EASTERN CREEK WASTE PROJECT

REVISED 27 FEBRUARY 2017

LANDFILL GAS MONITORING PROGRAM

Reviewed by: Pacific Environment (February 2016)

Former QUARRY SITE AT OLD WALLGROVE ROAD EASTERN CREEK

MATERIAL PROCESSING CENTRE (MPC)

WASTE TRANSFER FACILITY associated with an adjacent

SOLID WASTE LANDFILL

Document Control

Reference Documents

22 December 2009 Air Quality Management Plan by PAE Holmes – Consultant Aleks Todoroski (**PAE Holmes**)

December 2011 Landfill Environmental Management Plan by Douglas Partners (**LEMP**);

January 1996 Environmental Guidelines: Solid Waste Landfills – NSW Environment Protection Authority (**Environmental Guidelines 1996**)

March 2015 Draft Environmental Guidelines: Solid Waste Landfills – NSW Environment Protection Authority (**Draft Environmental Guidelines 2015**)

April 2016 Environmental Guidelines: Solid Waste Landfills – NSW Environmental Protection Authority (**Second Edition**)

September 2011 Victorian Environmental Protection Agency (EPA) Draft landfill gas fugitive emissions monitoring guidelines (**Victorian EPA 2011**)

September 2004 United Kingdom Environment Agency (UK EA) Guidance on monitoring landfill gas surface emissions, LFTGN 07 (**UK EA 2004**)

REVISION HISTORY

Version	Date	Reasons for Change	Prepared By	Authorised by
1	April 2015	Initial commission	Legal	Group General Counsel
2	April 2016	Review	Pacific Environment Ltd	Group General Counsel
3	February 2017	Review	Legal	Group General Counsel

Contents

1 INTRODUCTION

A Landfill Gas Monitoring Program is required to be prepared and implemented in accordance with Condition 37(g) of Schedule 3 of the Project Approval. Condition 37(g) is as follows.

*The Proponent shall prepare and implement an **Air Quality, Odour and Greenhouse Gas Management Plan** for the project to the satisfaction of the Director-General. This plan must:*

(g) Include a program for monitoring subsurface gas, surface gas emission, and gas accumulation in general accordance with the guidance in sections 15-18 of Appendix A of the DECCW's Environmental Guidelines for Solid Waste Landfills

An **Air Quality Management Plan** was prepared by PAE Holmes on 22 December 2009 in compliance with the Project Approval Condition 37 of Schedule 3.

This document has been prepared to provide a complete overview of the Landfill Gas Monitoring Program to be implemented at the Genesis Waste Facility.

This document has been created with reference to the following.

1. Air Quality Management Plan: Eastern Creek Landfill, Waste Transfer & Processing Facility – Final by PAE Holmes dated 22 December 2009 (**AQMP**);
2. Landfill Environmental Management Plan by Douglas Partners dated December 2011 (**LEMP**);
3. Environmental Guidelines: Solid Waste Landfills by NSW Environment Protection Authority dated January 1996 (**Environmental Guidelines 1996**);
4. Environmental Guidelines: Solid Waste Landfills by NSW Environment Protection Authority dated April 2016 (Environmental Guidelines 2016).
5. September 2011 Victorian Environmental Protection Agency (EPA) Draft landfill gas fugitive emissions monitoring guidelines (**Victorian EPA 2011**)
6. September 2004 United Kingdom Environment Agency (UK EA) Guidance on monitoring landfill gas surface emissions, LFTGN 07 (**UK EA 2004**)

Landfill gas emissions are expected to develop as filling proceeds and considering a small proportion of waste will be of an organic nature (but not necessarily putrescible), gas emissions need to be monitored and managed.

There are three types of landfill gas monitoring included in the program. Each will be addressed separately. A summary will be provided at the end.

2 SUBSURFACE GAS MONITORING

The purpose of subsurface gas monitoring is to measure concentrations of landfill gases in the ground in and around the shallow monitoring boreholes. The results of the monitoring data will be used to assess the potential for lateral migration of landfill gas off the boundary of the property and therefore likely risk levels to nearby receptors.

2.1 Reference Documents

Subsurface landfill gas monitoring will be undertaken in accordance with:

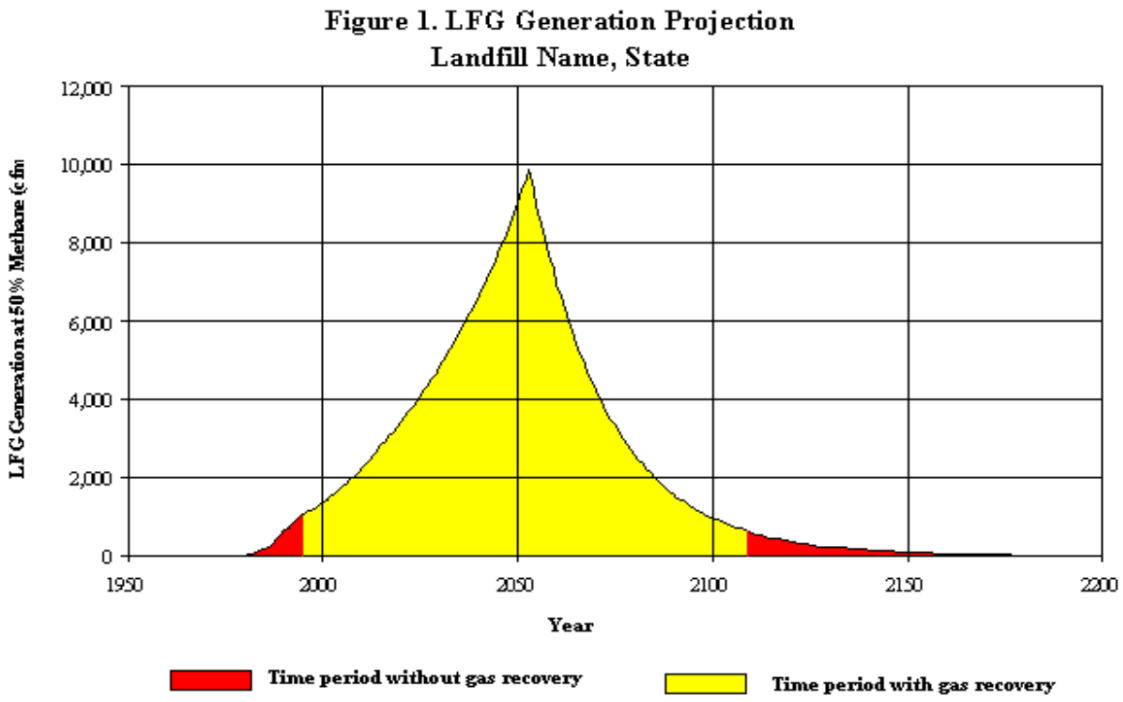
- Appendix A, Section 15 – 16 of the Environmental Guidelines 1996;
- Section 5.3 of the Environmental Guidelines 2016;
- Table 4.7 and Section 5.1 of the LEMP;
- Section 4.4 of the AQMP.
- Victorian EPA 2011
- UK EA 2004

2.2 Monitoring Frequency

Monitoring will be undertaken **quarterly** as recommended by the Environmental Guidelines.

The ***Guidance on the Management of Landfill Gas (UK Environment Agency, 2004)***, as referenced on the NSW EPA Environmental Guidelines "***Solid Waste Landfills***" (second Edition 2016), states: "*Depending on the type of waste, moisture content of waste, cover properties and other criteria, it can take anywhere from several months to several years for waste to reach the methanogenic phase of landfill gas production. As such, methane generation is not immediate. Even for bioreactor landfills, where gas production is maximized. For conventional landfills the time window may be as long as three to five years before measurable gas production begins, depending on the site-specific conditions, particularly for dry climate landfills*".

According with USEPA's LFG emissions model (LandGEM) (USEPA, 1997), gas generation resembles a bell curve as shown in the figure below:



LandGem is based on a first-order decomposition rate equation for quantifying emissions from the decomposition of landfilled material in municipal solid waste (MSW) landfills. The first-order decay model is also used by IPCC and is the standard and accepted technique for estimating LFG generation. During the early and late phases of a landfills lifetime, LFG generation is at is lowest, as shown on the figure. LFG generation decreases after the landfill is closed, as shown at the peak of the graph, which occurs the year after closure.

Based on the aforementioned, monitoring will be undertaken within the first three years of landfill operations. An evaluation of the landfill gas data collected will take place after the first three years of monitoring, to determine whether monitoring may be undertaken on an annual basis, a good indicative of efficient landfill gas management will be, if, during the preceding 3 years, levels above the threshold are not detected.

If concentrations of LFG exceed those prescribed in Section 2.5 of this document then monitoring frequency will increase to monthly. This will continue until concentrations fall below the threshold. If methane is not detected in the perimeter wells for 12 months, annual monitoring may take place.

2.3 Monitoring Procedure

A network of sub-surface gas monitoring wells will be installed around the perimeter of the site (i.e. not in or near the waste). The depths of the wells will extend to either, the minimum groundwater level, the greatest depth of the waste or 10 meters below underground utilities or manholes within 50 meters of the landfill. The wells will also be placed at intervals that are sufficiently small enough to enable detection of any potential off-site migration of gas.

There are 3 groundwater monitoring wells established to monitor landfill gas.

The wells will have slotted probes with bentonite seals between monitoring zones, with the monitoring zones backfilled with pea gravel to facilitate movement of gas.

A trained field technician will use a GA5000 (or equivalent) landfill gas analyser with attached in-line water trap and filter at each sampling location. The following procedure will be used:

1. Open bore to expose brass coupling
2. Zero flow reading on analyser
3. Connect LFG flow inlet tube to borehole, wait 60 seconds for flow to stabilise and record flow
4. Zero differential pressure reading
5. Connect LFG analyser to bore and record differential pressure
6. Sample (minimum 2 minute period) until stabilised or 10 minutes (whichever comes first)
7. Record available gas readings. If stabilisation is not achieved, then record peak and final gas concentrations with a note that stabilisation has not occurred. Data to be reviewed as per data validation procedure.
8. Disconnect analyser, secure probe and perform fresh air purge before commencing monitoring at next gas bore.

The parameters described in Table 1 will be recorded.

2.4 Monitoring Device

A zeroed and calibrated GA5000 Landfill Gas Analyser [commonly used] will be used to conduct sub-surface gas monitoring. The device is capable of detecting low concentrations of methane, carbon dioxide, balance gas, hydrogen sulphide and borehole flow and pressure.

2.5 Gas Threshold

If levels of methane are detected above **1.25% (v/v)**, the EPA will be notified within 24 hours. The frequency of monitoring will also be increased to monthly until levels fall below the threshold.

Within 14 days of notifying the EPA, a plan for further investigation and/or remediation of the elevated gas levels will be submitted to the EPA.

Table 1 - Subsurface monitoring - parameters to be measured with thresholds

Parameter	Units of measurement	Threshold	Action if threshold exceeded
Methane	%v/v	1.25	Inform EPA within 24 hours
Carbon Dioxide	%v/v	n/a	Information only. Increases above background should be observed
Balance gas (nitrogen)	%v/v	n/a	
Oxygen	%v/v	n/a	
Carbon monoxide	Parts per million (ppm)	100	100 ppm or any increase above background should be reported to the EPA within 24 hours
Hydrogen sulphide	ppm	n/a	Information only
Relative pressure	millibar	+/- 0.5	Information only
Borehole flow	Litres per hour	+/- 0.5	Information only

2.6 Landfill subsurface hot spot and fire

Methods for detecting subsurface fires has largely been adopted from LFTGN03 guidelines as described in the following section.

Temperature is an important factor influencing the rate of LFG production as well as indicating landfill subsurface fires. Initial aerobic phases of waste degradation in waste placement cells of less than 5 years are expected to have waste temperatures as high as 80 – 90°C. LFG temperatures are expected to stabilise at 35 – 45°C once methanogenesis is well established.

Generally a subsurface fire can be confirmed by a combination of the following conditions:

- Substantial settlement over a short period of time.
- Smoke or smouldering odour emanating from the LFG collection system or landfill.
- Levels of carbon monoxide (CO) in excess of 1000 parts per million (ppm).
- Combustion residue in LFG extraction wells and/or extraction lines.
- Increase in LFG temperatures in the extraction system (above 60°C).
- Waste mass temperatures in excess of 77°C.

The California Integrated Waste Management Board has been used as an additional resource on managing the potential for subsurface fires. The California Integrated Waste Management Board provides guidelines on using CO as a key performance indicator of landfill fire.

An assessment of a potential subsurface fire can be made using the following confirmation techniques using CO:

- CO in excess of 1,000 ppm is a positive indication of an active underground landfill fire.
- Levels of CO between 100 and 1,000 ppm are viewed as suspicious, requiring further air and temperature monitoring.
- Levels between 50 and 100 ppm indicates that active combustion could be present.

CO is to be regularly monitored using the LFG analyser in assessing the potential for a subsurface fire.

Where CO levels are reported to be >100 ppm the sample should be repeated and if a genuine reading reported to the EPA within 24 hours.

3 SURFACE GAS MONITORING

Monitoring of methane gas emissions from the landfill surface is undertaken to identify faults in the gas management system or capping layers, prioritise required remediation and to measure the level of emissions from the site. A qualitative estimate of methane emissions through the surface cap can be made using a hand-held instrument. However, very low flux cannot normally be detected and localised on a landfill cap.

3.1 Reference Documents

Surface landfill gas monitoring will be undertaken in accordance with:

- Appendix A, Section 17 of the Environmental Guidelines 1996;
- Section 5.2 of the Draft Environmental Guidelines 2015;
- Section 5.7 of the LEMP;
- Section 4.4 of the AQMP.

3.2 Monitoring Frequency

Monitoring will be undertaken **monthly** as recommended by the Environmental Guidelines.

Monitoring will be undertaken on a monthly basis for 3 years during operations from the first monitoring event. After this period, monitoring will be undertaken quarterly for the following 2 years. Following this period, monitoring may be performed on an annual basis if levels above the threshold are not detected.

The results of the emissions survey is used to identify areas of a landfill cap that require remediation.

Any areas where elevated readings are identified are rectified to design conditions by reworking the landfill cap to repair any defects where emissions have been detected. The area of concern is subsequently retested with an FID to ensure the area has been adequately remediated.

3.3 Monitoring Procedure

A trained field technician will test the atmosphere 5cm above the surface of the ground that is in areas with intermediate and final cover where wastes have been placed. The technician will start at a point that is 5 meters away from the waste perimeter and proceed to walk across the waste, parallel to the boundary until they reach the other side. This method will then be repeated at periods every 25 meters inward from the perimeter until the opposite side of the waste landfill is reached. These testing paths will be undertaken to form a grid pattern across the landfill.

Depressions in the cover material and any surface fissures away from areas sampled using the above method will also be tested.

Testing will be conducted on calm days where winds are below 10 kilometres per hour and also during period of relatively low and stable atmospheric pressure (i.e. less than 101.3kPa).

The following survey protocol will be adopted:

- Prior to mobilisation to the Site for completion of the monitoring event, the assigned technician completes a background check of the monitoring apparatus at a location nearby but not directly connected to the Site to determine background conditions.
- The instrument is connected by tubing to a funnel and pipe assembly, which allows the monitor to be placed in relative contact with the landfill cap surface without the need to bend over. Additionally, this set up minimises any potential interferences with sample collection by weather conditions during completion of emissions monitoring.
- Each location is monitored for a minimum of one minute, or until the reading is relatively stable. Additional measurement locations are added, at the discretion of the surveyor, based on observations noted during the monitoring operations.
- All measurements will be recorded either on a field form or through data logging as available.
- Levels of gas measuring 500 ppm or higher on the cap's surface will be identified with a marker intended to remain in-place until in-depth inspections can be completed.
- Monitoring data will be reviewed/analysed in a spatial context, after collection, to determine the need for additional follow-up monitoring to tighten the monitoring grid in areas that may appear to have hotspots of fugitive gases leaking through the landfill cap.
- Weather conditions at the time of the monitoring event will be observed and recorded including; temperature, cloud cover, barometric conditions (rise/fall) and wind conditions. The monitoring event will not be performed less than two days following a rainfall event.

3.4 Monitoring Device

A Flame Ionisation Detector (FID), or equivalent gas meter such as laser diode meter (Inspectra[1]), will be utilised for the survey.

3.5 Gas Threshold

If at any point on the landfill surface a concentration greater than **500 parts per million (v/v)** of methane is found, the threshold is exceeded. Corrective action will then take place such as repairing or replacing cover material and/or adjusting or installing gas extraction equipment.

4 ACCUMULATION LANDFILL GAS MONITORING

Accumulation gas monitoring is undertaken to ensure and demonstrate that gas does not accumulate in enclosed spaces on or near the landfill so as to create a risk of explosion. Notably, LEMP states that no buildings on or adjacent to the site are believed to be at significant risk from gas build up[2]. Yet, monitoring will take place.

4.1 Reference Documents

Accumulation landfill gas monitoring will be undertaken in accordance with:

- Appendix A, Section 18 of the Environmental Guidelines 1996;
- Section 5.4 of the Draft Environmental Guidelines 2015;
- Table 4.7 and Section 5.1 of the LEMP;
- Section 4.4 of the AQMP.

4.2 Monitoring Procedure

A trained field technician will test the atmosphere in all buildings within 250m of the landfill boundary. The technician will test throughout each building, ensuring that all likely points of gas entry are tested by positioning the sample inlet to within 50 mm these points. The following areas will be tested:

- Flooring, windows, doors, pipes, air conditioners, gas appliances and drains.

All buildings within 250 meters of deposited waste or leachate storage will be tested.

4.3 Monitoring Frequency

Monitoring will be undertaken **monthly** as recommended by the Environmental Guidelines.

[1] The Inspectra is specific for methane, the FID will detect VOCs. It is considered appropriate to measure methane (which is odourless) as a vector and bulk component of a gas mix that may contain trace gases at significantly lower concentrations that are odourous e.g. hydrogen sulphide.
[2] This statement has been made without any formal risk assessment having been undertaken

Monitoring will be undertaken on a monthly basis for 3 years during operations from the first monitoring event. After this period, monitoring will be undertaken quarterly for the following 2 years. Following this period, monitoring may be performed on an annual basis if levels above the threshold are not detected.

4.4 Monitoring Device

A tested and calibrated instrument designed for measuring VOCs in the ppm range should be used. The instrument will be calibrated and used with ppm and Lower Explosive Limit (LEL) scale readout. There a number of instruments suitable for this purpose such as an MX6 IBRID or QRAE 11; these are designed for occupational health monitoring[3].

4.5 Gas Threshold

If gas concentrations exceed **10 % LEL or 5000 ppm** inside buildings, the threshold is breached. In the event that the threshold is exceeded, daily monitoring will take place until ventilation or other control measures are put in place to control the build-up of methane. The concentration of VOCs in ppm, if below the threshold range, will be recorded and observed to ensure early release of LFG is identified. This will allow early preventative actions to be taken.

The EPA will be notified within 24 hours and will also be provided with a plan for further investigation and /or remediation of the elevated gas levels within 14 days.

5 SUMMARY

Table 2: Summary of monitoring frequencies and threshold levels initially required.

Type of Gas being Monitored	Frequency	Threshold
Subsurface Gas	Quarterly	1.25% methane (v/v)
Surface Gas	Monthly	500 parts per million (v/v)
Gas Accumulation	Monthly	10 % of the LEL or 5000 ppm

[3] Photo Ionisation detectors (PIDs) are not suitable for this application as they are not sensitive to methane