BUCKDEN LANDFILL SITE EA/EPR/RP3732SZ

LANDFILL GAS MANAGEMENT PLAN

1 Introduction

1.1 Report Context

The context of this management plan is to outline the procedure of how landfill gas shall be managed at Buckden Landfill Site. This includes the control and utilisation of landfill gas. This management plan fulfils the requirement of the environmental permit, EA/EPR/RP3732SZ.

1.2 Landfill Gas

Landfill gas is typically produced as a result of complex biological and physiochemical processes that occur with the microbial degradation of putrescible waste in an anaerobic environment.

Landfill gas typically has the following characteristics:

- Composition: Mixture of gases, primarily constituted of methane and carbon dioxide in a 60:40 ratio as the bulk gases but may also include small amounts of hydrogen, nitrogen and oxygen. There may also be trace components present within landfill gas and much lower concentrations than the bulk gases.
- Density: Variable and dependant on composition. Mixture ratio of 60:40 has a lower density than air.
- Solubility: Range of components of landfill gas can be dissolved in liquid and includes bulk and trace gas components. This includes methane and carbon dioxide.
- Asphyxiation: methane and carbon dioxide can act as asphyxiates in extreme cases if their presence displaces oxygen to a level lower than 18%.
- Flammability and explosivity: Methane is explosive when mixed in ambient air at concentrations of between 4.5% and 16.5%. Other flammable components exist within landfill gas, including hydrogen (4-75%) and hydrogen sulphide (4-44%).
- Toxicity: Toxic in high concentrations where little atmospheric dilution occurs. Hydrogen sulphide is toxic at low concentrations and can dull olfactory senses.
- Corrosion: Dependant on composition. Typically, carbon dioxide in liquid can form carbonic acid which is acidic by nature. Carbon dioxide at elevated temperatures can cause decarbonisation and carbonisation of varying alloys.
- Odour: Trace components of landfill gas can cause malodours, detectable to the human noise.
- Eco-toxicity: Can cause vegetation de-stress and crop die-back if allowed to migrate to adjacent fields as a result of oxygen displacement.
- Global warming potential: Carbon dioxide, methane and a variety of halocarbons found in landfill gas are all greenhouse gases and can contribute to global warming when not controlled. Number of trace gas components are ozone-depleting substances and can contribute to global warming.

1.3 Accepted Waste Types and Quantities

As highlighted in section 1.2, the characteristics of landfill gas are affected by the composition which is highly influenced by the waste type and quantities of waste that has been deposited in the landfill.

The landfill is classified to accept non-hazardous wastes. Historically the site accepted a range of commercial, industrial, domestic and inert waste types and is operated on the principle of engineered containment. Waste operations were continuous to 2013 until the site was

mothballed. Waste operations re-commenced in 2015, again as a non-hazardous landfill. Yearly waste breakdown is presented in Table 1.

	Municipal %	Trade %	Cover / Inert %	Sewage Sludge (%)
1994 - 2002	36	43	21	0
2003	58	26	16	0
2004	37	13	50	0
2005	39	13	48	0
2006	46	9	45	0
2007	51	15	34	0
2008	27	14	59	0
2009	30	31	39	0
2010	29	31	40	0
2011	17	17	66	0
2012	21	22	57	0
2013	0.1	41.5	58.4	0
2014	NO WASTE ACCEPTED			
2015	39.58	14.35	45.98	0.09
2016	59.40	18.42	21.64	0.54
2017	58.96	17.26	23.56	0.21
2018	64.37	17.26	18.20	0.17
2019	59.48	31.64	8.67	0.20
2020	56.63	25.24	17.39	0.74

Table 1: Annual Waste Breakdown (%)

1.4 Landfill Gas Generation and Extraction

As part of the Landfill Gas Risk assessment a landfill gas generation model is undertaken to determine the theoretical volume of landfill gas produced at the site. The last LFGRA was completed in 2021.

Landfill gas is primarily composed of methane and carbon dioxide. Site specific monitoring data at the gas plant inlet has been provided and normalised as part of the gas model, modelled landfill gas composition is available in the landfill gas risk assessment.

Computer model GasSimv2.5 has been used to model the landfill gas generation. The model verification predicted a total combusted gas for 2020 of 526m^3/hr (95%ile), the actual mean gas flow into the gas compound for 2020 was 617m^3/hr.

2 Landfill Gas Risk Assessment

An updated Landfill Gas Risk Assessment was completed by RPS in June 2021 (reference JER 9064). The Landfill Gas Risk will be periodically reviewed to account for future site engineering, waste quantities and composition..

The landfill gas control measures at the site are based on current best practice and the results of the Landfill Gas Risk Assessment. The landfill gas control measures are the subject of continual review and at present, carried out so that damage to or deterioration of the environment and risks to human health are minimised.

3 Landfill Gas Control Measures

3.1 Containment System

Buckden Landfill Site is operated upon the principle of engineered containment comprising of the following

- Engineered clay liner and side walls
- Engineered clay cap liner, minimum thickness of 0.5m or Geosynthetic Composite Liner (GCL)
- Temporary HDPE or LLDPE plastic capping, minimum thickness of 1mm

These factors will contribute greatly to limit egress of landfill gas to atmosphere or to lateral migration, and also to limit ingress of oxygen.

3.2 Landfill Gas Extraction

Landfill gas (LFG) control is based on an active gas extraction system incorporating a Gas Utilisation Plant (GUP) and at present, two temporary landfill gas flares (duty and standby).

Gas extraction is currently undertaking using two independent gas collection systems

Gas Utilisation Plant

The gas collected from primarily older capped and restored areas of the site is utilised within the GUP by 2 landfill gas engines. In the event of engine maintenance or shutdown, residual gas is flared through the GUP flare (Flare 1).

Temporary Flaring Operation

The gas collected from the operational areas of the site is currently directed to a temporary landfill gas flare (Flare 2) to provide additional flexibility of managing environmental control systems in the operational area. This flare allows the management of flow / suctions more suitable to the infrastructure attached to it and therefore not be potentially impacted by reduced suctions / flows caused by poor gas going to the main gas utilisation plant. In the event of the failure of the temporary flare a secondary temporary flare (Flare 3) is utilised.

The Engine and flare details are summarised in Table 2.

Engine / Flare Number	Model	Total Operating Capacity
Unit 969	Caterpillar 3516	300 – 830m^3/hr
Unit 997	Perkins 4006	200 – 300m^3/hr
Flare 1	Biogas Flare	150 – 1500 m^3/hr
Flare 2 (Temporary)	Uniflare UF10	200 – 2000 m^3/hr
Flare 3 (Temporary)	LFS Enclosed Flare	330 – 2000 m^3/hr

Table 2: Engine and Flare Operating Capacity

Gas extraction wells are installed according to Construction Quality Assurance (CQA) principles. Permanent gas extraction infrastructure at the site consists of drilled wells with optimal well spacing being defined through site-based knowledge and in line with Environment Agency (EA) guidance, Industry Codes of Practice and operational experience. Gas extraction wells have been spaced with a radius of influence to ensure that the landfill gas is drawn back towards the centre of the site, to minimise the risk of oxygen being drawn into the system from outside the landfill.

Vertical wells are drilled into the waste and lined with 160mm butt-fused sections of high density polyethylene (PE) pipe which is perforated intermediately to ensure gas is captured at the lower levels on the landfill. The vertical wells are retro drilled into the waste to no more than 80% of the depth of the waste or a minimum of three metre stand-off from the base to ensure there is no interference with the basal lining system. The well casing is connected to the 90mm and 63mm collection flow lines via a 125mm insert wellhead sealed by a 160mm X 125mm flex seal reducer although on some of the older parts of the gas-field flow-lines have been buried. Each wellhead is fitted with a sample point and 1" Cam-lock or screwed cap fitting to allow access for dipping.

Gas extraction pipework is consists of high-density polyethylene pipe (HDPE) in various sizes typically ranging from 63mm outside diameter to 355mm carrier mains.

All well heads are located above ground and have their own valves as well as at Manifolds. In order to simplify gas field monitoring and balancing, a manifold based system has been adopted within each phase of the site, where possible. Individual wells are connected to each manifold using 63mm or 90mm SDR 17.6 pipework. Where this is not possible, the flowlines are connected straight into the gas main via electro-fusion saddles.

In addition to the permanent drilled wells sacrificial gas collection systems are in place across the operational areas and comprise:

- Horizontal wells installed at regular intervals.
- Pin wells.
- Scavenger rings around leachate infrastructure.
- Scavenger collector lines beneath HDPE/LLDPE capping on the flank.

The site ring main which is connected to the GUP comprises 200mm diameter gas collection mains around the boundary of site connecting to a 355mm main near the gas compound. The gas extraction carrier lines from the infrastructure in the operational area are connected to the temporary flare by a 250mm carrier with spurs along the NE and SE of the operational area. The two systems are currently operated independently although a connecting 315/355mm carrier allows for them to be operated as one to allow greater flexibility if needed.

3.2.1 Condensate Management

Condensate management within the gas system is provided by knock-out pots fitted with automated air force pumps, discharging condensate into a discharge carrier line. The condensate is then recharged into the landfill. The collection pipe work is set to ensure

condensate drains either through the flow lines to the manifolds, gas main and subsequently to the knock out pots or back draining to the gas wells.

3.2.2 Inspection, Maintenance and Servicing Regime

Landfill gas extraction wells are inspected during each monitoring round to ensure their integrity.

Gas well condition surveys are also carried out to ascertain whether the gas wells are still intact within the waste.

If during any of these surveys any further remediation works are identified, action will be taken to program these works as soon as is reasonably practicable. If the works are extensive they shall be carried out in accordance with Agency guidance LFTGN03, 2004, Construction Quality Assurance (CQA).

4 Operational Procedures

4.1 Routine operation and monitoring

Monitoring and balancing of the gas extraction field is typically completed at a frequency of at least monthly by trained, experienced technicians. The frequency of monitoring and balancing may be increased in operational areas such that optimal gas extraction is achieved. The following procedure outlines the standard approach taken to monitoring and subsequent balancing of the gas extraction system.

Field gas monitoring of oxygen concentration, methane concentration, carbon dioxide concentration, relative pressure and valve setting is undertaken at each well or manifold by the gas technician. Gas field monitoring is carried out using a portable infra-red landfill gas analyser (Geotechnical Instruments (UK) Ltd GA5000 'Intrinsically Safe Gas Analyser' or similar device).

Long term trends of oxygen concentration, methane concentration, carbon dioxide concentration, power output, and extraction vacuum are recorded and analysed using a web-based system called 'LandfillDat'.

Field-based investigations are instigated where observed values are outside of optimal or agreed ranges. These may include repeat balancing of wells as well as investigating the integrity of the sampling point, well head and collector line. Further investigations may include camera surveys, well dipping and reviewing the potential for re-drilling depending on the findings of investigations. Monitoring in this manner enables rapid identification and adjustment of any under-performing well(s) and/or pipes.

4.2 Extraction rate optimisation

Maximisation of gas extraction from the landfill is a key aspect of gas plant operations with environmental drivers ensuring optimisation of this task. These environmental drivers are primarily parameters specified within the Environmental Permit and as agreed by the site manager and Velox Power to maximise extraction rates whilst ensuring environmental control.

Extraction rates will be reviewed and adjusted at an on-going basis to ensure extraction rates correspond with predicted rates.

4.3 Temporary Flare Operating Procedure and Parameters

The temporary landfill gas flare is currently being operated in accordance with Velox Power documents 'Buckden Secondary Flare Operating procedure 241021' and Buckden Gas Operating parameters Temporary Flare 241021.

Any amendments to the documents referenced above shall be submitted to the Environment Agency.

5 Monitoring Procedures

5.1 Internal Waste Monitoring

Gas extraction from the landfill is optimised to ensure effective environmental control. Monitoring and balancing of the gas extraction field is typically completed at a frequency of at least once per month by trained, experienced technicians. The frequency of monitoring and balancing may be increased in operational areas such that optimal gas extraction is achieved. Gas field monitoring is carried out using a portable infra-red landfill gas analyser.

Landfill gas extraction wells (and strategic points as appropriate) will be monitored in accordance with Table 3 below and in line with the typical accuracy range of the gas analyser used on site.

Determinants	Monitoring Frequencies (minimum)	Units and Accuracies
Methane (CH_4)	Monthly	%v/v ±3%
Carbon Dioxide (CO_2)	Monthly	%v/v ±3%
Carbon Monoxide (CO)	Monthly	±50 ppm
Oxygen (O_2)	Monthly	%v/v ±1%
Atmospheric Pressure	Monthly	±5mb
Differential pressure	Monthly	±4mb
Meteorological Data	Monthly	-

Table 3: Monitoring frequencies for landfill gas within the engineered containment

Carbon Monoxide (CO) is recorded using the infra-red gas analyser; however, due to the potential for interference between substances, gas bag samples will be taken for any internal gas wells which breach 100ppm CO (with an H2S filter in place) as indicated by the hand-held instrument. The laboratory undertaking the analysis of gas bag samples will be suitably accredited in accordance with LFTGN04.

Oxygen (O_2) is recorded using a gas analyser when oxygen is found in any well to be above 5% or a balance gas above 20%, an investigation is required. Investigations of findings as well as any repairs completed are produced and reported to the Environment Agency within the quarterly monitoring data submission.

Trends will be reviewed monthly against the Environmental Permit (EP) trigger levels and the agreed Gas Operating Parameters (GOPs) for the site. Extraction rates will be reviewed and adjusted at a frequency of at least once per month or more frequently if required.

Field-based investigations are instigated where observed values are outside of these parameters. To assist with fault-finding, monitoring will be completed at one or all of the strategic monitoring points located in key locations along the gas extraction main pipe line.

Landfill gas extraction wells are inspected during each monitoring round to ensure integrity. Any anomalies identified are reported to the appropriate site representative for rectification.

Hydrogen Sulphide (H_2S) is monitored on a six-monthly frequency from gas collection wells as required by the Environmental Permit. Where concentrations of H_2S are greater than the upper limit of the standard gas monitoring instrument (1000ppm) then these wells will be either monitored using an instrument with a higher range of H_2S measurement or using a Tedlar bag sample.

5.2 Trace Gas Component Monitoring

Trace gas monitoring is undertaken by Velox Power on an annual basis in accordance with Table S3.9 of the Environmental Permit. This same monitoring requirement shall also apply to the inlet to the temporary landfill gas flare, in accordance with the agreed Environment Agency Local Enforcement Position. All monitoring will be conducted in accordance with Environment Agency guidance document LFTGN04.

5.3 Gas Flare and Engine Monitoring

Gas flare and engine monitoring is undertaken by Velox Power in accordance with Tables S3.2 and S3.9 of the Environmental Permit. As well as the emissions monitoring from the engines and flare this includes weekly monitoring for Methane (CH_4) Carbon Dioxide (CO_2) Oxygen (O_2), Gas flow rate, Suction and Balance gas at the input to the Gas Utilisation Plant. This may also be supplemented with Hydrogen Sulphide (H_2S) and Carbon Monoxide (CO) monitoring as required.

This same monitoring requirement shall also apply to the temporary landfill gas flares, in accordance with the agreed Environment Agency Local Enforcement Position. All monitoring of gas engines and flares will be conducted in accordance with Environment Agency guidance documents LFTGN05 (gas flares) and LFTGN08 (gas engines).

5.4 Off-Waste Gas Monitoring (Subsurface Emissions)

5.4.1 Monitoring of Boreholes

Monitoring of boreholes will be carried out in accordance with the requirements of the Environmental Permits. Locations of the off-waste gas boreholes are marked on the MEPP plan for the site.

5.4.2 Derivation of Borehole Specific Control and Trigger Levels

Trigger levels for landfill gas Buckden landfill are listed in the Environmental Permit EPR/RP3732SZ table S4.5.

Action levels for CO_2 were calculated and approved by the Environment Agency in 2015. These assessment levels are presented in appendix 1 of this gas management plan.

5.4.3 Maintenance of LFG Perimeter Monitoring Points

Perimeter monitoring points are inspected when monitored and also on a regular basis by the site management. Any identified faults are logged within the site action plan and repaired as soon as reasonably practicable.

5.4.4 Monitoring Personnel

All monitoring is carried out by trained and competent personnel. Usually, monitoring will be completed by Enitial. However on occasion, FCC will undertake their own monitoring and shall use trained and competent personnel. Only experienced and reputable contractors will be used to monitor off-waste gas.

5.4.5 Monitoring Equipment

Monitoring of boreholes is undertaken using appropriate equipment which is maintained and calibrated according to manufacturer's instructions. This will usually be a landfill gas analyser, often a Geotechnical Instruments GA2000+ or GA5000 Gas Analyser.

5.4.6 Monitoring Methodology

Monitoring will be conducted in accordance with accordance with FCC procedure IMS-PRO-044 Environmental Monitoring and in accordance with the method statements provided by the external monitoring contractor.

5.4.7 Methodology for Data Storage, Retrieval and Presentation

Landfill Gas readings in the field are either stored electronically onto the Gas Analyser or recorded manually. Data is then transferred into a comma delineated file and imported to the Monitor-Pro database. The Monitor-Pro database holds all data and records any alterations made; it also allows data to be exported or presented in a number of ways.

5.4.8 Methodology for Data Interpretation

Data is interpreted as required and where appropriate. This process is often aided by the Monitor-Pro database.

5.4.9 Means of Communicating Results to the Regulator

Monitoring data will be submitted to the Environment Agency on a quarterly basis. This will include manipulated data where appropriate e.g. water levels may be converted to a meters above ordnance data (mAOD) format; but will include little discussion of results. An interpretive report will be submitted annually; this includes full interpretation and discussion of results.

5.5 Ambient Air Monitoring

5.5.1 Monitoring of Ambient Air

Monitoring of ambient air FID monitoring will be carried out in accordance with the requirement of the environmental permit. Methane concentrations within the ambient air are spot sampled from the locations marked on the MEPP plan for the site.
In the event that the methane permit level is exceeded during monitoring, hydrogen sulphide monitoring shall be conducted at the locations marked on the MEPP plan.

5.5.2 Derivation of Permitted Levels

Permitted levels for ambient air monitoring are listed in the Environmental permit EPR/RP3732SZ table S3.12.

5.5.3 Maintenance/Access of Monitoring Points

The location of the monitoring points are inspected when monitored and also on a regular basis by the site management. Any access issues faults are logged within the site action plan and remediated as soon as reasonably practicable.

5.5.4 Monitoring Personnel

All monitoring is carried out by trained and competent personnel. Usually, monitoring will be completed by Enitial. However on occasion, FCC will undertake their own monitoring and shall use trained and competent personnel. Only experienced and reputable contractors will be used to conduct the monitoring.

5.5.5 Monitoring Equipment

Monitoring of ambient air is undertaken using appropriate equipment which is maintained and calibrated according to manufacturer's instructions. This will usually be a flame ionisation detector for methane monitoring, and a portable monitor for hydrogen sulphide monitoring.

5.5.6 Monitoring Methodology

Monitoring will be conducted in accordance with FCC procedure IMS-PRO-044 Environmental Monitoring, the method statements provided by the external monitoring contractor and any guidance or comments as listed in table S3.12 of the Environmental Permit.

5.5.7 Methodology for Data Storage, Retrieval, Interpretation and Presentation

The processing and storage of data is conducted in accordance with FCC procedure IMS-PRO-044 and the procedures provided by the external monitoring contractor. Data is provided by the external monitoring contractor as a comma delineated file and imported to the Monitor-Pro database. The Monitor-Pro database holds all data and records any alterations made; it also allows data to be exported or presented in a number ways.

5.5.8 Means of Communicating Results to the Regulator

Monitoring data will be submitted to the Environment Agency as a part of the quarterly data submission. An interpretive environmental monitoring report will be submitted annually, which includes full interpretation and discussion of results.

5.6 Surface Emissions Monitoring (Annual FID walkover and Flux-Box Surveys)

5.6.1 Monitoring of Ambient Air

Annual FID walkover and flux box surveys will be carried out in accordance with Table S3.7 of the Environmental Permit and in accordance with EA guidance LFTGN07.

Both surveys will monitor the whole of the site, including any in-waste infrastructure identified on the MEPP plan.

5.6.2 Derivation of Permitted Levels

Permitted levels for annual FID walkover and flux-box surveys are presented within EA guidance LFTGN07.

Following breaches of the emission limits outlined in the EA guidance, remediation will be carried out as required. Details of actions will be incorporated into a remediation report, including resurvey results.

5.6.3 Monitoring Personnel

All monitoring is carried out by trained and competent personnel. Usually, monitoring will be completed by Enitial. However on occasion, FCC will undertake their own monitoring and shall use trained and competent personnel. Only experienced and reputable contractors will be used to conduct the monitoring.

5.5.5 Monitoring Equipment

Monitoring of annual FID walkover and flux box surveys is undertaken using appropriate equipment which is maintained and calibrated according to manufacturer's instructions. This will usually be a flame ionisation detector and for flux-box surveying, an appropriate designed flux box shall be used.

5.5.6 Monitoring Methodology

Monitoring will be conducted in accordance with FCC procedure IMS-PRO-044 Environmental Monitoring, the method statements provided by the external monitoring contractor and any guidance or comments as listed in table S3.7 of the Environmental Permit.

5.5.7 Methodology for Data Storage, Retrieval, Interpretation and Presentation

The processing and storage of data is conducted in accordance with FCC procedure IMS-PRO-044 and the procedures provided by the external monitoring contractor. A data report is provided by the external monitoring contractor as a PDF file.

5.5.8 Means of Communicating Results to the Regulator

The data report will be submitted to the Environment Agency as a part of the annual reporting requirement. A remediation report (if required) shall also be submitted to the Environment Agency as a part of the annual reporting requirement.

6 Action Plan

Actions to prevent non-compliance in the event of various scenarios are discussed below.

6.1 LFG Emergency Procedures

The gas extraction system incorporates a telemetry system with 24-hour cover provided by on-call technicians. Actions to prevent non-compliance in the event of various scenarios are discussed below.

6.1.1 Gas Utilisation Plant

Failure scenario	Action/Response
Failure of 1 engine	The flare (Flare 1) has sufficient capacity to combust landfill gas in the event of engine failure. Action will be taken to ensure that the engine becomes operational as soon as practicable.
Failure of 2 engines	As above
Failure of both engines and flare (Flare 1)	Attempts will be made to restart the plant as soon as reasonably practicable. If the shutdown is prolonged (e.g. as a result of a mains failure) then the gas will be redirected to the Temporary Flare (Flare 2) Agreements are in place with specialist suppliers/contractors to attend site within pre-determined amounts of time following a part failure and central stores holding strategic parts.
Failure of flare (Flare 1)	Investigation into failure and repair will be carried out as soon as practicable. Where possible the engine(s) would be operated to utilise all gas from the site until the flare is back in service.
Failure of blower	Investigation into failure and repair will be carried out as soon as possible. If on site repair not possible, then the gas will be redirected to the Temporary Flare (Flare 2).
Failure of the HV connection	If the shutdown is expected to be prolonged then gas will be redirected to the Temporary Flare (Flare 2) A review will be undertaken to determine the likely duration of the outage and if likely to be longer than 8 hours, a mobile generator will be provided to power the booster and flare,
Failure of air compressor	A secondary back-up air compressor is available on site and will be utilised. Investigation into failure and repair of the primary compressor will be carried out as soon as practicable.
Fracture of the gas collection main	The relevant section of pipework will be isolated. Pipework will be repaired prior to resumption of extraction.

6.1.2 Temporary Flare Operation

Failure scenario	Action/Response
Failure of Temporary Flare (Flare 2)	The backup Temporary Flare (Flare 3) has sufficient capacity to combust landfill gas in the event of the failure of the Temporary Flare (Flare 2).

	Action will be taken to ensure that the Temporary Flare (Flare 2) becomes operational as soon as practicable.
Failure of the electrical generator	Gas will be redirected to the Gas Utilisation Plant where it will be combusted in the engines and/or flare The Generator is under a service contract which requires the same-day attendance by an engineer. In the event that the fault cannot be rectified a replacement generator will be provided as soon as practicable.
Fracture of the gas collection main	The relevant section of pipework will be isolated. Pipework will be repaired prior to resumption of extraction.

6.2 Landfill Gas Migration

Where migration is identified, investigation into possible causes of the gas migration will be undertaken between FCC and Velox Power. The following action plan shall be implemented.

This will comprise identification of:

- Whether the gas extraction system/gas plant are operating normally
- The integrity of the external perimeter and gas extraction system
- Any recent changes to the gas extraction system/gas plant
- An assessment of weather conditions at the times of monitoring
- Possible fluctuations of leachate and groundwater levels in the vicinity of the migration
- Any other abnormal site condition or operation

In order to identify the possible cause of gas migration it may be necessary to:

- Visually inspect the integrity of the gas extraction system, including pipe work and all associated head works and valves (for signs of physical failure and possible vandalism)
- Check the gas extraction system for condensate blockages and well failures
- Assess the affected area of the site for signs of gas leakage and vegetation dieback

If the breaches in trigger levels are verified or the cause cannot be easily detected and rectified, the Environment Agency will be informed by FCC.

If no possible cause of gas migration is identified, and if, after an extended period of time gas levels show no sign of stabilising, the following measures will be considered by FCC in consultation with Velox Power and the Environment Agency:

- Further investigation (if possible) to determine the composition of gases and to identify the possible source of the gas
- Consideration of additional external boreholes further from the landfill to assess possible extent of gas migration
- Extension of the gas extraction system within affected areas and
- Revision of the landfill gas risk assessment (where relevant)

Following the evaluation of measures highlighted above, it may be necessary to agree and implement further measures.

6.3 Exceedance of CO_2 Action Levels

The following action plan will be implemented when levels of Carbon Dioxide exceed the Permitted limits or Action Levels.

Action Number	
1	The Site Business Manager will be informed of the borehole and Action levels which have been breached.
2	The borehole(s) will be re-monitored and the adjacent gas field will be checked within a period of 48h in the event of 3 consecutive breaches of the assessment level during normal monitoring are recorded in the same borehole
3	If the breach(s) are encountered 3 consecutive times the following list of parameters will be recorded, (as outlined in section 5 of the ICoP, Jan 2011), and further monitoring of the wells will continue. • Weather conditions (changes in atmospheric pressure over the preceding 2 days should be reviewed) • Ground conditions • Leachate or ground water fluctuations • Activities near the area • Pressure and flow within the well • Presence of methane, level of O2, balance of gas • Variability of the readings • Ground water levels • Temperature within the well • Odours coming from the well • Assessing the status of all gas management wells and gas field data • Check total gas abstraction volumes • Integrity of gas extraction system
4	An investigation will be carried out to determine the source of the gas and potential pathways. Any findings from the investigation will be submitted to the Environment Agency, within a practicable timescale.

6.4 Landfill Fire Action Plan

The site is routinely checked for the presence of possible landfill fires through visible inspection of the site and interpretation of monitoring results.

A hot spot may be suspected if a number of the following are observed during site inspection and monitoring:

- Substantial settlement over a short period of time;
- Smoke or smoulder emanating from the gas extraction system or landfill;
- Elevated levels of CO (exceeding 100 ppm) indicated on hand-held IR instrument)
- Elevated levels of oxygen greatly exceeding 5%
- Combustion residue in extraction wells or headers or
- Increase in gas temperatures in the extraction system/excessive temperatures

If it is suspected that a fire is present the following procedure will typically be followed:

1. The waste mass in and around the hot spot needs to become anaerobic. This will be achieved through turning off main isolation valves, closing all surrounding valves and wells, or completely turning off gas extraction.

2. The waste mass in and around the hot spot will be cooled through injection of water or leachate into the waste through existing wells, or if necessary, new wells.

3. The point at which oxygen enters into the waste mass will be identified and sealed. This will be achieved through location of all possible points and sealing using engineered clay, hydrated bentonite or membrane.

This basic procedure will be followed for all suspected fires. It will be adapted for each individual situation, and carried out together with carbon monoxide analysis and temperature recording appropriate to each occurrence.

7 Aftercare and Completion Plan

The volume of gas yielded can be expected to decrease over time in existing cells. Utilisation of the Landfill Gas will continue as long as economically viable.

In the event a situation should occur where the production of landfill is adequate to present a risk but inadequate to support economically viable utilisation, then landfill gas control will continue without utilisation. The Environment Agency shall be informed at this time.

Monitoring will continue until such a time as it can be demonstrated that the volume of landfill gas production is low enough to have ceased to cause a risk. It is, however, likely to be the case that risk posed by landfill gas reduces gradually over time and the frequency of monitoring should be progressively reduced to reflect this.

8 References

Environment Agency, 2004. LFTGN 03, Guidance on the Management of Landfill Gas.

Environment Agency, 2010. LFTGN 04, Guidance for Monitoring Trace Components in Landfill Gas.

Environment Agency, 2010. LFTGN 05, Guidance for Monitoring Enclosed Landfill Gas Flares.

Environment Agency, 2010. LFTGN 08, Guidance on Monitoring Landfill Gas Engine Emissions.

APPENDIX