Veolia Environmental Services (Australia) Pty Limited

Woodlawn Bioreactor Expansion Project

Independent Odour Audit #2

January 2014

FINAL REPORT

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Project Number: N1806L

Report Revision		
Revision Number	**Date**	**Description**
Draft Report V1	23.12.2013	Draft issued to client for review
Final Draft Report	23.01.2014	Final draft issued to client for approval
Final Report	30.01.2014	Final report issued
Report Preparation		
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Report Title: Veolia Environmental Services (Australia) Pty Limited Woodlawn Bioreactor Expansion Project – Independent Environmental Audit #2		

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APPENDICES

1 INTRODUCTION

In September 2013, Veolia Environmental Services (Australia) Pty Ltd (VES) engaged The Odour Unit Pty Ltd (TOU) to carry out the second 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, VES 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, VES 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 Bioreactor 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.

VES 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), VES is required to carry out an Independent Odour Audit 3 months from the date of project approval and annually thereafter, unless otherwise agreed by the Director-General. The Independent Odour Audit 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 second Independent Odour Audit 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 VES Woodlawn staff in regards to the operations of the Bioreactor. The odour emissions inventory developed in the 2012 Independent Odour Audit (2012 IOA) by the audit team was used as a basis for the sampling program in the Audit;

- *Reviewing:* a comprehensive review of all new relevant assessments undertaken and documentation since the 2012 IOA; and

- *Reporting:* a comprehensive summary of all aspects of the Audit, complying with the Audit objectives mentioned in **Section 1.2**

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 **Photo 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. At the time of the Audit, five landfill gas-fired engines were operational with each 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 more detail in the proceeding section.

Aside from generating 'green' electricity from waste at Woodlawn, VES 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.

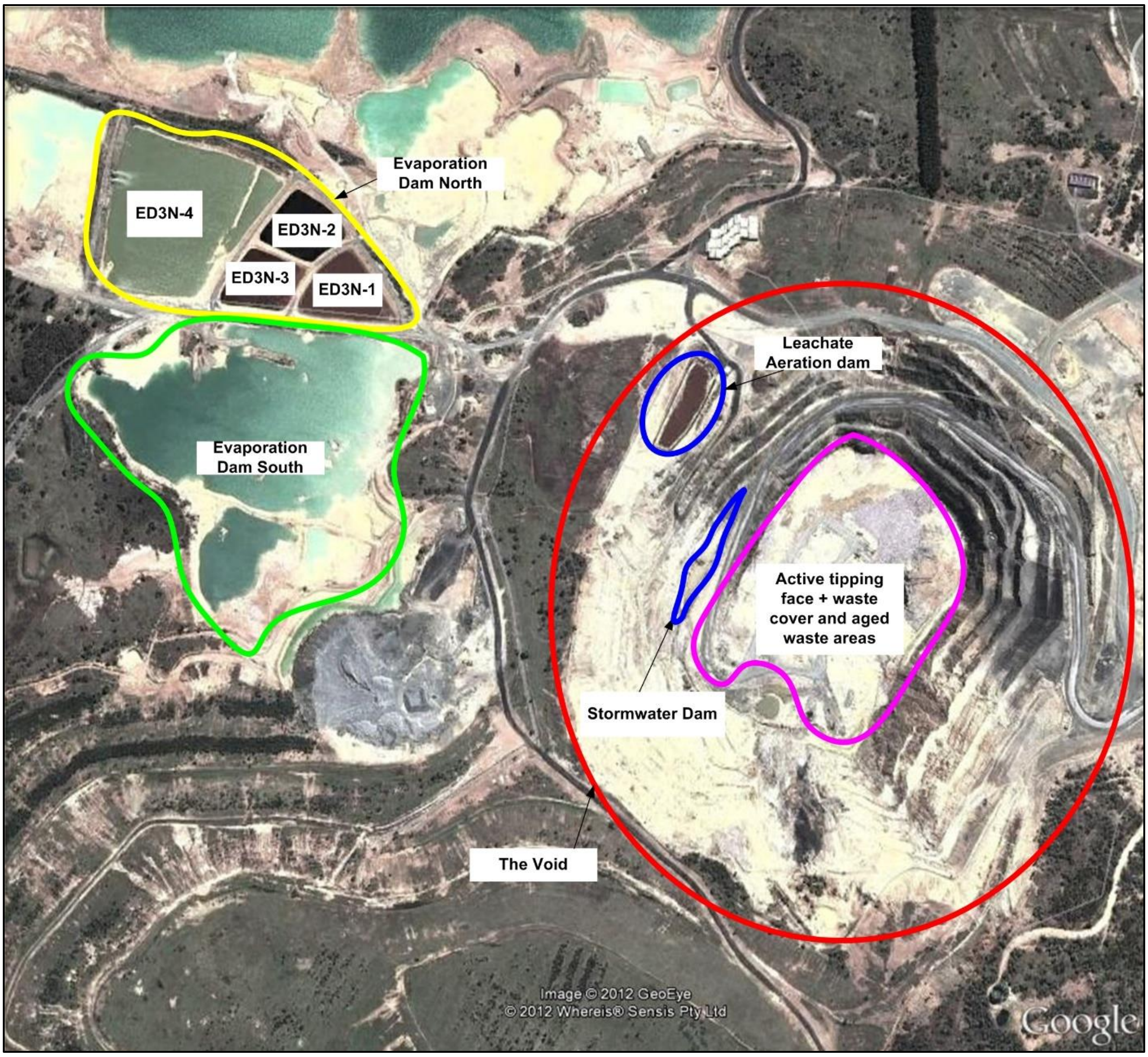


Photo 2.1 – An aerial view of the Site

2.2 PROCESS OVERVIEW

Woodlawn 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 following section. Further details in regards to these systems are contained in the Environmental Assessment (EA) Woodlawn Expansion Report (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 **Photo 2.2.**

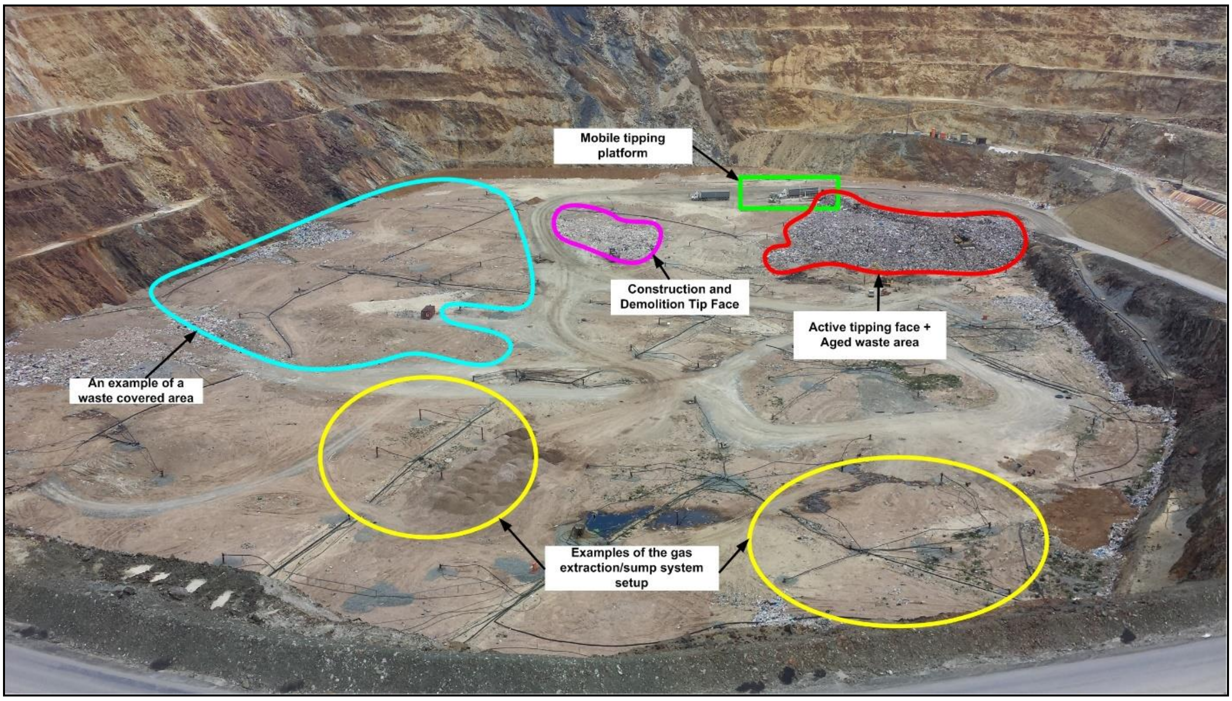


Photo 2.2 – Void Layout and Operations on 29 October 2013

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 VES 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. The active tipping face is progressively covered on a daily basis. As informed by VES, 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 that the size if the active tipping face had decreased since the previous audit (see **Section 7.2.1.5** for details).

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.

2.4 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* of the EA for the *Woodlawn Expansion Project (August 2010)*, the 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 have been described as follows.

2.4.1 Evaporation Dam 3 North (ED3N)

ED3N pond system covers an 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 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 but have not been used since the previous audit.

The mechanical evaporation systems are Turbomist evaporation pump units, each capable of spraying 350 L/min into the air.. These units are operated only 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 VES indicates that approximately 20% to 30% of the pumped water is evaporated, depending upon ambient temperature and RH conditions. ED3N-3 & 4 is equipped with two and three evaporator units respectively.

It is understood that the mechanical evaporator units in ED3N-2 have not been used since previous audit, due to the odorous quality of the previously stored liquid in ED3N - 1, 2, 3 lagoons at the time. Following the treatment of all ED3N-2 contents (discussed later in **Section 7.2.1.2**) and pond source findings in this Audit (see **Section 7.3.1**), VES has indicated that they intend on using the evaporator units in the future. This is provided of course that the quality of the treated leachate stored in ED3N is assessed to be of suitable quality. The use of the evaporator units is understood by the Audit to be an important part of volume reduction at the Site.

2.4.2 Evaporation Dam 3 South (ED3S)

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

2.4.3 Leachate Aeration Dam (LAD)

The LAD has become an integral part of the LMS at the Site. The LAD receives leachate directly from the Void or from untreated leachate stored in ED3N (if required). It is located in the upper levels of the Void in the north-western edge. Since the 2012 IOA, the LAD has been upgraded from a batch-based wastewater treatment system to a continuous plug-flow configuration, as shown in **Figure 2.1.**

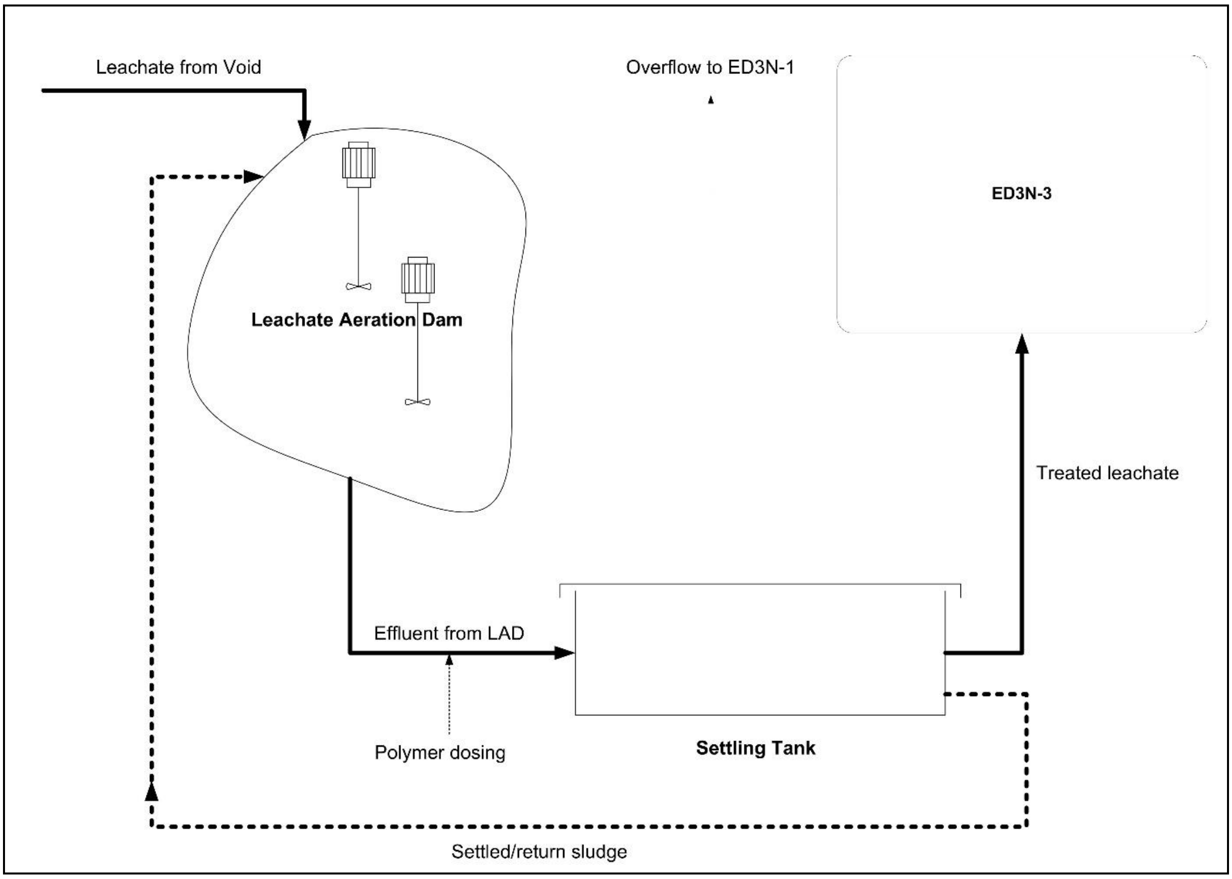


Figure 2.1 – Upgraded plug-flow leachate treatment system

The LAD has a hydraulic retention time (HRT) of 33 days and is capable of continuous treatment of approximately 350,000 L/day of untreated leachate. The maximum treatment volume capacity of the LAD is 12 ML. The effluent from the LAD is dosed in-situ with a polymer before passing through a settling tank (in the form of a modified shipping container). The settled/recycled sludge from the settling tank is returned to the LAD. This configuration requires the LAD to undergo desludging approximately every 5 months (as advised by VES).

The upgrade to the LAD system was commissioned in April 2013.

2.4.4 Storage Pond 7 (inside the Void)

At the time of the Audit, Storage Pond 7 has become defunct (and was previously located in the Void). As a result, it has been excluded as a valid odour emission source for the purposes of this Audit.

3 SAMPLING PROGRAM

As per *Condition 7 (e)* of *Schedule 4* in the *Specific Environmental Conditions - Landfill site,* this Audit measured all key sources at the Woodlawn Bioreactor Facility, with two exceptions (see comments further below for details). The odour emissions inventory developed in the 2012 IOA by the audit team was used as a basis for the sampling program in the Audit.

A total collection of twenty five samples, namely, twenty three gas samples and two liquid samples. The liquid samples, whilst not being a requirement for the purposes of this Audit, were collected from ED3N-2 & ED3N-3 only to simply 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.

The sampling program 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; and
- The Landfill Gas System.

Table 3.1 – Woodlawn Bioreactor Facility Sampling Program: 29 October 2013 – 6 November 2013 ^			
Location	**Date**	**Source Type**	**No. of samples collected**
The Bioreactor			
Active Tipping Face	31/10/2013	Area source	1
Waste Covered Area	6/11/2013		6
Aged Waste Area			2
Storage Pond 7	Pond is now defunct		
Construction and Demolition Area	6/11/2013	Area source	1
Leachate Aeration Dam	31/10/2013	Area source	2
ED3N Pond System			
ED3N - 1	29/10/2013 & 31/10/2013	Area source	2
ED3N - 2		Area Source (4) + Liquid odour measurement (1)	5
ED3N - 3		Area source (3) + Liquid odour measurement (1)	4
ED3N - 4		Area source	1
Landfill Gas System			
Gas engine inlet (i.e. landfill gas)	31/10/2013	Point source	1
TOTAL			**25**

^ Samples collected on 30 October 2013 were delayed in transit by an external courier and expired before odour analysis could be undertaken. These samples were recollected on 6 November 2013.

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, VES 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 7.1.1.5**, the Crisps Creek Intermodal Facility is not considered to be a significant contributor to the Site's overall odour emissions profile.

4 SAMPLING METHODOLOGIES

4.1 POINT SOURCE SAMPLING

4.1.1 Landfill Gas System

The method used for collecting samples from the landfill gas inlet involved drawing the sample air through a polytetrafluoroethylene (PTFE) sampling tube into a single use, Nalophan sample bag. The air sample was drawn into the sample bag using the positive pressure on the discharge side of the extraction fan driving the Landfill Gas Extraction System.

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 area sources. This was undertaken using 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	
Diameter (m)	0.406
Surface Area (m^2)	0.13
Volume (L)	30*

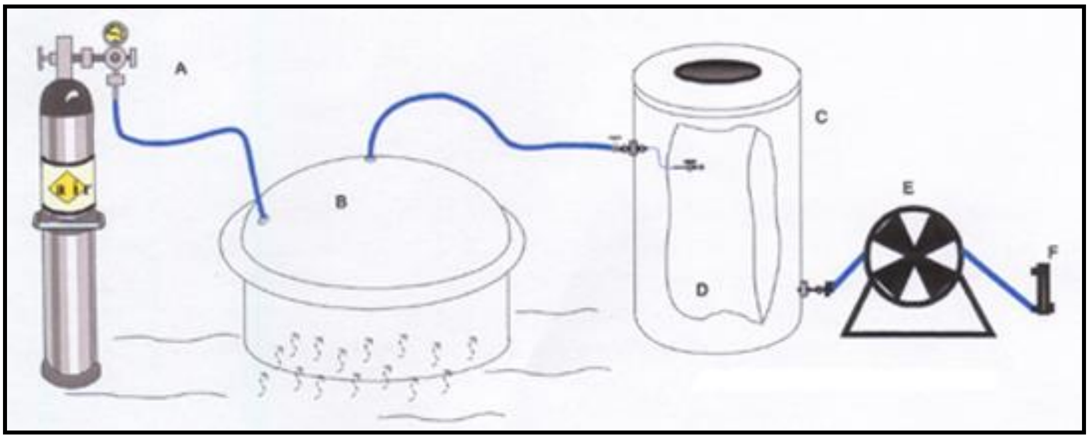
* When the skirt of the hood is immersed into the water or solid surface by the specified 25 millimetres.

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**)

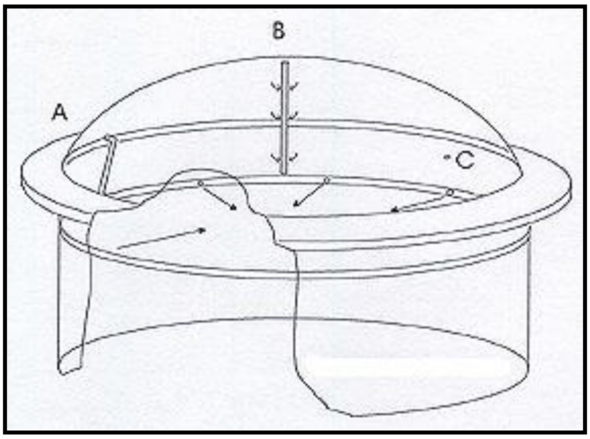
C Lung chamber (sampling drum)

D Nalophan sampling bag

E Sampling pump

F Air flow meter

Figure 4.2 - Schematic of the IFH



Source: Odotech - Odoflux IFH Manual

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.

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 has been illustrated in **Equations 4.1 & 4.2** below.

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

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

where

QC = 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 in the above manner.

4.2.1 Potential gas pathways from Bioreactor: Gas leakage

During the course of undertaking the fieldwork, the Audit attempted to collect samples from various area that were identified to be susceptible to gas leakage. This was undertaken by visual inspection and via testing with a personal gas monitor. All samples from these pathways were collected using the Area Source Sampling Method - IFH (as previously described in **Section 4.2**).

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 to five 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. It's 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™ V01 was last calibrated in October 2013 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

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. The odour emissions inventory developed in the 2012 IOA was used as a basis for the sampling program in this 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 2012 IOA;
- **Table 6.3** summarises in-situ H_2S and ammonia (NH_3) concentration measurement results undertaken on all collected samples in the Audit using a calibrated Jerome ® 631-X H_2S analyser (Jerome Analyser) and Gastec ® Detector Tubes (Gastec Tubes). 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 proceeding 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 2012 IOA.

Table 6.1 – The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 29 October 2013 – 6 November 2013

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 ($ou.m^3/m^2/s$)**
The Void						
Active Tipping Area						
Sample 21 - South western section of Void: Fresh waste less than 1 day old	TOUSC13592	6,890	3.64	garbage	1.0 – 7.3*	7.3 (wet fresh waste emission adopted)
Sample 7 - Aged waste: 5 days old): Northern section of area	TOUSC13595	6,660	2.93	garbage	0.5	
Sample 8 - Aged waste: 5 days old: Eastern section of area	TOUSC13596	5,790	2.55	garbage		
Waste Covered Area						
Sample 10 - Southeastern section of Void: Potential gas pathway	TOUSC13601	8,150,000	4,170	fermented pineapple	7.5 – 23.9	23.9
Sample 13 - Gas & Sump Area Point #98: Potential gas pathway	TOUSC13602	18,800,000	9,730	fermented pineapple		
Sample 14 -Gas & Sump Area Point #69: Potential gas pathway	TOUSC13600	161,000	85.6	fermented pineapple, garbage		
Sample 11 - Southern quadrant of Void Edge	TOUSC13598	10,100	4.86	fermented fruit, pineapple, gassy		
Sample 9 - Northern quadrant of Void	TOUSC13597	362	0.183	musty, dirty, gassy	0.1 - 0.2**	0.2
Sample 12 - Southern quadrant of Void: Inner area	TOUSC13599	675	0.325	dusty, musty, gassy		
Catchment Pond (stormwater + leachate)						
Storage Pond 7	n/m				2.1 – 8.8	8.8

***** includes dry and wet waste
****** includes dry and wet covered waste

Table 6.1 continued – The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 29 October 2013 – 6 November 2013

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 ($ou.m^3/m^2/s$)**
The Void						
Construction and Demolition Area						
Sample 22 - Southern end of Void	TOUSC13593	609	0.293	garbage	n/m	
Leachate Aeration Dam						
Sample 19 - Middle-east	TOUSC13590	631	0.354	sweet, garbage, ammonia	0.1 - 7.4****	3.6
Sample 20 - North-eastern end	TOUSC13591	512	0.293	sweet, garbage, ammonia		
Leachate Recirculation						
Leachate Recirculation	n/m				1.6 – 2.5	2.5
Evaporation Dams						
Evaporation Dam 3 North (ED3N) Pond System						
Sample 5 - ED3N-1 (Treated leachate: north-eastern end)	TOUSC13578	724	0.422	stagnant water, dirty water, fatty, grease	2.1 – 8.8	8.8
Sample 17 - ED3N-1 (Treated leachate: middle - east)	TOUSC13588	294	0.178	stagnant water, grain, wheat		
Sample 18 - ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13589	8,190	4.40	onion, cabbage, rotten egg	0.1 – 7.4	0.2***
Sample 3 – ED3N-2 (Partially treated leachate: south-western end)	TOUSC13581	71,500	46.1	rotten egg		
Sample 4 – ED3N-2 (Partially treated leachate: middle-west)	TOUSC13580	25,300	14.2	rotten egg		

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

Table 6.1 continued – The Audit vs. EA Woodlawn Expansion Project Odour Emissions Testing Results: 29 October 2013 – 6 November 2013

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 Dam 3 North (ED3N) Pond System						
Sample 6 – ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13579	27,600	15.8	rotten egg	0.1 – 7.4	0.2***
Sample 1 – ED3N-3 (Treated leachate: south-eastern end)	TOUSC13576	166	0.106	stagnant water		
Sample 2 - ED3N-3 (Treated leachate: middle-east)	TOUSC13577	140	0.0887	stagnant water		
Sample 16 - ED3N-3 (Treated leachate: middle - west)	TOUSC13587	478	0.270	stagnant water, sweet onion		
Sample 15 - ED3N-4 (Evaporation dam: middle-east)	TOUSC13586	97	0.0604	stagnant water	0.1 – 0.7	0.7*****
Landfill Gas Extraction System						
Sample 23 - Landfill gas inlet (Unconditioned)	TOUSC13594	8,800,000	n/a	rotten egg, garbage	n/m	
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

Table 6.2 – Global mean SOER results: Comparison between The Audit vs. 2012 IOA

Source	The Audit	2012 IOA
Location	**TOU SOER (ou.m^3/m^2/s)**	
ED3N-1	0.30	394
ED3N-2 & 3^	11.6 ^^^^	0.29
ED3N-2	20.1 ^^^	0.21
ED3N-3	0.2	0.37
ED3N-4	0.0604	0.41
Active Tipping Face	3.04	8.36
Leachate Aeration Dam	0.323	0.46
Construction and Demolition Tip Face	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 **Section 7.2.1.2** for details)
^^^^ bulk of emissions originating from ED3N-2 (see **Section 7.5.1.1** for details)

Table 6.3 – In-situ H_2S & NH_3 Measurements: 29 October 2013 – 6 November 2013

Sample Location	TOU Sample Number	H_2S in-situ concentration (ppm) *	NH_3 in-situ concentration (ppm) ***
Sample 1 – ED3N-3 (Treated leachate: south-eastern end)	TOUSC13576	n/d	n/m
Sample 2 - ED3N-3 (Treated leachate: middle-east)	TOUSC13577	n/d	n/m
Sample 3 – ED3N-2 (Partially treated leachate: south-western end)	TOUSC13581	12	n/m
Sample 4 – ED3N-2 (Partially treated leachate: middle-west)	TOUSC13580	7.9	n/m
Sample 5 - ED3N-1 (Treated leachate: north-eastern end)	TOUSC13578	n/d	n/m
Sample 6 – ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13579	6.4	n/m
Sample 7 - Active Tipping Area (Aged waste: 5 days old) - Northern section of area	TOUSC13595	0.02	n/m
Sample 8 - Active Tipping Area (Aged waste: 5 days old) - Eastern section of area	TOUSC13596	0.03	n/m
Sample 9 - Waste Covered Area (Northern quadrant of Void)	TOUSC13597	0.8	n/m
Sample 10 - Waste Cover Area (Southeastern section of Void)	TOUSC13601	30	n/m
Sample 11 - Waste Covered Area (Southern quadrant of Void - Edge)	TOUSC13598	0.1	n/m
Sample 12 - Waste Covered Area (Southern quadrant of Void - Inner area)	TOUSC13599	0.1	n/m
Sample 13 - Waste Covered Area (Gas & Sump Area Point #98)	TOUSC13602	405**	n/m
Sample 14 - Waste Covered Area (Gas & Sump Area Point #69)	TOUSC13600	9.1	n/m
Sample 15 - ED3N-4 (Evaporation dam: middle-east)	TOUSC13586	n/d	n/m
Sample 16 - ED3N-3 (Treated leachate: middle - west)	TOUSC13587	n/d	n/m
Sample 17 - ED3N-1 (Treated leachate: middle - east)	TOUSC13588	n/d	n/m
Sample 18 - ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13589	5.6	n/m
Sample 19 - Leachate Aeration Dam (middle-east)	TOUSC13590	n/d	> 60
Sample 20 - Leachate Aeration Dam (north-eastern end)	TOUSC13591	n/d	> 60
Sample 21 - Active Tipping Area (south western section of Void, fresh waste less than 1 day old)	TOUSC13592	0.14	n/m
Sample 22 - Construction and Demolition Area (Southern end of Void)	TOUSC13593	0.01	n/m
Sample 23 - Landfill gas inlet (Unconditioned)	TOUSC13594	805**	n/m

* determined using the Jerome Analyser
** required the use of high range H_2S Gastec Tubes as concentration levels exceeded the Jerome Analyser maximum measurement range
*** determined using NH_3 Gastec Tubes

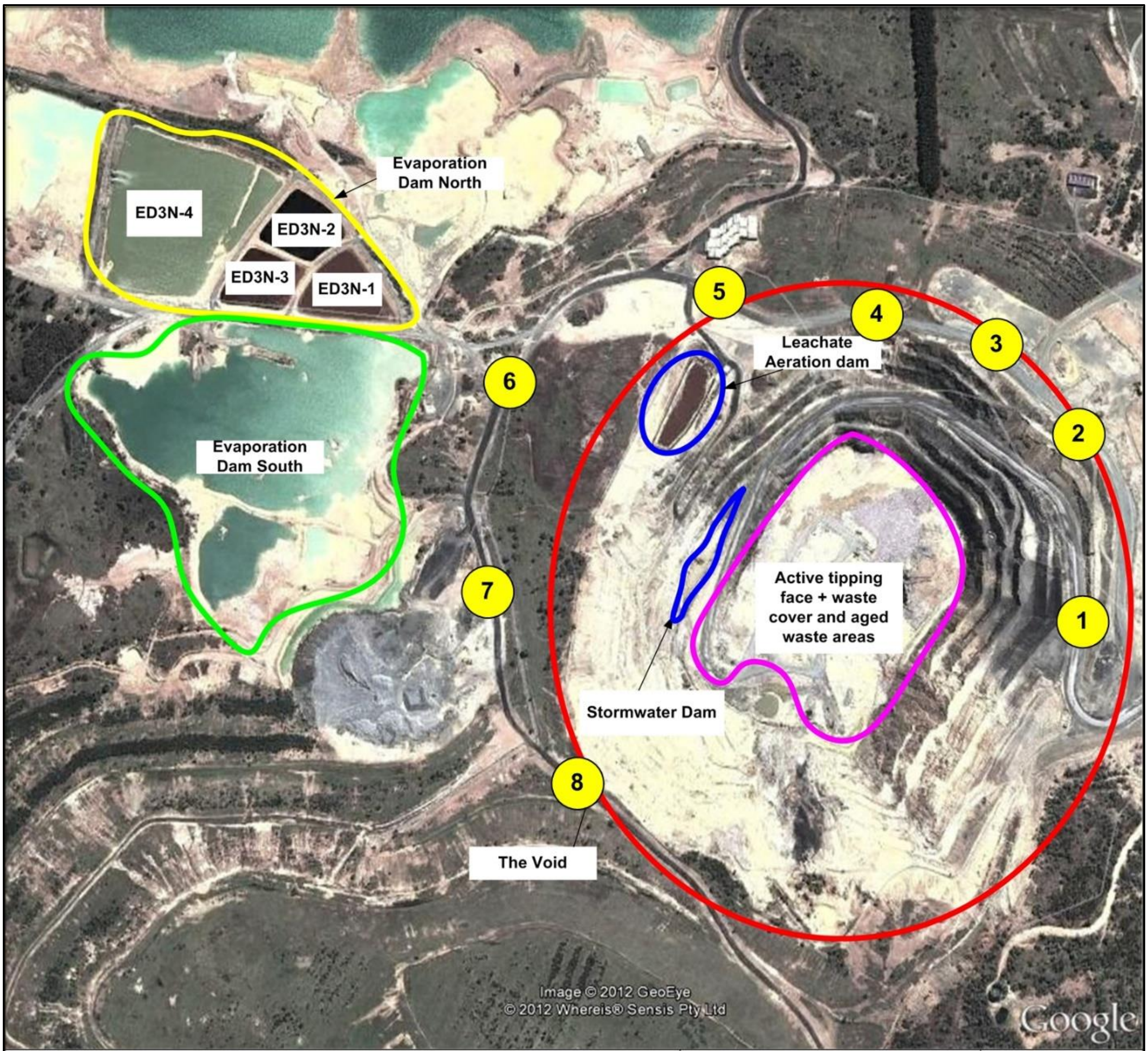
Table 6.4 – Liquid Odour Method Testing Results and Derived Odour Emission Rates

Sample Location	TOU Sample Number	Odour Concentration (ou)	Calculated Liquid Odour Potential (ou/mL)	Natural Evaporation Rate (L/s) *	Natural Evaporation Odour Emission Rate (ou.m³/s)	Mechanical Evaporation Rate (L/min)	Mechanical Evaporation Odour Emission Rate (ou.m³/s)	Audit Mean Odour Emission Rate (ou.m³/s)	Odour Character
ED3N-3 (Treated leachate)	TOUSC13603	7,510	455	0.20	89,500	Evaporators not used since 2012 IOA Audit		852	burnt, stagnant water
ED3N-2 (Partially treated leachate)	TOUSC13604	3,820	231	Pond has been completely dewatered (see **Section 6.2.2** for details)				n/a	burnt fat, stagnant water, ammonia

* Based on the mean natural evaporation rate from May 2007 – June 2012 as recorded by VES i.e. 92.67 mm/month respectively

6.1 FIELD AMBIENT H_2S ASSESSMENT RESULTS

In order to gauge the extent of fugitive odour emissions from the Void, the Audit team undertook a brief field ambient H_2S assessment (FAHA) survey using the Jerome Analyser around easily accessible routes of the Void's outer circumference. The measurement locations and results have been summarised in **Figure 6.1** and **Table 6.5.** Overall, the FAHA survey found relatively low H_2S levels, ranging from 0.002 ppm to 0.018 ppm (i.e. the minimum and maximum recorded measurement results by the Jerome Analyser across the entire survey period).



Map Plot Description

In-situ Field Ambient H_2S Monitoring –

Woodlawn Bioreactor Facility

Refer **FAHA Survey Logsheet – N1806-1** for details

CLIENT/PROJECT

VEOLIA ENVIRONMENTAL SERVICES

Independent Odour Audit #2

N

LOCAL WIND DIRECTION

Clear skies, no rain, calm to light wind conditions with west to northwest winds (1 – 4 m/s)

THE ODOUR UNIT PTY LTD Australian Technology Park Bay 4 Suite 3011, 2 Locomotive Street, EVELEIGH, NSW 2015 Phone: (02) 9209 4420 Fax: (02) 9209 4421 info@odourunit.com.au www.odourunit.com.au	DRAWN BY	M.ASSAL 16/12/2013	**Title** **Woodlawn Bioreactor Facility** Field ambient H_2S assessment Tarago, NSW	**Map Plot No.** 1806-1
	CHECKED	T.SCHULZ 17/01/2014		**Job No.** N1806L.03 (Rev 1)
	APPROVED	T.SCHULZ 17/01/2014		

Figure 6.1 –Field Ambient H_2S Assessment Map Plot

Table 6.5 - Map Plot No. 1806-1

Grid Ref. Position	Time (hrs)	Wind Direction	Wind Velocity (m/s)	H_2S Present? (Y/N)	Mean H_2S concentration (ppm)	Comments
1	1430	W/NW	1-4	Y	0.003	Near Road entrance to Void
2	1435			Y	0.004	None
3	1440			Y	0.0035	None
4	1450			Y	0.0037	Viewing Platform
5	1455			Y	0.002	None
6	1500			Y	0.002	None
7	1505			Y	0.0086	H_2S level varied from 0.002-0.0018 ppm
8	1510			Y	0.002	None

6.2 COMMENTS ON RESULTS

The following sections comment on the results presented in **Tables 6.1-6.5** in **Section 6.1.**

6.2.1 The Void Samples

- The SOER results for the Active Tipping Area (TOUSC13592 and TOUSC13595-TOUSC13596) within the Void continue to remain generally consistent with the results from the 2012 IOA and the values used in EA dispersion modelling.
- The Waste Covered Area samples 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.
- The areas sampled within the Void included:
  - Gas/sump well extraction points (TOUSC13600 & TOUSC13602);
  - Waste Covered Area with visible surface cracks (TOUSC13601);
  - Northern quadrant of Void on a waste covered area (TOUSC13597)
  - Edge of the southern quadrant of the Void (TOUSC13598); and
  - Inner sections of a waste covered area (TOUSC13599).
- The two samples (TOUSC13597 & TOUSC13599) collected on a typical waste covered area are judged to be representative of the bulk of the other waste covered areas inside the Void, based on the audits team's field observations at the Site during the Audit.
- Gas short-circuiting from potential pathways identified in the Void during this Audit (via an olfactory assessment and personal protective H_2S monitors) were found not to be solely landfill gas, but a combination of landfill gas and volatile esters such as ethyl butyrate (which has a fruity, pineapple character). This was a similar finding identified in the 2012 IOA. This could possibly explain why gas sample TOUSC13602 (18,800,000 ou) is more than double in odour

concentration than that collected from the supply pipe to the gas engines (i.e. TOUSC13594 with an odour concentration of 8,800,000 ou). This matter is further discussed in **Section 7.2.1.3**.

- The collected sample locations inside the Void have been nominally shown in **Figure 6.2.** The sample numbers shown below correspond with **Table 6.1.**

Figure 6.2 – Nominal locations within the Void

6.2.2 Leachate Samples

- No samples were collected at Storage Pond 7 as it is now defunct and therefore no longer a valid odour remission source at the Site.
- As mentioned in the 2012 IOA, the leachate recirculation system has been improved since sampling undertaken for the EA and is now operating as a direct injection system that does not have suitable access points for sampling.
- All samples from the ED3N system were collected at different locations, from the bank of the dams (where possible).
- ED3N-2 samples were representative of the pond during the fieldwork. VES has supplied evidence to the audit team to prove that this pond is now empty (discussed later in **Section 7.2.1.2**). As a result, the odour emissions rates found

as of drafting this Audit report are not applicable. It does show however the potential for low quality leachate leading to odorous emissions. As mentioned in the previous 2012 Audit, differing water quality in the ED3N was not considered in the EA.

- Excluding ED3N-2, all ED3N-1, ED3N-3 & ED3N-4 were found in general to be within the EA SOER range values.
- 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 high ammonia measurements are likely a function of the LAD operating pH (found to be greater than 7 as per documentation supplied by VES). The SOER results suggest however this is not an issue from an odour emission viewpoint.
- The SOER found in the Audit were in general within the EA SOER range values.

6.2.4 Landfill Gas Samples

- The landfill gas sample was collected from the gas supply pipe to the gas engines.
- The odour concentration in the landfill gas (8,800,000 ou) is statistically comparable with previous landfill gas testing by the audit team in the 2012 IOA (9,300,000 ou).

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 natural evaporation has only been included as the mechanical evaporators have not been used since the 2012 IOA.
- The natural evaporation rate shown is based on the mean rate between May 2007 to June 2012 at the Site.

- The collected liquid samples are a grab sample from ED3N-2 & ED3N-3 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.
- 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**).
- The LAD samples were analysed for NH_3 using Gastec tubes (i.e. TOUSC13590 & TOUSC13591).

6.2.7 FAHA Survey Results

- The low levels of H_2S around the circumference of the Void suggest that the fugitive emissions emanating from the Void at the time of the Audit were low. This is suggestive that fugitive emissions could vary diurnally and are not necessarily a continuous emission (given the testing results obtained from the known gas potential pathways mentioned earlier in **Section 6.2.1**).

7 DISCUSSION

7.1 PREVIOUS AUDIT RECOMMENDATIONS

The following **Tables 7.1 & 7.2** outline the mandatory and non-mandatory recommendations documented in the 2012 IOA respectively and VES 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. This has been comprehensively documented in the *Woodlawn Infrastructure Plan (WIP) Phase 1 - April 2012* (WIP 2012). The WIP was made available by VES to the audit team and a review of the relevant sections was undertaken (discussed in **Section 7.2.1.3**).

7.1.1 Mandatory recommendations

Table 7.1 – 2012 IOA Mandatory Recommendations

No.	2012 Independent Audit Recommendations	VES Response
1	*Maintaining the existing batch leachate treatment system but prioritising the removal of untreated excess leachate in ED3N-1 and adequately managing leachate within the Bioreactor or any excess leachate treated directly through the treatment system prior to storage in ED3N-1. If storage of untreated leachate is required in ED3N-1 for an extended period, the covering of ED3N-1 will need to be considered*;	VES has upgraded the leachate management system on-site. As discussed in **Section 2.4.3**, the former batch operated leachate aeration dam has now been configured into a continuous wastewater treatment plant. Following optimisation of the upgraded leachate management system (as specified in VES correspondence to the EPA on 31 July 2013 – appended as **Appendix C**), the Site was capable of treating all of the contents in ED3N-1. All the pond contents in ED3N-1 was emptied on 30 July 2013 (also see **Appendix C**). The Audit understands that the new LMS has eliminated the need to store excess leachate.
2	*Continue to develop the current batch leachate treatment system into a continuous leachate treatment system*	As above.
3	*In general, review and improvement of leachate treatment at the site.*	As above

Table 7.1 – 2012 IOA Mandatory Recommendations		
No.	**2012 Independent Audit Recommendations**	**VES Response**
4	*Continue to implement the current Gas Infrastructure Plan to increase gas capture, including from the perimeter areas.*	It was clear to the Audit that VES has continued to invest heavily in site infrastructure to improve both leachate collection and gas collection capability. The Audit understands that this is an on-going operational process at the Site and that the results may not be immediately evident. VES has a Woodlawn Gas Infrastructure Plan which outlines a comprehensive plan that is being implemented to increase gas capture. As evident in the issued document to the Audit VES Woodlawn Bioreactor Gas Collection Efficiency, there is general upward trend in gas capture, as measured in data collected from the National Greenhouse and Energy Reporting Scheme (NGERS). The Audit understand that gas capture is measured against a calculated emissions model issued by the Australian Government – Clean Energy Regulator. Advice and data supplied to the audit team revealed that a mean gas capture efficiency of 80% was achieved over a 12-month period since the last Audit (see **Section 7.2.1.3** and **Appendix B** for details).

7.1.2 Non-Mandatory recommendations

Table 7.2 – 2012 IOA Non-mandatory recommendations

No.	2012 IOA Non-Mandatory Recommendation	VES Response
1	***Biofiltration Trial:*** *filling areas of the Bioreactor perimeter identified as potential emission sources with suitable organic-based media for biofiltration of landfill gas short-circuiting due to 'wall effects' and monitor the effects*	VES is currently in the process of implementing this strategy, in consultation with TOU.
2	***Operation of the evaporator units****: It is recommended that VES reviews the operation of the Evaporator Units in light of the findings of this Audit regarding the potential of this process to emit odours in significant quantities. The review should re-examine appropriate weather conditions for their use and the significance of the quality of the effluent in generating odours during evaporation activity*	The Audit understands that the mechanical evaporator units have not been used since the previous Audit, due to the odorous quality of the previously stored liquid in ED3N at the time. Following the findings of the Audit, and treatment of all ED3N-2 contents (discussed later in **Section 7.2.1.2**), VES has indicated that they intend on using the evaporator units in the future given that higher quality treated leachate is now stored in ED3N. The audit team understands that the use of the evaporator units are an important part of volume reduction at the Site.

Table 7.2 continued – 2012 IOA Non-mandatory recommendations		
No.	**2012 IOA Non-Mandatory Recommendation**	**VES Response**
3	***Review gas and leachate quality in different areas of the Bioreactor***: *It is recommended that VES reviews gas and leachate quality to identify areas of higher potential odour sources that can be targeted with future gas collection infrastructure and leachate management strategies.*	This is an on-going, complex operational process. VES has shown clear intentions to continue expanding their leachate and gas collection capabilities at the Site. The Audit understands that a medium term plan for the improvement of gas capture requires long-term continuous leachate extraction and treatment. Following the upgraded LMS, and in-line with the *Woodlawn Gas Infrastructure Plan*, it is understood that the capture performance will continue to improve. Since the last Audit, it was clear that VES has several operational constraints over the past year (such as the upgrading the LMS whilst requiring priority removal and treatment of ED3N-1 and ED3N-2 contents). Following the completion of these operational constraints, it is expected further improvement to gas capture will be achieved. This will be reviewed in the next Audit.

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)

Audit the effectiveness of the odour controls on-site in regard to protecting receivers against offensive odour

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 2012 IOA, and complemented by this Audit's on-site experience and discussions with VES 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 Methods;
2. Continuous treatment of excess leachate from the Void;
3. Landfill Gas Extraction;
4. Improve evaporation capability;
5. Water cart to control dust;
6. Using the minimal active tipping face as practically possible; and
7. Transportation of waste in sealed containers until unloading at the Bioreactor.

7.2.1.1 Leachate recirculation methods

Direct injection based leachate recirculation continues to be practiced at the site. The 2012 IOA indicated that VES' adoption of this recirculation technique is more effective at minimising odours than previously utilised techniques. This continues to be the practice at the Site. VES maximises the recirculation potential of the waste, and leachate is only removed from the Void when it becomes an issue to operations at the waste surface. Leachate that is extracted from the Void now flows directly to the LAD.

7.2.1.2 Continuous treatment of excess leachate from the Void

The Audit understands that there is no longer a need to store excess leachate in the evaporation dams following the upgrade LAD system (see **Section 2.4.3** for details). This will be an important feature of mitigating odour emissions from the pond sources at the Site.

Since the 2012 IOA, the Audit has found that VES had encountered a number of operational issues during the development of the continuous leachate treatment system (see VES correspondence to EPA in **Appendix C**). As a result, VES was unable to meet the EPA's deadline of removing all leachate from ED3N-1 by 30 June 2013. This had a flow-on effect on the need to store partially treated leachate in ED3N-2 until the LMS could be restarted and returned to operational capacity. As shown in **Section 6**, this was reflected in the odour testing results for ED3N-2 with a mean SOER of 20.1 $ou.m^3/m^2/s$ and peak of 46.1 $ou.m^3/m^2/s$. In the lead up to this Audit report, VES have advised that all ED3N-2 contents have now been drained (see **Photo 7.1**) and no sub-optimal quality treated leachate remains stored in any of the ED3N lagoons. On this basis, and for the purposes of this Audit, no further action is required by VES in regards to mitigating odour emissions from ED3N-2.

If there are future operational issues with the LMS, VES should take the precautionary measures of notifying the EPA, neighbouring residents and other necessary external parties. As previously mentioned in **Section 7.2.1.1**, the Audit understands that with the current continuous leachate treatment configuration, untreated leachate will not be stored in the ED3N lagoons and instead flow directly from the Void and into the LAD.

Photo 7.1 – Photographic evidence of ED3N-2 fully drained: 18 December 2013

7.2.1.3 Landfill Gas Extraction System

Landfill gas extraction at this Site is an ongoing operational process. The Site has a comprehensive plan as outlined in the WIP to increase gas capture by undertaking the following:

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 repeated in this Audit report.

As outlined in the 2012 IOA, it is difficult to calculate a representative odour emission rate from the Void given the dynamic virtue of the surface layout. However, VES has indicated to the Audit that it has undertaken internal calculations for actual gas capture efficiency, which at the time of this Audit was approximately 80%. Based on the landfill gas odour concentration determined in this Audit, and using gas generation data provided by VES for the period of September 2012 to October 2013, this Audit has calculated that the total emission rate from leakage would theoretically be 1,170,000 ou.m^3/s for 80% gas capture efficiency (see **Appendix B** for assumptions and calculations used to derive these results), representing a proportional increase of 28% due to the increase in volume generation over that period (from 838,000 m^3 to 1,380,000 m^3). These very high concentrations are not compatible with the relatively low odour ambient odour levels within the Void and this Audit finds that either substantial odour reduction is occurring before the gas exists the waste layer, or the gas capture efficiencies are greater than the 70-80% estimates supplied by VES. Notwithstanding this finding, this Audit supports ongoing efforts by VES to improve gas capture, provided on-going documenting of gas capture is maintained. Variation in fugitive gas emissions could have the potential to be highly significant to odour emissions at the site

Further to the above, the odour characters of fugitive gas emissions from the Void as found by the Audit suggests that gas leaks are not necessarily landfill gas, and may be a combination of landfill gas and ‘non-landfill gases’ such as volatile organic acids (in the form of esters) from less mature decomposed waste. Evidence of this was noted by the presence of a ‘pineapple/fruity’ odour (likely dominated by ethyl butyrate) intermittently detectable in localised areas of the Void – a findings in the previous 2012 IOA. Despite its intermittent presence in the Void, as found by the Audit team through an olfactory assessment, the ambient odour levels in the Void were relatively low at both at the waste surface and immediately downwind of the Void (see **Section 6.1**). This also was a similar finding to the 2012 IOA and supports the hypothesis that biological oxidation in the upper aerobic layers of the Void may be occurring en route to the surface.

7.2.1.4 Landfill gas combustion

According to a recent Stephenson Stack Emission Survey on Generators No. 2, 3 & 4 carried out in June 2013, all combusted gas emissions from all three generators comply with the EPL Limits for NO_x, SO_3/H_2SO_4 and H_2S. Although no data are available for odour levels in the engine exhausts the internal combustion process is usually very effective in destroying odour, to the extent that these exhausts are considered to be an effective odour mitigation measure and highly unlikely to be emitting problematical odour emissions. This could be confirmed if odour testing was included in the next scheduled stack testing of these exhausts.

7.2.1.5 Using the minimal active tipping face as practically possible

VES continues to keep the active tipping face area to a practical minimum. This was observed by the reduced area found in the Audit (from 40,000 m^2 adopted in the EA to between 4,000 - 6,000 m^2). As identified in the 2012 IOA, 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.

Further to this, minimising the active tipping face is one of the key performance indicators at the Site for the following reasons, discussed also in the 2012 IOA, as follows:

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

The SOER values determined during this Audit for fresh to 1 week old waste varied from 2.55 to 3.64 $ou.m^3/m^2/s$. 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.

7.2.1.6 Improve evaporation capability

VES has not used the mechanical evaporators since the 2012 IOA as a result of the odorous quality of the leachate previously stored in ED3N lagoons. The Audit understands however that the mechanical evaporators will be used in the future and are an integral part of leachate management at the Site, as it provides a means of volume reduction of treated leachate.

7.2.1.7 Water cart to control dust

Use of the water cart is an ongoing operational activity, which is effective at minimising dust generation. The Audit observed that this was a continued practice at the Site.

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

Similarly to the 2012 IOA, 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 found very little evidence of any waste-based odour being generated at the Crips Creek Intermodal Facility. On this basis, the Audit determined that there was still no need to sample at this facility (as indicated in the 2012 IOA) 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 VES for this component of the Site's operations.

7.3 CONDITION 7 (C)

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 VES for the Site since the previous 2012 IOA. These were reviewed by the Audit and have been presented in **Appendix C.** It appears that all record-keeping duties in this regard are being adequately maintained. Complaint log records indicate that the necessary fields required by the *EPL Condition M4 Recording of pollution complaints* are being documented by VES.

7.4 CONDITION 7 (F)

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 two perspectives, namely odour complaint record analysis and compliance with the modelling-based, project-specific odour performance goal of 6 ou.

Similar to the 2012 IOA, a review of the recent complaint records for the Site indicates that adverse odour impacts still continue to occur, although a significant drop in the number of complaints has been received to date in 2013. Unfortunately, the complaint data does not assist in identifying the nature or likely source of the problematic odours. This Audit finds that VES has been actively undertaking measures to minimise odour emissions from the Site, including participation in a community consultation process designed to provide the necessary odour impact feedback (such as the correspondence dated 12 July 2013 which outlines VES response to an odour complaint – see **Appendix C**). This feedback is important given the widely different odour characters from the Void emissions and leachate.

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 upgrade of the LMS, 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** - **Table 7.1**), following the drainage of sub-optimal quality leachate in the ED3N lagoons. This excludes however the contributions from known areas causing significant fugitive gas emissions within the Void which pose practical difficulties in accurately modelling.

7.5 ODOUR EMISSIONS INVENTORY DISCUSSION

As per recommendation of the 2012 IOA, this 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 7.1 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. Despite these omissions it is considered that the incomplete inventory remains to have real value and is discussed later (see **Sections 7.5.1 & 7.5.2**).

Table 7.1 – Measureable odour emission rates for the Site ^

Parameter			The Audit			2012 IOA		EA		
Location	Current Area (m^2) ^^	2012 Area (m^2)	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	0.30	2,100	1,800	394	2,760,000	8.8	61,600	52,800
ED3N-2 & 3 ^^^	11,000	13,000	11.6	150,000	127,000	0.29	3,800	7.4	96,200	81,400
ED3N-2	5,500	6,500	20.1	131,000	111,000	0.21	1,350	n/a^^^		
ED3N-3	5,500	6,500	0.2	1,010	852	0.37	2,430			
ED3N-4	25,000	16,000	0.0604	966	1,510	0.41	6,600	0.7	11,200	17,500
Active Tipping Face	6,000	40,000 *	3.04	122,000	18,200	8.36	334,000	7.3	292,000	43,800
Leachate Aeration Dam	5,000	2,000	0.323	647	1,620	0.46	920	3.6	7,200 #	18,000
Construction and Demolition Tip Face	500	900	0.293	264	147	n/a	n/a	n/a	n/a	n/a
Storage Pond 7	n/a	1,200	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 VES
^^^ 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 following the dewatering of all ED3N-2 pond contents. 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.

7.5.1 Pond sources

7.5.1.1 ED3N

ED3N-1 has seen a huge reduction (> 99%) in odour emissions since the last Audit, mostly attributed to the removal and treatment of the untreated leachate that was previously stored in this dam, as found in the 2012 IOA. Since the last Audit, VES have upgraded the on-site leachate treatment capacity and configuration, through the conversion of the previous batch-based leachate treatment system to a more-continuous one, which has resulted in an optimisation to the leachate treatment process at the Site (see **Section 2.4.3** for details).The Audit understands that this upgrade has eliminated the need to store untreated leachate outside of the Void for current and future operations.

ED3N-2 &3 odour emissions have increased since the last Audit, with the increase of emissions originating from ED3N-2. The Audit was advised that VES had identified the contents of ED3N-2 as partially treated leachate remaining from the previous batch leachate treatment system and that the conditions in this dam were turning anoxic. This explains the observed increase in odour emissions from this pond source seen in the odour testing results (see **Section 6 – Table 6.1**). The Audit did note that VES were in the process of returning this sub-optimal quality leachate to the LAD for treatment. As shown in **Section 7** - **Photo 7.1**, all partially untreated leachate in ED3N-2 sampled during the Audit has undergone treatment, and no sub-optimal quality treated leachate remains stored in any of the ED3N lagoons. On this basis, and for the purposes of this Audit, no further action is required by VES in regards to mitigating odour emissions from ED3N-2.

Notwithstanding the above, the total odour emission rates for ED3N ponds in this Audit is 153,100 $ou.m^3/s$, equating to a 94% reduction in overall odour emissions from this source since the 2012 IOA (from 2,770,000 $ou.m^3/s$). This current emission rate is lower than that used in the EA, and will be even lower following the removal of partially treated leachate from ED3N-2 and the subsequent storage of fully treated leachate.

ED3N-4 continues to remain an insignificant odour emission source at the Site.

7.5.1.2 LAD

The LAD was found to be effective in treating the incoming leachate prior to storage in the dams. This has resulted in a notable reduction in odour emissions from this source.

7.5.1.3 Storage Pond 7

Storage Pond 7 has been completely removed (previously located in the Void) and is therefore not a valid odour emission source for the Audit.

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 2012 IOA. The Audit odour testing results indicate that the Void is now the major contributor to odour emissions at the Site, by virtue of the significant reduction in ED3N odour emissions. Based on discussions with VES and field observations, this appears to be related to gas capture across the Void (as discussed in **Section 7.2.1.3**).

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 gas emissions known to be occurring around the edges of the waste in the Bioreactor (wall effects) and identified areas where the detected H_2S levels were high (ranging from 0.1 – 405 ppm). These areas include particular gas/sump extraction wells where there was clear evidence of short-circuiting of landfill gas and non-landfill based gases (as found at Gas & Sump Areas #69 & #98). The odour characters of fugitive gas emissions suggest that gas leaks are not necessarily pure landfill gas and may be a combination of landfill gas and volatile esters (such as ethyl butyrate), given the pineapple, fruity odour readily detectable in some areas of the Void. This was a similar finding in the 2012 IOA. Further to this, as previously indicated in **Section 6.1**, the low levels of H_2S detected around the circumference of the Void during the FAHA survey suggests that fugitive emissions from the Void at the time of the Audit were low but could diurnally vary and are not necessarily a continuous emission. In addition, this could also the hypothesis that biological oxidation in the upper aerobic layers of the Void may be occurring en route to the surface (as previously mentioned in **Section 7.2.1.3** and the 2012 IOA).

7.6 OPERATION OF THE MECHANICAL EVAPORATOR UNITS

It is understood that the mechanical evaporators units have not been used since the previous Audit, due to the odorous quality of the previously stored liquid in ED3N at the time. Following the findings of this Audit, and treatment of all partially untreated leachate in ED3N-2, VES has indicated that they intend on using the evaporator units in the future given that higher quality treated leachate remains stored in ED3N. As previously mentioned in **Section 2.4.1**, the use of the evaporator units are an important part of volume reduction at the Site.

8 PRELIMINARY MITIGATION OPTIONS

Condition 7 (G & H)

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, VES 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.

8.1 MANDATORY MITIGATION MEASURES

8.1.1 Leachate management system

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.

8.1.2 Odour mitigation from the Void

Improve Gas Capture within the Void. 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.

8.2 NON-MANDATORY MITIGATION OPTIONS

8.2.1 Odour Mitigation from the Void

8.2.1.1 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 trialed 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.

8.2.1.2 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.

BIBLIOGRAPHY

1. Stephenson Environmental Management Australia, *Woodlawn Landfill Stack Emission Survey – Generator Nos. 2,3 & 4,* June 2013

2. NSW Government Department of Planning & Infrastructure, Development Assessments, Major Assessments, *Woodlawn Waste Facility: Woodlawn Expansion Project,* July 2012

3. Veolia Environmental Services, *Woodlawn Infrastructure Plan – Phase 1: Woodlawn Bioreactor,* April 2012

4. Submissions Report Woodlawn Expansion Project, *Appendix C – SLR Global Environmental Solution: Woodlawn Bioreactor Odour and Dust Impact Assessment Woodlawn Expansion Project,* March 2011

5. Environmental Assessment Woodlawn Expansion Project Volume 1 – Main Report, *Chapter 9 – Air Quality and Odour Assessment,* August 2010

6. Environmental Assessment Woodlawn Expansion Project Volume 2 – Appendices, *Appendix D – Air Quality and Odour Assessment,* March 2011

7. Veolia Environmental Services Pty Ltd, *Woodlawn Bioreactor Ambient Air Quality Monitoring Plan,* May 2007

REPORT SIGNATURE PAGE

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Woodlawn Bioreactor Expansion Project

Independent Odour Audit #2

January 2014

APPENDICES

APPENDIX A: ODOUR CONCENTRATION LABORATORY TESTING RESULT SHEETS

THE ODOUR UNIT PTY LTD

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ABN: 53 091 165 061

NATA

Accreditation Number: 14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	VES Woodlawn	Telephone	(02) 9841 2932
Contact	S. Bernhart	Facsimile	-
Sampling Site	Tarago, NSW	Email	Stephen.Bernhart@veolia.com.au
Sampling Method	AS/NZS4323.3:2001	Sampling Team	TOU

Order details:

Order requested by	S.Bernhart	Order accepted by	M. Assal
Date of order	24 October 2013	TOU Project #	N1806L
Order number	4502611880	Project Manager	M.Assal
Signed by	S.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 $2^2 \le \chi \le 2^{18}$ 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 V01
Instrumental Precision	The precision of this instrument (expressed as repeatability) for a sensory calibration must be $r \le 0.477$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V01: r = 0.1775 (October 2013) Compliance – Yes
Instrumental Accuracy	The accuracy of this instrument for a sensory calibration must be $A \le 0.217$ in accordance with the Australian Standard AS/NZS4323.3:2001. ODORMAT SERIES V01: A = 0.2106 (October 2013) 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, 31 October 2013

Panel Roster Number: SYD20131030_083

D. A. Hepple.

J. Schulz
NSW Laboratory Co-ordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20131030_083

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)
Sample #1 - ED3N-3 (Treated leachate: south-eastern end)	SC13576	29/10/2013 1358hrs	30/10/2013 1022hrs	4	8	--	--	166	166	0.106
Sample #2 - ED3N-3 (Treated leachate: middle east)	SC13577	29/10/2013 1358hrs	30/10/2013 1053hrs	4	8	--	--	140	140	0.0887
Sample #5 - ED3N-1 (Treated leachate: north-eastern end)	SC13578	29/10/2013 1539hrs	30/10/2013 1120hrs	4	8	--	--	724	724	0.422
Sample #6 - ED3N-2 (Partially treated leachate: south-eastern end)	SC13579	29/10/2013 1515hrs	30/10/2013 1203hrs	4	8	--	--	27,600	27,600	15.8
Sample #4 - ED3N-2 (Partially treated leachate : middle west)	SC13580	29/10/2013 1422hrs	30/10/2013 1315hrs	4	8	--	--	25,300	25,300	14.2

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: SYD20131030_083

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 ($ou.m^3/m^2/s$)
Sample #3 - ED3N-2 (Partially treated leachate : south western end)	SC13581	29/10/2013 1446hrs	30/10/2013 1346hrs	4	8	--	--	71,500	71,500	46.1

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

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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	SYD20131030_083	50,000	$20 \leq \chi \leq 80$	1,024	49	Yes

Comments Odour characters:

SC13576 stagnant water
SC13577 stagnant water
SC13578 stagnant water, dirty, water, fatty, grease
SC13579 rotten egg
SC13580 rotten egg
SC13581 rotten egg

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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NATA

Accreditation Number:
14974

Odour Concentration Measurement Results

The measurement was commissioned by:

Organisation	VES Woodlawn	Telephone	(02) 9841 2932
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Order details:

Order requested by	S.Bernhart	Order accepted by	M. Assal
Date of order	24 October 2013	TOU Project #	N1806L
Order number	4502611880	Project Manager	M.Assal
Signed by	S.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 V01

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 V01: $r = 0.1775$ (October 2013) 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 V01: $A = 0.2106$ (October 2013) 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, 31 November 2013 Panel Roster Number: SYD20131101_085

D. A. Hppl.

J. Schulz
NSW Laboratory Co-ordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20131101_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 ($ou.m^3/m^2/s$)
Sample #15-ED3N-4 (Evaporation dam: middle east)	SC13586	31/10/2013 0940hrs	01/11/2013 1040hrs	5	10	--	--	97	97	0.0604
Sample #16-ED3N-3 (Treated leachate: middle west)	SC13587	31/10/2013 0930hrs	01/11/2013 1114hrs	5	10	--	--	478	478	0.270
Sample #17-ED3N-1 (Treated leachate: middle east)	SC13588	31/10/2013 1049hrs	01/11/2013 1155hrs	5	10	--	--	294	294	0.178
Sample #18 - ED3N-2 (Partially treated leachate south-eastern end)	SC13589	31/10/2013 1051hrs	01/11/2013 1230hrs	5	10	--	--	8,190	8,190	4.40
Sample #19 - Leachate Aeration Dam (Middle-east)	SC13590	31/10/2013 1247hrs	01/11/2013 1346hrs	5	10	--	--	631	631	0.354

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).
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Odour Sample Measurement Results
Panel Roster Number: SYD20131101_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)
Sample #20 - Leachate Aeration Dam (north-eastern end)	SC13591	31/10/2013 1240hrs	01/11/2013 1418hrs	5	10	--	--	512	512	0.293
Sample #21 – Active Tipping Area (South-western section of Void, fresh waste less than 1 day old)	SC135592	31/10/2013 1415hrs	01/11/2013 1455hrs	5	8	--	--	6,890	6,890	3.64
Sample #22 – Construction and Demolition Area (Southern end of Void)	SC13593	31/10/2013 1400hrs	01/11/2013 1550hrs	5	8	--	--	609	609	0.293
Sample #23- Landfill Gas Inlet (Unconditioned)	SC13594	31/10/2013 1535hrs	01/11/2013 1626hrs	5	10	25L N_2 : 0.05L Sample	25L N_2 : 0.05L Sample	17,600	8,800,000	--

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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	SYD20131101_085	50,000	$20 \leq \chi \leq 80$	724	69	Yes

Comments Odour characters:

SC13586 stagnant water
SC13587 stagnant water, sweet onion
SC13588 stagnant water, grain, wheat
SC13589 onion, cabbage, rotten egg
SC13590 sweet, garbage, ammonia
SC13591 sweet, garbage, ammonia
SC13592 garbage
SC13593 garbage
SC13594 rotten egg, garbage

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.

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THE ODOUR UNIT PTY LTD

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

NATA

Accreditation Number: 14974

Odour Concentration Measurement Results

Organisation	VES Woodlawn	Telephone	(02) 9841 2932
Contact	S. Bernhart	Facsimile	-
Sampling Site	Tarago, NSW	Email	Stephen.Bernhart@veolia.com.au
Sampling Method	AS/NZS4323.3:2001	Sampling Team	TOU

Order details:

Order requested by	S.Bernhart	Order accepted by	M. Assal
Date of order	24 October 2013	TOU Project #	N1806L
Order number	4502611880	Project Manager	M.Assal
Signed by	S.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 V01
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 V01: r = 0.1775 (October 2013) 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 V01: A = 0.2106 (October 2013) 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, 07 November 2013

Panel Roster Number: SYD20131107_086

D. A. Hepple.

J. Schulz
NSW Laboratory Co-ordinator

D. Hepple
Authorised Signatory

Odour Sample Measurement Results
Panel Roster Number: SYD20131107_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 ($ou.m^3/m^2/s$)
Sample #7 - Active Tipping Face (Aged waste: 5 days old) – Northern section of area	SC13595	06/11/2013 1132hrs	07/11/2013 1045hrs	5	10	--	--	6,660	6,660	2.93
Sample #8 - Active Tipping Face (Aged waste: 5 days old) – Eastern section of area)	SC13596	06/11/2013 1130hrs	07/11/2013 1121hrs	5	10	--	--	5,790	5,790	2.55
Sample #9 - Waste Covered Area (Northern quadrant of Void)	SC13597	06/11/2013 1220hrs	07/11/2013 1158hrs	5	10	--	--	362	362	0.183
Sample #11 - Waste Covered Area (Southern quadrant of Void – Edge)	SC13598	06/11/2013 1413hrs	07/11/2013 1413hrs	5	10	--	--	10,100	10,100	4.86

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: SYD20131107_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 ($ou.m^3/m^2/s$)
Sample #12 – Waste Covered Area (Southern quadrant of Void – Inner Area)	SC13599	06/11/2013 1401hrs	07/11/2013 1401hrs	5	10	--	--	675	675	0.325
Sample #14 – Waste Covered Area(Gas & sump Area Point #69)	SC13600	06/11/2013 1521hrs	07/11/2013 1425hrs	5	10	--	--	161,400	161,400	85.6
Sample #10 – Waste Covered Area (South-eastern section of Void)	SC13601	06/11/2013 1241hrs	07/11/2013 1501hrs	5	10	25L N_2 : 0.25 L Sample	25L N_2 : 0.25 L Sample	80,700	8,150,000	4,170
Sample #13 – Waste Covered Area (Gas & Sump Area #98)	SC136602	06/11/2013 1456hrs	07/11/2013 1544hrs	5	10	25L N_2 :0.05L Sample	25L N_2 : 0.05L Sample	37,600	18,800,000	9,730
Sample # 24 – ED3N – 3 LOM	SC13603	06/11/2013 1450hrs	07/11/2013 1646hrs	5	8	--	--	7,510	7,510	--
Sample # 25 – ED3N – 2 LOM	SC13604	06/11/2013 1500hrs	07/11/2013 1729hrs	5	10	--	--	3,820	3,820	--

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	SYD20131107_086	50,000	$20 \leq \chi \leq 80$	832	60	Yes

Comments

Odour characters:

SC13595 garbage
SC13596 garbage
SC13597 musty, dirty, gassy
SC13601 fermented pineapple
SC13598 fermented fruit, pineapple, gassy
SC13599 dusty, musty, gassy
SC13602 fermented pineapple
SC13600 fermented pineapple, garbage

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

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APPENDIX B:

ODOUR EMISSIONS WORKSHEET

The Odour Unit Pty Ltd
Odour Emissions Worksheet
Client: Veolia Environmental Services (Australia) Pty Ltd
Sampling Site: Woodlawn Bioreactor Facility, Tarago, NSW
Audit No.: #2
Project Number: N1806L.03

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	H_2S in-situ concentration (ppm)	NH_3 in-situ concentration (ppm)
Sample 1 – ED3N-3 (Treated leachate: south-eastern end)	TOUSC13576	166	13.4	16.2	1.19	1.23	0.964	0.126	5	0.005	6.6	6.4	0.1	stagnant water	n/d	n/m
Sample 2 - ED3N-3 (Treated leachate: middle-east)	TOUSC13577	140	15.0	18.3	1.22	1.27	0.958	0.126	5	0.005	5.6	5.3	0.1	stagnant water	n/d	n/m
Sample 3 – ED3N-2 (Partially treated leachate: south-western end)	TOUSC13581	71,500	23.1	25.1	1.35	1.39	0.974	0.126	5	0.005	2,840	2,770	46.2	rotten egg	12.0	n/m
Sample 4 – ED3N-2 (Partially treated leachate: middle-west)	TOUSC13580	25,300	21.9	34.5	1.33	1.57	0.849	0.126	5	0.005	1,000	849	14.2	rotten egg	7.9	n/m
Sample 5 - ED3N-1 (Treated leachate: north-eastern end)	TOUSC13578	724	20.8	30.6	1.31	1.49	0.880	0.126	5	0.005	28.7	25.3	0.4	stagnant water, dirty water, fatty, grease	n/d	n/m
Sample 6 – ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13579	27,600	19.0	30.3	1.28	1.48	0.863	0.126	5	0.005	1,100	950	15.8	rotten egg	6.4	n/m
Sample 7 - Active Tipping Area (Aged waste: 5 days old) - Northern section of area	TOUSC13595	6,660	21.5	52.9	1.32	1.99	0.665	0.126	5	0.005	264	176	2.9	garbage	0.015	n/m
Sample 8 - Active Tipping Area (Aged waste: 5 days old) - Eastern section of area	TOUSC13596	5,790	24.0	55.3	1.37	2.05	0.666	0.126	5	0.005	230	153	2.6	garbage	0.028	n/m
Sample 9 - Waste Covered Area (Alternate Cover: Northern quadrant of Void)	TOUSC13597	362	26.0	46.5	1.40	1.83	0.766	0.126	5	0.005	14.4	11	0.2	musty, dirty, gassy	0.78	n/m
Sample 10 - Waste Covered Area (Alternate Cover: Southeastern section of Void)	TOUSC13601	8,150,000	26.2	46.0	1.41	1.82	0.773	0.126	5	0.005	323,000	250,000	4,170	fermented pineapple	30	n/m
Sample 11 - Waste Covered Area (Venom Cover: Southern quadrant of Void - Edge)	TOUSC13598	10,100	28.7	53.2	1.45	2.00	0.727	0.126	5	0.005	401.0	292.0	4.9	fermented fruit, pineapple, gassy	0.12	n/m
Sample 12 - Waste Covered Area (Venom Cover: Southern quadrant of Void - Inner area)	TOUSC13599	675	28.7	53.2	1.45	2.00	0.727	0.126	5	0.005	26.8	19.5	0.3	dusty, musty, gassy	0.093	n/m
Sample 13 - Waste Covered Area (Gas & Sump Area Point #98)	TOUSC13602	18,800,000	28.6	47.5	1.45	1.85	0.782	0.126	5	0.005	746,000	583,000	9,720	fermented pineapple	405	n/m
Sample 14 - Waste Covered Area (Gas & Sump Area Point #69)	TOUSC13600	161,000	24.1	40.9	1.37	1.70	0.804	0.126	5	0.005	6,390	5,140	85.7	fermented pineapple, garbage	9.1	n/m
Sample 15 - ED3N-4 (Evaporation dam: middle-east)	TOUSC13586	97	21.5	26.2	1.32	1.41	0.941	0.126	5	0.005	3.9	3.6	0.1	stagnant water	n/d	n/m
Sample 16 - ED3N-3 (Treated leachate: middle - west)	TOUSC13587	478	16.2	28.3	1.23	1.44	0.854	0.126	5	0.005	19.0	16.2	0.3	stagnant water, sweet onion	n/d	n/m
Sample 17 - ED3N-1 (Treated leachate: middle - east)	TOUSC13588	294	25.9	32.9	1.40	1.53	0.913	0.126	5	0.005	11.7	10.7	0.2	stagnant water, grain, wheat	n/d	n/m
Sample 18 - ED3N-2 (Partially treated leachate: south-eastern end)	TOUSC13589	8,190	16.2	32.2	1.23	1.52	0.812	0.126	5	0.005	325	264	4.4	onion, cabbage, rotten egg	5.6	n/m
Sample 19 - Leachate Aeration Dam (middle-east)	TOUSC13590	631	22.2	34.9	1.33	1.57	0.848	0.126	5	0.005	25	21.2	0.4	sweet, garbage, ammonia	n/d	> 60
Sample 20 - Leachate Aeration Dam (north-eastern end)	TOUSC13591	512	22.2	33.3	1.33	1.54	0.866	0.126	5	0.005	20.3	17.6	0.3	sweet, garbage, ammonia	n/d	> 60
Sample 21 - Active Tipping Area (south western section of Void, fresh waste less than 1 day old)	TOUSC13592	6,890	24.9	42.2	1.38	1.73	0.799	0.126	5	0.005	273	218	3.6	garbage	0.14	n/m
Sample 22 - Construction and Demolition Area (Southern end of Void)	TOUSC13593	609	24.9	49.3	1.38	1.90	0.728	0.126	5	0.005	24.2	17.6	0.3	garbage	0.011	n/m
Sample 23 - Landfill gas inlet (Unconditioned)	TOUSC13594	8,800,000												rotten egg, garbage	805	n/m

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)	Natural Evaporation Rate (L/s)	Odour Emission Rate (ou.m^3/s)	Odour Character	H_2S in-situ concentration (ppm)
Sample 24 - ED3N-3 (Treated leachate)	TOUSC13603	7,510	0.413	25	7,510	455	0.197	89,500	burnt, stagnant water	0.003
Sample 25 - ED3N-2 (Partially treated leachate)	TOUSC13604	3,820	0.413	25	3,820	231	Pond has been completely dewatered (see Audit Main Report for details)		burnt fat, stagnant water, ammonia	0.025

Document title:	Landfill Gas Capture Data
Data period:	September 2012 - October 2013

TOU calculation for mean gas capture

Landfill gas capture efficiency (%)	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	1,384,104	154,000	0.06	8,800,000	**523,000**
80	1,384,104	346,000	0.13	8,800,000	**1,170,000**
70	1,384,104	593,000	0.23	8,800,000	**2,010,000**

Data supplied by VES

Date	Landfill gas generated	Landfill gas flared	Landfill gas (Generation + Flared)
Sep-12	1,453,710.00	90,009.00	1,543,719
Oct-12	1,127,264.00	178,995.00	1,306,259
Nov-12	1,137,836.00	54,909.00	1,192,745
Dec-12	1,075,920.00	135,742.00	1,211,662
Jan-13	992,137.00	295,009.00	1,287,146
Feb-13	1,274,968.00	218,818.00	1,493,786
Mar-13	1,255,172.00	36,672.00	1,291,844
Apr-13	1,468,692.00	26,815.00	1,495,507
May-13	1,431,918.62	22,769.00	1,454,688
Jun-13	1,173,772.00	58,522.00	1,232,294
Jul-13	1,405,840.01	109,499.01	1,515,339
Aug-13	1,246,520.00	153,661.00	1,400,181
Sep-13	1,415,732.00	50,284.01	1,466,016
Oct-13	1,424,723.99	61,548.00	1,486,272
Mean total	**1,277,443**	**106,661**	**1,384,104**

APPENDIX C:

TECHNICAL DOCUMENTATION RELEVANT TO THE AUDIT

Stephenson
Environmental Management Australia

STACK EMISSION SURVEY – GENERATOR NOS. 2, 3, 4 & 5

WOODLAWN LANDFILL

VEOLIA ENVIRONMENTAL SERVICES

TARAGO, NSW

PROJECT NO.:	5211/S22403/13
DATE OF SURVEY:	11 - 13 JUNE 2013
DATE OF ISSUE:	28 JUNE 2013

Stephenson
Environmental Management Australia

Peter W Stephenson & Associates Pty Ltd
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STACK EMISSION SURVEY – GENERATOR NOS. 2, 3, 4 & 5

WOODLAWN LANDFILL

VEOLIA ENVIRONMENTAL SERVICES

TARAGO, NSW

PROJECT NO.: 5211/S22403/13

DATE OF SURVEY: 11 – 13 JUNE 2013

DATE OF ISSUE: 28 JUNE 2013

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, 4 and 5 Generators associated with the landfill gas power plant at their Woodlawn Landfill, Tarago, New South Wales (NSW).

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 Generator Nos. 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 11 to 13 June, 2013.

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/m^3	Annual	TM-32
Dry Gas Density*	mg/m^3 (kg/m^3)	Annual	TM-23
Moisture content	%	Annual	TM-22
Molecular weight of stack gases	g/g mole	Annual	TM-23
Nitrogen Oxides	mg/m^3	Annual	TM-11
Oxygen	%	Annual	TM-25
Sulphur Trioxide/Sulphuric Acid Mist	mg/m^3	Annual	TM-3
Sulphur Dioxide	mg/m^3	Annual	TM-4
Temperature	^oC	Annual	TM-2
Velocity	m/s	Annual	TM-2
Volatile Organic Compounds	mg/m^3	Annual	TM-34
Volumetric Flow Rate	m^3/s	Annual	TM-2

Key:

%	=	percent
^oC	=	degrees Celsius
g/g mole	=	grams per gram mole
kg/m^3	=	kilograms per cubic metre
m/s	=	metres per second
m^3/s	=	cubic metres per second
mg/m^3	=	milligrams per cubic metre at 0^oC 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/m^3) not milligrams per cubic metre (mg/m^3) as specified in EPL 11436.

3 PRODUCTION CONDITIONS

Veolia Environmental Services personnel considered the landfill and the associated gas fired power plant were operating under typical conditions on the days of testing. Generators 2, 3, 4 and 5 were operating on the day of testing.

However, Generator 1 was being rebuilt during the period of the emission monitoring and therefore was not operating and thus was unable to be tested.

Veolia Environmental Services provided the production records for the days of testing. A copy of these records is included in Appendix D.

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. 5211, 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 2013-1280. Analysis for SO_3/H_2SO_4 and H_2S samples were performed by the NATA accredited (NATA No. 825) ALS Environmental, Report No. EN1302226.

The stack emission test results are summarised in Table 4-1 and presented in detail in Tables A-1 to A-5 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 location is 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	Generator No. 2 EPL Point 8-2	Generator No. 3 EPL Point 8-3	Generator No. 4 EPL Point 8-4	Generator No. 5 EPL Point 8-5	EPL – Emission Concentration Limit
Dry Gas Density	kg/m^3	1.34	1.34	1.33	1.34	--
Moisture content	%	5.0	7.1	4.6	5.5	--
Molecular weight of stack gases	g/g mole	29.976	29.992	29.884	30.048	--
Temperature	^oC	464	476	436	474	--
Velocity	m/s	45.0	51.3	52.9	46.8	--
Volumetric Flow Rate	m^3/s	1.51	1.66	1.87	1.55	--
Carbon Dioxide	%	10.1	9.6	9.4	10.7	--
Carbon Monoxide	mg/m^3	981	622	784	922	--
Hydrogen Sulphide	mg/m^3	< 0.35	< 0.32	<0.29	< 0.33	5
Nitrogen Oxides @ 7% O_2	mg/m^3	296	323	267	318	450
Oxygen (O_2)	%	9.0	10.8	9.5	8.4	--
Sulphur Trioxide / Sulphuric Acid Mist	mg/m^3	5.00	7.15	5.72	5.87	100
Sulphur Dioxide	mg/m^3	136	83	121	30	--
Volatile Organic Compounds (as n-propane equivalent)	mg/m^3	<3.71	<3.12	<3.87	<4.13	--

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 2-5.

GENERATOR NO. 2

The measured SO_2 emission concentration ranged from 64 mg/m^3 to 185 mg/m^3 and averaged 136 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 29 mg/m^3 to 127 mg/m^3 and averaged 83 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 75 mg/m^3 to 142 mg/m^3 and averaged 121 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.

GENERATOR NO. 5

The measured SO_2 emission concentration ranged from 12 mg/m^3 to 52 mg/m^3 and averaged 30 mg/m^3 for the entire sampling period. Refer to Table 4-1 and Figure B-5 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 144 parts per million (ppm) (296 mg/m^3) during the sampling period. These emission concentrations *were 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 157 parts per million (ppm) (323 mg/m^3) during the sampling period. These emission concentrations *were 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 130 ppm (267mg/m^3) during the sampling period. These emission concentrations *were 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.

GENERATOR NO. 5

The 1-hour average NO_x (expressed as NO_2) emission concentration and corrected to 7% O_2 was 155 ppm (318 mg/m^3) during the sampling period. These emission concentrations *were in compliance* with the EPL NO_x limit of 450 mg/m^3. Refer to Table 4-1 and Figure B-5 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 8.9 to 9.5% and averaged 9.0% during the emission monitoring period. The CO_2 emission concentration ranged from 10.0 to 10.2% and averaged 10.1% during the emission monitoring period. The CO emission concentration ranged from 916 to 1068 mg/m^3 and averaged 981 mg/m^3 during the emission monitoring period.

GENERATOR NO. 3

The O_2 emission concentration ranged from 10.7 to 11.0% and averaged 10.8% during the emission monitoring period. The CO_2 emission concentration ranged from 9.5 to 9.7% and averaged 9.6% during the emission monitoring period. The CO emission concentration ranged from 605 to 796 mg/m^3 and averaged 622 mg/m^3 during the emission monitoring period.

GENERATOR NO. 4

The O_2 emission concentration ranged from 9.3 to 9.9% and averaged 9.5% during the emission monitoring period. The CO_2 emission concentration ranged from 9.2 to 9.6% and averaged 9.4% during the emission monitoring period. The CO emission concentration ranged from 741 to 853 mg/m^3 and averaged 784 mg/m^3 during the emission monitoring period.

GENERATOR NO. 5

The O_2 emission concentration ranged from 8.3 to 8.6% and averaged 8.4% during the emission monitoring period. The CO_2 emission concentration ranged from 10.5 to 10.8% and averaged 10.7% during the emission monitoring period. The CO emission concentration ranged from 883 to 996 mg/m^3 and averaged 922 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 5.0 mg/m^3 which *was 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 7.15 mg/m^3 which *was 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 5.72 mg/m^3 which *was 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.

GENERATOR NO. 5

The SO_3/H_2SO_4 emission concentration measured was 5.87 mg/m^3 which *was 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-5 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 0.35 mg/m^3. The H_2S emission concentration *was 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 0.32 mg/m^3. The H_2S emission concentration *was 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 0.29 mg/m^3. The H_2S emission *was 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.

GENERATOR NO. 5

The H_2S emission concentration measured was less than 0.33 mg/m^3. The H_2S emission *was in compliance* with EPL H_2S limit of 5 mg/m^3. Refer to Table 4-1 and Appendix A, Table A-5 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 3.71 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 3.12 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 less than 3.87 mg/m^3. Table 4-2 provides a summary of the detected VOCs.

GENERATOR NO. 5

The total VOCs emission concentration (as n-propane equivalent) was less than 4.13 mg/m^3. Table 4-2 provides a summary of the detected VOCs.

TABLE 4-2 SUMMARY OF VOCS SUITE – AVERAGE OF SAMPLING RUNS

VOCs	Generator No. 2 Concentration n-Propane equivalent (mg/m³)	Generator No. 3 Concentration n-Propane equivalent (mg/m³)	Generator No. 4 Concentration n-Propane equivalent (mg/m³)	Generator No. 5 Concentration n-Propane equivalent (mg/m³)
Aliphatic Hydrocarbons				
2-Methylbutane	< 0.4745	< 0.3993	< 0.4947	< 0.5277
n-Pentane	< 0.4745	< 0.3993	< 0.4947	< 0.5277
2-Methylpentane	< 0.3972	< 0.3343	< 0.4141	< 0.4418
3-Methylpentane	< 0.3972	< 0.3343	< 0.4141	< 0.4418
Cyclopentane	< 0.4880	< 0.4107	< 0.5088	< 0.5427
Methylcyclopentane	< 0.4068	< 0.3423	< 0.4241	< 0.4524
2,3-Dimethylpentane	< 0.3416	< 0.2875	< 0.3562	< 0.3799
n-hexane	< 0.3971	< 0.3342	< 0.4140	< 0.4416
3-Methylhexane	< 0.3416	< 0.2875	< 0.3562	< 0.3799
Cyclohexane	< 0.4066	< 0.3422	< 0.4239	< 0.4521
Methylcyclohexane	< 0.3486	< 0.2934	< 0.3635	< 0.3877
2,2,4-Trimethylpentane	< 0.2996	< 0.2521	< 0.3124	< 0.3332
n-Heptane	< 0.3416	< 0.2875	< 0.3562	< 0.3799
n-Octane	< 0.2996	< 0.2521	< 0.3124	< 0.3332
n-Nonane	< 0.2668	< 0.2246	< 0.2782	< 0.2968
n-Decane	< 0.2406	< 0.2025	< 0.2508	< 0.2675
n-Undecane	< 0.2189	< 0.1843	< 0.2283	< 0.2435
n-Dodecane	< 0.2009	< 0.1691	< 0.2095	< 0.2234
n-Tridecane	< 0.1857	< 0.1563	< 0.1936	< 0.2065
n-Tetradecane	< 0.1726	< 0.1452	< 0.1799	< 0.1919
α-Pinene	< 0.2512	< 0.2114	< 0.2619	< 0.2794
β-Pinene	< 0.2512	< 0.2114	< 0.2619	< 0.2794
D-Limonene	< 0.2513	< 0.2115	< 0.2620	< 0.2795
Chlorinated Hydrocarbons				
Dichloromethane	< 0.4032	< 0.3393	< 0.4204	< 0.4484
1,1-Dichloroethane	< 0.3458	< 0.2910	< 0.3605	< 0.3845
1,2-Dichloroethane	< 0.3459	< 0.2911	< 0.3607	< 0.3847
Chloroform	< 0.2867	< 0.2413	< 0.2989	< 0.3188
1,1,1-Trichloroethane	< 0.2566	< 0.2160	< 0.2675	< 0.2854
1,1,2-Trichloroethane	< 0.2566	< 0.2160	< 0.2675	< 0.2854
Trichloroethylene	< 0.2605	< 0.2193	< 0.2716	< 0.2897
Carbon tetrachloride	< 0.2226	< 0.1873	< 0.2321	< 0.2475
Perchloroethylene	< 0.2064	< 0.1737	< 0.2152	< 0.2296
1,1,2,2-Tetrachloroethane	< 0.2039	< 0.1716	< 0.2126	< 0.2268

Chlorobenzene	< 0.3040	< 0.2559	< 0.3170	< 0.3381
1,2-Dichlorobenzene	< 0.2329	< 0.1960	< 0.2428	< 0.2590
1,4-Dichlorobenzene	< 0.2329	< 0.1960	< 0.2428	< 0.2590
Miscellaneous				
Acetonitrile	< 0.8339	< 0.7018	< 0.8694	< 0.9274
n-Vinyl-2-pyrrolidinone	< 1.5401	< 1.2961	< 1.6057	< 1.7127
Benzene				
Ethylbenzene	< 0.0877	< 0.0738	< 0.0914	< 0.0975
Isopropylbenzene	< 0.0645	< 0.0543	< 0.0672	< 0.0717
1,2,3-Trimethylbenzene	< 0.0570	< 0.0479	< 0.0594	< 0.0633
1,2,4-Trimethylbenzene	< 0.0570	< 0.0479	< 0.0594	< 0.0633
1,3,5-Trimethylbenzene	< 0.0570	< 0.0479	< 0.0594	< 0.0633
Styrene	< 0.0570	< 0.0479	< 0.0594	< 0.0633
Toluene	< 0.0657	< 0.0553	< 0.0685	< 0.0731
p-Xylene &/or m-Xylene	< 0.0743	< 0.0625	< 0.0775	< 0.0826
o-Xylene	< 0.0645	< 0.0543	< 0.0672	< 0.0717
Ketones	< 0.0645	< 0.0543	< 0.0672	< 0.0717
Acetone				
Acetoin	< 0.5894	< 0.4960	< 0.6145	< 0.6555
Diacetone alcohol	< 1.9426	< 1.6349	< 2.0253	< 2.1604
Cyclohexanone	< 1.4735	< 1.2401	< 1.5363	< 1.6387
Isophorone	< 1.7430	< 1.4669	< 1.8172	< 1.9384
Methyl ethyl ketone (MEK)	< 1.2384	< 1.0423	< 1.2912	< 1.3773
Methyl isobutyl ketone (MIBK)	< 0.4748	< 0.3996	< 0.4950	< 0.5280
Ethyl alcohol	< 0.3418	< 0.2876	< 0.3563	< 0.3801
n-Butyl alcohol				
Isobutyl alcohol	< 3.7129	< 3.1248	< 3.8710	< 4.1291
Isopropyl alcohol	< 2.3086	< 1.9430	< 2.4070	< 2.5674
2-Ethyl hexanol	< 2.3099	< 1.9440	< 2.4083	< 2.5688
Cyclohexanol	< 2.8480	< 2.3969	< 2.9693	< 3.1672
Ethyl acetate	< 1.3143	< 1.1061	< 1.3703	< 1.4616
n-Propyl acetate	< 1.7082	< 1.4376	< 1.7810	< 1.8997
n-Butal acetate				
Isobutyl acetate	< 1.9424	< 1.6347	< 2.0251	< 2.1601
Ethyl ether	< 1.6764	< 1.4109	< 1.7478	< 1.8644
teri-Butyl methyl ether (MTBE)	< 1.4730	< 1.2397	< 1.5357	< 1.6381
Tetrahydrofuran (THF)	< 1.4730	< 1.2397	< 1.5357	< 1.6381
Glycols				

PGME	< 2.3099	< 1.9440	< 2.4083	< 2.5688
Ehylene glycol diethyl ether	< 1.9417	< 1.6342	< 2.0244	< 2.1594
PGMEA	< 2.3733	< 1.9974	< 2.4744	< 2.6394
Cellosolve acetate				
DGMEA	< 1.8993	< 1.5984	< 1.9802	< 2.1122
Sum of Reported VOCs	< 1.4483	< 1.2189	< 1.5100	< 1.6107

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, 4 and 5 at the Woodlawn Landfill gas fired power plant, the following conclusion can be drawn:

- The emissions from all four Generators 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
^{o}C	=	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 $0^{0}C$ and 1 atmosphere
mg	=	milligrams
mg/ m^3	=	milligrams per cubic metre at $0^{o}C$ 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
AN	=	Ali Naghizadeh
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	5211	5211
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator 2 - EPA Point 8	Generator 2 - EPA Point 8
Date	11-Jun-13	11-Jun-13
RUN	1	1
Sample Start Time (hrs)	14:00	12:55
Sample Finish Time (hrs)	15:00	15:46
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (°C)	464.0	464.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	44.9	44.5
Actual Gas Flow Volume (am^3/min)	259	257
Total Normal Gas Flow Volume (m^3/min)	91	95
Total Normal Gas Flow Volume (m^3/sec)	1.52	1.58
Total Stack Pressure (kPa)	100.89	100.89
Analysis	SO3/H2SO4	H2S
Method	TM-3	USEPA M11
SEMA Lab Number	722717	722721
Mass In Sample (mg)	5.00	< 0.1
Air Volume Sampled (am^3)	1.04	0.30
Normal Sample Volume (m^3)	1.00	0.29
Concentration at Stack O_2 (mg/m³)	5.00	< 0.346
Mass Emission Rate (g/s)	0.0076	< 0.0005
Moisture Content (% by volume)	5.0	NA
Molecular Weight Dry Stack Gas (g/g-mole)	29.976	29.976
Dry Gas Density (kg/m^3)	1.34	1.34
EPL Limit (mg/m³)	100	5
Isokinetic Sampling Rate (%)	98.6	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM, AP	PWS, JW, AM, AP
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	AP	AP
Calculations Checked by	JW	JW

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

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5221	5221
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator 3 - EPA Point 9	Generator 3 - EPA Point 9
Date	12-Jun-13	12-Jun-13
RUN	1	1
Sample Start Time (hrs)	10:55	9:07
Sample Finish Time (hrs)	11:55	12:07
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (°C)	476.0	476.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	51.3	50.6
Actual Gas Flow Volume (am^3/min)	296	292
Total Normal Gas Flow Volume (m^3/min)	100	106
Total Normal Gas Flow Volume (m^3/sec)	1.66	1.76
Total Stack Pressure (kPa)	100.78	100.78
Analysis	SO3/H2SO4	H2S
Method	TM-3	USEPA M11
SEMA Lab Number	722718	722722
Mass In Sample (mg)	8.00	< 0.1
Air Volume Sampled (am^3)	1.15	0.32
Normal Sample Volume (m^3)	1.12	0.31
Concentration at Stack O_2 (mg/m^3)	7.15	< 0.323
Mass Emission Rate (g/s)	0.01	< 0.0006
Moisture Content (% by volume)	7.1	NA
Molecular Weight Dry Stack Gas (g/g-mole)	29.968	29.992
Dry Gas Density (kg/m^3)	1.34	1.34
EPL Limit (mg/m^3)	100	5
Isokinetic Sampling Rate (%)	100.4	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM, AP	PWS, JW, AM, AP
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	AP	AP
Calculations Checked by	JW	JW

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

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5211	5211
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator 4	Generator 4
Date	12-Jun-13	12-Jun-13
RUN	1	1
Sample Start Time (hrs)	9:55	9:15
Sample Finish Time (hrs)	10:55	12:15
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (^oC)	436.0	436.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	52.9	52.4
Actual Gas Flow Volume (am^3/min)	305	303
Total Normal Gas Flow Volume (m^3/min)	112	116
Total Normal Gas Flow Volume (m^3/sec)	1.87	1.94
Total Stack Pressure (kPa)	101.16	101.16
Analysis	SO3/H2SO4	H2S
Method	TM-3	USEPA M11
SEMA Lab Number	722719	722723
Mass In Sample (mg)	7.00	< 0.1
Air Volume Sampled (am^3)	1.26	0.35
Normal Sample Volume (m^3)	1.22	0.34
Concentration at Stack O_2 (mg/m^3)	5.72	< 0.291
Mass Emission Rate (g/s)	0.01	< 0.0006
Moisture Content (% by volume)	4.6	NA
Molecular Weight Dry Stack Gas (g/g-mole)	29.884	29.884
Dry Gas Density (kg/m^3)	1.33	1.33
EPL Limit (mg/m^3)	100	5
Isokinetic Sampling Rate (%)	98.2	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	PWS, JW, AM, AP	PC, AN
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	AP	AP
Calculations Checked by	JW	JW

TABLE A - 4 DETAILED EMISSION TEST RESULTS – GENERATOR NO. 5

Emission Test Results	**SO_3/H_2SO_4**	**H_2S**
Project Number	5211	5211
Project Name	Veolia Environmental Services	Veolia Environmental Services
Test Location	Generator 1 - EPA Point 7	Generator 1 - EPA Point 7
Date	13-Jun-13	13-Jun-13
RUN	1	1
Sample Start Time (hrs)	9:00	7:57
Sample Finish Time (hrs)	10:00	10:57
Sample Location (Inlet/Exhaust)	Exhaust	Exhaust
Stack Temperature (°C)	474.0	474.0
Stack Cross-Sectional area (m^2)	0.096	0.096
Average Stack Gas Velocity (m/s)	46.8	46.3
Actual Gas Flow Volume (am^3/min)	270	267
Total Normal Gas Flow Volume (m^3/min)	93	97
Total Normal Gas Flow Volume (m^3/sec)	1.55	1.62
Total Stack Pressure (kPa)	100.83	100.83
Analysis	SO3/H2SO4	H2S
Method	TM-3	USEPA M11
SEMA Lab Number	722720	722724
Mass In Sample (mg)	6.00	< 0.1
Air Volume Sampled (am^3)	1.05	0.31
Normal Sample Volume (m^3)	1.02	0.31
Concentration at Stack O_2 (mg/m³)	5.87	< 0.327
Mass Emission Rate (g/s)	0.01	< 0.0005
Moisture Content (% by volume)	5.5	NA
Molecular Weight Dry Stack Gas (g/g-mole)	30.048	30.048
Dry Gas Density (kg/m^3)	1.34	1.34
EPL Limit (mg/m³)	100	5
Isokinetic Sampling Rate (%)	98.6	NA
Sample Storage Period	Consumed in Analysis	Consumed in Analysis
Sampling Performed by	JW, AM	JW, AM
Sample Analysed by (Laboratory)	ALS	ALS
Calculations Entered by	AP	AP
Calculations Checked by	JW	JW

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 – 11 JUNE 2013

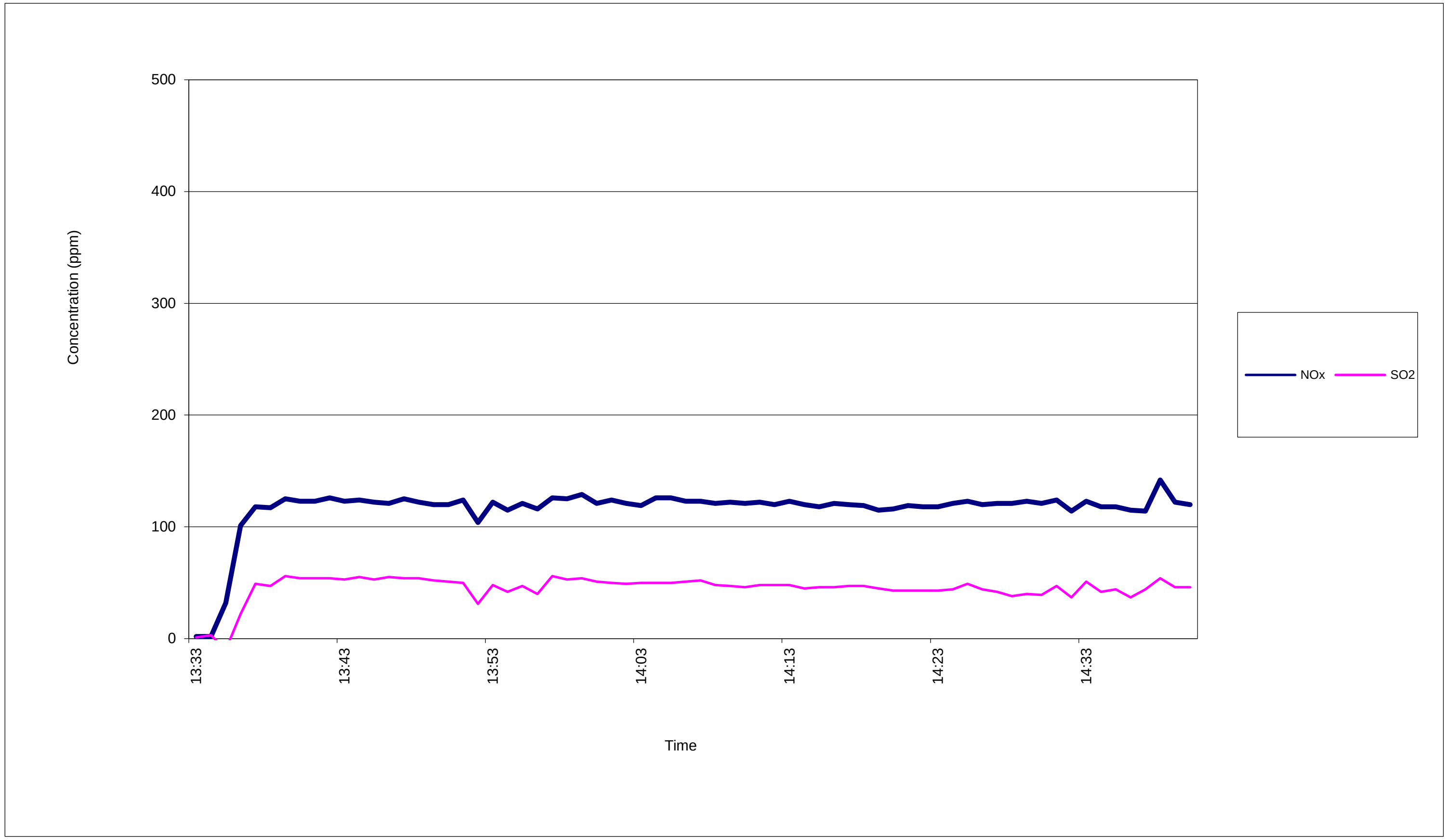


FIGURE B - 2 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 3 – 12 JUNE 2013

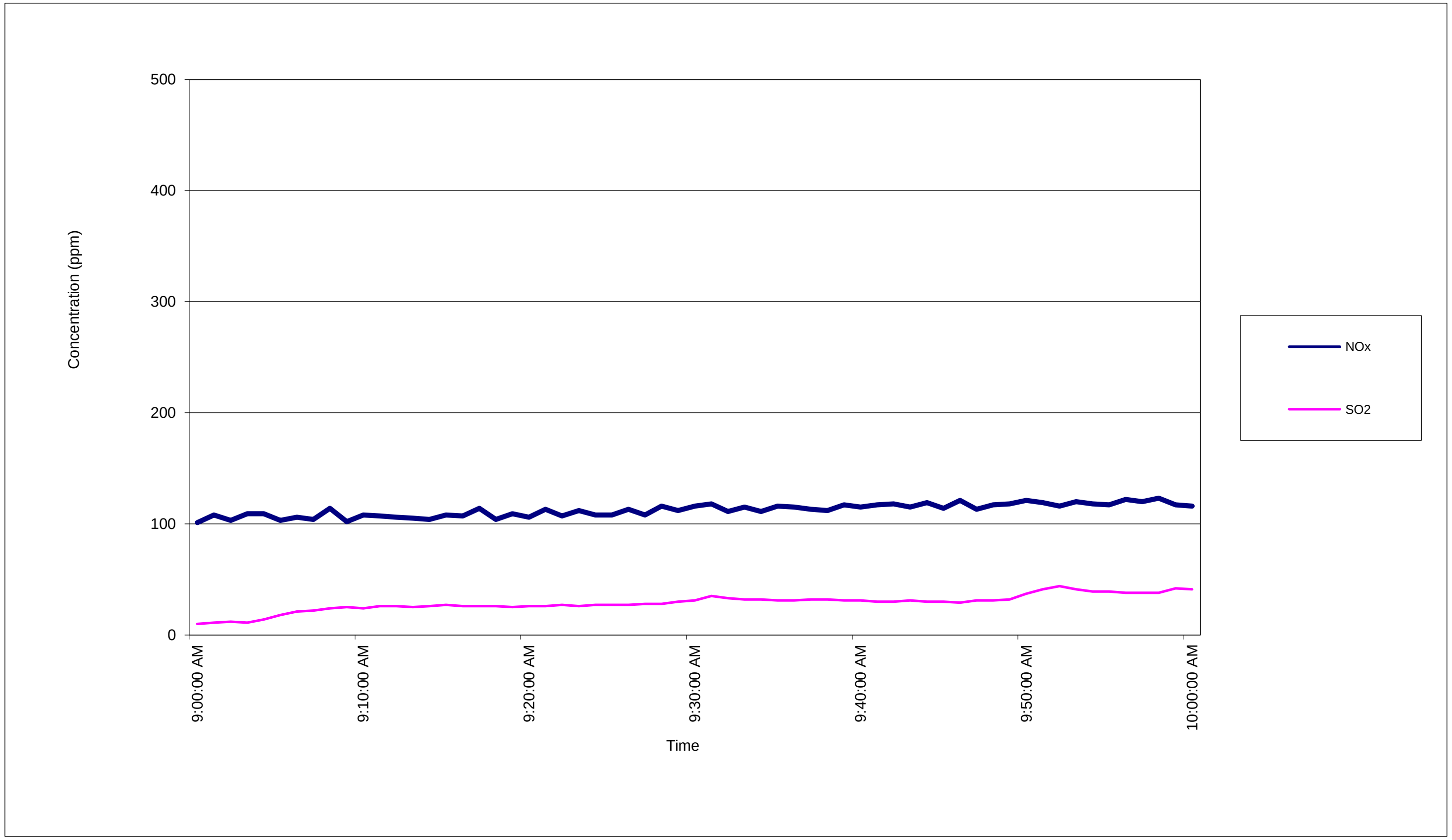


FIGURE B - 3 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 4 – 12 JUNE 2013

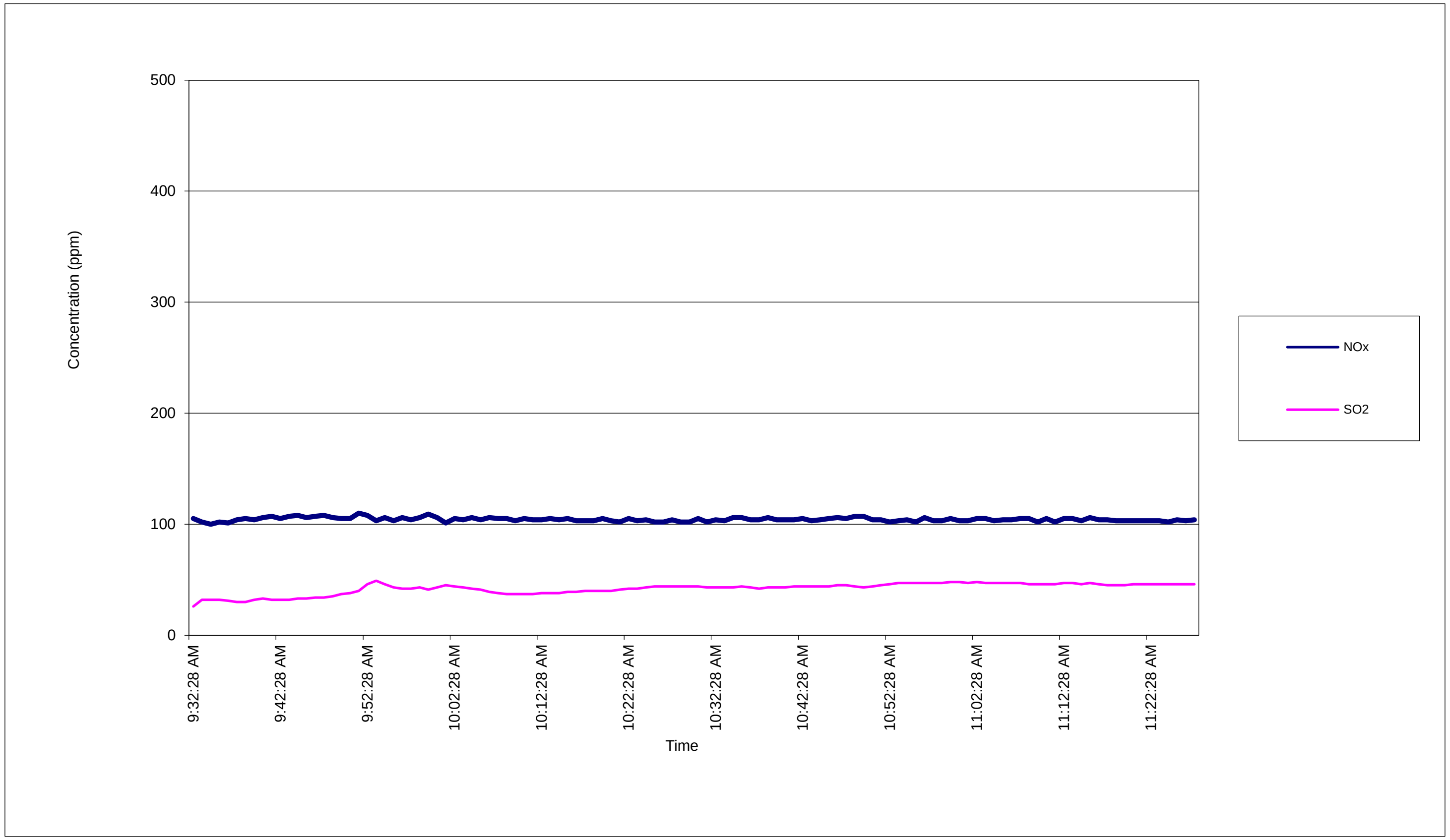
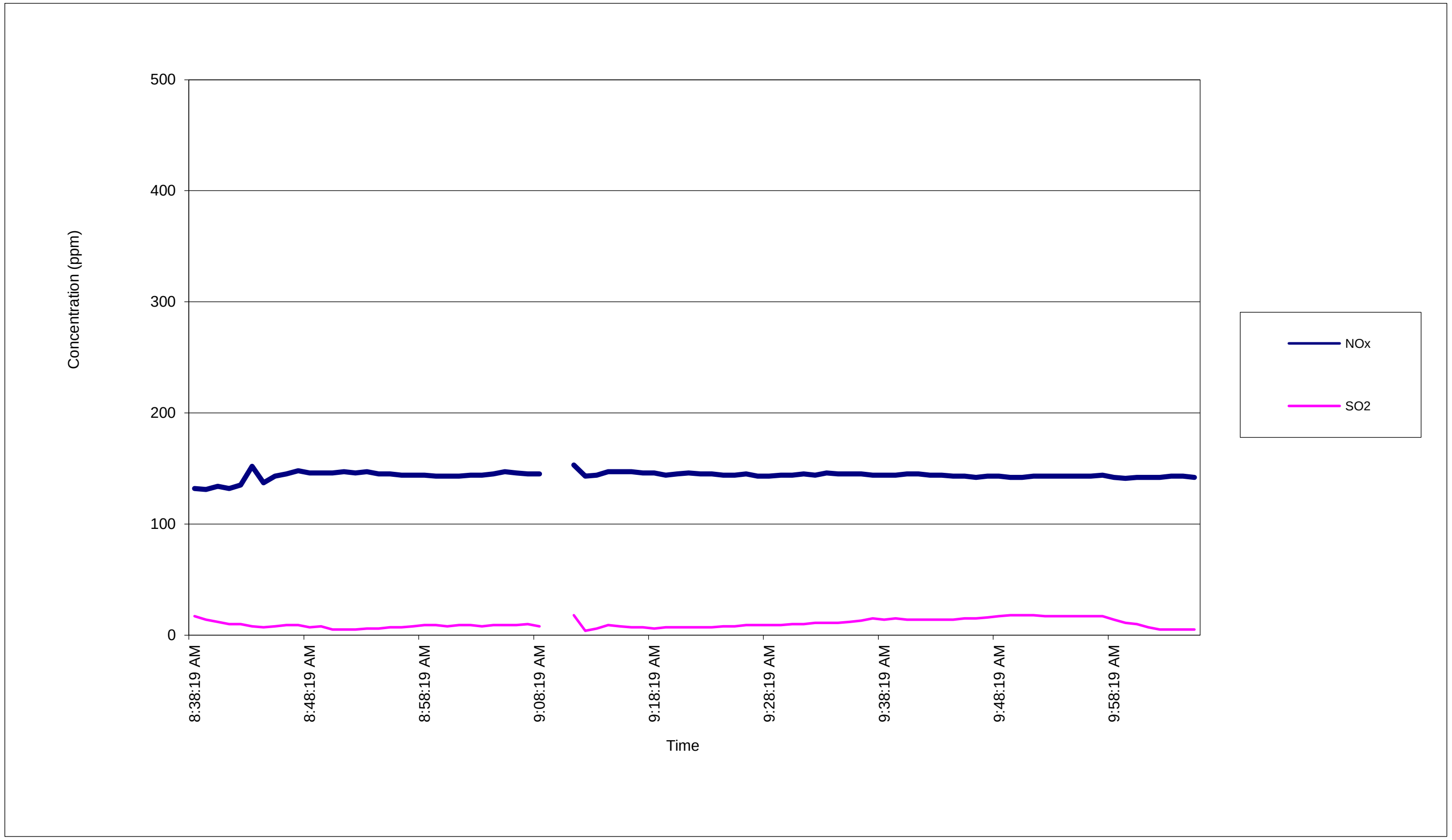


FIGURE B - 4 CONTINUOUS LOGGED RECORD OF SULPHUR DIOXIDE AND OXIDES OF NITROGEN – GENERATOR NO. 5 – 13 JUNE 2013



APPENDIX C – NATA EMISSION TEST REPORT INCLUDING CERTIFICATES OF ANALYSIS

Stephenson
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Fax: (02) 9737 9993
E-Mail: info@stephensonenv.com.au

Emission Test Report No. 5211

The sampling and analysis was commissioned by:

Client	Organisation:	Veolia Environmental Services
	Contact:	James Easterbrook
	Address:	610 Collector Road, Tarago, NSW 2850
	Telephone:	02 4844 6353
	Facsimile:	02 4844 6355
	Project Number:	5211/S22403/13
	Test Date(s):	11 - 13 June 2013
	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:	Generator Nos.2, 3,4 & 5 Stacks
	Sample ID Nos.:	Refer to Attachment A

NATA accredited laboratory number 15043.
Accredited for Compliance with ISO/IEC 17025.
This document is issued in accordance with NATA's accreditation requirements.
This report cannot be reproduced unless in full.

NATA
WORLD RECOGNISED ACCREDITATION

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.

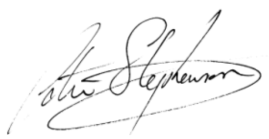
Test	*Test Method Number for Sampling and Analysis*	*NATA Laboratory Analysis By: NATA Accreditation No. & Report No.*
Carbon Dioxide	TM-24, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report 5211
Carbon Monoxide	TM-32, USEPA M10	SEMA, Accreditation No. 15043, Emission Test Report 5211
Dry Gas Density	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5211
Flow	NSW TM-2, USEPA M2A, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5211
Hydrogen Sulphide	NSW TM-5, USEPA M11	ALS Environmental, Accreditation No. 825, Report No. EN1302226
Moisture	NSW TM-22, USEPA M4	SEMA, Accreditation No. 15043, Emission Test Report 5211
Molecular Weight of Stack Gases	NSW TM-23, USEPA M3	SEMA, Accreditation No. 15043, Emission Test Report 5211
Oxides of Nitrogen	NSW TM-11, USEPA M7E	SEMA, Accreditation No. 15043, Emission Test Report 5211
Oxygen	NSW TM-25, USEPA M3A	SEMA, Accreditation No. 15043, Emission Test Report 5211
Stack Temperature	NSW TM-2, USEPA M2, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5211
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. EN132226
Velocity	NSW TM-2, USEPA M2A, 2C	SEMA, Accreditation No. 15043, Emission Test Report 5211
Volatile Organic Compounds	NSW TM-34, USEPA M18	WorkCover, Accreditation No. 3726, Report No. 2013-1280

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
28 June 2013



P W Stephenson
Managing Director

SUMMARY OF THE AVERAGE EMISSION RESULTS – TEST REPORT NO. 5211

Pollutant	Units	Generator No. 2 EPL Point 8-2	Generator No. 3 EPL Point 8-3	Generator No. 4 EPL Point 8-4	Generator No. 5 EPL Point 8-5
		11/6/2013	12/6/2013	12/6/2013	13/6/2013
Dry Gas Density	kg/m³	1.34	1.34	1.33	1.34
Moisture content	%	5.0	7.1	4.6	5.5
Molecular weight of stack gases	g/g mole	29.976	29.992	29.884	30.048
Temperature	°C	464	476	436	474
Velocity	m/s	45.0	51.3	52.9	46.8
Volumetric Flow Rate	m³/s	1.51	1.66	1.87	1.55
Carbon Dioxide	%	10.1	9.6	9.4	10.7
Carbon Monoxide	mg/m³	981	622	784	922
Hydrogen Sulphide	mg/m³	< 0.346	< 0.323	<0.291	< 0.327
Nitrogen Oxides @ 7% O_2	mg/m³	296	323	267	318
Oxygen (O_2)	%	9.0	10.8	9.5	8.4
Sulphur Trioxide / Sulphuric Acid Mist	mg/m³	5.00	7.15	5.72	5.87
Sulphur Dioxide	mg/m³	136	83	121	30
Volatile Organic Compounds	mg/m³	<3.71	<3.12	<3.87	<4.13

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 Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EN1302226**	Page	: 1 of 4
Client	: **STEPHENSON ENVIRONMENTAL MANAGEMENT AUSTRALIA**	Laboratory	: Environmental Division Newcastle
Contact	: MR PETER STEPHENSON	Contact	: Peter Keyte
Address	: UNIT 7/2 HOLKER STREET NEWINGTON NSW, AUSTRALIA 2127	Address	: 5 Rosegum Road Warabrook NSW Australia 2304
E-mail	: peter@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	: 5211	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: 3905		
C-O-C number	: ----	Date Samples Received	: 18-JUN-2013
Sampler	: ----	Issue Date	: 26-JUN-2013
Site	: ----		
		No. of samples received	: 10
Quote number	: SY/484/12	No. of samples analysed	: 10

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

Address 5 Rosegum Road Warabrook NSW Australia 2304 | PHONE +61-2-4968 9433 | Facsimile +61-2-4968 0349
Environmental Division Newcastle ABN 84 009 936 029 Part of the ALS Group An ALS Limited Company

Environmental www.alsglobal.com

RIGHT SOLUTIONS RIGHT PARTNER

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.

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 for samples EN1302226-006, -007 & -008.**
- **Particular samples required dilution prior to analysis due to matrix interferences. LOR values have been adjusted accordingly.**

Work Order : EN1302226
Client : STEPHENSON ENVIRONMENTAL MANAGEMENT AUSTRALIA
Project : 5211

Analytical Results

Sub-Matrix: IMPINGER SOLUTION (Matrix: AIR)			Client sample ID	722717	722718	722719	722720	722725
			Client sampling date / time	11-JUN-2013 15:00	12-JUN-2013 15:00	12-JUN-2013 15:00	13-JUN-2013 15:00	13-JUN-2013 15:00
Compound	CAS Number	LOR	Unit	EN1302226-001	EN1302226-002	EN1302226-003	EN1302226-004	EN1302226-005
EA143C: Sulfuric Acid and Sulfur Dioxide (as SO3)								
Volume - Impinger	----	1	mL	375	352	377	367	132
Sulfuric Acid as SO3	----	2	mg/sample	5	8	7	6	<2

Analytical Results

Sub-Matrix: IMPINGER SOLUTION (Matrix: AIR)			Client sample ID	722721	722722	722723	722724	722726
			Client sampling date / time	11-JUN-2013 15:00	12-JUN-2013 15:00	12-JUN-2013 15:00	13-JUN-2013 15:00	13-JUN-2013 15:00
Compound	CAS Number	LOR	Unit	EN1302226-006	EN1302226-007	EN1302226-008	EN1302226-009	EN1302226-010
EK089: Hydrogen Sulfide in Stack Testing Solutions								
Hydrogen Sulphide	7783-06-4	0.1	mg/sample	<0.1	<0.1	<0.1	<0.1	<0.1
Volume - Impinger	----	1	mL	53	51	55	57	40

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Environmental Division
Newcastle
Work Order
EN1302226
Telephone : +61-2-4968 9433

Chain of Custody & Analysis Request

Document No: S22621
Project No: 5211
Purchase Order No.: 3905
Purchase Results Required By: Normal
Lab Name: ALS Newcastle
Lab Telephone: 02 4968 9433 Lab Facsimile: 02 4968 0349
Lab Contact Name: Sample Receipts / Peter Keyte

	Location	Sampling Date	Sample ID	Lab Sample ID	Parameter	NSW Test Method	USEPA Method		Temperature Chilled/ Ambient
1	G2	11/6/2013	722717		SO_3 / H_2SO_4	TM-3	USEPA M8		Ambient
2	G3	12/6/2013	722718		SO_3 / H_2SO_4	TM-3	USEPA M8		Ambient
3	G4	12/6/2013	722719		SO_3 / H_2SO_4	TM-3	USEPA M8		Ambient
4	G5	13/6/2013	722720		SO_3 / H_2SO_4	TM-3	USEPA M8		Ambient
5	Blank	13/6/2013	722725		SO_3 / H_2SO_4	TM-3	USEPA M8		Ambient

Relinquished By: Alok Pradhan Date/Time: 17/06/2013 @ 9:00 Received By: [illegible] Date/Time: 18 / 6 /2013 @ 1520
Samples Sent Intact: YES [signature] Samples Received Intact: YES / NO

Comments: **Please contact us immediately should you have any questions with regards to the samples or analysis or if there will be any delays with the reporting.**

P: QUALITY SYSTEMS/FORMS/SITE WORK
ISSUE DATE: 12 AUGUST 2009
VERSION: 1.3
PAGE 1 of 2

Stephenson
Environmental Management Australia

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info@stephensonenv.com.au
peter@stephensonenv.com.au

Chain of Custody & Analysis Request

Document No: S22621

Project No: 5211

Purchase Order No.: 3905

Purchase Results Required By: Normal

Lab Name: ALS Newcastle

Lab Telephone: 02 4968 9433 Lab Facsimile: 02 4968 0349

Lab Contact Name: Sample Receipts / Peter Keyte

	Location	Sampling Date	Sample ID	Lab Sample ID	Parameter	NSW Test Method	USEPA Method		Temperature Chilled/ Ambient
6	G2	11/6/2013	722721		H_2S	TM-5	USEPA M11		Ambient
7	G3	12/6/2013	722722		H_2S	TM-5	USEPA M11		Ambient
8	G4	12/6/2013	722723		H_2S	TM-5	USEPA M11		Ambient
9	G5	13/6/2013	722724		H_2S	TM-5	USEPA M11		Ambient
10	Blank	13/6/2013	722726		H_2S	TM-5	USEPA M11		Ambient

Relinquished By: Alok Pradhan | Date/Time: 17/06/2013 @ 9:00 | Received By: KL | Date/Time: 18/6 /20123@ 1150am

Samples Sent Intact: YES | Samples Received Intact: YES / NO

Comments: **Please contact us immediately should you have any questions with regards to the samples or analysis or if there will be any delays with the reporting.**

P: QUALITY SYSTEMS/FORMS/SITE WORK
ISSUE DATE: 12 AUGUST 2009

VERSION: 1.3
PAGE 2 of 2

Test Safe AUSTRALIA
'Safety is no Accident'

CHEMICAL ANALYSIS BRANCH

WorkCover NEW SOUTH WALES

Alok Pradhan
Stephenson Environmental Management Australia
Unit 7/2 Holker Street
NEWINGTON NSW 2127

Lab. Reference: 2013-1280

SAMPLE ORIGIN: Project No. 5211

DATE OF INVESTIGATION: Not Stated **DATE RECEIVED:** 14/06/13

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: 25/06/13

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

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NSW GOVERNMENT | WorkCover

Test Safe AUSTRALIA

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

Client : Alok Pradhan
Sample ID : 722727

Sample : 2013-1280-1F

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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Accreditation No. 3726

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TestSafe Australia – WorkCover NSW *Chemical Analysis Branch*
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Telephone: 61 2 9473 4000 Facsimile: 61 2 9980 6849 Email: lab@workcover.nsw.gov.au
Website: testsafe.com.au/chemical.asp WorkCover Assistance Service: 13 10 50

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Test Safe AUSTRALIA

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

Client : Alok Pradhan

Sample ID : 722728 **Sample : 2013-1280-2F**

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

Accreditation No. 3726

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Test Safe AUSTRALIA

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

Client : Alok Pradhan
Sample ID : 722729

Sample : 2013-1280-3F

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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TestSafe AUSTRALIA

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

Client : Alok Pradhan

Sample ID : 722730 **Sample : 2013-1280-4F**

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

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Test Safe AUSTRALIA

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

Client : Alok Pradhan

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.

Total Volatile Organic Compounds (TVOC) test result in µg/section is calculated by comparison to the average mass detector response of the 73 quantified compounds. The response of a mass detector is dependent on the fragmentation of the molecule. 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 less than the addition of the total amount of the 73 quantified compounds then the TVOC result is of little value other than for comparative purposes. 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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Stephenson
Environmental Management Australia

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

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Unit 7/2 Holker Street
Newington NSW 2127 Australia
Tel: (02) 9737 9991
Fax: (02) 9737 9993
e-mail:
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info@stephensonenv.com.au
peter@stephensonenv.com.au

Chain of Custody & Analysis Request

Document No: S22622

Project No: 5211

Purchase Order No.: 3906

Purchase Results Required By: Normal

Lab Name: Workcover (TestSafe) Australia

Lab Telephone: 02 9473 4000 Lab Facsimile: 02 9980 6849

Lab Contact Name: Sample Receipts

Location	Sampling Date	Sample ID	Lab Sample ID	Parameter	NSW Test Method	Workcover Method		Temperature Chilled/ Ambient
G2	11/6/2013	722727		VOC Scan	TM-34	WCA.207		Ambient
G3	12/6/2013	722728		VOC Scan	TM-34	WCA.207		Ambient
G4	12/6/2013	722729		VOC Scan	TM-34	WCA.207		Ambient
G5	13/6/2013	722730		VOC Scan	TM-34	WCA.207		Ambient

Relinquished By: Alok Pradhan	Date/Time: 14 /6/2013 @ 11:00	Received By:	Date/Time: / /2013 @
Samples Sent Intact: YES		Samples Received Intact: YES / NO	

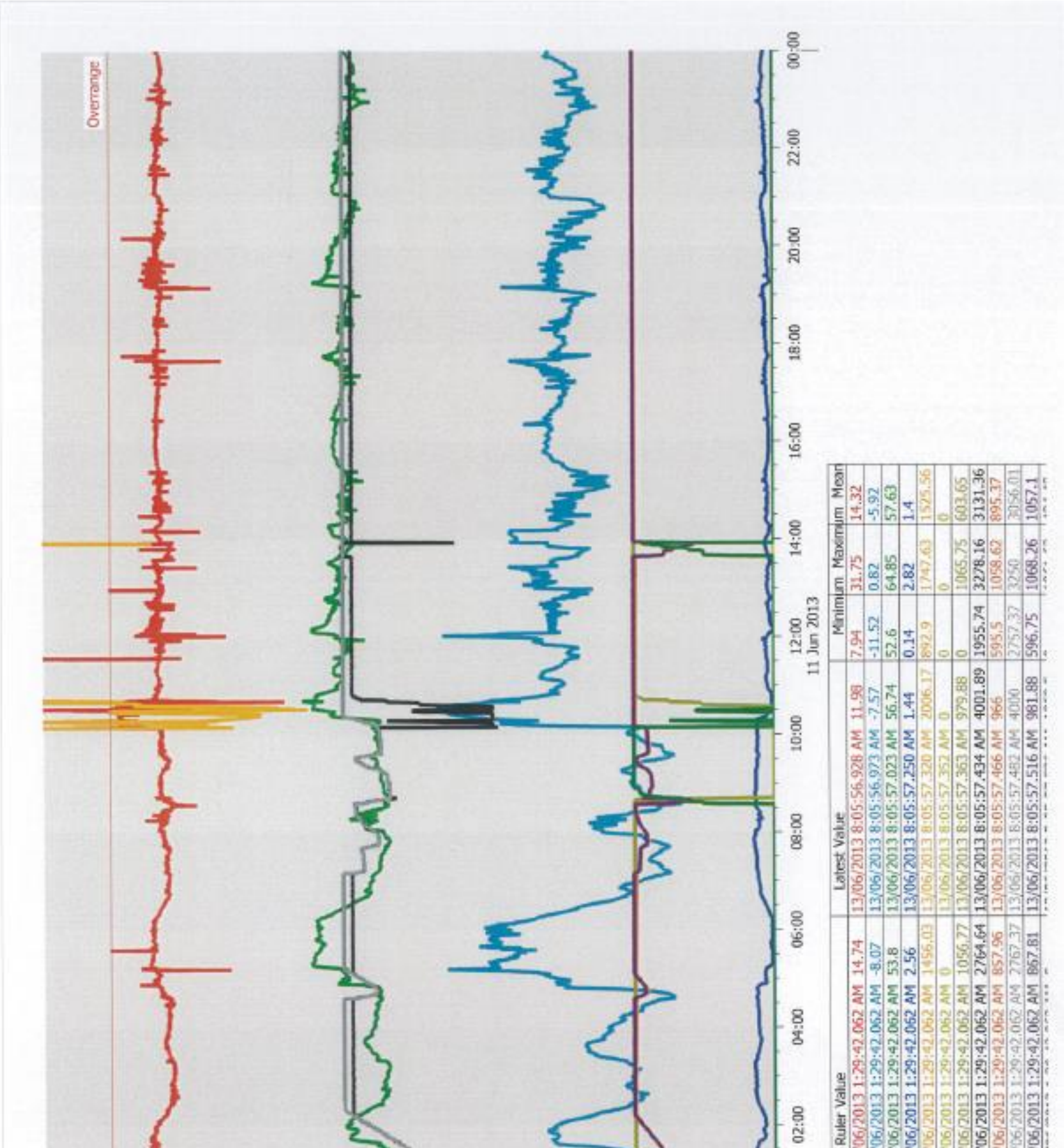
Comments: **Please contact us immediately should you have any questions with regards to the samples or analysis or if there will be any delays with the reporting.**

P: QUALITY SYSTEMS/FORMS/SITE WORK
ISSUE DATE: 12 AUGUST 2009

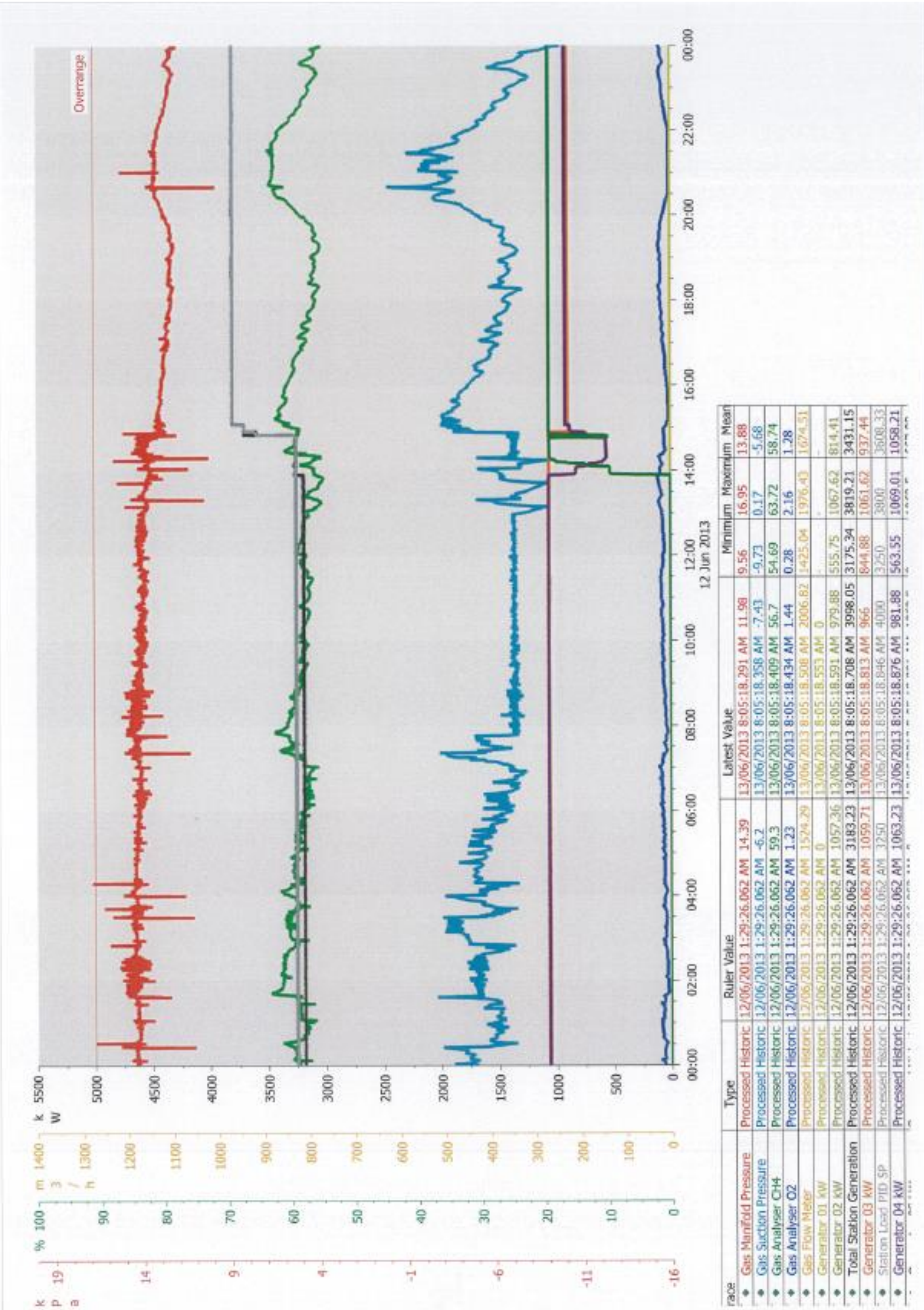
VERSION: 1.3
PAGE 1 of 1

APPENDIX D – PRODUCTION RECORDS

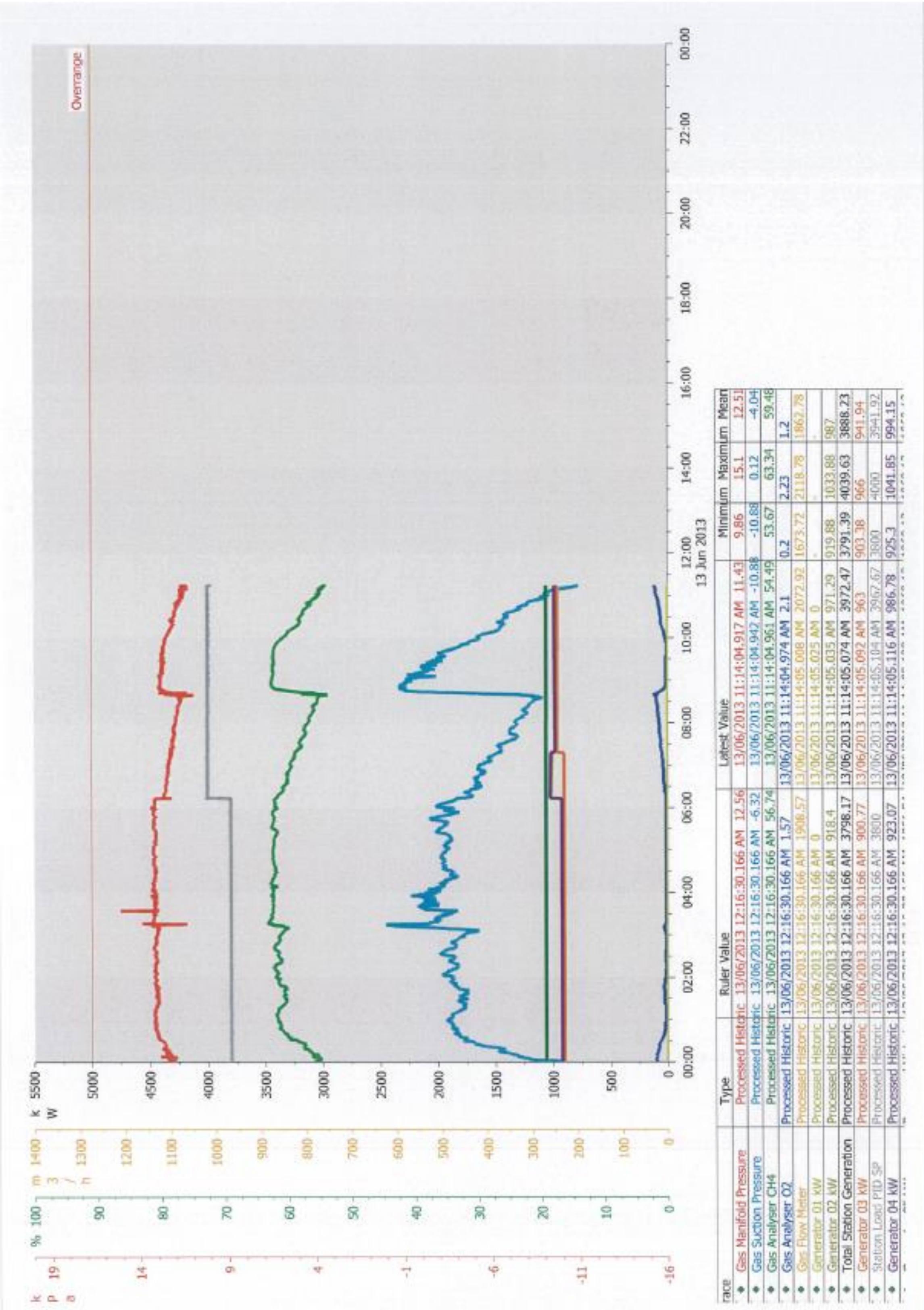
GENERATORS 2, 3, 4 & 5 PRODUCTION DATA - 11 JUNE 2013



GENERATORS 2, 3, 4 & 5 PRODUCTION DATA 12 JUNE 2013

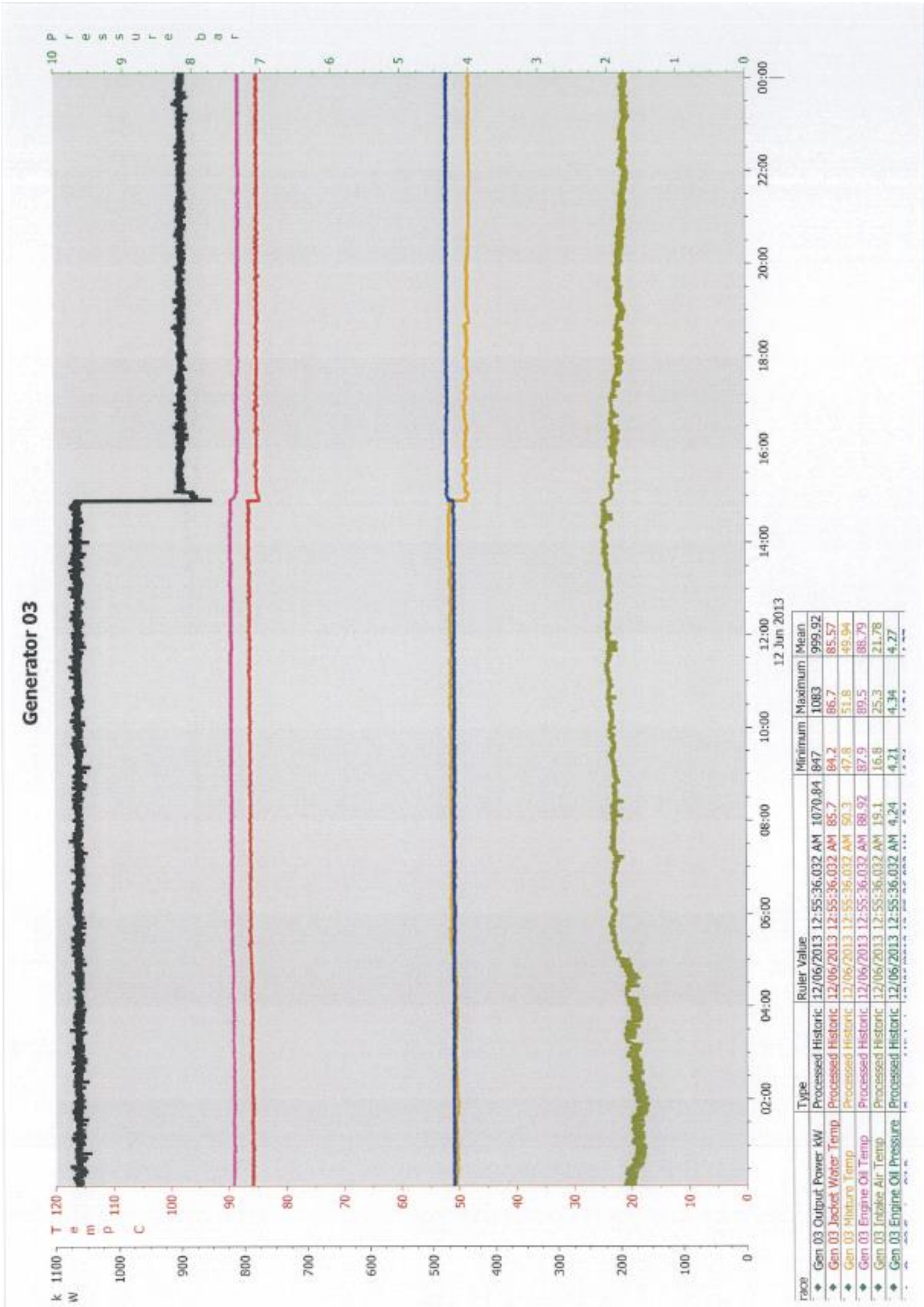


GENERATORS 2, 3, 4 & 5 PRODUCTION DATA 13 JUNE 2013

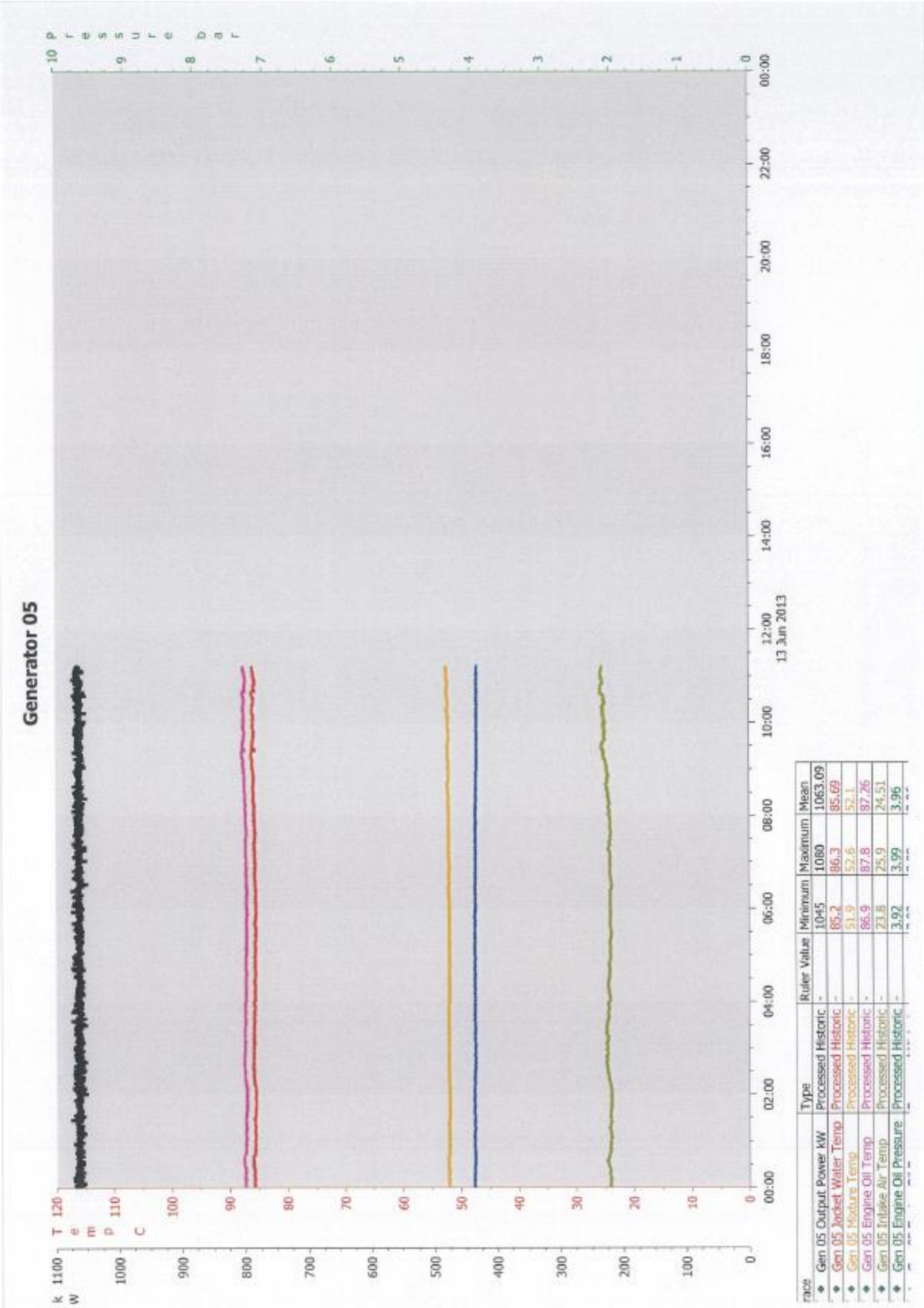


race	Type	Ruler Value	Latest Value	Minimum	Maximum	Mean
Gas Manifold Pressure	Processed Historic	13/06/2013 12:16:30.166 AM 12.56	13/06/2013 11:14:04.917 AM 11.43	9.86	15.1	12.51
Gas Suction Pressure	Processed Historic	13/06/2013 12:16:30.166 AM -6.32	13/06/2013 11:14:04.942 AM -10.88	-10.88	0.12	-4.04
Gas Analyser CH4	Processed Historic	13/06/2013 12:16:30.166 AM 56.74	13/06/2013 11:14:04.961 AM 54.49	53.67	63.34	59.48
Gas Analyser O2	Processed Historic	13/06/2013 12:16:30.166 AM 1.57	13/06/2013 11:14:04.974 AM 2.1	0.2	2.23	1.2
Gas Flow Meter	Processed Historic	13/06/2013 12:16:30.166 AM 1908.57	13/06/2013 11:14:05.008 AM 2072.92	1673.72	2118.78	1862.78
Generator 01 kW	Processed Historic	13/06/2013 12:16:30.166 AM 0	13/06/2013 11:14:05.025 AM 0	-	-	-
Generator 02 kW	Processed Historic	13/06/2013 12:16:30.166 AM 918.4	13/06/2013 11:14:05.035 AM 971.29	919.88	1033.88	987
Total Station Generation	Processed Historic	13/06/2013 12:16:30.166 AM 3798.17	13/06/2013 11:14:05.074 AM 3972.47	3791.39	4039.63	3888.23
Generator 03 kW	Processed Historic	13/06/2013 12:16:30.166 AM 900.77	13/06/2013 11:14:05.092 AM 963	903.38	966	941.94
Station Load PID SP	Processed Historic	13/06/2013 12:16:30.166 AM 3800	13/06/2013 11:14:05.104 AM 3967.67	3800	4000	3941.92
Generator 04 kW	Processed Historic	13/06/2013 12:16:30.166 AM 923.07	13/06/2013 11:14:05.116 AM 986.78	925.3	1041.85	994.15

GENERATOR 3 PRODUCTION DATA 12 JUNE 2013



GENERATOR 5 PRODUCTION DATA -13 JUNE 2013



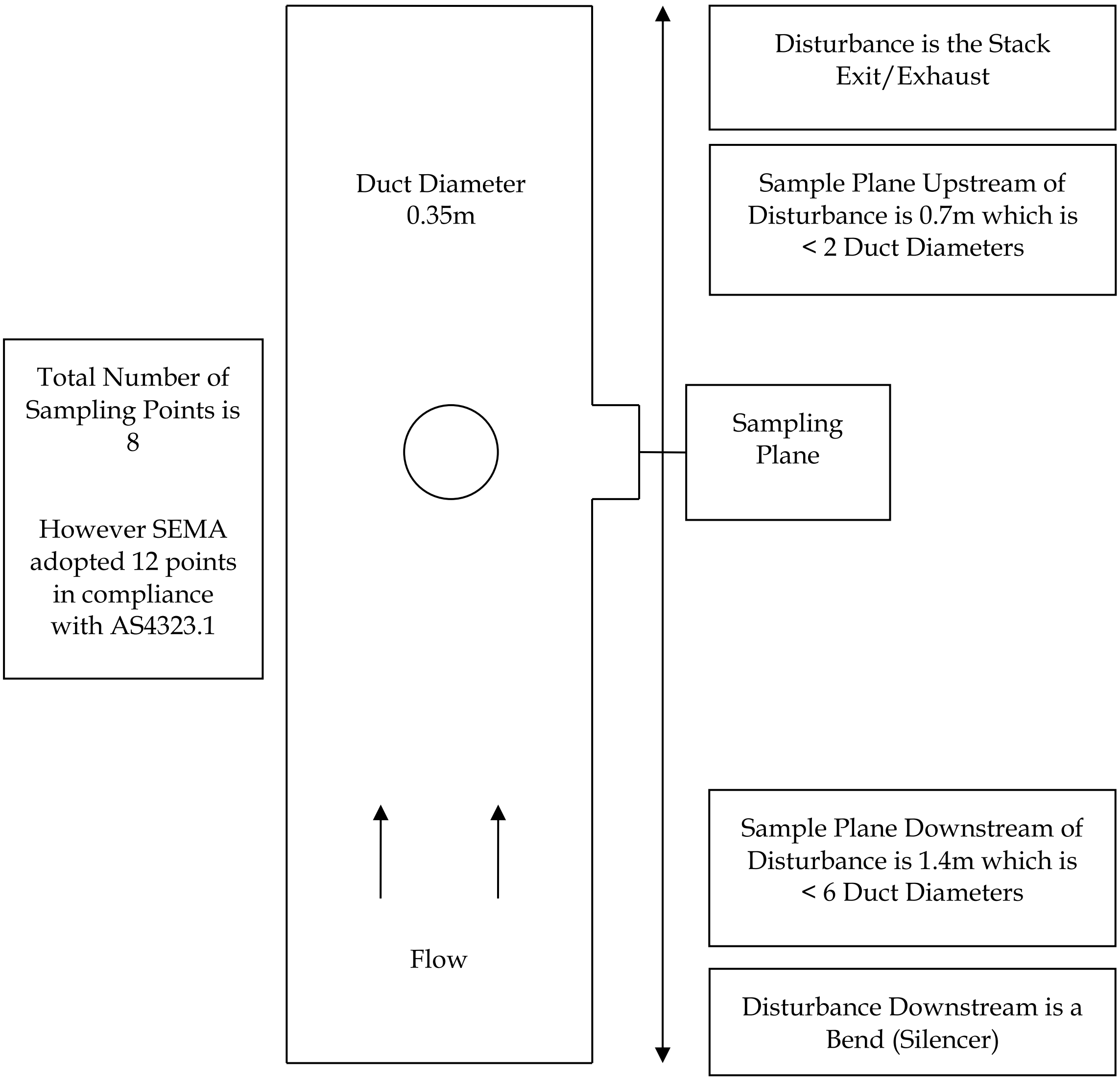
APPENDIX E – INSTRUMENT CALIBRATION INFORMATION

TABLE E - 1 INSTRUMENT CALIBRATION DETAILS

SEMA Asset No.	Equipment Description	Date Last Calibrated	Calibration Due Date
815	Digital Manometer	22-Jun-12	22-Jun-13
726	Pitot	20-Jul-12	20-Jul-2013 Visually inspected On-Site before use
858	Digital Temperature Reader	07-Mar-13	07-Sep-13
863	Thermocouple	13-May-13	13-Nov-13
905	Gas Meter	14-Jun-12	14-Jun-13
906	Gas Meter	14-Jun-12	14-Jun-13
792	Gas Meter	15-Oct-12	15-Oct-13
846	Stopwatch	12-Apr-13	12-Apr-14
911	Gas Meter	15-Oct-12	15-Oct-13
613	Barometer	11-Mar-13	11-Mar-14
633	Calibrated Site Mass	08-Oct-12	08-Oct-13
816	Balance		Response Check with SEMA Site Mass
833	Personal Sampler	17-May-13	17-May-14
834	Personal Sampler	17-May-13	17-May-14
761	Buck Calibrator 1Cc/Min - 6L/M	17-Jan-13	17-Jul-13
655	Testo 350	17-Jan-13	17-Jul-13
811	Flue Gas Analyser	16-Jan-13	16-Jul-13
Air Liquide & BOC Special Gas Mixtures used for Analyser Span Response			
Conc.	**Mixture**	**Cylinder No.**	**Expiry Date**
953ppm 10.1% 9.9%	Carbon Monoxide Carbon Dioxide Oxygen In Nitrogen	ALTE8597	28-Sep-15
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	ALTT8731	30-May-14
278 ppm	Sulphur Dioxide In Nitrogen	399945	21-Sep-14
406 ppm	Sulphur Dioxide In Nitrogen	ALSX6543	20-Dec-13

APPENDIX F – SAMPLE LOCATIONS

FIGURE F - 1 SAMPLE LOCATION – GENERATOR NO. 2

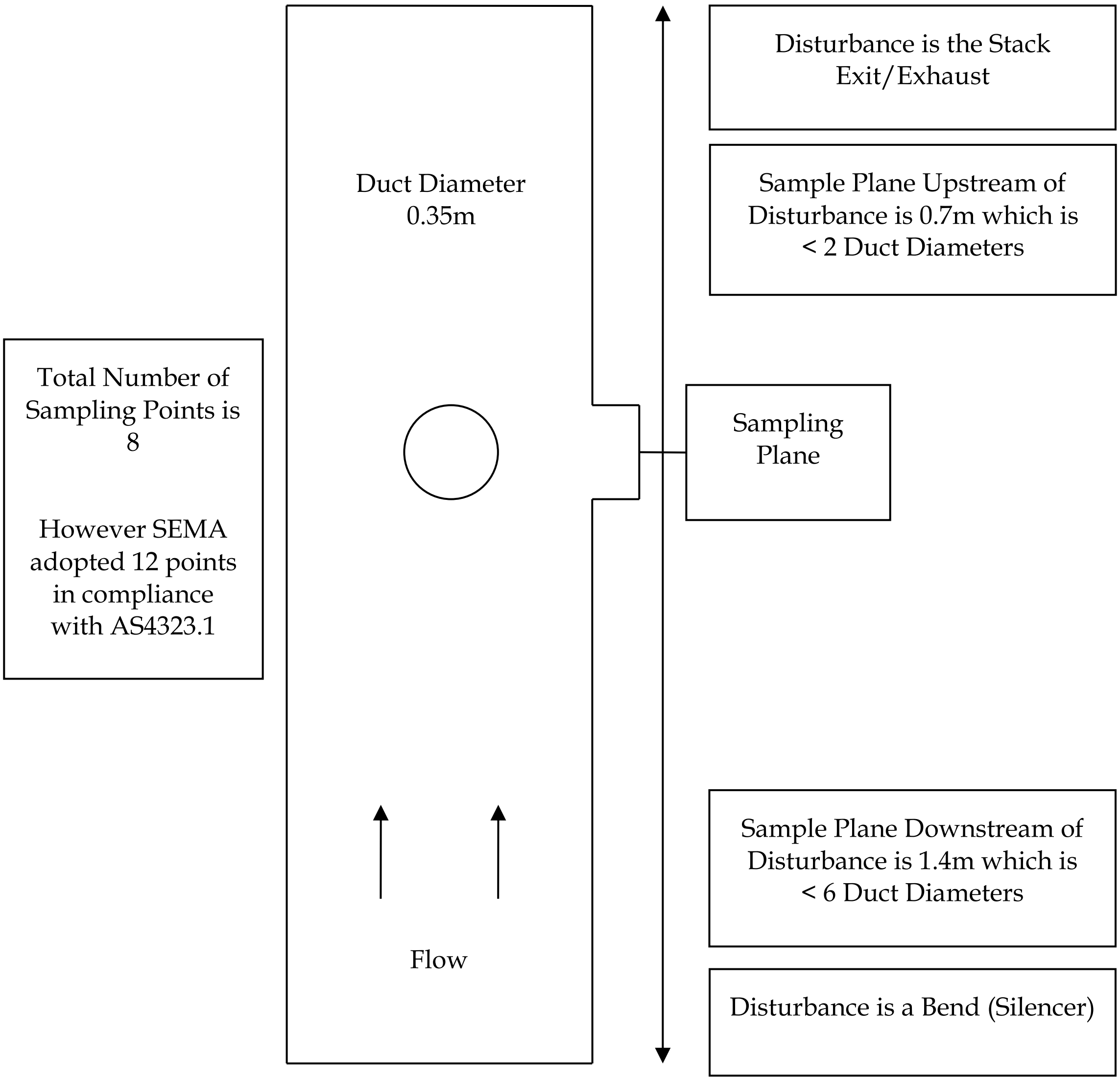


In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1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

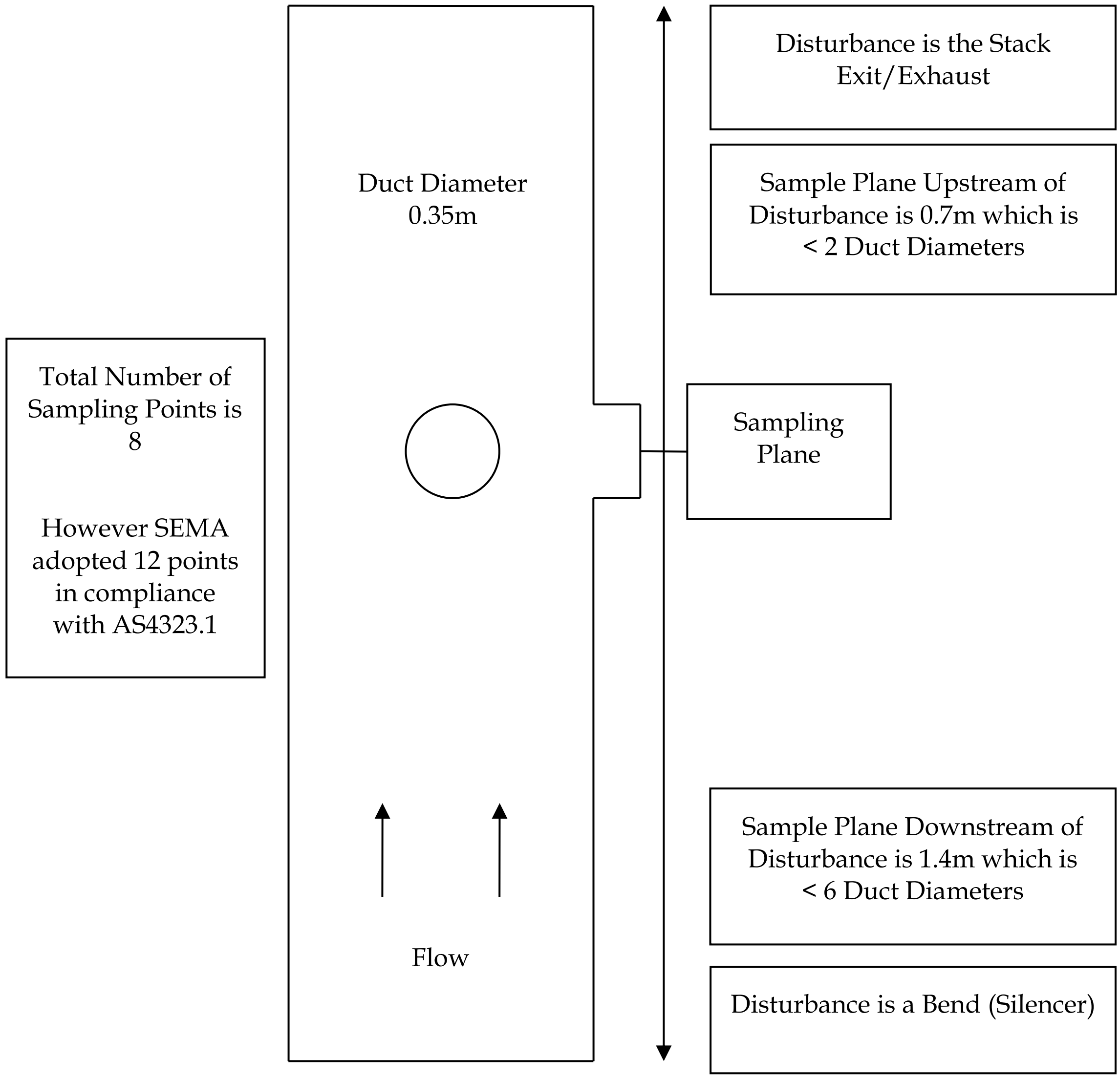


In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1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

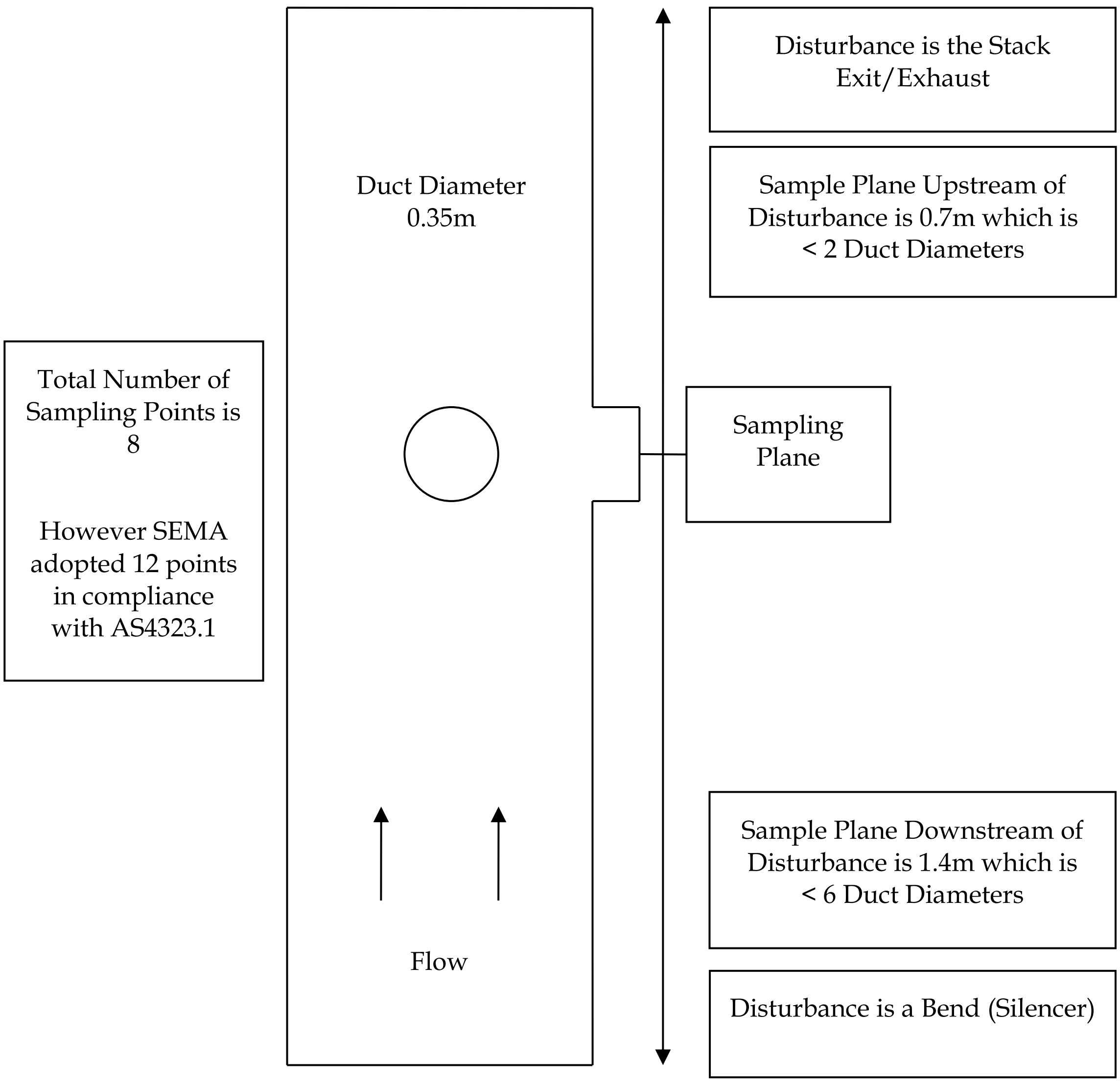


In the absence of cyclonic flow activity ideal sampling plane conditions will be found to exist at 6-8 duct diameters downstream and 2-3 duct diameters upstream from a flow disturbance. The sampling plane does not meet this criterion. Additional sample points were adopted in accordance with AS4323.1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

FIGURE F - 4 SAMPLE LOCATION – GENERATOR NO. 5



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.

Document Title: Waste input into Bioreactor
Data period: Sep-12 to Oct-13
Waste into Bioreactor per month (tonnes/month)

Date	Clyde	Regional
Sep-12	35,799.56	1,994.70
Oct-12	41,594.32	3,688.05
Nov-12	41,165.56	2,286.39
Dec-12	40,108.20	1,760.55
Jan-13	44,408.20	2,705.19
Feb-13	38,297.89	1,627.33
Mar-13	41,939.18	1,042.55
Apr-13	41,578.94	3,069.95
May-13	40,917.81	1,748.02
Jun-13	37,739.50	840.18
Jul-13	42,641.00	1,428.38
Aug-13	42,183.81	1,095.00
Sep-13	41,813.42	1,624.86
Oct-13	43,290.37	1,200.57

ODOUR COMPLAINTS LOG AS OF 9 OCTOBER 2013

Month: Complaints:

Date:	Complaints	Time:	Name:	Location:	Rating	duration	Collex response	Council Involved:	Other Comments:
8/12/2005	1	5.30pm	Dennis Clark	Tarago - Village			Visited complainant	Yes	Complaintant believed the odour smelt like decomposing waste Coucil contacted other residints and none had smelt an odour
16/12/2005	1	9.30am	John Chinnery	Tarago - Village			Visited complainant	No	Complaintant believed the odour was coming from the IMF
19/12/2005	1	9.30am	Clarice Beileiter	Tarago - Village			Visited complainant	Yes	Complaintant believed the odour was "sweet" and coming from the landfill
21/01/2006	1	7.00am	Julie Grey	Taylors Creek Road			Spoke to complainant	No	Complainant suggested that all her neighbour had experienced the odour - Collex contacted neighbours and they did not smell any odours that day.
30/01/2006	1	11.30am	John Chinnery	Tarago - Village			Visited complainant	No	Complaintant believed the odour was coming from the IMF
1/02/2006	1	9.20am	Dennis Clark	Tarago - Village			Phoned complainant	Yes	Visited site along with council officer and detected no odours
9/02/2006	1	11.25am	Barbara Fairfax	Taylors Creek Road			Phoned complainant	No	Complaints were in relation to the day before - also commented thast she had been detecting odours for 12 months.
9/02/2006	1	9.00am	Brian Ohlback	Goulbourn Council			Spoke to complainant	Yes	Complaint was in relation to a leaking container
13/02/2006	1	12.00pm	Mrs Harper	Taylors Creek Road			Phoned complainant	No	Complaint was for the the day before
14/02/2006	1	9.00am	Richard Fairfax	Taylors Creek Road			Phoned complainant	No	Complaintant wanted to know what we are doing about this
6/03/2006	1	11.00am	Jean Reardon	Taylors Creek Road			Phoned complainant	no	Complaintant had not smelt any odours before - but this was quite strong
29/03/2006	1	9.30am	Dennis Clark	Tarago - Village			Visited complainant	Yes	
30/08/2006	1	2.25pm	Barbara Fairfax	Taylors Creek Road					
9/09/2006	1	10.10am	Janelle Olds				left messages		
20/04/2007	1	9.30am	Jean Reardon	Taylors Creek Road			Phoned complainant		
7/05/2007	1	10.20am	Jean Reardon	Taylors Creek Road			Phoned complainant		
7/05/2007	1	12.00pm	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
4/06/2007	1	12.30pm	Dennis Clark	Tarago - Village			Phoned complainant		
8/02/2008	1	12.25pm	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
17/12/2008	1	9.00am	Clarice Beileiter	Tarago - Village			Phoned complainant		
17/12/2008	1	9.15am	Dennis Clark	Tarago - Village			Phoned complainant		
23/12/2008	1	9.00am	Dennis Clark	Tarago - Village			Phoned complainant		
28/01/2009	1	10.00am	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
20/02/2009	1	9.00am	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
5/06/2009	1	4.15pm	Clarice Beileiter	Tarago - Village			Phoned complainant		
26/10/2009	1	10.45am	Jean Reardon	Taylors Creek Road			Phoned complainant		
6/11/2009	1	8.50am	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
18/06/2010	1	8.30pm	Mark Davies	Tarago - Village			Phoned complainant		
8/07/2010	1	10.00am	Jean Reardon	Taylors Creek Road			Phoned complainant		
29/07/2010	1	9.10am	Clarice Beileiter	Tarago - Village			Phoned complainant		
9/08/2010	1	9.30am	Jean Reardon	Taylors Creek Road			Phoned complainant		
10/08/2010	1	9.45am	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
13/08/2010	1	1.00pm	Angela Sheratt	Tarago - Village			Phone complaint		
14/08/2010	1	1.00pm	Angela Sheratt	Tarago - Village			Phone complaint to council		
13/09/2010	1	12.25pm	Joan Limon	Taylors Creek Road			Phoned complainant		
28/09/2010	1	3.52pm	Unknown	Tarago - Village			Notified from EPA		
29/09/2010	1	10.00pm	Joan Limon	Taylors Creek Road			Phoned complainant		
8/10/2010	1	12.00pm	Dennis Clark	Tarago - Village			Phoned complainant		
18/10/2010	1	8.30am	Unknown	Tarago - Village			Notified from EPA		
22/10/2010	1	7.45am	Unknown	Tarago - Village			Notified from EPA		
16/12/2010	1	10.30am	Ruth Corrigan	Taylors Creek Road			Phoned complainant		
17/12/2010	1	11.00am	Barbara Fairfax	Taylors Creek Road			Phoned complainant		
31/12/2010	1	9.00am	Clarice Beileiter	Tarago - Village			Phoned complainant		
13/01/2011	1	1.50pm	Barbara Fairfax	Taylors Creek Road			Phone		
30/01/2011	1	7.00pm	Unknown	Tarago - Village			Notified from EPA		
2/02/2011	1	8.15am	Richard Fairfax	Taylors Creek Road			Phoned complainant		
7/02/2011	1	9.30am	Denzil Sturgis	Bungendore Road			Spoke to complainant		
14/02/2011	1	7.15am	Denise Keatley	Currawang			Spoke to complainant		
20/02/2011	1	7.00am	Unknown	Tarago - Village			Notified from EPA		
24/02/2011	1	10am	Pauline Croker	Tarago - Village			Spoke to complainant		
24/02/2011	1	7.00am	Unknown	Tarago - Village			Notified from EPA		
24/02/2011	1	8.15am	Clarice Beileiter	Tarago - Village			Spoke to complainant		
24/02/2011	1	8.30am	Martin Payne	Tarago - Village			Spoke to complainant		
24/02/2011	1	9.40am	Helena Hook	Tarago - Village			Spoke to complainant		
24/02/2011	1	9.45am	Kathy McCabe	Boro			Spoke to complainant		
25/02/2011	1	9.45am	Jean Reardon	Taylors Creek Road			Spoke to complainant		
2/03/2011	1	2.10pm	Richard Fairfax	Taylors Creek Road			Spoke to complainant		
13/03/2011	1	8.00pm	Unknown	Tarago - Village			Notified from EPA		
16/03/2011	1	10.00am	Richard Fairfax	Taylors Creek Road			Spoke to complainant		
30/03/2011	1	9.25am	Barbara Fairfax	Taylors Creek Road			Spoke to complainant		
12/04/2011	1	9.35am	Neil Shepard	Tarago - Village			Spoke to complainant		
2/05/2011	1	12.10pm	Barbara Fairfax	Taylors Creek Road			Spoke to complainant		
28/06/2011	1	3.45pm	Debbie Meagher	Tarago - Village			Spoke to complainant		
20/10/2011	1	9.15am	Chris Elford	Tarago - Village			Spoke to complainant		
22/11/2011	1	10.50am	Clarice Beileiter	Tarago - Village			Spoke to complainant		
22/11/2011	1	8.45am	Mark Davies	Tarago - Village			Spoke to complainant		
9/12/2011	1	9.10am	Barbara Fairfax	Taylors Creek Road			Spoke to complainant		
14/12/2011	1	8:00am	Denise Keatley	Currawang			Spoke to complainant		
15/01/2012	1	11.15am	Barbara Fairfax	Taylors Creek Road			Spoke to complainant		
20/01/2012	1	9.05am	Richard Fairfax	Taylors Creek Road			Spoke to complainant		
25/01/2012		12.35 pm	Barbara Fairfax	Taylors Creek Road					
2/02/2012		11.15 am	Denise Keatley	Currawang					
3/02/2012		7.30 pm	Unknown	Currawang					
13/02/2012		10.30 am	Barbara Fairfax	Taylors Creek Road					
17/02/2012		9.30 am	Mark Davies	Tarago - Village					
20/02/2012		11.25 am	Mark Davies	Tarago - Village					
23/02/2012		9.10 am	Mark Davies	Tarago - Village					
27/02/2012		11.15 am	Richard Fairfax	Taylors Creek Road					
27/02/2012		12.00 pm	Barbara Fairfax	Taylors Creek Road					
5/03/2012		7.45 am	Denis Clark	Tarago - Village					
17/03/2012		11.30 am	Denise Keatley	Currawang			AG responded	sickly sweet	reported personally to A Gardner
22/03/2012		4.30 pm	Richard Fairfax	Taylors Creek Road			Meeting arranged 10/4	still, overcast	
23/03/2012		9:00 AM	Mark Davies	Tarago - Village					*also on 21/3
27/03/2012		9:00 AM	Denise Keatley	Currawang		morning		sunny, fine	reported personally to A Gardner
27/03/2012		2.05 pm	Barbara Fairfax	Taylors Creek Road		all day		sunny, fine	
29/03/2012		8.30 am	Luther Davis	Tarago - Village					
29/03/2012		9.00 am	Chris Elford	Tarago - Village					
29/03/2012		AM *	Clarice Beileiter	Tarago - Village		morning			*reported on 4/4/12
31/03/2012		8.00am	Andy Westcott	Tarago - Village	8	all day			Reported on the 3/4/12
31/03/2012		9.00am	Mark Davies	Tarago - Village					
31/03/2012		AM *	Clarice Beileiter	Tarago - Village		morning			*reported on 4/4/12
1/04/2012		7.30am	Andy Westcott	Tarago - Village	5	morning			Reported on the 3/4/12
3/04/2012		4.00 pm	Unknown	Tarago - Village					
3/04/2012		7.30pm	Mark Davies	Tarago - Village					
3/04/2012		9.00 pm *	Clarice Beileiter	Tarago - Village					*reported on 4/4/12
3/04/2012		9.00am	Andy Westcott	Tarago - Village	3	morning	email		*Also smelt odour 31/3/12 and 1/4/12
7/04/2012			Clarice Beileiter	Tarago - Village		morning			reported on 11/4/12
12/04/2012		1.30 pm	Luther Davis	Tarago - Village	6	morning		frost, sunny, no wind	
13/04/2012		10.30 am	Unknown						voicemail message only
13/04/2012		9.15 am	Margie Mulligans	Tarago - Village	6	morning	AG responded		
16/04/2012		8:00 AM	Luther Davis	Tarago - Village	8	morning		rotten egg	over past couple days
16/04/2012		11:00 AM	Barbara Fairfax	Taylors Creek Road	8	morning		waste smell	
17/04/2012		7.50 am	Janelle Olds	Currawang	7	mornings			3 days over past week
20/04/2012		7.30 am	Mark Davies	Tarago - Village	8	morning		foggy	
30/04/2012		9.15 am	Barbara Fairfax	Taylors Creek Road	7	morning		foggy	
2/05/2012		9.50 am	Chris Elford	Tarago - Village				foggy fine	voicemail message only
2/05/2012		9.50 am	Clarice Beileiter	Tarago - Village		morning		foggy fine	voicemail message only
16/05/2012		9.00am	Alicia Oosting	Tarago - Village	9 - 5	morning	AG responded	foggy fine	noticing more over past months
17/05/2012		8.45 am	Mark Davies	Tarago - Village	unaccept	always		foggy	
30/05/2012		7.30am	Luther Davis	Tarago - Village	10	weeks		foggy	
30/05/2012		8.40 am	Rowen Thatcher	Tarago - Village	7	morning		foggy	usually notice in early mornings but it disperses quickly except today
4/06/2012		11.10 am	Barbara Fairfax	Taylors Creek Road	10	last nite			from around 5.30 pm onwards on Sunday 3/6/12
4/06/2012		11.50 am	Ruth Corrigan	Taylors Creek Road	9	last nite			over weekend mostly in afternoon
5/06/2012		8.40 am	Mark Davis	Tarago - Village	10	morning		Wet	
5/06/2012		9.00am	Mark Tomlinson	Mayfield Rd		morning	HG spoke directly	wet	
7/06/2012		9.30am	Mark Tomlinson	Mayfield Rd				fine	
12/06/2012		2.45 pm	Tim Meth	Currawang		continuous	AG responded	raining	over past 3 days
14/06/2012		10.00 am	Richard Fairfax	Taylors Creek Road	7	morning		foggy/overcast	
26/06/2012		9.15 am	Barbara Fairfax	Taylors Creek Road	10	4am - 7am			had to shut all windows
6/07/2012		8.20 am	Luther Davis	Tarago - Village	10	morning			
9/07/2012		10.00 am	Barbara Fairfax	Taylors Creek Road	unaccept	weekend			sat 7/7 11.30am unable to sit outside 8/7 10.30pm smell inside house
24/07/2012			Barbara Fairfax	Taylors Creek Road		PM & night			
13/08/2012		7.50 am	Mark Davis	Tarago - Village	unaccept			foggy	
13/08/2012			Lou Alaimo	Willandra Lane		AM & PM			email sent to Justin
21/08/2012		7.30 am	Paul Beileiter	Tarago - Village		last nite			
21/08/2012		10.30 am	Clarice Beileiter	Tarago - Village	really bad	last nite			John Chinnery has been ringing her to make his compliant
21/08/2012		2.00 pm	Barbara Fairfax	Taylors Creek Road	xtreme ba	last nite			voicemail message

20/09/2012		9.20 am	Ruth Corrigan	Taylors Creek Road		AM			voicemail message - still feeling sick from it
29/10/2012		9.30 am	Barbara Fairfax	Taylors Creek Road	8	AM			
3/01/2013		9.10 am	Barbara Fairfax	Taylors Creek Road	11	am			Irrate - 90yr old mother unable to sit on verandah
16/01/2013		9.30 am	Clarice Beileiter	Tarago - village	strong	am			rank rubbish smell
21/01/2013		6.15 pm	Barbara Fairfax	Taylors Creek Road	strong	pm			stink is appauling
9/02/2013		7.50 am	Clarice Beileiter	Tarago - village	strong	am			dreadful also Friday morning
21/03/2013		10:00am	Mr Hoorweg	N/A	N/A	am			N/A
21/03/2013		9.15 am	Barbara Fairfax	Taylors Creek Road	dreadful	last nite			waste and leachate
3/04/2013		9.00 am	Barbara Fairfax	Taylors Creek Road	strong	am			Garbage
8/04/2013		9.25 am	Ruth Corrigan	Taylors Creek Road	appaulling	am		foggy	
9/04/2013		8.30am	Barbara Fairfax	Taylors Creek Road	strong	am		foggy	Garbage also 3am Monday morning woke the house up
10/04/2013		5:00-8:00 am	Mr Hawke	N/A	N/A	am			N/A
10/04/2013		5:00-8:00 am	Mr Clark	N/A	N/A	am			N/A
22/04/2013		9.00 am	Adam Hawke	Braidwood Rd	"toxic"	am	HG spoke directly		
22/04/2013		10.30 am	Steve Casey	21 Roseberry St	strong	am	HG spoke directly		has a list of date and times
9/05/2013		8.00 am	Pauline Croker	Tarago - village	strong	am			sweet smell - mostly mornings and then late evenings
6/06/2013		8:00am	Mr Graham Hawke	1702 Braidwood Road	st has expe	am			N/A
11/07/2013		11:14am	Ms Grey	119 Taylors Creek Road	rotting sme	am			Not available
11/07/2013		7:00pm	Ms Fairfax	N/A	rotting sme	pm			Not available
13/07/2013		8.10 am	residents of	Tarago - village			voice message		awful bloody smell, want to do something about it
25/07/2013		9.50 am	Sue Collins	2796 Mayfield Road	strong	am	8 km from lumley road	foggy	sometimes faint smell but today quite strong since 8am
26/08/2013		7-9:05 am	N/A	Braidwood Road	N/A	am			N/A
30/09/2013		4-7 pm	N/A	Roseview Street in Tara	Bad odour	pm			Bad odour (sweet chemical in nature)
9/10/2013		7-8 pm	N/A	Braidwood Road south	Strong	pm			Strong

VES CORRESPONDENCE

12 July 2013

Nick Feneley
Senior Operations Officer
PO Box 513
Wollongong NSW 2520

In response to the Email dated the 11th of April 2013, Veolia makes the following response.

<u>Odour Complaint's – 11th July 2013</u>

Dear Nick,

This letter is in regarding to the odour complaint about the Woodlawn Bioreactor site received by the EPA on the 11th July 2013, in addition to this a odour complaint direct to the Woodlawn office on the 12th of July. A request for further information was passed on to VES via email.

a) The date, time and duration of the odour incident:

As per your email correspondence the alleged incident occurred around 11:14 am, 11th July 2013. The duration of the incident for the complainant is unknown at this stage.

The second complaint was received 8 hours after the alleged incident. The odour was detected between the hours of 7pm and 10pm at another premise

b) A description of the nature of the odour:

The odour was described as a "*rotting smell"*.

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c) The meteorological conditions prevailing at the time the odour was reported:

The time when Ms Grey experienced the odour was about 11:14 am on the 11th July 2013. The meteorological data recorded from our site showed that the average wind direction at the time was 94.1 degrees. The average temperature recorded was 5.6 degrees. The average wind speed was 0.361 m/s.

The time at which Ms Fairfax experience the odour was around 7pm, the meteorological data recorded from our site showed that the average wind direction at the time was 35.2 degrees. The average wind speed was 0.341 m/s.

d) The location of the place where the odour was detected:

The odour incident occurred at 119 Taylors Creek Road. After the notification was received by VES, an investigation was carried out at the complainants address. I manage to get to the location by approximately 1pm – at this time the odour was not detected and the meteorological conditions had changed. Due to the reported time of Ms Fairfax's complaint, I was unable to ascertain the type of odour. I tried to contact both Ms Grey and Ms Fairfax to no avail. I will continue to try over the coming days

e) The circumstances in which the odour incident occurred:

Based on the previous discussion with the EPA and the odour consultants/auditors, the source of odour is likely to be the remaining volume of untreated leachate from the storage lagoon (ED3N-1). The consultants had assessed the odour issues at Woodlawn Bioreactor and conducted an odour audit on September 2012. The audit concluded that the untreated leachate at the storage lagoon was the main contributing factor for the odour at Woodlawn.

Based on the description of the odour by the complainant, the likely cause is the remaining untreated liquid in the treatment dam.

f) Time and date stamped photographs of the active landfill cell showing intermediate and daily cover:

Diagram: Picture of the landfill cell on 11th of July 2013 on the Woodlawn Bioreactor viewing platform

g) The action taken or proposed to be taken to deal with the incident, including follow-up contact with any complainants:

The solution that the VES is working on is to keep improving the current leachate treatment process. This includes removing and treating all the rest of the raw leachate in Lagoon 1. For details of the measures please see **Section h**.

h) Details of any measures taken or proposed to be taken to prevent or mitigate against a recurrence of such an incident:

- Reactivation of the leachate treatment by adding activated sludge into the aeration pond. (Early April 2013)
- Literature and pilot plant studies to achieve better understanding of both leachate characteristics and treatment operations. (Since April 2013)
- Commissioning of external settlement tank allows us to operate the system with a more efficient de sludging process. (Early May 2013)
- Selection of more relevant monitoring indicators allowing us to make right judgment and reducing the chance of odour reproduction at the evaporation pond. (Since May 2013)

- Frequent in-house and lab analysis for ensuring the best effluent quality with the least amount of treatment time. (Since May 2013)

- Comprehensive monitoring procedures include daily and weekly monitoring programs. (Since May 2013)

- Systematic treatment schedule with high treatment rate without compromising the quality of the leachate effluent.

- At the time of writing – the volume of untreated leachate in the lagoon stands at 4.5ML. The objective of removing the leachate from the storage dam by June 30, was not achieved due to factors outlined below in the status report dated the 5th of July.

Leachate Treatment Projection of the ED3N-1, as of 5th July 2013

The deadline that the EPA set for treating all of the raw leachate in ED3N-1 is the 30th of June 2013. There is still approximately 5.24 ML of raw leachate left in ED3N-1. The raw leachate in ED3N-1 was considered as a main odour emission point at the premises, but since the liquid level has dropped from 17.5 ML (see Figure 1) to 5.24 ML (see Figure 2) over the last 2 months.

The following explains the cause for delaying the schedule and a plan for treating the rest 5.24 ML of the leachate in ED3N-1.

Figure 1: ED3N-1 Volume on 6th of may 2013 (17.5 ML)

Figure 2: Estimated ED3N-1 Volume on 5th of July 2013 (5.24 ML)

Plan for the rest of the Untreated Leachate:

The Lagoon 'ED3N-1' volume was 17.52 ML at the end of April 2013. It has dropped by 12.3 ML over the last 2 months by sending it into the aeration pond for treatment. If similar treatment rate applies at 6.13 ML/month, the rest of the raw leachate in the lagoon will be treated at the end of July 2013. (see Figure 4).

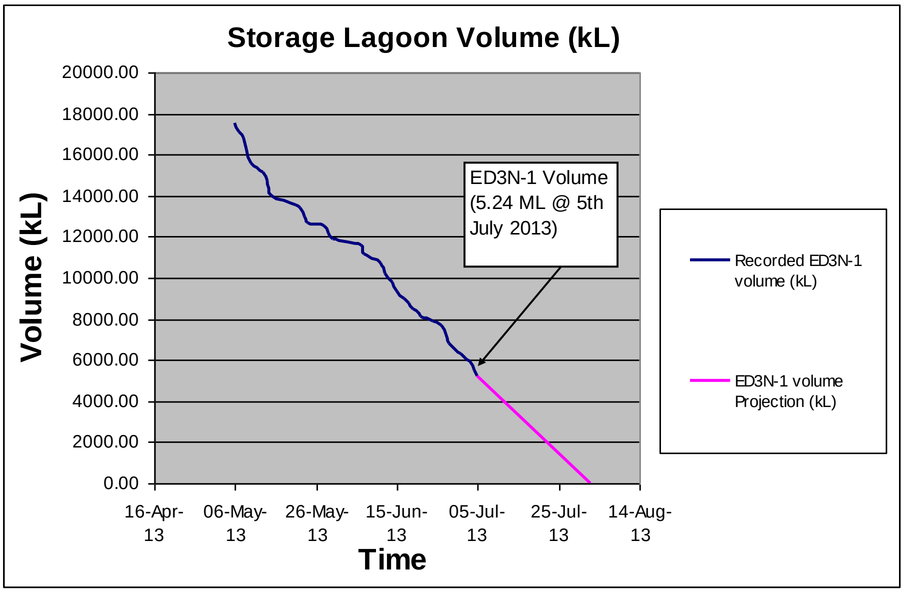

Figure 4 – Projection of Raw Leachate Volume at ED3N- 1

Challenges

There are number of reasons that may have slowed down the operational schedule. These include failure of the Aeration Outlet Pump (2 weeks), Buffer Tank Outlet Pump (1 week), and Polymer Dosing Pump (2 weeks). Other non-operational challenges include the extreme weather conditions (below freezing temperatures and heavy rainfall events) which may have affected the biological treatment activity and the performance of polymer for sludge settlement.

If there are any further questions relating to the above information, please do not hesitate to contact me via email: henry.gundry@veolia.com.au or phone 02 4844 6352.

Regards

Henry Gundry
Woodlawn - Environment & Operations Manager

VEOLIA
WATER
Solutions & Technologies

Mr Henry Gundry
Environment and Operations Manager – Woodlawn
Veolia Environmental Services (Australia) Pty Ltd 29/07/2013

Dear Henry,

I understand that the EPA has notified VES that they have not met the deadline for emptying the raw leachate pond. To assist VES, Veolia Water Solutions & Technologies P/L has been providing technical support on various activities to aim to meet the deadline, and as such I offer the following technical points in relation to the project.

In response to the odour problem, VES has set about optimising the aerated bioreactor which had been constructed on the west rim of the pit, so that the raw leachate can be processed through it, to remove the odour causing compounds by biologically breaking them down.
VES has:

- Evacuated treated leachate from the aerated pond, to make room for the raw leachate, whilst retaining sufficient volume in the aeration pond to keep the aerators running.
- Found a viable source of a large quantity of bacteria to "seed" the bioreactor, to increase its processing speed.
- Transported that biomass to the bioreactor.
- Acclimatised the biomass to the type of nutrients stored in the Raw Leachate Pond.
- Fed the raw leachate to the pond at a speed which does not overload the biomass (which would cause the aerated bioreactor water to become toxic to the biomass, leading to a cessation of processing).
- Fed Phosphorous to the aeration pond, to ensure the biomass have the correct balance of trace elements in the feed.

If any of the above steps were not taken, the raw leachate may have become a much worse source of odours when it was transferred to the aerated bioreactor, because:

1. the aeration may have released the volatile odour causing compounds at a far greater rate than whilst stored stagnant in the raw leachate pond.
2. the biomass may have become anaerobic, and reacted with the high sulphate concentration in the water to release newly formed odorous Hydrogen Sulphide.

The deadline seemed feasible at the time it was set, but sourcing viable biomass was difficult, and the leachate treatment process is new, and subject to uncertainties, including the weather. Notwithstanding these challenges, VES has almost met the deadline, and is soon to empty the raw leachate pond, and has done so without worsening the odours on site in the process.

Also, due to the careful establishment of the aerated bioreactor, the raw leachate treatment process is now established, and future odorous leachates will not need to be stockpiled.

I hope that this detail helps all to understand the circumstance in relation to this, and I am more than happy to give further technical information, such as operating guidelines for aerated bioreactors, monitoring data, and an explanation of that data, to help demonstrate that the disposal of the raw leachate has proceeded as best as possible.

Yours sincerely,

Michael O'Neill BE(mech), BSc (phys)
Hydrex Technical Consultant

VEOLIA
ENVIRONMENTAL SERVICES

WOODLAWN BIOREACTOR
NEW SOUTH WALES

Wednesday 31st July 2013

Cate Woods
Unit Head – waste operations
PO Box 513
Wollongong NSW 2520

Dear Cate,

Show Cause
Veolia Environmental Services (Australia) Pty Ltd – Woodlawn Bioreactor Collector road, Tarago – EPL No.11436 – Failure to Comply with Licence Conditions

I refer to the Show Cause letter from Environment Protection Authority (EPA) dated the 22nd July 2013 regarding a potential breach of licence condition U2.1.

Veolia accept the facts as specified in the EPA letter, being that as part of a condition under an agreed Pollution Reduction Programme added to the licence on 1st May 2013; to remove all leachate from the storage lagoon ED3N-1, this condition was not met by the agreed date of 30th June 2013. The fact we were unable to meet this deadline was known and this fact, a progress report and a request for the application of an extension was not and should have been communicated to the EPA. This omission was a gross oversight on Veolia's part.

In mitigation, Veolia has been working hard to address the treatment of leachate, with considerable success. The treatment and removal of leachate from ED3N-1 is now complete as of 30th July, one month late and we are in the process of de-sludging the lagoon to remove all potential odour sources from ED3N-1.

The failure to report was an error on Veolia's part although at no time did we knowingly or intentionally disguise the fact progress was delayed, nor did we deliberately set out to over run the deadline. This is we hope demonstrated by the openness of our communication in general and the fact that the progress of the leachate treatment was outlined to the EPA in a response to an odour complaint on the 11th July 2013, clearly identifying that the treatment was progressing well, but that the emptying of the lagoon was not yet complete.

Veolia was also regularly liaising with the Council's Supervisory Licence Holder, Larry Meng, regarding the treatment process and progress towards the deadline to remove

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the leachate from ED3N-1. Furthermore, in the Community Liaison Meetings held in March and June 2013, we have also been communicating our progress on the treatment process and that the leachate storage volumes would be removed by July; this information was subsequently included in the July edition of the Tarago Times.

The point we are trying to make is that at no point has Veolia tried to hide or disguise the fact, once it became clear, that we would not meet the deadline of 30th June and in the enthusiasm to resolve the issue and to address the operational challenges which were presented, we simply overlooked the requirement to keep the EPA informed.

We encountered a number of operational issues during the development of continuous leachate treatment. We have been working with our Veolia Water business to provide advice and the required technology to meet these treatment objectives. We attach a letter which identifies some of these challenges, but in summary, the focus during the early stage of treatment was to seed the treatment dam with suitable biomass to promote effective treatment. Several attempts to locate a suitable product was made and after finding an appropriate source and decision to remove a further 4ML from the treatment dam and add this into ED3N-1, in order to increase the effectiveness of the biomass added to the treatment pond. This decision set us back, meaning the stored volume in ED3N-1 increased from 14ML to 18ML. In addition, we discovered that the polymer dosing system was susceptible to the harsh climatic conditions experienced at Woodlawn during this time of the year, which caused blockages to the pipe network and failures to the pumping system. This then required overhaul and resulted in subsequent delays to the treatment process. The process was then restarted and continued to completion.

Up until 2 to 3 weeks prior to the deadline date there was still a likely possibility that the deadline would have been met, given leachate treatment volumes were progressing well, however the challenges we encountered slowed down and then required cessation of treatment. Whilst it was possible to have removed the leachate from ED3N-1 and returned it into the void, simply to meet the deadline, we never considered this as an option. Such action would likely have been detrimental to the overall operation, by further reducing gas capture and increasing the potential for odour. Instead we chose to persist with solving the challenges of the leachate treatment process to final conclusion, believing this to be the most environmentally sustainable outcome.

Whilst we therefore took decisions to continue to address the specific issue and underlying causes to odour, we accept that we failed to advise the EPA of our actions and intentions.

As noted in your letter, Veolia has been working with the EPA to develop a long-term solution to the ongoing odour issues from the Woodlawn Bioreactor for a considerable time, this included the implementation of works to remove untreated leachate from ED3N-1, which was identified as a major source of odour in the recent independent odour assessment completed as part of the Development Consent.

Veolia has appreciated the ongoing advice and assistance we have had from the EPA over the years of the development of the Woodlawn Bioreactor. This relationship has always been open and honest and we have always found the EPA to be reasonable and supportive when challenges have arisen. For this reason there was no advantage for Veolia to deliberately or knowingly ignore this directive and put this relationship in jeopardy.

The highest priority for the site in 2013 is to action all the recommendations of the independent odour audit. This has always included the development of the leachate treatment methodology and ongoing development and improvement to the gas and leachate infrastructure.

Considering the enormous effort and expense that has been put into improving odour management on site over the years there is a real excitement in being so close to finalising the long term objectives of improvements to the management of leachate and gas. The result being the significant reduction in potential odour sources through major increases in gas capture and extraction. The development of a robust continuous leachate treatment method is imperative to achieving this goal and at no time was this project considered a hindrance to our progress; it is a necessity. The ability to remove leachate from the waste and to treat in a continuous process when required underpins our future strategy for the improvement of environmental performance and is key to eliminating the future requirement for storage of untreated leachate on site. Veolia now have a treatment method that can allow the treatment of up to 400,000L/day.

Veolia has invested heavily in site infrastructure to improve leachate collection, and gas collection, and as a result the gas capture % (as measured under NGERS) has been as high as 85% as a long-term average (from 60% in 2008-2011). We have therefore already made significant improvements.

The medium term plan for the improvement of gas capture requires long-term continuous leachate extraction and treatment, without the requirement for storage of raw leachate in evaporation dams. However with oversaturation of the landfill and our inability to continuously treat leachate, over the past 6 months our gas collection efficiency has remained flat. We are only weeks away from being able to begin to measure the success of what has been a long-term cumulative program of investment and we look forward to sharing these results with you. We include some supporting information which explains how we have been measuring and assessing our performance in this respect.

Finally, when it comes to community engagement, the Woodlawn site has always been open and honest. We have had thousands of visitors to site and show our operation with great pride, the feedback we get is testament to that. In particular, people are always impressed with the professional approach we have. We have regular meetings with our Community Liaison Committee and now have a presence on the Local Progress Association. All this is in order to get information about our progress out into the community. The local community is aware of our challenges in addressing the impact of the facility on the local environment and we have found them sympathetic now they understand the challenges we face. Regular visitors to site include Universities and schools who see this site as a great example of how large scale waste management operations should be run. Our open, honest and constructive relationship with government departments such as the EPA is used as an example to students of how important Veolia sets environmental compliance and how these professional relationships should work.

We have recently had a third open day at site where we invite all the local community and beyond to come to site and find out what is happening in particular with progress on odour management and new developments. This year over 250 people attended and the feedback received again showed how impressed people are with the way Veolia manages the site.

We believe the majority of the local community appreciate our open and honest approach and our willingness to share information, understand the challenges we have and the processes we are following to manage odour. This is reflected in the great knowledge locals have in what we do and where we are heading. There is certainly a positive attitude amongst the locals who choose to communicate with us.

Thank you for the opportunity to discuss this issue prior to our submission, we hope we have provided sufficient explanation through those discussions, this letter and associated attachments. We remain available at your convenience to clarify or provide further information as necessary.

Yours faithfully

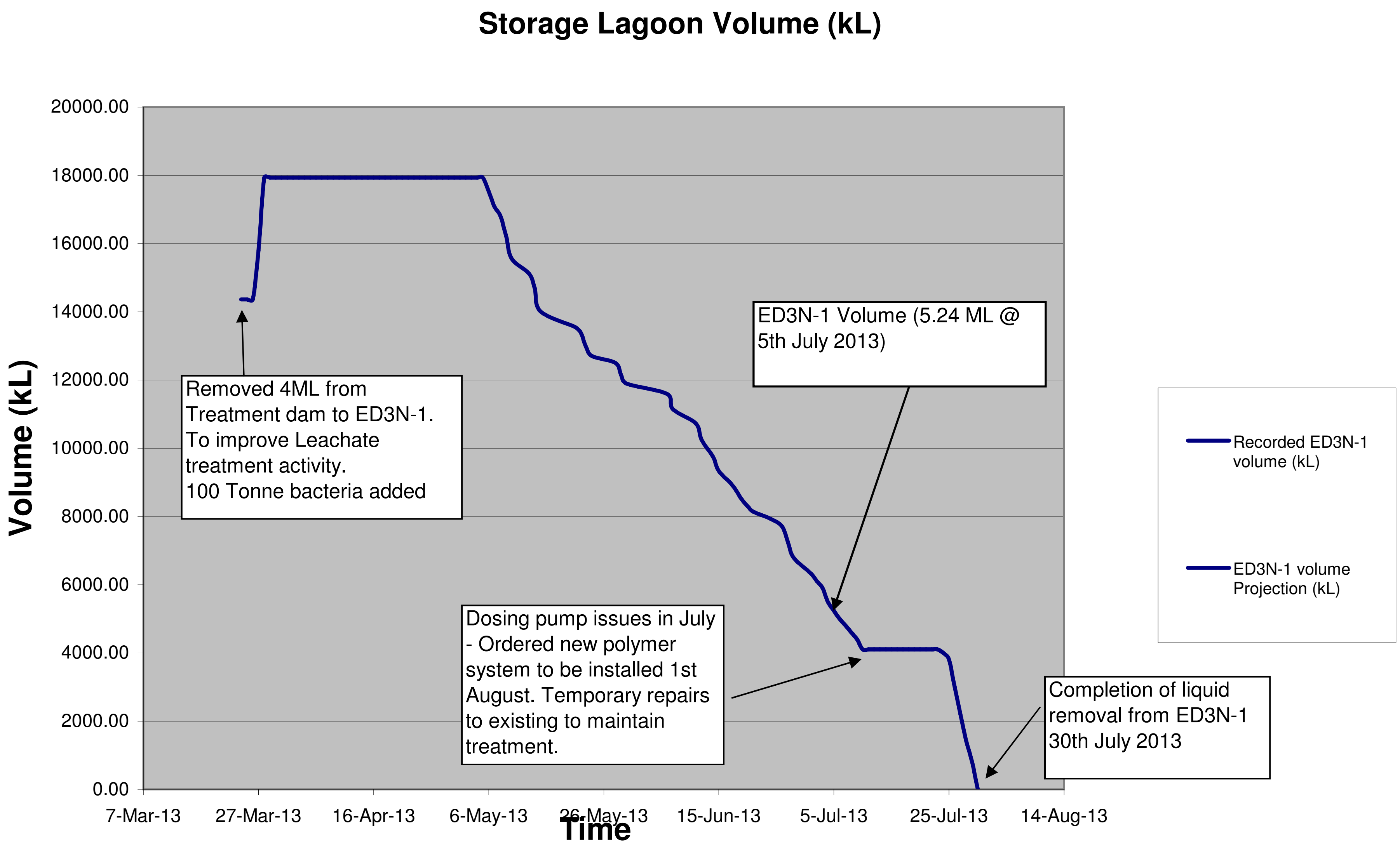
Mark Taylor
General Manager – NSW Resource Recovery

Attachments:

ED3N-1 Progress Graph
29th July 2013 Veolia Water Letter to VES
12th July 2013 Veolia Response to Odour complaint
Woodlawn Gas Collection Efficiency
Tarago Times Article July 2013
Community Liaison Meeting Minutes 13 March 2013
Community Liaison Meeting Minutes 12 June 2013

THE ODOUR UNIT

ED3N-1 DRAINAGE PROGRESS TREND



Storage Lagoon Volume (kL)
Volume (kL)
20000.00
18000.00
16000.00
14000.00
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
7-Mar-13
27-Mar-13
16-Apr-13
6-May-13
26-May-13
15-Jun-13
5-Jul-13
25-Jul-13
14-Aug-13
Time
Removed 4ML from Treatment dam to ED3N-1. To improve Leachate treatment activity.
100 Tonne bacteria added
ED3N-1 Volume (5.24 ML @ 5th July 2013)
Dosing pump issues in July - Ordered new polymer system to be installed 1st August. Temporary repairs to existing to maintain treatment.
Completion of liquid removal from ED3N-1 30th July 2013
Recorded ED3N-1 volume (kL)
ED3N-1 volume Projection (kL)

EVAPORATION DATA SUPPLIED BY VES

Evaporation	2006								2006				2007					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	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**

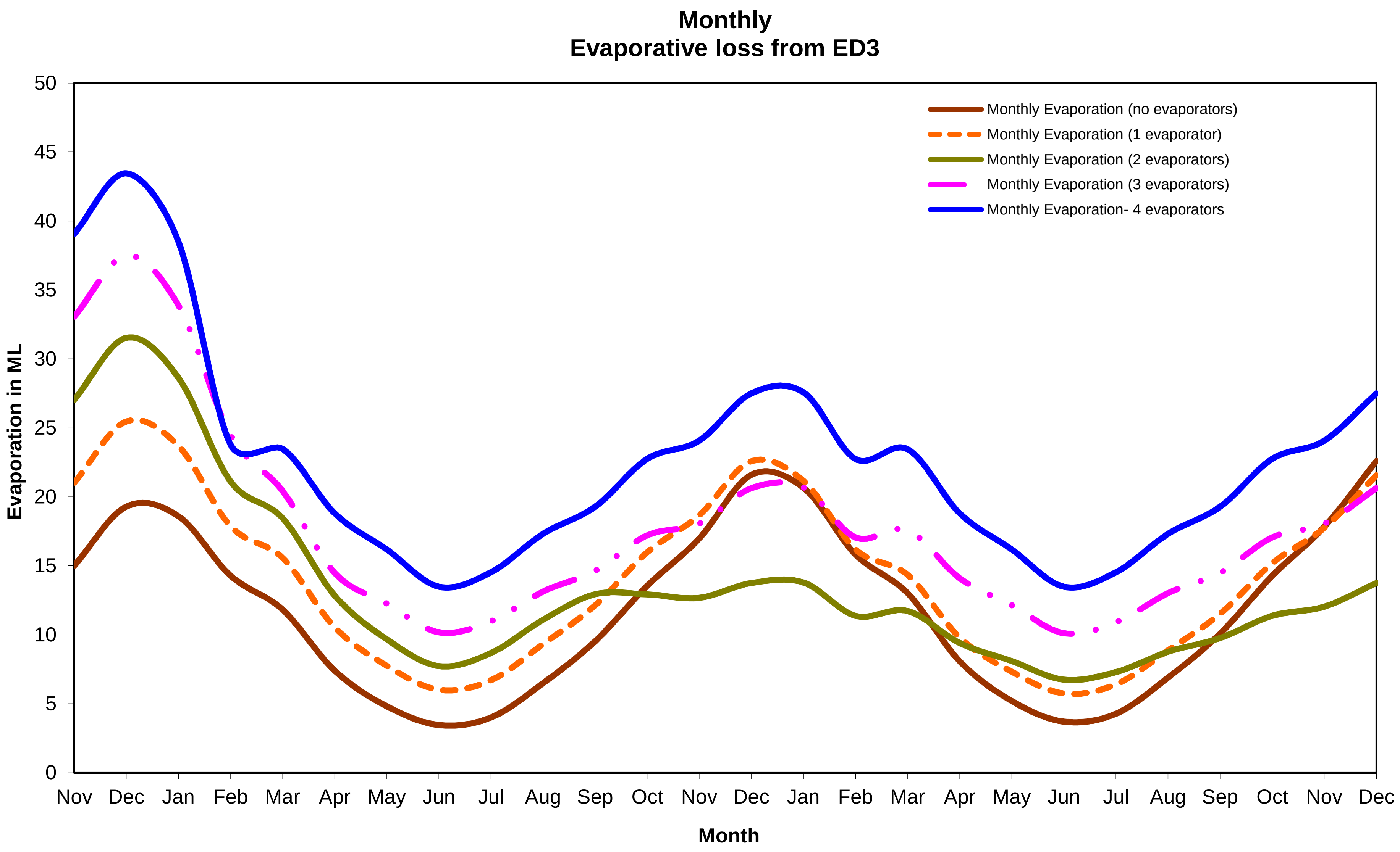
eather Station

										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**

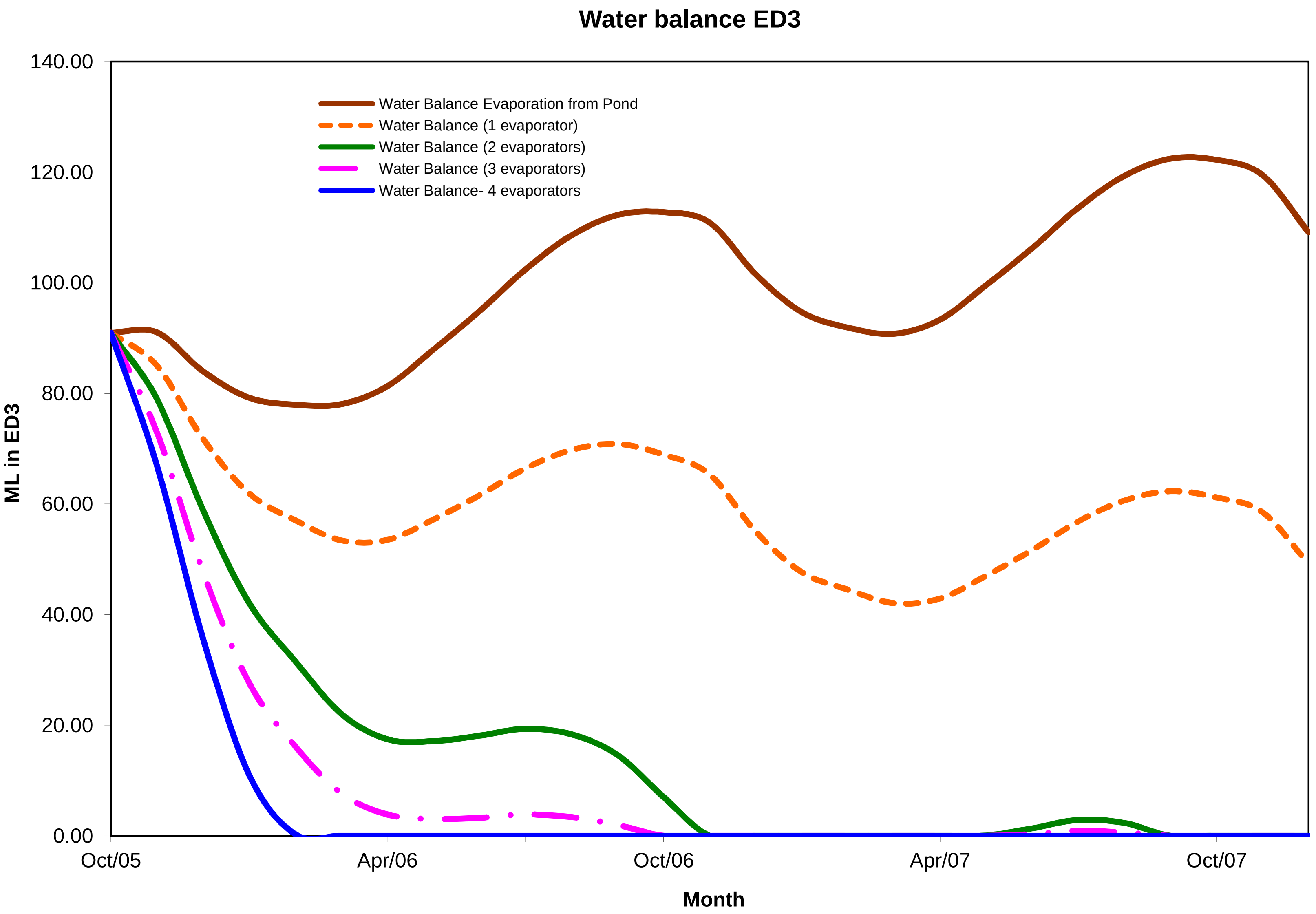
						2011							
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1.268	1.296	2.57	3.375	4.13	1.186	7.051	7.012	2.274	1.106	1.672	0.987	1.048	1.254
1.044	1.432	3.342	2.595	1.913	1.338	7.866	9.26	4.678	3.107	1.878	1.056	0.911	2.284
0.452	1.033	0.811	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
Month
Monthly Evaporation (no evaporators)
Monthly Evaporation (1 evaporator)
Monthly Evaporation (2 evaporators)
Monthly Evaporation (3 evaporators)
Monthly Evaporation- 4 evaporators
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


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
	30	31	31	28	31	30	31	30	31	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
	5	6.2	6.3	5.5	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.8
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
Estimated monthly evaporation (M3) attributed to 1 evaporator (350 l/min)	6019	6875	6895	5686	5862	4701	4046	3371	3632	4330	4820	5687
Estimated monthly evaporation (M3) attributed to 2 evaporators (350 l/min)	12037	13751	13789	11372	11725	9402	8093	6742	7264	8659	9640	11375
Estimated monthly evaporation (M3) attributed to 3 evaporators (350 l/min)	18056	20626	20684	17058	17587	14103	12139	10113	10895	12989	14460	17062
Estimated monthly evaporation (M3) attributed to 4 evaporator(s) (350 l/min)	24075	27502	27578	22744	23449	18804	16186	13484	14527	17318	19280	22750
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
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
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
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
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
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%
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%
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%
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%
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
Incident Rainfall	10081.5	7243.5	8819.25	8027.25	6913.5	5626.5	6435	5395.5	6575.25	7656	8217	9050.25
Water Pumped In	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000

	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)	16982.3	21601.0	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)	12643.1	15705.6	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)	643.3	0.0	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	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	0.0	0.0
Evaporator evaporation as % of Surface Evaporation (1 evaporator)	35.4%	31.8%	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)	70.9%	63.7%	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))	106.3%	95.5%	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))	141.8%	127.3%	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	16982.28	21600.97867	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	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

	Initial Volume stored in ED3	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Progressive Water Balance (no evaporators)	90976	91051	84003	79226	77967	78054	81283	87902	94840	102413	108581	112268	112774
Progressive RL of dam	789.09	789.09	789.02	788.96	788.95	788.95	788.99	789.06	789.13	789.21	789.27	789.31	789.31
Progressive Water Balance (1 evaporator)	90976	85032	71813	61939	57093	53428	53509	57192	61569	66443	69775	70859	68929
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
Progressive Water Balance (2 evaporators)	90976	79013	58919	42151	31618	22091	17471	17108	18114	19355	18358	14622	7005
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
Progressive Water Balance (3 evaporators)	90976	72995	47751	27693	16238	7727	3868	3042	3259	3861	3385	1963	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
Progressive Water Balance- 4 evaporators	90976	66976	35767	11085	320	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

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Progressive Water Balance (no evaporators)	110874	101516	94678	91891	90787	93333	99571	106259	113562	119323	122457	122233	119485	109135
Progressive RL of dam	789.29	789.20	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)	65349	55011	47672	44513	42082	42911	47025	51674	56845	60628	62327	61197	58521	49205
Progressive RL of dam	788.78	788.64	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	0	0	68	1346	2885	2339	0	0	0	0
Progressive RL of dam	784.50	784.50	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	0	0	282	955	587	0	0	0	0
Progressive RL of dam	784.50	784.50	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	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	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
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
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
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
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
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

	1/12/2006	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)	21.601	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)	22.581	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)	13.751	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)	20.626	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	27.502	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			

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 collected from the Woodlawn Bioreactor Facility were sourced from the partially treated leachate and treated leachate in lagoons ED3N-2 and ED3N-3 respectively. 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:

- Dispense 25 L of dry nitrogen into a conditioned Nalophan bag
- 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
- Remove the liquid sample from cold storage
- Rinse the microlitre syringe (5 x) with the liquid sample
- Draw up the required volume of liquid sample (see **Liquid Sample Size** and **Table D1**) and record the exact volume in the syringe
- 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.

- 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.
- Vigorously shake the bag to disperse the liquid droplets inside the bag (to aid in the evaporation rate)
- 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
- 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		
Parameter	**Value**	**Unit**
Volume of liquid (ED3N-3 – Treated Leachate)	0.413	mL
Volume of dry N_2	25	L
Measured odour concentration	7,510	ou
Calculated liquid odour concentration	= (7,510 x 25/1000)/0.413 = 455	ou.m^3/mL

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-3) that returned a measured odour concentration of 455 ou.m^3/mL (see **Table D2**) with an evaporation rate of 0.197 L/sec (based on on-site evaporation data collected by VES over May 2007 - June 2012).

Odour concentration	= 455 ou.m^3/mL
Ambient pond evaporation rate	= 0.196.6 L/sec
Odour emission rate	= 455 ou.m^3/mL x 196.6 mL/sec
	= 89,500 ou.m^3/sec