DEPARTMENT OF RESOURCES RECYCLING AND RECOVERY

1001 I Street - Sacramento, CA 95814
Engineering Support Branch
(Closed Illegal & Abandoned Site Investigation Unit)

Landfill Gas Sampling Procedures For Subsurface Landfill Gas Monitoring Wells

PREPARED BY:
California Department of Resources Recycling and Recovery (CalRecycle)
Engineering Support Branch
(Closed, Illegal & Abandoned Sites Investigation Unit)

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Section 1. Introduction

These standards were developed to help and guide CalRecycle's field staff and LEAs involved with the collection of landfill gas samples primarily from gas monitoring wells installed according to Title 27 CCR, Section 20925 et seq (see more below). Gas sampling should be used as a tool for compliance or as a screening method for a landfill gas assessments. Gas sampling and analysis must be conducted in a defensible manner that allows the data to be used to support LEA Enforcement actions. Sampling and Analysis Plans with QA/QC procedures and the use of an accredited laboratory are important in collecting defensible evidence.

Ensuring that landfill gas samples are collected adequately and following a standardized procedure, are important steps in having meaningful and quality results.

Be aware that these procedures are not to address every single field condition and they are not a substitute for field experience but what they will accomplish, is the homogeneity and standardized sample collection steps among all field staff.

1.1 Subsurface Gas Monitoring Wells

CalRecycle's regulations require the installation of landfill gas compliance wells for the purpose of monitoring subsurface migration of landfill gas past the permitted property boundary or an alternative boundary of the landfill/disposal site as well as preventing the accumulation of landfill gas in on-site structures.

As such, CalRecycle requires gas monitoring wells to be designed, monitored and reported to comply with Section 20925 et seq. For additional information please refer to Title 27 California Code of Regulations (CCR).

1.2 Constituents of Potential Concern

The primary constituents of potential concern (CPC) are those chemicals associated with the decomposition of waste materials in landfills. It has been recognized that methane and carbon dioxide gases are produced in equal proportions. Other predominant gases encountered are oxygen, nitrogen, hydrogen sulfide and volatile organic compounds. Table 1, shows the specific analytes and their associated methods for laboratory analysis.

Table 1. Constituents of Potential Concern

CPC	Analytical Method	Screening Criteria Under Title 27 CCR
Methane	ASTM D1946	5% v/v (Gas Offsite Migration) Tittle 27 CCR, Section 20921(a)(2)
Fixed Gases: - Oxygen - Carbon Dioxide - Nitrogen	ASTM D1946	None
Hydrogen Sulfide	EPA 15/16	None

Volatile Organic Compounds (VOCs) aka Trace Gases	EPA TO-15	None “Control to Prevent Exposure” Title 27 CCR, Section 20921(a)(3)
Note: Additional analytes and methods maybe used and required depending on the specific goals of the sampling plan and assessment (e.g., LFG fingerprinting). However, those advanced methods and analytes are not discussed here.		

1.3 Sampling Containers

For the purpose of this guide it will be assumed that the sampling container of choice is canisters (aka Summa® Canisters, Stainless-Steel Canisters, Glass Bottle Canisters, Air Sampling Canisters), which are normally found in two common volumes (1 and 6 liters). Based on CalRecycle’s staff field experience, it has been found that canisters offer various advantages over other containers, specifically over polyvinyl bags (Tedlar® Bags). Canisters have superior inertness, hold time to analysis and ruggedness. Canisters are certified by the laboratory and have undergone specific preparations to ensure that the container is free from cross-contamination. Additionally, canisters are easier to use in the field as they do not require a sampling pump for sample collection – eliminating with this the potential for cross contamination and poor field quality control.

Canisters are fully suited to contain any landfill gas sample for the analyses mentioned above. With the exception of hydrogen sulfide, where field staff should request lined canisters for sample collection to avoid chemical reactions of the hydrogen sulfide with the canister inner wall surfaces.

Section 2. LFG Sampling Procedures

2.1 Sampling Plan

Sampling Plans provide documentation of specific methods and procedures followed to ensure the quality of the data. As a matter of organization and preparation all staff should develop a sampling plan that includes a map or a plot with the locations of the wells and a sampling schedule (monitoring protocol). This will aid with sampling criteria and target goals before field work. An example of a sampling schedule is provided in Table 2 and should be helpful not only for field work planning but also when accounting for materials needed and laboratory costs.

2.2 Materials and Equipment

Summarized below are some suggestions for materials that should be obtained previous to sampling field work, these are just suggestions and are not to address every single field condition – adjustments should be made as necessary:

- Sample Containers, Preservatives, Shipping Containers;
- Portable Gas Indicator (GEM-2000/RKI Eagle) or similar – to perform screening analyses;
- Thermometer – to determine probe temperature;
- Digital Camera;
- Sampling Train – to collect sample;

- Sampling Plan – maps, sampling schedule/protocol;
- Gas Monitoring Log Sheet – record field information;
- Chain-of-Custody Forms;
- Sample Container Labels;
- Mailing/Courier Forms and Labels;

2.3 Gas Screening

Before collecting landfill gas samples, field staff should perform "screening analyses" using a combustible gas indicator (GEM-2000 or similar) to determine potential methane concentrations present (hot spots) and other fixed gases within the targeted gas probes. The data gathered by the screening analysis should be used to determine the number of samples and lab analyses according to the sampling plan.

2.3.1 Gas Screening Analysis

a. Follow the combustible gas indicator instrument manufacturer's warm-up and calibration procedures;
b. Connect the gas indicator to a sampling train or directly to the probe's sampling port in the absence of one;
c. Turn open probe valve;
d. Allow gas indicator to provide a steady gas readout (normally from 10 to 30 seconds) without purging the probe;
e. Using a log sheet record the landfill gas (CH_4, CO_2, O_2 H_2S, and Balance/N_2) concentrations as well as ambient temperature, weather conditions and other relevant comments (see log sheet attached at the end of this document).

2.3.2 Protocol for Selection of Samples (examples)

Examples of common sampling protocols are as follows:

a. If the methane concentration measured with the gas indicator for any of the probes exceeds 1% v/v, one sample should be collected from all the probes above this concentration;
b. If the methane concentration measured with the gas indicator does not exceed 5% v/v in any of the probes, collect one sample from the probes with the highest methane concentration above 1% v/v from at least 5-10 probes;
c. If the methane concentration measured with the gas indicator for any of the probes exceeds 5% v/v, collect one sample from the probes with the highest methane concentration above 5% v/v from at least 5-10 probes
d. Alternatively but not desirable, samples should be collected from specific probes (authoritative sampling).

Note: If no gas is detected by the combustible gas indicator or is below a certain parameter (e.g., below 0.5% v/v) of combustible gas as methane, sampling of probe should be discarded, since not enough gas is present at this probe, methane is below regulatory limits, and the purpose of laboratory analysis is to confirm the accuracy of the portable gas indicator.

2.4 Procedures for Canister Grab Sampling

The procedures described below are intended for grab samples (taken over short intervals; normally in seconds) as opposed to integrated samples (taken over an extended time; normally hours) – integrated sampling is mostly used for indoor air quality assessments.

These procedures are typical for the collection of landfill gas samples from gas monitoring wells installed pursuant to Title 27 CCR. Actual field conditions and procedures may vary.

2.4.1 Using a Sampling Train

i. Starting at your first probe, check that the probe's sampling valve is closed;
ii. Verify that the canister valve is closed and remove the canister's brass cap;
iii. Assemble your sampling train by connecting the various parts in the following order:
    a. Sampling train to probe sampling port;
    b. Combustible gas indicator (GEM-2000) to sampling train;
    c. Canister to sampling train;
iv. Verify and record the canister's initial vacuum if your train is equipped with a vacuum gauge – make sure to close the canister's valve after this is completed;
v. Turn open the sampling port's valve and run your combustible gas indicator and perform a gas screening analysis as explained in previous sections and record your stable gas reading – idle or turn off the pump of your gas indicator;
vi. By pass the gas indicator to allow for sample collection and open the valve of the canister (1/2 to 1 full turn) and allow to fill for about 15 seconds;
vii. Close (hand tighten) the valve of canister – clockwise;
viii. Record the canister's final vacuum and replace the brass cap;
ix. Close the valve of the gas monitoring probe;
x. Disconnect the parts of your train and perform a decontamination procedure of the train using a free-flow air suction using the pump of the gas indicator (GEM-2000) for 10-15 seconds.

2.4.2 Direct Sampling (No Sampling Train)

i. Starting at your first probe, check that the probe's sampling valve is closed;
ii. Verify that the canister valve is closed and remove the canister's brass cap;
iii. Install compression fittings to the canister (never use tube in tube connections as they are loose connections and will dilute your sample through air intrusion);
iv. At the probe; connect the combustible gas indicator, open the sampling port's valve and perform a gas screening analysis as explained in previous sections and record your stable gas reading – idle or turn off the pump of your gas indicator and at the same time close the probe sampling port;
v. Disconnect the gas indicator from the gas probe;
vi. Connect the canister to the probe's sampling port via the compression fittings;
vii. Open the probe's valve then, open the valve of the canister (1/2 to 1 full turn) and allow to fill for about 15 seconds;
viii. Close (hand tighten) the valve of canister – clockwise,
ix. Close the valve of the gas monitoring probe.
x. Disconnect compression fittings from the probe and canister and replace the brass cap on the canister.

2.5 Sample Labeling and Packaging

2.5.1 Labeling

Using the laboratory provided labels or tags, identify each canister with the following information:

- Sample ID (Probe name and depth);
- Client (CalRecycle);
- Date and Time;
- Project Name;
- Analyses Required;
- Sampler Initials;

2.5.2 Chains-of-Custody Forms

A custody form should always accompany all sample containers. Fill out the forms provided by the contracted laboratory making sure that all the samples are included in the form, all of the tests required are confirmed and any additional notes regarding delivery times and signatures are completed. Make sure to keep the third copy of the form for your records (normally pink color) and include the rest of the forms in the shipping container(s).

2.5.3 Packing and Shipping

Prepare the samples for shipment as follows:

- Use the shipping container provide by the laboratory, normally compartmentalized cardboard-box;
- If no box is available, use an ice-chest;
- Canisters should not have excessive play inside box/ice-chest, use packaging materials to secure gas canisters (e.g., paper);
- Ensure that all samples, labels and chains-of-custody are complete and in the shipping container;
- Tape shipping container shut and seal if applicable;
- Fill out the shipping manifests and keep copies for your records;
- Arrange for pick up or deliver boxes to the nearest courier service shop.

Section 3. QA/QC

2.6 Various Methods

Sample Type	Rationale	Comment	Recommendation
Field Duplicates	Field duplicates involve collecting two separate samples of the same matrix at the same time and same location, and using the same sampling procedures to document that sampling techniques are consistent and are not influencing the analytical results	However, gas samples are inherently heterogeneous, therefore, even if two samples are collected at the same exact gas probe, the analytical results will be different and may not be comparable because as the gas is drawn from a probe casing, gas concentrations would change as the sample gets diluted over time or more gas is withdrawn into the casing from surrounding plumes	Field duplicates of gas matrix are therefore not a reliable indicator of accuracy, representativeness, or precision and should not be collected
Trip Blanks	A trip blank generally involves a solution that is placed into the same type of sampling container that will be used for the environmental sample and kept with the set of sample containers both before and after sample collection	Samples of gas plumes from probes (are gas matrix) not liquid samples, and are collected into containers that are not used for liquid samples	Therefore trip blanks are not applicable to this type of assessments
Background Samples	Backgrounds samples involve the collection of gas samples from an assumed clean area/air environment to establish the chemical concentrations or background levels within the specific location.	In some cases background chemical concentrations levels are irrelevant to the decision-making process. Examples: i. For a gas plume release whose constituents are known and not expected to have been released to the environment from any source other than the landfill site, ii. In other cases, background levels of methane gas may not exceed the regulatory limits (5% v/v).	Therefore, background analysis would not be relevant.

2.7 Data Validation

Data validation of the analytical testing should be conducted during report preparation and include the following:

- Sample holding time;
- Sample methods;
- Analytical method;
- Sample preservation;
- Chain-of-custody records;
- Detection limits;
- Possible transcription errors;
- Surrogate recoveries;
- Matrix spike recoveries and matrix spike duplicate recoveries, and
- Calibration checks.

Section 4. Reporting Requirements

For field sampling events, minimum reporting should be performed that includes the following:

- Prepare a brief memo/email to the LEA in charge of the site with information pertaining to the results of the sampling event;
- Include laboratory results, field log-sheets and custody forms;
- Update the SWIS database with information about the sampling event;
- Provide copies of all records to CalRecycle's Library on the 13th floor within 30 days after receipt of laboratory results.

Table 2. Sampling Schedule (example).

Sampling Schedule of Gas Wells Canyon Park Dump/Rancho Duarte Golf Course Las Lomas Road and Hacienda Drive – Duarte, CA 91010					
			Analytical Testing*		
Sample ID	Gas Screening	Container	F.G. & Methane	VOCs	C_2-C_6
LFG-1-S	X	Summa Can. (1 lt)			
LFG-1-M	X	Summa Can. (1 lt)			
LFG-1-D	X	Summa Can. (1 lt)			
LFG-2-S	X	Summa Can. (1 lt)			
LFG-2-M	X	Summa Can. (1 lt)			
LFG-2-D	X	Summa Can. (1 lt)			
LFG-3-S	X	Summa Can. (1 lt)			
LFG-3-M	X	Summa Can. (1 lt)			
LFG-3-D	X	Summa Can. (1 lt)			
LFG-4-S	X	Summa Can. (1 lt)			
LFG-4-M	X	Summa Can. (1 lt)			
LFG-4-D	X	Summa Can. (1 lt)			
LFG-5-S	X	Summa Can. (1 lt)			
LFG-5-M	X	Summa Can. (1 lt)			
LFG-5-D	X	Summa Can. (1 lt)			
LFG-6-S	X	Summa Can. (1 lt)			
LFG-6-M	X	Summa Can. (1 lt)			
LFG-6-D	X	Summa Can. (1 lt)			
LFG-7-S	X	Summa Can. (1 lt)			
LFG-7-M	X	Summa Can. (1 lt)			
LFG-7-D	X	Summa Can. (1 lt)			
LFG-8-S	X	Summa Can. (1 lt)			
LFG-8-M	X	Summa Can. (1 lt)			
LFG-8-D	X	Summa Can. (1 lt)			
QA/QC (Duplicates and Background)					
Duplicate 1	X	Summa Can. (1 lt)	X	X	X
Background 1	X	Summa Can. (1 lt)	X	X	X
Total Samples			18	18	18
Total Containers		18			

Gas Sampling Log-Sheet (Template)

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Landfill Gas Monitoring Logsheet

Location: _____ **Instrument:** _____

Date: _____

Project: _____ **Field Staff:** _____

Weather Conditions _____

Bar. Pressure: _____ **Comments:** _____

Sample ID	Location	Time	Pressure (in WC)	Temperature (^oF)	Monitoring Data					Field Observations
					CH4 (%)	CO_2 (%)	O_2 (%)	Balance (%)	H_2S (ppm)	

Map with Probe Locations (Example)

Chain-of-Custody (Example)

Oilfield Environmental and Compliance
307 Roemer Way Suite 300, Santa Maria CA 93454
phone: (805) 922-4772 fax: (805) 925-3376 www.oecusa.com

Highway 33, McKittrick CA
phone: (661) 762-9143

CHAIN OF CUSTODY

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Company: CALRECYCLE
Address: 1001 I ST.
City/State/ZIP: SACRAMENTO - CA 95814
Phone: (916) 341-6724 Fax: E-mail: abel.martinez@calrecycle.ca.gov
Report To: ABEL MARTINEZ Sampler: BA
Send report via- FAX- ☐ PDF- ☒ Coll/LUFT EDF- ☐ EDD- ☐
Turnaround Time: 10 Days- ☒ 5 Days- ☐ 72 hr- ☐ 48 hr- ☐ 24 hr- ☐ ASAP- ☐

Project Name/#: ANTIOCH - LYNCH LANDFILL
Site:

OEC Sample ID	Date/Time Sampled	Matrix	# of Cont.	Client Sample ID	CAM-17/7010 EPA-6010	VOCs 8260B	TPH C6-C44	SVOCs (8270) FULL LIST	TRPH (1664)						Special Instructions:
1204699-1A	9/17/12 9:30 am	SOIL	1	LFG-1 (5)	X	X	X	X							
2A	9:50 am			LFG-1 (25)											
3A	10:40 am			LFG-1 (50)											
4A	11:00 am			LFG-1 (55)											
5A	11:30 am			LFG-1 (60)											
6A-C	10:05 am	X	1	LFG-1 (DRUM-1)											
(LY) ~~7A~~	10:35 am	X	1	LFG-1 (DRUM-2)	X	X	X	X	X						
	1:40 PM	X	1	LFG-1 (DRUM-3)											
7A-E	2:45 PM	X	1	LFG-2 (DRUM)											
	9/18/12 8:45 am	X	1	LFG-4 (DRUM)											
	11:50 am	X	1	LFG-5 (DRUM)	X	X	X	X	X						
	2:15 PM	X	1	LFG-3,4,5 (DRUM)											
	3:50 PM	X	1	LFG-3 (DRUM)											

SAME COMPOSITE SAMPLE

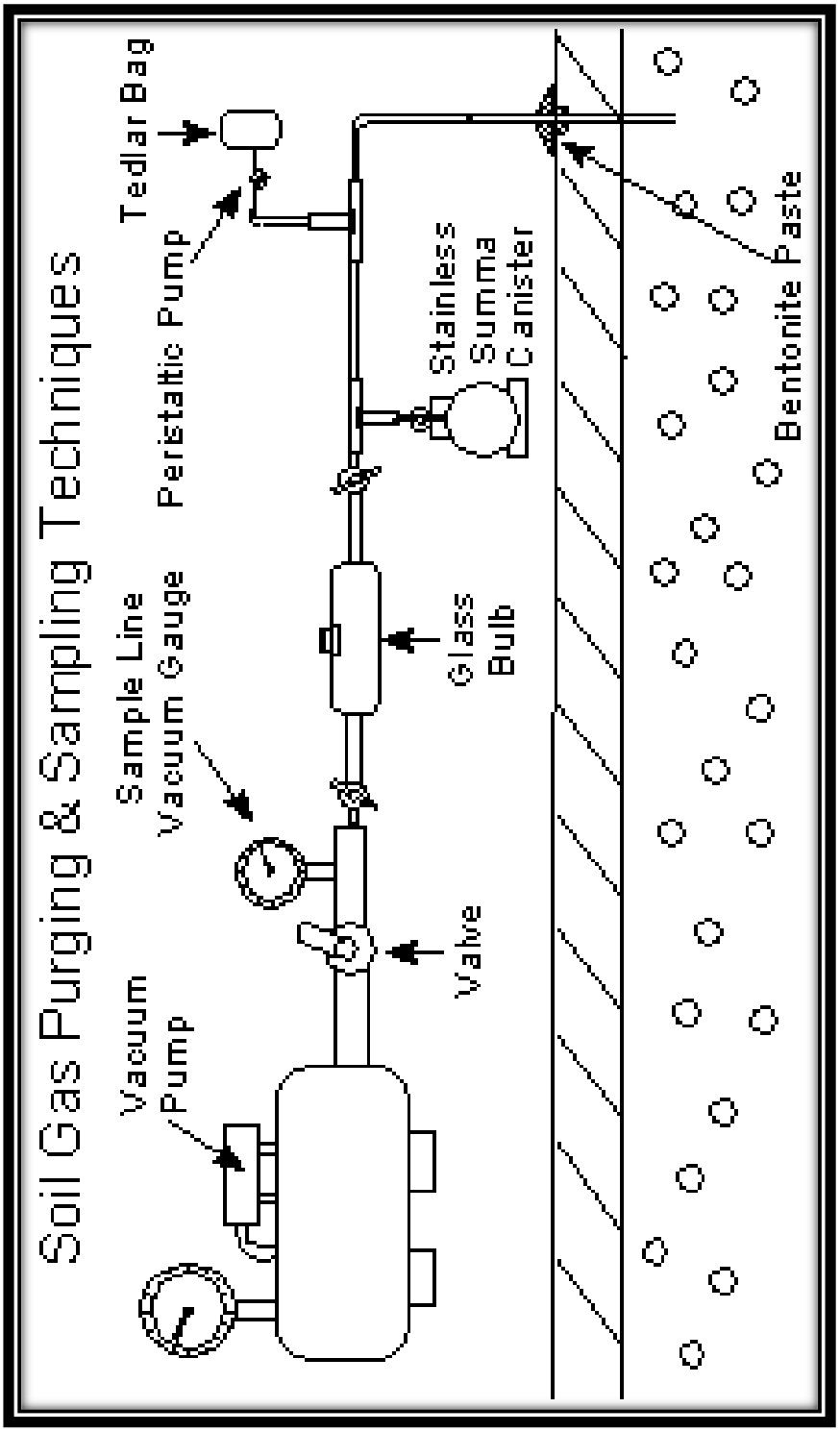
SAME COMPOSITE SAMPLE

24 hr TAT per client (LY) 9-20-12

Relinquished By:		Date:	Time:
Received By:		Date:	Time:
Relinquished By:	ABEL MARTINEZ	Date: 9/19/12	Time: 9:18 am
Received By:		Date:	Time:
Relinquished By:	FedEx	Date:	Time:
Received By:	Lynnette Yes	Date: 9-20-12	Time: 1010

Comments/PO#:
SAVE SAMPLES AS STLC/CAM-5 AND TCLP/RCRA MAY BE REQUIRED.

Gas Sampling Train Diagram (Typ)



REFERENCES

Air Toxics LTD., “Guide to Air Sampling and Analysis”, March 2014, Folsom, CA.

CA Integrated Waste Management Board, “Workplan Canyon Park Dump – Landfill Gas Investigation”, April 2006, Sacramento, CA.

Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency, “Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (Method TO-15)”, January 1999, Cincinnati, OH.

South Coast Air Quality Management District, “Rule 1150.1. Control of Gaseous Emissions from Municipal Solid Waste Landfills”, April 2011, Diamond Bar, CA.

United States Environmental Protection Agency, “Summa Canister Field Standards”, September 1994, Atlanta GA.

United States Environmental Protection Agency, “Method 25C – Determination of Non-Methane Organic Compounds (NMOC) in Landfill Gas”, January 2014, Research Triangle Park, NC.