropriate emission area for these sources in order to calculate an odour emission rate ($ou.m^3/s$) derived from the SOER ($ou.m^3/m^2/s$) and the area (m^2). This was a similar constraint in the previous IOAs.

Table 6.1 - The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 30 September 2014 – 2 October 2014						
Source	**The Audit**				**EA**	
Sample Location	**Sample Number**	**Odour Concentration (ou)**	**SOER (ou.m³/m²/s)**	**Odour Character**	**SOER Range (ou.m³/m²/s)**	**SOER Model Input (ou.m³/m²/s)**
Bioreactor (The Void)						
Active Tipping Area						
Sample #16 - Active Tipping Face (< 1 day old)	SC14589	6,320	4.10	garbage	1.0 – 7.3*	7.3 (wet fresh waste emission adopted)
Sample #17 - Active Tipping Face (< 1 day old)	SC14590	6,890	4.47	garbage		
Aged Waste	n/m***				0.5	
Waste Covered Area						
Sample #10 - Waste Covered Area (LE80 – Normal capping material)	SC14583	41	0.025	dirt	0.1 - 0.2** (covered)	0.2
Sample #11 - Waste Covered Area (Normal Capped Area between LE80 & LE91)	SC14584	41	0.025	weak garbage		
Sample #12 - Waste Covered Area (LE74 - Biofilter capping material)	SC14585	362	0.208	earthy, garbage	7.5 – 23.9^	23.9^
Sample #13 - Waste Covered Area (Void perimeter with biofilter capping material)	SC14586	362	0.257	metallic, green waste		
Sample #15 - Waste Covered Area (Biofilter capping material - NW slopping end)	SC14588	215	0.122	fruity, garbage		

***** includes dry and wet waste
****** includes dry and wet covered waste
*** unable to be sampled in this Audit due to access and safety concerns prevailing at the time
^ represents potential gas pathways
n/m = not measured

Table 6.1 continued - The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 30 September 2014 – 2 October 2014						
Source	**The Audit**				**EA**	
Sample Location	**Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2/s$)**	**Odour Character**	**SOER Range ($ou.m^3/m^2/s$)**	**SOER Model Input ($ou.m^3/m^2/s$)**
Bioreactor (The Void)						
Construction and Demolition Area						
Construction and Demolition Area	n/m				n/a	
Leachate Aeration Dam						
Sample #8 - Leachate Aeration Dam	SC14581	32	0.021	stale water	0.1 - 7.4****	3.6
Sample #9 - Leachate Aeration Dam	SC14582	45	0.030	stale water		
Leachate recirculation system						
Sample #23 – Recirculated leachate injection point: Covered Area (North-western Void Perimeter)	SC14602	1,330	0.807	burnt hair, dirty water	1.6 – 2.5	2.5
Sample #25 - Recirculated leachate injection point: Covered Area(North-western Void Perimeter)	SC14604	664	0.403	burnt hair, dirty water, muddy		
Landfill Gas Extraction System						
Landfill gas inlet	n/m				n/a	
Catchment Pond (stormwater + leachate)						
Storage Pond 7	n/m				2.1 – 8.8	8.8
Other sources in Void						
Sample #14 - LE74 Positive displacement pump pressure relief vent	SC14587	46,300	n/a	H_2S, landfill	n/a	

**** includes partially / fully treated leachate (dependent on the treatment stage of the process at the time samples were collected)

^ represents potential gas pathways

Table 6.1 continued- The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 30 September 2014 – 2 October 2014							
Source	**The Audit**					**EA**	
Sample Location	**Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2/s$)**	**Odour character**		**SOER Range ($ou.m^3/m^2/s$)**	**SOER Model Input ($ou.m^3/m^2/s$)**
Evaporation Dams							
Evaporation Dam 3 North (ED3N) Pond System							
Sample #6 - ED3N-1	SC14579	25	0.018	dusty		2.1 – 8.8	8.8
Sample #7 - ED3N-1	SC14580	23	0.017	stale air			
Sample #2 - ED3N-2	SC14572	108	0.072	stale water, burnt, nutty, sewage		0.1 – 7.4	0.2***
Sample #4 - ED3N-2	SC14574	91	0.061	burnt, nutty, sewage, soil			
Sample #1 - ED3N-3	SC14571	38	0.025	musty, soil, rubber			
Sample #3 - ED3N-3	SC14573	59	0.039	cooking oil, fat, grease			
Sample #5 - ED3N-4	SC14578	32	0.023	rubbery		0.1 – 0.7	0.7*****
Sample #LOM1 - ED3N-4	SC14575	21	n/a	dirty water		n/a	
Sample #LOM2 - ED3N-3	SC14576	99	n/a	rubber, stale water			
Sample #LOM3 - ED3N-2	SC14577	108	n/a	rubber, stale water			
Evaporation Dam 3 South (ED3S) Pond System							
ED3S (Stormwater)	n/m					0.0 - 0.5	0.5

*** partially / fully treated leachate
***** includes groundwater and fully treated leachate
n/a = not applicable
n/m = not measured

Table 6.1 continued - Biofilter trial odour testing results: 30 September 2014 – 2 October 2014						
Source	**The Audit**				**EA**	
Sample Location	**Sample Number**	**Odour Concentration (ou)**	**SOER ($ou.m^3/m^2/s$)**	**Odour character**	**SOER Range ($ou.m^3/m^2/s$)**	**SOER Model Input ($ou.m^3/m^2/s$)**
Waste covered area (biofilter trial)						
Sample #19 - LE57 Normal capping material Location #1	SC14598	12,600	7.96	rotten egg, landfill gas, pineapple, garbage	**n/a**	
Sample #20 - LE57 Normal capping material Location #2	SC14599	861	0.544	garbage, landfill gas		
Sample #18 - LE 52 Biofilter capping material (300 mm + dry)	SC14597	92,700	67.9	pineapple, rotten garbage, landfill gas		
Sample #21 - LE52 Biofilter capping material (300 mm + wet)	SC14600	92,700	61.2	pineapple, landfill gas		
Sample #22 - LE76 Biofilter capping material (500 mm + dry)	SC14601	25,300	15.4	pineapple, landfill, garbage		
Sample #24 - LE76 Biofilter capping material (500 mm + wet)	SC14603	2,900	1.72	garbage, pineapple, dirty water		

n/a = not applicable

Table 6.2 – Global mean SOER results: Comparison between The Audit and previous IOAs			
Source	**The Audit**	**2013 IOA**	**2012 IOA**
Location	**TOU SOER (ou.m^3/m^2/s)**		
ED3N-1	0.017	0.30	394
ED3N-2 & 3^	0.049	11.6 ^^^^	0.29
ED3N-2	0.066	20.1 ^^^	0.21
ED3N-3	0.032	0.2	0.37
ED3N-4	0.023	0.0604	0.41
Active Tipping Face	4.28	3.04	8.36
Leachate Aeration Dam	0.026	0.323	0.46
Construction and Demolition Tip Face	n/a#	0.293	n/a
Storage Pond 7	n/m^^		85

^ as specified in the EA

^^ no longer exists - see **Section 2.4.4** for details

^^^ represents the sub-optimal pond contents that has now been treated (see **IOA 2013 Report** for details)

^^^^ bulk of emissions originating from ED3N-2 (see **IOA 2013 Report** for details)

There was no designated area in the Audit. See **Section 6.2.1** for details

n/a = not applicable

n/m = not measured

Table 6.3 – Global Jerome H_2S Measurement Results: 30 September 2014 – 2 October 2014		
Sample Location	**TOU Sample Number**	**Jerome H_2S concentration reading in bag (ppm)**
Evaporation Dam 3 North (ED3N) System		
Sample #1 - ED3N-3	SC14571	n/m
Sample #2 - ED3N-2	SC14572	n/m
Sample #3 - ED3N-3	SC14573	n/m
Sample #4 - ED3N-2	SC14574	n/m
Sample #5 - ED3N-4	SC14578	0.000
Sample #6 - ED3N-1	SC14579	0.004
Sample #7 - ED3N-1	SC14580	0.004
Leachate Aeration Dam		
Sample #8 - Leachate Aeration Dam	SC14581	0.000
Sample #9 - Leachate Aeration Dam	SC14582	0.000
Active Tipping Area		
Sample #16 - Active Tipping Face (< 1 day old)	SC14589	0.116
Sample #17 - Active Tipping Face (< 1 day old)	SC14590	0.080
Waste Covered Area		
Sample #10 - Waste Covered Area (LE80 – Normal capping)	SC14583	0.006
Sample #11 - Waste Covered Area (Normal Capped Area between LE80 & LE91)	SC14584	0.016
Sample #12 - Waste Covered Area (LE74 - Biofilter capping material)	SC14585	0.006
Sample #13 - Waste Covered Area (Void perimeter with biofilter capping material)	SC14586	0.038
Sample #23 - Recirculated leachate balance pond area: Covered Pond (North-western Void Perimeter)	SC14602	0.000
Sample #25 – Recirculated leachate balance pond area: Covered Pond (North-western Void Perimeter)	SC14604	0.000
Sample #15 - Waste Covered Area (Biofilter capping material - NW slopping end)	SC14588	0.000
Other sources in Void		
Sample #14 - LE74 Positive displacement pump pressure relief vent	SC14587	9.6

Table 6.3 continued – Global Jerome H_2S Measurement Results: 30 September 2014 – 2 October 2014		
Sample Location	**TOU Sample Number**	**Jerome H_2S concentration reading in bag (ppm)**
Biofilter trial		
Sample #19 - LE57 Normal capping material Location #1	SC14598	1.6
Sample #20 - LE57 Normal capping material Location #2	SC14599	0.041
Sample #18 - LE 52 Biofilter capping material (300 mm + dry)	SC14597	2.2
Sample #21 - LE52 Biofilter capping material (300 mm + wet)	SC14600	4.8
Sample #22 - LE76 Biofilter capping material (500 mm + dry)	SC14601	3.0
Sample #24 - LE76 Biofilter capping material (500 mm + wet)	SC14603	0.380

Table 6.4 – LOM **d**erived odour emission rates for mechanical and natural evaporation methods: 30 September 2014 – 2 October 2014						
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**Calculated Liquid Odour Potential (ou/mL)**	**Mechanical Evaporation Rate (L/min) per evaporator^ η = 20% / 30%**	**Mechanical Evaporation Odour Emission Rate ($ou.m^3/s$) per evaporator η = 20% / 30%**	**Mechanical Evaporation Odour Emission Rate ($ou.m^3/s$) ALL evaporators^^^ η = 20% / 30%**
Evaporation method: Mechanical						
ED3N-2	SC14577	108	6.54	70 / 105	7,630 / 11,500	22,900 / 34,500
ED3N-3	SC14576	99	5.99		6,980 / 10,500	20,900 / 31,500
ED3N-4	SC14575	21	1.27		1,480 / 2,220	4,440 / 6,660
Evaporation method: Natural						
Sample Location	**TOU Sample Number**	**Odour Concentration (ou)**	**Calculated Liquid Odour Potential (ou/mL)**	**Current Area (m^2)**	**Natural Evaporation rate (L/s) ^^**	**Natural Evaporation Odour Emission Rate ($ou.m^3/s$)**
ED3N-2	SC14577	108	6.54	5,500	0.882	1,270
ED3N-3	SC14576	99	5.99	5,500	0.194	1,160
ED3N-4	SC14575	21	1.27	25,000	0.194	1,120

^ Mechanical evaporation rate is based on 20% / 30% evaporation efficiency per evaporator
^^ The natural evaporation rate is based on the mean evaporation rate recorded between May 2007 to June 2012, equivalent to 92.67 mm/month
^^^ Based on three active and identical evaporators

6.2 COMMENTS ON RESULTS

The following sections comment on the results presented in **Tables 6.1 to 6.4** in **Section 6.1.**

6.2.1 The Void Samples

- The sampling locations inside the Void have been nominally shown in **Figure 6.1.** The sample numbers presented in **Figure 6.1** correspond with those in the sampling location column in **Table 6.1.** The conditions prevailing in the Void at the time of the Audit is visually presented in **Photo 6.1**;
- The SOER results for the Active Tipping Area (SC14589 & 14590) within the Void continue to remain generally consistent with the results from the 2012 & 2013 IOAs and well below the SOER model input value used in EA dispersion modelling (i.e. below 7.3 $ou.m^3/m^2/s$);
- The Waste Covered Area samples (SC14583 – SC14586 & SC14588) were collected from areas within the Void identified by the audit team as potential gas pathways (i.e. areas identified in this Audit as potentially having a higher fugitive emission level than other areas around the Void) and other strategic locations designed to gauge the general emissions emanating from the Void. There were two type of covered areas sampled in this Audit, including:

    1. Areas covered with normal cover material used in the Bioreactor; and
    2. Areas covered with biofilter capping material.

- The results for the Waste Covered Areas component of this Audit indicate a substantial reduction in odour emissions and are now below the target SOER Model Input of 0.2 $ou.m^3/m^2/s$ for a covered area and 23.9 $ou.m^3/m^2/s$ for potential gas pathways. SC14583 & SC14584 were judged to be a covered area and SC14585-14588 were judged to be a potential gas pathways (as Veolia had advised that biofilter material was placed in these areas to fill visible cracks). This effort by Veolia to fill cracks with the biofilter medium appears to be effective in attenuating odour emissions from known potential gas pathways;

- In addition the Waste Covered Area component of the Audit, the sampling was extended to exclusively evaluate the effectiveness of the biofilter medium currently being trialled within the Void around sump areas, cracks and other known potential gas pathways (SC14598 – SC14601 & SC14603). There appears to be a reduction with the biofilter at 500 mm and no significant effect at 300 mm. This is discussed further in **Section 7.2.1.6;**
- The Waste Covered Area (biofilter trial) samples (SC14597-SC14501 & SC14603) were collected from areas where oversized compost fractions, mulch and fines (referred to as biofilter medium) have been used as a second cover layer over areas with perimeter cracking and high settlement. The objective of collecting these samples was to gauge the effectiveness of this type of covering system under varying conditions. In this Audit only a preliminary trial was carried out where the biofilter medium was sampled with a fill depth of 300 mm and 500 mm. Veolia are using between 300 mm to 500 mm fill depth as the current practice;
- The sampled positive displacement pump returned an odour concentration result of 46,300 ou and a H_2S measurement of approximately 10 ppm. This indicates that there could be potential seepage of landfill gas into the air pressure relief streams and a source of fugitive odour emissions from the Void (discussed further in **Section 7.5.2**); and
- There was no designated Construction and Demolition Tipping Area during the undertaking of the Audit.

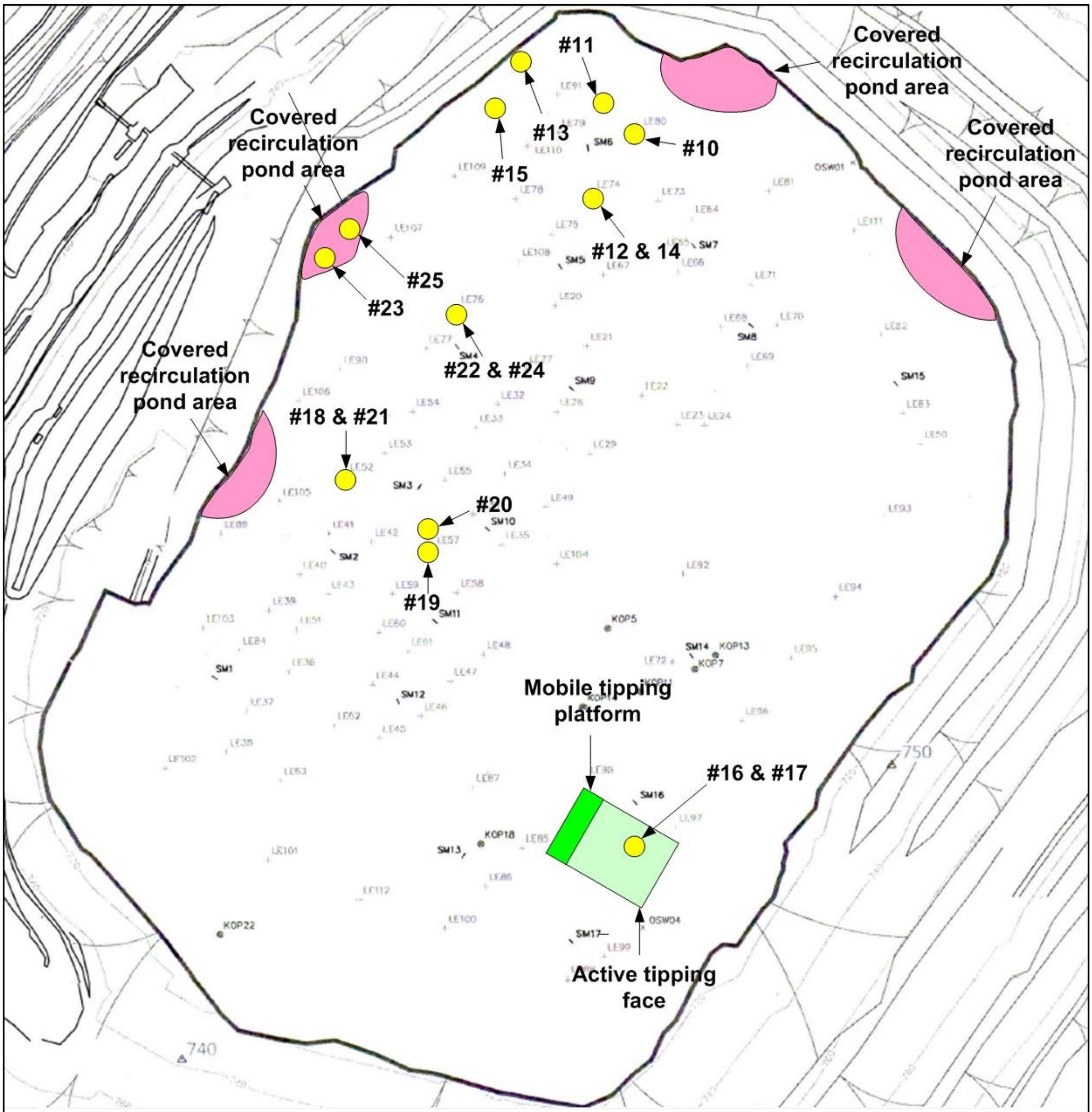


Figure 6.1 - Nominal sampling locations within the Void: 30 September 2014 – 2 October 2014

Photo 6.1 – Conditions prevailing in the Void during the Audit

6.2.2 Leachate Samples

- The leachate recirculation system continues to operate as a direct injection system that does not have suitable access points for sampling;
- The samples collected from the leachate recirculation system included an area within the Void that is used as a reinjection point for leachate recirculation back into the waste areas (SC14602 & SC14604). The leachate recirculation location is covered with backfill material and is not exposed. There was no leachate ponding on the Void at the time of the Audit; The measured values from this area are below the EA SOER model input value of 2.5 ou.$m^3/m^2/s$ indicating the current practice is effective at attenuating emissions from leachate reinjection areas;
- All samples from the ED3N system were collected at different locations, from the bank of the dams (where possible);
- All samples collected from the ponds in ED3N Pond system (i.e. SC14571-SC14574 & SC14578 – SC14580) are below the EA SOER model input. The very low SOER values for all ponds (between 0.017 - 0.072 ou.$m^3/m^2/s$) indicate that the leachate treatment quality is very high and that the leachate management system (i.e. the LAD & WALTER ® settling tank processes – see

Section 2.4) is performing at an very high performance efficiency from an odour emission viewpoint; and

- Dam ED3S was not considered to emit any odour at the time of this Audit and was not sampled.

6.2.3 Leachate Aeration Dam Samples

- The LAD was found to be operating under normal operating conditions at the time of the Audit.
- The SOER results suggest that the LAD is not a significant odour emission source. This implies that the LAD was operating in optimum conditions at the time of the Audit, suggesting that adequate aerobic conditions and breakdown of organic containments are prevailing; and
- The SOER found in the Audit were well below the EA SOER range values.

6.2.4 Landfill Gas Samples

- No gas samples were collected from the extracted landfill gas en-route to the Landfill Gas Co-Generation System. The previous IOAs in 2012 & 2013 clearly indicate that landfill gas has a high potential to be odorous if it were released directly to atmosphere in an untreated state;
- The global mean odour concentration for all previous audits for landfill gas en-route to the cogeneration hardware is 9,000,000 ou; and
- Fugitive landfill gas emissions from the Void are discussed further in **Section 7.5.2**).

6.2.5 Liquid Odour Measurement Samples

- The Liquid Odour Measurement results represent the odour that would be released if the sample were evaporated, either by natural or mechanical means. For the purposes of this Audit the mechanical and natural evaporation has been used in calculations;
- The natural evaporation rate shown is based on the mean rate between May 2007 to June 2012 at the Site;
- The liquid odour sample results (SC14575 – SC14577), tested using the LOM, indicate that the leachate is very low in odour. This result is consistent with the

results from the collected gas samples from the ED3N Pond System (see **Section 6.2.2**). The implication of this result is discussed in **Section 7.2.1.5**; and

- The collected liquid samples are a grab sample from ED3N-2, ED3N-3 & ED3N-4 and may not be representative of the entire lagoon contents.

6.2.6 Chemical Measurement Results

- Measurements were taken directly from the gas sample bags following the completion of sample collection; and
- All gas samples were analysed for H_2S using a calibrated Jerome Analyser (with the exception of two samples as indicated in **Table 6.3**.

7 DISCUSSION

7.1 PREVIOUS AUDIT RECOMMENDATIONS

The following **Tables 7.1 & 7.2** outline the mandatory and non-mandatory recommendations documented in the 2013 IOA respectively and Veolia's response to those recommendations since that time.

It is important to note that some of these recommendations are and will continue to remain an integral part of the on-going process operations at the Site. These on-going process operations include, but are not limited to:

- Planned infrastructure instalments including each waste lift;
- Continuous monitoring (leachate and gas extraction);
- Operational management programs including:
  - Leachate management;
  - Pumps and pumping solutions; and
  - De-sludging the LAD.

The above on-going process operations (and others) have been comprehensively documented in the WIP 2012, which has been made available by Veolia and relevant sections reviewed by the Audit in the 2013 IOA. It is understood that the WIP 2012 is a 'live' document that is constantly updated as the volumes of waste into the Void is increased. The WIP appears to be due for update post-2014.

7.1.1 Mandatory recommendations

The mandatory recommendations from the 2013 IOA is summarised in **Table 7.1** and includes Veolia's response since that time.

7.1.2 Non-mandatory recommendations

The non-mandatory recommendations from the 2013 IOA is summarised in **Table 7.2** and includes Veolia's response since that time.

Table 7.1 – 2013 IOA Mandatory Recommendations

No.	2013 Independent Audit Recommendations	Veolia Response
1	<u>Leachate management system</u> *Continue to adequately maintain and manage the upgraded leachate management system to ensure it is operating in an optimum state. This will significantly attenuate the potential for odour generation from the leachate stored in ED3N.*	Veolia has significantly improved the LMS processes including the optimisation of the LAD and WALTER processes. The improvement since the 2013 Audit can be seen in the leachate quality data and odour emission results (see **Appendix C** & **Table 6.1**)
2	<u>Improve Gas Capture within the Void</u> *VES has a WIP which outlines a comprehensive plan that is being implemented to increase gas capture. The continued implementation of this plan will more than likely reduce fugitive odour emissions/gas from the Void. The Audit endorses this strategy as the primary measure to reduce odour emissions from the Void and recommends that VES continue the implementation of the gas systems detailed in the WIP, including the proposed perimeter gas collection infrastructure systems. The gas capture efficiency should be continuously monitored and recorded and the surface of the Void monitored to determine effectiveness of capture within specific areas of the Void.*	Improvements to gas capture require effective collection infrastructure in line with efficient leachate removal. Veolia have implemented significant improvements to both systems and intend to upgrade the leachate treatment system to increase extraction capacity to further improve overall outcomes. Veolia continues to implement its Waste Infrastructure Plan.

Table 7.2 - 2013 IOA Non-mandatory recommendations		
No.	**2013 IOA Non-Mandatory Recommendation**	**Veolia Response**
1	**Odour Mitigation from the Void** Biofiltration *As per the 2012 IOA, consideration should be given to the use of simple biofiltration as a means of mitigating the effects of fugitive landfill gas/odour releases around the perimeter of the Void. This process uses aerobic processes, similar to those found in aerobic wastewater treatment processes, to oxidise odorous compounds present in a gas stream.* *While biofilters are not commonly used for this particular application, the presence of the ester-like compounds in the observed gas emissions in the Void indicates that biological oxidation of the landfill gas odours is already occurring, and biofiltration could be trialled around the perimeter. In its simplest form the biofilter would consist of a compost-based biofilter medium positioned at known problematically emission locations, to a depth of 0.5 – 1.0m and a width of 3-5 m. This medium would need to be kept moist by the application of stormwater or aerobic treated effluent. It could be reused around the site until exhausted.* *VES is currently in the process of implementing this strategy in consultation with TOU.*	Veolia has implemented this non-mandatory recommendation from the 2013 IOA to mitigate known fugitive odour emission sources (see **Section 4.2.1** for further details), while continuing to improve gas collection at the Site. It is Veolia's intention that the biofilter capping material will be used in the future as a contingency measure to assist in odour management at the Site. Preliminary results on its effectiveness has already been generated and included in the Audit (see **Section 7.2.1.6**).

Table 7.2 continued - 2013 IOA Non-mandatory recommendations		
No.	**2013 IOA Non-Mandatory Recommendation**	**Veolia Response**
2	**Odour Mitigation from the Void** Odour Monitoring of Generator Exhaust Stacks *Consideration should be given to including odour monitoring of generator exhaust stacks during the next stack emission survey. While it is not expected to be a significant odour source, odour sampling results will enable the Audit to assess the significance of engine exhaust emissions to the overall Site's odour emission profile.*	This was undertaken in June 2013 however the results were not able to be carried out within the expiration testing period (as per AS4323.3). Nevertheless the results generated indicated very low odour emissions (see **Section 7.2.1.4).** This will be retested in the next round of stack testing.

7.2 DISCUSSION OF AUDIT FINDINGS

The following discussion examines the results of the Audit against each of the conditions of consent.

7.2.1 Condition 7 (B & D)

Condition 7 (B & D) of the Audit requirements stipulates that the following will be carried out in the IOA:

- *Audit the effectiveness of the odour controls on-site in regard to protecting receivers against offensive odour; and*
- *Review the relevant odour sections of the Air Quality and Greenhouse Gas Management Plan for the project and assess the effectiveness of odour control.*

As mentioned in the previous 2012 & 2013 IOA, and complemented by this Audit's on-site experience and discussions with Veolia personnel, it is clear that there continues to be a range of current and on-going odour controls implemented at the Site designed to mitigate off-site impacts arising from its waste management operations. These revolve around:

1. Leachate recirculation method (see **Section 7.2.1.1**);
2. Optimisation and continuous treatment of excess leachate from the Void (see **Section 7.2.1.2)**;
3. Improvement of landfill gas extraction from the Bioreactor (see **Section 7.2.1.3**);
4. Adequate combustion of landfill gas (see **Section 7.2.1.4**) ;
5. Improve evaporation capability (see **Section 7.2.1.5**);
6. The implementation of improved capping material in the form of a biofilter trial program (see **Section 7.2.1.6**)
7. Using the minimal active tipping face as practically possible (see **Section 7.2.1.7**);
8. Water cart to control dust (see **Section 7.2.1.8**); and
9. Transportation of waste in sealed containers until unloading at the Bioreactor (see **Section 7.2.1.9**).

In addition to the established odour controls above, an additional odour control measure that has been adopted by the Site is the trialing of the use of an alternative capping material, in the form of biofilter medium (see in **Section 7.2.1.6**), to fill cracks in the Void and known potential gas pathways (such as around the internal Void perimeter). The Audit considers that this non-mandatory recommendation made in the 2013 IOA has been actioned (see **Table 7.2**).

7.2.1.1 Leachate recirculation method

In order to maximise the recirculation potential of the waste, leachate generated within the Bioreactor is removed when it becomes excess to the field capacity or interferes with gas extraction infrastructure. Any excess leachate that is extracted from the Void flows directly to the LAD for primary leachate treatment (see **Section 2.4** for further details).

The leachate recirculation method currently practiced within the Void continues to be via direct injection techniques (see **Section 2.3.1**). As explained in the 2012 & 2013 IOAs, this has the effect of minimising the potential exposure of leachate partitioning from the liquid phase to the gas phase, through aerosol generation and/or evaporation pathways, and subsequently leading to the generation of odorous emissions. The 2012 IOA indicated that Veolia's adoption of this recirculation technique is more effective at minimising odours than previously utilised techniques. The 2013 IOA concurred with this finding.

As indicated in **Section 6.2.2**, it was possible in the Audit to collect gas samples of recirculated leachate through an area within the Void that is used as a reinjection point back into the waste. The Audit did find that these reinjection points are covered with backfill material and was not exposed at the time. In addition, the SOER values during the Audit were found to be below the EA SOER model input value of 2.5 ou.$m^3/m^2/s$ (i.e. 0.403 & 0.807 ou.$m^3/m^2/s$ – see **Table 6.1**), suggesting that the current practice of covering these reinjection points is effective at attenuating potential odour emissions from these points. On this basis, it is not envisaged that reinjection points will be problematically from an odour emission viewpoint, providing the covering of these ponds is continued practice.

Overall, based on the above analysis, no further action by Veolia is required on this matter.

7.2.1.2 Optimisation and continuous treatment of excess leachate from the Void

The Audit understands that there is no longer a need to store untreated leachate in the evaporation dams following the upgrade improvements made to the LAD system since April 2013 (see **Section 2.4.3** for details) and the growing waste volumes in the Bioreactor.

Since the 2012 IOA, the Audit has found that Veolia had encountered a number of operational issues during the development of the continuous leachate treatment system. This had a flow-on effect on the need to store partially treated leachate in the ED3N pond system at the time until the LMS could be restarted and returned to operational capacity. It is clear from the odour testing results, leachate treatment data and current leachate treatment configuration that Veolia has significantly optimised the operation of the LAD and WALTER processes and treatment is virtually streamlined. Veolia has intentions to continue proactively to improve and optimise the LMS. No partially/untreated leachate was stored in ED3N in the year period between the Audit and the 2013 IOA Report.

No further action is therefore required by Veolia on this matter. If however there are future operational issues with the LMS, Veolia should take the precautionary measures of notifying the EPA, neighbouring residents and other necessary external parties.

7.2.1.3 Improvement of landfill gas extraction from the Bioreactor

Landfill gas extraction at this Site is an ongoing operational process. The WIP 2012 has clearly indicated that there is a comprehensive plan by Veolia to increase gas capture by undertaking the following key items:

1. Continuous expansion of the new drainage systems to promote gas collection; and
2. Management of Leachate – including recirculation and continuous treatment.

Further information regarding the design and operation of the Landfill Gas Extraction System has been previously documented in extensive detail in the 2012 IOA Report. As such, it has not been documented in this Audit report.

As outlined in the 2012 & 2013 IOAs, it is difficult to calculate a representative odour emission rate from the Void given the dynamic virtue of the surface layout. Therefore, an alternative approach has been taken where improvement in landfill gas capture efficiency is used as an indicator of reduced potential for fugitive gas emissions from the Void surface. **Table 7.3** summarises the results in landfill gas capture over the period between November 2013 and September 2014 and compares the results with those obtained in the 2013 IOA. **Figure 7.1** visually plots the landfill gas capture trend since monitoring commence in January 2009 till September 2014.

As can be derived from the results **Table 7.3**, the monthly averaged landfill gas extraction over the period between November 2013 and September 2014 was approximately 1,540,000 m^3. In comparison to the gas extraction result obtained from the previous period in the 2013 IOA (i.e. 1,380,000 m^3), this represents a relative increase of approximately 12% in gas extraction volume (equivalent to an increase landfill gas volume of 160,000 m^3) over the current period. The odour emission rates at each gas extraction efficiency can be considered a conservative, worst-case scenario estimate and represent potential emissions from the Void surface only. In reality, the extent of odour emission rates is likely to be much lower than that estimated, based on field observations and the previous 2012 & 2013 IOA. This viewpoint is supported by the general upward trend in gas capture, as measured in data collected in November 2013 to October 2014 under the National Greenhouse and Energy Reporting Scheme (NGERS).

The Audit understands that gas capture is measured against a calculated emissions model issued by the Australian Government – Clean Energy Regulator. This aspect is outside the scope of the Audit and is therefore not discussed further. Nevertheless, it remains clear that fugitive landfill gas emissions emitted from the Void surface have a very high odour emission potential (between 535,000 ou.m^3/s to 2,300,000 oum^3/s as found in the previous 2013 IOA and the Audit at varying gas extraction efficiencies). Therefore, the Audit continues to endorse Veolia's plan to actively improve gas extraction capability from the Bioreactor and the items addressed in the WIP 2012.

Table 7.3 – Gas capture volumes and estimated odour remission rate from Void surface: The Audit vs. 2013 IOA

Landfill gas capture efficiency (%)	Mean landfill gas capture/month (m^3/month)		Landfill gas from surface (m^3/month)		Landfill gas from Void Surface (m^3/s)		Landfill gas Odour Concentration (ou)^	Landfill gas OER from surface (ou.m^3/s)	
	Sep 2012 – Oct 2013	Nov 2013 – Sep 2014	Sep 2012 – Oct 2013	Nov 2013 – Sep 2014	Sep 2012 – Oct 2013	Nov 2013 – Sep 2014		Sep 2012 – Oct 2013^^	Nov 2013 – Sep 2014
90	1,384,104	1,542,829	154,000	171,000	0.06	0.07	9,000,000	535,000	594,000
80	1,384,104	1,542,829	346,000	386,000	0.13	0.15	9,000,000	1,200,000	1,340,000
70	1,384,104	1,542,829	593,000	661,000	0.23	0.26	9,000,000	2,060,000	2,300,000

^ mean of 2012 & 2013 IOA

^^ corrected from 8,800,000 ou to the mean odour concentration calculated and used in the Audit

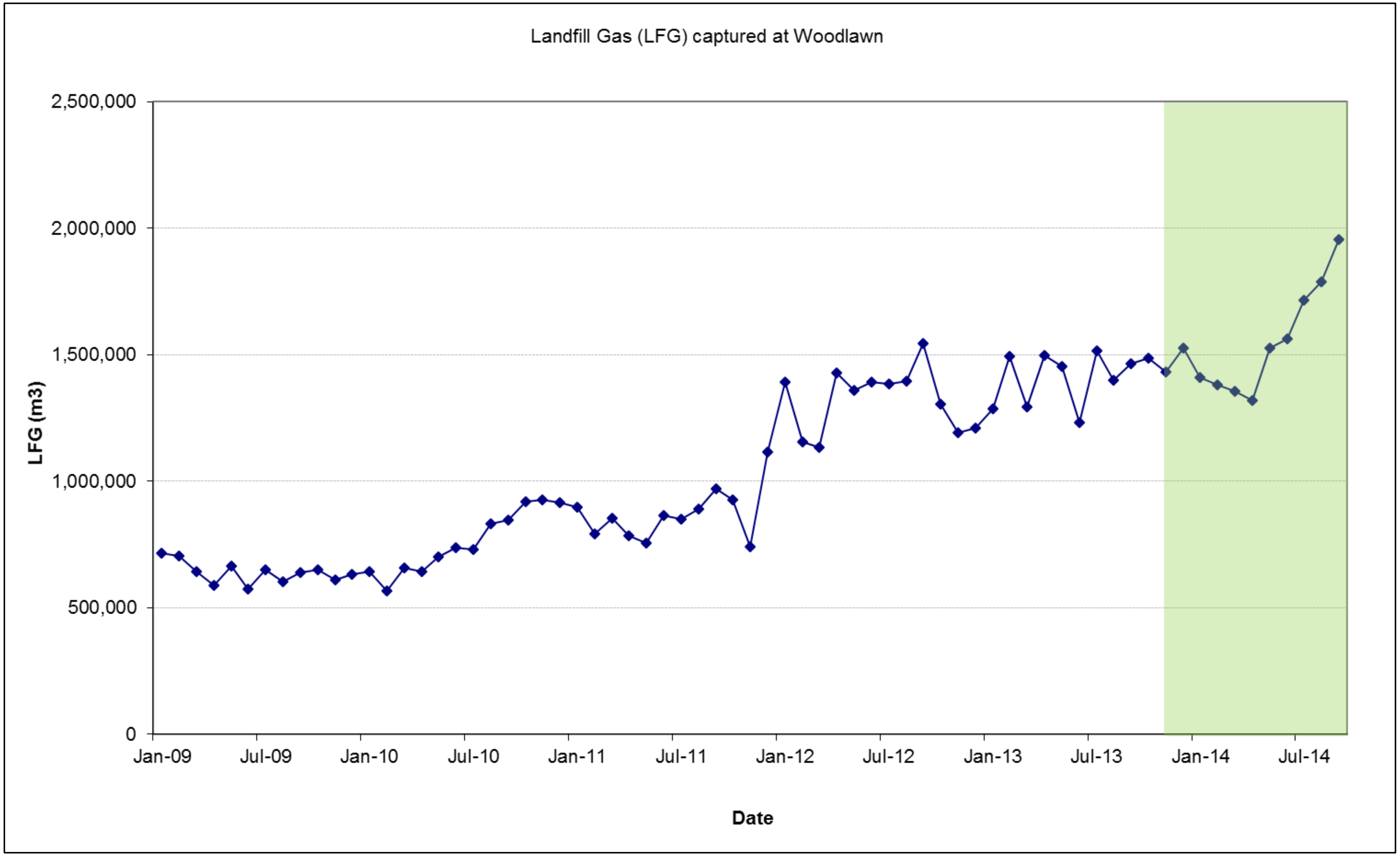


Figure 7.1 - Landfill gas capture since January 2009 to September 2014

7.2.1.4 Landfill gas combustion

According to a recent Stephenson Stack Emission Survey on Generators No. 2, 3 & 4 carried out in March 2014, all combusted gas emissions from all three generators comply with the EPL Limits for NO_x, SO_3/H_2SO_4 and H_2S.

As per the non-mandatory recommendation in the previous 2013 IOA (see **Table 7.2**), Veolia had decided to undertake odour monitoring simultaneously with the Stack Emission Survey in March 2014. A gas sample was collected at each Generator Stack for testing at TOU's NATA Accredited Sydney Odour Laboratory. A total of three gas samples were collected during this sampling exercise. The odour testing results from this sampling are summarised in **Table 7.4**.

Table 7.4 - Generator stacks odour testing results: 25 March 2014

Sampling location	TOU Sample ID	Odour concentration (ou) *	Odour character	Volumetric Flow (Nm^3/s)**	Odour emission rate ($ou.m^3/s$)
Engine 2 Stack	SF14010	2,440	metallic, gassy	1.53	3,730
Engine 3 Stack	SF14011	2,900	metallic, gassy	1.69	4,900
Engine 4 Stack	SF14012	3,450	metallic, gassy	1.73	5,970

* The odour samples were tested after 30 hours of sample collection. Therefore the results shown are not in accordance with AS4323.3: 2001.
**As measured by Stephenson on 25 March 2014

The above odour emission results are relatively low and the 'metallic, gassy' odour character indicates that the landfill gas feed is being fully combusted prior to discharge. On this basis, and provided the landfill gas cogeneration engines continue to operate under optimal conditions, and there is no significant deterioration in combustion performance, the landfill gas engine exhaust stacks are not considered to be significant odour emission sources at the Site. These results are consistent with the judgements made in the previous 2012 & 2013 IOAs that the engine stacks were considered to be a very minor source of odour (given the operating combustion temperatures) and highly unlikely to result in adverse odour impact beyond the Site boundary.

7.2.1.5 Improve evaporation capability

Veolia has only recently recommenced mechanical evaporation, since this activity was ceased following the 2012 IOA finding of the odorous quality of the leachate previously stored in ED3N lagoons. The background for this has been well documented in the previous 2012 & 2013 IOAs. The Audit understands that Veolia have recommenced the use of the mechanical evaporators given the substantial improvement in leachate quality in recent times. The Audit odour testing results for ED3N confirm this (see **Table 6.1**).

The quality of the treated leachate currently stored in ED3N pond system is close to odour-free with no evidence of untreated leachate character present in any of the samples collected. This result is consistent with the liquid test results which provide an indication on the liquid odour potential if the liquid was to partition to gas phase either by natural or mechanical evaporation processes. All testing results for LMS in the Audit has been summarised in **Table 7.5**.

The odour testing result via conventional area source sampling and the liquid odour measurement potential techniques indicate a very low SOER and odour concentration values respectively. In addition, the evaporation liquid odour character as determined by the panelists during laboratory testing indicated a rubber, stale water character suggesting that there is no original untreated leachate character and full treatment of the stored effluent in the ED3N Pond System. These testing results indicate the following:

- The ED3N contents are very low in odour (almost odour-free);
- The observed highly coloured water in ED3N-1, 2 & 3 (an example of ED3N-1 & 3 is shown in **Photo 7.1**) appears to have no correlation with odour emission potential. The colour is likely due to other quality factors; and
- From **Table 6.3**, there was virtually no H_2S detectable in the gas samples collected, with a slight exception to ED3N-1.

Table 7.5 - ED3N Pond System Stored Liquid Quality - Odour testing results

Sampling technique:	Area source sampling	Liquid odour measurement potential			
Pond location	**TOU SOER ($ou.m^3/m^2/s$)**	**Odour concentration (ou)**	**Mechanical Evaporation Odour Emission Rate ($ou.m^3/s$) per evaporator (η = 20% / 30%)**	**Mechanical Evaporation Odour Emission Rate ($ou.m^3/s$) ALL evaporators^^^ (η = 20% / 30%)**	**Evaporated liquid odour character**
ED3N-1	0.017	n/m^			
ED3N-2	0.066	21	7,630 / 11,500	30,500 / 46,000	rubber, stale water
ED3N-3	0.032	99	6,980 / 10,500	27,900 / 42,000	rubber, stale water
ED3N-4	0.023	108	1,480 / 2,220	5,920 / 8,880	dirty water

^ inaccessible safely for liquid sample collection

η = evaporation efficiency

Photo 7.1 – A view of ED3N-1 & ED3N-3 looking east at the Void on 1 October 2014

In addition to the odour testing results, a review into the *Leachate Treatment Operation Manual Woodlawn Bioreactor (Draft) – December 2013* and leachate testing data supplied by Veolia appears to be consistent with the odour testing results observed. All key target parameters appears to be within ranges that result in a high quality treated effluent that is very low in odour (discussed further in **Section 7.5.1**). The leachate quality results (i.e. for treated leachate) provided by Veolia to the Audit are presented in **Appendix C.**

Based on the above analysis the current stored quality contents in ED3N-1, ED3N-2, ED3N-3 and ED3N-4 are suitable for mechanical evaporation and is unlikely to result in adverse odour impact, provided the effluent quality continues to remain of high quality as found in the Audit (discussed further in **Section 7.5.1**). Before the commencement of mechanical evaporation however the Audit recommends that a suitable mechanical evaporation management protocol be developed that addresses simple procedures of how, when and under what conditions to carry out mechanical evaporation (such as wind direction). This has been included in the Audit as a mandatory recommendation (see **Section 8.2**).

7.2.1.6 The implementation of improved capping material in the form of a biofilter trial program

The philosophy behind the trial of this material is as follows:

1. The medium will enable the biofiltration of fugitive gas emissions prior to release from the Void surface;
2. The biofilter medium will potentially offer better sealing properties than the current cover material, which has a tendency to crack when drying based on experience gained by Veolia and the Audit; and
3. The biofilter medium offers the potential for biological oxidation of the landfill gas/other intermediate gas emissions that are generated (such as volatile gas emissions (esters) during anaerobic digestion – as found in the 2012 & 2013 IOA).

Table 7.6 – Biofilter trial odour testing results summary			
Sample Location	**TOU Sample Number**	**SOER ($ou.m^3/m^2/s$)**	**H_2S concentration reading in bag (ppm)**
Normal capping material Location #1	SC14598	7.96	1.6
Normal capping material Location #2	SC14599	0.544	0.041
Biofilter capping material (300 mm + dry)	SC14597	67.9	2.2
Biofilter capping material (300 mm + wet)	SC14600	61.2	4.8
Biofilter capping material (500 mm + dry)	SC14601	15.4	3.0
Biofilter capping material (500 mm + wet)	SC14603	1.72	0.380

The result from the biofilter medium trial is summarised in **Table 7.6**.

The rationale behind the preliminary biofilter capping material trial was to test the effect of moisture and medium depth. Moisture is a key parameter as it provides the mass transfer interface necessary for the gas emissions to partition into the aqueous phase to enable biodegradation by microorganisms. The medium depth is another key parameter that influences the residence time of the gas which effectively determines the time duration that the gas has contact with the medium and in effect enhance the potential of mass transfer between the gas and aqueous phase before exiting the medium surface.

For the preliminary testing, a wet and dry scenario was undertaken at two different depths of 300 mm and 500 mm. The wet scenario represents the medium being dosed with water prior to sampling and the dry scenario represents the medium as found. The sampling locations for both scenarios were identical. The results in **Table 7.6** indicate that medium depth and moisture appear to influence the emissions levels.

The preliminary trial results can be summarised as follows:

- At 300 mm depth, there was no measureable change to odour concentration between wet and dry. The results were statistically identical and quite high under both scenarios (mean SOER of approximately 65 $ou.m^3/m^2/s$);
- At 500 mm depth, a difference in emission levels from the surface was observed between wet and dry. In addition, the increase in medium depth appear to have a substantial impact equivalent to an 88% reduction in emissions (from 15.4 to 1.72 $ou.m^3/m^2/s$).

Given the preliminary trial results, there is a case where another biofilter trial, in the form of a simple pilot scale biofilter, could be setup to see the effect to landfill gas containment/treatment with varying medium depths (and possibly moisture) under more controlled conditions. This has therefore been adopted as a non-mandatory recommendation, similarly to the 2013 IOA (see **Section 8.3**).

7.2.1.7 Using the minimal active tipping face as practically possible

As identified in the previous 2012 & 2013 IOAs, the active tipping face can vary depending on the tonnage input and how the waste is managed. For the Audit, the exposed active tipping face was revised to reflect more realistic conditions that are prevalent in the Void (discussed further below). In addition to this, minimising the active tipping face continues to be one of the key performance indicators at the Site for the following reasons (as outlined in the 2012 & 2013 IOAs):

1. Reduces surface area of potential odour source;
2. Minimises temporary decommissioning of gas extraction infrastructure;
3. Minimises fuel usage, particularly in dozer and compactorr; and
4. To meet EPA benchmark techniques.

Veolia continues to actively and practically maintain a minimal active tipping face area in the Void. The active tipping face was visually observed in the Audit and was considered to be similar in size to the 2013 IOA. **Photo 7.2** provides a visual indication of the active tipping face area size at the time of the Audit field visit. The original value adopted in the EA for the active tipping face was 40,000 m^2 and this was revised to between 4,000 - 6,000 m^2 in the 2013 IOA to reflect more realistic and current operating conditions. This continues to be the case and will therefore remain revised for the purposes of the Audit until such time where operational circumstances in the Void vary significantly.

Photo 7.2 - A visual indication of the active tipping face area size as found on 1 October 2014

The mean SOER value determined during this Audit was 4.3 ou.m^3/m^2/s. This compares well with the value used in the EA modeling (7.1 ou.m^3/m^2/s). On the basis of these results, the predicted SOER values used in the EA would still be considered appropriate, for the current and future operations. No further action is required from Veolia on this matter.

7.2.1.8 Water cart to control dust

Use of the water cart is an ongoing operational activity, which is effective at minimising dust generation. This was visually evident during the fieldwork component of the Audit. The Audit observed that the operating practice of using a water cart to control dust will be a continued practice at the Site. On this basis, no further action is required by Veolia for this component of the Site's operations.

7.2.1.9 Transportation of waste in sealed containers until unloading at the Bioreactor

Similarly to the 2012 & 2013 IOAs, the Audit has found that the current measures used for the waste transport operations are very effective at mitigating any odour emissions. The Audit team inspected the Crips Creek Intermodal Facility and conducted brief downwind olfactometry assessment to determine any presence of waste-based odour. The inspection did not find any evidence of any waste-based odour being generated at the Crips Creek Intermodal Facility. On this basis, the Audit determines that there is still no need to sample at this facility (as indicated in the 2012 & 2013 IOAs) as it is very unlikely to generate problematical odour emissions. This is provided that the waste containers used in the process continue to be adequately maintained and remain fully sealed during waste transportation. As such, current practices should be continued and monitored. No further action is required by Veolia for this component of the Site's operations.

7.3 CONDITION 7 (C)

Condition 7 (C) of the Audit requirements stipulates that the following will be carried out in the IOA:

- *Review the proponents' production data (that are relevant to the odour Audit) and complaint records*

The production data that is relevant to the Audit includes:

- Waste throughput to the Bioreactor;
- On-site evaporation data (from the 2012 IOA); and
- Landfill gas consumption in the generators and flare system.

This Audit obtained recent production data, complaint records and evaporation data from Veolia for the Site since the previous 2013 IOA. These were reviewed and used by the Audit and have been presented in **Appendix C.** Complaint log records indicate that the necessary fields required by the *EPL Condition M4 Recording of pollution complaints* are being documented by Veolia.

On the above basis, the Audit is satisfied that all relevant record-keeping duties continue to be adequately maintained.

7.4 CONDITION 7 (F)

Condition (F) of the Audit requirements stipulates that the following will be carried out in the IOA:

- *Determine whether the project is complying with the requirements in this approval to protect receivers against offensive odour*

This Audit has examined compliance or otherwise with *Condition 7(f)* from three perspectives, namely:

- Odour complaints data review and analysis and associated response letters from Veolia (discussed in **Section 7.4.1**);
- Odour diary entries analysis (discussed in **Section 7.4.2**); and
- Compliance with the modelling-based, project-specific odour performance goal of 6 ou (discussed in **Section 7.4.3**).

The above points have been discussed in the following sections.

7.4.1 Odour complaints analysis and response letters from Veolia

The odour complaints data logged by Veolia and associated response letters were reviewed and analysed in the Audit. **Figure 7.2** illustrates the odour complaints between 8 October 2010 and 11 October 2014 and the seasonal variations in the number of odour complaints logged over that period.

The odour complaints analysis indicated the following:

- Since the previous 2013 IAOA, over the period of 20 October 2013 to 11 October 2014, there were 29 logged odour complaints. This indicates that adverse odour impacts in the community is present, however, represents no significant difference in the number of logged complaints since the previous period (i.e. 24);

- Over the period of 8 October 2010 to 11 October 2014 there were 143 logged complaints. Of these logged complaints, 66% were in the winter and autumn seasonal periods and the difference being in the summer and spring (34%) periods. There were no complaints in summer period of December 2013 to February 2014. These findings suggests that the bulk of odour impact potentially experienced in the community occur in the winter and autumns periods, as illustrated in **Figure 7.2**; and

- The odour complaints data continue to not assist in identifying the nature or likely source of the problematic odours. This matter has been addressed however with the use of Odour Diaries that were distributed to participating community members in May/June 2014 (discussed further in **Section 7.4.2**).

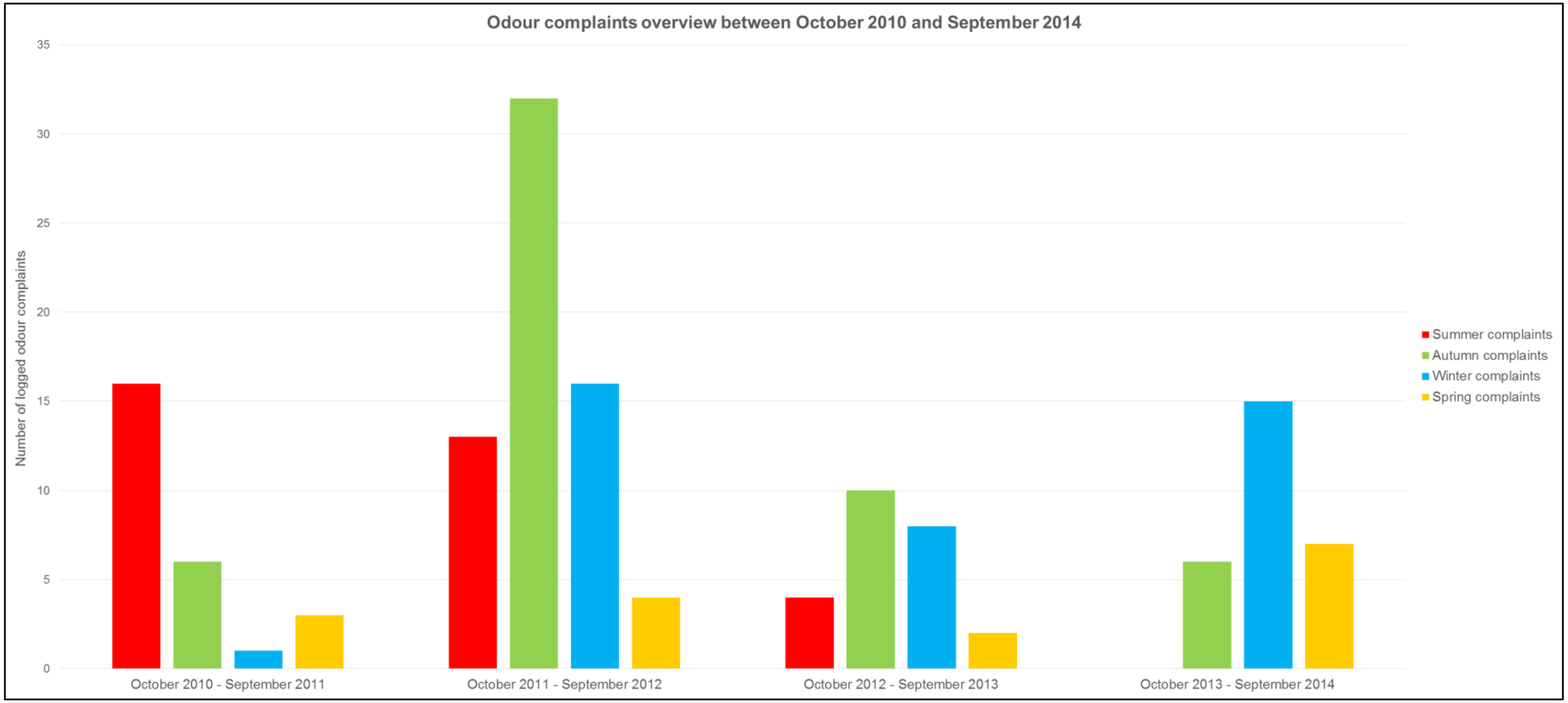


Figure 7.2 – Number of logged odour complaints between October 2010 and September 2014

7.4.2 Odour diary entries analysis

The Odour Diary project is a joint initiative between TOU and Veolia in early-2014 and was complete and issued to the community in May/June 2014.The purpose of the Odour Diary is to collect real-time data on ambient odour levels at residential properties. Whilst not being an Audit requirement, the odour diaries are relevant to the discussion of the Audit as it provides a better understanding on the nature and likely source of odours that are emitted beyond the Site boundary and experienced by the community. The Odour Diary will also open another direct communication channel between Veolia and the community in a standardised feedback format. This information will be assessed and a formal response provided to the community. To date, up to twelve odour diaries have been distributed to the surrounding community. The locations of these odour diaries is shown in **Figure 7.4.**

Out of the twelve odour diaries distributed by Veolia, the Audit received and analysed a total of eight odour diaries. During the analysis, two types of entries were identified and classed as:

- A positive entry: odour was detected by the entrant at their residential premises and recorded; and
- A negative entry: odour was not detected by the entrant at their residential premises and recorded.

A summary of logged entries is shown in **Table 7.7** with the electronic odour diary entries presented in **Appendix E**. **Table 7.8** summaries the logged odour intensity responses for the major odour characters identified. **Figure 7.3** illustrates the odour character responses across all positive entries.

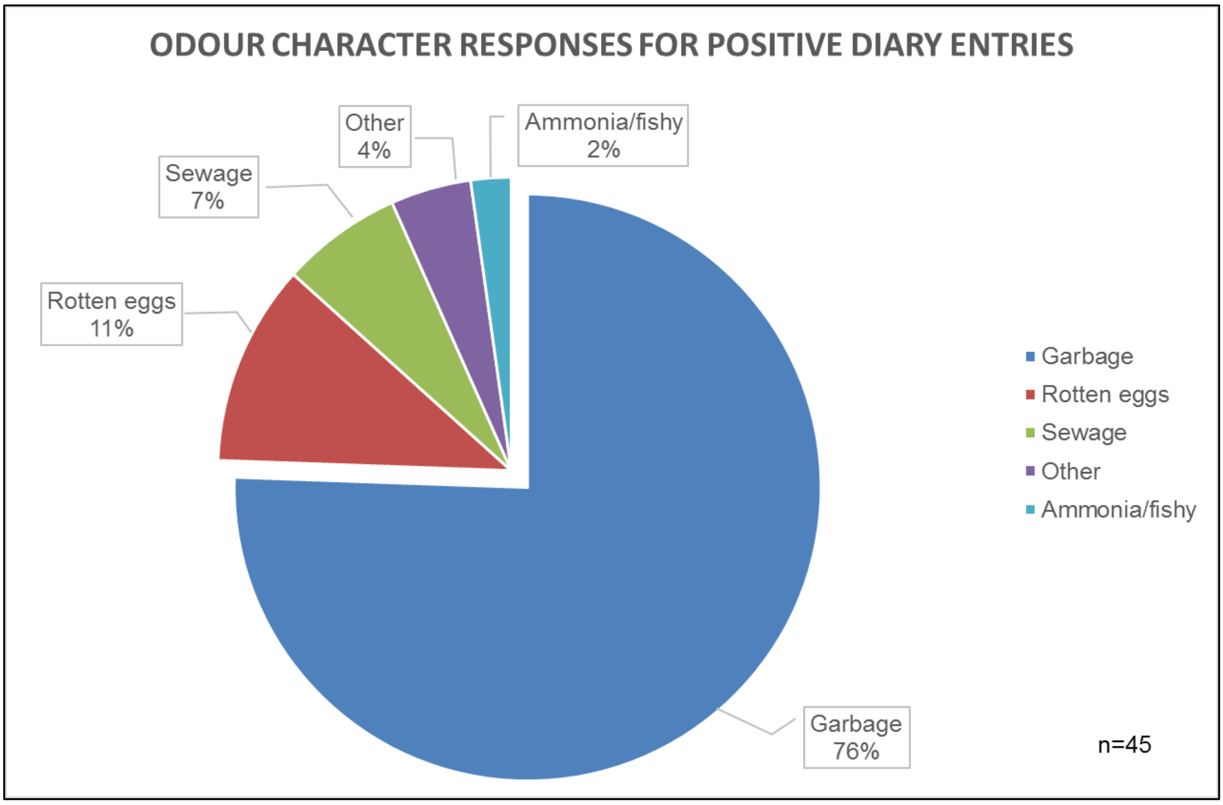


Figure 7.3 – Odour character responses for positive diary entries

Table 7.7 – Summary of logged odour entries as of October 2014		
Parameter	**Value**	**% of total entries**
Positive entries	46	39.7
Number of entries in morning	33	28.4
Number of entries in evening	13	11.2
Negative entries	70	60.3
Number of entries in morning	70	60.3
Number of entries in evening	0	0.0%
Proportion of total entries in morning and evening		
Number of entries in morning	103	88.8%
Number of entries in evening	13	11.2%
Total entries	**116**	**100**

Table 7.8 – Logged odour intensity entries for major odour characters^					
Odour character	**Garbage**				**Total**
Odour Intensity	**1**	**2**	**3**	**4**	**-**
Number of positive entries	8	13	9	4	34
Odour character	**Rotten Eggs**				**Total**
Odour Intensity	**1**	**2**	**3**	**4**	**-**
Number of positive entries	0	3	1	1	5

The following comments can be based on the outcome of the odour diary analysis:

- In the event of a positive entry, odour was detected at an intensity of 1 (i.e. very weak) or more. The highest intensity recorded was strong (i.e. odour intensity of 4);
- The 'Other' odour character had only two entries from a single entrant and was logged as 'sour rotting spicy Indian food'. This character was not logged by any other entrant;
- A majority of positive entries were logged during calm to light winds and under westerly wind conditions;
- The major odour characters record for all positive entries was 'Garbage' (76%) followed by 'Rotten eggs' (11%);
- No odour characters were logged that could be directly related to the pond sources at the Site;
- Of all positive entries, 72% occurred in the morning period (i.e. between 0800 hrs-1200 hrs) and 28% occurred in the evening (post-1800 hrs);
- Of all entries recorded, 60% were negative entries i.e. no odour was detected at the entrants residential premises;
- Approximately 88% of positive entries that detected and recorded garbage as the odour character ranked the odour intensity between 1 and 3 (i.e. very weak to distinct). The remaining 12% of positive entries ranked it as 4 (strong);
- All positive entries that recorded rotten eggs as the odour character (i.e. 11%) ranked the odour intensity between 2 to 4 (i.e. weak to strong); and
- One diary entry selected garbage and rotten eggs in combination as the detected odour character. It has been excluded from the analysis results presented in **Table 7.7 & Figure 7.3** given that it is a unique result. This entry would suggest

landfill gas and/or other fugitive emission sources from the Void was been detected at the time.

Based on the above odour diary entries analysis, it can be concluded that odour impact is predominately experienced by the participating entrants under calm to light wind conditions with westerly winds. The major odour characters detected and recorded were garbage and rotten eggs, indicating that the Void is the likely source based on field observations and experience gained by the audit team.

The odour diary analysis suggests that there is a need to validate the community's ability to characterise between the various odours detected. Notwithstanding this shortcoming, the results from the odour diaries appear consistent with findings from the downwind Field Ambient Odour Assessment (FAOA) Surveys that was conducted separately by the audit team where a garbage odour character was recorded for the bulk of the surveys with one instance of a rotten eggs odour character detected and recorded at downwind location that is within close vicinity of the Site.

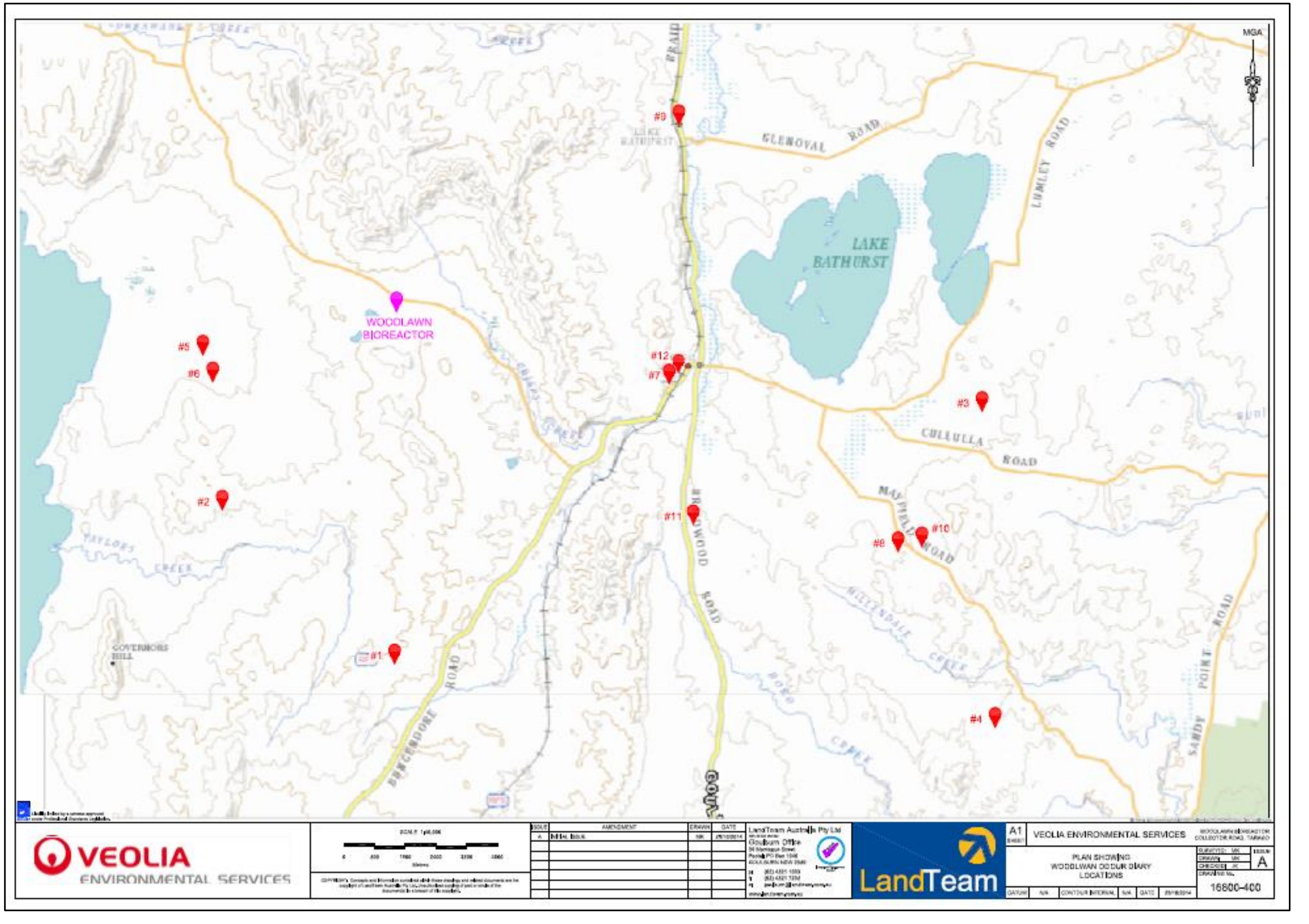


Figure 7.4– Odour diary distribution locations as of 29 October 2014

7.4.3 Compliance with the project-specific odour performance goal of 6 ou

The Audit did not have access to the site-specific odour dispersion model used in the EA and did not carry out modelling, using the odour emission rates determined in the Audit. It is therefore unable to determine whether compliance with the 6 ou criterion is being achieved, based on the approach used in odour dispersion modelling, whereby the modelled emission rates prevail over an entire year. Following the substantial improvement in measured odour emissions for both pond and non-pond sources, a re-run of the existing dispersion model to quantitatively check compliance should perhaps be undertaken. The Audit results suggest that compliance is likely to be achieved given that the majority of SOER results in this Audit are within the ranges used in the EA (see **Section 7.5**). This excludes once again however the contributions from known areas causing significant fugitive gas emissions within the Void which pose practical difficulties in accurately modelling.

Overall, the Audit finds that Veolia continues to actively undertake measures to minimise odour emissions from the Site, including participation in a community consultation process designed to provide the necessary odour impact feedback. This feedback will continue to be important given the widely different odour characters from the pond and non-pond sources at the Site. The Audit recommends that this continue in the future as a means exercise in determining compliance or otherwise with the project-specific goal.

7.5 ODOUR EMISSIONS INVENTORY DISCUSSION

As per recommendation of the 2012 & 2013 IOAs, the Audit recommends using an overall odour emissions inventory for the Site and examined it in order to place into context the emissions from any single source.

Table 7.9 details the odour emission inventory for the Site as determined by the testing carried out in this Audit, and compares these results with predictions of emissions contained in the EA. It also makes a comparison with the impact of the revised areas for each odour emission source as found in the Audit. It is acknowledged that there are odour emissions not listed in this inventory, emanating mostly from sources where quantitative measurement or even estimates are difficult. These include the fugitive odour releases from the Void, previously described as potential gas pathways, arising from gas leakages from the covered areas and around the walls of the Void and leachate recirculation air pressure relief vent (discussed further in **Section 7.5.1.3**). Despite these omissions it is considered that the incomplete inventory remains to have real value and is discussed later (see **Sections 7.5.1 & 7.5.1.3).**

Table 7.9 – Measureable odour emission rates for the Site ^

Parameter			The Audit		2013 IOA			2012 IOA		EA		
Location	**Current Area (m^2) ^^**	**2012 Area (m^2)**	**SOER ($ou.m^3/m^2/s$)**	**OER - Current Area ($ou.m^3/s$)**	**SOER ($ou.m^3/m^2/s$)**	**OER 2012 Area ($ou.m^3/s$)**	**OER - Current Area ($ou.m^3/s$)**	**SOER ($ou.m^3/m^2/s$)**	**OER ($ou.m^3/s$)**	**SOER ($ou.m^3/m^2/s$)**	**OER ($ou.m^3/s$)**	**OER - Current ($ou.m^3/s$)**
ED3N-1	6,000	7,000	0.017	104	0.30	2,100	1,800	394	2,760,000	8.8	61,600	52,800
ED3N-2 & 3 ^^^	11,000	13,000	0.049	543	11.6	150,000	127,000	0.29	3,800	7.4	96,200	81,400
ED3N-2	5,500	6,500	0.066	365	20.1	131,000	111,000	0.21	1,350	n/a^^^		
ED3N-3	5,500	6,500	0.032	178	0.2	1,010	852	0.37	2,430			
ED3N-4	25,000	16,000	0.023	575	0.0604	966	1,510	0.41	6,600	0.7	11,200	17,500
Active Tipping Face	6,000	40,000 *	4.28	25,700	3.04	122,000	18,200	8.36	334,000	7.3	292,000	43,800
Leachate Aeration Dam	5,000	2,000	0.026	129	0.323	647	1,620	0.46	920	3.6	7,200 #	18,000
Construction and Demolition Tip Face	500	900	n/a^	n/a	0.293	264	147	n/a	n/a	n/a	n/a	n/a
Storage Pond 7	n/a	1,200	n/m^^	n/a	n/m	n/m	n/m	85	102,000	n/m	n/m	n/m

^ All odour emission rates represent the mean derived SOER values for each location
^^ as advised by Veolia
^^^ n/a = reported in EA as a single emission source i.e. ED3N-2 & ED3N-3 as single area
# represents mean result for different batches of leachate between 2007 to 2011
* as per AAQMP estimate

From a comparative viewpoint, the SOER results in **Table 7.1** show close agreement between the Audit results and the EA value for all emission sources. This is a significant result as it shows that the SOER predictions in the EA are suitable for current and future operations at the Site. Similarly to the previous 2012 IOA, ED3N-2 & ED3N-3 have been reported both as separate emission sources and a single source (as per the EA) in order to determine the relative contribution of odour emission from each pond separately.

The following sections discuss the results from the odour emission inventory and Audit for both pond and non-pond sources (see **Sections 7.5.1 & 7.5.2** respectively).

7.5.1 Pond sources

All pond sources at the Site sampled in the Audit are considered area sources, including:

- ED3N Pond System: this includes ED3N-1, 2, 3 and 4; and
- LAD.

The following sections discussed each of the above sources.

7.5.1.1 Storage Pond 7

Storage Pond 7 remains non-existent (previously located in the Void) and is therefore not a valid odour emission source in the Audit. The Audit understands that Veolia has no intention in recommissioning this pond system in the future. The WALTER system is a fully enclosed system with no exposed area. On this basis, it is not considered a significant odour emission source at the Site.

7.5.1.2 Leachate Aeration dam

The LAD was found to be very effective in treating the incoming leachate prior to storage in ED3N Pond System. The SOER derived in the Audit from this source is 0.026 ou.$m^3/m^2/s$, representing almost a 92% reduction since the previous 2013 IOA. Veolia's recent upgrade and optimisation works to the LAD system appears to have resulted in substantial improvement in treatment capacity and treated leachate quality. This improvement is observed in the leachate quality data provided to the Audit by Veolia which indicates a substantial reduction in BOD, Ammonia, Volatile Fatty Acids (VFAs), sulphide and solids in the leachate effluent prior to storage in ED3N.

The Leachate Treatment Operation Manual (December 2013), developed by Veolia Water, establishes the monitoring targets that are aimed at the leachate treatment process. These targets are designed to reduce potential odour emission from the treated leachate. It is clear that these targets are resulting in treated leachate that is virtually odour-free. The Audit finds that this manual comprehensively addresses both leachate quality and odour issues arises from the management of leachate at the Site, and should be considered as a 'live' document that is continuously updated as required to reflect the Site's operational demands and identifications of new constraints and/or issues.

7.5.1.3 ED3N Pond System

In the context of the odour emissions inventory for the Site, the Audit finds that at the current and above performance targets for leachate quality, leachate effluent stored in ED3N-1, 2 & 3 is almost odour-free and represents the lowest SOERs derived since the IOAs began in 2011. The derived mean SOER's for ED3N-1, 2 & 3 in this Audit is 0.017 ou.$m^3/m^2/s$, 0.066 ou.$m^3/m^2/s$ and 0.032 ou.$m^3/m^2/s$. At these values, this represents an overall reduction of approximately 91% in odour emissions from ED3N-1, 2 & 3 since the 2013 IOA. On this basis, the Audit finds that the leachate performance targets set by Veolia are appropriate in attenuating odour emissions from pond-related sources. It can be considered that any significant deviation of the monitoring targets would be a reasonable indicator that the odour emission generation from pond sources would likely be impacted.

7.5.2 Non-pond sources

The activities within the Void were judged to be similar in terms of process operations to that found in the 2013 IOA. The Audit odour testing results indicate that the Void continues to remain as the major contributor to odour emissions at the Site, by virtue of the significant reduction in ED3N odour emissions in recent times. Based on discussions with Veolia and field observations, this appears to be related to gas capture capabilities within the Void and the need to meet the shortfalls with the currently applied cover material (previously discussed in **Section 7.2.1.6**) in areas where existing cover materials are not performing adequately.

In terms of the significance of the fugitive odour emissions from the Site, and the Void in particular, this Audit produced quantitative emission data for the following:

a) Landfill gas emissions known to be occurring around the edges of the waste in the Bioreactor (wall effects);
b) Leachate extraction sump surface areas; and,
c) More recently, the pressure relief vent from the Airwell pumps used for the recirculation of leachate within the Bioreactor.

The following sections discuss the above points.

7.5.2.1 Fugitive landfill gas emissions

The fugitive landfill gas emissions that arises due to wall effects is an on-going operational issue at the Site. Since the previous 2013 IOA, Veolia has adopted trialling biofiltration-based organic medium (a non-mandatory recommendation in the 2013 IOA and discussed in **Section 7.2.1.6**) in known problematically areas including the leachate extraction sump surface areas and Void perimeter.

The fugitive gas emissions levels from wall effects appears to have reduced since the 2013 IOA by approximately 94% (from 4.86 ou.m^3/m^2/s to 0.257 ou.m^3/m^2/s) and appears to be related to the application of the biofilter cover material. This result was found with the leachate extraction sump surface areas. However, more vigorous testing and validation is required to determine this more definitively and identify if the application of biofilter cover material has contributed to this results. It is understood that Veolia has intentions to commence a pilot biofilter trial at the Site to assist in this testing and validation process.

7.5.2.2 Other potential odour emission sources from the Void

As part of the sampling schedule in the Void, a sample was collected from a leachate extraction sump area (#74) Airwell pressure relief vent. The sample was collected over six venting cycles, occurring approximately every 20-30 seconds. The results indicated that this sample had a H_2S concentration level of almost 10 ppm, an odour concentration of 46,300 ou and odour character of 'rotten eggs' (or H_2S), landfill gas' indicating that the emission is likely to be landfill gas in nature.

Based on technical information provided by Veolia, each vent discharge event from a typical operating pump in the Void is estimated to release between 2.89 to 4.8 litres/sec of air (this release rate is considered to be a conservative estimation by Veolia). Taking into consideration the maximum air release rate, the derived odour emission rate is 222 $ou.m^3/s$ per pump. It is important to note that the derived odour emission rate is conservative and, in reality, vary as a pump vent release occurs intermittently i.e. every 20-30 seconds for 5 seconds and is not a continuous emission. Additionally, the volume of air that is vented can differ across pumps. Notwithstanding this, the derived odour emission rate indicates that, despite the emission release during each vent cycle having a high odour concentration, the overall mass emission rate of odour is relatively low by virtue of the small volumes of air released during each vent cycle event.

The pump pressure relief vents have the potential to be a significant contributor to odour emissions from the Void, in the event that the odour concentration is higher than that measured in the Audit and/or the number of operating pumps in use increase in the future. Therefore, the cause and extent of landfill gas seepage into the air pressure relief streams should be investigated by Veolia as part of the odour management of the Void. Preliminary advice from Veolia to the Audit is that the seepage effect is an indicator of the decline of a pumps performance over time.

8 AUDIT RECOMMNEDATIONS

8.1 CONDITION 7 (G & H)

The following section is designed to address the following Audit requirement:

- *Outline all reasonable and feasible measures (including cost/benefit analysis, if required) that may be required to improve odour control at the site and; and*
- *Recommend and prioritise (mandatory and non-mandatory) recommendations for their implementations*

Based on the findings from this Audit, the following mandatory and non-mandatory measures have been recommended. In addition to these measures, Veolia should continue the current community liaison program (including the Woodlawn Community Liaison Committee and the Tarago and District Progress Association Inc.) to notify affected/nearby residents of works and address concerns. Veolia should also continue to log odour complaints in the current odour complaints register and odour diary project.

8.2 MANDATORY RECOMMENDATIONS

The mandatory recommendations in this Audit revolve around the leachate management system, the continuation of odour mitigation from the Void and the development of a mechanical evaporation procedure/protocol. These have been discussed in the following sections.

8.2.1 Leachate management system

Continue to adequately maintain and manage the upgraded leachate management system to ensure it is operating in an optimum state and meeting the leachate quality monitoring targets as outlined in the Leachate Treatment Operation Manual and recommended by Veolia Water. This manual should be considered as a 'live' document to reflect any variation in quality and operational demands and identifications of new constraints and/or issues. This will significantly attenuate the potential for odour generation from the leachate stored in ED3N both now and in the future.

8.2.2 Odour mitigation from the Void

Improve Gas Capture within the Void: Veolia has a WIP 2012 which outlines a comprehensive plan that is being implemented to increase gas capture. The continued implementation of this plan will more than likely reduce fugitive odour emissions/gas from the Void. The Audit endorses this strategy as the primary measure to reduce odour emissions from the Void and recommends that Veolia continue the implementation of the gas systems detailed in the WIP, including the proposed perimeter gas collection infrastructure systems. The gas capture efficiency should be continuously monitored and recorded and the surface of the Void monitored to determine effectiveness of capture within specific areas of the Void. It appears that the WIP will require update post-2014 and this will be reviewed in the next Audit.

8.2.3 Mechanical Evaporation Plan of stored effluent in ED3N

Given the high quality of treated leachate now stored in ED3N, the Audit finds that mechanical evaporation can now be recommenced for the purposes of volume reduction. A mechanical evaporation protocol/procedure should be developed that provides advice on the conditions under which treated leachate can be mechanically evaporated. Important items that would need to be address included:

- Is the leachate treatment process meeting the set monitoring targets;
- Wind direction and speed;
- Number of evaporators used at any given time; and
- The conditions under which to commence/terminate mechanical evaporation.

8.3 NON-MANDATORY RECOMMENDATIONS

The non-mandatory recommendations in this Audit revolve around the non-mandatory odour mitigation from the Void, odour monitoring of the generator exhaust stacks, and the undertaking of a site-wide sulphur loading investigation. These have been discussed in the following sections.

8.3.1 Odour Mitigation from the Void

8.3.1.1 Biofiltration

The Audit recommends expansion and continuation of the biofiltration medium trial to be used in areas where there is an identified risk of fugitive odour emissions from the Void surface. While biofiltration-type cover material is not commonly used for this particular application, the presence of the ester-like compounds in the observed gas emissions in the Void indicates that biological oxidation of the landfill gas odours is already occurring and biofiltration could be trailed in known problematical areas in the Void.

The development of a pilot-scale biofilter system to evaluate the effect of medium depth on landfill gas emissions is also recommended. A pilot-scale biofilter unit could be setup in an appropriate location (possibly in the Void) where safe and easy flow diversion of landfill gas is possible. Only small and continuous gas volumes would be required for this exercise. The conditions should address the effect on landfill gas odour at varying medium depths. A suitable medium depth range to trial would be between 0.5 – 1.0 m given the outcomes from the Audit. The medium would need to be keep adequately moist and possibly inoculated with sludge/leachate to assist with the acclimatisation of suitable microorganisms in the biofilter bed. Veolia has already indicated that it intends on undertaking this trial and is in consultation with TOU.

8.3.1.2 Seepage of landfill gas in the air pressure relief vent

The cause and extent of this landfill gas seepage into the air pump pressure relief streams should be investigated by Veolia. All possible mitigation improvements that could be practically implemented to maintain and improve pump performance and reduce potential odour emissions from this source should be undertaken. This source will be further investigated by the audit team in the next Audit.

8.3.2 Odour Monitoring of Generator Exhaust Stacks

Consideration should be given to repeating the odour monitoring of the generator exhaust stacks during the next stack emission survey in 2015. While it is still expected to not be a significant odour source, odour sampling results will enable the Audit to assess the significance of engine exhaust emissions to the overall Site's odour emission profile and use the results for modelling purposes if need be.

8.3.3 Site Sulphur Loading Investigation

Veolia should begin to investigate the Site sulphur loading and develop a protocol to optimise dosing of iron (or other metal based compounds) into waste to bond with available sulphur. The intention of this recommendation is to minimise the potential for hydrogen sulphide generation and emission.

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REPORT SIGNATURE PAGE

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Woodlawn Bioreactor Expansion Project

Independent Odour Audit #3

December 2014

APPENDICES

APPENDIX A:

ODOUR CONCENTRATION LABORATORY TESTING RESULT SHEETS

THE ODOUR UNIT PTY LTD

THE ODOUR UNIT

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NATA

Accreditation Number: 14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Veolia (Australia) Pty Ltd	Telephone	(02) 4844 6262
Contact	Stephen Bernhart	Facsimile	-
Sampling Site	Tarago, NSW	Email	stephen.bernhart@veolia.com
Sampling Method	AS/NZS4323.3:2001	Sampling Team	TOU

Order details:

Order requested by	Stephen Bernhart	Order accepted by	M. Assal
Date of order	19/08/2014	TOU Project #	N1806L
Order number	4502889368	Project Manager	M.Assal
Signed by	Stephen Bernhart	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. NATA accredited for compliance with ISO/IEC 17025. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between 22ºC and 25ºC.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT SERIES V05
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V05: $r = 0.2635$ (April 2014) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V05: $A = 0.1843$ (April 2014) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

Date: Thursday, 2 October 2014

Panel Roster Number: SYD20141001_084

J. Schulz
NSW Laboratory Co-ordinator

A. Schulz
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20141001_084

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
#1 - ED3N-3	SC14571	30/09/2014 1534 hrs	01/10/2014 1042 hrs	4	8	--	--	38	38	0.025
#2 - ED3N-2	SC14572	30/09/2014 1550 hrs	01/10/2014 1114 hrs	4	8	--	--	108	108	0.072
#3 - ED3N-3	SC14573	30/09/2014 1553 hrs	01/10/2014 1154 hrs	4	8	--	--	59	59	0.039
#4 – ED3N-2	SC14574	30/09/2014 1605 hrs	01/10/2014 1227 hrs	4	8	--	--	91	91	0.061
#LOM1 – ED3N-4	SC14575	30/09/2014 1505 hrs	01/10/2014 1430 hrs	4	8	--	--	21	21	n/a
#LOM2 – ED3N-3	SC14576	30/09/2014 1450 hrs	01/10/2014 1503 hrs	4	8	--	--	99	99	n/a
#LOM 3 - ED3N-2	SC14577	30/09/2014 1500 hrs	01/10/2014 1533 hrs	4	8	--	--	108	108	n/a

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20141001_084	50,000	$20 \leq \chi \leq 80$	861	58	Yes

Comments Samples SC14575, SC14576 and SC14577 were tested by the Liquid Odour method.

Disclaimer Parties, other than TOU, responsible for collecting odour samples hereby certify that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.

Note This report shall not be reproduced, except in full, without written approval of The Odour Unit Pty Ltd. Any attachments to this Report are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd.

END OF DOCUMENT

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Accreditation Number: 14974

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Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. NATA accredited for compliance with ISO/IEC 17025. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between 22ºC and 25ºC.
Measuring Dates	The date of each measurement is specified with the results.
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Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V05: $A = 0.1843$ (April 2014) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

Date: Friday, 3 October 2014

Panel Roster Number: SYD20141002_085

J. Schulz
NSW Laboratory Co-ordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20141002_085

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
#5 - ED3N-4	SC14578	01/10/2014 0842 hrs	02/10/2014 1038 hrs	4	8	--	--	32	32	0.023
#6 - ED3N-1	SC14579	01/10/2014 0909 hrs	02/10/2014 1105 hrs	4	8	--	--	25	25	0.018
#7 - ED3N-1	SC14580	01/10/2014 0928 hrs	02/10/2014 1131 hrs	4	8	--	--	23	23	0.017
#8 – Leachate Aeration Dam	SC14581	01/10/2014 1026 hrs	02/10/2014 1158 hrs	4	8	--	--	32	32	0.021
#9 – Leachate Aeration Dam	SC14582	01/10/2014 1038 hrs	02/10/2014 1223 hrs	4	8	--	--	45	45	0.030
#10 – WCA (LE80 – Normal cap. mat.)	SC14583	01/10/2014 1255 hrs	02/10/2014 1325 hrs	4	8	--	--	41	41	0.025
#11 – – WCA (Normal cap. area. b/w LE80 & L91)	SC14584	01/10/2014 1255 hrs	02/10/2014 1352 hrs	4	8	--	--	41	41	0.025
#12 – WCA (LE74 Biofilter cap. mat.)	SC14585	01/10/2014 1332 hrs	02/10/2014 1415 hrs	4	8	--	--	362	362	0.208

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Odour Sample Measurement Results
Panel Roster Number: SYD20141002_085

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
#13 – WCA (Void perimeter biofilter cap. mat.)	SC14586	01/10/2014 1339 hrs	02/10/2014 1444 hrs	4	8	--	--	362	362	0.257
#14 – LE74 Positive displace. pump pressure relief Vent (6x)	SC14587	01/10/2014 1340 hrs	02/10/2014 1510 hrs	4	8	--	--	46,300	46,300	n/a
#15 – WCA (Biofilter cap. mat. NW sloping end)	SC14588	01/10/2014 1423 hrs	02/10/2014 1550 hrs	4	8	--	--	215	215	0.122
#16 – Active Tip Face (<1 Day Old)	SC14589	01/10/2014 1538 hrs	02/10/2014 1612 hrs	4	8	--	--	6,320	6,320	4.10
#17 – Active Tip Face (<1 Day Old)	SC14590	01/10/2014 1551 hrs	02/10/2014 1643 hrs	4	8	--	--	6,890	6,890	4.47

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

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2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20141002_085	50,000	$20 \leq \chi \leq 80$	861	58	Yes

Comments None

Disclaimer Parties, other than TOU, responsible for collecting odour samples hereby certify that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.

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THE ODOUR UNIT PTY LTD

THE ODOUR UNIT

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Internet: www.odourunit.com.au
ABN: 53 091 165 061

NATA

Accreditation Number:
14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	Veolia (Australia) Pty Ltd	Telephone	(02) 4844 6262
Contact	Stephen Bernhart	Facsimile	-
Sampling Site	Tarago, NSW	Email	stephen.bernhart@veolia.com
Sampling Method	AS/NZS4323.3:2001	Sampling Team	TOU

Order details:

Order requested by	Stephen Bernhart	Order accepted by	M. Assal
Date of order	19/08/2014	TOU Project #	N1806L
Order number	4502889368	Project Manager	M.Assal
Signed by	Stephen Bernhart	Testing operator	A. Schulz

Investigated Item	Odour concentration in odour units 'ou', determined by sensory odour concentration measurements, of an odour sample supplied in a sampling bag.
Identification	The odour sample bags were labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification), sampling date and time, dilution ratio (if dilution was used) and whether further chemical analysis was required.
Method	The odour concentration measurements were performed using dynamic olfactometry according to the Australian Standard 'Determination of Odour Concentration by Dynamic Olfactometry AS/NZS4323.3:2001. NATA accredited for compliance with ISO/IEC 17025. Any deviation from the Australian standard is recorded in the 'Comments' section of this report.
Measuring Range	The measuring range of the olfactometer is $2^2 \leq \chi \leq 2^{18}$ ou. If the measuring range was insufficient the odour samples will have been pre-diluted. The machine is not calibrated beyond dilution setting 2^{17}. This is specifically mentioned with the results.
Environment	The measurements were performed in an air- and odour-conditioned room. The room temperature is maintained between 22ºC and 25ºC.
Measuring Dates	The date of each measurement is specified with the results.
Instrument Used	The olfactometer used during this testing session was: ODORMAT SERIES V05
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \leq 0.477$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V05: $r = 0.2635$ (April 2014) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \leq 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V05: $A = 0.1843$ (April 2014) Compliance – Yes
Lower Detection Limit (LDL)	The LDL for the olfactometer has been determined to be 16 ou (4 times the lowest dilution setting)
Traceability	The measurements have been performed using standards for which the traceability to the national standard has been demonstrated. The assessors are individually selected to comply with fixed criteria and are monitored in time to keep within the limits of the standard. The results from the assessors are traceable to primary standards of n-butanol in nitrogen.

Date: Friday, 3 October 2014

Panel Roster Number: SYD20141003_086

J. Schulz
NSW Laboratory Co-ordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20141003_086

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
#18 – LE 52 Biofilter cap. mat. (300mm + Dry)	SC14597	02/10/2014 0915hrs	03/10/2014 1426hrs	4	8	--	--	92,700	92,700	67.9
#19- LE57 Normal cap. mat. Loc. #1	SC14598	02/10/2014 0924hrs	03/10/2014 1453hrs	4	8	--	--	12,600	12,600	7.96
#20 – LE57 Normal cap. mat. Loc. #2	SC14599	02/10/2014 1005hrs	03/10/2014 1526hrs	4	8	--	--	861	861	0.544
#21 – LE52 Biofilter cap. mat (300 mm + Wet)	SC14600	02/10/2014 1105hrs	03/10/2014 1105hrs	4	8	--	--	92,700	92,700	61.2
#22 –LE 76 Biofilter cap. mat (500mm + Dry)	SC14601	02/10/2014 1139hrs	03/10/2014 1616hrs	4	8	--	--	25,300	25,300	15.4

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Odour Sample Measurement Results
Panel Roster Number: SYD20141003_086

Sample Location	TOU Sample ID	Sampling Date & Time	Analysis Date & Time	Panel Size	Valid ITEs	Nominal Sample Dilution	Actual Sample Dilution (Adjusted for Temperature)	Sample Odour Concentration (as received, in the bag) (ou)	Sample Odour Concentration (Final, allowing for dilution) (ou)	Specific Odour Emission Rate (ou.m^3/m^2/s)
#23– Recirculated Leachate Injection Point: Covered area (NW void perimeter) – 1/2	SC14602	02/10/2014 1207hrs	03/10/2014 1645hrs	4	8	--	--	1,330	1,330	0.807
#24– LE 76 Biofilter cap. mat (500mm + Wet)	SC14603	02/10/2014 1218hrs	03/10/2014 1710hrs	4	8	--	--	2,900	2,900	1.72
#25 – Recirculated Leachate Injection Point: Covered area (NW void perimeter) – 2/2	SC14604	02/10/2014 1248hrs	03/10/2014 1737hrs	4	8	--	--	664	664	0.403

Note: The following are not covered by the NATA Accreditation issued to The Odour Unit Pty Ltd:

1. The collection of Isolation Flux Hood (IFH) samples and the calculation of the Specific Odour Emission Rate (SOER).
2. Final results that have been modified by the dilution factors where parties other than The Odour Unit Pty Ltd. have performed the dilution of samples.

Odour Panel Calibration Results

Reference Odorant	Reference Odorant Panel Roster Number	Concentration of Reference gas (ppb)	Panel Target Range for n-butanol (ppb)	Measured Concentration (ou)	Measured Panel Threshold (ppb)	Does this panel calibration measurement comply with AS/NZS4323.3:2001 (Yes / No)
n-butanol	SYD20141003_086	50,000	$20 \leq \chi \leq 80$	724	69	Yes

Comments None

Disclaimer Parties, other than TOU, responsible for collecting odour samples hereby certify that they have voluntarily furnished these odour samples, appropriately collected and labelled, to The Odour Unit Pty Ltd for the purpose of odour testing. The collection of odour samples by parties other than The Odour Unit Pty Ltd relinquishes The Odour Unit Pty Ltd from all responsibility for the sample collection and any effects or actions that the results from the test(s) may have.

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APPENDIX B:

ODOUR EMISSIONS WORKSHEET

THE ODOUR UNIT PTY LTD
Surface Odour Emission Rate for Isolation Flux Hood
Calculation Sheet

Client: Veolia (Australia & New Zealand)
Sampling Site: Woodlawn Bioreactor Facility
Project Number: N1806L - Audit #3

Sample Location	TOU Sample Number	Odour Concentration (ou)	Nominal Air Temperature (°C)	Measured Internal Flux Hood Odour Temperature (°C)	Emission Factor Nominal Air Temperature	Emission Factor measured air temperature	Temperature Correction Factor	Enclosed surface area (m^2)	Flux chamber sweep air flow rate - Q (L/min)	Flux chamber sweep air flow rate - Q (m^3/min)	Odour Emission Rate at Source (Not corrected for temperature) ($ou.m^3/m^2/min$)	Odour Emission Rate at Source (Corrected for temperature) ($ou.m^3/m^2/min$)	Specific Odour Emission Rate ($ou.m^3/m^2/s$)	Odour character
Sample #1 - ED3N-3	SC14571	38	25.0	24.3	1.384	1.371	1.009	0.126	5	0.005	1.51	1.52	0.025	musty, soil, rubber
Sample #2 - ED3N-2	SC14572	108	25.0	24.3	1.384	1.371	1.009	0.126	5	0.005	4.29	4.32	0.072	stale water, burnt, nutty, sewage
Sample #3 - ED3N-3	SC14573	59	25.0	24.3	1.384	1.371	1.009	0.126	5	0.005	2.34	2.36	0.039	cooking oil, fat, grease
Sample #4 - ED3N-2	SC14574	91	25.0	24.3	1.384	1.371	1.009	0.126	5	0.005	3.61	3.64	0.061	burnt, nutty, sewage, soil
Sample #5 - ED3N-4	SC14578	32	25.0	18.6	1.384	1.274	1.087	0.126	5	0.005	1.27	1.38	0.023	rubbery
Sample #6 - ED3N-1	SC14579	25	25.0	18.6	1.384	1.274	1.087	0.126	5	0.005	0.99	1.08	0.018	dusty
Sample #7 - ED3N-1	SC14580	23	25.0	18.6	1.384	1.274	1.087	0.126	5	0.005	0.91	0.99	0.017	stale air
Sample #8 - Leachate Aeration Dam	SC14581	32	25.0	23.8	1.384	1.363	1.016	0.126	5	0.005	1.27	1.29	0.021	stale water
Sample #9 - Leachate Aeration Dam	SC14582	45	25.0	23.8	1.384	1.363	1.016	0.126	5	0.005	1.79	1.81	0.030	stale water
Sample #10 - Waste Covered Area (LE80 - Clay)	SC14583	41	25.0	29.8	1.384	1.473	0.940	0.126	5	0.005	1.63	1.53	0.025	dirt
Sample #11 - Waste Covered Area (Normal Capped Area between LE80 & LE91)	SC14584	41	25.0	29.8	1.384	1.473	0.940	0.126	5	0.005	1.63	1.53	0.025	weak garbage
Sample #12 - Waste Covered Area (LE74 - Biofilter capping material)	SC14585	362	25.0	36.0	1.384	1.597	0.867	0.126	5	0.005	14.37	12.45	0.208	earthy, garbage
Sample #13 - Waste Covered Area (Void perimeter with biofilter capping material)	SC14586	362	25.0	19.4	1.384	1.287	1.076	0.126	5	0.005	14.37	15.45	0.257	metallic, green waste
Sample #14 - LE74 Positive displacement pump pressure relief vent	SC14587	46,300	-	-	-	-	-	-	-	-	-	-	-	H_2S, landfill
Sample #15 - Waste Covered Area (Biofilter capping material - NW slopping end)	SC14588	215	25.0	36.8	1.384	1.613	0.858	0.126	5	0.005	8.53	7.32	0.122	fruity, garbage
Sample #16 - Active Tipping Face (< 1 day old)	SC14589	6,320	25.0	26.5	1.384	1.411	0.981	0.126	5	0.005	250.79	245.95	4.099	garbage
Sample #17 - Active Tipping Face (< 1 day old)	SC14590	6,890	25.0	26.5	1.384	1.411	0.981	0.126	5	0.005	273.41	268.13	4.469	garbage
Sample #18 - LE 52 Biofilter capping material (300 mm + dry)	SC14597	92,700	25.0	17.1	1.384	1.249	1.108	0.126	5	0.005	3678.57	4076.44	67.941	pineapple, rotten garbage, landfill gas
Sample #19 - LE57 Clay capping material Location #1	SC14598	12,600	25.0	28.5	1.384	1.448	0.956	0.126	5	0.005	500.00	477.76	7.963	rotten egg, landfill gas, pineapple, garbage
Sample #20 - LE57 Clay capping material Location #2	SC14599	861	25.0	28.5	1.384	1.448	0.956	0.126	5	0.005	34.17	32.65	0.544	garbage, landfill gas
Sample #21 - LE52 Biofilter capping material (300 mm + wet)	SC14600	92,700	25.0	25.2	1.384	1.388	0.997	0.126	5	0.005	3678.57	3669.02	61.150	pineapple, landfill gas
Sample #22 - LE76 Biofilter capping material (500 mm + dry)	SC14601	25,300	25.0	31.6	1.384	1.508	0.918	0.126	5	0.005	1003.97	921.42	15.357	pineapple, landfill, garbage
Sample #23 - Recirculated leachate balance pond area: Covered Pond (North-western Void Perimeter)	SC14602	1,330	25.0	31.6	1.384	1.508	0.918	0.126	5	0.005	52.78	48.44	0.807	burnt hair, dirty water
Sample #24 - LE76 Biofilter capping material (500 mm + wet)	SC14603	2,900	25.0	33.5	1.384	1.546	0.895	0.126	5	0.005	115.08	103.04	1.717	garbage, pineapple, dirty water
Sample #25 – Recirculated leachate balance pond area: Covered Pond (North-western Void Perimeter)	SC14604	664	25.0	31.6	1.384	1.508	0.918	0.126	5	0.005	26.35	24.18	0.403	burnt hair, dirty water, muddy

THE ODOUR UNIT

VEOLIA

Liquid Odour Measurement Emission Results (Mechanical Evaporators)

Liquid Odour Measurement - Calculation (25L N_2 with 413 µL sample)	TOU Sample Number	Odour Concentration (ou)	Volume of Liquid (mL)	Volume of dry N_2 (L)	Odour Concentration (ou/m^3)	Calculated Liquid Odour Concentration (ou/mL)	Mechanical Evaporation Rate (L/min) @ 20% efficiency	Odour Emission Rate (ou.m^3/min)	Odour Emission Rate (ou.m^3/s)	Mechanical Evaporation Rate (L/min) @ 30% efficiency	Odour Emission Rate (ou.m^3/min)	Odour Emission Rate (ou.m^3/s)	Odour Character
Sample #L1 - ED3N-4	SC14575	21	0.413	25	21	1.27	70	88,900	1,480	105	133,000	2,220	dirty water
Sample #L2 - ED3N-3	SC14576	99	0.413	25	99	5.99	70	419,000	6,980	105	629,000	10,500	rubber, stale water
Sample #L3 - ED3N-2	SC14577	108	0.413	25	108	6.54	70	458,000	7,630	105	687,000	11,500	rubber, stale water

Mechanical evaporation rate is based on 20 % / 30% evaporation efficiency per evaporator

	per evaporator		All evaporators	
Evaporation efficiency	**20%**	**30%**	**20%**	**30%**
ED3N-2	7,630	11,500	22,900	34,500
ED3N-3	6,980	10,500	20,900	31,500
ED3N-4	1,480	2,220	4,440	6,660

Liquid Odour Measurement Emission Results (Natural Evaporation)

Liquid Odour Measurement - Calculation (25L N_2 with 413 µL sample)	TOU Sample Number	Odour Concentration (ou)	Volume of Liquid (mL)	Volume of dry N_2 (L)	Odour Concentration (ou/m^3)	Calculated Liquid Odour Concentration (ou/mL)	Area (m^2)	Natural evaporation rate (mm/month)	Natural evaporation rate (L/s)	Odour emission rate (ou.m^3/s)
Sample #L1 - ED3N-4	SC14575	21	0.413	25	21	1.27	25,000	92.67	0.882	1,120
Sample #L2 - ED3N-3	SC14576	99	0.413	25	99	5.99	5,500	92.67	0.194	1,160
Sample #L3 - ED3N-2	SC14577	108	0.413	25	108	6.54	5,500	92.67	0.194	1,270

The natural evaporation rate is based on the mean evaporation rate recorded between May 2007 to June 2012 i.e. 92.67 mm/month

APPENDIX C:

TECHNICAL DOCUMENTATION RELEVANT TO THE AUDIT

ODOUR COMPLAINTS REGISTER:

20 OCTOBER 2013 TO 11 OCTOBER 2014

Odour complaints from 20 October 2013 to 11 October 2014

Month:	Complaints:	Date:	Complaints	Time:	[redacted]	Rating	Duration	Collex response	Council Involved:	Other Comments:
	Letter	20/10/2013		9am	[redacted]	Foul smell	am	email		Refer to email response
	Letter	2/04/2014		8-9am	[redacted]	odour	am	email		Refer to email response
	Letter	2/04/2014		10.00am	[redacted]	odour	am	HG spoke directly		
		3/04/2014		9.50 am	[redacted]	stink	am			
		21/04/2014		8.22 am	[redacted]	smell		no name given		
	Letter	19/05/2014		Noticeble intermittently over 4 days	[redacted]	Smilar smell to before	Intermittently over 4 days	phone/email		Refer to email response
	Letter	19/05/2014		Noticeble intermittently over 4 days	[redacted]	Smilar smell to before	Intermittently over 4 days	phone/email		Refer to email response
	Letter	1/06/2014			[redacted]					
		2/06/2014		Evening	[redacted]	N/A	Evening	Email		Refer to email response
		5/06/2014		10.00 am	[redacted]	6	am		foggy	
	Letter	7/06/2014		9.18 am	[redacted]	smell		no name given		shocking past 12 hours
	Letter	13/06/2014		12:15pm	[redacted]	High	most of the week	phone/email		Refer to email response
		18/06/2014		7.15 am	[redacted]	smell				sour tip smell since about 6 am
	Letter	19/06/2014		Morning	[redacted]	N/A	Couple of morning	email		Refer to email response
	Letter	20/06/2014		Morning	[redacted]	Phenominal				EPA notification of complaint
	Letter	7/07/2014		9.20 am	[redacted]					
	Letter	9/07/2014		Morning	[redacted]	Stench				
	Letter	27/07/2014			[redacted]					
	Letter	27/07/2014		Morning	[redacted]					
	Letter	4/08/2014		6:30am	[redacted]					
	Letter	5/08/2014		9:50pm	[redacted]					
	Letter	25/08/2014		8:45am	[redacted]					
	Letter	1/09/2014		10:00am	[redacted]					
	Letter	14/09/2014		8:00am	[redacted]					
	Letter	15/09/2014		8:30am	[redacted]					
	Letter	23/09/2014		9:30am	[redacted]					
	Letter	29/09/2014		6:00pm	[redacted]					
	Letter	10/10/2014		8:45am	[redacted]					
	Letter	11/10/2014		Morning	[redacted]					

THE ODOUR UNIT

STEPHENSON STACK EMISSION SURVEY –

23 APRIL 2014

Stephenson

Environmental Management Australia

STACK EMISSION SURVEY – GENERATORS NO. 2, 3 & 4

WOODLAWN LANDFILL

VEOLIA ENVIRONMENTAL SERVICES

TARAGO, NSW

PROJECT NO.:	5324/S23034/14
DATE OF SURVEY:	24 AND 25 MARCH 2014
DATE OF ISSUE:	23 APRIL 2014

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75002600526

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STACK EMISSION SURVEY – GENERATORS NO. 2, 3 & 4

WOODLAWN LANDFILL

VEOLIA ENVIRONMENTAL SERVICES

TARAGO, NSW

PROJECT NO.: 5324/S23034/14

DATE OF SURVEY: 24 AND 25 MARCH 2014

DATE OF ISSUE: 23 APRIL 2014

P W STEPHENSON

J WEBER

A MCGHIE

A PRADHAN

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1 INTRODUCTION

Stephenson Environmental Management Australia (SEMA) was requested by Veolia Environmental Services (Veolia) to assess the emissions from the No. 2, 3 and 4 Generators associated with the landfill gas power plant at their Woodlawn Landfill, Tarago, New South Wales (NSW). Generators No. 4 and 5 were not operating on the day of testing.

The objective of the tests was to determine the concentration of emissions to be reported to the Environment Protection Authority (EPA) according to their Environment Protection Licence (EPL) No.11436. The EPA is now part of the Office of Environment and Heritage (OEH).

The exhaust stacks serving Generators No.1, 2, 3, 4 and 5 are referred to in the EPL as EPA Identification Point No.8.

The stack emission from each generator engine set was assessed for the following components:

- Exhaust flow, velocity, temperature and moisture
- Dry gas density
- Molecular Weight of Stack Gases
- Oxygen (O_2)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO_2)
- Hydrogen Sulphide (H_2S)
- Oxides of Nitrogen (NO_x) (as Nitrogen Dioxide (NO_2))
- Sulphur Dioxide (SO_2)
- Sulphur Trioxide/Sulphuric Acid Mist (SO_3/H_2SO_4)
- Volatile Organic Compounds (VOCs).

The emission tests were undertaken on the stacks serving four Generators during normal operations during the period of 24 and 25 March, 2014.

2 LICENCE AND REGULATORY LIMITS

The facility at Woodlawn is licensed by the NSW OEH under EPL No. 11436. Condition L2.4 of the EPL specifies the concentration limits from the generator exhaust stack. Table 2-1 summarises the EPL concentration limits.

TABLE 2-1 EPL 100 PERCENTILE CONCENTRATION LIMITS (EPL POINT NO. 8)

Parameter	EPL Emission Limit
Nitrogen Oxides	450 mg/m^3
Hydrogen Sulphide	5 mg/m^3
Sulphuric Acid Mist and Sulphur Trioxide	100 mg/m^3

Key:
mg/m^3 = milligrams per cubic metre @ reference conditions specified in Condition L3.5

Condition L3.5 specifies the reference conditions which are:

- For Nitrogen Oxides (NO_x): dry, 273 Kelvin (K), 101.3 kilopascals (kPa), 7% Oxygen (O_2).
- For Sulphuric Acid Mist (H_2SO_4) and Sulphur Trioxide (SO_3): dry, 273 K, 101.3 kPa.

Table 2-2 specifies the monitoring requirements under Condition M2.1 of EPL No.11436.

TABLE 2-2 MONITORING REQUIREMENTS AS PER EPL 11436

Pollutant	Units	Frequency	Sampling Method
Carbon Dioxide	%	Annual	TM-24
Carbon Monoxide	mg/m³	Annual	TM-32
Dry Gas Density*	mg/m³ (kg/m³)	Annual	TM-23
Moisture content	%	Annual	TM-22
Molecular weight of stack gases	g/g mole	Annual	TM-23
Nitrogen Oxides	mg/m³	Annual	TM-11
Oxygen	%	Annual	TM-25
Sulphur Trioxide/Sulphuric Acid Mist	mg/m³	Annual	TM-3
Sulphur Dioxide	mg/m³	Annual	TM-4
Temperature	°C	Annual	TM-2
Velocity	m/s	Annual	TM-2
Volatile Organic Compounds	mg/m³	Annual	TM-34
Volumetric Flow Rate	m³/s	Annual	TM-2

Key:

%	=	percent
°C	=	degrees Celsius
g/g mole	=	grams per gram mole
kg/m³	=	kilograms per cubic metre
m/s	=	metres per second
m³/s	=	cubic metres per second
mg/m³	=	milligrams per cubic metre at 0°C and 1 atmosphere and reference conditions
TM	=	Test Method

* Note: The unit for Dry Gas Density is normally reported in kilograms per cubic metre (kg/m³) not milligrams per cubic metre (mg/m³) as specified in EPL 11436.

3 PRODUCTION CONDITIONS

Veolia Environmental Services personnel considered the landfill and the associated gas fired power plant to be operating under typical conditions on the days of testing. Generators No. 2, 3 and 4 were operating on the day of testing. Generator No.1 was not operating due to a problem with the alternator and Generator No.5 was not operating due to an electrical fault.

Veolia Environmental Services provided the production records for the days of testing. A copy of these records is included in Appendix D. However, the time scale on these records does not appear to have been adjusted for daylight saving time.

4 EMISSION TEST RESULTS

4.1 INTRODUCTION

SEMA completed the sampling for all emission test parameters and the analysis of flow, temperature, moisture, velocity, dry gas density, molecular weight of stack gases, O_2, NO_x, SO_2, CO and CO_2. SEMA is NATA accredited for this sampling and analysis, Accreditation No. 15043.

Refer to SEMA's Emission Test Report No. 5324, Appendix C, which includes a summary of results and the associated certificates of analysis.

The VOC samples collected by SEMA were analysed by the NATA accredited (NATA No. 3726) TestSafe Laboratories, Report No 2014-0560. Analysis for SO_3/H_2SO_4 and H_2S samples were performed by the NATA accredited (NATA No. 825) ALS Environmental, Report No. EN1401018.

The stack emission test results are summarised in Table 4-1 and presented in detail in Tables A-1 to A-3 of Appendix A. Appendix B presents a graphical logged record of SO_2 and NO_x continuous emission analysis.

Details on the most recent calibration of each instrument used to take measurements is summarised in Appendix E, while the sample locations are presented in Appendix F.

SEMA adopts the following protocol when performing average calculations;

- Where 50% or more of the sample results for a particular pollutant are below the analytical detection limit, zero may be reported for those samples.
- Where a sample result is reported below the analytical detection limit for the test, half the analytical detection limit value may be used for that sample for average calculation purposes.

TABLE 4-1 AVERAGE EMISSION CONCENTRATIONS TEST RESULTS

Pollutant	Units	Gen No. 2 EPL ID 8(2)	Gen No. 3 EPL ID 8(3)	Gen No. 4 EPL ID 8(4)	EPL Emission Concentration Limit
Dry Gas Density	kg/m^3	1.33	1.35	1.34	--
Moisture content	%	5.9	7.3	5.8	--
Molecular weight of stack gases	g/g mole	29.90	30.19	29.90	--
Temperature	^oC	471	474	458	--
Velocity	m/s	46.2	52.5	51.7	--
Volumetric Flow Rate	m^3/s	1.53	1.69	1.73	--
Carbon Dioxide	%	9.7	11.6	9.7	--
Carbon Monoxide	mg/m^3	766	819	878	--
Hydrogen Sulphide	mg/m^3	<0.354	<0.355	<0.345	5
Nitrogen Oxides @ 7% O_2	mg/m^3	414	346	368	450
Oxygen (O_2)	%	8.6	8.3	8.8	--
Sulphur Trioxide / Sulphuric Acid Mist	mg/m^3	6.95	5.07	7.08	100
Sulphur Dioxide	mg/m^3	410	395	411	--
Volatile Organic Compounds (as n-propane equivalent)	mg/m^3	<4.178	<4.122	0.099	--

Key:
< = less than
g/g mole = grams per gram mole
-- = No limit
kg/m^3 = kilograms per cubic metre
^oC = degrees Celsius
m/s = metres per second
% = percent
m^3/s = cubic metres per second
mg/m^3 = milligrams per cubic metre at 0^oC (273 K) and 1 atmosphere

4.2 SULPHUR DIOXIDE (SO_2)

EPL does not specify an SO_2 emission limit for Generators 1-5.

GENERATOR NO. 2

The measured SO_2 emission concentration ranged from 366 to 469 mg/m^3 and averaged 410 mg/m^3 for the entire sampling period. Refer to Table 4-1 and Figure B-2 in Appendix B for detailed results in tabulated and graphical formats respectively.

GENERATOR NO. 3

The measured SO_2 emission concentration ranged from 369 to 422 mg/m^3 and averaged 395 mg/m^3 for the entire sampling period. Refer to Table 4-1 and Figure B-3 in Appendix B for detailed results in tabulated and graphical formats respectively.

GENERATOR NO. 4

The measured SO_2 emission concentration ranged from 359 to 444 mg/m^3 and averaged 411 mg/m^3 for the entire sampling period. Refer to Table 4-1 and Figure B-4 in Appendix B for detailed results in tabulated and graphical formats respectively.

4.3 OXIDES OF NITROGEN (NO_X)

GENERATOR NO. 2

The 1-hour average NO_x (expressed as NO_2) emission concentration and corrected to 7% O_2 was 202 parts per million (ppm) (414 mg/m^3) during the sampling period, which is *in compliance* with the EPL NO_x limit of 450 mg/m^3. Refer to Table 4-1 and Figure B-2 in Appendix B for detailed results in tabulated and graphical formats respectively.

GENERATOR NO. 3

The 1-hour average NO_x (expressed as NO_2) emission concentration and corrected to 7% O_2 was 169 parts per million (ppm) (346 mg/m^3) during the sampling period, which is *in compliance* with the EPL NO_x limit of 450 mg/m^3. Refer to Table 4-1 and Figure B-3 in Appendix B for detailed results in tabulated and graphical formats respectively.

GENERATOR NO. 4

The 1-hour average NO_x (expressed as NO_2) emission concentration and corrected to 7% O_2 was 179 ppm (368 mg/m^3) during the sampling period, which is *in compliance* with the EPL NO_x limit of 450 mg/m^3. Refer to Table 4-1 and Figure B-4 in Appendix B for detailed results in tabulated and graphical formats respectively.

4.4 OXYGEN (O_2), CARBON DIOXIDE (CO_2) & CARBON MONOXIDE (CO)

GENERATOR NO. 2

The O_2 emission concentration ranged from 8.5 to 9.3% and averaged 8.6% during the emission monitoring period. The CO_2 emission concentration ranged from 9.1 to 9.8% and averaged 9.7% during the emission monitoring period. The CO emission concentration ranged from 716 to 798 mg/m^3 and averaged 766 mg/m^3 during the emission monitoring period.

GENERATOR NO. 3

The O_2 emission concentration ranged from 8.2 to 8.3% and averaged 8.3% during the emission monitoring period. The CO_2 emission concentration averaged 11.6% during the emission monitoring period. The CO emission concentration ranged from 799 to 834 mg/m^3 and averaged 819 mg/m^3 during the emission monitoring period.

GENERATOR NO. 4

The O_2 emission concentration ranged from 8.6 to 10.0% and averaged 8.8% during the emission monitoring period. The CO_2 emission concentration ranged from 8.8 to 9.8% and averaged 9.7% during the emission monitoring period. The CO emission concentration ranged from 794 to 903 mg/m^3 and averaged 878 mg/m^3 during the emission monitoring period.

4.5 SULPHUR TRIOXIDE/SULPHURIC ACID MIST (SO_3/H_2SO_4)

GENERATOR NO. 2

The SO_3/H_2SO_4 emission concentration measured was 6.95 mg/m^3 which is *in compliance* with EPL SO_3/H_2SO_4 limit of 100 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-2 for the detailed results in tabulated format.

GENERATOR NO. 3

The SO_3/H_2SO_4 emission concentration measured was 5.07 mg/m^3 which is *in compliance* with EPL SO_3/H_2SO_4 limit of 100 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-3 for the detailed results in tabulated format.

GENERATOR NO. 4

The SO_3/H_2SO_4 emission concentration measured was 7.08 mg/m^3 which is *in compliance* with EPL SO_3/H_2SO_4 limit of 100 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-4 for the detailed results in tabulated format.

4.6 HYDROGEN SULPHIDE (H_2S)

GENERATOR NO. 2

The H_2S emission concentration measured was less than 0.354 mg/m^3 which is *in compliance* with EPL H_2S limit of 5 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-2 for the detailed results.

GENERATOR NO. 3

The H_2S emission concentration measured was less than 0.355 mg/m^3 which is *in compliance* with EPL H_2S limit of 5 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-3 for the detailed results.

GENERATOR NO. 4

The H_2S emission concentration measured was less than 0.345 mg/m^3 which is *in compliance* with EPL H_2S limit of 5 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-4 for the detailed results.

4.7 VOLATILE ORGANIC COMPOUNDS (VOCS)

The Protection of the Environment Operations (Clean Air) Regulation 2010 requires VOCs to be reported as n-propane equivalent.

SEMA has adopted the highest reportable detection limit specified by the analytical laboratory for reporting total VOC emission concentrations as non-detects. When averaging two sample concentrations, SEMA regards a non-detect as zero (0) for average calculations.

GENERATOR NO. 2

The total VOCs emission concentration (as n-propane equivalent) was less than 4.18 mg/m^3. Table 4-2 provides a summary of the detected VOCs.

GENERATOR NO. 3

The total VOCs emission concentration (as n-propane equivalent) was less than 4.12 mg/m^3. Table 4-2 provides a summary of the detected VOCs.

GENERATOR NO. 4

The total VOCs emission concentration (as n-propane equivalent) was 0.1 mg/m^3. Table 4-2 provides a summary of the detected VOCs.

The only detected VOC emission from the three generators tested was benzene for Generator No.4. whilst the other two generator VOC emissions were below the limit of detection for analytical method.

Table 4-2 Summary of VOCs Suite – Average of Sampling Runs

VOCs	No.2 EPL Point 8-2 Concentration n-propane equivalent (mg/m³)	No.3 EPL Point 8-3 Concentration n-propane equivalent (mg/m³)	No.4 EPL Point 8-4 Concentration n-propane equivalent (mg/m³)
Aliphatic Hydrocarbons			
2-Methylbutane	< 0.5339	< 0.5268	< 0.5339
n-Pentane	< 0.5339	< 0.5268	< 0.5339
2-Methylpentane	< 0.4470	< 0.4410	< 0.4470
3-Methylpentane	< 0.4470	< 0.4410	< 0.4470
Cyclopentane	< 0.5491	< 0.5418	< 0.5491
Methylcyclopentane	< 0.4577	< 0.4516	< 0.4577
2,3-Dimethylpentane	< 0.3844	< 0.3793	< 0.3844
n-hexane	< 0.4469	< 0.4409	< 0.4469
3-Methylhexane	< 0.3844	< 0.3793	< 0.3844
Cyclohexane	< 0.4575	< 0.4514	< 0.4575
Methylcyclohexane	< 0.3923	< 0.3871	< 0.3923
2,2,4-Trimethylpentane	< 0.3371	< 0.3326	< 0.3371
n-Heptane	< 0.3844	< 0.3793	< 0.3844
n-Octane	< 0.3371	< 0.3326	< 0.3371
n-Nonane	< 0.3003	< 0.2963	< 0.3003
n-Decane	< 0.2707	< 0.2671	< 0.2707
n-Undecane	< 0.2464	< 0.2431	< 0.2464
n-Dodecane	< 0.2261	< 0.2231	< 0.2261
n-Tridecane	< 0.2089	< 0.2062	< 0.2089
n-Tetradecane	< 0.1942	< 0.1916	< 0.1942
α-Pinene	< 0.2827	< 0.2789	< 0.2827
β-Pinene	< 0.2827	< 0.2789	< 0.2827
D-Limonene	< 0.2828	< 0.2791	< 0.2828
Chlorinated Hydrocarbons			
Dichloromethane	< 0.4537	< 0.4477	< 0.4537
1,1-Dichloroethane	< 0.3891	< 0.3839	< 0.3891
1,2-Dichloroethane	< 0.3893	< 0.3841	< 0.3893
Chloroform	< 0.3226	< 0.3183	< 0.3226
1,1,1-Trichloroethane	< 0.2888	< 0.2849	< 0.2888
1,1,2-Trichloroethane	< 0.2888	< 0.2849	< 0.2888
Trichloroethylene	< 0.2932	< 0.2892	< 0.2932
Carbon tetrachloride	< 0.2505	< 0.2471	< 0.2505
Perchloroethylene	< 0.2323	< 0.2292	< 0.2323
1,1,2,2-Tetrachloroethane	< 0.2295	< 0.2264	< 0.2295
Chlorobenzene	< 0.3421	< 0.3375	< 0.3421
1,2-Dichlorobenzene	< 0.2620	< 0.2586	< 0.2620
1,4-Dichlorobenzene	< 0.2620	< 0.2586	< 0.2620
Miscellaneous			
Acetonitrile	< 0.9384	< 0.9259	< 0.9384
n-Vinyl-2-pyrrolidinone	< 1.7330	< 1.7099	< 1.7330
Aromatic Hydrocarbons			
Benzene	< 0.0986	< 0.0973	0.099
Ethylbenzene	< 0.0725	< 0.0716	< 0.0725
Isopropylbenzene	< 0.0641	< 0.0632	< 0.0641
1,2,3-Trimethylbenzene	< 0.0641	< 0.0632	< 0.0641
1,2,4-Trimethylbenzene	< 0.0641	< 0.0632	< 0.0641
1,3,5-Trimethylbenzene	< 0.0641	< 0.0632	< 0.0641
Styrene	< 0.0740	< 0.0730	< 0.0740
Toluene	< 0.0836	< 0.0825	< 0.0836
p-Xylene &/or m-Xylene	< 0.0726	< 0.0716	< 0.0726
o-Xylene	< 0.0726	< 0.0716	< 0.0726

Ketones			
Acetone	< 0.6632	< 0.6544	< 0.6632
Acetoin	< 2.1860	< 2.1568	< 2.1860
Diacetone alcohol	< 1.6581	< 1.6360	< 1.6581
Cyclohexanone	< 1.9613	< 1.9352	< 1.9613
Isophorone	< 1.3936	< 1.3750	< 1.3936
Methyl ethyl ketone (MEK)	< 0.5343	< 0.5271	< 0.5343
Methyl isobutyl ketone (MIBK)	< 0.3846	< 0.3795	< 0.3846
Alcohols			
Ethyl alcohol	< 4.1780	< 4.1223	< 4.1780
n-Butyl alcohol	< 2.5978	< 2.5632	< 2.5978
Isobutyl alcohol	< 2.5992	< 2.5646	< 2.5992
Isopropyl alcohol	< 3.2047	< 3.1620	< 3.2047
2-Ethyl hexanol	< 1.4790	< 1.4592	< 1.4790
Cyclohexanol	< 1.9222	< 1.8966	< 1.9222
Acetates			
Ethyl acetate	< 2.1857	< 2.1566	< 2.1857
n-Propyl acetate	< 1.8864	< 1.8613	< 1.8864
n-Butal acetate	< 1.6575	< 1.6354	< 1.6575
Isobutyl acetate	< 1.6575	< 1.6354	< 1.6575
Ethers			
Ethyl ether	< 2.5992	< 2.5646	< 2.5992
teri-Butyl methyl ether (MTBE)	< 2.1850	< 2.1558	< 2.1850
Tetrahydrofuran (THF)	< 2.6706	< 2.6350	< 2.6706
Glycols			
PGME	< 2.1372	< 2.1087	< 2.1372
Ehylene glycol diethyl ether	< 1.6298	< 1.6080	< 1.6298
PGMEA	< 1.4574	< 1.4379	< 1.4574
Cellosolve acetate	< 1.4574	< 1.4379	< 1.4574
DGMEA	< 1.0930	< 1.0785	< 1.0930
Sum of Reported VOCs	**< 4.1780**	**< 4.1223**	**0.099**

Key:

<	=	less than
%	=	percent
mg/m^3	=	milligrams per cubic metre at 0^oC (273 K) and 1 atmosphere

5 CONCLUSIONS

From the data presented and test work conducted during typical operational conditions of Generators No. 2, 3 and 4 at the Woodlawn Landfill gas fired power plant, the following conclusion can be drawn:

- The emissions from all three Generators tested complied with EPL limits for NO_x, SO_3/H_2SO_4 and H_2S.

6 TEST METHODS

6.1 EXHAUST GAS VELOCITY AND TEMPERATURE

(OEH NSW TM-1 & 2)

Velocity profiles were obtained across the stack utilising an Airflow Developments Ltd. S-type pitot tube and digital manometer. The exhaust gas temperature was measured using a Digital thermometer (0-1200^{o}C) connected to a chromel/alumel (K-type) thermocouple probe.

6.2 CONTINUOUS GASEOUS ANALYSIS

(OEH NSW TM- 4, 11, 24, 25 & 32)

Sampling and analysis of exhaust gas were performed using a SEMA mobile combustion and environmental monitoring laboratory. Emission gases were distributed to the analysers via a manifold. Flue gas from each stack was pumped continuously. The following components of the laboratory are relevant to this work:

Sulphur Dioxide, Oxides of Nitrogen Oxygen, Carbon Monoxide, Carbon Dioxide	Testo 350XL
Calibration	BOC Special Gas Mixtures relevant for each analyser. Instrument calibrations performed at start and finish of sampling at all locations.
QA/QC	Calibration (Zero/Span) checks Sample line integrity calibration check

6.3 HYDROGEN SULPHIDE

(OEH NSW TM-5)

Samples drawn through 3%H_2O_2 then $CdSO_4$ solution in midget impingers, per USEPA Method 11. Sample collection time was increased from 10 minutes to approximately 3 hours to increase the lower detection limit. Test method requires sample to be taken over at least a 10-minute duration. Samples, collected in solution, were analysed by NATA accredited ALS Environmental.

6.4 SULPHUR TRIOXIDE/SULPHURIC ACID MIST (SO_3/H_2SO_4)

(OEH NSW TM- 3)

SO_3/H_2SO_4 were sampled isokinetically and drawn through a glass probe into four Greenburg Smith impingers in series. The first and second impingers in the train contained 100 ml of 80% isopropanol, the third was empty and the fourth contained silica gel. The impinger train was mounted in an ice water bath. Analysis was performed by the NATA accredited laboratories of ALS Environmental.

6.5 VOLATILE ORGANIC COMPOUNDS (VOCS)

(OEH NSW TM-34)

A sample of stack air is drawn onto an activated carbon adsorption tube and analysed using Gas Chromatography/Mass Spectrometry (GC/MS) performed by the NATA accredited laboratory TestSafe Australia, accreditation number, 3726.

6.6 ACCURACY

All results are quoted on a dry basis. SEMA has adopted the following (Table 6-1) uncertainties for various stack testing methods.

TABLE 6-1 ESTIMATION OF MEASUREMENT UNCERTAINTY

Pollutant	Methods	Uncertainty
Carbon Monoxide	TM-32, USEPA M10	15%
Hydrogen Sulphide	TM-5 USEPA 11& 15	25% ++++
Moisture	AS4323.2, TM-22, USEPA 4	25%
Nitrogen Oxides	TM-11, USEPA 7E	15%
Oxygen and Carbon Dioxide	TM-24, TM-25, USEPA 3A	1% actual
Sulphur Dioxide	TM-4, USEPA 6C	15%
Sulphur Trioxide/Sulphuric Acid Mist (SO_3/H_2SO_4)	TM-3, USEPA 8	20%
Velocity	AS4323.1, TM-2, USEPA 2A & 2C	5%
Volatile Organic Compounds (adsorption tube)	TM-34, USEPA 18	25%

Key: Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

++++ = Similar to test method for Fluorine and SO_3/H_2SO_4 which is about 25%

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK*

Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

APPENDIX A – EMISSION TEST RESULTS

Glossary:

%	=	percent
^oC	=	Degrees Celsius
am^3/min	=	cubic metre of gas at actual conditions per minute
Normal Volume (m^3)	=	cubic metre at 0°C and 760 mm pressure and 1 atmosphere
am^3	=	cubic metre of gas at actual conditions
g/g mole	=	grams per gram mole
g/s	=	grams per second
hrs	=	hours
kg/m^3	=	kilograms per cubic metre
kPa	=	kilo Pascals
m^2	=	square metre
m/s	=	metre per second
m^3/sec	=	cubic metre per second at 0^0C and 1 atmosphere
mg	=	milligrams
mg/ m^3	=	milligrams per cubic metre at 0^oC and 1 atmosphere
O_2	=	Oxygen

Abbreviations of Parameters

H_2S	=	Hydrogen Sulphide
SO_3/H_2SO_4	=	Sulphur Trioxide/ Sulphuric Acid Mist

Abbreviations of Personnel

PWS	=	Peter Stephenson
JW	=	Jay Weber
AP	=	Alok Pradhan
AM	=	Argyll McGhie

TABLE A - 1 DETAILED EMISSION TEST RESULTS – GENERATOR NO. 2

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5324	5324
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator No.2 EPA Point 8.2	Generator No.2 EPA Point 8.2
Date	24-Mar-14	24-Mar-14
RUN	1	1
Sample Start Time (hrs)	13:17	12:20
Sample Finish Time (hrs)	13:27	15:17
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (°C)	471.0	471.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	46.2	45.6
Actual Gas Flow Volume (am^3/min)	266	263
Total Normal Gas Flow Volume (m^3/min)	92	96
Total Normal Gas Flow Volume (m^3/sec)	1.53	1.61
Total Stack Pressure (kPa)	101.00	101.00
Analysis	SO_3/H_2SO_4	H_2S
Method	TM-3	USEPA M11
SEMA Lab Number	723328	723332
Mass In Sample (mg)	7.00	< 0.1
Air Volume Sampled (am^3)	1.07	0.30
Normal Sample Volume (m^3)	1.01	0.28
Concentration at Stack O_2 (mg/m^3)	**6.95**	**< 0.354**
Mass Emission Rate (g/s)	0.0106	< 0.0006
Moisture Content (% by volume)	5.9	NA
Molecular Weight Dry Stack Gas (g/g-mole)	29.896	29.896
Dry Gas Density (kg/m^3)	1.33	1.33
EPL Limit (mg/m^3)	**100**	**5**
Isokinetic Sampling Rate (%)	98.6	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM	PWS, JW, AM
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	JW	JW
Calculations Checked by	AP	AP

TABLE A - 2 DETAILED EMISSION TEST RESULTS – GENERATOR NO. 3

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5324	5324
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator No.3 EPA Point 8.3	Generator No.3 EPA Point 8.3
Date	25-Mar-14	25-Mar-14
RUN	1	1
Sample Start Time (hrs)	10:30	7:59
Sample Finish Time (hrs)	11:30	11:11
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (^oC)	474.0	474.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	52.5	51.7
Actual Gas Flow Volume (am^3/min)	303	298
Total Normal Gas Flow Volume (m^3/min)	102	108
Total Normal Gas Flow Volume (m^3/sec)	1.69	1.80
Total Stack Pressure (kPa)	100.31	100.31
Analysis	SO_3/H_2SO_4	H_2S
Method	TM-3	USEPA M11
SEMA Lab Number	723329	723333
Mass In Sample (mg)	6.00	< 0.1
Air Volume Sampled (am^3)	1.27	0.30
Normal Sample Volume (m^3)	1.18	0.28
Concentration at Stack O_2 (mg/m^3)	**5.07**	**< 0.355**
Mass Emission Rate (g/s)	0.01	< 0.0006
Moisture Content (% by volume)	7.3	NA
Molecular Weight Dry Stack Gas (g/g-mole)	30.188	30.188
Dry Gas Density (kg/m^3)	1.35	1.35
EPL Limit (mg/m^3)	**100**	**5**
Isokinetic Sampling Rate (%)	103.5	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM	PWS, JW, AM
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	JW	JW
Calculations Checked by	AP	AP

TABLE A - 3 DETAILED EMISSION TEST RESULTS – GENERATOR NO. 4

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5324	5324
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator No.4 EPA Point 8.4	Generator No.4 EPA Point 8.4
Date	25-Mar-14	25-Mar-14
RUN	1	1
Sample Start Time (hrs)	9:41	9:15
Sample Finish Time (hrs)	10:41	12:15
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (°C)	458.0	458.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	51.6	51.1
Actual Gas Flow Volume (am^3/min)	298	295
Total Normal Gas Flow Volume (m^3/min)	104	109
Total Normal Gas Flow Volume (m^3/sec)	1.74	1.82
Total Stack Pressure (kPa)	100.55	100.25
Analysis	SO_3/H_2SO_4	H_2S
Method	TM-3	USEPA M11
SEMA Lab Number	723330	723334
Mass In Sample (mg)	8.00	< 0.1
Air Volume Sampled (am^3)	1.22	0.31
Normal Sample Volume (m^3)	1.14	0.29
Concentration at Stack O_2 (mg/m^3)	**7.08**	**< 0.345**
Mass Emission Rate (g/s)	0.01	< 0.0006
Moisture Content (% by volume)	5.7	NA
Molecular Weight Dry Stack Gas (g/g-mole)	29.904	29.904
Dry Gas Density (kg/m^3)	1.34	1.34
EPL Limit (mg/m^3)	**100**	**5**
Isokinetic Sampling Rate (%)	98.0	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM	PWS, JW, AM
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	JW	JW
Calculations Checked by	AP	AP

APPENDIX B – CONTINUOUS LOGS

REPRESENTATIVE SECTION OF CHART SHOWING CONCENTRATIONS OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN

FIGURE B - 1 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 2 – 24 MARCH 2014

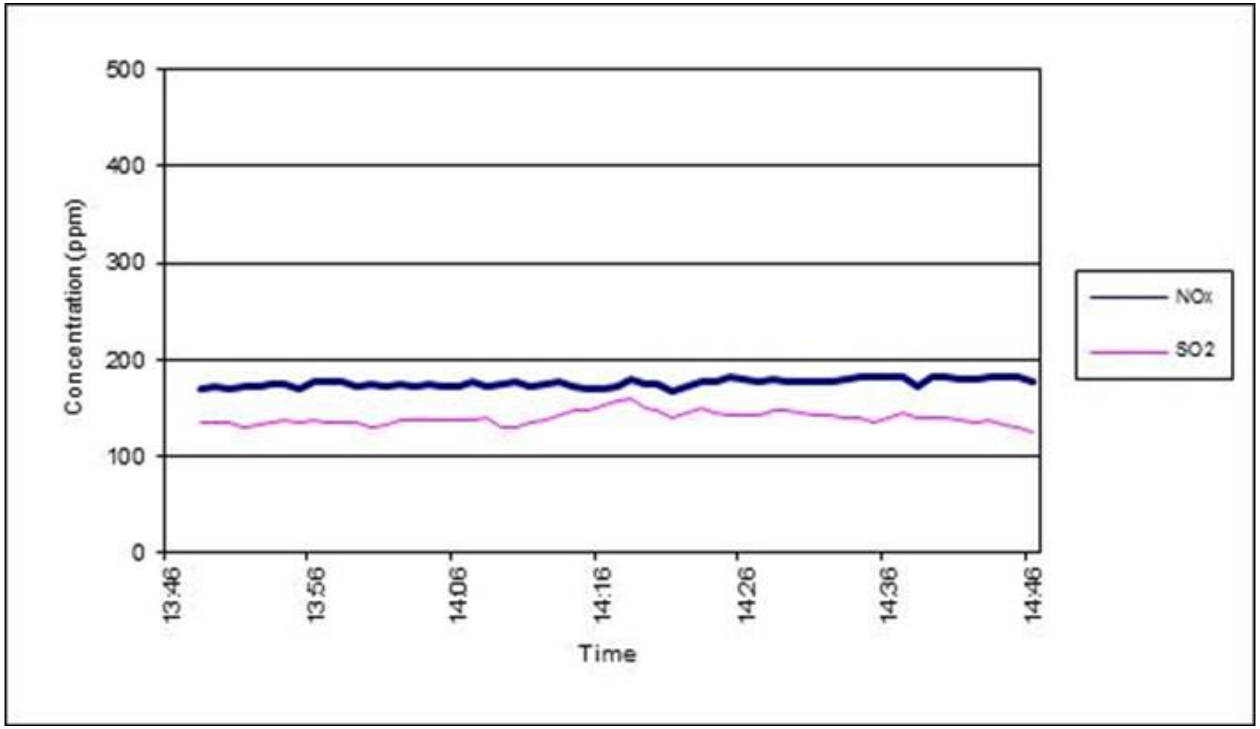


FIGURE B - 2 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 3 – 24 MARCH 2014

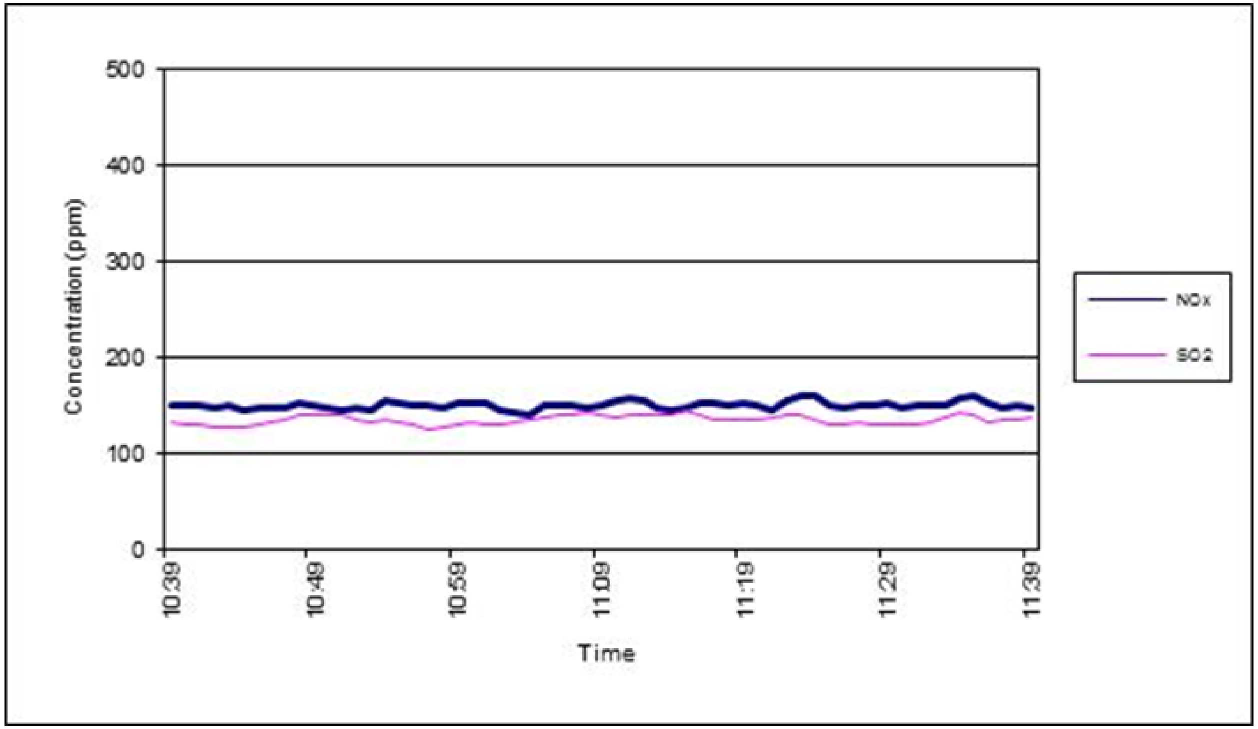
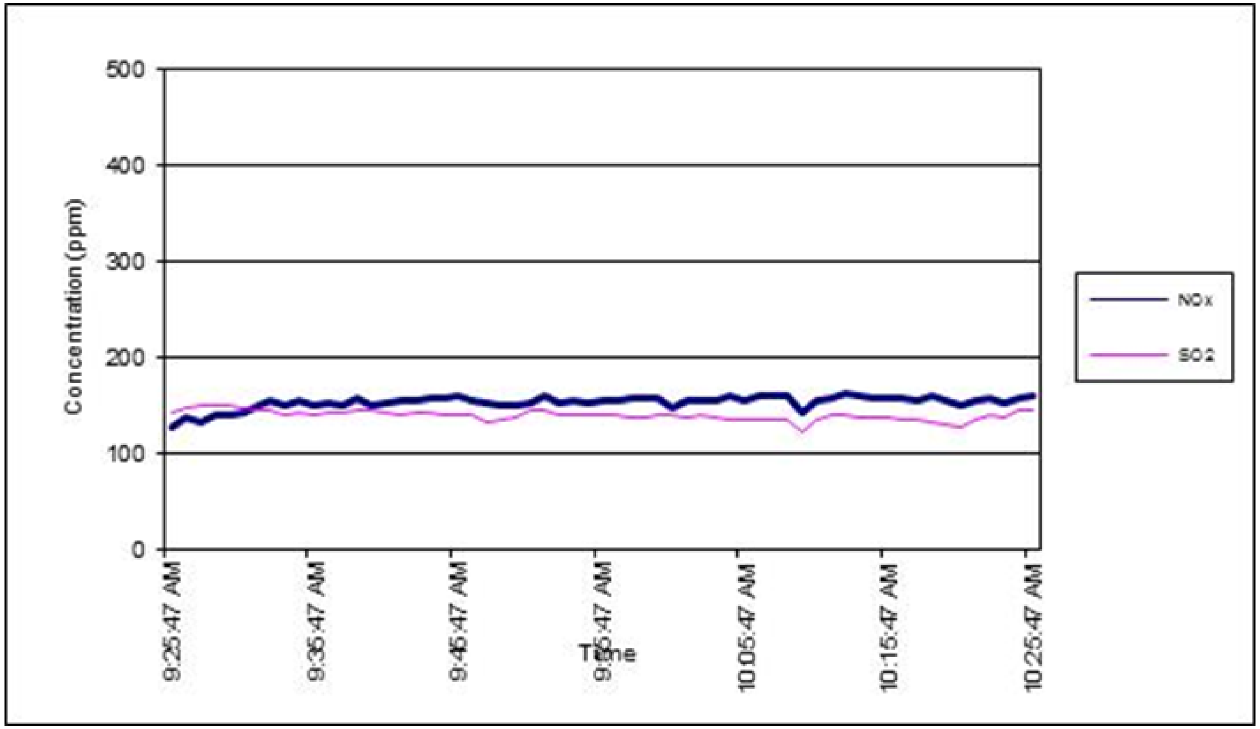


FIGURE B - 3 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 4 – 25 MARCH 2014



APPENDIX C – NATA EMISSION TEST REPORT INCLUDING CERTIFICATES OF ANALYSIS

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
ACN 002 600 526 (Incorporated in NSW)
ABN 75 002 600 526

Newington Business Park
Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
E-Mail: info@stephensonenv.com.au

Emission Test Report No. 5324

The sampling and analysis was commissioned by:

Client	Organisation:	Veolia Environmental Services
	Contact:	Vaughn Melano
	Address:	610 Collector Road, Tarago, NSW 2850
	Telephone:	02 4844 6353
	Facsimile:	02 4844 6355
	Project Number:	5324/S23034/14
	Test Date(s):	24 and 25 March 2014
	Production Conditions:	Normal operating conditions during testing
	Analysis Requested:	Flow, temperature, moisture, dry gas density, molecular weight of stack gases, Carbon Monoxide, Carbon Dioxide, Hydrogen Sulphide, Oxygen, Nitrogen Oxides, Sulphur Dioxide, Sulphur Trioxide/Sulphuric Acid Mist, and Volatile Organic Compounds
	Sample Locations:	Generators No.2, 3 & 4 Stacks
	Sample ID Nos.:	Refer to Attachment A

NATA
WORLD RECOGNISED ACCREDITATION

Accredited for Compliance with ISO/IEC 17025

Identification	The samples are labelled individually. Each label recorded the testing laboratory, sample number, sampling location (or Identification) sampling date and time and whether further analysis is required.

Test	***Test Method Number for Sampling and Analysis***	***NATA Laboratory Analysis By: NATA Accreditation No. & Report No.***
Carbon Dioxide	TM-24, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report 5324
Carbon Monoxide	TM-32, USEPA M10	SEMA, Accreditation No. 15043, Emission Test Report 5324
Dry Gas Density	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5324
Flow	NSW TM-2, USEPA M2A, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5324
Hydrogen Sulphide	NSW TM-5, USEPA M11	ALS Environmental, Accreditation No. 825, Report No. EN1401018
Moisture	NSW TM-22, USEPA M4	SEMA, Accreditation No. 15043, Emission Test Report 5324
Molecular Weight of Stack Gases	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5324
Oxides of Nitrogen	NSW TM-11, USEPA M7E	SEMA, Accreditation No. 15043, Emission Test Report 5324
Oxygen	NSW TM-25, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report 5324
Stack Temperature	NSW TM-2, USEPA M2, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5324
Sulphur Dioxide	NSW TM-4, USEPA M6-6C	SEMA, Accreditation No. 15043, Emission Test Report 5211

Sulphuric Acid Mist	NSW TM-3, USEPA M8	ALS Environmental, Accreditation No. 825, Report No. EN1401018
Velocity	NSW TM-2, USEPA M2A, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5324
Volatile Organic Compounds	NSW TM-34, USEPA M18	WorkCover, Accreditation No. 3726, Report No. 2014-0560

Deviations from Test Methods	Nil
Sampling Times	NSW - As per Test Method requirements or if not specified in the Test Method then as per Protection of the Environment Operations (Clean Air) Regulations Part 2.
Reference Conditions	NSW – As per (1) Environment Protection Licence conditions, or (2) Part 3 of the Protection of the Environment Operations (Clean Air) Regulations

All associated NATA endorsed Test Reports/Certificates of Analysis are provided separately in Attachment A.

Issue Date
11 April 2014

P W Stephenson
Managing Director

NATA accredited laboratory number 15043

SUMMARY OF THE AVERAGE EMISSION RESULTS – TEST REPORT NO. 5324

Pollutant	Units	Generator No. 2 EPL Point 8-2	Generator No. 3 EPL Point 8-3	Generator No. 4 EPL Point 8-4
		24/03/2014	24/03/2014	25/03/2014
Dry Gas Density	kg/m³	1.33	1.35	1.34
Moisture content	%	5.9	7.3	5.8
Molecular weight of stack gases	g/g mole	29.90	30.19	29.90
Temperature	°C	471	474	458
Velocity	m/s	46.2	52.5	51.7
Volumetric Flow Rate	m³/s	1.53	1.69	1.73
Carbon Dioxide	%	9.7	11.6	9.7
Carbon Monoxide	mg/m³	766	819	878
Hydrogen Sulphide	mg/m³	<0.354	<0.355	<0.345
Nitrogen Oxides @ 7% O_2	mg/m³	414	346	368
Oxygen (O_2)	%	8.6	8.3	8.8
Sulphur Trioxide / Sulphuric Acid Mist	mg/m³	6.95	5.07	7.08
Sulphur Dioxide	mg/m³	410	395	411
Volatile Organic Compounds	mg/m³	<4.178	<4.122	0.099

Key:

*	=	corrected to 7% O_2 (oxygen)
°C	=	degrees Celsius
<	=	less than
%	=	percentage
kg/m³	=	kilograms per cubic metre
g/g mole	=	grams per gram mole
m³/s	=	dry cubic metre per second 0°C and 101.3 kilopascals (kpa)
m/s	=	metres per second
mg/m³	=	milligrams per cubic metre at 0°C and 101.3 kilopascals (kpa)

ESTIMATED UNCERTAINTY OF MEASUREMENT

Pollutant	Methods	Uncertainty
Carbon Monoxide	TM-32, USEPA M10	15%
Hydrogen Sulphide	TM-5, USEPA 11	25% ++++
Moisture	AS4323.2, TM-22, USEPA 4	25%
Nitrogen Oxides	TM-11, USEPA 7E	15%
Oxygen and Carbon Dioxide	TM-24, TM-25, USEPA 3A	1% actual
Sulphur Dioxide	TM-4, USEPA 6C	15%
Sulphur Trioxide/Sulphuric Acid Mist (SO_3/H_2SO_4)	TM-3, USEPA 8	20%
Velocity	AS4323.1, TM-2, USEPA 2A & 2C	5%
Volatile Organic Compounds (adsorption tube)	TM-34, USEPA 18	25%

Key:

Unless otherwise indicated the uncertainties quoted have been determined @ 95% level of Confidence level (i.e. by multiplying the repeatability standard deviation by a co-efficient equal to 1.96) (Source – Measurement Uncertainty)

++++ = Similar to test method for Fluorine and SO_3/H_2SO_4 which is about 25%

Sources: *Measurement Uncertainty – implications for the enforcement of emission limits by Maciek Lewandowski (Environment Agency) & Michael Woodfield (AEAT) UK*

Technical Guidance Note (Monitoring) M2 Monitoring of stack emissions to air Environment Agency Version 3.1 June 2005.

ATTACHMENT A – NATA CERTIFICATES OF ANALYSIS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EN1401018**	Page	: 1 of 4
Client	: **STEPHENSON ENVIRONMENTAL MANAGEMENT AUSTRALIA**	Laboratory	: Environmental Division Newcastle
Contact	: MR JAY WEBER	Contact	: Peter Keyte
Address	: UNIT 7/2 HOLKER STREET NEWINGTON NSW, AUSTRALIA 2127	Address	: 5/585 Maitland Road Mayfield West NSW Australia 2304
E-mail	: jay@stephensonenv.com.au	E-mail	: peter.keyte@als.com.au
Telephone	: +61 02 97379991	Telephone	: 61-2-4968-9433
Facsimile	: +61 02 97379993	Facsimile	: +61-2-4968 0349
Project	: 5324	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 4096		
C-O-C number	: S23055	Date Samples Received	: 27-MAR-2014
Sampler	: JW	Issue Date	: 03-APR-2014
Site	: ----		
		No. of samples received	: 8
Quote number	: SY/464/13	No. of samples analysed	: 8

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK089: Test results indicate the presence of an oxidising interferant.**
- **Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.**

Work Order : EN1401018
Client : STEPHENSON ENVIRONMENTAL MANAGEMENT AUSTRALIA
Project : 5324

Analytical Results

Sub-Matrix: **IMPINGER SOLUTION** (Matrix: **AIR**)

Compound	CAS Number	LOR	Unit	G2	G3	G4	BLANK	G2
Client sample ID				723548	723549	723550	723551	723552
Client sampling date / time				24-MAR-2014 15:00	25-MAR-2014 15:00	25-MAR-2014 15:00	25-MAR-2014 15:00	24-MAR-2014 15:00
				EN1401018-001	EN1401018-002	EN1401018-003	EN1401018-004	EN1401018-005
EA143C: Sulfuric Acid and Sulfur Dioxide (as SO3)								
Volume - Impinger	----	1	mL	372	373	328	196	----
Sulfuric Acid as SO3	----	2	mg/sample	7	6	8	<2	----
EK089: Hydrogen Sulfide in Stack Testing Solutions								
Hydrogen Sulphide	7783-06-4	0.1	mg/sample	----	----	----	----	<0.1
Volume - Impinger	----	1	mL	----	----	----	----	62

Work Order : EN1401018
Client : STEPHENSON ENVIRONMENTAL MANAGEMENT AUSTRALIA
Project : 5324

Analytical Results

Sub-Matrix: **IMPINGER SOLUTION** (Matrix: **AIR**)

Compound	CAS Number	LOR	Unit					
			Client sample ID	**G3**	**G4**	**BLANK**	----	----
				723553	**723554**	**723555**		
			Client sampling date / time	25-MAR-2014 15:00	25-MAR-2014 15:00	25-MAR-2014 15:00	----	----
				EN1401018-006	**EN1401018-007**	**EN1401018-008**	----	----
EK089: Hydrogen Sulfide in Stack Testing Solutions								
Hydrogen Sulphide	7783-06-4	0.1	mg/sample	<0.1	<0.1	<0.1	----	----
Volume - Impinger	----	1	mL	**62**	**55**	**49**	----	----

Test Safe AUSTRALIA 'Safety is no Accident'

CHEMICAL ANALYSIS BRANCH

WorkCover NEW SOUTH WALES

Jay Weber
Stephenson Environmental Management Australia
PO Box 6398
SILVERWATER NSW 1811

Lab. Reference: 2014-0560

SAMPLE ORIGIN: Project No. 5324

DATE OF INVESTIGATION: 24th & 25th March 2014 **DATE RECEIVED:** 26/03/14

ANALYSIS REQUIRED: Volatile Organic Compounds

REPORT OF ANALYSIS

See attached sheet(s) for sample description and test results.

The results of this report have been approved by the NATA signatory whose signature appears below.

For all administrative or account details please contact Jeanine Wells.

Martin Mazereeuw
Manager

Date: 9/04/14

TestSafe Australia – *Chemical Analysis Branch*
ABN 77 682 742 966 5A Pioneer Avenue Thornleigh NSW 2120 AUSTRALIA
Telephone: 61 2 9473 4000 Facsimile: 61 2 9980 6849 Email: lab@workcover.nsw.gov.au
WorkCover Assistance Service 13 10 50 Website: www.workcover.nsw.gov.au

ilac-MRA NATA Accreditation No. 3726
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

NSW GOVERNMENT | WorkCover — TestSafe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Weber
Sample ID : 723556 — **Sample : 2014-0560-1**

No	Compounds	CAS No	Front (µg/section)	Back (µg/section)	No	Compounds	CAS No	Front (µg/section)	Back (µg/section)
	Aliphatic hydrocarbons (LOD = 5µg/compound/section)					**Aromatic hydrocarbons** (LOD = 1µg/compound/section)			
1	2-Methylbutane	78-78-4	ND	ND	39	Benzene	71-43-2	ND	ND
2	n-Pentane	109-66-0	ND	ND	40	Ethylbenzene	100-41-4	ND	ND
3	2-Methylpentane	107-83-5	ND	ND	41	Isopropylbenzene	98-82-8	ND	ND
4	3-Methylpentane	96-14-0	ND	ND	42	1,2,3-Trimethylbenzene	526-73-8	ND	ND
5	Cyclopentane	287-92-3	ND	ND	43	1,2,4-Trimethylbenzene	95-63-6	ND	ND
6	Methylcyclopentane	96-37-7	ND	ND	44	1,3,5-Trimethylbenzene	108-67-8	ND	ND
7	2,3-Dimethylpentane	565-59-3	ND	ND	45	Styrene	100-42-5	ND	ND
8	n-Hexane	110-54-3	ND	ND	46	Toluene	108-88-3	ND	ND
9	3-Methylhexane	589-34-4	ND	ND	47	p-Xylene &/or m-Xylene	106-42-3 & 108-38-3	ND	ND
10	Cyclohexane	110-8-27	ND	ND	48	o-Xylene	95-47-6	ND	ND
11	Methylcyclohexane	108-87-2	ND	ND		**Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s)			
12	2,2,4-Trimethylpentane	540-84-1	ND	ND	49	Acetone	67-64-1	ND	ND
13	n-Heptane	142-82-5	ND	ND	50	Acetoin	513-86-0	ND	ND
14	n-Octane	111-65-9	ND	ND	51	Diacetone alcohol	123-42-2	ND	ND
15	n-Nonane	111-84-2	ND	ND	52	Cyclohexanone	108-94-1	ND	ND
16	n-Decane	124-18-5	ND	ND	53	Isophorone	78-59-1	ND	ND
17	n-Undecane	1120-21-4	ND	ND	54	Methyl ethyl ketone (MEK)	78-93-3	ND	ND
18	n-Dodecane	112-40-3	ND	ND	55	Methyl isobutyl ketone (MIBK)	108-10-1	ND	ND
19	n-Tridecane	629-50-5	ND	ND		**Alcohols** (LOD = 25µg/compound/section)			
20	n-Tetradecane	629-59-4	ND	ND	56	Ethyl alcohol	64-17-5	ND	ND
21	α-Pinene	80-56-8	ND	ND	57	n-Butyl alcohol	71-36-3	ND	ND
22	β-Pinene	127-91-3	ND	ND	58	Isobutyl alcohol	78-83-1	ND	ND
23	D-Limonene	138-86-3	ND	ND	59	Isopropyl alcohol	67-63-0	ND	ND
	Chlorinated hydrocarbons (LOD = 5µg/compound/section)				60	2-Ethyl hexanol	104-76-7	ND	ND
24	Dichloromethane	75-09-2	ND	ND	61	Cyclohexanol	108-93-0	ND	ND
25	1,1-Dichloroethane	75-34-3	ND	ND		**Acetates** (LOD = 25µg/compound/section)			
26	1,2-Dichloroethane	107-06-2	ND	ND	62	Ethyl acetate	141-78-6	ND	ND
27	Chloroform	67-66-3	ND	ND	63	n-Propyl acetate	109-60-4	ND	ND
28	1,1,1-Trichloroethane	71-55-6	ND	ND	64	n-Butyl acetate	123-86-4	ND	ND
29	1,1,2-Trichloroethane	79-00-5	ND	ND	65	Isobutyl acetate	110-19-0	ND	ND
30	Trichloroethylene	79-01-6	ND	ND		**Ethers** (LOD = 25µg/compound/section)			
31	Carbon tetrachloride	56-23-5	ND	ND	66	Ethyl ether	60-29-7	ND	ND
32	Perchloroethylene	127-18-4	ND	ND	67	*tert*-Butyl methyl ether (MTBE)	1634-04-4	ND	ND
33	1,1,2,2-Tetrachloroethane	79-34-5	ND	ND	68	Tetrahydrofuran (THF)	109-99-9	ND	ND
34	Chlorobenzene	108-90-7	ND	ND		**Glycols** (LOD = 25µg/compound/section)			
35	1,2-Dichlorobenzene	95-50-1	ND	ND	69	PGME	107-98-2	ND	ND
36	1,4-Dichlorobenzene	106-46-7	ND	ND	70	Ethylene glycol diethyl ether	629-14-1	ND	ND
	Miscellaneous (LOD #37= 5µg & #38=25µg/compound/section)				71	PGMEA	108-65-6	ND	ND
37	Acetonitrile	75-05-8	ND	ND	72	Cellosolve acetate	111-15-9	ND	ND
38	n-Vinyl-2-pyrrolidinone	88-12-0	ND	ND	73	DGMEA	112-15-2	ND	ND
	Total VOCs (LOD =50µg/compound/section)		ND	ND		Worksheet check		YES	YES

2014-0560.xlsx — Page 2 of 5

TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
WorkCover NSW ABN 77 682 742 966 5A Pioneer Avenue, Thornleigh, NSW 2120, Australia
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WC03147 0412

ilac-MRA NATA
Accreditation No. 3726
Accredited for compliance with ISO/IEC 17025

NSW GOVERNMENT WorkCover

Test Safe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Weber
Sample ID : 723557
Sample : 2014-0560-2

No	Compounds	CAS No	Front	Back	No	Compounds	CAS No	Front	Back
			µg/section					µg/section	
	Aliphatic hydrocarbons (LOD = 5µg/compound/section)					**Aromatic hydrocarbons** (LOD = 1µg/compound/section)			
1	2-Methylbutane	*78-78-4*	ND	ND	39	Benzene	*71-43-2*	ND	ND
2	n-Pentane	*109-66-0*	ND	ND	40	Ethylbenzene	*100-41-4*	ND	ND
3	2-Methylpentane	*107-83-5*	ND	ND	41	Isopropylbenzene	*98-82-8*	ND	ND
4	3-Methylpentane	*96-14-0*	ND	ND	42	1,2,3-Trimethylbenzene	*526-73-8*	ND	ND
5	Cyclopentane	*287-92-3*	ND	ND	43	1,2,4-Trimethylbenzene	*95-63-6*	ND	ND
6	Methylcyclopentane	*96-37-7*	ND	ND	44	1,3,5-Trimethylbenzene	*108-67-8*	ND	ND
7	2,3-Dimethylpentane	*565-59-3*	ND	ND	45	Styrene	*100-42-5*	ND	ND
8	n-Hexane	*110-54-3*	ND	ND	46	Toluene	*108-88-3*	ND	ND
9	3-Methylhexane	*589-34-4*	ND	ND	47	p-Xylene &/or m-Xylene	*106-42-3 & 108-38-3*	ND	ND
10	Cyclohexane	*110-8-27*	ND	ND	48	o-Xylene	*95-47-6*	ND	ND
11	Methylcyclohexane	*108-87-2*	ND	ND		**Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s)			
12	2,2,4-Trimethylpentane	*540-84-1*	ND	ND	49	Acetone	*67-64-1*	ND	ND
13	n-Heptane	*142-82-5*	ND	ND	50	Acetoin	*513-86-0*	ND	ND
14	n-Octane	*111-65-9*	ND	ND	51	Diacetone alcohol	*123-42-2*	ND	ND
15	n-Nonane	*111-84-2*	ND	ND	52	Cyclohexanone	*108-94-1*	ND	ND
16	n-Decane	*124-18-5*	ND	ND	53	Isophorone	*78-59-1*	ND	ND
17	n-Undecane	*1120-21-4*	ND	ND	54	Methyl ethyl ketone (MEK)	*78-93-3*	ND	ND
18	n-Dodecane	*112-40-3*	ND	ND	55	Methyl isobutyl ketone (MIBK)	*108-10-1*	ND	ND
19	n-Tridecane	*629-50-5*	ND	ND		**Alcohols** (LOD = 25µg/compound/section)			
20	n-Tetradecane	*629-59-4*	ND	ND	56	Ethyl alcohol	*64-17-5*	ND	ND
21	α-Pinene	*80-56-8*	ND	ND	57	n-Butyl alcohol	*71-36-3*	ND	ND
22	β-Pinene	*127-91-3*	ND	ND	58	Isobutyl alcohol	*78-83-1*	ND	ND
23	D-Limonene	*138-86-3*	ND	ND	59	Isopropyl alcohol	*67-63-0*	ND	ND
	Chlorinated hydrocarbons (LOD = 5µg/compound/section)				60	2-Ethyl hexanol	*104-76-7*	ND	ND
24	Dichloromethane	*75-09-2*	ND	ND	61	Cyclohexanol	*108-93-0*	ND	ND
25	1,1-Dichloroethane	*75-34-3*	ND	ND		**Acetates** (LOD = 25µg/compound/section)			
26	1,2-Dichloroethane	*107-06-2*	ND	ND	62	Ethyl acetate	*141-78-6*	ND	ND
27	Chloroform	*67-66-3*	ND	ND	63	n-Propyl acetate	*109-60-4*	ND	ND
28	1,1,1-Trichloroethane	*71-55-6*	ND	ND	64	n-Butyl acetate	*123-86-4*	ND	ND
29	1,1,2-Trichloroethane	*79-00-5*	ND	ND	65	Isobutyl acetate	*110-19-0*	ND	ND
30	Trichloroethylene	*79-01-6*	ND	ND		**Ethers** (LOD = 25µg/compound/section)			
31	Carbon tetrachloride	*56-23-5*	ND	ND	66	Ethyl ether	*60-29-7*	ND	ND
32	Perchloroethylene	*127-18-4*	ND	ND	67	tert-Butyl methyl ether (MTBE)	*1634-04-4*	ND	ND
33	1,1,2,2-Tetrachloroethane	*79-34-5*	ND	ND	68	Tetrahydrofuran (THF)	*109-99-9*	ND	ND
34	Chlorobenzene	*108-90-7*	ND	ND		**Glycols** (LOD = 25µg/compound/section)			
35	1,2-Dichlorobenzene	*95-50-1*	ND	ND	69	PGME	*107-98-2*	ND	ND
36	1,4-Dichlorobenzene	*106-46-7*	ND	ND	70	Ethylene glycol diethyl ether	*629-14-1*	ND	ND
	Miscellaneous (LOD #37= 5µg & #38=25µg/compound/section)				71	PGMEA	*108-65-6*	ND	ND
37	Acetonitrile	*75-05-8*	ND	ND	72	Cellosolve acetate	*111-15-9*	ND	ND
38	n-Vinyl-2-pyrrolidinone	*88-12-0*	ND	ND	73	DGMEA	*112-15-2*	ND	ND
	Total VOCs (LOD =50µg/compound/section)		ND	ND		Worksheet check		YES	YES

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NSW GOVERNMENT | WorkCover

Test Safe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Weber
Sample ID : 723558 — **Sample : 2014-0560-3**

No	Compounds	CAS No	Front	Back	No	Compounds	CAS No	Front	Back
			µg/section					µg/section	
	Aliphatic hydrocarbons (LOD = 5µg/compound/section)					**Aromatic hydrocarbons** (LOD = 1µg/compound/section)			
1	2-Methylbutane	*78-78-4*	ND	ND	39	Benzene	*71-43-2*	1	ND
2	n-Pentane	*109-66-0*	ND	ND	40	Ethylbenzene	*100-41-4*	ND	ND
3	2-Methylpentane	*107-83-5*	ND	ND	41	Isopropylbenzene	*98-82-8*	ND	ND
4	3-Methylpentane	*96-14-0*	ND	ND	42	1,2,3-Trimethylbenzene	*526-73-8*	ND	ND
5	Cyclopentane	*287-92-3*	ND	ND	43	1,2,4-Trimethylbenzene	*95-63-6*	ND	ND
6	Methylcyclopentane	*96-37-7*	ND	ND	44	1,3,5-Trimethylbenzene	*108-67-8*	ND	ND
7	2,3-Dimethylpentane	*565-59-3*	ND	ND	45	Styrene	*100-42-5*	ND	ND
8	n-Hexane	*110-54-3*	ND	ND	46	Toluene	*108-88-3*	ND	ND
9	3-Methylhexane	*589-34-4*	ND	ND	47	p-Xylene &/or m-Xylene	*106-42-3 & 108-38-3*	ND	ND
10	Cyclohexane	*110-8-27*	ND	ND	48	o-Xylene	*95-47-6*	ND	ND
11	Methylcyclohexane	*108-87-2*	ND	ND		**Ketones** (LOD #49, #54 & #55 =5µg/c/s; #50, #51, #52 & #53 =25µg/c/s)			
12	2,2,4-Trimethylpentane	*540-84-1*	ND	ND	49	Acetone	*67-64-1*	ND	ND
13	n-Heptane	*142-82-5*	ND	ND	50	Acetoin	*513-86-0*	ND	ND
14	n-Octane	*111-65-9*	ND	ND	51	Diacetone alcohol	*123-42-2*	ND	ND
15	n-Nonane	*111-84-2*	ND	ND	52	Cyclohexanone	*108-94-1*	ND	ND
16	n-Decane	*124-18-5*	ND	ND	53	Isophorone	*78-59-1*	ND	ND
17	n-Undecane	*1120-21-4*	ND	ND	54	Methyl ethyl ketone (MEK)	*78-93-3*	ND	ND
18	n-Dodecane	*112-40-3*	ND	ND	55	Methyl isobutyl ketone (MIBK)	*108-10-1*	ND	ND
19	n-Tridecane	*629-50-5*	ND	ND		**Alcohols** (LOD = 25µg/compound/section)			
20	n-Tetradecane	*629-59-4*	ND	ND	56	Ethyl alcohol	*64-17-5*	ND	ND
21	α-Pinene	*80-56-8*	ND	ND	57	n-Butyl alcohol	*71-36-3*	ND	ND
22	β-Pinene	*127-91-3*	ND	ND	58	Isobutyl alcohol	*78-83-1*	ND	ND
23	D-Limonene	*138-86-3*	ND	ND	59	Isopropyl alcohol	*67-63-0*	ND	ND
	Chlorinated hydrocarbons (LOD = 5µg/compound/section)				60	2-Ethyl hexanol	*104-76-7*	ND	ND
24	Dichloromethane	*75-09-2*	ND	ND	61	Cyclohexanol	*108-93-0*	ND	ND
25	1,1-Dichloroethane	*75-34-3*	ND	ND		**Acetates** (LOD = 25µg/compound/section)			
26	1,2-Dichloroethane	*107-06-2*	ND	ND	62	Ethyl acetate	*141-78-6*	ND	ND
27	Chloroform	*67-66-3*	ND	ND	63	n-Propyl acetate	*109-60-4*	ND	ND
28	1,1,1-Trichloroethane	*71-55-6*	ND	ND	64	n-Butyl acetate	*123-86-4*	ND	ND
29	1,1,2-Trichloroethane	*79-00-5*	ND	ND	65	Isobutyl acetate	*110-19-0*	ND	ND
30	Trichloroethylene	*79-01-6*	ND	ND		**Ethers** (LOD = 25µg/compound/section)			
31	Carbon tetrachloride	*56-23-5*	ND	ND	66	Ethyl ether	*60-29-7*	ND	ND
32	Perchloroethylene	*127-18-4*	ND	ND	67	*tert*-Butyl methyl ether (MTBE)	*1634-04-4*	ND	ND
33	1,1,2,2-Tetrachloroethane	*79-34-5*	ND	ND	68	Tetrahydrofuran (THF)	*109-99-9*	ND	ND
34	Chlorobenzene	*108-90-7*	ND	ND		**Glycols** (LOD = 25µg/compound/section)			
35	1,2-Dichlorobenzene	*95-50-1*	ND	ND	69	PGME	*107-98-2*	ND	ND
36	1,4-Dichlorobenzene	*106-46-7*	ND	ND	70	Ethylene glycol diethyl ether	*629-14-1*	ND	ND
	Miscellaneous (LOD #37= 5µg & #38=25µg/compound/section)				71	PGMEA	*108-65-6*	ND	ND
37	Acetonitrile	*75-05-8*	ND	ND	72	Cellosolve acetate	*111-15-9*	ND	ND
38	n-Vinyl-2-pyrrolidinone	*88-12-0*	ND	ND	73	DGMEA	*112-15-2*	ND	ND
	Total VOCs (LOD =50µg/compound/section)		**87**	ND		Worksheet check		YES	YES

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Accreditation No. 3726

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WC03147 0412

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Test Safe AUSTRALIA

Analysis of Volatile Organic Compounds in Workplace Air by GC/MS

Client : Jay Weber

Stephenson Environmental Management Australia

ND = Not Detected
VOCs = Volatile Organic Compounds
Method : Analysis of Volatile Organic Compounds in Workplace Air by Gas Chromatography/Mass Spectrometry
Method Number : WCA.207
Detection Limit : 5µg/section; 25µg/section for oxygenated hydrocarbons except acetone, MEK and MIBK at 5µg/section and aromatic hydrocarbon at 1µg/section.
Brief Description : Volatile organic compounds are trapped from the workplace air onto charcoal tubes by the use of a personal air monitoring pump. The volatile organic compounds are then desorbed from the charcoal in the laboratory with CS_2. An aliquot of the desorbant is analysed by capillary gas chromatography with mass spectrometry detection.

The Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by combining the determined values of the 73 compounds with other VOCs that have been identified by mass spectrometry in the sample. These extra VOCs were individually estimated by the response of the nearest internal standard to that compound. Therefore, the TVOC test result should be interpreted as a semi-quantitative guide to the amount of VOCs present. If the TVOC test result is greater than the addition of all the compounds quantified then this can indicate that there are additional compounds present other than the 73 quantified compounds reported.

PGME : Propylene Glycol Monomethyl Ether
PGMEA : Propylene Glycol Monomethyl Ether Acetate
DGMEA : Diethylene Glycol Monoethyl Ether Acetate

Measurement Uncertainty
The measurement uncertainty is an estimate that characterises the range of values within which the true value is asserted to lie. The uncertainty estimate is an expanded uncertainty using a coverage factor of 2, which gives a level of confidence of approximately 95%. The estimate is compliant with the "ISO Guide to the Expression of Uncertainty in Measurement" and is a full estimate based on in-house method validation and quality control data.

Quality Assurance
In order to ensure the highest degree of accuracy and precision in our analytical results, we undertake extensive intra- and inter-laboratory quality assurance (QA) activities. Within our own laboratory, we analyse laboratory and field blanks and perform duplicate and repeat analysis of samples. Spiked QA samples are also included routinely in each run to ensure the accuracy of the analyses. WorkCover Laboratory Services has participated for many years in several national and international inter-laboratory comparison programs listed below:-

- Workplace Analysis Scheme for Proficiency (WASP) conducted by the Health & Safety Executive UK;
- Quality Management in Occupational and Environmental Medicine QA Program, conducted by the Institute for Occupational, Social and Environmental Medicine, University of Erlangen – Nuremberg, Germany;
- Quality Control Technologies QA Program, Australia;
- Royal College of Pathologists QA Program, Australia.

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Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50
WC03147 0412

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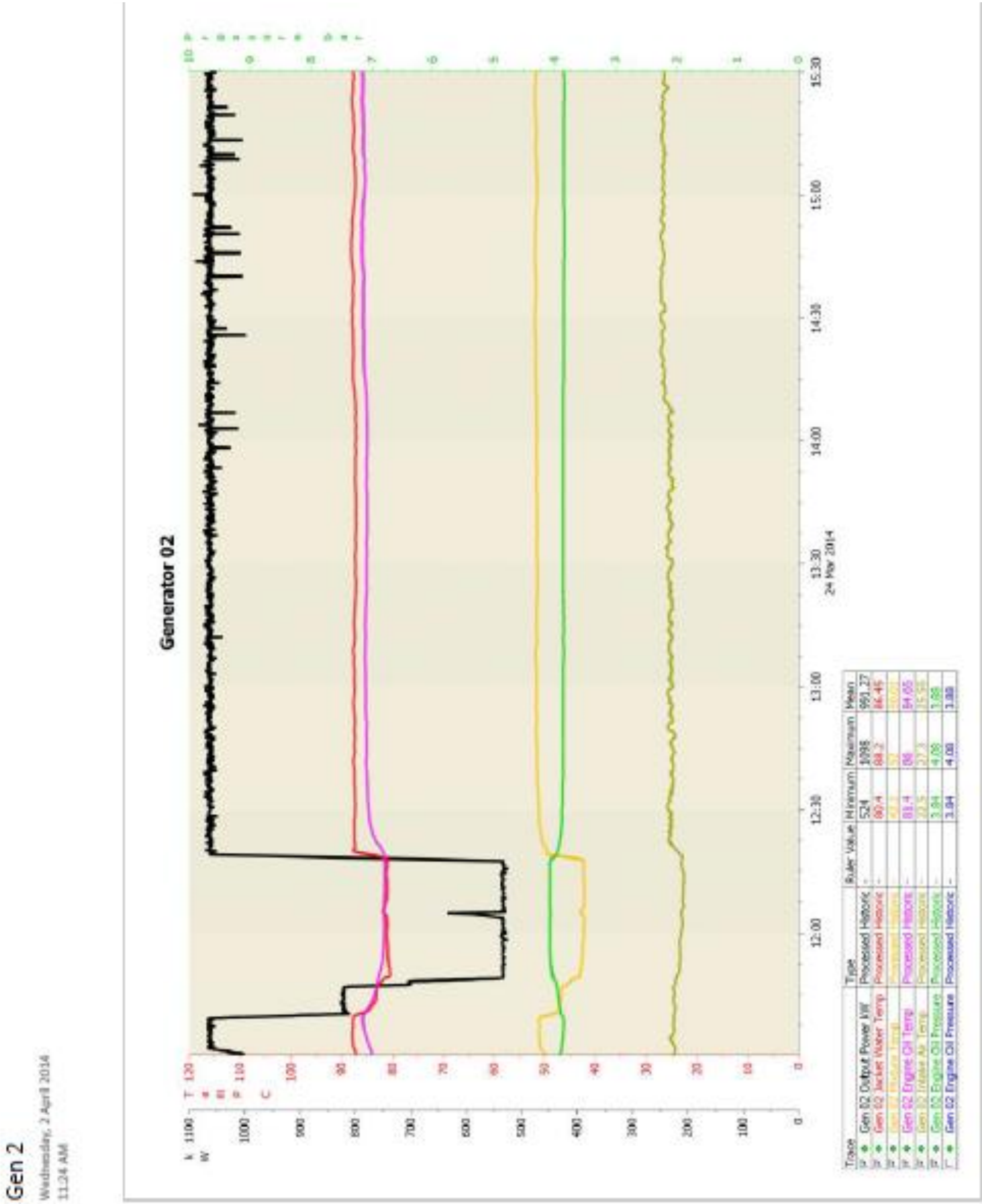
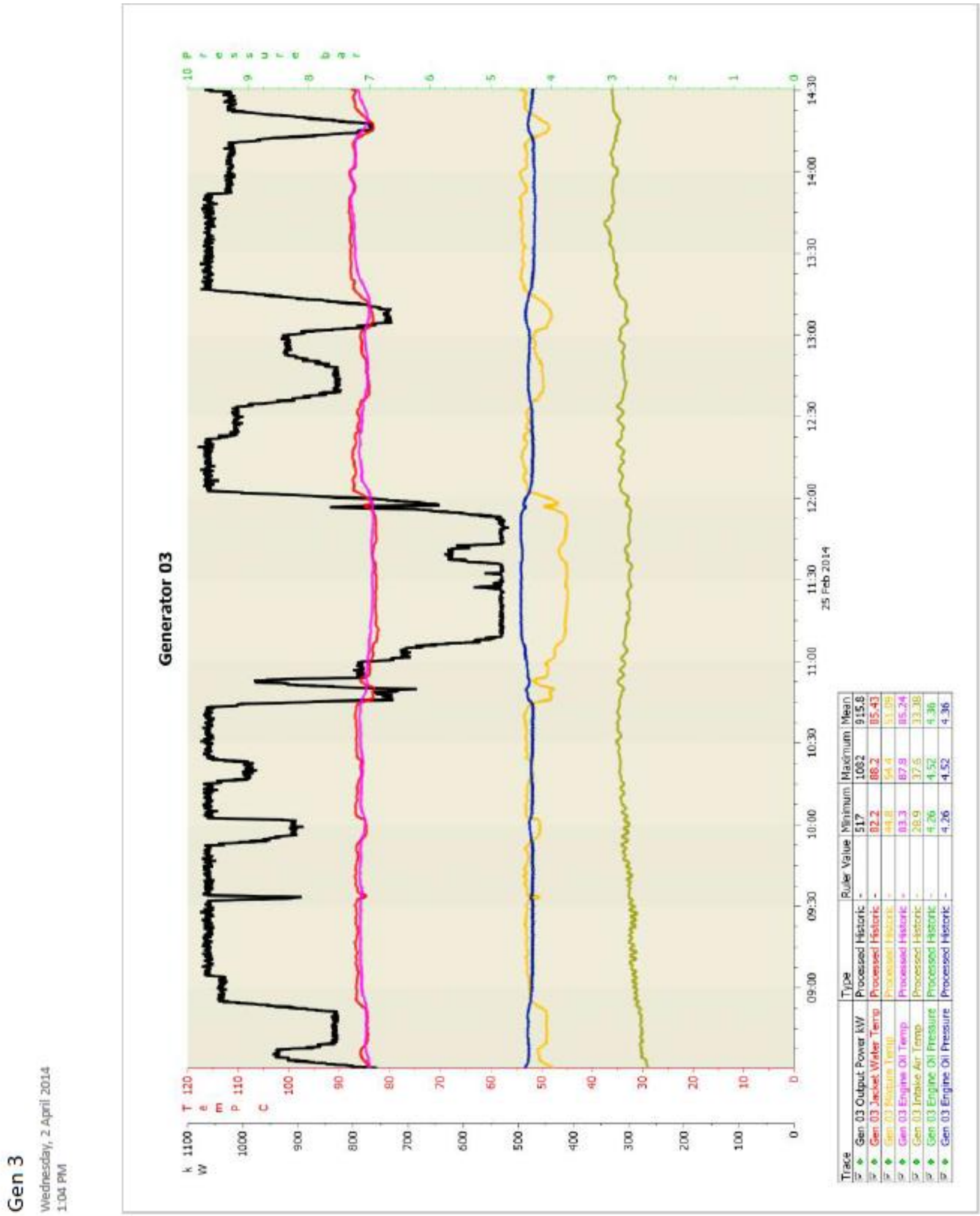
Accreditation No. 3726
Accredited for compliance with ISO/IEC 17025

APPENDIX D – PRODUCTION RECORDS

GENERATOR NO.2 PRODUCTION DATA -24 MARCH 2014

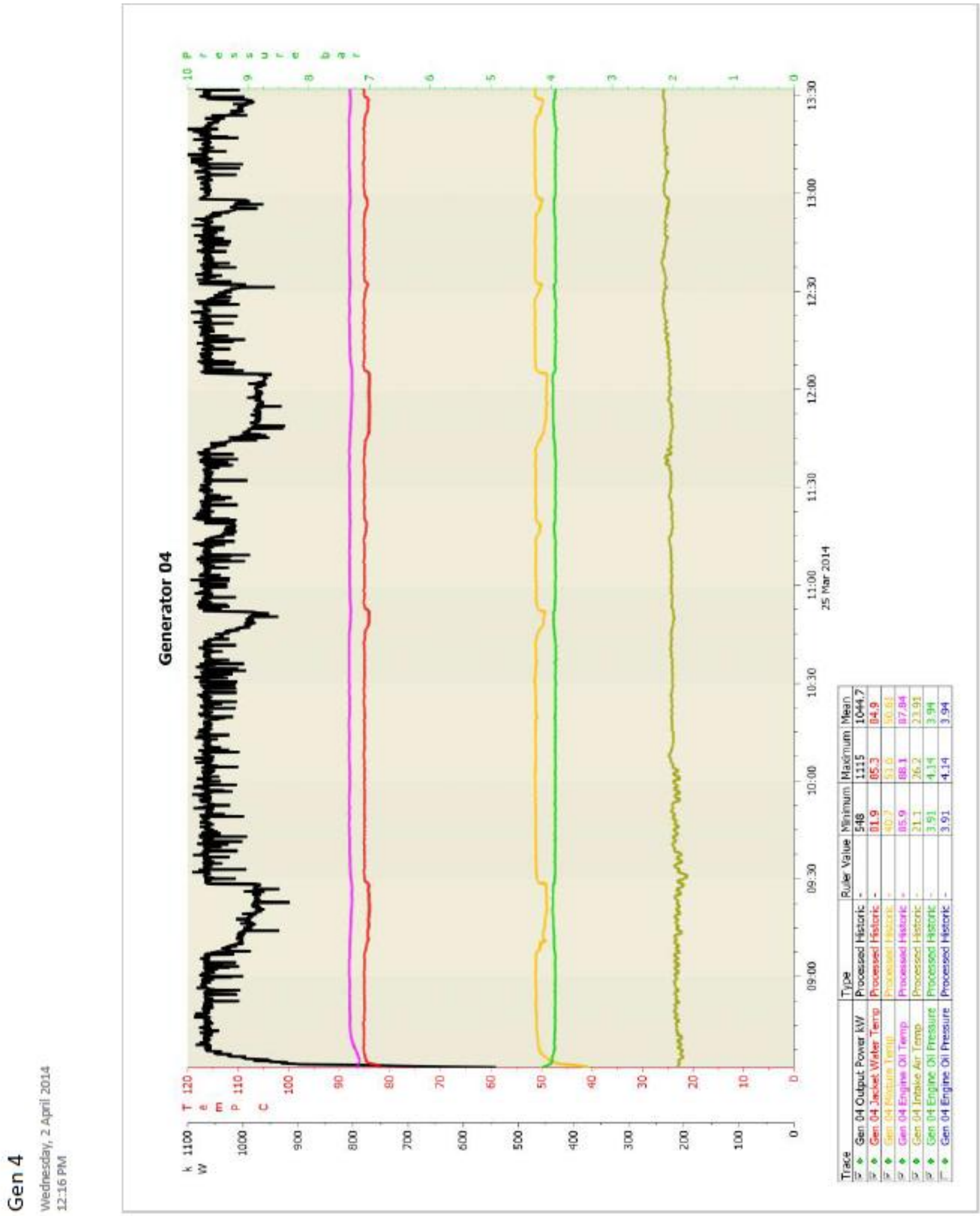


GENERATOR NO.3 PRODUCTION DATA 25 MARCH 2014



Note: Time not adjusted to daylight saving time.

GENERATOR NO. 4 PRODUCTION DATA 25 MARCH 2014



APPENDIX E – INSTRUMENT CALIBRATION INFORMATION

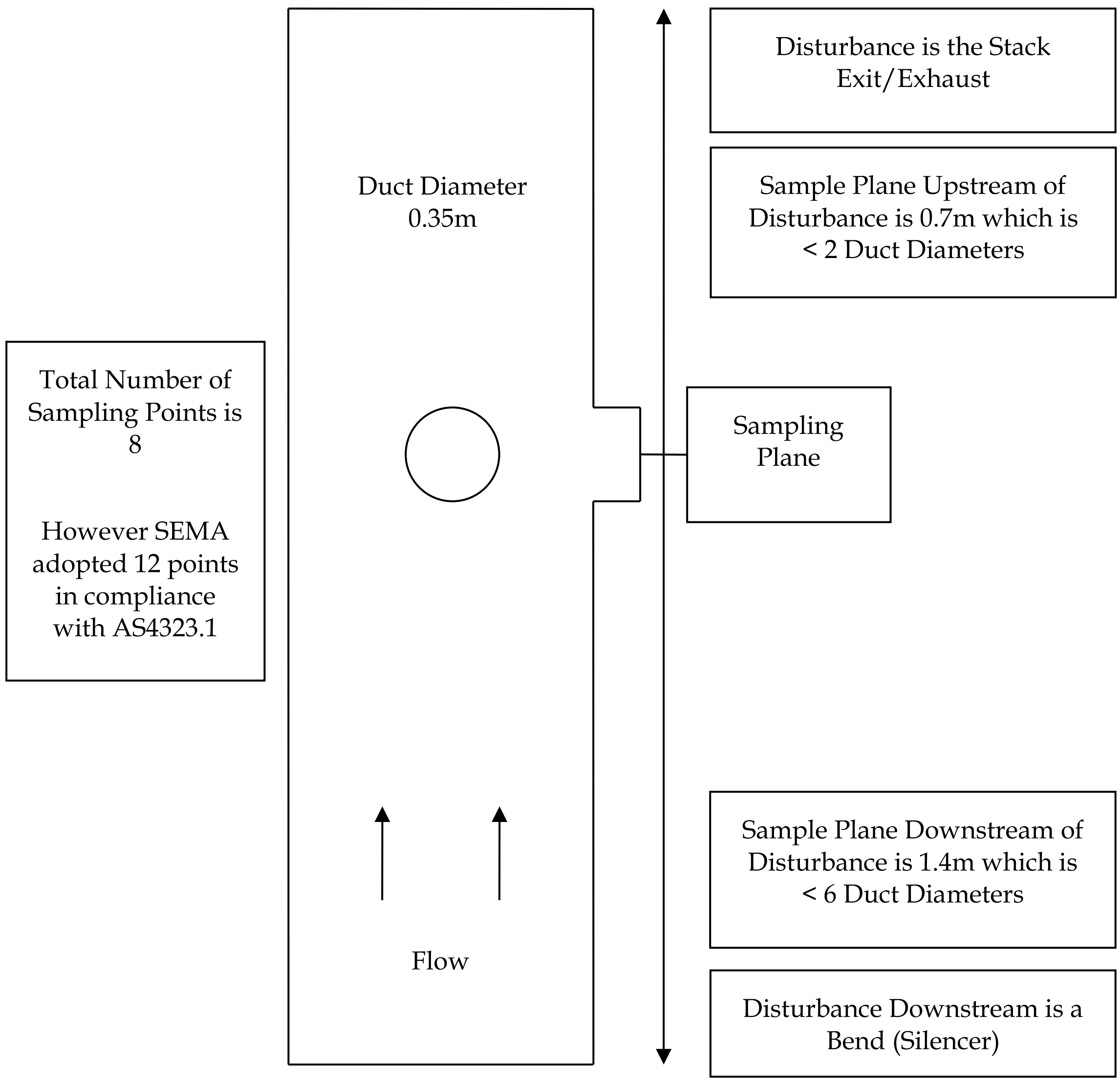
TABLE E - 1 INSTRUMENT CALIBRATION DETAILS

SEMA Asset No.	Equipment Description	Date Last Calibrated	Calibration Due Date
733	Testo 350	01-Nov-13	01-May-14
811	Testo 350	01-Nov-13	01-May-14
845	Stopwatch	12-Apr-13	12-Apr-14
792	Gas Meter	09-Sep-13	09-Sep-14
867	Gas Meter	07-Jun-13	07-Jun-14
858	Digital Temperature Reader	03-Mar-14	03-Sep-14
720	Thermocouple	15-Jan-14	15-Jul-14
815	Digital Manometer	02-Jul-13	02-Jul-14
613	Barometer	06-Mar-14	06-Mar-15
725	Pitot	08-Jul-13	08-Jul-2014 Visually inspected On-Site before use
927	Balance		Response Check with SEMA Site Mass
929	Field Mass Weight	25-May-13	25-May-14
12	Personal Sampler	10-Sep-13	10-Sep-14
934	Personal Sampler	19-Nov-13	19-Nov-14
725	Pitot	08-Jul-13	08-Jul-2014 Visually inspected On-Site before use
407	Usepa Metals Nozzle Set - Glass	13-Jan-14	13-Jan-15
811	Testo 350	01-Nov-13	01-May-14

Gas Mixtures used for Analyser Span Response			
Conc.	**Mixture**	**Cylinder No.**	**Expiry Date**
902 ppm 10.4% 9.8%	Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen	ALSB4980	07-Feb-18
387 ppm 387 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen	5BM6049	20-Feb-18
255 ppm 255 ppm	Nitric Oxide Total Oxide Of Nitrogen In Nitrogen	ALTT8831	30-May-14
278 ppm	Sulphur Dioxide In Nitrogen	399945	21-Sep-14
383 ppm	Sulphur Dioxide In Nitrogen	ALSD3948	25-Oct-18

APPENDIX F – SAMPLE LOCATIONS

FIGURE F-1 SAMPLE LOCATION – GENERATOR NO. 2

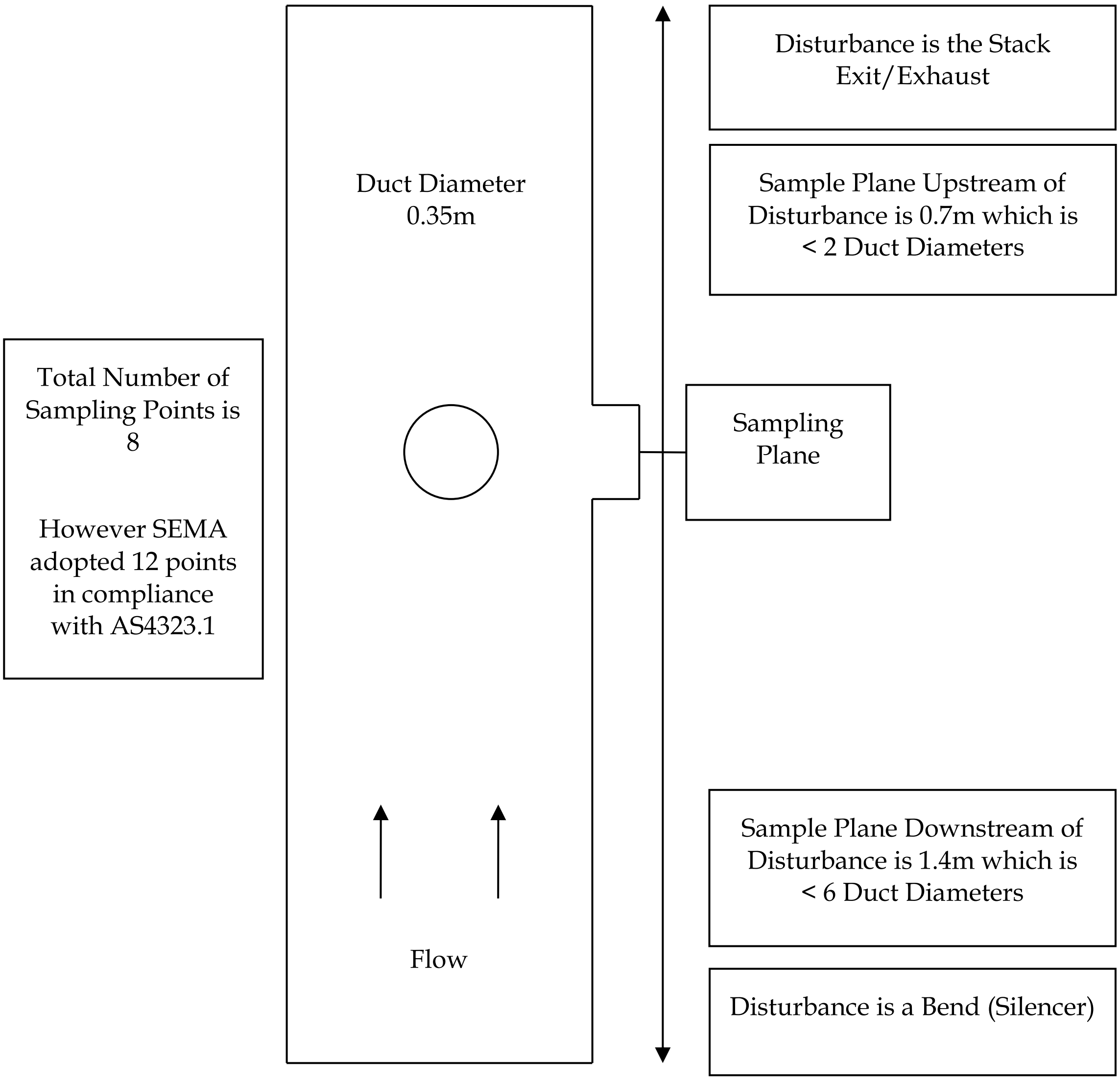


In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1 to compensate for the non-ideal sampling plane.

However the sampling plane does meet the minimum requirements; sampling plane conditions will be found to exist at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 criteria for temperature, velocity and gas flow profile and therefore is satisfactory for gas flow sampling.

FIGURE F-2 SAMPLE LOCATION – GENERATOR NO. 3

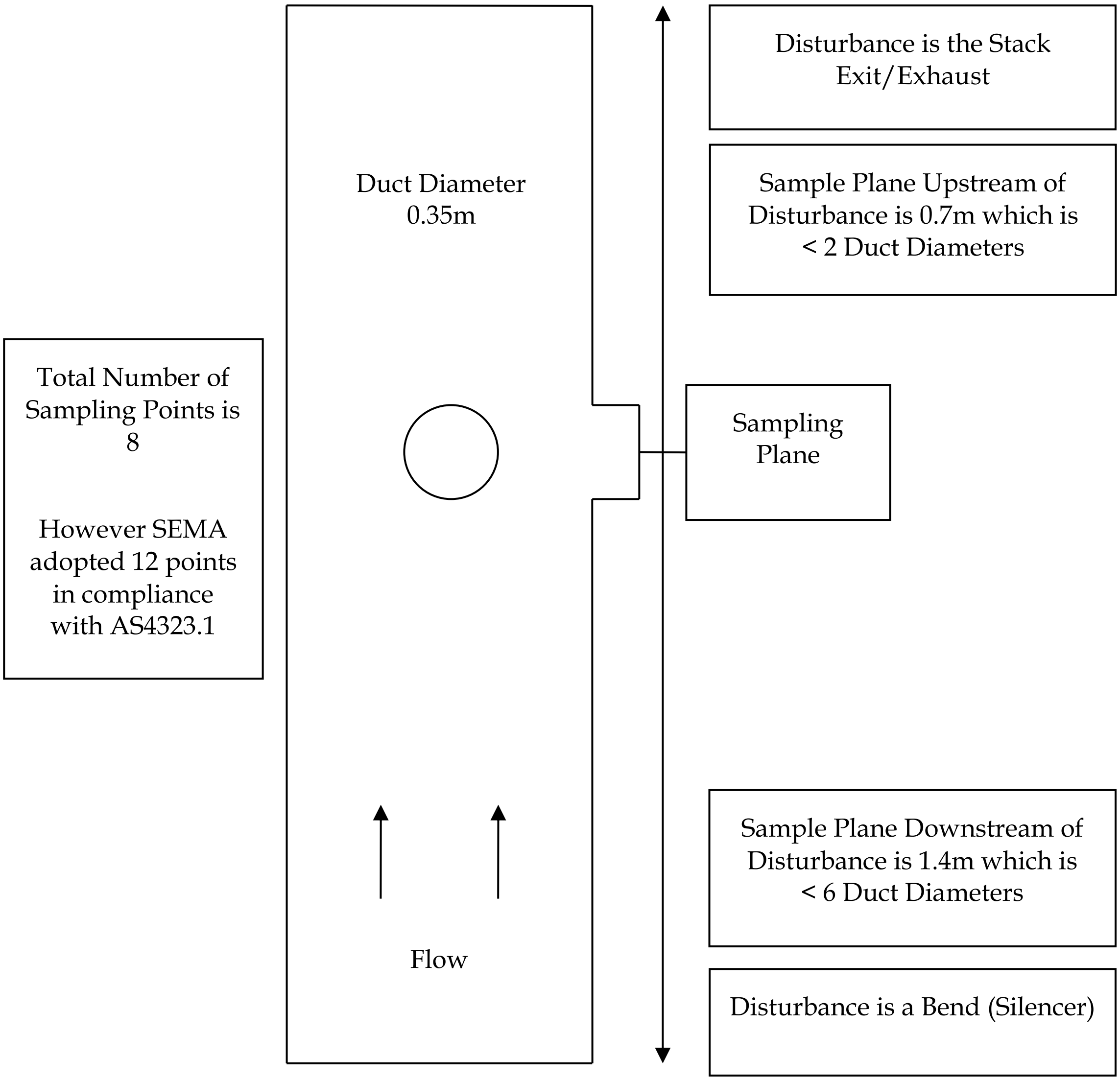


In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1 to compensate for the non-ideal sampling plane.

However the sampling plane does meet the minimum requirements; that is, sampling plane conditions will be found to exist at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 criteria for temperature, velocity and gas flow profile and therefore is satisfactory for gas flow sampling.

FIGURE F-3 SAMPLE LOCATION – GENERATOR NO. 4



In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1 to compensate for the non-ideal sampling plane.

However the sampling plane does meet the minimum requirements; that is, sampling plane conditions will be found to exist at 2 duct diameters downstream and 0.5 duct diameters upstream from a flow disturbance.

The location of the sampling plane complies with AS4323.1 criteria for temperature, velocity and gas flow profile and therefore is satisfactory for gas flow sampling.

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EVAPORATION DATA SUPPLIED BY VES

Evaporation	2006 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	2006 Sep	Oct	Nov	Dec	2007 Jan	Feb	Mar	Apr	May	Jun
1	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.60	6.80	5.00	3.00	1.50	1.41
2	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	2.20	2.60	4.80	3.60	2.40	1.04
3	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	2.60	5.00	3.80	3.80	3.19	1.16
4	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.00	6.40	7.60	2.80	4.52	1.30
5	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.80	7.40	6.60	3.00	2.68	0.69
6	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	8.20	3.60	4.60	2.52	1.00
7	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.60	7.00	5.00	2.40	2.43	0.67
8	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	5.80	4.60	3.60	1.40	1.87	0.83
9	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.60	6.80	5.00	2.40	1.37	0.48
10	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.40	5.20	4.80	2.00	1.41	0.73
11	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.60	3.60	5.40	3.20	1.48	1.24
12	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	11.40	2.20	7.00	3.60	1.74	0.77
13	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	13.40	3.80	3.60	2.60	2.19	1.23
14	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	4.40	2.80	3.00	1.51	1.02
15	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.80	5.80	4.80	3.60	2.03	0.43
16	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	6.20	6.20	4.00	2.09	0.64
17	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.80	3.80	4.60	2.80	1.47	0.84
18	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	5.60	2.40	3.40	1.49	0.75
19	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	6.00	1.60	2.00	3.80	0.72	0.63
20	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.60	3.60	0.20	2.20	1.53	0.43
21	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	11.00	6.80	2.20	2.60	2.14	1.13
22	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.40	7.40	3.40	2.60	2.21	1.12
23	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.60	5.60	4.40	2.60	1.69	1.35
24	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	9.40	5.20	4.80	1.80	1.59	1.11
25	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	7.20	4.60	4.00	0.60	1.81	1.16
26	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.00	4.20	2.60	1.20	1.75	0.57
27	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	12.40	3.60	2.80	2.40	1.56	0.27
28	6.40	5.40	4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	10.60	3.00	2.80	1.40	2.20	0.42
29	8.20		4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.80		4.20	1.40	1.75	0.79
30	8.20		4.10	2.60	1.70	1.10	1.20	1.90	2.80	3.90	5.00	6.20	8.00		3.00	1.80	2.65	1.27
31	8.20		4.10		1.70		1.20	1.90		3.90		6.20	10.00		3.40		1.24	
Total Month	**203.8**	**151.2**	**127.1**	**78**	**52.7**	**33**	**37.2**	**58.9**	**84**	**120.9**	**150**	**192.2**	**246.8**	**141**	**126.4**	**79.6**	**60.68**	**26.47**
Accumulated Year	**204**	**355**	**482.1**	**560.1**	**612.8**	**645.8**	**683**	**741.9**	**825.9**	**946.8**	**1096.8**	**1289**	**246.8**	**387.8**	**514.2**	**593.8**	**654.48**	**681**

Evaporation data recorded from the Goulburn Tafe W

						2008												2009	
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
1.21	1.13	4.17	4.49	2.73	2.82	7.058	4.079	4.42	3.876	2.082	1.889	2.563	2.158	1.339	3.822	8.25	5.487	6.915	7.353
0.82	1.27	2.87	5.04	4.66	2.286	7.126	2.908	4.566	3.485	1.918	0.485	1.146	0.953	2.667	4.838	2.408	7.579	8.11	6.754
1.21	2.29	3.26	5.41	4.31	5.675	7.446	4.000	4.257	5.316	1.977	0.828	1.139	1.469	2.828	6.486	3.711	6.729	6.339	6.712
1.75	0.94	2.94	8.39	1.49	4.147	2.006	4.788	4.536	2.663	2.314	0.46	1.32	1.967	1.616	6.588	3.963	6.955	5.254	5.055
1.18	1.59	2.46	5.05	3.30	4.956	7.4	1.496	4.274	3.13	2.225	0.771	0.847	1.659	1.006	1.318	5.035	5.046	6.369	4.618
0.72	1.67	1.44	5.48	2.40	1.109	6.6	1.512	4.457	3.239	2.423	0.76	1.387	1.263	1.288	2.328	3.928	5.442	8.86	6.982
1.06	1.65	1.87	5.68	4.5	4.2	6.883	4.498	5.111	2.656	2.177	1.026	1.22	1.656	1.162	3.205	6.31	7.507	8.46	7.344
1.02	1.71	1.38	3.90	2.097	3.395	6.251	3.381	3.829	2.231	2.323	1.351	1.312	1.147	2.65	3.387	3.199	6.765	8.21	8.81
0.70	2.11	1.61	3.89	2.106	4.31	6.6	2.689	4.053	1.712	2.209	0.5	1.227	1.663	2.508	4.196	3.801	6.172	3.146	8.3
0.90	2.39	2.04	3.91	2.929	6.974	5.175	2.861	4.623	1.81	2.056	1.211	0.51	1.35	3.038	4.017	5.71	6.895	4.802	2.73
1.19	3.15	2.55	4.12	4.648	3.645	6.945	4.415	4.768	2.685	2.026	0.588	0.875	0.664	2.896	4.264	5.541	3.662	4.78	1.038
1.44	3.09	1.69	4.89	5.543	1.426	7.747	4.853	4.954	3.052	1.296	0.865	1.079	1.452	3.56	3.963	5.464	1.874	4.981	4.292
1.09	2.27	2.29	3.87	5.421	5.00	5.179	3	4.862	2.614	1.532	1.672	1.215	1.511	4.341	4.769	6.244	0.951	4.415	1.801
1.02	1.69	3.53	4.15	6.033	4.40	7.447	1.161	4.992	2.11	1.757	1.089	1.621	1.801	5.149	4.463	6.274	4.303	6.69	3.05
0.86	1.02	4.08	4.78	6.794	5.362	1.344	3.54	4.861	2.854	1.874	1.572	2.064	1.693	2.177	1.793	6.243	3.726	9	2.4
1.06	1.08	3.46	6.31	6.455	5.385	6.369	5.299	5.892	2.901	1.997	1.141	1.281	1.726	4.05	3.63	6.192	5.567	9.69	2.225
1.04	1.87	3.82	7.67	5.901	0.933	4.194	5.042	4.894	2.611	1.468	0.794	1.247	1.834	2.663	4.097	4.685	6.225	7.435	3.11
1.34	0.82	2.25	4.52	6.297	4.659	4.4	4.186	4.841	1.902	1.245	1.042	1.28	2.186	2.098	4.755	5.378	3.919	6.079	2.313
1.30	0.95	3.21	4.95	5.31	4.40	2.054	4.73	5.056	2.09	1.432	1.056	1.051	1.361	3.326	4.845	3.55	4.689	6.418	3.187
1.52	0.78	4.30	5.30	6.444	2.116	1.72	4.48	2.672	1.27	1.881	0.842	1.652	2.009	4.809	5.672	2.603	5.48	7.43	5.529
1.49	0.94	1.92	5.45	6.425	1.79	3.779	5.237	4.843	1.596	1.602	0.297	1.258	2.209	5.661	4.572	3.418	4.656	7.28	3.265
1.15	1.14	3.13	7.20	6.425	5.306	2.357	2.445	1.335	2.494	1.74	1.192	1.394	2.44	4.423	3.561	5.702	5.765	7.637	4.303
0.78	0.88	3.23	6.92	0.573	2.921	4.681	5.397	1.763	1.229	1.673	1.271	1.551	1.138	4.422	3.28	2.389	6.683	5.991	3.535
1.51	1.16	3.62	4.15	1.268	4.309	5.547	6.058	3.212	2.211	1.193	1.118	1.17	1.594	2.527	3.602	2.16	3.337	6.481	4.391
1.60	1.70	4.87	1.97	2.786	4.859	6.208	5.649	1.777	1.685	1.456	1.126	1.146	2.284	2.461	4.178	5.332	1.37	7.481	6.763
1.99	2.03	4.68	1.29	5.691	5.20	4.636	4.078	0.872	1.569	1.499	1.623	1.547	2.553	3.68	5.96	4.286	6.181	4.449	5.653
1.86	2.98	3.07	2.36	4.37	6.216	6.022	5.26	2.734	3.338	1.253	1.242	1.2	2.669	4.221	5.949	3.299	7.006	6.364	5.124
1.30	3.73	3.92	4.32	6.6	3.844	6.413	3.85	3.058	2.642	1.484	1.607	0.866	2.212	5.675	8	5.683	4.365	4.688	4.802
1.73	4.86	5.73	4.75	5.35	6.515	5.972	0.894	2.139	1.338	1.37	1.198	1.235	1.744	6.15	5.297	3.178	5.461	6.868	
1.18	3.51	3.62	5.87	3.106	6.941	6.752		3.646	2.208	1.425	1.927	1.503	1.283	3.495	1.819	5.458	7.121	7.29	
1.56	3.98		5.56		7.736	6.868		3.861		1.726		1.703	2.13		5.019		6.405	7.182	
38.56	**60.372**	**92.97**	**151.606**	**131.946**	**132.835**	**169.179**	**111.786**	**121.158**	**74.517**	**54.633**	**32.543**	**40.609**	**53.778**	**97.886**	**133.673**	**139.394**	**163.323**	**205.09**	**131.44**
719.5	**779.88**	**872.8**	**1024.45**	**1156.4**	**1289.23**	**169**	**280.965**	**402.123**	**476.64**	**531.273**	**563.816**	**604.425**	**658.203**	**756.089**	**889.762**	**1029.16**	**1192.48**	**205**	**336.533**

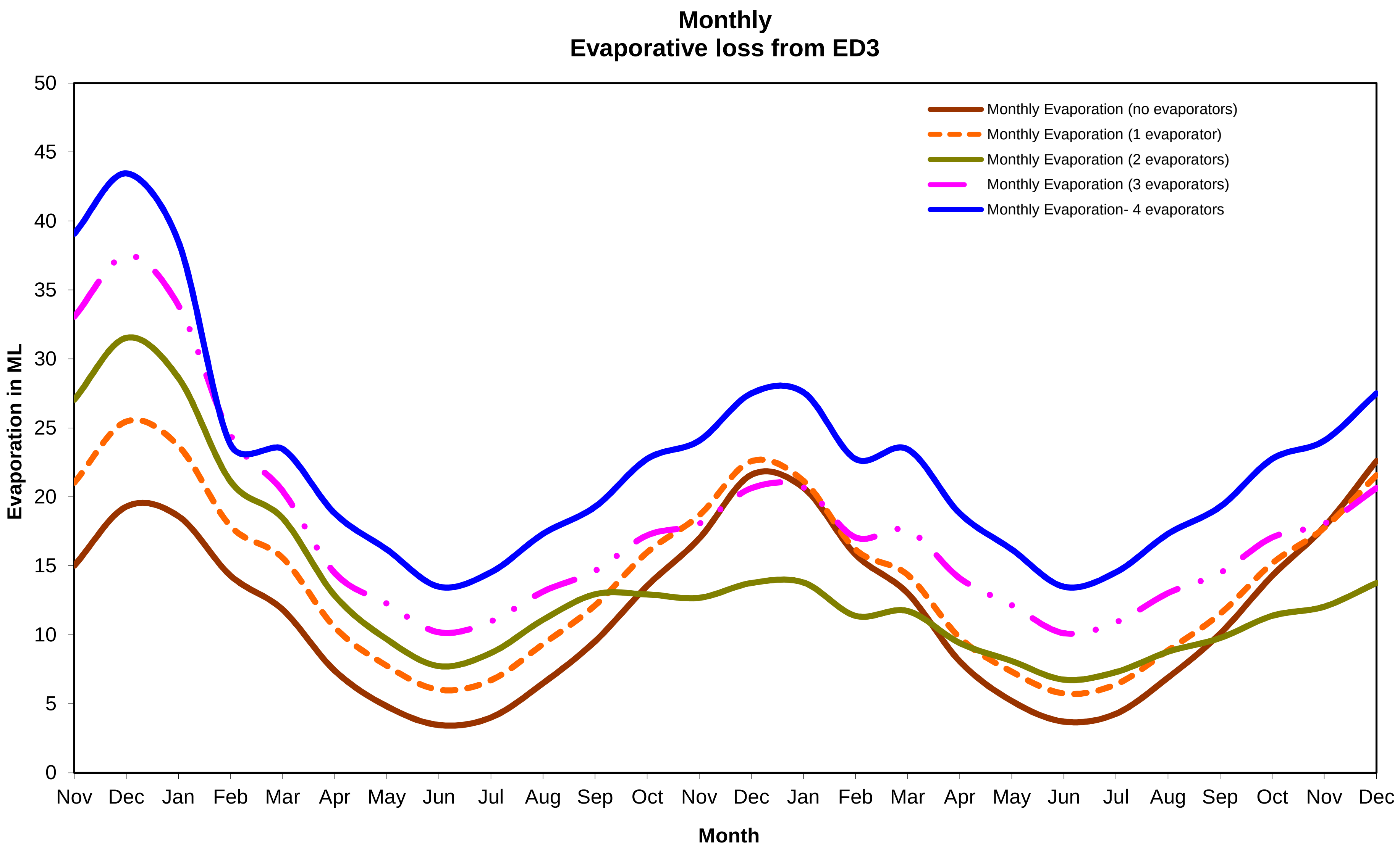
eather Station

										2010					
Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
6.917	2.423	1.755	1.077	1.847	1.551	1.984	4.057	4.662	2.028	3.998	5.099	3.148	2.332	1.695	0.878
4.472	1.71	2.372	0.801	1.384	1.814	2.912	6.426	5.645	5.513	6.6	6.074	1.88	3.354	1.916	1.125
3.878	1.453	1.88	0.787	1.089	1.202	2.841	1.895	5.112	5.577	4.735	5.207	2.762	2.975	2.831	1.087
3.498	3.908	2.072	0.56	1.165	2.058	1.365	0.766	7.929	7.173	4.158	3.146	3.891	2.655	1.683	0.855
5.725	2.928	2.129	0.701	1.104	1.529	2.454	1.152	5.29	6.583	4.044	3.664	4.055	2.152	2.958	0.907
4.923	3.621	1.981	1.211	1.493	1.623	3.174	2.186	1.641	6.23	5.176	2.508	1.321	3.063	1.433	1.303
4.612	2.546	2.117	1.313	0.921	1.996	3.339	2.677	2.032	6.638	7.148	2.434	3.007	1.81	2.05	1.055
4.945	2.97	2.058	0.786	1.202	2.192	1.115	1.318	4.208	7.695	3.889	1.551	1.534	1.5	1.903	1.346
2.91	3.12	1.763	1.105	0.611	2.206	2.108	3.38	5.156	7.358	5.272	1.77	3.112	3.291	1.955	1.332
3.338	3.284	2.182	0.895	0.771	1.865	1.68	2.502	6.205	4.17	7.378	5.177	3.092	2.66	1.906	0.827
3.617	1.841	1.215	1.285	0.927	1.887	2.787	2.709	6.607	6.303	7.771	4.201	2.743	3.463	2.485	1.431
4.376	2.073	1.848	1.049	0.982	1.502	3.644	2.501	6.865	6.729	7.485	6.063	3.919	3.058	3.087	1.381
3.763	2.514	1.946	0.691	2.192	1.643	5.067	1.654	6.934	7.03	9.3	4.934	2.812	3.207	1.911	1.201
1.961	0.469	2.119	1.578	1.559	2.055	6.87	3.239	4.736	6.693	5.012	0.81	3.277	2.865	2.033	1.074
3.811	1.969	1.581	1.521	0.818	1.996	2.964	2.22	6.605	3.489	2.788	0.918	2.577	3.386	1.734	1.141
4.779	4.187	1.602	1.015	1.049	2.365	3.78	2.346	5.514	6.185	3.759	3.496	3.634	2.66	1.728	1.179
4.66	3.699	1.789	0.784	1.013	3.062	3.287	3.11	7.546	8	3.442	4.03	4.26	2.696	1.379	1.443
4.282	2.983	1.842	1.059	1.434	2.581	3.727	3.306	5.807	11.73	6.841	5.162	4.197	2.758	0.917	0.864
4.783	2.608	1.432	1.027	1.474	2.222	2.763	3.298	5.604	1.331	4.313	4.24	4.181	2.507	1.724	1.379
3.871	1.738	1.076	1.456	1.814	2.725	3.061	4.18	6.838	6.966	6.507	3.96	3.73	2.511	1.701	0.776
4.548	1.094	1.284	1.107	2.203	2.918	3.498	5.517	8	3.649	7.994	4.726	4.999	2.921	0.885	1.32
4.535	1.638	1.287	0.589	2.459	1.673	3.687	5.776	4.833	7.337	7.766	6.52	4.999	2.688	1.165	1.185
4.201	1.488	0.719	1.161	2.013	2.523	2.501	4.272	6.697	6.719	9.95	6.017	3.975	2.918	1.664	0.491
5.067	1.991	1.288	0.863	0.761	2.127	1.283	5.039	0.884	7.524	9.65	5.734	4.213	3.392	1.157	1.154
6.118	1.73	1.478	0.824	1.547	1.984	3.13	5.359	1.841	8.85	4.516	4.929	3.705	1.498	0.839	0.983
5.434	1.438	1.413	1.087	1.784	2.257	4.556	1.522	6.292	0.754	6.134	4.726	4.034	2.387	0.64	1.076
3.611	1.52	0.777	0.838	0.859	2.071	1.988	1.903	5.591	0.895	7.369	4.487	4.923	2.272	0.491	0.995
2.982	1.68	1.037	1.244	1.546	3.473	1.579	2.641	4.326	3.024	6.039	4.945	4.015	1.531	0.891	1.21
3.861	1.917	0.689	0.798	1.562	4.048	2.576	4.087	8.2	4.501	3.961	[redacted]	4.129	2.867	1.166	1.24
4.352	1.667	0.843	0.898	1.621	1.767	3.663	2.571	3.657	6.765	6.124	[redacted]	1.592	2.643	0.628	1.417
2.855	[redacted]	0.777	[redacted]	1.283	2.321	[redacted]	5.037	[redacted]	6.318	3.125	[redacted]	0.785	[redacted]	0.27	[redacted]
132.69	**68.21**	**48.35**	**30.11**	**42.49**	**67.24**	**89.38**	**98.65**	**161.26**	**179.76**	**182.24**	**116.53**	**104.50**	**80.02**	**48.83**	**33.66**
469.218	**537.425**	**585.776**	**615.886**	**658.373**	**725.609**	**814.992**	**913.638**	**1074.895**	**1254.652**	**182**	**298.77**	**403.27**	**483.29**	**532.12**	**565.77**

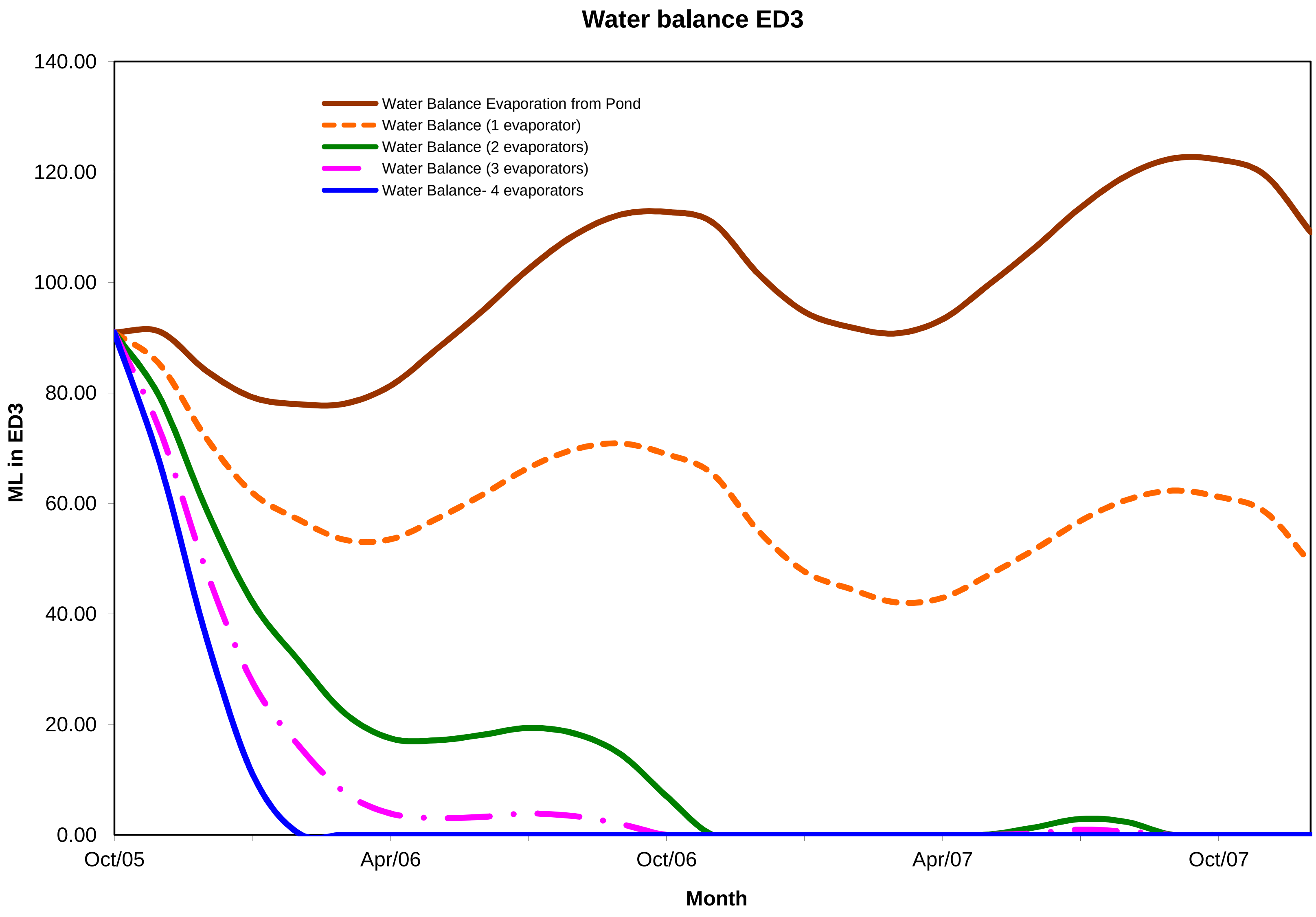
						2011							
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1.268	1.296	2.57	3.375	4.13	1.186	7.051	7.012	2.274	1.106	1.672	0.987	1.048	1.254
1.044	1.432	3.342	2.595	1.913	1.338	7.866	9.26	4.678	3.107	1.878	1.056	0.911	2.284
0.452	1.033	0.811	2.4	2.259	3.215	3.502	5.421	3.477	3.304	0.655	1.016	1.027	1.942
1.215	1.468	1.109	1.091	4.22	2.258	0.963	3.908	5.296	3.294	1.914	1.53	1.616	3.34
1.111	1.031	0.862	2.602	1.355	3.228	2.593	2.614	5.187	3.215	2.064	0.861	1.293	3.226
1.077	1.714	1.645	4.097	1.948	4.476	5.333	6.545	3.419	1.963	2.11	1.51	1.004	3.188
0.573	1.737	1.99	3.927	2.165	3.351	3.727	1.692	3.268	1.802	1.676	1.527	0.864	1.604
1.348	1.679	2.243	3.864	4.228	5.486	3.458	4.228	4.416	2.223	2.087	1.093	1.247	1.912
1.326	1.577	2.275	3.793	4.414	4.11	4.247	3.948	4.142	3.183	2.375	0.862	1.228	0.946
0.814	1.94	1.779	2.713	3.68	1.728	2.307	3.324	3.978	3.395	1.6	1.092	1.16	1.769
0.855	0.94	2.288	2.238	3.89	4.773	2.736	4.659	1.385	1.308	2.051	1.078	1.079	1.23
0.7	0.917	1.423	2.36	5.513	5.854	1.677	2.874	1.6	2.148	1.193	1.34	1.41	0.462
1.493	0.976	1.389	3.446	5.371	5.957	4.233	2.073	3.28	1.747	1.684	0.956	1.458	1.427
0.631	2.024	1.307	1.812	6.154	5.745	3.408	1.502	4.49	1.923	1.434	0.744	0.815	1.582
1.03	1.39	0.437	3.58	3.953	4.113	3.981	4.138	0.749	2.724	1.743	0.804	1.333	1.771
1.381	1.588	1.027	1.264	1.957	6.395	5.885	3.005	2.157	2.568	1.959	0.557	1.19	1.495
1.225	1.2	3.789	2.281	4.89	3.684	6.391	1.15	2.357	2.236	1.344	0.813	0.589	1.994
1.302	1.883	2.998	3.349	4.525	5.331	7.255	3.479	1.534	2.029	1.467	1.074	1.178	0.561
1.433	1.683	2.743	3.847	6.084	3.731	5.497	2.893	0.69	2.608	1.735	1.222	0.831	0.867
0.826	1.684	2.645	3.02	2.109	3.686	4.004	3.746	1.547	2.338	1.71	1.208	0.475	0.819
1.377	1.882	2.91	3.964	5.642	2.636	4.759	4.729	1.814	1.341	1.56	1.517	1.369	0.957
1.379	1.539	3.202	4.17	6.288	5.074	6.263	4.947	0.758	2.355	1.738	0.914	0.853	1.532
1.336	2.092	2.737	4.903	5.996	5.285	4.855	4.657	3.055	2.246	1.803	0.864	0.721	1.235
1.201	1.533	2.271	3.476	4.515	6.343	6.291	4.763	2.44	2.209	0.854	1.412	1.208	1.695
1.573	1.865	3.718	2.227	5.96	2.143	5.118	4.651	2.026	2.329	1.129	1.207	0.621	2.437
1.431	1.816	2.922	2.794	5.9	5.442	6.436	4.057	3.047	1.251	1.797	1.25	0.674	3.024
1.326	1.186	4.061	4.945	4.33	3.951	7.204	5.033	2.824	1.474	1.694	1.653	1.431	3.163
1.452	1.803	3.858	4.318	5.672	3.478	6.509	2.284	2.365	1.764	1.191	1.369	1.506	2.636
0.515	2.243	3.876	3.221	1.734	5.219	5.086		3.328	1.206	1.303	0.969	2.089	2.91
0.838	2.186	3.174	4.233	1.189	6.065	5.724		2.678	1.313	1.275	0.918	2.003	2.894
0.86	1.966		4.17		6.422	6.781		3.709		0.946		2.083	1.518
34.39	**49.30**	**71.40**	**100.08**	**121.98**	**131.70**	**151.14**	**112.592**	**87.968**	**65.709**	**49.641**	**33.403**	**36.314**	**57.674**
600.17	**649.47**	**720.87**	**820.94**	**942.93**	**1074.63**	**151.14**	**263.732**	**351.7**	**417.409**	**467.05**	**500.453**	**536.767**	**594.441**

				2012									
Sep	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
2.471	2.435	4.777	2.325	5.891	5.284	0.9	3.54	1.227	1.373	1.384			
2.241	1.588	4.316	4.913	6.209	2.501	1.154	2.845	2.177	0.793	0.822			
2.59	1.69	3.187	3.823	6.572	0.926	0.938	2.605	1.285	0.278	1.289			
3.132	3.258	2.896	5.667	7.179	1.351	0.919	3.164	2.134	0.594	1.277			
3.208	3.717	5.035	2.502	3.869	5.308	1.289	2.861	1.909	1.126				
2.879	2.781	6.021	4.276	5.369	6.111	4.487	2.241	1.845	0.44				
3.472	1.184	5.481	2.521	4.112	3.608	2.485	3.182	1.434	1.351				
2.624	1.667	4.105	4.129	6.458	1.226	1.009	3.775	1.077	1.279				
2.148	2.349	3.484	1.996	2.415	1.754	1.291	3.02	2.012	1.112				
1.354	2.354	4.679	5.002	6.068	2.106	3.155	2.901	2.752	1.18				
2.113	3.671	3.949	4.417	5.436	4.055	4.215	2.367	3.317	1.241				
1.992	2.976	4.623	3.436	3.858	2.691	3.676	2.476	2.556	0.629				
3.06	3.96	5.283	2.506	5.435	3.405	1.858	2.471	2.095	0.589				
2.947	3.783	4.932	2.187	6.049	3.371	3.285	2.797	1.384	1.253				
3.867	2.61	7.31	4.185	2.996	4.062	2.97	1.622	1.75	1.101				
3.495	3.47	6.555	5.44	2.083	4.704	4.013	2.658	1.504	1.735				
4.641	4.797	1.852	2.785	4.367	5.012	3.449	2.979	1.687	0.388				
4.808	4.456	4.183	5.786	5.552	3.774	2.386	1.349	1.343	1.027				
5.481	4.215	5.886	3.902	6.141	3.874	3.566	1.094	1.883	1.354				
5.343	4.925	7.084	1.302	6.487	4.644	2.513	2.241	1.763	1.264				
2.999	5.604	2.288	4.018	4.825	2.77	3.803	2.089	0.999	1.125				
3.491	5.794	4.966	2.69	4.856	4.255	4.005	1.749	1.613	1.895				
4.132	4.353	1.416	4.248	4.142	3.313	1.574	1.236	2.124	0.979				
5.552	5.458	2.959	5.868	3.036	4.821	3.37	2.224	2.66	1.068				
0.677	6.477	1.808	6.049	4.872	5.508	3.169	1.13	1.581	1.355				
1.441	0.997	0.889	6.216	2.176	5.785	2.475	0.934	1.061	1.264				
2.871	1.547	4.708	2.701	3.709	2.374	3.162	1.885	0.925	0.88				
3.301	2.761	4.889	4.081	2.485	2.673	1.564	1.73	1.416	0.587				
1.057	4.003	5.752	4.757	4.831	1.274	1.226	2.061	0.983	1.278				
1.649	2.008	5.654	6.255	5.77		3.304	1.868	1.428	1.283				
	4.498		3.977	2.548		3.262		1.146					
91.036	**105.386**	**130.967**	**123.96**	**145.796**	**102.54**	**80.472**	**69.094**	**53.07**	**31.821**	**4.772**	**0**	**0**	**0**
685.477	**790.863**	**921.83**	**1045.79**	**145.796**	**248.336**	**328.808**	**397.902**	**450.972**	**482.793**	**487.565**	**487.565**	**487.565**	**487.565**

Nov	Dec
0	0
487.565	487.565



Monthly
Evaporative loss from ED3
Evaporation in ML
0
5
10
15
20
25
30
35
40
45
50
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Monthly Evaporation (no evaporators)
Monthly Evaporation (1 evaporator)
Monthly Evaporation (2 evaporators)
Monthly Evaporation (3 evaporators)
Monthly Evaporation- 4 evaporators



Water balance ED3
Water Balance Evaporation from Pond
Water Balance (1 evaporator)
Water Balance (2 evaporators)
Water Balance (3 evaporators)
Water Balance- 4 evaporators
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ML in ED3
Oct/05
Apr/06
Oct/06
Apr/07
Oct/07
Month

	November	December	January	February	March	April	May	June	July	August	September	October	November	December
	30	31	31	28	31	30	31	30	31	31	30	31	30	31
	58.7	46.1	59.8	51.2	55.6	49.3	47.5	37.9	52.4	47.6	65.2	61.9	58.7	46.1
	5	6.2	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8	5	6.2
Average Monthly Pan Evaporation (mm- total)	0.1725	0.22165	0.2232	0.1778	0.1488	0.093	0.0589	0.0405	0.04495	0.06975	0.099	0.13795	0.1725	0.22165
Estimated monthly evaporation (M3) attributed to 1 evaporator (350 l/min)	6019	6875	6895	5686	5862	4701	4046	3371	3632	4330	4820	5687	6019	6875
Estimated monthly evaporation (M3) attributed to 2 evaporators (350 l/min)	12037	13751	13789	11372	11725	9402	8093	6742	7264	8659	9640	11375	12037	13751
Estimated monthly evaporation (M3) attributed to 3 evaporators (350 l/min)	18056	20626	20684	17058	17587	14103	12139	10113	10895	12989	14460	17062	18056	20626
Estimated monthly evaporation (M3) attributed to 4 evaporator(s) (350 l/min)	24075	27502	27578	22744	23449	18804	16186	13484	14527	17318	19280	22750	24075	27502
Estimated Evaporation (M3) attributed to surface evaporation (no evaporator)	15006.3	19291.2	18596.0	14286.3	11827.1	7397.5	4816.0	3457.6	4001.9	6488.1	9529.3	13544.4	16982.3	21601.0
Estimated Evaporation (M3) attributed to surface evaporation (1 evaporator)	15006.3	18586.8	16798.5	12188.2	9715.6	5845.2	3705.0	2647.1	3070.1	4994.2	7313.1	10292.7	12643.1	15705.6
Estimated Evaporation (M3) attributed to surface evaporation (2 evaporator)	15006.3	17777.3	14847.0	9755.6	6725.4	3443.3	1581.8	988.8	1414.3	2427.2	3296.7	1550.3	643.3	0.0
Estimated Evaporation (M3) attributed to surface evaporation (3 evaporator)	15006.3	16861.3	13193.4	7424.1	2837.6	382.6	121.3	65.6	78.0	143.4	178.4	144.2	0.0	0.0
Estimated Evaporation (M3) attributed to surface evaporation (4 evaporator(s))	15006.3	15950.5	10922.7	1049.4	25.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Evaporator evaporation as % of Surface Evaporation (1 evaporator)	40.1%	35.6%	37.1%	39.8%	49.6%	63.5%	84.0%	97.5%	90.8%	66.7%	50.6%	42.0%	35.4%	31.8%
Evaporator evaporation as % of Surface Evaporation (2 evaporators)	80.2%	71.3%	74.2%	79.6%	99.1%	127.1%	168.0%	195.0%	181.5%	133.5%	101.2%	84.0%	70.9%	63.7%
Evaporator evaporation as % of Surface Evaporation (3 evaporator(s))	120.3%	106.9%	111.2%	119.4%	148.7%	190.6%	252.1%	292.5%	272.3%	200.2%	151.7%	126.0%	106.3%	95.5%
Evaporator evaporation as % of Surface Evaporation (4 evaporator(s))	160.4%	142.6%	148.3%	159.2%	198.3%	254.2%	336.1%	390.0%	363.0%	266.9%	202.3%	168.0%	141.8%	127.3%
Evaporation from Pond	15006.33158	19291.2246	18595.96903	14286.305	11827.0785	7397.5361	4815.98473	3457.57676	4001.9273	6488.09051	9529.31306	13544.40844	16982.28	21600.97867
Incident Rainfall	10081.5	7243.5	8819.25	8027.25	6913.5	5626.5	6435	5395.5	6575.25	7656	8217	9050.25	10081.5	7243.5
Water Pumped In	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

	January	February	March	April	May	June	July	August	September	October	November	December
	31	28	31	30	31	30	31	31	30	31	30	31
	59.8	51.2	55.6	49.3	47.5	37.9	52.4	47.6	65.2	61.9	58.7	46.1
	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8	5	6.2
Average Monthly Pan Evaporation (mm- total)	0.2232	0.1778	0.1488	0.093	0.0589	0.0405	0.04495	0.06975	0.099	0.13795	0.1725	0.22165
Estimated monthly evaporation (M3) attributed to 1 evaporator (350 l/min)	6895	5686	5862	4701	4046	3371	3632	4330	4820	5687	6019	6875
Estimated monthly evaporation (M3) attributed to 2 evaporators (350 l/min)	13789	11372	11725	9402	8093	6742	7264	8659	9640	11375	12037	13751
Estimated monthly evaporation (M3) attributed to 3 evaporators (350 l/min)	20684	17058	17587	14103	12139	10113	10895	12989	14460	17062	18056	20626
Estimated monthly evaporation (M3) attributed to 4 evaporator(s) (350 l/min)	27578	22744	23449	18804	16186	13484	14527	17318	19280	22750	24075	27502
Estimated Evaporation (M3) attributed to surface evaporation (no evaporator)	20657.1	15814.9	13016.6	8081.2	5197.2	3706.7	4272.1	6895.5	10083.4	14273.9	17829.0	22594.3
Estimated Evaporation (M3) attributed to surface evaporation (1 evaporator)	14263.7	10500.7	8482.3	5096.7	3274.3	2374.8	2773.1	4542.8	6698.9	9492.6	11738.3	14684.1
Estimated Evaporation (M3) attributed to surface evaporation (2 evaporator)	0.0	0.0	0.0	0.0	0.0	1.5	32.2	107.1	123.3	0.0	0.0	0.0
Estimated Evaporation (M3) attributed to surface evaporation (3 evaporator)	0.0	0.0	0.0	0.0	0.0	0.0	6.8	35.5	30.9	0.0	0.0	0.0
Estimated Evaporation (M3) attributed to surface evaporation (4 evaporator(s))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Evaporator evaporation as % of Surface Evaporation (1 evaporator)	33.4%	36.0%	45.0%	58.2%	77.9%	90.9%	85.0%	62.8%	47.8%	39.8%	33.8%	30.4%
Evaporator evaporation as % of Surface Evaporation (2 evaporators)	66.8%	71.9%	90.1%	116.3%	155.7%	181.9%	170.0%	125.6%	95.6%	79.7%	67.5%	60.9%
Evaporator evaporation as % of Surface Evaporation (3 evaporator(s))	100.1%	107.9%	135.1%	174.5%	233.6%	272.8%	255.0%	188.4%	143.4%	119.5%	101.3%	91.3%
Evaporator evaporation as % of Surface Evaporation (4 evaporator(s))	133.5%	143.8%	180.1%	232.7%	311.4%	363.8%	340.0%	251.2%	191.2%	159.4%	135.0%	121.7%
Evaporation from Pond	20657.05538	15814.9363	13016.6113	8081.18995	5197.22556	3706.71156	4272.10208	6895.50571	10083.4006	14273.9441	17829.0205	22594.3205
Incident Rainfall	8819.25	8027.25	6913.5	5626.5	6435	5395.5	6575.25	7656	8217	9050.25	10081.5	7243.5
Water Pumped In	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

	Initial Volume stored in ED3														
Progressive Water Balance (no evaporators)	90976	91051	84003	79226	77967	78054	81283	87902	94840	102413	108581	112268	112774	110874	101516
Progressive RL of dam	789.09	789.02	788.96	788.95	788.95	788.99	789.06	789.13	789.21	789.27	789.31	789.31	789.29	789.20	789.13
Progressive Water Balance (1 evaporator)	90976	85032	71813	61939	57093	53428	53509	57192	61569	66443	69775	70859	68929	65349	55011
Progressive RL of dam	789.09	789.03	788.87	788.73	788.67	788.62	788.62	788.67	788.73	788.79	788.84	788.85	788.83	788.78	788.64
Progressive Water Balance (2 evaporators)	90976	79013	58919	42151	31618	22091	17471	17108	18114	19355	18358	14622	7005	0	0
Progressive RL of dam	789.09	788.96	788.70	788.46	788.26	788.07	787.81	787.75	787.93	788.02	787.98	787.28	785.83	784.50	784.50
Progressive Water Balance (3 evaporators)	90976	72995	47751	27693	16238	7727	3868	3042	3259	3861	3385	1963	0	0	0
Progressive RL of dam	789.09	788.88	788.55	788.18	787.58	785.97	785.23	785.08	785.12	785.23	785.14	784.87	784.50	784.50	784.50
Progressive Water Balance- 4 evaporators	90976	66976	35767	11085	320	0	0	0	0	0	0	0	0	0	0
Progressive RL of dam	789.09	788.80	788.34	786.60	784.56	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50

Progressive Water Balance (no evaporators)	94678	91891	90787	93333	99571	106259	113562	119323	122457	122233	119485	109135
Progressive RL of dam	789.13	789.10	789.09	789.11	789.18	789.25	789.32	789.38	789.41	789.41	789.38	789.27
Progressive Water Balance (1 evaporator)	47672	44513	42082	42911	47025	51674	56845	60628	62327	61197	58521	49205
Progressive RL of dam	788.55	788.50	788.46	788.48	788.54	788.60	788.67	788.72	788.74	788.73	788.69	788.57
Progressive Water Balance (2 evaporators)	0	0	0	0	68	1346	2885	2339	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.51	784.76	785.05	784.94	784.50	784.50	784.50	784.50
Progressive Water Balance (3 evaporators)	0	0	0	0	0	282	955	587	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.50	784.55	784.68	784.61	784.50	784.50	784.50	784.50
Progressive Water Balance- 4 evaporators	0	0	0	0	0	0	0	0	0	0	0	0
Progressive RL of dam	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50	784.50

	1/11/2005	1/12/2005	1/01/2006	1/02/2006	1/03/2006	1/04/2006	1/05/2006	1/06/2006	1/07/2006	1/08/2006	1/09/2006	1/10/2006	1/11/2006	1/12/2006
Monthly Evaporation (no evaporators)	15.006	19.291	18.596	14.286	11.827	7.398	4.816	3.458	4.002	6.488	9.529	13.544	16.982	21.601
Monthly Evaporation (1 evaporator)	21.025	25.462	23.693	17.874	15.578	10.546	7.752	6.018	6.702	9.324	12.133	15.980	18.662	22.581
Monthly Evaporation (2 evaporators)	27.044	31.528	28.636	21.127	18.450	12.845	9.675	7.731	8.678	11.086	12.937	12.925	12.681	13.751
Monthly Evaporation (3 evaporators)	33.063	37.487	33.877	24.482	20.425	14.485	12.261	10.179	10.973	13.132	14.638	17.207	18.056	20.626
Monthly Evaporation- 4 evaporators	39.081	43.452	38.501	23.793	23.475	18.804	16.186	13.484	14.527	17.318	19.280	22.750	24.075	27.502

	1/01/2007	1/02/2007	1/03/2007	1/04/2007	1/05/2007	1/06/2007	1/07/2007	1/08/2007	1/09/2007	1/10/2007	1/11/2007	1/12/2007
Monthly Evaporation (no evaporators)	20.657	15.815	13.017	8.081	5.197	3.707	4.272	6.896	10.083	14.274	17.829	22.594
Monthly Evaporation (1 evaporator)	21.158	16.187	14.345	9.798	7.321	5.746	6.405	8.872	11.519	15.180	17.757	21.560
Monthly Evaporation (2 evaporators)	13.789	11.372	11.725	9.402	8.093	6.744	7.296	8.766	9.763	11.375	12.037	13.751
Monthly Evaporation (3 evaporators)	20.684	17.058	17.587	14.103	12.139	10.113	10.902	13.024	14.491	17.062	18.056	20.626
Monthly Evaporation- 4 evaporators	27.578	22.744	23.449	18.804	16.186	13.484	14.527	17.318	19.280	22.750	24.075	27.502

Net pan evaporation (inches/month)	Percentage of volume pumped by evaporator	Net pan evaporation (inches/month)	Percentage of volume pumped by evaporator
1.5	20	7.0	40
2.0	28	7.5	41
2.5	29	8.0	42
3.0	30	8.5	43
3.5	32	9.0	44
4.0	34	9.5	45
4.5	35	10	46
5.0	36	10.5	47
5.5	37	11	48
6.0	38	11.5	49
6.5	39	12	50
7.0	40	12+	up to 85

Net pan evaporation Percentage of volume pumped by evaporator (from manufacturer specifications)

1.5	20%	38.1	21.8%	21.8%
2	28%	50.8	24.4%	24.4%
2.5	29%	63.5	26.7%	26.7%
3	30%	76.2	28.7%	28.7%
3.5	32%	88.9	30.5%	30.5%
4	34%	101.6	32.2%	32.2%
4.5	35%	114.3	33.8%	33.8%
5	36%	127	35.2%	35.2%
5.5	37%	139.7	36.6%	36.6%
6	38%	152.4	37.9%	37.9%
6.5	39%	165.1	39.1%	39.1%
7	40%	177.8	40.3%	40.3%
7.5	41%	190.5	41.4%	41.4%
8	42%	203.2	42.5%	42.5%
8.5	43%	215.9	43.5%	43.5%
9	44%	228.6	44.6%	44.6%
9.5	45%	241.3	45.5%	45.5%
10	46%	254	46.5%	46.5%
10.5	47%	266.7	47.4%	47.4%
11	48%	279.4	48.3%	48.3%
11.5	49%	292.1	49.1%	49.1%
12	50%	304.8	50.0%	50.0%
12+	up to 86			

LEACHATE QUALITY DATA:

TREATED LEACHATE

	Date	6/06/2013	30/07/2013	8/08/2013	22/08/2013	29/08/2013	5/09/2013	12/09/2013
	Unit	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent
Field Readings								
pH		9.05	9.21	9.15	9.33	9.48	9.35	9.2
DO	mg/L	9.76	4.73	1.93	10.66	1.96	6.96	5.6
Conductivity	uS/cm	21080	18010	18760	18590	18140	18150	18000
Temperature	C	8.1			6.6	12.1	15.2	N/A
Organics								
COD	mg/L	5234	3574	3674	3766	3636	3897	3397
BOD	mg/L	42	110			20	36	20
VFA	mg/L	350	313	224	245	330	296	305
Sulphur Compounds								
Sulphate	mg/L	1400	700	300	200	570	470	470
Sulphide	mg/L	0.61	0.36	0.63	0.37	0.14	0.26	0.39
Sulphite	mg/L						25	25
Nitrogen Compounds								
Ammonia	mg/L	158	169	760	132	175	193	155
TKN	mg/L						400	390
Total Oxydised Nitrogen	mg/L						0.49	0.76
Total Nitrogen								
Nitrite	mg/L						N/A	
Nitrate	mg/L						N/A	
Others								
Total Alkalinity	mg/L		5610		5240	5720	5800	5510
TSS	mg/L	270	280			260	130	110
VSS	%	70	85				66	86

	Date	19/09/2013	26/09/2013	1/10/2013	10/10/2013	17/10/2013	5/11/2013	12/11/2013	21/11/2013	28/11/2013	5/12/2013	11/12/2013
	Unit	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent
Field Readings												
pH		9.56	9.04	8.88	8.7	8.73	8.75	8.68	8.82	8.76	8.79	8.74
DO	mg/L	10.01	5.36	8.68	7.59	8.7	5.57	6.45	1.33	0.35	<1	
Conductivity	uS/cm	17000	17710	19200	21020	21510	20230	20660	18870	18230	18540	19320
Temperature	C	7.4	11.7	15.6	17.6	18.2	13.3	15.1	18.7	22.9	19.4	20.3
Organics												
COD	mg/L	3991	3414	4580	4270	4460	3704	4189	3774	4050	3819	
BOD	mg/L			1700		39	92	120	210	186	203	
VFA	mg/L	263	239	285	366		91		450	142	470	252
Sulphur Compounds												
Sulphate	mg/L	440	450	220	490	330	700		1000	800	1300	1000
Sulphide	mg/L	0.4	0.33	0.11	0.63	0.48	0.51		1.08	0.01	1.43	0.59
Sulphite	mg/L			12		20	20	34	88	51.4	97.8	
Nitrogen Compounds												
Ammonia	mg/L	128	239	285	627	718	728	882	780	576	666	714
TKN	mg/L			660		1100	1000	1200	1000	826	980	
Total Oxydised Nitrogen	mg/L			0.22		0.23	0.66	0.13	<0.5	<0.05	<0.5	
Total Nitrogen												
Nitrite	mg/L											
Nitrate	mg/L											
Others												
Total Alkalinity	mg/L					7560	7170	7550	5780	6270	6550	
TSS	mg/L			270		170	340	250	510	340	472	
VSS	%			64		72	85	85	74	89	83	

	Date	17/12/2013	24/12/2013	6/01/2014	6/01/2014	7/02/2014	3/03/2014	25/03/2014	14/04/2014	27/05/2014	3/07/2014	12/08/2014
	Unit	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent	WALTER Effluent
Field Readings												
pH		8.81	8.85	8.79	8.79	8.38		8.49	7.46		7.68	8.57
DO	mg/L	0	6.55	5.2	5.2	0.51		0.12	1.41		2.43	3
Conductivity	uS/cm	20630	20010	18570	18570	22800		24800	21700			27100
Temperature	C	21	17.4	22.5	22.5	23.8		17.6	15.6		8.7	8.9
Organics												
COD	mg/L	3701	4258	4070	4070	4312		5355	4957		7471	
BOD	mg/L	66					44		125	183	223	164
VFA	mg/L	174	109	286	286	242		366	522		362	846
Sulphur Compounds												
Sulphate	mg/L	1000	800	1000	1000	1600		1200	1100		600	
Sulphide	mg/L	0.82	1.34	0.82	0.82	0.58		0.51	0.73		0.5	0.71
Sulphite	mg/L	34					68.4		24.4	3.65	11	7.35
Nitrogen Compounds												
Ammonia	mg/L	961	884	625	625	574		883	331		>700	663
TKN	mg/L	1240					210		620	800	1130	1650
Total Oxydised Nitrogen	mg/L	<0.5					1190		1470	1750	1910	1300
Total Nitrogen							1400		2090	2550	3040	2950
Nitrite	mg/L											
Nitrate	mg/L											
Others												
Total Alkalinity	mg/L	7860					713		590	535	1860	5580
TSS	mg/L	508					217		712	373	305	171
VSS	%	80								67	220	74

LANDFILL GAS CAPTURE DATA:

NOVEMBER 2013 – SEPTEMBER 2014

Document title: Landfill Gas Capture Data
Data period: November 2013 - September 2014

TOU calculation for mean gas capture					
Landfill gas capture efficiency (%)	**Mean landfill gas capture/month (m^3/month)**	**Landfill gas from Surface (m^3/month)**	**Landfill gas from Void Surface (m^3/s)**	**Landfill gas Odour Concentration (ou)^**	**Landfill gas OER from surface (ou.m^3/s)**
90	1,542,829	171,000	0.07	9,000,000	594,000
80	1,542,829	386,000	0.15	9,000,000	1,340,000
70	1,542,829	661,000	0.26	9,000,000	2,300,000

^NB: Landfill gas odour concentration is the mean result of the 2012 & 2013 IOA

Data supplied by VES			
Date	**Landfill gas generated**	**Landfill gas flared**	**Landfill gas (Generation + Flared)**
Nov-13	1,386,272	45,965	1,432,237
Dec-13	1,226,536	300,472	1,527,008
Jan-14	1,248,544	160,282	1,408,826
Feb-14	1,324,644	56,860	1,381,504
Mar-14	1,226,140	129,709	1,355,849
Apr-14	807,208	512,874	1,320,082
May-14	1,325,496	199,675	1,525,171
Jun-14	1,392,000	170,194	1,562,194
Jul-14	1,651,500	64,231	1,715,731
Aug-14	1,668,540	118,121	1,786,661
Sep-14	1,849,428	106,430	1,955,858
Mean total	**1,373,301**	**169,528**	**1,542,829**

TOU calculation for mean gas capture September 2012 - October 2013 (Sourced from 2013 IOA)			
	Landfill gas from Void Surface (m^3/s)	**Landfill gas Odour Concentration (ou)^**	**Landfill gas OER from surface (ou.m^3/s)**
Corrected	0.06	9,000,000	535,000
	0.13	9,000,000	1,200,000
	0.23	9,000,000	2,060,000

Summary table

2013 IOA LFG Extraction (m^3)	1,373,301
2014 IOA LFG Extraction (m^3)	1,542,829
% improvement	12.3%

APPENDIX D:

LIQUID ODOUR MEASUREMENT METHODOLOGY

Methodology

The Liquid Odour Method is comprised of the following components:

- Evaporation of a known amount of liquid in a known volume of dry nitrogen contained in a Nalophan odour sample bag;
- Determination of the odour concentration of the gaseous sample by Dynamic Dilution Olfactometry following AS/NZS 4323.3:2001; and
- Calculation of the odour concentration in the liquid from the gaseous odour concentration (ou/m^3) and the volume of liquid evaporated to produce the gaseous sample.

Procedure

Liquid Sample Storage

The liquid samples analysed from the Woodlawn Bioreactor Facility were collected from stored leachate in lagoons ED3N-2, ED3N-3 and ED3N-4. These were refrigerated prior to testing. A liquid sample was extracted immediately from the refrigerated sample bottle and not allowed to warm to room temperature. This is the general procedure when carrying out the liquid odour measurement method for aqueous samples.

Liquid Sample Size

The volume of liquid is determined by the requirement to produce a gaseous sample with relative humidity of less than 100%. This equates to less than 2.3% v/v water at 20º C, or for a 25 L sample, 413 µL of aqueous sample. The method development work carried out to date has shown that 413 µL of liquid sample in 25 L dry nitrogen will evaporate in approximately 30 mins. The nominal liquid sample size required for the Liquid Odour method can be specified as 340-413 µL, which provides a gaseous sample with 80-100% RH. For the liquids samples collected at the Woodlawn Bioreactor Facility, 413 µL of liquid sample was used in 25 L dry nitrogen.

Table D1 details a range of liquid volumes and approximate evaporation times observed from the method development work carried out to date.

Table D1 - Liquid sample volumes, evaporation and equilibration time		
Volume µL (% saturation)	**Approximate evaporation time (in 25 L dry nitrogen)**	**Recommended equilibration time (in 25 L dry nitrogen)**
280 µL (60%)	20-30 min	60 min
340 µL (80%)	30-40 min	60 min
413 µL (100%)	40-60 min	60 min

Sample Equilibration and Ageing

The development work to date has shown that condensate derived odour samples are not stable and degrade significantly over time. However, the degradation appears insignificant in the first 2-4 hours after preparation of the gaseous samples. Therefore, samples must be tested within that time period after preparation. For samples prepared at 100% saturation or below, the equilibration time can be standardised to 1 hour.

Sample Preparation and Odour Testing Procedure

The gaseous sample for odour testing is prepared as follows:

1. Dispense 25 L of dry nitrogen into a conditioned Nalophan bag.
2. Place a piece of clear packaging tape (approximately 100 mm long) onto the wall of the bag half way between the ends. Ensure that the a least a 1 cm^2 section of tape is completely adhered to the bag with no air bubbles trapped between the tape and bag that could allow a leak of gas to the edge of the tape
3. Remove the liquid sample from cold storage.
4. Rinse the microlitre syringe (5 x) with the liquid sample.
5. Draw up the required volume of liquid sample (see **Liquid Sample Size** and **Table D1**) and record the exact volume in the syringe.
6. Inject the liquid through the tape and wall of the bag at the point where the tape has completely adhered to the bag. Tap the syringe to displace residual drop that adheres to the needle and withdraw the syringe from the bag.

7. Place a second piece of packaging tape over the first piece such that the puncture hole is sealed. Ensure no air bubbles are trapped between the layers of tape such that a leak could occur.
8. Vigorously shake the bag to disperse the liquid droplets inside the bag (to aid in the evaporation rate).
9. Store the bag in the laboratory for the prescribed equilibration time (see **Sample Equilibration and Ageing** and **Table D1**) to allow all the liquid to evaporate.
10. At the completion of the equilibration time, carry out the measurement of odour concentration using AS/NZS 4323.3:2001.

Calculation of Liquid Odour Concentration

The odour concentration from a liquid (ou per mL) is calculated from the gaseous sample odour concentration, the volume of liquid used to prepare the gaseous sample and the volume of dry nitrogen:

$$[odour]_{liquid} = \frac{\left(\frac{OU}{m^3} \times \frac{litres_{Nitrogen}}{1000}\right)}{mL_{liquid}}$$

An example of the calculation is presented in **Table D2**.

Table D2 – Example calculation of liquid odour concentration for ED3N-4		
Parameter	**Value**	**Unit**
Volume of liquid from ED3N-4	0.413	mL
Volume of dry N_2	25	L
Measured odour concentration	21^	ou
Calculated liquid odour concentration	= (21 x 25/1000)/0.413 = 1.27	ou.m^3/mL

^ TOU Sample Number SC14575 – see **Table 6.4** in Main Report

Calculation of Odour Emission Rates from Evaporation of Liquids

A primary driver for development of a liquid odour measurement is the requirement to predict odour emission rates from liquids area sources (such as storage ponds) as well as condensates. In particular, evaporation of condensates or other odorous refinery waters in cooling towers has been implicated as a significant contributor to refinery odour. With a measurement of the odour from liquids now available, the estimation of emission rates can be considered.

An example is presented below for the treated leachate pond (i.e. ED3N-4) that returned a measured odour concentration of 1.27 ou.m^3/mL (see **Table D2**) with an evaporation rate of 0.882 L/sec (based on on-site evaporation data collected by Veolia between May 2007 and June 2012).

Odour concentration	= 1.27 ou.m^3/mL
Ambient pond evaporation rate	= 0.882 L/sec
Odour emission rate	= 1.27 ou.m^3/mL x 882 mL/sec
	= 1,120 ou.m^3/sec (see **Table 6.4** in Main Report)

THE ODOUR UNIT

APPENDIX E:

ODOUR DIARY ENTRIES SUMMARY TABLES

Document title:	Summary table of odour diary entries								
Resident ID:	A								
Diary Entry No.	**Date**	**Wind direction**	**Wind speed**	**Odour character**	**Other odour character**	**Odour detected**	**Odour offensiveness**	**Odour intensity**	**Duration**
1	Jul-14	W	Light		-	0			
2	Jul-14	W	Steady		-	0			
3	Jul-14	N/D	N/D	Garbage	-	1		3	Constant
4	Jul-14	W	Strong	Garbage	-	1		1	Constant
5	Jul-14	N/D	Steady		-	0			
6	Jul-14	W	Light		-	0			
7	Jul-14	W	Light	Rotten eggs	-	1		3	Constant
8	Jul-14	W	Light	Garbage	-	1		2	Intermittent
9	Aug-14	W	Light		-	0			
10	Aug-14	N/D	N/D	Garbage	-	1	Yes	2	Constant
11	Aug-14	N/D	N/D		-	0			
12	Aug-14	W	Light	Other	sour rotting spicy indian food	1	Yes	5	Constant
13	Aug-14	N/D	N/D	Other	sour rotting spicy indian food	1	Yes	2	Constant
14	Aug-14	W	Light		-	0			
15	Aug-14	W	Light		-	0			
16	Sep-14	N/D	N/D		-	0			
17	Sep-14	N/D	N/D		-	0			
18	Sep-14	N/D	N/D		-	0			
19	Sep-14	N/D	N/D		-	0			
20	Oct-14	W	Light	Garbage	-	1	Yes	2	Constant
21	Oct-14	N/D	Light		-	0			
22	Oct-14	N/D	N/D	Rotten eggs	-	1	Yes	4	Constant

Document title: Summary table of odour diary entries
Resident ID: B

Diary Entry No.	Date	Wind direction	Wind speed	Odour character	Other odour character	Odour detected	Odour offensiveness	Odour intensity	Duration
2	Jul-14	N/D	Calm			0			
3	Jul-14	W	Light	Rotten eggs		1	Yes	2	Constant
4	Jul-14	W	Light			0			
5	Jul-14	NW	Light			0			
6	Jul-14	W	Calm			0			
7	Aug-14	N/D	Calm			0			
8	Aug-14	N/D	Calm	Garbage		1	Yes	1	Constant
9	Aug-14	N/D	Calm			0			
10	Aug-14	N/D	Calm			0			
11	Aug-14	N/D	Calm			0			
12	Aug-14	SW	Calm			0			
13	Aug-14	N/D	Calm	Garbage		1	Yes	3	Constant
14	Sep-14	SE	Calm			0			
15	Sep-14	SW	Calm	Garbage		1	Yes	2	Intermittent
16	Sep-14	N/D	Calm			0			
17	Sep-14	W	Calm	Rotten eggs		1	Yes	2	Intermittent
18	Sep-14	N/D	Calm			0			
19	Sep-14	N/D	N/D			0			
20	Oct-14	N/D	N/D	Garbage		1	Yes	1	Constant
21	Oct-14	N/D	N/D			0			
22	Oct-14	N/D	N/D			0			

Document title: Summary table of odour diary entries
Resident ID: C

Diary Entry No.	Date	Wind direction	Wind speed	Odour character	Other odour character	Odour detected	Odour offensiveness	Odour intensity	Duration
1	Sep-14	N/D	Calm			0			
2	Sep-14	N/D	Calm	Garbage		1	Yes	3	Constant
3	Sep-14	N/D	Calm	Garbage		1	Yes	2	Constant
4	Sep-14	N/D	Steady	Garbage		1	Yes	2	Constant
5	Sep-14	N/D	Calm	Garbage		1	Yes	2	Constant
6	Oct-14	N/D	Calm	Garbage		1	Yes	3	Constant
7	Oct-14	N/D	Calm	Garbage		1	Yes	4	Constant
8	Oct-14	N/D	Calm	Garbage		1	Yes	4	Constant
9	Oct-14	N/D	Calm			0			

Document title: Summary table of odour diary entries									
Resident ID: D									
Diary Entry No.	**Date**	**Wind direction**	**Wind speed**	**Odour character**	**Other odour character**	**Odour detected**	**Odour offensiveness**	**Odour intensity**	**Duration**
1	Sep-14	SW	Steady	Ammonia/fishy		1	Yes	4	Constant
2	Sep-14	SW	Light	Garbage		1	Yes	1	Intermittent
3	Oct-14	SW	Light	Garbage		1	Yes	2	Constant
4	Oct-14	SW	Calm	Garbage		1	Yes	2	Constant
5	Oct-14	N/D	Calm	Garbage		1	Yes	2	Constant

Document title: Summary table of odour diary entries									
Resident ID: E									
Diary Entry No.	**Date**	**Wind direction**	**Wind speed**	**Odour character**	**Other odour character**	**Odour detected**	**Odour offensiveness**	**Odour intensity**	**Duration**
1	Jul-14	W	Light			0			
2	Jul-14	W	Light			0			
3	Jul-14	W	Gusting			0			
4	Jul-14	S	Calm			0			
5	Jul-14	N/D	Calm			0			
6	Jul-14	N/D	Calm	Garbage		1	Yes	2	Constant
7	Jul-14	N/D	Calm			0			
8	Jul-14	W	Light			0			
9									
10	Aug-14	N/D	Calm			0			
11	Aug-14	W	Calm			0			
12	Aug-14	N/D	Calm	Garbage		1	No	1	Intermittent
13	Aug-14	N/D	Calm			0			
14	Aug-14	SE	Calm			0			
15	Aug-14	N/D	Calm			0			
16	Aug-14	SE	Light			0			
17	Aug-14	N/D	Calm			0			
18	Sep-14	S	Light			0			
19	Sep-14	SE	Light			0			
20	Sep-14	W	Light			0			
21	Sep-14	N/D	Calm			0			
22	Sep-14	NE	Calm	Sewage		1	Yes	4	Constant
23	Sep-14	W	Steady			0			
24	Sep-14	W	Calm			0			
25	Sep-14	W	Calm			0			
26	Sep-14	NE	Light	Garbage		1	Yes	3	Intermittent
27	Sep-14	W	Calm			0			
28	Oct-14	N/D	Calm	Sewage		1	Yes	3	
29	Oct-14	NE	Light	Sewage		1		3	Constant
30	Oct-14	N/D	Calm			0			

Document title: Summary table of odour diary entries
Resident ID: F

Diary Entry No.	Date	Wind direction	Wind speed	Odour character	Other odour character	Odour detected	Odour offensiveness	Odour intensity	Duration
1	Jul-14	W	Light			0			
2	Jul-14	W	Strong			0			
3	Jul-14	N/D	Calm	Garbage		1		3	Constant
4	Jul-14	N/D	Calm	Garbage		1		3	Constant
5	Jul-14	W	Calm	Garbage		1	Yes	1	Constant
6	Jul-14	W	Steady	Garbage		1	Yes	1	Constant
7	Jul-14	W	Light			0			
8	Jul-14	N/D	N/D			0			
9	Aug-14	SW	Calm			0			
10	Aug-14	N/D	Calm	Garbage		1	Yes	2	Constant
11	Aug-14	N/D	Calm	Garbage		1	Yes	1	Constant
12	Aug-14	W	Light	Garbage		1	Yes	3	Constant
13	Aug-14	W	Light			0			
14	Aug-14	W	Calm			0			
15	Sep-14	SE	Light			0			
16	Sep-14	W	Light	Garbage		1		2	Constant
17	Oct-14	NW	Calm	Garbage		1	Yes	4	Constant
18	Oct-14	W	Calm	Garbage		1	Yes	3	Constant
19	Oct-14	N/D	Calm	Garbage		1	Yes	4	Constant
20	Oct-14	N/D	Calm			0			

Document title:	Summary table of odour diary entries								
Resident ID:	G								
Diary Entry No.	**Date**	**Wind direction**	**Wind speed**	**Odour character**	**Other odour character**	**Odour detected**	**Odour offensiveness**	**Odour intensity**	**Duration**
1	Jul-14	NW	Calm			0			
2	Jul-14	NW	Calm			0			
3	Jul-14	SW	Light	Garbage	Rotten eggs	1	Yes	2	Constant
5	Jul-14	NW	Light			0			
6	Aug-14	NW	Light			0			
7	Aug-14	NW	Calm			0			
8	Aug-14	NW	Calm			0			
9	Sep-14	NW	Calm			0			