

#### REPORT

# Sandsfield Gravel Company Ltd

Landfill Gas Management and Monitoring Plan - Milegate Eastern Extension

Submitted to:

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20148978.641/A.0

28 June 2022

# **Distribution List**

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#### **REPORT CONTEXT** 1.0

#### 1.1 **Terms of Reference**

Sandsfield Gravel Company Ltd ('Sandsfield') has requested Golder Associates (UK) Ltd ('Golder') develops a Landfill Gas Management and Monitoring Plan at Milegate Extension Landfill Site ('Milegate Extension Landfill') including the proposed extension towards east ('Eastern Extension') which are collectively referred to as the 'Site'. A location plan for the Site is provided in Drawing ESID1 - Site Location Plan.

The Pre-Operational Measures issued as a part of the Permit have now been addressed and appropriate actions have been implemented as outlined in the current EP Table S1.2.

This report details the Landfill Gas Management and Monitoring Plan implemented at the Site. It has been developed in accordance with the Landfill Gas Risk Assessment (GRA; ref. 20148978.635) of the Permit variation application; and incorporates the requirements of, and wholly supersedes, Landfill Gas Management and Monitoring Plan (ref. 06529180.507) submitted to the Environment Agency (EA) as a response to Pre-operational condition 10 and Improvement condition 3 and 4.

#### 1.2 **Report Structure**

Defined within the EA publication LFGTN 03, 2004 'Guidance on the management of landfill gas' (September 2004), the Gas Management Plan:

...provides a framework for the management of landfill gas based on the site characteristics and the nature and extent of the gas control system ... '

Key elements of the Gas Management and Monitoring Plan include the landfill gas risk assessment, specification of control measures and definition of operational procedures, monitoring plan, and action plan. This Gas Management and Monitoring Plan details each of these elements as applied to the Site set out as follows:

- Section 2.0 describes the landfill gas generation and risk assessment for the Site;
- Section 3.0 describes the principles of landfill gas management at the Site;
- Section 4.0 describes the external landfill gas monitoring infrastructure to be installed at the Site;
- Section 5.0 describes the internal landfill gas extraction and monitoring infrastructure to be installed at the Site:
- Section 6.0 describes the maintenance of landfill gas monitoring boreholes and how they will be decommissioned;
- Section 7.0 describes the landfill gas monitoring plan;
- Section 8.0 describes the monitoring of surface emissions;
- Section 9.0 describes monitoring of the gas flare;
- Section 10.0 describes the monitoring of the gas engine; and
- Section 11.0 describes the trace gas monitoring.



#### LANDFILL GAS RISK ASSESSMENT 2.0

The range and quantities of wastes received at the Site generate landfill gas. The anaerobic degradation of biodegradable wastes results in the production of landfill gas made up of a mixture of methane and carbon dioxide with trace quantities of a number of organic gases.

An updated detailed assessment of the generation of landfill gas and associated risk assessment including the Eastern Extension as well as gas engine installation and operation has been completed as part of the variation application, Gas Risk Assessment (GRA, ref. 20148978.635).

#### LANDFILL GAS MANAGEMENT 3.0

A scheme for the monitoring and control of landfill gas within the performance specifications detailed in LFGTN 03 'Guidance on the management of landfill gas' (September 2004) is set out below. It is anticipated that within the period of operation of the Site, changes in the understanding of the technology will occur, which will be reflected in amendments to the advice given to the industry or the regulations issued by Government. This statement will be periodically reviewed to reflect such changes.

Gas management and control will be achieved by:

- The operation of an internal gas monitoring system;
- The operation of an external gas monitoring system;
- An active gas extraction system;
- The low permeability lining system installed across the base, perimeter slopes and top of the Site;
- An enclosed ground flare; and
- And two micro generator gas engines.

An active gas control system is required for the Site, due to the waste types and quantities that are deposited. Currently, landfill gas is removed from the landfill via gas extraction wells. A landfill gas extraction system consisting of pipework and manifolds connects the wells to the enclosed flare where the gas undergoes combustion. An enclosed Biogas high-temperature (1,000°C combustion temperature) flare with a maximum capacity of 1,000 Nm<sup>3</sup>/hr is currently installed at the Site.

The current GRA (ref. 20148978.635) finds the quantities of gas generated at the Site to be sufficient for energy generation via two micro generator gas engines. These will be located in the northwest corner of the Site, within close proximity of the gas flare.

Perimeter landfill gas monitoring is completed in boreholes installed outside the waste mass at the Milegate Extension Landfill to identify any migration of landfill gases from the Site. A comparable scheme will be extended to the Eastern Extension.



# 4.0 PERIMETER LANDFILL GAS MONITORING INFRASTRUCTURE

### 4.1 Location and Installation of Boreholes

Section A *Environmental Setting and Installation Design* and Section D *Landfill Gas Generation and Risk Assessment* of the original PPC application have demonstrated that the lateral gas migration risk from the Site is low. The geological environment is typically matrix permeability dominated strata and there is no development within 250 m. The recommended borehole spacing, as given in the EA's guidance LFTGN 03 (2004), is therefore 20 to 50 m.

As such, the monitoring of landfill gas concentrations outside of the engineered containment system is carried out in 22 landfill gas monitoring boreholes around the perimeter of the Milegate Extension Landfill, at an approximate spacing of 50 m, as shown in **Drawing ESID8 - Landfill Gas Management Infrastructure**.

### 4.2 Design of Boreholes

Each borehole is advanced to the anticipated depth of the base of the landfill cell or into the Boulder Clay, which is approximately 15 m below ground level. Each borehole was drilled to a diameter of 150 mm. Landfill gas wells comprise a 50 mm inside diameter PVC or HDPE casing, perforated throughout its length except for the top metre. The casing is surrounded with a filter wrap to prevent ingress of fines and is surrounded with a 2 to 6 mm gravel pack, except for the top metre fitted with a bentonite seal. End caps are fitted to the base of the well casing and the top of the casing is fitted with a gas tap. Secure lockable headworks are fitted over the top of the well and concreted into position. The design specification for the landfill gas monitoring boreholes is shown in **Drawing GMP1**.

### 4.3 Construction Quality Assurance of New and Replacement Monitoring Points

Installation of new or replacement landfill gas monitoring boreholes has been and will continue to be undertaken in accordance with the following Construction Quality Assurance (CQA) Plan which covers the elements of the design and installation.

The CQA Plan will include but not be limited to the following:

CQA supervision will be carried out full time during the Site works. The engineer will conduct the following:

- Record the drilling locations;
- Make observations regarding the lithology encountered during drilling and record details regarding water strikes;
- Record the depth of drilling;
- Describe the materials in relation to the specification;
- Record the way installation materials are delivered, handled and stored with reference to the manufacturer's recommendations; and
- Record the installations with reference to the design.

Landfill gas monitoring boreholes will be drilled and recorded in accordance with BS 5930 Code of Practice for Ground Investigations. Borehole logs and *as-built* installation details will be forwarded to the EA and will provide the following information:



- Labelling of the borehole;
- Date of drilling and installation;
- Geological strata descriptions;
- Groundwater level (and any perched water levels);
- Design of the borehole if more than one type is being used on the Site;
- Depth of borehole (metres) and level of the bottom of the borehole in metres above ordnance datum (m AOD);
- The surveyed height of the top of the borehole in metres above ordnance datum, and the surveyed ground level at the point if it differs; and
- The National Grid Reference of the boreholes (10 figure).

A CQA validation report will be provided that includes the above details and borehole construction detail drawings. The CQA validation report will be submitted to the EA within 3 months of completion of installation.

Following installation, all landfill gas monitoring boreholes will be levelled to Ordnance Datum, and an elevation reference mark permanently placed on the point. Where any monitoring well is extended or repaired, the well will be resurveyed within one month.

# 5.0 IN-WASTE LANDFILL GAS EXTRACTION AND MONITORING INFRASTRUCTURE

### 5.1 **Temporary Gas Extraction**

In the light of an early onset of gas production during filling, horizontal scavenger systems may be installed prior to completion of filling in future phases to control odour and landfill gas. These sacrificial systems have the advantage that the degree of gas control can be adjusted during the filling processes by installing additional horizontal scavenger pipes as the level of waste increases. A common outlet gas pipe can be connected to the main gas extraction system to connect the scavenger system to the enclosed ground flare. Detailed plans will be submitted when deemed necessary, i.e. in response to landfill gas being detected in perimeter landfill gas monitoring boreholes or odour problems being encountered while filling, and in accordance with the EA.

### 5.2 Permanent Extraction Well Design and Location

The permanent gas extraction system has been and will continue to be progressively installed within 12 months after each cell has been filled at the Site. The landfill gas extraction wells are spaced with an approximate 20 m minimum radius of influence (40 m grid) to ensure that the landfill gas is drawn back towards the centre of the Site and away from the side slope liner.

### 5.3 Gas Extraction Well Design

Each extraction well has been and will continue to be drilled at a nominal diameter of 250 mm, with a nominal 150 mm diameter well liner installed in the borehole, the annulus being filled with typically 20 mm granular material. The gas wells extend to no more than 80% of the depth of the waste. The proposed gas well location shall be surveyed immediately prior to drilling to confirm the required drilling depth and to ensure no damage to the lining system. The well liner is slotted to 2 m below the capping layer.



#### 5.4 **Carrier Pipework and Fittings**

Gas extraction pipelines from individual wells connect to a ring main feeding the gas flare and any future microturbines installed at the Site. The ring main collects gas via a system of manifolds and has condensate traps (pots) installed in the system at appropriate intervals to prevent the build-up of condensate inside of the pipework. Pipework and fittings comprise varying sizes fabricated from HDPE or MDPE materials. A continuation of the currently existing system is planned to be extended to the Eastern Extension and the ring main will feed the gas engine.

Sections to be welded shall be cleaned and otherwise prepared for electrofusion welding. All joints are to be quality controlled electrofusion joints or butt joints installed by an automated controller unit with hard copy output.

Automatic welding techniques shall be used and the logs of each weld shall be included in the CQA reporting. All welds shall be uniquely identified on the joint with white permanent marker and a white 'tell-tale' mark made across the joint; where possible joints shall be clamped during welding and cooling.

#### 5.5 Construction Quality Assurance of the Landfill Gas Management Systems

A third party CQA Engineer has and will continue to supervise all drilling work and installation of carrier pipework, manifolds and dewatering legs. A record of all materials used in the construction of the landfill gas collection system, details of all joints and other connections, and as-built records of gas extraction wells and dewatering legs shall be submitted as part of the CQA report for capping and restoration. Construction Quality Assurance shall include inspection, recording and approval of:

- Delivery and storage of material; collation of material quality control certificates;
- Installation and welding preparation procedures;
- Welds and collation of welding logs and records;
- Repair of defective welds;
- Construction of dewatering points;
- Effective dewatering of pipework during construction; and
- Drilling works and well installations.

The landfill gas extraction wells are used as monitoring points to determine gas concentrations, and for active extraction when required. To enable monitoring, a port is installed on the side of the wells or at the manifold to allow suitable access for monitoring equipment. Monitoring commences from the date of installation of the landfill gas extraction wells within the respective cells.

As the volume and quality of gas decreases with time after Site closure and gas collection ceases, on-Site landfill gas concentrations will be monitored in a limited number of wells to be identified and agreed with the EA.



#### MAINTENANCE OF LANDFILL GAS MONITORING POINTS 6.0

#### 6.1 **Borehole Maintenance**

Landfill gas monitoring boreholes are maintained in a condition that allows them to fulfil their required purpose. Boreholes are inspected for damage each time that they are monitored or sampled. Any damage noted is repaired within seven days of detection, where possible. Where a borehole is damaged, such that it requires replacement, a replacement borehole will be drilled within one month subject to availability of drilling contractor, weather conditions, and access to the location, and in any event, no later than within three months.

Details of inspections of monitoring boreholes, remedial actions undertaken, or replacement boreholes installed are recorded in the site diary, to include relevant dates of inspections and remedial works and details of who carried out the inspection or works.

#### 6.2 Borehole Redundancy and Decommissioning

The following details for decommissioning of redundant boreholes have been based on guidelines from the EA.

Decommissioning will proceed with the following objectives:

- Remove the hazard of any open hole (safety issues); and
- Prevent the borehole acting as a conduit for contamination to enter groundwater.

The borehole shall be made free from all obstructions. In particular, pipe work and the condition of the casing shall be checked to ensure retention of the grout. The hole should be backfilled with uncontaminated material of a similar permeability to that of the geological strata against which they are placed.

When sealing the top of the borehole the final two metres from ground level should be filled with cement concrete or bentonite grout and a concrete or cement cap should then be installed over the top of the borehole and surrounding ground.

Where necessary, the decommissioning process should mimic the existing permeability of the geological stratigraphy and prevent a contamination pathway occurring.

The following shall be recorded when decommissioning:

- Reasons for abandonment;
- Measurement of groundwater level prior to backfilling;
- The depth and position of each layer of backfilling and sealing material;
- Any changes made to the borehole during abandonment; and
- Any problems encountered during the abandonment procedure.

#### EXTERNAL AND INTERNAL LANDFILL GAS MONITORING PLAN 7.0

#### 7.1 External Landfill Gas Monitoring Plan

#### 7.1.1 **External Programme**

The existing external landfill gas monitoring programme at the Site, in accordance with Table S3.5 of the Permit, and the future planned monitoring due to the addition of the Eastern Extension is presented in Table GMP1. Existing and proposed monitoring points are shown on Drawing HRA1 - Monitoring and Extraction Point Plan.



Location 1	Measurement or Analysis Required	Frequency
Existing Boreholes BHG01, BHG02, BHG03, BHG04, BHG05, BHG06, BHG07, BHG08, BHG09, BHG10, BHG11, BHG12, BHG13, BHG14, BHG15, BHG16, BHG17, BHG18, BHG19, BHG20, BHG21, BHG22, BHG21, BHG22,	Methane, Carbon Dioxide, Oxygen, Atmospheric Pressure, Differential Pressure, Temperature, Meteorological data	Monthly
Eastern Extension Boreholes BHG23, BHG24, BHG25, BHG26, BHG27, BHG28, BHG29, BHG30, BHG31, BHG32, BHG33, BHG34, BHG35, BHG36, BHG37, BHG38, BHG39, BHG40, BHG41, BHG42	Methane, Carbon Dioxide, Oxygen, Atmospheric Pressure, Differential Pressure, Temperature, Meteorological data	Monthly

#### Table GMP1: External Landfill Gas Monitoring Programme

#### 7.1.2 External Landfill Gas Limits and Action Plans

The monitoring results obtained from the existing external landfill gas monitoring boreholes (BHG01 to BHG22) have been and will continue to be compared against trigger levels. The trigger level for methane is set at 1% above background concentrations and the trigger level for carbon dioxide is set at 1.5% above background concentrations. Trigger levels are set at 1% v/v for methane, and at 6.4% v/v for carbon dioxide.

For the new boreholes in the Eastern Extension, BHG23 to BHG42, background methane and carbon dioxide limits will need to be established to determine appropriate action levels and compliance limits. These action levels and compliance limits will be completed in line with the following documents:

- The Environment Agency Position Statement on Industry Code of Practice of Soil Gas (August 2011);
- Industry Guidance 'Perimeter soil gas emissions criteria and associated management' (January 2011, Version 1.01, the 'ICoP')

The ICOP states that carbon dioxide should not be used to regulate emissions as there are alternative sources in the sub-surface environment. It takes the position that no compliance (formerly trigger) limits should be set for carbon dioxide in the future emissions performance assessment of a site. However, carbon dioxide data should continue to be collected and assessed against a lower action (formerly control) level because this activity informs the conceptual model and initiates investigatory action by the Operator.

24 to 30 background data points should be viewed as a minimum before statistics can be reliably applied to the data set and compliance/action limits set.

All routine perimeter well monitoring data on operational sites will be assessed at monthly intervals to establish whether there are any changes to the normal and seasonal trends which may be indicative of a problem and could require additional monitoring or emergency measures to be taken. Any variance from the established trends will be reported to the EA. Remedial measures will, if required, be agreed in conjunction with the EA.



Where results for any borehole(s) exceed(s) the compliance or trigger levels, then the requirements of the landfill gas emergency plan will be implemented. These will incorporate agreement of further actions in conjunction with the EA.

In complying with the following sections, where a compliance or trigger level, is exceeded, the EA will be informed immediately and where additional monitoring is required under the following sections, this will be forwarded to the EA on the day of measurement. If, after reverting back to normal monitoring, a compliance or trigger is subsequently again exceeded the EA will be re-notified of the exceedance.

The actions, responses and procedures outlined in Table GMP2 will be taken in respect to methane and carbon dioxide data obtained from perimeter monitoring boreholes.

Limit	Immediate Action by Technician	Action by Site Manager	Subsequent Action				
BH1 to BH22	BH1 to BH22						
CO2 trigger levels exceeded	Move to weekly monitoring of the boreholes subject to exceedance and adjacent boreholes. Inform Site Manager	EA notified	None				
CH4 levels in any boreholes exceed 1% v/v	Move to daily monitoring of the boreholes subject to exceedance and adjacent boreholes. Inform Site Manager	EA notified	Further investigation and/or control measures as agreed with the EA				
BH23 to BH42							
CH4 Action level exceeded	management reactions are required because exceedance may mean an operational loss of gas control	EA does not need to be informed	none				
CH4 Compliance limit exceeded	Move to daily monitoring of the boreholes subject to exceedance and adjacent boreholes. Inform Site Manager	EA notified	Further investigation and/or control measures as agreed with the EA				

#### Table GMP2: Landfill Gas Action Plan

### 7.2 Internal Landfill Gas Monitoring Plan

### 7.2.1 Internal Monitoring Programme

The internal landfill gas monitoring programme undertaken at the Site is presented in Table GMP3 in accordance with Table S3.8 of the Permit.



Location	Measurement or Analysis Required	Frequency
In waste gas monitoring boreholes or sealed leachate wells or sacrificial gas extraction system	Methane, Carbon Dioxide, Oxygen, Carbon Monoxide Atmospheric Pressure, Differential Pressure, Temperature, Meteorological data.	Monthly
	Hydrogen sulphide	Six monthly Quarterly for cells which have no active gas extraction
Input to Gas Flare/Turbine	Methane Carbon Dioxide Oxygen Gas flow rate Suction % Balance Gas (calculated as the difference between the sum of measured gases and 100%)	Weekly

#### Table GMP3: Internal Landfill Gas Monitoring Programme

Notes: After installation - final number of boreholes to depend on Site conditions.

In accordance with Table S3.8 of the PPC Permit, for input to the flare, where the oxygen level exceeds 5%, or where the % balance gas is greater than 20% an assessment of air ingress into thesystem shall be undertaken.

### 7.3 Quality Assurance of Monitoring and Sampling

### 7.3.1 Monitoring Personnel

Landfill gas monitoring is only undertaken by personnel who are familiar with the equipment and its limitations. The Company ensures that the personnel engaged in monitoring activities are trained to undertake the task. These comprise the company's own technical personnel, the Landfill Manager or nominated deputy, or a suitably experienced sub-contractor, following appropriate training by technical personnel. All monitoring staff undergo a period of job training and in addition external courses are used to supplement internal training.

### 7.3.2 Monitoring Procedures

Monitoring by portable instruments is carried out for methane, carbon dioxide, oxygen, and temperature.

Calibration and servicing of the portable instruments are carried out in accordance with the manufacturer's recommendations, and records of calibration certificates are maintained on Site, as per externally verified QA procedures.

As part of calibration and servicing, the manufacturer carries out a pre-calibration test against calibration gases to a known and traceable standard, to confirm the accuracy of the instrument pre-calibration. Servicing is undertaken at 6-monthly intervals and includes a pre-calibration check against gases of known standard, repairs and servicing, calibration and a post calibration check. The pre-calibration test certificate (or copy) is also held on-Site with the post calibration test certificate (or copy).

#### 7.3.3 Monitoring Methodology

Before taking gas measurements, the gas monitoring instrument is switched on and the methane and carbon dioxide readings allowed to zero whilst drawing clean air (away from any potential sources of venting landfill gas). All landfill gas monitoring boreholes are monitored by connecting the probe from the gas measuring instrument directly to the sampling tap of the borehole to be monitored.

Boreholes are not to be monitored with the removable cap taken off as this would allow air dilution of the gases within the borehole being monitored. Once connected to the borehole, gas is drawn through the instrument and the readings monitored until stable readings are obtained. Once stable readings have been obtained, the values are recorded. Where a Geotechnical Instruments analyser is being used, the results are logged electronically on the instrument for future reference and downloading. Once the measurement has been taken and recorded, the sampling tap on the borehole are closed. The instrument is allowed to purge, and methane and carbon dioxide readings allowed to zero, before connecting to the next borehole to be monitored.

When required in accordance with the landfill gas action plan, samples may be taken for subsequent laboratory analysis using an appropriately approved technology and relevant sampling methodology.

#### 7.3.4 Analytical Methodologies

The Geotechnical Instruments hand-held instruments have infra-red gas detection for methane and carbon dioxide, and electrochemical cells for other analytes. Where samples are sent for laboratory determination, gas chromatographic (GC) analytical techniques will be used to obtain the required analysis. External laboratories to be used for GC analysis will be accredited to UKAS or equivalent accreditation scheme.

### 7.4 Quality Assurance Plan and Quality Control Procedures for Results

#### 7.4.1 Validation of Results

Validation of results is undertaken by the trained monitoring personnel, who is also familiar with landfill gas management and the contents of the landfill gas management plan.

### 7.5 Making and Submission of Records

All landfill gas monitoring results are logged electronically on the gas measuring instrument where electronic data logging instruments are being used. Alternatively, a hard copy is made whilst the monitoring is in progress. Monitoring data sheets are retained on site and may be made available for inspection by officers of the EA upon request. A copy of the results of all landfill gas monitoring is forwarded to the EA quarterly within one month of the end of each quarter, along with details of any parameters which have been identified as being in excess of trigger levels.

An annual report is provided to the EA by 31 January of every year (or other date agreed in writing by the EA) in accordance with Section 4.2 of the EP, detailing a review of the environmental monitoring results obtained from the Site during the previous year, ending up to 3 months before the due date of the report. This review will include an interpretation of the accuracy and validity of results along with an interpretation of the trend of the results against background and trigger levels.



### 8.0 LANDFILL GAS FROM CAPPED SURFACES

### 8.1 Surface Emissions Monitoring

This section details how, in accordance with EA guidance, surface emissions monitoring has been and will continue to be undertaken, including the frequency and location of the monitoring.

### 8.1.1 Monitoring Methodology

The monitoring of surface emissions at the Site has been and will continue to be undertaken in accordance with EA *Guidance on monitoring of landfill gas surface emissions* LFTGN07 V2 (2010). The Site walkover survey will demonstrate whether there are inadequacies in the gas containment and collection system. Only when deficiencies have been located and remediated such that the concentration of gas above the surface is low is it appropriate to begin the second stage comprising a quantitative survey of surface flux.

### 8.1.1.1 Site walkover Survey

- 1) Background data relating to the Site will be gathered.
- 2) The Site's major characteristics will be identified at the outset and recorded on a suitable form similar to the example contained within Appendix B of LFTGN 07, 2010.
- 3) Based on the Site plan, the landfill will be divided into a number of zones dependant on the cap properties.
- 4) Prior to the walkover survey any major faults in the gas management system will be identified and rectified.
- 5) Prior to the walkover survey the general weather conditions will be noted including barometric pressure, recent precipitation, wind speed and direction. Also the nature of areas adjacent to the survey will be noted e.g. activities that may emit gas or lead to gas migration.
- 6) The Site walkover survey will be conducted with a flame ionisation detector (FID) or similar. The sample probe will be held as close to the surface (< 5 cm) as possible. The air at head height will periodically be sampled (to enable distinction of surface emissions from the landfill from other potential upwind sources). Zones identified in the desk study will be traversed in a systematic manner, typically along regular lines 50 m apart on a permanent cap and 25 m apart on a temporary cap. These distances will be reduced where failures in the containment of gas are more likely. In addition, the walkover survey will be directed by observations of the surface, methane emissions measured and secondary factors such as odour. Where high concentrations of methane are detected, the survey will deviate to locate the likely source of the emission. Care will be undertaken when taking measurements in the vicinity of heavy plant, as the unburnt hydrocarbons in diesel exhausts will register on the FID and give potentially misleading results.</p>
- 7) The survey will also identify:
  - a. Surface cracking or fissures;
  - b. Stressed vegetation;
  - c. Interfaces between capped zones;
  - d. Landfill edges and side slopes;
  - e. Gas wells and monitoring points;
  - f. Junctions in gas collection pipework;
  - g. Pathways where pipework may be buried in trenches; and
  - h. Leachate sumps, towers, risers and other monitoring points.

- 8) Where the survey identifies locations with particularly high emissions, these will be marked with paint or poles for attention during subsequent remedial work. It is noted that many fluorescent survey paints are very high in VOCs and will give misleading results for several days if sprayed directly on the landfill surface.
- 9) If the survey demonstrates the cap is not consistent and there are discrete features emitting substantial amounts of landfill gas, remedial action is required as soon as possible.
- 10) The Site survey and subsequent remedial action will continue until the concentration of methane in air is:
  - i. Less than 100 ppmv immediately above the surface on the main zones of the cap; and
  - j. Less than 1000 ppmv close to any discrete features.

#### 8.1.2 Monitoring Frequency

After a zone or area has been capped an initial walkover survey should be undertaken to identify and rectify any major faults in the gas management system. Walkover surveys should be continued until the gas concentrations on the survey are low, as described in section 9.1.1.1, point 10.

This remedial action and re-monitoring of the whole zone by walkover surveys must be completed within a year of placing the cap.

Once a zone or area of a landfill has passed the initial walkover survey regular additional walkover surveys should be carried out to show that there are no gross point source emissions. The frequency of these additional walkovers is site specific, but at a minimum should be quarterly.

Permanently capped, closed areas progressively achieve a reliable degree of gas control. If a previously capped zone has been shown to and there have been no significant physical changes in the gas management during the year, an annual detailed walkover survey to demonstrate the surface emissions are under control may be used.

#### 8.1.3 Reporting of Results

Monitoring data from any surveys undertaken at the Site will be processed following the methodology outlined in Chapter 9, *'Reporting'* contained within LFTGN 07 (2010). Data will be processed, and a mass emission rate reported for each zone or feature.

The results of any walkover survey or remediation plan developed will be presented to the EA.

#### 8.1.4 Remediation

If any zone is found to be non-compliant, the results of the survey will be used to review the overall gas management plan.

Remediation measures will be carried out as soon as reasonably practicable and within timescales agreed with the EA.

### 9.0 GAS FLARE MONITORING

A landfill gas flare is installed at the Site to safely combust landfill gas. The emissions monitoring of the gas flare is undertaken in accordance with EA *Guidance for monitoring enclosed landfill gas flares* LFTGN05 v2 (2010).



#### 9.1 Monitoring Methodology

The monitoring has been and will continue to be undertaken in line with LFTGN v2 05 (2010):

- Sample ports must be fitted in accordance with the requirements of Technical Guidance Document M1or, an alternative method using in situ probes can be utilised.
- Sampling must be undertaken downstream of the flame. Flare designs must include sufficient shroud to fully enclose the flame at all times.
- Emissions must not be impeded by cowls or any other fixture on top of the flare during operation.
- The indicative operational requirements for an enclosed landfill gas flare is to maintain operational control so as to achieve a minimum temperature of 1,000°C and 0.3 seconds retention time at this temperature across the likely range of landfill gas composition and throughput.
- An equivalent validated set of conditions to give complete combustion are acceptable providing compliance with the emission standard is demonstrated. The operating temperature must be monitored.
- The flow and composition of the input gas at the flare must be monitored to demonstrate consistency with operational requirements and the design specification of the flare.

Flares that are unable to meet their operational requirements of 1,000°C and 0.3 seconds retention time at this temperature, or have not been maintained, are unlikely to be monitored in a representative or safe manner. They are unlikely to meet the emission standard and must be regarded as non-compliant. Emissions testing on these flares should not be undertaken until these operational faults have been rectified.

#### 9.2 Parameters to be Monitored

The gas flare emissions will be monitored in accordance with Table S3.2 of the Permit as presented in Table GMP4, below:

Table GMP4: Emission Standards for Enclosed Landfill Gas Flares

Parameter	Compliance Concentration mg/m <sup>3*</sup>		
Oxides of nitrogen as NO <sub>2</sub>	150		
Carbon monoxide (CO)	50		
Total volatile organic compounds as Carbon	10		
Flow	-		
Temperature	-		

\* At STP (273K (0oC), 101.3 kPa), dry gas, 3 per cent oxygen.

#### **Monitoring Frequency** 9.3

In line with Table S3.2 of the EP monitoring of the emissions from the gas flare should be conducted on an annual basis at a minimum.

#### 9.3.1 **Reporting of Monitoring Results**

The monitoring has been and will continue to be reported in accordance with LFGTN05 (2010) and includes details of:



- The test methods;
- Variations from standard methods;
- A tabulated data summary; and
- Ambient conditions during sampling.

Any data considered to be approaching the limit as defined in Section 5.4.2 of LFGTN05 (2010) will be accompanied with information on how uncertainty during future monitoring will be reduced.

If any data is assessed as non-compliant, this will be investigated and reported to the EA. The action undertaken will be in accordance with Section 5.4.2 of LFGTN05 (2010).

### **10.0 GAS ENGINE MONITORING**

Two landfill gas engines will be installed at the Site to generate gas to energy. The emissions monitoring of the engines is undertaken in accordance with EA Guidance for monitoring landfill gas engine emissions LFTGN08 v2 (2010).

### 10.1 Monitoring Methodology

The monitoring has been and will continue to be undertaken in line with LFTGN08 v2 (2010):

- Discharges must be vertically upwards and unimpeded by cowls or any other fixture on top of the exhaust.
- Sampling sockets must be fitted to all new installations, and it is recommended that they are fitted to existing installations.
- The management of crankcase emissions to minimise their release to the environment is recommended.
- Continuous assessment of methane and flow in the inlet gas is recommended.

All annual compliance monitoring of engine emissions must be carried out using an MCERTS accredited organisation using methods detailed in the EA guidance Monitoring stack emissions: techniques and standards for periodic monitoring (2021).

### **10.2** Parameters to be Monitored

The emissions will be monitored, and the engines should comply with the emission standards in Table GMP4, below:

#### Table GMP5: Emission Limits for Spark Ignition Landfill Gas Engines

Parameter	Compliance Concentration mg/m <sup>3*</sup>
NOx	500
CO	1400
VOCs	1000

\* At STP (273K (0°C), 101.3 kPa), dry gas, 5 per cent oxygen.



#### 10.3 **Monitoring Frequency**

An annual emissions compliance test should be undertaken annually at a minimum. Additional monitoring of NOx and CO is required using suitable portable instruments in accordance with the procedure set out in Appendix C, LFTGN08 v2 (2010) to check for any significant upward drift in emissions between annual assessments. The engines should be re-tuned to ensure emissions are within the appropriate limits.

#### 10.3.1 **Reporting of Monitoring Results**

The monitoring will be reported in accordance with LFGTN08 (2010) in the format shown in Appendix A and includes details of:

- The test methods:
- Variations from standard methods:
- A tabulated data summary; and
- Ambient conditions during sampling.

Any data considered to be approaching the limit as defined in Section 4.6.2 of LFGTN08 (2010) will be accompanied with information on how uncertainty during future monitoring will be reduced.

If any data is assessed as non-compliant, this will be investigated and reported to the EA. The action undertaken will be in accordance with Section 4.6.4 of LFGTN08 (2010).

### 11.0 TRACE GAS MONITORING

Trace gas components in gas are monitored at permitted sites. This is undertaken in accordance with EA Guidance for monitoring trace components in landfill gas LFTGN04 v3 (2010).

#### 11.1 Monitoring Methodology

The monitoring has been and will continue to be undertaken in line with LFTGN04 v3 (2010):

- select the sampling point(s) so the gas sampled is representative of the gas collected at the site, or is representative of a particular area of the site under investigation;
- meter the gas sample to provide an accurate value for the sample volume;
- take precautions to avoid moisture or condensate entering the sampling system;
- take care to prevent contamination or degradation of the sample during transfer to the laboratory and preparation for analysis;
- report any priority trace components that are not positively identified, using the recommended methods as being present at below their respective detection limits. (See Appendix 3 for the recommended detection limits); and
- report any other trace components other than the priority components that are detected.

#### 11.2 Parameters to be Monitored

Trace gases outlined in Table GMP6 will be monitored. Example monitoring techniques are also outlined in Table GMP6 below.



Category	Sampling Method	Analytical Method*			
Priority components	Priority components				
Speciated VOCs <sup>1</sup>	Dual solid sorbent	ATD-GC-MS			
Aldehydes	Reactive sorbent	HPLC			
Hydrogen sulphide	Direct on-site measurement of raw gas or Tedlar Bag and GCMS	Hand-held instrument Laboratory GC			
Arsenic	Solid sorbent	ICP-MS/AAS			
Additional components					
Mercury	Solid sorbent	ICP-MS/CV-AAS			
PCDDs and PCDFs	Solid sorbent	GC-HRMS			
Carbon monoxide	Gresham tube/Tedlar bag	Laboratory GC			

 Table GMP6: Components and Recommended Methods for Monitored Priority Trace Components in

 Landfill Gas

<sup>1</sup> Table 1.1 in LFTGN04 compounds except for those listed subsequently.

### **11.3 Monitoring Frequency**

Monitoring of priority trace components should be carried out annually as a minimum but may be done more frequently subject to site-specific circumstances such as significant changes to the gas management system, high concentrations of particular trace compounds or waste composition

### 11.3.1 Reporting of Monitoring Results

The monitoring will be reported in accordance with LFGTN04 (2010) in the format shown in Appendix 4 and includes details of:

- The test methods;
- Variations from standard methods;
- A tabulated data summary; and
- Ambient conditions during sampling.

Any priority trace components that are not positively identified must be reported as being present at below their respective detection limits.

# Signature Page

Golder WSP

Rounda

Rebecca Brownlow Environmental Consultant

Nicola White Project Manager

Date: 28 June 2022

RB/JS/NW/ab

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#### DRAWINGS

Drawing ESID1 - Site Location Plan

Drawing ESID8 - Landfill Gas Management

Drawing HRA1 - Monitoring and Extraction Point Plan

Drawing GMP1 - Landfill Gas Monitoring Borehole

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#### TITLE SITE LOCATION PLAN

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