

**SOLID WASTE PERMITTING
SUBMISSION INSTRUCTION NO. 13**

**LANDFILL GAS MANAGEMENT, REMEDIATION, and ODOR PLANS
FOR SOLID WASTE DISPOSAL FACILITIES**

Developed by:

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I. LANDFILL GAS MANAGEMENT PLAN

A Landfill Gas Management Plan (LFGMP) is required for all solid waste disposal facilities and should be submitted with the Part B Application or Part B Modification Application as Attachment IX to DEQ Form SW PTB. VSWMR [9 VAC 20-81-130](#).K. provides for an exception to this requirement for CDD and Industrial Landfills that have demonstrated that gas formation is not a concern at their facility. Such demonstrations are discussed in [Section II](#) below, and should be provided in Attachment IX in lieu of a LFGMP, if applicable. [9 VAC 20-81-200]

The LFGMP shall also address the requirements of [40 CFR 60 Subpart Cc \(60.33c\)](#), [Subpart Cf \(60.33f\)](#), [Subpart WWW \(60.750\)](#), and [Subpart XXX \(60.760\)](#) (Standards of performance for new and guidelines for control of existing municipal solid waste landfills) and [9 VAC5-40-5800](#), as applicable. This submission instruction does not address the information required for complying with these provisions; however, documents prepared to meet these provisions will be reviewed by the appropriate DEQ Regional Office Air Program personnel and shall be incorporated into the LFGMP upon completion of the review.

Format The format used for the LFGMP should encourage clear analysis and presentation of the proposed system for the control and detection of landfill gas. The LFGMP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

A. Introduction

Provide a brief history of landfill gas monitoring activities performed and reference that the plan has been prepared in accordance with the VSWMR, [9 VAC 20-81-200](#).

B. Gas Monitoring Standard

Indicate the landfill gas monitoring and control system designed for the solid waste disposal facility has been provided for the protection of public health and safety and the environment and will ensure that landfill gas generated at the facility during the periods of operation, closure, and post-closure care will not exceed the methane gas concentrations specified in [9 VAC 20-81-200](#).A.1. [9 VAC 20-81-140.A.5. and 200.A.1.]

C. Landfill Gas Control

Provide a description of the landfill gas control features installed or planned to be installed to protect the landfill cap and prevent migration of landfill gas into structures or beyond the facility boundary. [9 VAC 20-81-200]

1. Peak Flow

Estimate the gas generation rate at the point of expected maximum. Describe data sources and methods used to make the calculations. Provide copies of calculations and/or modeling results as an appendix to this plan.

2. Gas Venting & Collection System(s)

Discuss the design and spacing of landfill gas vents and extraction wells, the associated pipe network and extraction/collection equipment. Discuss the pipe type, strength, and size to be used, referencing the Technical Specifications as appropriate and providing supporting calculations as an appendix to this plan. Describe gas venting and collection systems in detail, including equipment capabilities and schematic diagrams of equipment and setup. All equipment and pipe installations should be completed in accordance with recognized and generally accepted good engineering practices.

Gas vents and extraction wells are typically drilled to a depth of approximately 80 percent of waste depth at all locations, but can be other depths based on the extraction system design. Vents/extraction wells should be constructed with slotted or perforated pipe and surrounded by a granular material to facilitate collection of gases. The vents/extraction wells must be constructed in a manner compatible with the installation of the final cover system. Features of the gas venting and collection system that should be discussed include:

a. *Passive Gas Vents*

A passive venting system will allow for the transmission of landfill gases from the waste mass and venting of the gases under atmospheric conditions; the effectiveness of a passive venting system is dependent on climatic conditions. Typically, a minimum of 1 passive vent per acre should be installed as a starting point.

b. *Active Gas Wells*

An active venting system would include a mechanical device (a blower) to ensure effective collection and venting of gas under all conditions. Active gas extraction well spacing should be determined through pump tests or other generally accepted good engineering practices conducted in accordance with industry standards.

c. *Active Gas Collection System*

A gas collection system is another component of an active gas extraction system. The collection system may consist of vertical extraction wells (similar to vents), a lateral collection system, or a combination of the two designs. A collection system incorporates piping, valves, sampling locations and mechanical blowers.

d. *Active Gas Destruction System*

Describe the flare system, landfill gas to energy plant, or other equipment used to manage landfill gas. These systems may be installed voluntarily by the facility or as required under the Clean Air Act (40 CFR 60.33c, 40 CFR 60.33f, 40 CFR 60.750, and 40 CFR 60.760) and the Emission Standards for Municipal Solid Waste Landfills ([9 VAC 5-40-5800](#)).

D. Perimeter Monitoring Network

The perimeter monitoring network shall consist of a series of constructed landfill gas probes that are located, designed, and maintained as outlined in the subsections that follow. Perimeter landfill gas probes act as points of compliance to monitor lateral migration of landfill gas. When monitoring results indicate concentrations of methane in excess of the action level or compliance level at any probe within the gas monitoring network, the facility is required to take remedial actions in accordance with [9 VAC 20-81-200.C.](#) and as outlined within this Submission Instruction.

1. Description of Migration Potential

Discuss the probable gas migration paths, accounting for site specific characteristics including, but not limited to:

- Local soil and rock conditions;
- Hydrogeological and hydraulic conditions surrounding the landfill;
- Locations of buildings and structures relative to the waste deposit area;
- Adjacent land use, and inhabitable structures within 1,000 feet of the landfill facility boundary;
- Manmade pathways, such as underground construction; and
- The nature and age of waste and its potential to generate decomposition gas.

[9 VAC 20-81-200.B.1. and B.2.]

2. Location

Monitoring probes shall be located at or near the facility boundary. The location of the perimeter gas monitoring network at the facility shall be provided on the Site Monitoring Plan provided in Part B Attachment III. For an existing facility that does not have a complete set of Design Plans provided as Part B Attachment III, a Landfill Gas Site Monitoring Plan should be provided as an appendix to this LFGMP.

The applicant may propose an alternate boundary closer to the waste mass requiring fewer probes, based on the knowledge of site factors. If an alternate boundary is proposed, the plan must show where the applicant will install additional monitoring probes closer to the facility boundary, or how the operator will implement gas control procedures when compliance levels are exceeded at the alternate boundary.

The entire perimeter of the landfill may not warrant the installation of monitoring probes. In this case, the operator shall demonstrate to the satisfaction of the Department that gas migration could not occur along a specific pathway owing to geologic or hydraulic barriers, and that no inhabitable structure or other offsite use of property within 1,000 feet of the landfill facility boundary are threatened by gas migration. Note the lack of receptors within 1,000 feet of the facility boundary is not a valid reason for not installing any monitoring probes but may be justification for an increased spacing as discussed in item 3 that follows.

3. Spacing

Show the spacing of all gas monitoring probes. Justify the proposed plan based upon, but not limited to, the nature of the structure(s) to be protected and its proximity to the waste. Probes shall be spaced to align with gas permeable structural or stratigraphic features, such as dry sand or gravel, onsite or offsite structures, and areas of dead or stressed vegetation that might be due to gas migration. Generally, the lateral spacing between adjacent monitoring probes should not exceed 250 feet, unless the applicant shows that such spacing would be unwarranted based on the site-specific factors. The spacing between the probes shall be reduced as necessary to protect persons and structures threatened by decomposition gas migration. Installation of additional probes may be required when on or offsite property development encroaches upon the facility boundary and/or approved alternate boundary.

4. Depth

The depth of the monitoring well bore shall at least equal the maximum depth of waste as measured within 1,000 feet of the monitoring point. When conditions limit the practicality or do not warrant the well bore depth criteria, the applicant may demonstrate that probes located at alternate depths are sufficient to detect migrating decomposition gas and provide protection to public health and safety, and the environment. All probes shall be installed above the permanent low seasonal water table, above and below perched ground water, and above bedrock. The specified depths of monitoring probes within the well bore shall be adjusted, based on geologic data obtained during drilling, and probes shall be placed adjacent to soils which are most conducive to gas flow.

Nested probes are beneficial for characterizing the depth at which gas migration may be occurring, which is an important factor to consider when determining what type of remedial action should be implemented. For example, a facility may propose excavation of a perimeter trench to prevent gas migration offsite; however, if the path of gas migration is deeper than the depth at which the equipment (backhoe or other) is capable of excavating, then a trench may not successfully remedy the gas migration. Normally, the number and depths of nested monitoring probes within the well bore should be installed in accordance with the following criteria:

- A shallow probe installed 5 to 10 feet below the surface;
- An intermediate probe installed at or near half the depth of the well bore; and
- A deep probe at or near the depth of the well bore.

When the depth of the well bore does not exceed 30 feet, the applicant may reduce the number of probes to two, with one probe located in the shallow zone as indicated above, and the other located adjacent to permeable soils at or near the depth of the well bore. Nested probes are not needed when depth of waste or depth to groundwater results in a well bore hole only being 10 to 15 feet deep.

This guidance is not intended to require retrofitting of existing probes if the network is capable of detecting gas migration and nested probes were not installed; however, new or replacement probes should include nested probe designs.

Provide a table listing the probe name / identification number and probe surface elevation and depth.

5. Monitoring Probe Construction and Identification

Provide a general description of the monitoring probe construction, referencing the Technical Specifications for landfill gas probe construction as provided in Part B Attachment VII. For an existing facility that does not have a complete set of Technical Specifications provided as Part B Attachment VII, technical specifications relating to the design of landfill gas probes should be provided as an appendix to this LFGMP.

Boring / As-Built logs, should be included as an appendix to this LFGMP and include the names of the person(s) logging the hole, the probe material and depth, extent and type of filter pack, thickness and material used for seals, extent and materials used for backfill, size and interval of perforations, description of the soil composition and depth to groundwater in the vicinity of each probe, and a description of any shutoff valves or covers. Probes should be sealed with a quick connect, valve, or other mechanism to prevent venting to the atmosphere between monitoring events and the casing should be equipped with either a cap or locking mechanism to prevent tampering and protect the probes from exposure to the elements.

All gas monitoring probes should be permanently labeled or tagged with the probe name or identification number. Where there are multiple probes within a well bore, each probe should be labeled or tagged to clearly identify the depth of each probe (in feet) or relative depths in relation to other probes (e.g. (S) shallow, (I) intermediate, and (D) deep).

6. Probe Repair and Replacement

Provide a description of procedures that will ensure the gas monitoring network is maintained and operated as designed, including preventative maintenance, inspection, and protocols for making repairs to damaged probes.

Repairs to gas monitoring probes (including, but not limited to, dewatering if necessary because probes cannot be routinely monitored or making repairs to the concrete pad, cap, lock, or cover) should be completed prior to the next gas monitoring event unless an alternate repair timeframe is requested and approved. All repairs should be completed in accordance with recognized and generally accepted good engineering practices.

Replacement of an existing probe that has been damaged or rendered inoperable, without change to location, design, or depth of the probe can be made after notification to DEQ 14 days in advance of the probe replacement. In general, the replacement probe should be planned within 15-20 feet of the probe being replaced and design and depth of the replacement should be similar. This action is considered a permittee change per [9 VAC 20-81-600.F.](#), Table 5.2. Notifications should include a map illustrating the probe(s) to be replaced and the reason for the planned action. Replacements not meeting these criteria should be reviewed by DEQ and approved through a minor permit modification. The LFGMP may specify a suggested timeframe for full replacement of a monitoring probe.

7. **Probe Abandonment**

Provide a description of probe abandonment procedures. Abandonment procedures should consider the distance to the seasonal high groundwater table and use of backfill materials that will not cause a groundwater impact.

E. **Structure Monitoring**

Include a description of the onsite landfill structures, both adjacent to and on top of the waste mass, that will be monitored for landfill gas. Structures include, but are not limited to buildings, subsurface vaults and utility components if such structures provide a potential offsite migration pathway, or any other areas where potential gas buildup would be of concern. For each structure identified, indicate the areas within that will be monitored. Areas of the structure where gas may accumulate may include, but are not limited to areas in, under, beneath and around basements, crawl spaces, floor seams or cracks, and subsurface utility connections. Gases less dense than air may also rise and accumulate in areas along ceiling corners or rafters. [9 VAC 20-81-200.B.1.]

F. **Sampling & Analysis**

Specify the equipment and calibration and monitoring procedures to be used to measure the concentrations of methane gas both within the perimeter monitoring network and onsite structures. [9 VAC 20-81-200.A.]

Field measurements are usually collected with a portable methane meter, explosimeter, or organic vapor analyzer. Instruments of the hot-wire Wheatstone bridge type (i.e., catalytic combustion) directly measure combustibility of the gas mixture withdrawn from the probe and are NOT appropriate. The thermal conductivity type meter is susceptible to interference as the relative gas composition, and therefore the thermal conductivity changes. Instruments should be field calibrated prior to measurements and should be rechecked after that day's monitoring activity. Gas samples also may be collected in glass or metal containers for laboratory analysis. Laboratory measurements, with organic vapor analyzers or gas chromatographs, should be used to confirm the identity and concentrations of gas.

The facility's proposed monitoring procedure will vary depending on the equipment selected; however, the procedure should be sure to include an initial measurement of

the probe pressure at each probe depth prior to sampling. The procedure can include purging of a maximum of two probe casing volumes as determined based on the volume of the probe casing and the sample pump flow rate. In this situation, the maximum methane concentration should be recorded along with the concentration of oxygen and carbon dioxide. If the methane concentration is slowly increasing as the probe is pumped, the concentration at two probe volumes should be recorded for the compliance reading. The objective behind this method is to record the conditions of the gas around the probe and not gasses trapped in the probe casing or gasses that can be pulled into the probe via the purging process. In any case, ambient/external air should not be allowed to enter the probe prior to or during gas sampling to avoid inaccurate readings.

Onsite structures may be monitored using permanently installed monitoring probes, gas surveys, or continuous monitoring systems. Structures located on top of the waste mass should be monitored on a continuous basis. When practical, structures shall be monitored after they have been closed overnight or for the weekend to allow for an accurate assessment of gas accumulation. For safety purposes, oxygen concentrations should be monitored in conjunction with methane for structures. There may also be other standards (e.g. OSHA) applicable to entry of confined spaces.

G. Monitoring Conditions

Landfill gas monitoring should occur when the potential for landfill gas migration is highest. Landfill gas tends to migrate along the path of least resistance, and moves from high pressure and concentration areas to low pressure and concentration areas. Migration is also affected by the permeability of the compacted waste, landfill cover material, and surrounding soils, as well as the height of the groundwater table. Barometric pressure also influences landfill gas migration, and low or falling barometric pressure may allow methane to migrate out of the landfill and into surrounding areas. Additionally, saturated or frozen soils on the surface of a landfill tend to impede surface migration and therefore increase the likelihood of lateral migration below the surface. However, subsurface migration of landfill gas is difficult to predict. Therefore, a monitoring program should include events that occur during varying weather conditions, including during periods of a falling barometer, prolonged low pressure or prolonged steady barometric pressure events.

In addition, gas monitoring of all facility probes/structures should be conducted on the same day where possible. If the monitoring is conducted over multiple days, the monitoring report should reflect the atmospheric conditions for each day of monitoring.

H. Monitoring Frequency

The frequency of monitoring should be sufficient to detect landfill gas migration based on subsurface conditions and changing landfill conditions such as partial or complete capping, landfill expansion, gas migration control system operation or failure, construction of new or replacement structures, and changes in landscaping or land use

practices. The rate of landfill gas migration as a result of these anticipated changes and site specific conditions provides the basis for establishing monitoring frequency. This plan shall justify the monitoring frequency selected; however, at a minimum, monitoring should be conducted quarterly, or at an interval corresponding to approximately 90 days. Facilities monitoring on a quarterly frequency should perform one monitoring event during each calendar quarter (Jan. – March, April – June, July – Sept., and Oct. – Dec.) for a minimum of 4 gas monitoring events performed per calendar year. Quarterly monitoring events should not be less than 60 days or more than 120 days apart. [9 VAC 20-81-200.B.4.]

I. Response and Reporting Requirements

1. All Readings below Action Level

If all landfill gas measurements during the monitoring event are below the action level (25% of the methane lower explosive limit (LEL) in facility structures or 80% LEL at the facility boundary), there are no response requirements. The facility shall place the monitoring records, per [Section I.J.](#), in its operating record.

2. Action Level Exceedance

Indicate the facility's response to concentrations of methane detected at or above the action level (25% of the methane lower explosive limit (LEL) in facility structures or 80% LEL at the facility boundary) and below the compliance level as discussed in [Section I.I.3](#). At a minimum, the facility's response shall include:

- a. Taking all immediate steps necessary to protect public health and safety (safety precautions should include evacuation of occupied structures, if affected; notifying local fire/safety officials of potential landfill gas migration; and coordinating for offsite monitoring of structures located within 1,000 feet of the facility boundary);
- b. Investigating any active or passive gas control or remediation systems for proper connections and operation and making adjustments to vacuum, flow, or control valves, removing condensate, or making any other adjustments or repairs necessary to ensure proper operation;
- c. Written notification within 5 working days of the methane action level exceedance indicating what has been done or is planned to be done to resolve the problem; and
- d. Increasing the gas monitoring frequency of a subset of the perimeter monitoring network when the action level exceedance is detected where:
 - (1) Offsite receptors are within 1000 ft of the waste management boundary; or
 - (2) Terrain, such as karst topography, or other conduit may provide pathways for migration of landfill gas than can pose hazards to public health and safety and the environment:

The perimeter monitoring network subset should include the exceeding probe(s) and structure(s) and those probes/structures immediately adjacent, such that at least one (1) probe on either side of each exceeding probe/structure is being monitored at the increased frequency.

The increased monitoring frequency shall be weekly unless an alternate frequency is approved by the Department. Weekly means an interval corresponding to approximately 7 days. Facilities monitoring on a weekly basis should perform one monitoring event during each calendar week. Return to quarterly monitoring frequency is addressed in [Section III.D.](#)

[9 VAC 20-81-200.C.1. and C.2.]

3. Compliance Level Exceedance

Indicate the facility's response to concentrations of methane detected at or above the compliance level (25% LEL in facility structures or 100% LEL at the facility boundary). At a minimum, the facility's response should include:

- a. Actions 2.a. and 2.b. listed above ([Section I.I.2.](#)) for response to an action level exceedance;
- b. 24-hr oral notification of the compliance level exceedance;
- c. Written notification within 5 working days of the methane compliance level exceedance containing a description of the circumstances and its cause; the period of occurrence, including exact dates and times, and, if the circumstance has not been corrected, the anticipated time it is expected to continue. It shall also contain steps taken or planned to reduce, eliminate, and prevent reoccurrence of the circumstances resulting in an unusual condition or noncompliance;
- d. Increasing the gas monitoring frequency of a subset of the perimeter monitoring network to include the exceeding probe(s) and structure(s) and those probes/structures immediately adjacent, such that at least one (1) probe on either side of each exceeding probe/structure are being monitored at the increased frequency.

The increased monitoring frequency should be weekly at landfills in urban areas, those where offsite receptors are within 1000 feet of the waste management boundary in the area of the exceedance, or those where terrain, such as karst topography, or other conduit may provide pathways for migration of landfill gas than can pose hazards to public health and safety and the environment. Monthly monitoring is appropriate for landfills in rural areas or those without offsite receptors within 1000 feet of the waste management boundary in the area of the compliance level exceedance.

Any other frequency or condition regarding when increased monitoring frequency should start should be outlined in the facility's Landfill Gas

Remediation Plan and approved by the Department. Return to quarterly monitoring frequency is addressed in [Section III.D.](#)

- e. Implementing and submitting a Landfill Gas Remediation Plan, as discussed in [Section III](#) below, to the Department for review and incorporation into the facility's permit. Should the facility desire feedback on the LFGRP prior to implementation, the facility may request a meeting with the regional DEQ staff and/or submit the plan to the regional DEQ office prior to the 60-day implementation deadline. Note that plan approval is not required prior to implementation.
- f. Assessing the spacing of the entire perimeter monitoring network. If the spacing between any probes in the perimeter monitoring network exceeds the 250-foot spacing specified in [Section I.D.3.](#), the facility should install additional perimeter probes to satisfy the spacing requirement unless the facility can show that such spacing continues to be unwarranted based on site-specific factors. Additional probes may be required if property development has encroached upon any boundary of the landfill property.

Any agreement by DEQ that a larger spacing is sufficient should take into account adjacent property use and distance to on and offsite structures (including underground utility lines, sewers and water mains, and above or below ground structures). Spacing approvals should also be caveated to take into account future potential development on adjacent property. Under no circumstances should bar punches be used in place of constructed landfill gas probes to satisfy the 250-foot spacing requirement.

[9 VAC 20-81-200.C.2. and C.5.]

4. **Other Reporting Requirements**

The following incidents related to landfill gas should also be reported as unusual conditions in accordance with the 24-hour oral and 5-working day written notification requirements listed above ([Section I.I.3.](#)).

- Compliance level exceedances detected during routine or non-routine maintenance activities;
- Planned or unplanned shutdowns of active gas control or remediation systems lasting longer than 48 hours; and
- Other noncompliance or unusual conditions that may endanger health or environment, such as when a system is not operating in a manner to maintain compliance.

[9 VAC 20-81-200.C.5]

J. **Recordkeeping**

Indicate the parameters to be monitored and recorded during each landfill gas monitoring event. Records should include:

- Date, time, barometric pressure, atmospheric temperatures, general weather and land surface conditions, and probe pressures (time, barometric pressures, atmospheric temperatures and weather/land surface conditions should be noted at the start and end of each day's monitoring event);
- Names of sampling personnel, apparatus utilized, and a brief description of the methods used;
- A number system to correlate monitoring results to a corresponding probe location;
- The initial and steady-state concentrations of methane as measured at each probe and within each onsite structure (Note: the steady-state concentration should be used to evaluate compliance with 9 VAC 20-81-200); and
- Monitoring and design records for any gas remediation or control system; and
- Field calibration information to include the date, time, calibration gas type, and expiration date of field calibration gas canister. Records of factory calibration, performed at a frequency as indicated by the manufacturer, should also be maintained with gas monitoring records. If a third-party performs gas monitoring, the facility should have assurances from the third-party that equipment used is factory calibrated as specified by the manufacturer. Factory calibration of third-party owned equipment does not have to be maintained by the facility.

[9 VAC 20-81-200.A.1. and 200.E.]

II. LANDFILL GAS DEMONSTRATION

Sections A through C apply only to CDD and Industrial Landfills that wish to demonstrate that gas formation is not a concern at their facility. The demonstration as discussed in this section should be provided as Attachment IX to DEQ Form SW PTB in lieu of a LFGMP. A successful demonstration will present information on one or more of the following topics in relation to the facility. [9 VAC 20-81-130.K.]

Section D is provided to address Alternate Gas Source Demonstrations. The information described in Section D can be submitted as a stand-alone request for review prior to performing the demonstration described if feedback on the proposal is desired, or submitted as part of a landfill gas monitoring network permit modification.

Format The format used for the Landfill Gas Demonstration should present clear and concise information regarding the site specific features that indicate landfill gas will not be a concern at the facility. The Demonstration should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

A. Types of Waste

Provide a description of the types of waste accepted and provide information on waste decomposition.

B. Barriers to Migration

1. To make the claim that there is a hydrogeologic barrier to prevent landfill gas migration, provide information on site hydrogeology and depth of waste in relation to depth of groundwater, referencing information provided in the Part A application as applicable.
2. For sites where the elevation of the facility boundary is below the depth of waste, provide a site plan showing the depth of waste and topographic contours.

C. Landfill Gas Demonstration

Provide a plan to assess future landfill gas generation and migration at the landfill. Indicate monitoring procedures to be employed at some point after the start of landfilling to determine whether waste decomposition is generating landfill gas. Also, provide proposed locations for perimeter gas monitoring probes and a monitoring frequency to check for landfill gas migration.

D. Alternate Gas Source Demonstrations

This subsection is provided here as guidance on the minimum information that DEQ will accept when determining whether a source other than the landfill is the cause of

elevated methane levels detected within a landfill's gas monitoring network. It is important to note that until the demonstration described herein is completed and approved, the DEQ's assumption is that methane detected within facility structures or the gas monitoring network is originating from the landfill.

To avoid wasting time or resources, the facility should provide a demonstration work plan for the alternate source demonstration prior to implementation. At a minimum, alternate gas source demonstration work plans should include a gas fingerprinting analysis for EPA Method TO-15 organics, siloxanes, and sulfur compounds. Additional or alternate constituents may be appropriate based on types of wastes disposed. Gas samples for fingerprinting should be collected from the exceeding probes as well as from landfill gas sources that can be definitively tied to the landfill (i.e. extraction wells, leachate collection sumps, or other areas as appropriate). Field comparison of the concentrations of methane, carbon dioxide, oxygen, and gas pressure at each of the sampling points is also appropriate for correlation. Additional demonstration procedures may also be requested.

After the gas demonstration work plan has been implemented, and if the demonstration is successful, the facility will need to propose an alternate source of the methane detected. The successful demonstration that the gas is not from the regulated landfill may not alleviate the facility from managing the methane source, as the presence of methane at or above the defined landfill gas compliance level (i.e. 25% of LEL for methane in structures or at or above the LEL for methane at the facility boundary) is one of the safety criteria for open dump classification of solid waste disposal facilities under 40 CFR 257.3-8 as incorporated under 9 VAC 20-81-45.B. For example, if the source of methane is determined to be an onsite unregulated (pre-88) landfill unit or from fill material existing or brought onsite as part of landfill operations or property maintenance, the source should be addressed by the facility / property owner. If the source is determined to be from offsite, the property owner of the detected methane source will be responsible for management and remediation as appropriate to protect public health and safety.

III. LANDFILL GAS REMEDIATION PLAN

A Landfill Gas Remediation Plan (LFGRP) should be submitted in accordance with the requirements of [9 VAC 20-81-200.C.](#) with a Part B Modification Application as Attachment IX to DEQ Form SW PTB. A LFGRP is only required for those facilities found to exceed the landfill gas compliance levels at one or more perimeter boundary probes or within landfill structures. Note that implementation of the plan is required within 60 days of a landfill gas compliance exceedance. Should the facility desire feedback on the LFGRP prior to implementation, the facility may request a meeting with the regional DEQ staff and/or submit the plan to the regional DEQ office prior to the 60-day implementation deadline.

Format The format used for the LFGRP should encourage clear analysis and presentation of the proposed plans for landfill gas remediation. The LFGRP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

A. Introduction

Provide an introduction that describes the circumstances leading up to submission of the LFGRP. The introduction should provide a history of the exceedance, a summary of the immediate actions taken in response to the compliance level exceedance and indicate the affected probe(s) and/or structure(s). [9 VAC 20-81-200.C.2.]

B. Nature and Extent of Gas Migration

1. Affected Probes/Structures Monitoring

Identify the exceeding probes and structures prompting implementation of this LFGRP and the affected probe subset to be monitored at an increased frequency. The affected probe subset should include the exceeding probe(s) and structure(s) and those probes/structures immediately adjacent, such that at least one (1) probe on either side of each exceeding probe/structure is being monitored at the increased frequency. A description of the soil composition and depth to groundwater in the vicinity of the probes should be provided if known.

Also, provide an evaluation of the depth (if known) and spacing of the perimeter gas monitoring network based on hydrogeological setting and hydraulic conditions, proximity to structures and utilities, gas composition, and any potential gas migration barriers, and identify gaps in the network where adjacent probes exceed the 250-foot spacing specified in [Section I.D.3.](#) of this submission instruction. Specify locations where additional perimeter probes are needed to satisfy the spacing requirement unless the facility can show that such spacing is unwarranted based on site-specific factors (see also [Section I.D.2.](#)). Any agreement by DEQ that a larger spacing is sufficient should take into account adjacent property use and distance to on and offsite structures (including

underground utility lines, sewers and water mains, and above or below ground structures). Under no circumstances should bar punches be used in place of constructed landfill gas probes to satisfy the 250-foot spacing requirement.

Finally, assess the risk to human health and safety of onsite/offsite structures, and summarize the monitoring performed to date in response to the initial landfill gas compliance level exceedance. Discuss trends in the data, noting any changes made to the landfill gas venting, collection, or perimeter monitoring system that may have affected the monitoring results.

2. Existing Operations Impacting Gas Migration

If the facility has existing gas control measures in place, explain the reason(s) for increases in gas migration if known and initial or continuing gas exceedances since the control measures were implemented. Describe the operational status and discuss whether the cause of the exceedances can be tied to operation of the existing gas controls, onsite/offsite land use changes, or other landfill operational changes such as waste disposal, cover placement, or other activities that may impact landfill gas migration.

Evaluate whether the existing control measures remain capable of bringing the exceedance to within compliance limits. Identify and describe in detail any known or potential limitations in the functionality of the existing system, including any problems with pipe size or integrity, equipment limitations, gaps in system coverage, or extraction well spacing. Explain any impacts due to hydrogeological and hydraulic conditions beneath and surrounding the landfill property on existing gas control measures. Any unique conditions including, but not limited to, karst topography or mining activities should be included.

For active gas extraction systems, summarize the results from any investigation of issues that may affect system balance, such as oxygen intake caused by damaged valves/lines, decoupled lines, improperly sealed boreholes or other maintenance or operational issues. Any limitations on the ability to evaluate the effectiveness of the current gas control measures should be described (e.g. lack of strategic placement of sampling ports).

[9 VAC 20-81-200.B.4. and C.2.]

C. Gas Control Measures

1. Gas Control Description

Provide a description of the proposed gas control measures to be implemented to address the compliance level exceedance. It is beneficial to provide a phased approach to landfill gas control, so that additional landfill gas remediation plans are not necessary if the proposed remediation is unsuccessful. Any new gas control measures or proposed upgrades to the existing gas control system should be described in detail, including equipment capabilities and schematic diagrams of

equipment and setup. All equipment and pipe installations should be completed in accordance with recognized and generally accepted good engineering practices.

Gas control measures to protect structures and public health and safety could include one or more of the following: flexible membrane liners, active gas collection systems, passive gas venting systems designed to be upgraded to an active system, alarms, ignition source control, utility collars installed within structures and outside in trenches, and ventilation. Gas controls such as perimeter air injection systems or passive systems, including cutoff trenches, slurry walls and vent trenches are some of the mechanisms used to prevent the migration of landfill gas. Passive systems must be installed to the depth of permanent low seasonal ground water or keyed into a low permeability layer below the limit of migration. Impermeable geomembranes are used with vent trenches to create a barrier to gas migration.

[9 VAC 20-81-200.C.2.]

2. **Maintenance and Repair**

Provide a description of procedures that will ensure the gas control measures (including both passive and active collection, control, or destruction systems) are maintained and operated as designed, including preventative maintenance, inspection, and protocols for making repairs to damaged components.

Repairs to gas control measures should be completed as soon as possible unless an alternate repair timeframe is requested and approved. All repairs should be completed in accordance with recognized and generally accepted good engineering practices. Please note that practices like using duct tape to seal or couple lines will not be considered by the Department to be a recognized and generally accepted good engineering practice as a permanent repair. Duct tape is susceptible to weathering and deterioration as seasonal temperature fluctuations, precipitation, and UV radiation will weaken the adhesive over time and eventually cause the tape to become detached from the structure or compromise the integrity of the repair.

Replacement of a perimeter gas monitoring probe, gas remediation well, or gas vent that has been damaged or rendered inoperable, without change to location, design, or depth of the well can be made after notification to DEQ 14 days in advance of the well/probe replacement. In general, the replacement probe, well, or vent should be planned within 15-20 feet of the probe, well, or vent being replaced and design and depth of the replacement should be similar. This action is considered a permittee change per [9 VAC 20-81-600.F.](#), Table 5.2. Notifications should include a map illustrating the well(s)/probe(s) to be replaced and the reason for the planned action. Replacements not meeting these criteria should be reviewed by DEQ and approved through a minor permit modification.

Repair or replacement of gas collection and control system components installed pursuant to Emission Guidelines or New Source Performance Standards shall be done so in accordance with the facility's Air Permit and Gas Collection and Control System Design Plan.

3. Remediation Standard

Discuss how the construction and operation of the proposed control measures at the facility will:

- Prevent methane accumulation in onsite structures;
- Reduce methane concentrations at monitored facility boundary to below compliance levels; and
- Provide for the collection and treatment and/or disposal of decomposition gas condensate produced at the surface. Note that condensate generated from gas control systems may be recirculated into the landfill provided the facility complies with the liner and leachate control systems design requirements of [9 VAC 20-81-130](#).J.1.a. or b. and [9 VAC 20-81-210](#).D. or the facility has an approved RDD Plan in accordance with [9 VAC 20-81-600](#).F.7.

[9 VAC 20-81-200.C.3.]

4. Coordination with Air Program.

If required, reference the systems to be designed and constructed to control emissions of nonmethane organic compounds under the Clean Air Act or [9 VAC 5-40-5800](#). [9 VAC 20-81-200.C.4.]

5. Implementation Schedule

Provide a schedule that specifies timeframes for implementing the proposed remedial actions, evaluating the effectiveness of such remedial actions, and milestones for proceeding with additional phases of the remediation plan, if necessary. Schedules for facilities that have detected an exceedance along the property boundary where offsite receptors are within 1000 ft of the waste management boundary should be accelerated to address the gas migration and protect public health and safety. The schedule should be provided in tabular form and include monitoring and evaluation periods following installation or implementation of each remedial action or remediation plan phase. Monitoring and evaluation periods following installation of a remedial action or remediation plan phase should not exceed 60 days or an alternate timeframe as approved by the Department. Alternate monitoring and evaluation periods should be based on the facility's proximity to sensitive receptors or migration pathways (e.g. occupied structures, utility right-of-ways, etc.), the concentration of methane detected, and type of remediation being implemented. If methane concentrations do not return to compliance or show decreasing trends within the specified timeframe, then the next phase of the remediation plan should be implemented. Proposed remedial actions and implementation schedules should attempt to resolve landfill gas

exceedances within 18 months of the initial compliance level exceedance. [9 VAC 20-81-200.C.2.]

D. Return to Compliance Monitoring Procedures

Provide a return to compliance monitoring frequency. As indicated in [Section I.I.2.](#) and [Section I.I.3.](#) above, the facility should implement weekly monitoring of the exceeding probe(s)/structure(s) and those probes/structures immediately adjacent, such that at least one (1) probe on either side of each exceeding probe/structure is being monitored at the increased frequency. In order to return to the required minimum quarterly monitoring schedule, the facility will need to continue to implement weekly monitoring, if required, of the affected probe/structure subset until consecutive weekly readings are below the action level for a month (i.e. four (4) consecutive weeks of data showing methane concentrations below 4% methane). Weekly means an interval corresponding to approximately 7 days. Facilities monitoring on a weekly frequency should perform one monitoring event during each calendar week. As indicated in [Section I.G.](#), if possible monitoring should be performed during varying weather conditions, including during periods of a falling barometer, prolonged low pressure or prolonged steady barometric pressure events.

The facility should then continue with monthly monitoring of the probe/structure subset until consecutive monthly readings are below the action level for a quarter (i.e. three (3) consecutive months of data showing methane concentrations below 4% methane). Monthly means an interval corresponding to approximately 30 days. Facilities monitoring on a monthly frequency should perform one monitoring event during each calendar month. To fit the monthly definition, monitoring should be completed within a window of 23-37 days from the prior event. Again, if possible, monitoring should be performed during varying weather conditions, including during periods of a falling barometer, prolonged low pressure or prolonged steady barometric pressure events. Once the monthly monitoring condition is satisfied, the facility may return to quarterly monitoring.

An alternate return to compliance gas monitoring frequency may be approved based on site specific conditions. [9 VAC 20-81-200.C.4.]

E. Response and Reporting

The facility should follow the response and reporting requirements outlined in [Section I.I.](#) of this submission instruction when performing increased frequency return to compliance monitoring.

If monitoring results show methane concentrations are below the action level, 24-hour oral notification and written notification within 5 working days is not required for that particular monitoring event. However, once a facility has completed the required minimum number of consecutive monitoring events resulting in gas concentrations below action level to justify returning to a lesser monitoring frequency (i.e. monthly or quarterly) as outlined in [Section III.D.](#), DEQ requests that the facility submit

monitoring data for ALL monitoring events since the implementation of the remedial action or remediation plan phase in order to assess progress towards return to compliance. If the return to a lesser monitoring frequency takes longer than six (6) months, monitoring data should be submitted in tabular form with an accompanying graph to clearly document trends in data over time to justify the change in monitoring frequency.

IV. ODOR MANAGEMENT PLAN

An Odor Management Plan (OMP) should be submitted in accordance with the requirements of 9 VAC 20-81-200.D. and maintained in the facility's Operating Record. An OMP is only required for those facilities found to have created an odor nuisance or hazard under normal operating conditions and upon notification from the department. OMPs developed in accordance with the Virginia Air Regulations ([9 VAC 5-40-140](#), [9 VAC 5-50-140](#), or other state air pollution control regulations) will suffice for this plan.

Format The format used for the OMP should encourage clear analysis and presentation of the proposed plans for odor management. The OMP should start with a title page and table of contents followed by the following sections and discussions. The title page should identify the facility name and permit number, the permit applicant, document date, and document preparer information. In addition, the header or footer of each page should include the facility name, permit number, document title, revision date, and page number.

A. Introduction

Provide an introduction that describes the circumstances leading up to submission of the OMP. The introduction should provide a summary of the odor complaint(s) received and the immediate actions taken in response. [9 VAC 20-81-200.D.]

B. Odor Contact

Indicate the name, address, and telephone number of the person or office that citizens can notify about odor concerns. [9 VAC 20-81-200.D.2.]

C. Handling Odor Complaints

Specify procedures for handling odor complaints from citizens. [9 VAC 20-81-200.D.1.]

1. Documenting the complaint

Provide a form for landfill personnel to use to document complaints. An example form is provided as [Attachment A](#).

2. Facility Investigation

Discuss steps landfill personnel will take in response to the complaint received. Such steps should include:

- Using equipment or olfactory senses to monitor the odor complaint location, the facility boundary point closest to the complaint location area, the working face, and any other potential odorous areas. Locations selected for monitoring should take into account the weather conditions at the time of the complaint;
- Placing documentation in the operating record describing the response(s) taken to odor complaints received;
- Notifying the DEQ Regional Office within 24 hours of the complaint.

- Follow-up with the complainant to provide a summary of the work completed since the complaint was logged.

3. Remedial Measures

Discuss the potential remedial measures to be employed by the facility once the source of the odor has been identified. Such remedial actions could include:

- Evaluate the incoming waste stream for odor producing materials and reduce the amount of the odor producing material so identified or modify operations to improve handling;
- Apply six inches of soil cover or approved alternate cover material to exposed working areas;
- Apply an odor reducing/controlling agent;
- Repair leachate seeps; or
- Make any necessary repairs to the landfill gas and leachate management systems.

D. Annual Plan Review

The OMP shall be reviewed by appropriate facility personnel annually and updated as necessary. Procedures for documenting this review and update can be found in [Guidance Memo 01-2011A: Implementation of New Operations Manual Requirements](#). [9 VAC 20-81-200.D.3.]

Attachment A

Odor Complaint Tracking Form

ODOR COMPLAINT FORM

FACILITY NAME: _____
FACILITY ADDRESS: _____

DATE: _____
TIME: _____

RECEIVED BY: _____

Contact Information of Caller

Name: _____
Address: _____
Address 2: _____
Phone: _____
Email: _____

Odor Information

Date Detected: _____
Time Detected: _____
Location Detected: _____

Description of Complaint

Type of Odor: _____

Intensity of Odor: _____

Weather Conditions when odor was detected: _____

Have odors been noticed at this location in the past? _____

Weather Conditions at the time odors were detected (based on weather monitoring station or internet resources):

Wind Direction & Speed: _____ Rainfall: _____ Temperature: _____
Barometric Pressure: _____ Humidity: _____

Follow-up Contact with Caller

Was follow-up contact made with the caller?

If yes, answer the following questions:

When was contact made? Date: _____ Time: _____

Who made contact? _____

How was contact made? (Letter, Phone Call, E-mail, etc.)

What issues were discussed with the caller?

Description of Corrective Measures: _____

