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GUIDANCE FOR EVALUATING LANDFILL GAS EMISSIONS FROM CLOSED OR ABANDONED FACILITIES: Appendix C

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by

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EPA Contract No. 68-C-00-186, Task Order 3

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U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

Abstract

This document provides guidance to superfund remedial project managers, on-scene coordinators, facility owners, and potentially responsible parties for conducting an air pathway analysis for landfill gas emissions under the Comprehensive Environmental Response, Compensation, and Liability Act, Superfund Amendments and Reauthorization Act, and the Resource Conservation and Recovery Act. The document provides procedures and a set of tools for evaluating LFG emissions to ambient air, subsurface vapor migration due to landfill gas pressure gradients, and subsurface vapor intrusion into buildings. The air pathway analysis is used to evaluate the inhalation risks to offsite receptors as well as the hazards of both onsite and offsite methane explosions and landfill fires.

Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

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This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Sally Gutierrez, Director
National Risk Management Research Laboratory

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Appendix C

Example
Generic Quality Assurance Project Plan

EXAMPLE GENERIC
QUALITY ASSURANCE PROJECT PLAN
for the
APPLICATION OF GUIDANCE FOR EVALUATING LANDFILL GAS EMISSIONS AT CLOSED or ABANDONED SITES

EPA Contract No. 68-c-00-186
Task Order Number 3
EQ Project No. 030177.0003

Prepared for

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QUALITY ASSURANCE PROJECT PLAN: EVALUATING LANDFILL GAS EMISSIONS AT CLOSED or ABANDONED SITES

EPA Contract No. _____
Work Assignment No:_____

EPA Remedial Project Manager: _____
Name Date

EPA WA Manager: _____
Name Date

EPA QA Officer: _____
Name Date

Contractor Project Manager: _____
Name Date

Contractor QA Officer: _____
Name Date

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List of Acronyms

Acronym	Definition
ARARs	applicable or relevant and appropriate requirements
ASTM	American Society of Testing and Materials
CCV	continuing calibration verifications
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLU-IN	Hazardous Waste Cleanup Information
COC	chain of custody
COPCs	contaminants of potential concern
DQA	data quality assessment
DQOs	data quality objectives
ELCT	electrolytic conductivity detector
ERTC	Environmental Response Team Center
FID	flame ionization detector
FRM	Federal reference method
GC/MS	gas chromograph/mass spectrometer
IS	internal Standard
LEL	lower explosive limit
LFG	landfill gas
LOI	limit of identification
MDL	method detection limit
MQL	method quantitation limit
MRL	method reporting limit
MS/MSD	matrix spike/matrix spike duplicate
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMOCs	nonmethane organic compounds
NSCEP	National Service Center for Environmental Publications
OSHA	Occupational Safety and health Administration
OVA	organic vapor analyzer
PE	performance evaluation
PID	photoionization detector
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RDL	reliable detection limit
RPD	relative percent difference

List of Acronyms (concluded)

Acronym	Definition
RPM	remediation project managers
RRT	relative retention time
SARA	Superfund Amendments and Reauthorization Act
SCS	Soil Conservation Service
SOP	standard operating procedure
TAL	target analyte list
TCD	thermal conductivity detector
THC	total hydrocarbon concentration
TNR	toluene-normalized response
TOM	task order manager
UHP	ultra high purity
VOCs	volatile organic compounds

Distribution List

EPA Remediation Project Manager
EPA Laboratory Manager
EPA WA Manager
EPA QA Manager
Contractor Project Manager
Contractor QA Officer

Contact task order manager to determine the date of the most recent version of this QAPP.

ELEMENT A - PROJECT MANAGEMENT

A.1 Project Definition and Background

EPA recently developed a draft guidance document to assist remediation project managers (RPMs), risk assessors, and others in assessing human health and safety concerns associated with landfill gas (LFG) emissions at closed or abandoned landfill sites. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) mandate the characterization of all contaminant migration pathways from contaminated sites. At CERCLA landfills, characterization of the air pathway is often delayed until the cover systems are designed. Recently there has been increased interest in the use of alternative (i.e., permeable) cover systems that may not adequately control LFG. In these cases, it is necessary to characterize the nature of the LFG emissions and the risks that would result from exposure. To address these concerns, a guidance document entitled Guidance for Evaluating Landfill Gas Emissions at Closed or Abandoned Sites has been developed. A fact sheet and the guidance is available for viewing or downloading from EPA's Hazardous Waste Cleanup Information (CLU-IN) Web site at http://cluin.org (accessed August 2005). Hard copies are available free of charge from:

U.S. EPA National Service Center for Environmental Publications (NSCEP)
P.O. Box 42419
Cincinnati, OH 45242-2419
Telephone: (513) 489-8190 or (800) 490-9198
Fax: (513) 489-8695

The task order manager (TOM) and RPM will determine which sites are to be selected. It is anticipated that existing information will indicate if LFG is being emitted from the landfill in an uncontrolled manner, if there is a groundwater plume migrating offsite, if there are nearby offsite structures, and if access to the site and nearly structures is assured.

The primary purpose of the project is to provide the RPMs with information that will allow them to determine if LFG controls are needed and if compliance with applicable or relevant and appropriate requirements (ARARs) have been achieved. Field work is a means to collect the information needed to implement the procedures included in the guidance. Comparability of concentration data from site-to-site is not anticipated. Still there needs to be a unifying level of acceptable uncertainty in order to define measurement quality objectives. Data quality objectives are a starting point of an interactive process, and they do not necessarily constitute definitive rules for accepting or rejecting results. The measurement quality objectives have been defined in terms of standard methods with accuracy, precision, and completeness. These objectives are believed to be achievable based on method specifications, instrument capabilities, historic data, and experience.

The density of sample locations will be determined on a site-specific basis. It is anticipated that the number of samples will be statistically robust, and the completeness goals recognize that the guidance techniques can be evaluated without collecting a massive number of samples. The study design is such that the impacts of the LFG emissions on the residence closest to the portion of the landfill with the highest contaminant of potential concern (COPC) and methane (CH_4) concentrations are evaluated. Whether or not there are other off site receptors that may be adversely affected by the LFG emissions is not determined.

This generic Quality Assurance Project Plan (QAPP) will be used as a guidance document for preparing site-specific QAPPs. This QAPP will be applied to all activities involving environmental measurements. This document includes sections that detail the procedures that will be used to sample and analyze LFG. Preparation of this QAPP follow EPA requirements as stated in the document EPA QA/R-5 Requirements for quality assurance project plans (March 2001).

A.2 Project Organization

The project organization chart is shown in Figure A-1. _____ is the TOM. She/he is responsible for coordinating activities and for obtaining the staff and resources needed to complete this project. _____is the contractor project manager with primary responsibility for both administrative and technical matters. This project is a collaborative effort between (organizations). Close coordination between the project participants will be needed to ensure that the QAPP requirements are understood and that all of the project objectives are met.

The TOM has overall responsibility for ensuring that the project meets EPA objectives and quality standards. The TOM is also responsible for defining the scope of work and deliverables required for the delivery order. She/he will ensure that the performance of assigned tasks addresses the quality assurance (QA), quality control (QC), and chain-of-custody (COC) procedures specified in this QAPP. She/he is responsible for selecting the landfill sites and for coordinating activities at them. The TOM must review and approve the QAPP.

The EPA QA manager will be responsible for reviewing and approving the generic and site-specific QAPPs. The EPA QA manager may schedule audits at her/his discretion.

The site laboratory manager is responsible for directing all of the onsite activities including obtaining equipment, supplies, and qualified personnel. He/she will assign duties to the site monitoring and sampling team as required to complete the study effort in a cost-effective and timely manner. The site laboratory manager is responsible for organizing and deploying competent field crews. He/she will communicate regularly with the TOM and project manager to ensure that progress is achieved and that expenditures are controlled. The sampling and monitoring team will include persons that have the training and experience needed to carry out the activities described in the generic and site-specific QAPPs. The sampling and monitoring field team leader is responsible for documenting compliance with the QAPP and standard operating procedures (SOPs). The field team leader shall implement corrective actions as needed and he/she shall report any sampling or monitoring issues that may affect data quality to the quality assurance officer. The site laboratory manager must review and approve the QAPPs.

The contractor project manager is responsible for preparing project deliverables and for managing the project. She/he will ensure that the agreed project milestones budgets and schedules are achieved. He/she will communicate regularly with the TOM, the Environmental Response Team Center (ERTC) project manager, and the site-specific remedial project coordinators to ensure that the project and QAPP is completed as planned. The project manager must approve the QAPPs.

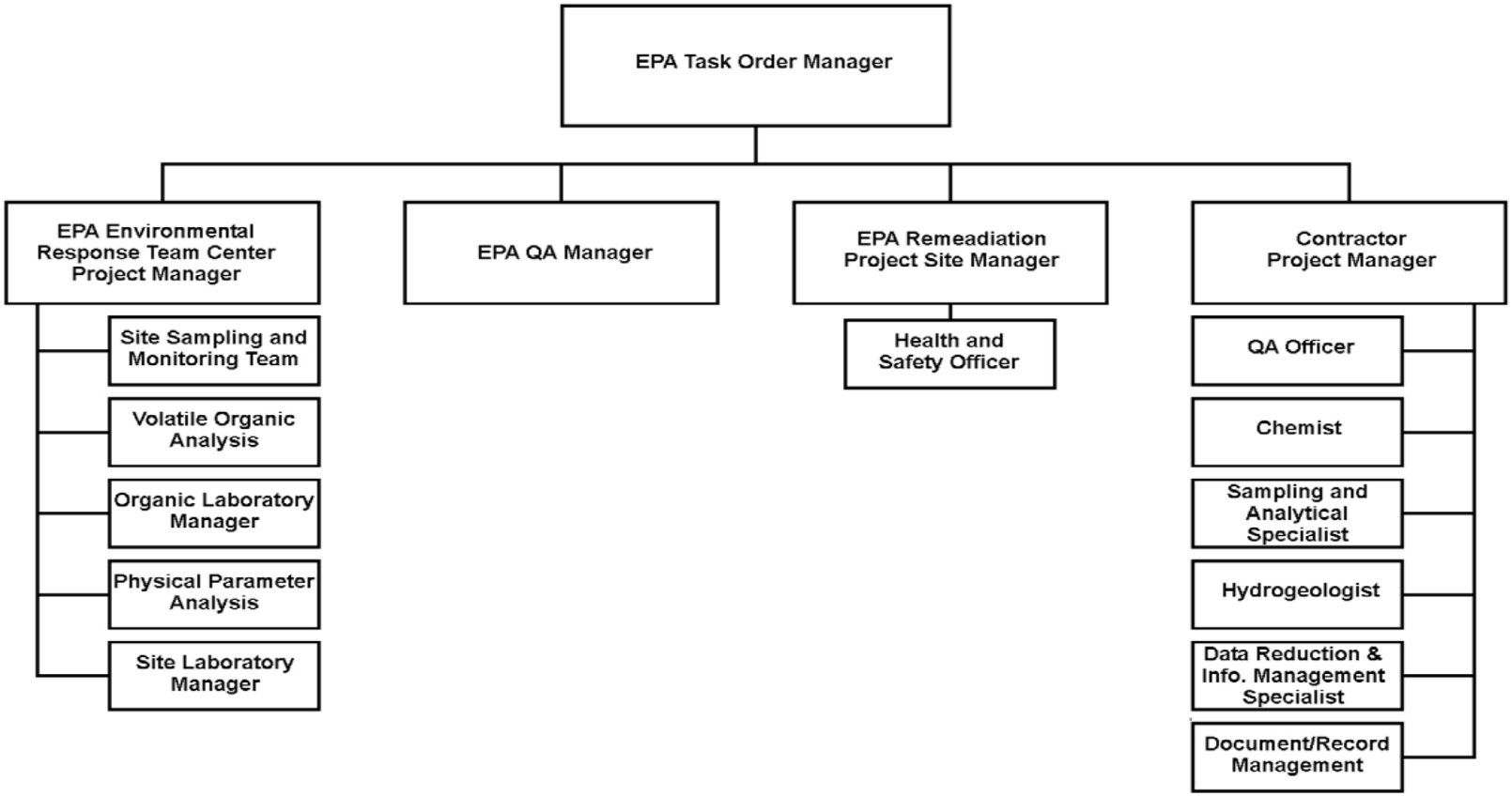

Figure A-1. Project Organization Chart

The RPM is responsible for providing background and historical information, site access, site security, utilities, and health and safety training. The background information will include site plans, topographic maps, historical sampling data, and so forth. The RPM is also responsible for defining ARARs and acceptable risk ranges on a site-by-site basis. The RPM must approve the generic QAPP and the site-specific QAPP applicable to his/her site.

The QA officer will remain independent of the day-to-day activities and will have direct access to the corporate executive staff as needed to resolve any QA disputes. In these roles she/he will:

- Maintain QA/QC oversight;
- Prepare and review QAPPs and amendments;
- Review and provide audit reports;
- Initiate, review, and follow-up on corrective actions;
- Approve QAPPs and amendments; and
- Participate in project meetings as directed.

The QA officer shall be responsible for reviewing and approving the generic and site-specific QAPP. The QA officer shall review the laboratory reports to determine if the methods and procedures have been properly followed and documented. Discrepancies will, if feasible, be corrected, and appropriate annotations will be recorded. Any variances that cannot be corrected will be flagged, and the usefulness and limitation of the laboratory data will be ascertained. The QA officer will conduct field audits in order to verify that QAPP and SOP requirements are being followed. The field audit will be completed during the first two days of each site investigation. Corrective actions will be initiated from the field in order to minimize adverse impacts. Audit items will include:

- Verification of field instrument calibration,
- Duplicate reading of direct read instruments at 5 percent of locations,
- Predefined precision, accuracy, and completeness objectives,
- Review of Log Books, and
- Verification of training.

The sampling and analytical specialist is an expert that can be accessed by the field team.

The document and record manager is responsible for preparation of all reports and for filing all material in the appropriate project file.

The hydrogeologist is a subject area expert that will provide assistance in evaluating the soil properties and the nature and extent of any groundwater contamination.

The data reduction and information management specialist will be responsible for entering the field and laboratory results into a data management system. The system will allow the concentration gradients to be calculated and graphed accordingly. The system will allow for statistical evaluation and it will include flags and audit tails that will allow one to find the original information source.

The technical staff for this project are experienced employees who possess the degree of specialization and technical competence required to effectively and efficiently perform the work described herein. Each manager as shown on the organization chart is responsible for the qualification and capabilities of the staff being selected and assigned to this project.

A.3 Project Task Descriptions

The air pathway evaluation procedures contained in the draft guidance document encompass estimates of emissions to the ambient air and subsequent air dispersion and inhalation exposures. Figure A-2 is a flow chart for assessing air impacts by modeling. Emission estimation procedures use the LandGEM model[1] along with LFG sampling to estimate the uncontrolled release of toxic and nontoxic LFG constituents to the ambient air. Ambient air dispersion is simulated using both screening-level and refined models to estimate exposure point concentrations for both risk evaluation purposes and for comparison with air pathway ARARs.[2] In addition to an ambient air exposure evaluation, subsurface vapor transport and intrusion into aboveground structures must also be evaluated. Subsurface vapor intrusion into buildings can be caused by convective vapor transport (i.e., due to pressure gradients) and diffusive vapor transport from contaminated groundwater below the structure. These exposure pathways are evaluated using a combination of modeling and sampling. Figure A-3 is a flow chart for assessing the impacts from contaminated groundwater. The following tasks will be completed during this project.

Task 1 - Preparation of QAPP

In cooperation with the TOM and the EPA site laboratory manager, the contractor will prepare a QAPP that specifies the type of data to be collected at each of the sites being evaluated. Sites may vary significantly in age, size, content, design, meteorology, topography, and so forth. Comparability of concentration data from site-to-site is not anticipated. The TOM and the RPM will determine which site is being evaluated. The QAPP will indicate (1) the specific data and information to be collected at each site by EPA Regional personnel, (2) the field testing and sampling to be conducted by the sampling and analysis team, and (3) the data and information to be collected and analyzed by the contractor. A site-specific QAPP will specify the sampling and analytical procedures to be employed as well as the QA and QC procedures to be used to ensure that the data obtained are of sufficient quality and quantity for risk evaluation purposes. Each site-specific QAPP will act as a road map for conducting site-specific data acquisition and site information retrieval.

Task 2 - Estimation of LFG Emissions

For each site, historical data will be collected on the size of the landfill, the amount and type of waste deposited, and the waste deposition dates and frequencies. For sites that lack these data, the volume of each landfill will be estimated based on the landfill dimensions; the total amount of waste will be estimated based on a default value of the in situ waste density. Waste deposition frequencies and distributions will also be approximated if historical data are lacking. From these data and the distribution of wastes in the landfill or landfill cells, the LandGEM model will be employed to estimate the time-dependent LFG emissions over a residential exposure duration of 30 years for risk evaluation purposes and over the appropriate averaging time(s) for the purposes of comparison with any air pathway ARARs. The emissions of individual toxic components of the LFG will also be

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[1]Landfill Gas Emission Model, Version 3.01. U.S. EPA Control Technology Center, EPA-600/R-05/047. Available at http://www.epa.gov/ttn/catc/dir1/landgem-v302-guide.pdf (accessed August 2005) .

[2]Guidance for Evaluating Landfill Gas Emission at Closed or Abandoned Facilities, EPA-600/R-05/123a.

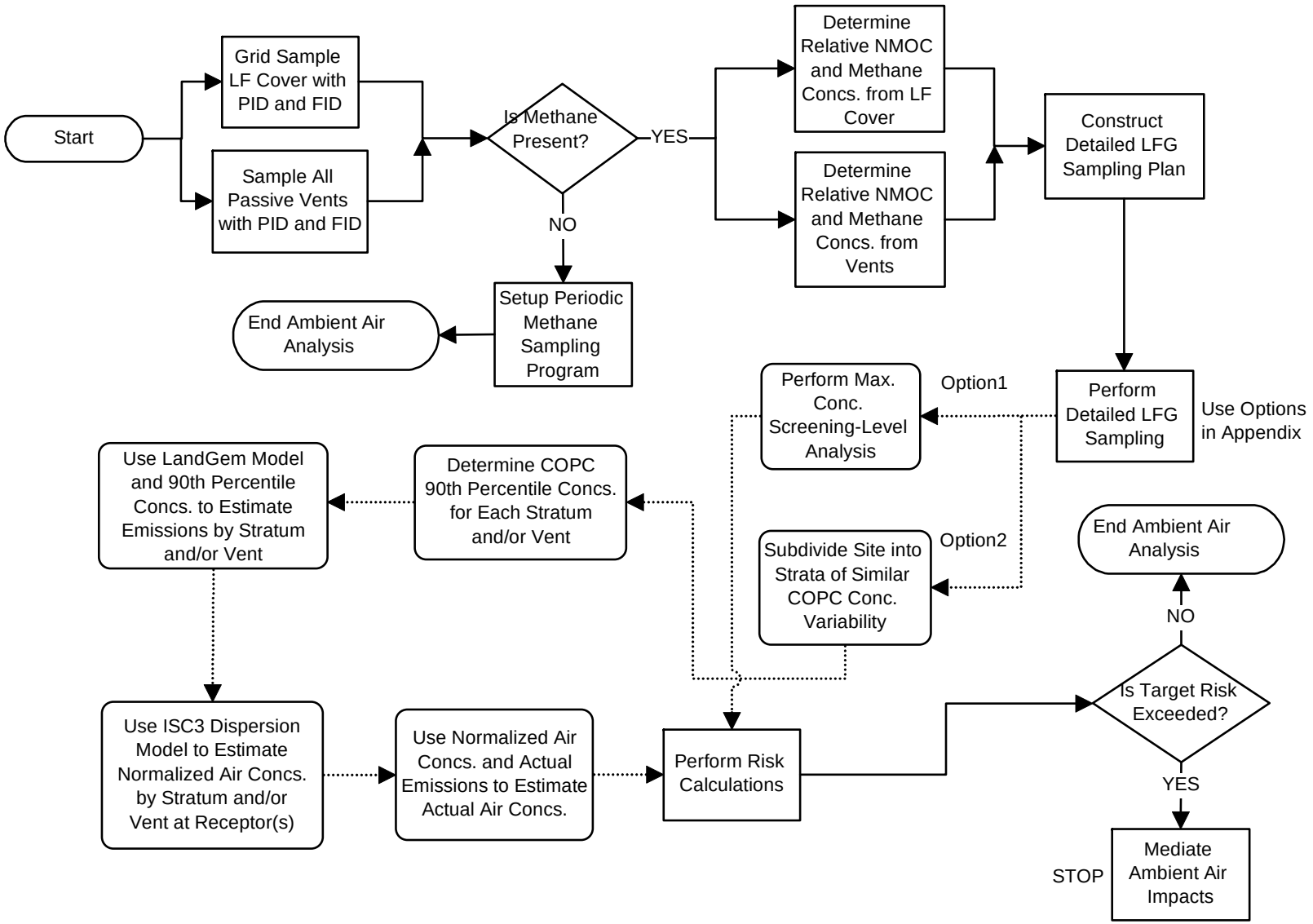

Figure A-2. Flow Chart for Assessing Air Impacts by Modeling.

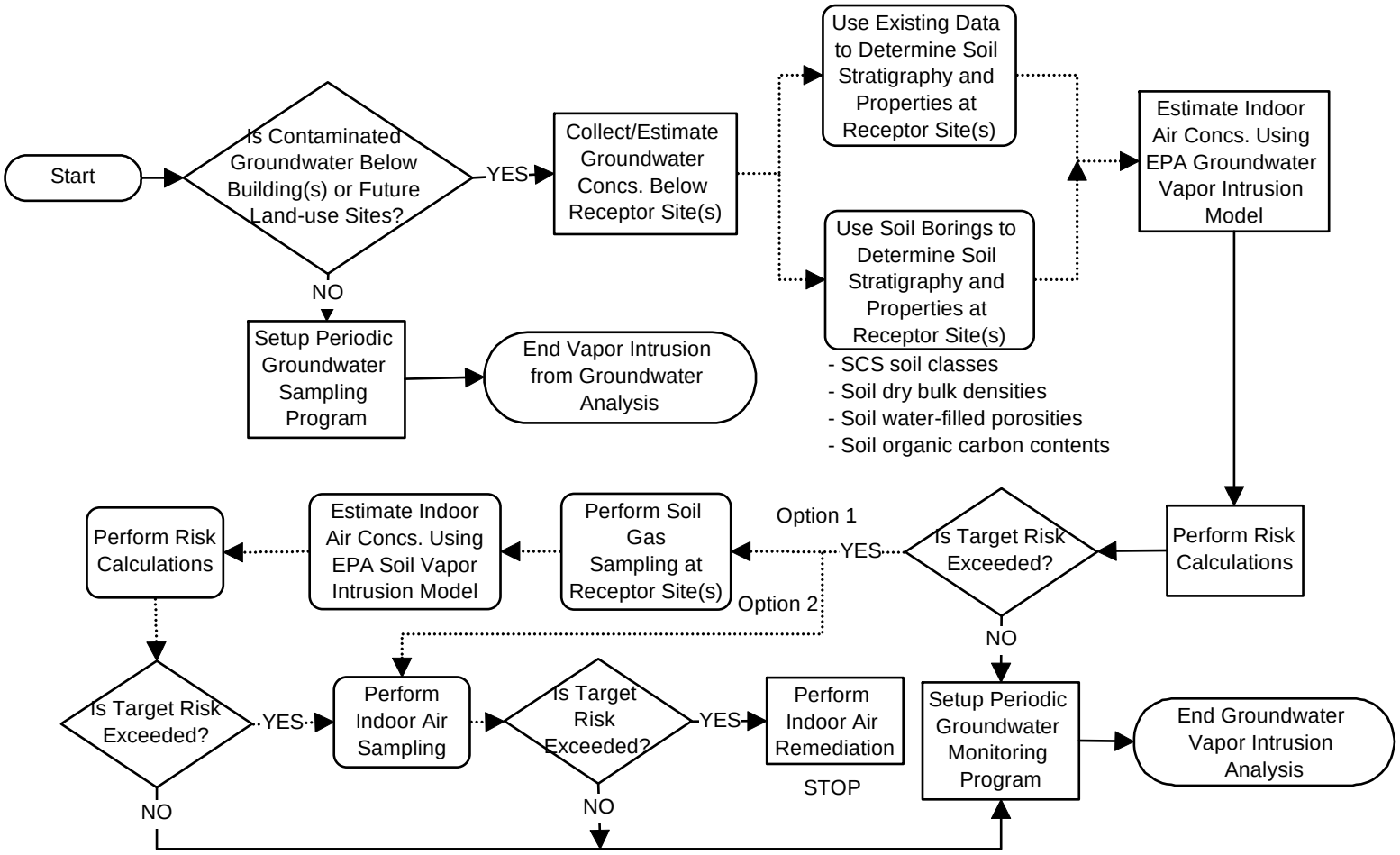

Figure A-3. Flow Chart for Assessing Vapor Intrusion from Contaminated Groundwater.

estimated using the LandGEM model. This requires an average LFG concentration of each constituent. These concentrations will be measured using LFG sampling techniques.

If the landfill employs uncontrolled vents, each vent will be sampled separately. If vents are not employed or if the area of influence for the vents is not adequate, site LFG concentrations will be delineated using a superimposed grid system. The number of sampling points will be determined as a function of the landfill size, homogeneity of its contents, and the amount of resources available for sampling and analysis activities. Soil gas sampling will be conducted approximately one meter below any landfill cover using either a slam-bar sampling device or a Geoprobe sampling rig depending on equipment availability and soil properties. It is assumed that ERTC will provide all sampling equipment required. Screening level sampling will be performed using portable instruments that respond to either methane and non-methane organic compounds (NMOCs). EPA Method 25A will be used to determine total hydrocarbon concentration (THC). The NMOC concentration will be determined by placing a charcoal trap between the sample location and the instrument. From these data, the relative NMOC concentrations will be determined by the difference between the total organic concentrations with and without methane. Once the NMOC concentrations have been determined, the areal extent of the site will be partitioned statistically into contiguous areas of near homogeneous NMOC concentration.

The number of samples that must be obtained to estimate the mean concentration of an area is strongly dependent on the heterogeneity of the chemical distribution. Thus, for an area with uniform distribution, few samples are needed to provide good characterization. Conversely, an area with widely variable distribution would require a great number of samples. For areas with nonuniform distribution such as a landfill, the total number of samples can be reduced by subdividing the area into zones with similar levels of contamination and variability. The objective of screening is to identify the areas with near homogeneous NMOC concentration; the Wilcoxon rank sum test (also known as Mann-Whitney test) will be used to determine if there is an area with a higher mean concentration when compared to the entire landfill.

The Wilcoxon rank sum test may be used to test for a shift in location between two independent populations (i.e., the measurements from one population tend to be consistently larger than those from the other population). This statistical procedure does not require normal distribution. The method is not adversely affected by no detect values, and an equal number of samples is not required.

The Wilcoxon rank sum test procedure is as follows.
H_O: Populations from which the two data sets have been drawn have the same mean.
H_A: The population have different means.

For this project, a significance level (α) has been set to 5 percent.

1. Consider all $m = n_1 + n_2$ data as one set. Rank the m data from 1 to m; that is, assign the rank 1 to the smallest datum, the rank 2 to the next largest datum, . . . , and the rank m to the largest datum. If several data have the same value, assign them the midrank, that is, the average of the ranks that would otherwise be assigned to those data.
2. Sum the ranks assigned to the n_1 measurements from population one; denote this sum by W_{rs}.
3. If $n_1 \leq 10$ and $n_2 \leq 10$, the test of H_O may be made by referring W_{rs} to the appropriate critical

value in Table X in Christensen (1977)[3] page A-14.

4. If $n_1 > 10$ and $n_2 > 10$ and no ties are present, compute the large sample statistic

$$Z_{rs} = \frac{W_{rs} - n_1(m+1)/2}{\left[n_1 n_2 (m+1)/12\right]^{1/2}}$$

5. If $n_1 > 10$ and $n_2 > 10$ and ties are present, compute

$$Z_{rs} = \frac{W_{rs} - n_1(m+1)/2}{\left\{\frac{n_1 n_2}{12}\left[m+1-\frac{\sum_{j=1}^{g} t_j\left(t_j^2-1\right)}{m(m-1)}\right]\right\}^{1/2}}$$

where j is the number of tied groups and t_j is the number of tied data in the jth group.

6. For a one-tailed α level test of H_O versus the H_A that the measurements from population one tend to exceed those from population two, reject H_O and accept H_A if $Z_{rs} \geq Z_{1-\alpha}$.
7. For a one-tailed α level test of H_O versus the H_A that the measurements from population two tend to exceed those from population one, reject H_O and accept H_A if $Z_{rs} \leq - Z_{1-\alpha}$.

This procedure will be repeated until the landfill has been divided in zones or areas of near homogeneity. This partitioning will be subsequently used to determine sampling patterns for the second round of sampling.

Each area with a near homogenous NMOC concentration as determined by the screening level results will be sampled, using a slam-bar or Geoprobe for subsurface sampling and stack sampling equipment for vents. LFG samples will be collected in Summa or equivalent canisters. An on-site gas chromatography/mass spectrometer (GC/MS) will be provided by the ERTC for sample analysis. EPA Method TO-15, "Determination of Volatile Organic Compounds" will be used for analyzing the cannister contents. The target analytes for all sites are listed in Table A-1. This list may be expanded on a site-specific basis if other chemicals of potential concern are identified by the RPM. In addition, duplicate samples in canisters will be sent to the ERTC offsite laboratory for analyses. The duplicate sample concentrations will be compared with the on site GC/MS results to estimate any potential sample bias. This is important because on-site GC/MS analysis is not anticipated to be a commonly available analytical option for future users of the guidance, and it provides a QC check of the methods being used. Sample concentrations will be subsequently corrected for air infiltration according to the procedures specified on page 2-8 in the draft guidance document.

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[3]Christensen, Howard, 1977. Statistics - Step by Step, Houghton Mifflin Company, Boston.

Table A-1. Preliminary Target Analyte List

Classification	Analyte	Estimated LFG Concentration (ppmv)
Very Volatile Organic	Methane	500,000
	Nonmethane Organic Compounds (NMOCs)	4,000
Speciated Volatile Organic Compounds	1,1,1-Trichloroethane (Methyl Chloroform)	4
	1,1-Dichloroethene (Vinylidene Chloride)	15
	1,2-Dichloroethane (Ethylene Dichloride)	32
	Acrylonitrile	28
	Benzene	93
	Carbon Tetrachloride	0.25
	Chlorobenzene	10
	Chloroethane (Ethyl Chloride)	7
	Chlorofluorocarbons (as Dichlorodifluoromethane)	56
	Chloroform	2
	Dichlorobenzene (Meta- and Para-isomers)	0.33
	Ethylene Dibromide	0.001
	Dichloromethane (Methylene Chloride)	46
	Perchloroethylene (Tertrachloroethylene)	15
	Toluene	380
	Trichloroethylene (Trichloroethene)	8
	Vinyl Chloride	20
	Xylenes (all isomers)	80

With the area-dependent mean concentrations of LFG constituents, the mass emissions of each constituent for each near homogeneous area will be estimated using the LandGEM model based on steady-state constituent concentrations. The LandGEM model will be run for a period of 30 years (and for ARAR-specific averaging times) for each area. The time-dependent emissions of each LFG constituent will then be determined as the product of the yearly LFG emissions predicted by the LandGEM model and the constituent mass fraction. The time-averaged emissions of each constituent from each area will then be calculated using a trapezoidal approximation of the integral over the exposure duration as specified on Page 2-13 of the draft guidance document.

Task 3 - Estimation of Ambient Air Concentrations

Time-averaged ambient air concentrations of each constituent will be approximated using the SCREEN3 dispersion model[4] as specified in the draft guidance document. A risk evaluation will then be performed for each constituent based on default residential inhalation exposure assumptions at the point of maximum plume impact. Residential exposure assumptions are defined for the inhalation/pathway by the following equations and assumptions:

$$CR_{inh(i)} = ADI \times CSF_{inh(i)}$$

$$ADI = \frac{C_a \times IR \times ET \times EF \times ED \times 0.001 mg/\mu g}{BW \times AT \times 365 days/yr}$$

$$CSF_{inh(i)} = \frac{URF_i \times BW \times 10^3 \mu g/mg}{IR}$$

where

ADI = Average daily intake of chemical i,
$CSF_{inh(i)}$ = Chemical specific inhalation cancer slope factor,
URF_i = Chemical specific inhalation unit risk factor,
C_a = Total air concentration of COPC i,
IR = Inhalation rate of 0.63 m^3/h adults; 0.3 m^3/h children,
ET = Exposure time, 24 h/day,
EF = Exposure frequency = 350 days/yr,
ED = Exposure duration; 30 yr-adult, 6 year child,
BW = Body weight 70 kg adult, 15 kb/ child, and
AT = Averaging time 70 yr.

As required, a comparison of estimated ambient air concentrations with the appropriate air pathway ARARs will also be made. Estimated average exposure point concentrations and resulting inhalation risks will be compared with the acceptable risk range and also compared with any regulatory standards as specified in the site-specific air pathway ARARs. The RPM is responsible for establishing the acceptable risk range, regulatory standards, and ARARs on a site-specific basis. Determination of ARARs and risk ranges are site-specific determinations that are beyond the scope of this example generic QAPP. The guidance presents procedures and techniques for estimating ambient air and indoor air concentrations that can be compared to the applicable regulatory and health standard. If the results of the SCREEN3 dispersion modeling indicate that the exposure point air concentrations are clearly not a problem, the ambient air risk and ARAR evaluations can be

[4]SCREEN3 Screening Procedure for Estimating Air Quality Impacts of Stationary Sources Revised EPA 450/R-92-019.

considered accomplished. If the screening level comparison indicates there is a potential problem, dispersion modeling will be continued using the refined ISC3 model. The refined model uses site-specific information (location, geometry, meteorological, etc.) to estimate the ambient air concentration at the selected receptor locations. If refined dispersion modeling indicates that the exposure point concentrations still represent a potential health risk or that air pathway ARARs may be exceeded, ambient air sampling may be considered at the discretion of the TOM. Such ambient air sampling would consist of a series of stationary Summa canisters.

Task 4 - Estimation of Indoor Air Concentrations Due to LFG Transport

At each selected site, pre-existing LFG monitoring data (e.g., pressure, COPC concentration, CH_4 concentration, NMOC concentration, flowrate, etc.) will be obtained. This information will be used to estimate the subsurface methane and LFG COPC concentrations at selected landfill boundary points. If these data are lacking and if approved by the TOM, cluster wells will be drilled to determine subsurface methane and COPC concentrations. If required, drilling, equipment, and personnel to install the cluster wells will be supplied by the RPM. LFG constituent concentrations (e.g., methane, NMOCs, COPCs) will be determined for each soil stratum between the ground surface and the depth of the landfill in proximity to the landfill boundary closest to an offsite structure. If any subsurface methane concentration is greater than the lower explosive limit (LEL) at the site boundary, preliminary vapor transport and intrusion modeling will be performed for methane and COPCs using the Little et al. (1992)[5] steady-state model as specified in the guidance. This involves estimates of the subsurface pressure at the landfill boundary and the soil vapor permeability. If data are available for in situ soil saturated hydraulic conductivity, the soil vapor permeability will be estimated based on this value. If saturated hydraulic conductivity data are lacking, the soil vapor permeability will be estimated based on the Soil Conservation Service (SCS) soil textural classifications. This involves taking subsurface soil samples and analyses of soil particle size distributions through an American Society for Testing and Materials (ASTM) standard method (ASTM methods D2216, D1587, D854, and D422). Subsurface pressure at the landfill boundary must be empirically determined for the most permeable soil strata between the landfill boundary and the offsite structure(s) of interest. If subsurface monitoring wells are available, pressure will be measured using the procedures specified in 40 CFR 60, Appendix A, Method 2E. In addition to vapor transport and intrusion modeling, portable photoionization detection (PID) instruments will be used to detect any methane in preferential subsurface convection pathways or conduits (e.g., water meters, utility lines, etc.) as well as within and under any potentially affected offsite structure(s).

If preliminary modeling or sampling indicates potential indoor air methane concentrations greater than 25 percent of the LEL, or COPC concentrations that represent unacceptable risks, soil gas sampling below or adjacent to potentially affected buildings or indoor air sampling will be considered at the direction of the TOM. If soil gas sampling is used, further modeling[6] will be employed to better estimate indoor air concentrations based on soil gas sampling results. If indoor air sampling is used,

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[5]Little, J.C., J.M. Daisey, and W.W. Nazaroff. 1992. "Transport of subsurface contaminants into buildings" *Environ. Sci. Technol*., 26(11):2058–2066.

[6]Users Guide for Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings, EPA-OERR, June 2003.

other sources of the COPCs must also be accounted for including outdoor air and anthropo- genic sources inside the structure of interest such as off-gassing of household chemicals and building products.

Task 5 - Estimation of Indoor Air Concentrations Due to Vapor Intrusion from Contaminated Groundwater

Existing site data will be reviewed to determine if groundwater contaminated by landfill waste has migrated off site under houses or other structures. If so, COPC concentrations within the contaminated groundwater will be estimated from existing site data as a function of downgradient location and distance. These data will be provided by the RPM. These data will then be used by the contractor to estimate, through modeling, the potential indoor air concentrations of COPCs due to vapor transport and intrusion into offsite structures. The screening-level models described in the draft guidance document will be used to predict indoor air concentrations. Use of these models requires data on subsurface soils directly below potentially affected structures. These data include soil dry bulk density, moisture content, and vapor permeability (top soil stratum only). If data are lacking, continuous soil cores would be taken from the soil surface to the top of the water table at locations adjacent to the structure(s). Enough cores must be obtained to allow for a reasonably accurate estimate of average values below the structures. It is assumed that all equipment required to obtain these soil samples will be provided by the RPM. If the subsequent risk evaluation indicates possible adverse health effects, soil gas or indoor air sampling would be performed at the direction of the TOM to verify predicted indoor air concentrations.

Task 6 - Preparation of Work Assignment Report

At the conclusion of the field investigation part of the work assignment, the contractor will prepare a written report summarizing the results of the field investigations, present a series of lessons learned, and provide recommendations to be used in revising the draft guidance document and draft fact sheet previously prepared under a separate EPA contract and work assignment. Revisions will be suggested based on the results of applying the draft guidance document procedures at the test landfill sites. Upon approval of the written report by the TOM, the contractor will revise the draft guidance document and fact sheet and prepare three case studies for use in the draft guidance document based on the three test sites. These documents will then be submitted to the TOM for review. Upon receipt of all final comments from the TOM on the revised guidance document and fact sheet, the contractor will prepare and submit to the TOM final versions of both documents.

This QAPP describes a sampling, analysis, and monitoring program designed to estimate the emissions of hazardous and toxic compounds that exist in the LFGs at each site. A general overview of the data collection effort is provided in Table A-2.

Determination of conformance with the National Contingency Plan (NCP), 40 CFR Part 300, or compliance with any non air pathway ARARs, permit conditions, or Federal, state, or local regulations and statutes is beyond the scope and intent of this example generic QAPP. The sampling and analytical procedures described herein are designed to evaluate the significance of the emissions from the landfill. Action levels for the air pathway are site specific. The site-specific QAPP will include the information needed to complete Table A-3.

Table A-2. Summary of Data Collection Efforts.

- Site Background Information
  1. Administrative contact, address, and telephone number
  2. Maps (topographic, site plan, proximity, soil, groundwater, basement, wetland, etc.)
  3. Landfill cross section and areal dimensions
  4. Cover design basis (engineering specifications and design parameters)
  5. LFG collection and treatment system design basis
  6. Description and quantification of landfill contents and COPCs
  7. Operational history (annual acceptance rates, years of operation, fill plan, etc.)
  8. Extent and nature of groundwater contamination

- Sampling, Monitoring, and Analytical Components [a]
  - Methane and NMOC via portable flame ionization detectors (FID) on a 30-meter grid and at all vents and on-site structures
  - CO_2, CH_4, N_2, and O_2 via Method 3C at 20 locations with highest NMOC concentration
  - Site-specific COPC Tedlar bags or Summa canisters and mobile GC/MS (Laboratory-SOP 2102 or 1819) at locations with highest NMOC concentrations for each near homogeneous area (not to exceed 20)
  - If needed, LFG gas flow rate via five equal volume wells spread over the landfill using Federal Reference Method 2E
  - Soil properties (% moisture, bulk density, particle density, particle size) at locations with the highest NMOC soil gas concentration using Laboratory-SOP 2012 and ASTM methods D2216, D1587, D854, and D422 standard for each near homogeneous area
  - In situ LFG pressure at up to 10 locations with 30-meter spacing along the landfill boundary closest to any off-site structures
  - Site-specific volatile organic target analyte list via Tedlar bags or Summa cannister and mobile GC/MS (Laboratory-SOP 2102 or 1819) at up to 10 landfill boundary locations having the highest NMOC soil gas concentration
  - If needed, in situ hydraulic conductivity of permeable soil horizons via standard constant head (D2434) methods at up to 10 boundary locations
  - If needed, site-specific COPCs via Tedlar bag or Summa canisters and mobile GC/MS (Laboratory-SOP 2102 or 1819) at up to three locations between the landfill boundary having the highest NMOC soil gas concentration and the nearest off-site structure
  - If needed, indoor air for site-specific COPCs via Tedlar Bag or Summa Cannister and mobile GC/MS (Laboratory-SOP 1819) at the off-site structure closest to the boundary location having the highest NMOC soil gas concentration
  - If needed, up to three ambient outdoor air samples for site specific COPCs via Summa cannister and mobile GC/MS (Laboratory-SOP 1819) at the off-site laboratory
  - If needed, soil properties (% moisture, bulk density, particle density, and particle size) at up to three potentially affected off-site structures using standard laboratory methods (ASTM Methods - D2216, D1587, D854, and D422)
  - If needed, up to three groundwater samples for the site-specific COPCs via 40-ml volatile organic analysis (VOA) vials and GC/MS (SW846-8260) at potentially affected off-site structures located over the top of the groundwater plume

[a] Site-specific QAPP will identify when the "if needed" samples are to be collected.

Table A-3. Air Pathway Action Levels.

Chemical of Potential Concern	Limits of Explosivity,[a] %	Non-carcinogenic Reference Concentration,[b] $\mu g/m^3$	Carcinogenic Inhalation Unit Risk Factor,[b] $(\mu g/m^3)^{-1}$	State/local Ambient Air Toxics Standard, $\mu g/m^3$
1,1,1-Trichloroethane	1.8 – 14	1×10^3	NA[c]	
1,1-Dichloroethene	6.5 – 15.5	3.2×10^1	5×10^{-5}	
1,2-Dichloroethane	6.2 – 16	1×10^1	2.6×10^{-5}	
Acrylonitrile	3 – 17	2.0×10^0	6.8×10^{-5}	
Benzene	1.2 – 7.8	6×10^1	7.8×10^{-6}	
Carbon Tetrachloride	NA	2.5×10^0	1.5×10^{-5}	
Chlorobenzene	1.3 – 9.6	2.0×10^1	ND[d]	
Chloroethane	3.0 – 15.4	1×10^4	ND	
Chlorofluorocarbons (as Dichlorodiflur-methane)	NA	2×10^2	ND	
Chloroform (Trichloromethane)	NA	3.5×10^1	2.3×10^{-5}	
1,2-Dichlorobenzene	2.2 – 9.2	2.0×10^2	ND	
Ethylene Dibromide	NA	2×10^{-1}	2.2×10^{-4}	
Hydrogen Sulfide	4 – 44	ND	ND	
Methylene Chloride	13 – 23	3×10^3	4.7×10^{-7}	
Tetrachloroethylene	NA	3.5×10^1	5.8×10^{-7}	
Toluene	1.1 – 7.1	4.0×10^2	ND	
Trichloroethylene	8 – 10.5	2.1×10^1	1.7×10^{-6}	
Vinyl Chloride	3.6 – 33	1.0×10^2	4.4×10^{-6}	
Xylene (P)	1.1 – 7.0	7×10^3	ND	
Xylene (M)	1.1 – 7.0	7×10^3	ND	
Xylene (O)	0.9 – 6.7	7×10^3	ND	
Methane	5.4 – 15	ND	ND	
Mercury	NA	3×10^{-1}	ND	

[a] Pocket Guide to Chemical Hazards USDHHS-CDC-1998
[b] Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, July 1998.
[c] NA - Not applicable
[d] ND - No data

Site-specific QAPPs will include a listing of the methods, procedures, and protocols. The O&M manuals, field related SOPs for sampling and analysis, Health and Safety Plan, and QAPP will be available for the field team to use and reference during onsite activities. The site laboratory manager is responsible for assuring that the appropriate documents are available. The site-specific QAPP components will be submitted to the TOM at least 30 days prior to the beginning of any data generating activity at the site. The QA requirements are described in EPA QAR-5, "Requirement for Quality Assurance Project Plans." The contractor anticipates that the TOM and EPA Q/A officer will review and approve any substantive changes in the QAPP.

Figure A-4 presents an example of an idealized project schedule. Site-specific schedules will be developed at least 30 days prior to initiating any field activities on a site-by-site basis.

Project and quality record requirements may include:
- Site-specific QAPP,
- Audit reports,
- Status reports,
- Corrective action reports,
- Data review and data validation reports, and
- Project data records .

A.4 Quality Objectives and Criteria

Data quality objectives (DQOs) are qualitative and quantitative statements developed using EPA's DQO process (QA/G-4 Guidance for DQO Process). The statements clarify the project's objectives, define the appropriate types of data, and specify tolerable levels of potential decision errors. These end use requirements form the basis for establishing the quality and quantity requirements of the data being generated. DQOs define the performance criteria that must be met in order to limit the probability of making unacceptable decision errors.

DQOs are quantitative and qualitative statements that are designed to:
- Clarify study objectives,
- Define type of data,
- Establish most appropriate conditions from which to collect data, and
- Specify acceptable levels of decision error that will be used as the basis for establishing the quantity and quality of the data needed to support the outcome decisions.

For this project the qualitative objectives are to evaluate the kinds and amounts of emissions from selected landfill and to determine whether the draft guidance allows the users to determine if LFG controls are needed. This generic QAPP and the site-specific QAPP result from the systematic planning process and contain information needed to carry out the data gathering and meet the DQOs. No criteria are currently in place to decide which types or how many data gaps or procedural problems will trigger a revision or even abandonment of the draft guidance. Combined with the likely variability of emissions and the proximity to off site structures, the threshold of what will qualify as significant will probably be when it is determined that the procedures are to costly or that the guidance user is unable to reach an acceptable end point for one of the three sites being evaluated. Based on

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12	Site 3 Field Work	10 days	Mon 5/20/02	Mon 6/3/02
13	Site 2 Data Analysis	25 days	Mon 5/13/02	Mon 6/17/02
14	Site 3 Data Analysis	25 days	Tue 6/4/02	Tue 7/9/02
15	Site 2 Case Study	8 days	Tue 6/18/02	Thu 6/27/02
16	Site 3 Case Study	8 days	Wed 7/10/02	Fri 7/19/02
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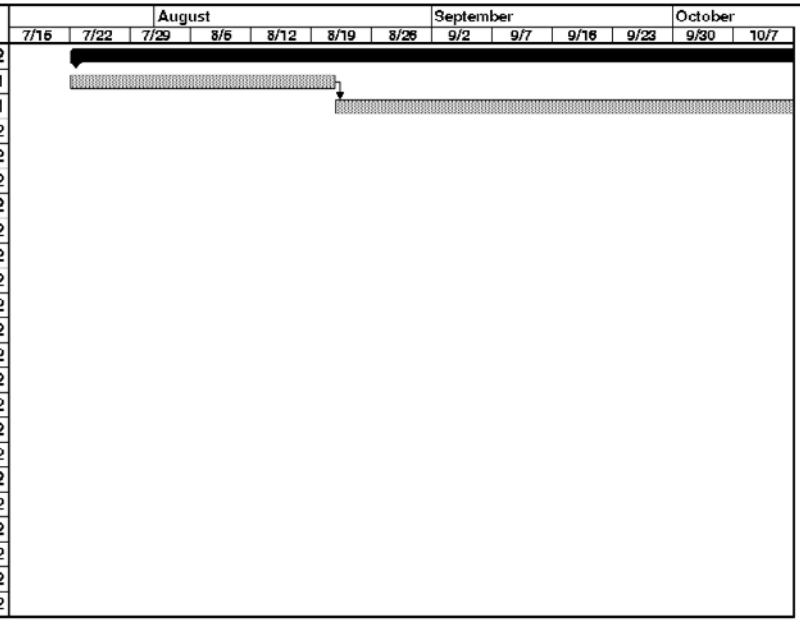

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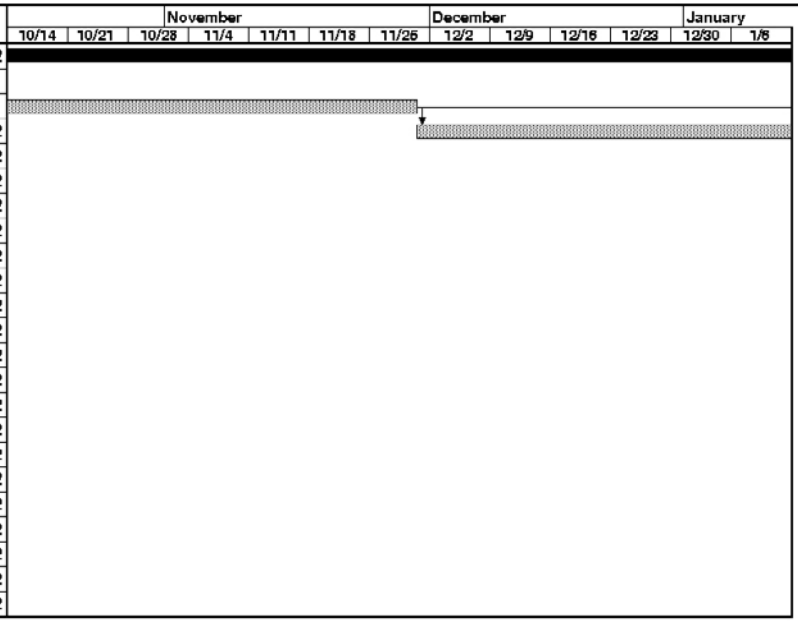

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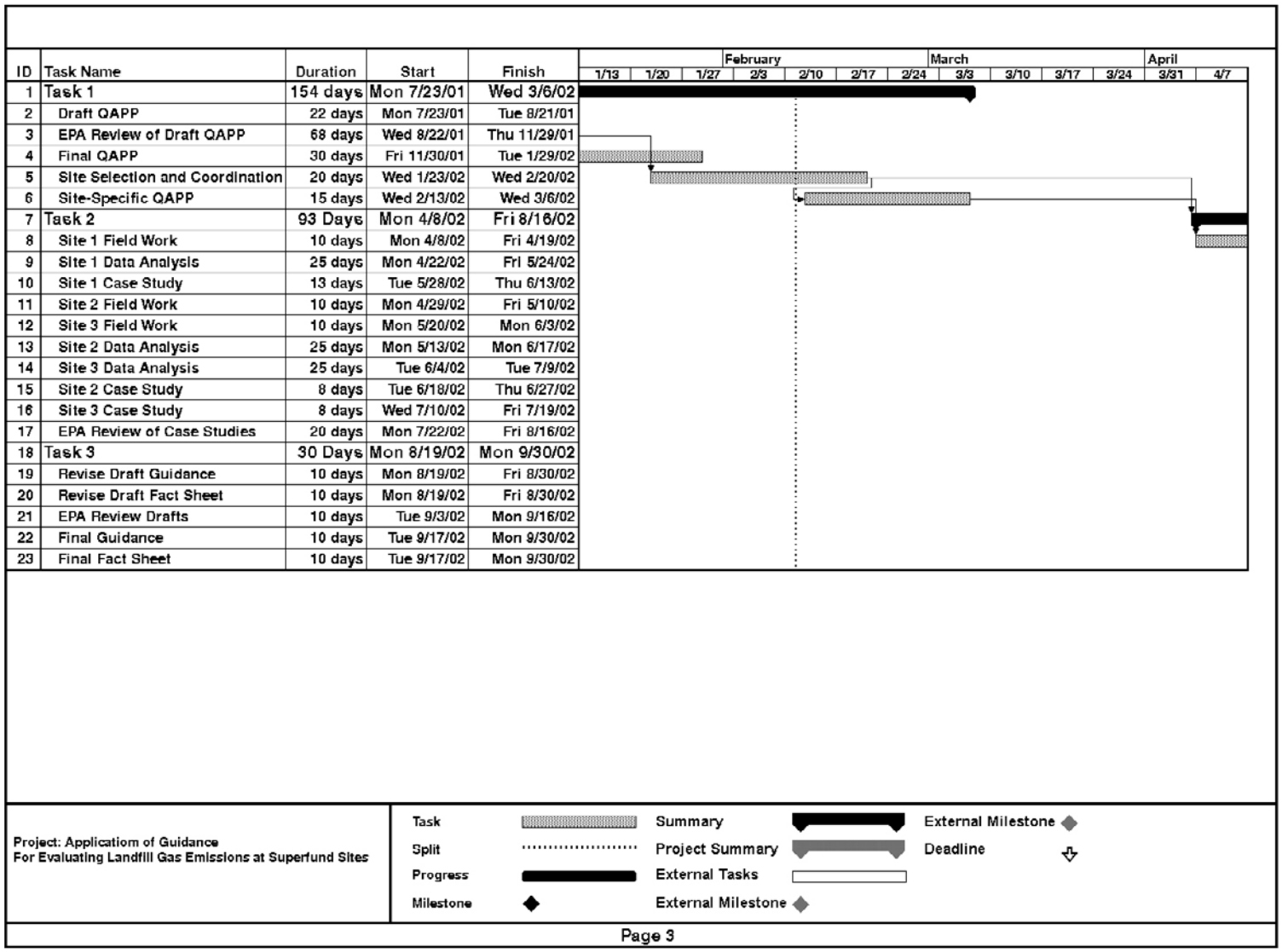

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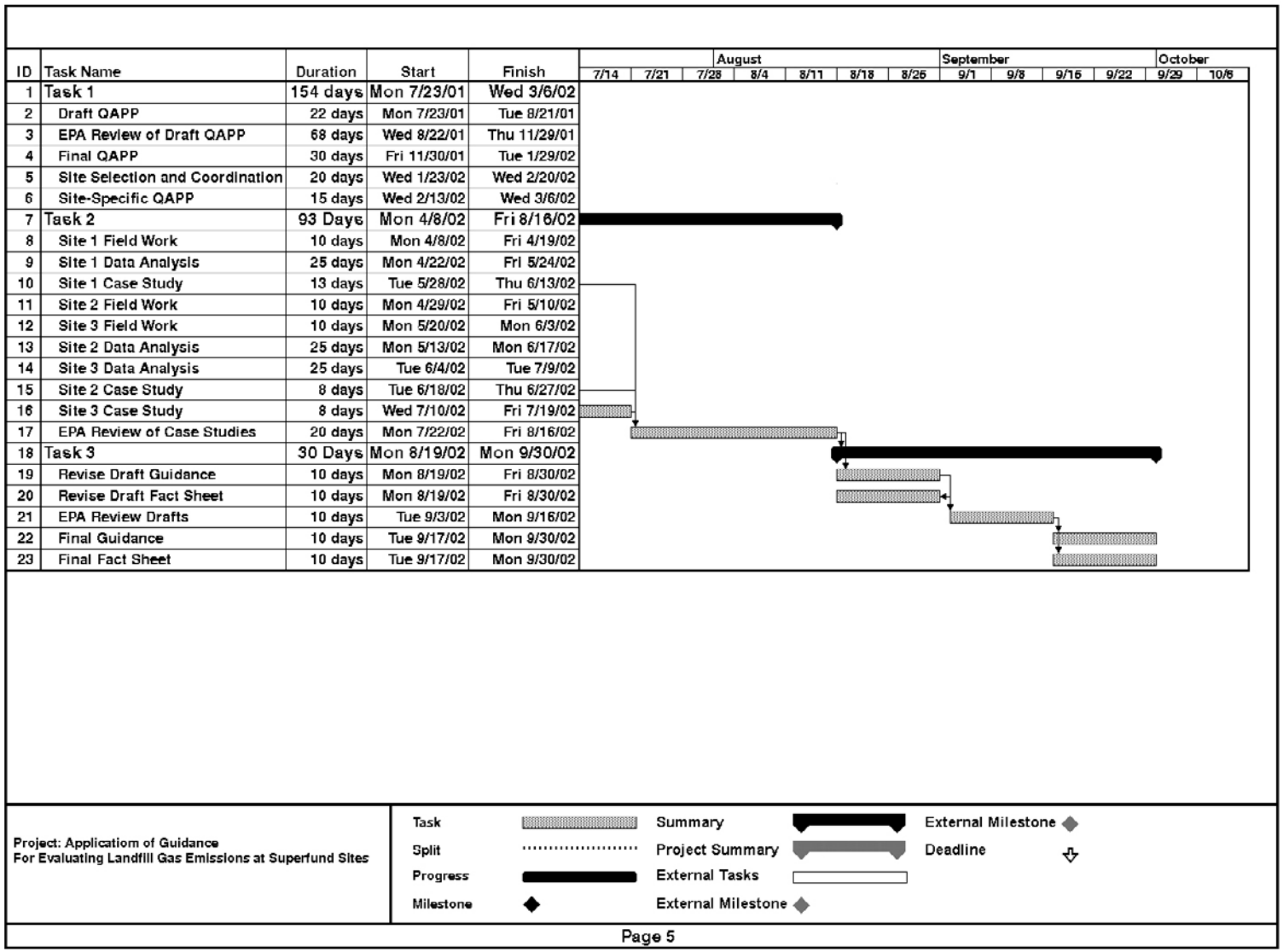

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these premises, quantitative objectives are established for critical measurements in terms of data quality indicators goals for accuracy, precision, and completeness.

The overall QA objective is to determine if the LFG emissions to the ambient air and subsurface vapor intrusion into buildings create acceptable or unacceptable inhalation risks or hazards of fire or explosion and whether potential ambient air ARARs may be exceeded.

The objectives are achieved if as a result of conducting the field investigation and implementing the guidance one can:

- Determine compliance with air pathway specific ARARs,
- Determine if the methane concentration at receptors is greater than 25 percent of the LEL, and
- Determine if the health risks due to LFG migration and vapor migration from groundwater to off-site receptors are acceptable.

The guidance document assumes that the user will gather available information and that said information has been generated in a manner consistent with good management practices. The conduct of basic research or resolution of disputes concerning the following is beyond the scope of work for this project:

- Age of landfill,
- Dimensions and cross sections of landfill,
- Content of landfill and identification of COPCs on a section-by-section basis,
- Annual waste acceptance rate,
- Design basis of the landfill cover, and
- Design basis of the LFG collection and vent system .

It should be noted, however, that the adequacy and correctness of the existing information may materially affect the outcome and decisions that are made concerning health risk and explosion hazards.

For QA purposes the existing site data and information will be accepted and used if:

- It has been publicly acknowledged and accepted by EPA and
- It has been included in the publicly available site-specific records and documents and there has been no dispute concerning the validity or acceptability of the records and documents.

If there are data gaps in the existing data and information, the site-specific case study will note the critical data gap(s).

For QA purposes physical and chemical data will be accepted if it is from standard and commonly accepted references (e.g., CRC Handbook of Chemistry).

QA objectives and protocols for the field sampling and analysis portion of the project are summarized in Table A-4. The number of samples to be collected for this project/event are site specific and will be included in an appendix at least 30 days prior to conducting the field activities presented in Table A-4. This table identifies analytical parameters desired; type, volume, and number of containers needed; preservation requirements; number of samples to be collected; and associated

number and type of QA/QC samples based on QA level III. All project deliverables will receive an internal peer review prior to release. The following QA protocols are applicable to the sample matrices:

1. Sample documentation in the form of field logbooks, the appropriate field data sheets, and COC forms will be provided. COC sheets are optional for field screening locations.
2. All instrument calibrations and performance check procedures or methods will be summarized and documented in the field/personnel or instrument log notebook.
3. Detection limit(s) will be determined and recorded, along with the data, where appropriate.
4. Sample holding times will be documented; this includes documentation of sample collection and analysis dates.
5. Initial and continuing instrument calibration data will be provided.
   a. For air samples, lot blanks, field blanks, collocated samples, trip blanks, and breakthrough samples will be included.
   b. For soil gas samples, duplicate samples, zero air samples, field standards, ambient air samples, and matrix spikes will be included.

Table A-4. Field Sampling Summary for Each Site

Source	Parameter	Media	Holding Time[a]	Flow Rate, L/min	Volume, L	No. of Samples
Landfill cover, passive vents, extractive vents	A. CH_4 screen	in situ	Direct read instrument	1.0	1.0	TBD
	B. CH_4 QC duplicate	in situ	Direct read instrument	1.0	1.0	5% A
	C. NMOC screen	in situ	Direct read instrument	1.0	1.0	TBD
	D. NMOC QC duplicate	in situ	Direct read instrument	1.0	1.0	5% C
	E. Organic COPCs	Tedlar bag or Summa cannister	7 day	0.1	1.0 to 6.0	3 per homogeneous area
	F. Organic COPC QC collocate/ split	Summa cannister	7 day	0.1	6.0	5% E
	G. Fixed gas	in situ	Direct read instrument	1.0	1.0	E
	H. Fixed gas QC collocate/ split	Summa cannister	7 day	0.1	6.0	5% G
	I. Trip/plot blank	Summa cannister	7 day		6.0	10% F or 1/day

continued

Source	Parameter	Media	Holding Time [a]	Flow Rate, L/min	Volume, L	No. of Samples
Native Offsite Soil	A. CH_4	Tedlar bag or Summa cannister	7 day	0.01	1.0 to 6.0	TBD
	B. CH_4 QC Duplicate	Summa cannister	7 day	0.01	6.0	5% A
	C. Organic COPCs	Tedlar bag or Summa cannister	7 day	0.01	1.0 to 6.0	TBD
	D. Organic COPC - QC duplicate	Summa cannister	7 day	0.01	6.0	5% C
	E. Organic COPC QC collocate/ split	Summa cannister	7 day	0.01	6.0	5% D
	F. Soil properties	Split barrel	24 h	NA[b]	0.5	TBD
	G. Soil properties QC Duplicate	Split barrel	24 h	NA	0.5	5% F
	H. Gas pressure	in situ	Direct read instrument	NA	NA	TBD
	I. Gas pressure QC Duplicate	in situ	Direct read instrument	NA	NA	5% H
	J. Trip/lot blank	Summa cannister	7 day	0.01	6.0	10% E or 1/day
Air (ambient or indoor)	A. Organic COPC	Summa cannister	7 day	0.01	6.0	TBD
	B. Organic COPC QC Duplicate	Summa cannister	7 day	0.01	6.0	5% A
	C. Trip/lot blank	Summa cannister	7 day	0.01	6.0	10% B or 1/day

[a] All samples are unpreserved, stored at temperatures between 65 and 75 °F and away from sunlight.
[b] NA = not applicable.

6. Performance evaluation (PE) samples are not anticipated but may be included at the discretion of the TOM.
7. The following three options are applicable:
   a. Definitive Identification - analyte identification on 10 percent of the screened (field or lab) or 100 percent of the unscreened samples will be confirmed using a U.S. EPA-approved method; documentation such as chromatograms, mass spectra, etc., will be provided.
   b. Quantitation - documentation for quantitative results from screening and U.S. EPA-approved verification methods (for screened samples) or quantitative results (in the case of unscreened samples) will be provided.
   c. Analytical Error - the analytical error will be determined by calculating the precision, accuracy, and coefficient of variation on a subset of the screened samples or on all of the unscreened samples using an EPA-approved method.

The quality components of precision, accuracy, representativeness, completeness, and comparability for this project are discussed below. This QAPP applies to any project site that requires sampling or monitoring. Site-specific information, however, will be addressed in a site-specific QAPP.

A.4.1 Precision and Accuracy

Uncertainty associated with the measurement data is expressed in terms of accuracy and precision. The accuracy of a single value contains the component of random error in a measurement and also the systematic error, or bias. Accuracy thus reflects the total error for a given measurement. Precision values represent a measure of only the random variability for replicate measurements. In general, the purpose of calibration is to eliminate bias, although inefficient analyte recovery or matrix interferences can contribute to sample bias, which is typically assessed by analyzing matrix spike samples. At very low levels, blank effects (contamination or other artifacts) can also contribute to low-level bias. Bias can also be introduced by laboratory contamination. The potential for bias is evaluated by method blanks. Instrument bias is evaluated by control samples.

Calibration standards, QC check samples, and performance evaluation samples will be prepared from vendor-certified standards or generated from stock materials of known purity. Records of the preparation and validation of all QA/QC-related samples will be maintained by the laboratories responsible for the analyses. Laboratories will be identified in the site-specific QAPPs.

Experience in conducting volatile organic compound (VOC) measurement programs has shown that the typical analytical precision values that can be attained, measured as the percent coefficient of variation (%CV), are $\leq$50 percent for electrolytic conductivity detector (ELCD) compounds and $\leq$30 percent for flame ionization detector (FID) compounds and fixed gases. Accuracy values of between 50 and 150 percent recovery can typically be achieved for the ELCD compounds, and recoveries between 70 and 130 percent can typically be achieved for the FID compounds and fixed gases. The instrument detection limit for many of the VOC compounds are typically below 1 ppbv for low-level samples. In high-level samples, however, compounds present in low concentrations will be masked by the largest peaks or will be below detectable quantities because of dilution or injection volume considerations. This is particularly a problem when one or two compounds are orders of magnitude higher in concentration than the remaining compounds in the sample. These matrix effects can adversely affect the precision and accuracy of the method.

The soil gas and air samples being collected as part of this project are expected to be relatively low in concentration, resembling unaffected ambient air samples, while the extractive/passive vent samples are expected to contain ppm-level concentrations (e.g., 5-250 ppm) of hydrocarbons. Both sample sets will be quantitated for the same list of target analytes (Table A-1). The main differences in the two analyses will be the method the samples are injected into the chromatograph and the number and concentration of the calibration standards. Tables A-5, A-6, and A-7 list the accuracy, precision, and targeted/estimated detection limits for a subset of the target analytes. Analytical detection limits are matrix, laboratory, instrument specific. Each laboratory will be required to explain and justify only differences that are discovered during the project. Table A-5 shows anticipated limits for the low-level analysis (i.e., soil gas samples) for compounds where these limits have been experimentally and empirically determined. This same information for the high-level samples (i.e., vent and gas collection system samples) is shown in Table A-6. For compounds not on these lists, the accuracy, precision, and detection limits may or may not have been empirically determined. The collection of duplicate samples during this program will help assess the precision of the other compounds; however, for cost control purposes and because the information is not needed to meet the project objectives, no attempt will be made to derive empirical detection limits or accuracy estimates for compounds not included in the site-specific target analytes list (TAL).

Table A-5. Summary of Precision, Accuracy, and Detection Limits for VOC Analysis of Air Samples, Low-level Sample Technique.

Analyte (VOC Compound Number)	Analytical Precision[a]	Analytical Accuracy[b]	Target Detection Limits[c] (ppbv)
PRIMARY COMPOUND LIST (Includes TO-14 Compounds): These compounds are monitored daily for precision and accuracy.			
Benzene[d,e,f,g] (#79)	30%	70-130%	0.4
Benzyl chloride[f] & m-dichlorobenzene[f] (#230)	50%	50-150%	0.6
Chlorobenzene[f] (#128)	30%	50-150%	0.5
Ethylbenzene[d,e,f] (#129)	30%	50-150%	0.7
n-Decane[e] & p-dichlorobenzene[f] (#231)	30%	50-150%	0.7
o-Dichlorobenzene[f,h] (#163)	30%	50-150%	0.7
o-Xylene[d,f,h,i] (#137)	30%	50-150%	0.5
p-Xylene & m-xylene[d,f,i] (#131)	30%	70-130%	1.0
Methane	30%	70-130%	0.2
Arcylonitrile	30%	70-130%	0.2
Ethylene Dibromide	30%	70-130%	0.7
Toluene[d,e,f,g] (#111)	30%	70-130%	0.5
1,1,1-Trichloroethane[f] (methyl chloroform - #76)	50%	50-150%	0.2
1,2-Dichloroethane[f,g] (#74)	50%	50-150%	0.2
1,1-Dichloroethylene[f] (vinylidene chloride - #42)	50%	50-150%	0.2
Carbon tetrachloride[f] (#80)	50%	50-150%	0.5
Chloroethane[f] (ethyl chloride - #21)	50%	50-150%	0.2
Chloroform[f] (#67)	50%	50-150%	0.1
Dichlorodifluoromethane[f] (freon 12 - #7)	50%	50-150%	0.2

continued

Analyte (VOC Compound Number)	Analytical Precision[a]	Analytical Accuracy[b]	Target Detection Limits[c] (ppbv)
Methylene chloride[f,g] (dichloromethane - #44)	50%	50-150%	0.2
Tetrachloroethylene[f] (#125)	50%	50-150%	0.1
Trichloroethylene[f] & Bromodichloromethane (#235)	50%	50-150%	0.1
Vinyl chloride[f] (#10)	50%	50-150%	0.3

[a] Analytical precision is measured from duplicate analysis of the daily calibration standard (DCS) or continuing calibration checks (CCCs) at a concentration of 2-8 ppbv for primary compounds.

[b] Analytical accuracy is measured using two sigma control charts using DCS recoveries or from laboratory control sample recoveries when available (see footnote e). No more than two compounds from FID and three compounds from ELCD (or the appropriate 95% Poison probability value) should exceed these tolerances in any valid standard analysis for the system to be in statistical control. NOTE: This measurement reflects analytical accuracy and does not include sampler recovery, storage stability, or matrix effects.

[c] Instrument detection limits (IDLs) for core compounds represent the most conservative measured value (rounded up) based on seven replicate detection limit determination studies. These IDLs may change with actual IDL determination and sample matrix. The IDLs listed for TAL represent a one-time seven replicate detection limit study. NOTE: These detection limits assume a dilution factor of 1. This procedure is based on guidance contained in 40 CFR Part 136 Appendix B.

[d] Compounds in standard used to measure database (qualitative) accuracy.

[e] Compounds used to determine carbon response factor accuracy with a second source standard.

[f] TO-15 analyte.

[g] Analytical individual response factor (IRF) accuracy will be determined by comparing compounds common in both the individual response factor laboratory control standard (IRF-LCS) and the DCS.

[h] Compound may coelute with other compounds in typical VOC sample patterns. Polar compounds may coelute with several compounds, especially when present at high concentration.

[i] Carbon response factor, not an IRF, will be used for quantitation because of chromatographic coelution in the DCS.

Table A-6. Summary of Precision, Accuracy, and Detection Limits for VOC Analysis of Air Canister Samples, High-Level Sample Technique

Analyte (VOC Compound Number)	Analytical Precision[a]	Analytical Accuracy[b]	Target Detection Limits[c] (ppbv)
CALIBRATED COMPOUND LIST: These compounds are monitored on daily basis. This is a high level standard.			
Benzene[d,e,f,g] (#79)	30%	70-130%	100
Benzyl chloride[f] & m-dichlorobenzene[f] (#230)	50%	50-150%	150
Chlorobenzene[f] (#128)	30%	50-150%	125
Ethylbenzene[d,e,f] (#129)	30%	50-150%	175
n-Decane[e] & p-dichlorobenzene[f] (#231)	30%	50-150%	175
o-Dichlorobenzene[f,h] (#163)	30%	50-150%	175
o-Xylene[d,f,h,i] (#137)	30%	50-150%	125
p-Xylene & m-xylene[d,f,i] (#131)	30%	70-130%	250
Toluene[d,e,f,g] (#111)	30%	70-130%	125
1,1,1-Trichloroethane[f] (methyl chloroform - #76)	50%	50-150%	50
1,2-Dichloroethane[f,g] (#74)	50%	50-150%	50
1,1-Dichloroethylene[f] (vinylidene chloride - #42)	50%	50-150%	50
Carbon tetrachloride[f] (#80)	50%	50-150%	125
Chloroethane[f] (ethyl chloride - #21)	50%	50-150%	50
Chloroform[f] (#67)	50%	50-150%	25
Chloromethane[f] (methyl chloride - #5)	50%	50-150%	250

continued

Analyte (VOC Compound Number)	Analytical Precision[a]	Analytical Accuracy[b]	Target Detection Limits[c] (ppbv)
Dichlorodifluoromethane[f] (freon 12 - #7)	50%	50-150%	50
Methylene chloride[f,g] (dichloromethane - #44)	50%	50-150%	50
Tetrachloroethylene[f] (#125)	50%	50-150%	25
Trichloroethylene[f]	50%	50-150%	25
c-1,3-Dichloroethylene	50%	50-%50	50
t-1,3-Dichloroethylene	50%	50-150%	50
Vinyl chloride[f] (#10)	50%	50-150%	75

[a] Analytical precision is measured from duplicate analysis of the daily calibration standard (DCS) or continuing calibration checks (CCCs) at a concentration of 2-8 ppbv for primary compounds.
[b] Analytical accuracy is measured using two sigma control charts using DCS recoveries or from laboratory control sample recoveries when available (see footnote e). No more than two compounds from FID and three compounds from ELCD (or the appropriate 95% Poison probability value) should exceed these tolerances in any valid standard analysis for the system to be in statistical control. NOTE: This measurement reflects analytical accuracy and does not include sampler recovery, storage stability, or matrix effects.
[c] Instrument detection limits (IDLs) based on a load volume of 0.5 mL for core compounds represent the most conservative measured value (rounded up) based on seven replicate detection limit determination studies. These IDLs may change with actual IDL determination and sample matrix. NOTE: These detection limits assume a dilution factor of 1. This procedure is based on guidance contained din 40 CFR Part 136 Appendix B.
[d] Compounds in standard used to measure database (qualitative) accuracy.
[e] Compounds used to determine carbon response factor accuracy with a second source standard.
[f] TO-15 analyte.
[g] Analytical individual response factor (IRF) accuracy will be determined by comparing compounds common in both the Individual response factor laboratory control standard (IRF-LCS) and the DCS.
[h] Compound may coelute with other compounds in typical VOC sample patterns. Polar compounds may coelute with several compounds, especially when present at high concentration.
[i] Carbon response factor, not an IRF, will be used for quantitation because of chromatographic coelution in the DCS.

Table A-7. Summary of Precision, Accuracy and Completeness Goals for Physical Parameters.

Parameter	Precision	Accuracy (%)	Completeness
Fix Gas (CO_2, CH_4, N_2, O_2)			80
Gas Standard	5% RSD	20% Bias	
Calibration Error	NA[a]	2% Bias	
Sampling Bias	NA	5% Bias	
Zero and Drift	NA	3% Bias	
Soil Properties			80
Percent Moisture	5% RSD	5	
Bulk Density	5% RSD	5	
Particle Density	5% RSD	5	
Particle Size	5% RSD	5	
Balance Calibration Check	0.5 g	5	

[a] NA = not applicable.

The Guidance for Evaluating Landfill Gas Emissions at Closed or Abandoned Sites (EPA-600/R-05/123a) notes that modern analytical techniques are not capable of achieving a detection or quantitation limit that would demonstrate there is no significant risk (e.g., 1×10^{-6}) for at least seven of the COPCs. The guidance assumes that if the COPC is measurable and quantifiable, then one can determine if LFG controls are necessary and if the risks are acceptable. The guidance recommends that if the laboratory does not detect a specific COPC in any sample then the chemical be excluded from the risk and remediation analysis. If the laboratory reports a COPC concentration for some samples but no COPC concentration for other samples, then a value equal to 50 percent of the quantitation limit will be assigned to the non-detects (NDs) and the average concentration be calculated accordingly.

Analytical precision estimates for this program will be based on the collection and analysis of duplicate samples collected from different locations across the landfill. A discussion of the experimental design, including duplicate sample collection, is presented in Section B.1. Duplicate samples will be collected at a minimum frequency of 5 percent of the total number of samples. In order to assess both sampling and analytical precision, a nested design will be used with each duplicate also being analyzed in duplicate.

Accuracy estimates for the TAL list will be obtained by analyzing known standards or spiked samples—i.e., lab control standard (LCS) and LCS duplicate (LCSD) samples. Accuracy estimates for the on-site analyzers will be obtained by analyzing certified standards.

A.4.2 Representativeness

A key consideration is collecting enough samples to adequately incorporate the large spatial variability inherent in a population of gaseous emissions. Soil vapor sites generally depict seasonal patterns that fluctuate in response to soil surface-sealing events such as precipitation and frost, in contrast to dry warm periods. Precipitation and frost tended to alter the physical structure of the soil pore spaces, rendering the soil less permeable. During soil surface-sealing events, the preferential escape route for soil gas flow is through the unrestricted soil vapor wells due to their penetration through the surface seal. (Similar responses have been noted in protected crawl spaces beneath homes.) The literature indicates that annual cycles depict highest methane concentrations around spring thaws, secondarily high concentrations around early fall, and the rest of the year showing considerably lower concentrations. From an environmental perspective, the most disconcerting changes are those noted at monitoring locations that initially had low-to-insignificant combus-tible gas concentrations, but later exhibited escalating LEL values. Long-term temporal variability is not represented in this study. Short-term variability will be incorporated and assessed.

Emission samples will be collected at approximately 20 sample points following a preliminary screen for areas of higher emissions (described in Section A-6 under Task 2). Section B.1 discusses the rationale for the sampling design. Thus, a biased sampling approach is intended to ensure that the areas of higher emissions are included in the sample design. The soil gas emissions are expected to be relatively small compared with the passive vent emissions. All of the passive vents will be screened for flow rates and LFG to ensure the most accurate representation of this parameter.

Samples from the gas extraction system will be collected from each vent. The combined header is the best location to obtain a representative sample of LFG because this source is a spatial composite

of all the extraction wells. Although it will be necessary to collect grab (rather than time-integrated) samples, samples will be collected at different times over the course of the study to incorporate short-term sample variation in the design and obtain the best representation of the extracted LFG.

Nongaseous samples are also scheduled to be analyzed for the TAL and other physical chemical properties. These include native soils, landfill cover soils, and potentially, groundwater. These samples will all be collected in a way to ensure that the samples are representative of the time and space they inhabit, but the sample design is not intended to incorporate the large component of spatial or temporal variability. These samples will, therefore, not purport to represent the landfill site as a whole or the surrounding areas.

A.4.3 Completeness

Data completeness, or the rate of data capture, is defined as the percentage of the total number of observations of a given parameter that is considered valid. For these sample types, data completeness will equal the number of valid sampling and analysis events divided by the total number of sampling and analytical episodes attempted. The data capture objective for this program is 80 percent.

A.4.4 Data Usability

The analytical data will be reviewed and checked against the defined quality specifications for each method. The effect of failing to meet any objective depends on the particular situation. In any case, when the quality criteria are not met, the effect will be evaluated and discussed in the final data report. Corrective action will be initiated, as appropriate. Any qualifications in the usability of the data will be delineated.

A.5 Special Training/Certification

Quality work can only be expected from staff who are qualified to perform project assignments. As a minimum, project personnel shall receive training, as applicable, on (1) QAPPs, (2) site health and safety plans, and (3) instrument calibration procedures. The sites are undergoing a hazardous substance response that is covered under CERCLA; as such, employees (including contractor employees) engaged in field activities are subject to the Occupational Safety and Health Act (OSHA) standards specified in 40 CFR 1910.120. All field workers must demonstrate that they have received a minimum of 40 hours of training prior to arriving on site.

Additionally, on-site management and supervisors must demonstrate that they have received at least eight additional hours of specialized training on managing hazardous substance operations. Project staff conducting site work shall be under the direct supervision of a trained and experienced supervisor for at least three days before routine operations may begin. The contractor anticipates that site-specific health and safety training will be conducted by the site safety and health officer as designated by the RPM.

At least one field team member, prior to arrival onsite, will be trained on the Department of Transportation standards that are applicable when shipping hazardous materials.

The sampling, monitoring, analytical, and data reduction techniques and procedures are believed

to be routine and standardized. Each person assigned a duty or task shall have demonstrated proficiency and experience prior to arriving at the site or conducting an assigned task. Records of personnel qualification and training are to be maintained by each participating organization. Affirmative statements from each person participating in the field project will be obtained to indicate that the person has been appropriately trained on the QAPP, calibration procedures, health and safety plan, and OSHA requirements prior to their being allowed to work on the sites. This information shall be recorded in a log book by the field team manager.

A.6 Documents and Records

Document control is the process of ensuring that documents are reviewed for adequacy, approved for release or distribution, and used where a prescribed activity is to be performed. Record control is the process of providing ready and reliable storage, protection and disposition of records. The records manager will prepare an index of the records used to complete this project.

The TOM will be responsible for ensuring that the most up-to-date and approved version of the QAPP has been distributed to those persons identified on the distribution list.

The following types of records will be compiled. The RPM will provide an index and cross reference to all site-specific documents and files that are being used to provide the historical data concerning the site. This index will be included in the project files and stored until the project records are disposed.

- Field Logbooks - The field team manager is responsible for ensuring that logbooks include sufficient information to document the events so that reliance on memory is minimized. The title page of each logbook will include:
  - Person to whom the logbook is assigned,
  - Logbook number,
  - Project name,
  - Start date,
  - End date, and
  - Number of completed pages.

  Entries into the logbook will include but not be limited to:
  - Names of persons conducting field activities;
  - Level of personal protection equipment;
  - Signature of person making entry;
  - Sample number and description of sample event;
  - Equipment and methods used;
  - Climatic conditions;
  - Sample location (coordinates and description);
  - Instrument readings and reference to raw data sheets used;
  - Changes and variance from SOPs (nonconformance document);
  - Corrective actions taken to correct and minimize impact of nonconforming actions (corrective action report);
  - Field data, observation notes, and calibration results; and
  - Description of packaging, shipping, and custody records.

- COC Records - COC forms will be used to ensure that sample custody is documented. Standardized COC forms and procedures will be followed. A copy of the COC form used for each group of samples will be placed in the project files.
- QC Sample Records - Information needed to document the generation of QC samples (such as field, trip, equipment, duplicate, and matrix spike) shall be compiled and placed in the project files. The information will include documentation on sample integrity and preservation, calibration, and standards traceability.
- Corrective Action Reports - These reports will be compiled whenever there is a variance from the QAPP. The report will describe the reasons for the variance and document the effects on the data usability.
- Manifest Records - If applicable and necessary to show regulatory compliance, copies of manifest records will be prepared and placed in the project records.
- Laboratory Records - Each laboratory will compile and maintain sufficient records to document that samples were managed in accordance with the site-specific QAPP and the laboratory-specific QAPP. Each laboratory shall include the following information as part of its deliverable:
  - Sample data (e.g., run date and time, batch number, quantity, results),
  - Sample management records (COC, handling and storage, preservation),
  - Test method (sample preparation, extraction, instrument calibration results, detection and reporting limits, test-specific QC criteria), and
  - QA/QC reports demonstrating proper control and compliance with the analytical methods or applicable SOPs.

The format of the data packages will be consistent with the site-specific QAPP requirements. Records and project files will be retained for at least three years from the date that the revised draft guidance document is submitted for EPA review and approval. The index of records will be retained for at least 5 years. The record will be retained at the contractors project office.

The evidence files for analytical data will be maintained at the contractor's Project Management Office. The content of the evidence file will include all relevant records, reports, correspondence, logs, field logbooks, laboratory sample preparation and analysis logbooks, data package, pictures, subcontractor's reports, COC records/forms, data review reports, etc. The evidence file will be under custody of _____, in a secured area.

Raw data from the VOC chromatograms will be stored on magnetic tape or disks. Other analytical data (i.e., records of injections, volumes, dilutions, and absorbency values) will be recorded in bound paginated instrument logbooks. All logbook entries will be dated and initialed by the author. In addition to the analytical results, the preparation of analytical standards and QC samples will also be documented. Typical information will include the dates of preparation for stock standards, manufacturers' lot numbers, preparation procedures, and so forth. Chromatograms, standard curves, and other laboratory documentation will be maintained in a central file for future inspection. Copies of instrument logbooks and maintenance records will also be available for review.

ELEMENT B. DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

Although this QAPP applies to all sites being monitored and sampled, specific sampling process design can only by addressed on a site-specific basis.

The information needed to determine the practicality and usefulness of the guidance will be captured by observing the field activities, documenting issues and questions that arise, determining if the required data was obtained, and seeking input from the project participants concerning the level of effort required versus the level of effort anticipated. The project team led by the TOM will collaboratively determine if the guidance was practical and useful.

This document describes a monitoring program designed to estimate the emission rates and the concentrations of methane and other chemicals of potential concern. The experimental design is to study the composition and emission rates of the landfill gas being emitted to ambient air. Each of the three selected landfill sites will be sampled to:

- Provide the landfill gas composition that is representative of each section of the landfill as a whole,
- Provide the landfill gas composition at the landfill boundary in the subsurface strata,
- Provide the landfill gas composition in the subsurface strata immediately above a groundwater plume and adjacent to potentially affected off-site structures,

A general overview of the sampling and monitoring approach is provided in Table B-1.

The limitations inherent in this study include logistical constraints on the number of samples that can be evaluated. Spatial and temporal variability are considered to be important variables relative to sampling. Landfills are known to exhibit large variations in gas production from one area to the next. The focus of the sample design is to maximize the spatial coverage by collecting LFG information from all vents and on-site structures and from locations that are established by using a systematic 30 m by 30 m sampling grid that is defined by the landfill cover and extends to 30 m beyond the landfill boundary. This systematic screening technique is designed to identify hot spot locations for both methane and NMOCs. The screening results will be used to identify up to 20 locations that will be sampled for the COPC-TAL. Depending on the landfill cover material, it is assumed that the landfill vents will have higher LFG concentrations, and their impact on the ambient air will be greater than the impacts derived from the surface emissions. The sample design assumes that the emissions from the 20 locations with the highest NMOC concentration will adequately characterize the total landfill emissions.

Table B-1. Summary of Sampling and Analytical Approach.

Emission Source	Parameter	Sampling Technique	Analytical Technique	
			On-site	Off-site
Landfill grid size 30 × 30 m plus vents and onsite structures	CH_4 and NMOC hot spots	Direct reading instrument	Modified FRM[a] 21 Section 4.3.1	
Landfill NMOC hot spots (not to exceed 20 locations)	COPCs	Summa canister SOP 1704	TAGA - SOP 1712 Mobile GC/MS SOP 1819	
	COPCs	Summa canister SOP 1704		TO15
	Fixed LFG (CH_4, CO_2, N_2, and O_2)	Summa cannister Direct reading	Multigas analyzer	FRM 3C Multigas monitor with appropriate detectors
Permeable native subsurface soil gas at boundary locations (not to exceed 20 samples)	CH_4	Summa canister SOP 1704	Multigas manager	
	COPC	Summa canister SOP 1704	Mobile GC/MS SOP 1819	TO15
	Soil properties (% moisture, bulk density, particle size, classification)	Split barrel SOP 2012		ASTM D2216, D1587, D854, D422, D2487
	Gas pressure	Direct reading instrument	FRM 2-E	
Permeable native subsurface soil gas at off-site structure(s) (not to exceed 3 samples)	Soil properties (% moisture, bulk density, particle size, classification)	Split barrel sampling SOP 2012		ASTM D2216, D1587, D054, D422, D2487
Indoor air (not to exceed 3 samples)	COPCs	Low-level Summa cannister SOP 1704	Mobile GC/MS SOP 1819	
Outdoor air (not to exceed 3 samples)	COPCs	Low-level Summa canister SOP 1704	Mobile GC/MS SOP 1819	

[a] FRM = Federal reference method.

The sample design assumes that the proximity of off-site structures to the landfill boundary is the dominant risk driver for subsurface vapor intrusion into off-site buildings via pressure gradients. This assumption may be invalid if there are interceptors, diversion structures, barriers, geologic faults, and preferential vapor pathways between the landfill and the building.

The sample design assumes that up to 10 clustered LFG monitoring wells, spaced 30 m apart and situated along the landfill boundary closest to the nearest off-site building, is sufficient to delineate the presence of a methane vapor plume. This assumption may be invalid if the LFG concentration and pressures outside of the established study area are higher than those inside the study area. Site-specific data concerning native soil variability, LFG concentration variability, and distances between the nearest structure and the landfill all affect the risks posed by the landfill. The number of wells and the spacing may be adjusted up and down at the discretion of the TOM.

The sample design assumes that the nearest off-site building may be affected by the subsurface migration of LFG. Off-site subsurface soil gas sampling for up to three locations in the vicinity of the nearest building is anticipated. These samples will be collected within each soil strata and as close to the building foundations as practicable. Three indoor air and three ambient air samples may be collected if screening level modeling shows potentially unacceptable risks. The ambient air samples would be collected just outside of the building's roof drip line.

The sample design assumes that at least one building may be affected by vapor volatilizing from contaminated groundwater. The sample design assumes that the groundwater concentration of each COPC is already known and that soil gas sampling will be conducted in the vicinity of a building located within the areal extent of the groundwater plume. The sample design assumes that soil gas samples may be collected within each permeable soil strata and as close to the potentially affected building foundation as possible.

The sample design also assumes that three indoor air samples may be collected from the basement or an interior room of the potentially affected building located above the groundwater plume. Up to three ambient air samples will be collected just outside of the building's roof drip line. The following technical criteria will be used to identify the building:

- Accessibility and
- Proximity to most contaminated groundwater.

Soil gas emissions are controlled by many physical and chemical properties and processes. Soil gas monitoring does not provide repeatable quantitative information over time because of the dynamic nature of phase equilibria, geologic variability, temperature variability, biodegradation, abiogenic degradation, and so forth. The study design is not intended to address temporal variability. Field activities will be halted and rescheduled if the ground has been saturated by rain, snow, or flood waters within 48 hours of the scheduled sampling date. The field team leaders will record in a logbook local temperature, humidity, barometric pressure, and elapsed time since a significant (0.1 inch) rain, snow melt, or flood.

The sample design proposes that hand-held global positioning system devices will be used to guide the field technician in establishing the X, Y, Z coordinates for each sample or measurement taken. The project-specific QAPP will include a local coordinate system, and it will establish a bench

mark that will allow the locations to be plotted on a scale map of the study area. Field technicians will use professional judgment in determining whether or not they can reasonably collect the samples or instrument readings at the predefined location. Log notes will be used to document the rational and decision process whenever a sample location is modified. The field technician will collect duplicate samples at the next location if a sample cannot be collected within 15 m of the predefined location. These replicate samples will be used to evaluate reproducibility and variability of the sampling and analysis procedures.

The maximum tolerable uncertainty associated with determining the LFG-COPC concentrations and the pressure measurements has not been established. The concentration data will be used in equations and models that use other parameters and constants that have a substantial degree of uncertainty already associated with them. Expending additional resources to improve the measurement data quality by a factor of two to five would require the use of ultra trace techniques that are much more costly and time consuming. The sampling and analytical methods proposed herein are well defined and commonly used.

The sample design assumes that the RPM will select the off-site building and obtain access agreements.

The sample design assumes that the RPM will have already completed the utility checks and that they are accurately plotted on scale drawings.

B.2 Sampling Methods

This section describes the sampling and analytical methods that will be used to complete this project. The monitoring will consist of measuring the concentration of LFG components (CH_4, NMOCs, CO_2, N_2, O_2, and COPCs), determinating soil properties, and determinating in situ LFG pressure.

The soil gas samples will be collected at site-specific locations. The soil gas sampling will be performed in accordance with U.S. EPA - ERT standard operating procedures (Laboratory-SOP 2042 - Soil Gas Sampling). The soil gas samples will be obtained by the slam-bar method to create a small-diameter hole that is approximately 5 to 6 feet below ground surface. A narrow diameter tube will be inserted into the hole to a point just above the bottom of the hole. The top of the hole will be sealed. The soil gas sampling tube will be purged by use of a sampling pump before a soil gas sample is collected.

If Summa canisters are used to collect LFG samples, all canisters will be cleaned prior to the sampling event, by placing them in areas maintained at 150 °C; the canisters will be evacuated to at least 10^{-3} torr and then pressurized with humidified nitrogen to 30 psig. This process will be repeated three times. This process is described in Laboratory-SOP-1703 - Summa Canister Cleaning.

The extractive vents (individual gas collection wells) will be sampled for gas temperature, gas flow rate, and gas composition, including methane, carbon dioxide, total NMOCs and the COPCs included on the target analyte list. The moisture content will be determined on the basis of adiabatic saturation. The extractive vents will be operating under a relatively high vacuum (e.g., 10 to 12 in.

of Hg); hence, the cannister samples will be filled until the canister and duct pressures are equal. Subatmospheric sampling will require a regulator, pressure gauge, and temperature gauge to be part of the sampling equipment. The volume of gas is to be collected is fixed by the volume of the Summa canister (6 L).

Passive vents will be sampled to determine LFG flow rates. The passive vent flow rates will be determined using a vane anemometer or a turbine meter (EPA reference Method 2D). These methods are intrinsically safe and simple to operate, and measurements can be conducted without modifying the vents. The gas will be collected into Summa canisters and Tedlar bags as specified in the sampling strategy. The sample line will be inserted several feet inside the vent. Canisters will be kept at a slight vacuum (e.g., 1 to 4 in. Hg) following sample collection.

Ambient air sampling (indoor and outdoor) must be performed by following SOP 2105 - Air Assessment Sampling and Monitoring Guidelines. Any ambient air samples will be collected over an 8- to 10-hr period.

The gas samples will be collected in a Summa canister(s) as specified in the sampling strategy. Samples will be drawn into the Summa canisters in accordance with Laboratory SOP 1704 - Summa Canister Sampling. All samples will be documented following Laboratory SOP 4001 - Log Book Documentation, Laboratory SOP 2002 - Sample documentation, Laboratory SOP 2004 - Sample packaging and shipment, and the COC procedures described in Section B.3.

The gas samples will be analyzed for the organic COPC target analyte list by using the mobile GC/MS and following SOP 1819 - Analysis of Volatile Organic Compounds in air samples by Viking Spectratrack 620 Gas Chromatography/Mass Spectrometry. All Summa canisters destined for off-site analysis will be shipped to the laboratory that will be named in the site-specific QAPP.

B.3 Sample Handling and Custody

The following text and COC procedures will be followed.

A sample or evidence file is under one's custody if either:

- Are in your possession,
- Are in your view, after being in your possession,
- Are in your possession and you place them in a secured location, and
- Are in a designated secure area.

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the COC intact. Standard procedures for sample handling and custody include:

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible will handle the samples;
- All canister and bag containers will be tagged with sample numbers and locations;
- Sample tags will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because the ballpoint pen would not function in freezing weather;

- The field team leader will review all field activities to determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

Field logbooks will provide the means of recording data collection activities performed. As such, entries will be described in as much detail as possible so that a particular situation could be reconstructed without reliance on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the document control center when not in use. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:
- Person to whom the logbook is assigned,
- Logbook number,
- Project name,
- Project start date, and
- End date.

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the station, which includes compass and distance measurements, will be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the site-specific QAPP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. A sample identification number will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

The COC form is used to track and document unbroken custody of samples as identified by the unique sample number. The contractor's standard form is shown on Figures B-1 and B-2. Blank forms can be obtained by contacting The contractor's QA/QC staff personnel. The original COC form will be kept by the receiving laboratory and will accompany the analytical report. A copy of the COC form from each group of samples will be supplied to the contractor's's QA/QC chemist, and a copy will be placed in the project files.

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ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Reference Document No. _____
Page 1 of ___

Project Name _____
Project Number _____
Project Manager _____
Sample Team Leader _____

Lab Destination _____
Lab Contact/Phone _____
Lab Purchase Order No. _____
Carrier/Waybill No. _____

Report to: _____

Bill to: _____

ONE CONTAINER PER LINE

Sample Number	Sample Description/Type	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Analytical Method/(Parameters)	Condition of Receipt (Lab)

Special Instructions:

Possible Hazard Identification:
Non-hazard ☐ Flammable ☐ Skin Irritant ☐ Other _____

Sample Disposal:
Return to Client ☐ Disposal by Lab ☐ Archive _____ (mos.)

Turnaround Time Required:
Normal ☐ Rush ☐ Results Required by _____

QA Requirements:

1. Relinquished by (Signature/Affiliation)	Date: _____ Time: _____	1. Received by (Signature/Affiliation)	Date: _____ Time: _____
2. Relinquished by (Signature/Affiliation)	Date: _____ Time: _____	2. Received by (Signature/Affiliation)	Date: _____ Time: _____

Comments:

Figure B-1. Chain-of-Custody Form.

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Management, Inc.

ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Reference Document No. _____
Page ___ of ___

Project Name _____ Project No. _____ Sample Shipment Date _____

ONE CONTAINER PER LINE

Sample Number	Sample Description/Type	Date/Time Collected	Container Type	Sample Volume	Pre-servative	Requested Analytical Method/(Parameters)	Condition of Receipt

Figure B-1. Chain-of-Custody Form (continued).

Stainless Steel Canister Chain-of-Custody

To be Completed by Field Sampler

Sample Control Number _____

Canister Number _____

Date Sampled _____ Time: _____

Well/Station Number _____

OVA Reading (Peak) _____

Address/Refinery Location _____

Sampler's Initials _____

Type (Circle One) Ambient or Point Source (specify): _____

Comments:

To be Completed by Lab (Part One)

Operation	Date	Initials	Comments
1. Canister Cleaned			
2. Canister Blanked			
3. Filter Cleaned			
4. Canister Evacuated			Pressure:
5. Canister Shipped			
6. Canister Received			ΔP_L =
7. Analysis Completed			ΔP_F =
8. Sample Discarded			$\Delta P_L - \Delta P_F$ =

To be Completed by Lab (Part Two)

Parameter	Dilution 1	Dilution 2	Dilution 3	Dilution 4
Initial Pressure				
Final Pressure				
Add UHP Air				
Dilution Factor				
FINAL Dilution Factor				
Dilution Date				
Dilution Time				
Initials				

Figure B-2. Chain-of-Custody Report for Canister Samples.

Samples will be accompanied by a properly completed COC form, and the sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in each sample container. Shipping containers will be locked and secured with strapping tape and EPA custody seals for shipment to the laboratory. The preferred procedure includes use of a custody seal attached to the front right and back left of the container. The custody seals are covered with clear plastic tape. The container is strapped shut with strapping tape in at least two locations.

All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and the pink and yellow copies will be retained by the sampler for returning to the sampling office.

If the samples are sent by common carrier, a bill of lading should be used. Receipts of bills of lading will be retained as part of the permanent documentation. If sent by mail, the package will be registered with return receipt requested. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

The contractor's chemist must be notified prior to any sample collection activity. This person will be the primary line of communication between the project site and the laboratory.

The designated laboratory sample receipt clerk is authorized to accept samples and is charged with the responsibility for proper completion of the required sample receipt documentation. As required, analysts are assigned to assist the sample receipt clerk in sample log-in procedures. In all cases, COC and analytical request documents become part of the permanent file relative to the samples collected. Those files are retained indefinitely in the laboratory's facility.

All samples in storage at the laboratory are retained in the custody of the designated sample custodian until released as required for analytical work. A record of the custody change is made by the analyst and checked by the sample custodian at the time the sample is taken from the cold storage. Internal custody files are retained indefinitely in laboratory files.

After analysis is complete on a sample set, the samples or sample processing products will be held for 30 days. The laboratory is responsible for disposing the samples, and it must be accomplished in complete accordance with all regulations governing such activities.

All samples, including those collected with direct reading instruments, will be given a unique sample identification number that identifies the type of sampling medium, the date collected, and the sample type (regular, blank, collocated). This information will facilitate manipulation of the data. Each sample number will have five distinct parts. An example is shown below.

The first part of the sample number designates the sample type:
- LFSG indicates landfill soil gas;
- NSG indicates native soil gas;
- PVG indicates passive vent gas;
- EVG indicates extractive vent gas;
- AAl indicates ambient air indoor;
- AAO indicates ambient air outdoor;
- OC indicates other condensate sample type;
- OL indicates other liquid sample type, groundwater, leachate, etc.; and
- OS indicates other soil type, split barrel.

The second part designates the sample media:
- 00 indicates Tedlar bag sample,
- 01 indicates Summa canister sample,
- 02 indicates direct-read gas analysis,
- 04 indicates fixed gas (CH_4, O_2, N_2, CO_2) analysis, and
- 05 indicates soil sample to be analyzed for physical properties.

The next six numbers represent the date the sample was collected (MMDDYY). The next letter indicates the sample type: R for Regular, D for duplicate, C for Collocated or B for Blank. The last three digits are a sequential number unique for each site, starting at 001 and continuing until the sampling is complete.

B.4 Analytical Methods

The analytical methods for this project are divided into on-site analysis—organic vapor, fixed gases (oxygen, nitrogen, methane, carbon dioxide), and flow rate measurements—and off-site analyses (VOC canisters and physical properties). The analytical methods to be used in this project include:

Compound	Method
Gaseous Organic COPC	TO-15 per EPA/600/R-96/033, March 1996
Methane	TO-15 per EPA/600/R-96/033, March 1996
Gaseous NMOC	GC/FID per EPA/600-R-98/16
Fixed Gases (CO_2, CH_4, N_2, O_2)	FRM 3C
Soil Moisture	ASTM D2216
Bulk Density	ASTM D1587
Particle Density	ASTM D854
Particle Size	ASTM D422
Aqueous Liquids	SW846 Method 8260
	SW846 Method 8270
LFG Pressure	FRM 2E

Acceptance criteria is established by data generated from a specific method and instrument, and will be laboratory specific. Procedures (laboratory SOPs or published methods) will include specific information on tuning criteria, calibration procedures, and acceptance criteria for QC check standards. The specific information on laboratory analysis will be included in the site-specific QAPPs.

B.4.1 On-site Analyses

The Agilent 6890 gas chromatograph and 5973N mass spectrometer (GC/MS) will be used to perform on-site analysis of gas samples. The target compounds are site specific but inclusive of the COPCs identified in Table A-3.

Organic vapor samples will be analyzed by trapping and subsequent thermal desorption of aliquots via an OI analytical 4560 sample concentrator followed by GC/MS analysis. The ChemStation data system will be used to evaluate and process the data. Table B-2 lists the targeted Agilent GC/MS and the OI Analytical 4560 Sample Concentrator operating conditions. Once the trap is cooled, an aliquot of sample (250 to 1000 mL) will be drawn onto the sorbent trap along with 25 nL of the internal standard. The internal standard is a mixture of bromochloromethane, chlorobenzene-d_5 and 1,4-diflorobenzene at 10 ppbv in accordance with Method TO-15. The sample will be injected by thermal desorption onto the column head of the GC/MS for subsequent analysis. The GC is temperature programmed to separate the VOCs that will be detected by the MS detector. VOCs in the sample will be identified by comparing their retention times and mass spectra to those of an analytical standard and a reference mass spectral database, the National Institute of Standards and Technology (NIST) library.

The fixed gases of methane, oxygen, nitrogen, and carbon dioxide will be analyzed using the micro gas chromatograph (Model M200H MGC). The M200H MGC will be set up on site. The site-specific QAPP will define the setup procedures that will be used by EPA-Laboratory. Soil gas samples will be collected and brought to the M200H MGC location for analysis. The M200H MGC will be operated in accordance with the manufacturer's operating manual.

The M200H MGC is a dual capillary column (A and B) and micro-chip thermal conductivity detector (μTCDs) analytical instrument. An internal sampling pump pulls a vapor-phase sample through a fixed sampling loop for a programmed period of time. Injection valves are activated, and a sample aliquot is simultaneously injected onto both capillary columns.

Once injected into the MGC system, the sample components are separated by the capillary columns into discrete peaks. The peaks are detected by the μTCDs, and the results are electronically stored by the EZChrom 200 data system. The dual column and dual μTCD system allows independent detection and identification of compounds. The results from column A are reported for nitrogen and oxygen. The results from column B are reported for carbon dioxide and methane.

The EZChrom 200 data system controls all operations for the M200H MGC. The identification and quantitation of compound peaks are conducted by comparing the sample peak responses and retention times with those of standards stored in the EZChrom 200 method calibrations. Both single-point and multipoint calibrations can be used. The gas samples will be analyzed using a multipoint calibration for CH_4, O_2, and N_2 (the primary target compounds), and a single-point calibration for CO_2 (the secondary target compound) with an additional check standard to verify results.

Table B-2. Targeted Instrument Conditions for Analysis of VOCs.

Agilent GC/MS	
Column	Rtx-Volatiles, 0.18 mm ID × 20 m, 2.0 µm df
Head Pressure	16.82 psi
Flow rate	helium at 0.8 mL/min
Split Ratio	40:1
GC Temperature	35 °C (hold 1.0 min)
	15 °C per min to 190 °C
	10 °C per min to 200 °C (hold 5.0 min)
Injector Temperature	180 °C
Mass Spectrometer	Electron impact ionization at a nominal electron energy of 70 electron volts, scanning from 36 to 260 amu at one scan/s
Source Temperature	230 °C
QI Analytical 4560 Sample Concentrator	
Purge Gas	helium
Flow Rate	40 mL/(min)
Purge[a]	±12 min at 20°C
Sample Vacuum Flow	50 mL/min
Valve Temperature	150 °C
Transfer Line Temperature	150 °C
Adsorption Temperature	Ambient (27 °C)
Desorb Temperature	4 min at 190 °C
Bake	8 min at 200 °C
Water Management Heat	ON
During Purge	100 °C
During Desorb	0 °C
During Bake	240 °C

[a] Total purge time varies depending on the total sample volume.

Two landfill systems will be monitored for flow rate: the extractive system vents and passive landfill gas vents. The flow rate from the extractive system will be measured using a standard pitot tube placed at the centroid of the header pipe or from an in-line orifice plate. The duct temperature will also be measured. The delta pressure inside the pipe, static pressure of the pipe, gas temperature, gas molecular weight, and moisture content, and pipe cross-sectional area will be used to calculate a volumetric flow rate. The equations used to calculate the volumetric flow rate are shown below. To help minimize any effect caused by disturbance of the pitot tube itself, a ⅛-inch-diameter standard pitot will be used.

$$P_d = P_a + P_s \quad (1)$$

$$V_s = \sqrt{(T_d)(\Delta P) / (MW)(P_d)} \quad (2)$$

$$Q_a = (V_s)(A)(3600) \quad (3)$$

$$Q_s = (Q_a)(528°\text{R})/T_d)(P_d/29.92) \quad (4)$$

Where: P_d = absolute duct pressure (inches Hg),
P_a = ambient pressure (inches Hg),
P_s = duct static pressure (inches Hg),
V_s = vapor recovery well velocity (feet per second),
T_d = duct temperature (degrees Rankine),
ΔP = differential pressure across the pipe (inches H_2O),
MW = average gas molecular weight (pounds per pound-mole),
Q_a = actual flow rate (cubic feet per hour),
A = cross-sectional area of duct (square feet),
Q_s = standard flow rate (SCFH),
528°R = standard temperature in degrees Rankine (68 °F), and
29.92 in. Hg = standard pressure.

The LFG molecular weight will be determined from results of canister analysis using EPA Method 3 procedures. The moisture content will either be estimated on the basis of duct temperature and adiabatic saturation tables, measured directly using EPA Method 4, or taken from plant measurements.

Flow rate measurements from the LFG passive vents will be performed using a vane anemometer or portable turbine meter (EPA Method 2D). These devices provide a measure of linear velocity and are very adapted to measuring ducts and vents. The velocity can then be converted to volumetric flow using the vent cross-sectional area. Gas temperature and barometric pressure will be measured and used to calculate a standard volumetric flow.

Organic vapor analyzers (OVA) will be used on site to "sniff" out areas of high methane and NMOC concentrations. These instruments use FIDs or PIDs to measure methane and non-methane hydrocarbon concentrations. These instruments will be used to identify locations where the LFG escaping from the landfill has the highest NMOC concentration. The instruments will be calibrated daily during the project using methane or ethane (10,000 ppmv) in air standards traceable to NIST

standards. The OVA's will also be checked using a zero point—ultra high purity-air (UHP-air)—and low range (100 ppmv) calibration gas.

B.4.2 Off-site Analyses

Bulk density is the ratio of the mass of the dry solids to the bulk volume of the sample. The bulk volume includes the volume of the solids, pores, and any liquid that may be present. For lithified geologic materials (rocks, stones, gravel), the bulk density for a given sample is a fixed value. For unconsolidated sediments, the bulk density will vary as a function of grain packing. If expandable clays are present, the bulk density will vary as a function of moisture content. For this project, bulk density will be determined using ASTM method D854. The mass of the samples is calculated by difference using a top-loading balance. The dimensions of the specimen (cube or cylinder) are measured using a ruler having a precision of ±1 mm. The bulk density is calculated by dividing the mass by the volume (grams per cubic meter).

For particles less than 4.75 mm in diameter, particle density is determined by measuring the mass of liquid required to fill a closed container of known volume containing a known mass of solids. The volume of the liquid is calculated from the mass of the liquid and the known density of the liquid at the temperature at which the measurements are made. The volume of the solids is the difference between the volume of the container and the volume of the liquid. Particle density is the mass of the solids divided by the volume of the solids. In ASTM Method D 854, specific gravity is defined as "the ratio of the weight in air of a given volume of a material at a stated temperature to the weight in air of an equal volume of distilled water at a stated temperature." If specific gravity rather than density is desired, then the density of the solids at the stated temperature is divided by the density of water at a stated temperature.

The water content or moisture content of the soil samples will be determined using ATSM Method D 2216. In this method, a measured mass of soil is dried in an oven at 110 ±5 °C until the sample reaches a constant mass. If performed on site, a microwave oven may be used to dry the soil samples. The water content, expressed as a percentage, is then calculated as the ratio of the mass of water present to the mass of soil, multiplied by 100.

The particle size distribution of the soil samples will be determined using ASTM D422-63, which is performed in two steps. The first step, for particulates above 75 μm, (retained on a Number 200 sieve) uses a number of sieves of various sizes to achieve fractionation down to 75 μm (Number 200 sieve). In the second step, the size distribution of the material that passes the Number 200 sieve (i.e., less than 75 μm) will be determined by using a sedimentation process and a hydrometer.

As specified in the sampling strategy, some organic vapor samples will be sent to an off-site laboratory. The VOCs collected will be analyzed using a GC equipped with dual columns and multiple detectors. The detectors include a FID, a PID, and an ELCD. Samples will also be analyzed using GC/MS to confirm compound identity and help identify compounds not identified by other methods. Fixed gas (i.e., N_2, O_2, CO_2, and CH_4) analyses will also be performed off site using a thermal conductivity detector (TCD). Calibration information is presented in Section B.7.

The canisters will be shipped to the site-specific laboratory for analysis. On arrival, the canister

COC forms will be reviewed for completeness, and the final field pressures will be checked to verify that the canisters did not leak during transit. Canisters determined to have leaked will be voided and not analyzed. Following pressure checks, the canisters will be pressurized with UHP-grade helium to both dilute the sample and facilitate its removal from the canister. Helium will be used because UHP-grade nitrogen or air would normally interfere with the fixed-gas analysis.

The speciated VOC analysis samples will use Method TO-15. EPA method TO-15 provides techniques for the analysis of airborne VOCs collected as whole air or LFG samples in stainless steel canisters. Up to 0.5 L of gas is withdrawn from the canister through a mass flow controller and is either cryofocused via liquid argon or concentrated using a multi-sorbent bed. The focused sample is then flash heated through a hydrophobic drying system which removes water from the sample stream prior to analysis by full scan GC/MS. For low level analysis, a cryogenic valve is employed to cold trap the gases onto the GC column.

Compounds are qualitatively identified based on retention time and by comparing background-subtracted sample spectra to the reference library spectra. An analyte is qualitatively identified when the following two criteria are met:

- The relative retention time (RRT) for the analyte must be within ±0.06 RRT units of the RRT of the analyte in the daily continuing calibration check. When high moisture in a sample causes a retention time shift, an exception is taken, providing the shift is consistent based on the internal standards;
- Ions present in the standard spectrum greater that 10 percent of the most abundant ion must be present. Also, the relative intensity of the ions greater than 10 percent, must be ± 20 percent of the intensity in the standard spectrum.

The ion intensity test is performed by the GC/MS software. Ions that do not meet the intensity criteria are flagged in the raw data. Failure to meet the intensity criteria my be indicative of matrix interference or low signal to noise (i.e., low concentration).

Quantitation is based on the integrated abundance of the primary ion for each analyte. If the response for any quantitation ion exceeds the initial calibration range of the GC/MS system, the sample is diluted and reanalyzed.

When interference with the primary quantitation ion occurs, quantitation on the secondary ion is carried out after a new response factor (using the secondary ion) is generated from the calibration. Therefore, the same ion used to establish the response factor is used to quantify target analytes in the sample. This is noted in the laboratory narrative included in the report. The criterion for using the secondary ion for quantitation is a difference in the reported result of 50 percent or more.

Canisters are connected to the inlet of the focusing unit with ¼ in. stainless steel fittings, and connections are leak checked by monitoring the flow on the controller. As vacuum is achieved, the flow will drop to less than 5 ml/min. After leak checking is complete, the valve on the canister is opened and flow allowed to equilibrate. The equilibration period also allows for sweeping of the line and trap. During this time, a 1-cc gas sample valve injection of internal standard/surrogate standards is made.

Sampling is initiated by rotating the port valve into the sample position. Air from the canister flow into the focusing trap. Sampling continues until the desire volume of air has been withdrawn.

Following the sampling period, the port valve is rotated into the back flush position, and the trap heater is turned ON. Contents of the trap are then swept by carrier gas into the drier. Following this, the drier is flash heated and the contents back flushed into the GC/MS. For low level analysis, the gases are cold-trapped on to the GC column using a cryogenic valve. A 4 to 5 min bake cycle is then used to clean the system for the next sample. The bake cycle eliminates sample carryover by sweeping both the heated trap and heated drier to vent.

VOC samples collected in Summa polished stainless steel canisters are subject to a 7-day hold time. The 7-day analytical hold time is not meant to be a statement of compound stability or sample integrity. All compounds on the target analyte list have been studied for compound stability in Summa canisters and found to be stable up to 30 days (there have been very limited studies of stability beyond 30 days).

The identification of peaks will be based on normalized retention times, detector responses, and individual compound response from the daily calibration standard in accordance with Method TO-15. The retention time of each peak on the FID will be calculated relative to the retention time (RRT) of toluene. The PID data will then be scanned for any peaks that matched the FID retention times. The corresponding PID/FID response ratio will then be compared with the sample's PID/FID response for toluene to generate a toluene-normalized response (TNR) factor. Different compound classes and individual compounds produce characteristic TNRs. The RRT and TNR data will be compared with the compound database parameters as well as the daily analysis of calibration standard for potential matches. The potential matches will be reviewed and validated by experienced personnel (both at the performing laboratory and by the contractor's chemist) to ensure data quality. During this program, the chromatograms will be validated for the major compounds (i.e., those contained in the calibration standard) found in the chromatogram followed by evaluation of the chromatograms for compounds not calibrated. The quantitation of the major compounds will be based on individual response factors, which will be calculated daily by analyzing either a low-level standard (cryogenic trapping technique) or a higher-level standard (fixed loop method). The remaining compounds will be quantitated on the basis of a hexane response. The identification will be based on a library search. The lessons learned project summary will note whenever compounds not on the target list are identified, but there will be no attempt to quantify the concentrated by rerunning the samples with a different set of calibration curves.

B.5 Quality Control

The overall QA objective is to provide defensible data of known quality meeting QA objectives. To that end, procedures are developed and implemented for field sampling, COC, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. Specific procedures for sampling, COC, instrument calibration, laboratory analysis, data reporting, audits, preventive maintenance of field equipment, and corrective action are described in Section B6 of this QAPP.

Each laboratory participating in this project will have established a QA program with the objective of providing sound analytical chemical or physical measurements. This laboratory-specific program will incorporate the QC procedures, any necessary corrective actions, and all documentation required during data collection, as well as the QA measures performed by the laboratory's management to ensure acceptable data production. The contractor's QA officer will verify that the laboratory has a written QA plan and that the laboratory has an organizational structure committed to

- Maintaining data integrity, validity, and usability;
- Ensuring that analytical measurement systems are maintained;
- Detecting problems through data assessment and established corrective action procedures that keep the analytical process reliable; and
- Documenting all aspects of the measurement process to provide data that are technically sound and defensible.

The EPA laboratory team manager will select the laboratories using their existing contractor selection processes. The purpose of this section is to address the specific objectives for accuracy, precision, completeness, representativeness, and comparability.

Field blank, trip blank, duplicate and matrix spike, and split/collocated samples will be analyzed to assess the quality of the data derived from the field sampling program. Field blank samples consist of distilled water and are analyzed to check for procedural contamination at the site that may cause sample contamination. Trip blanks consist of distilled water and or reagents. These trip blanks will be used to assess the potential for sample contamination during sample shipment and storage. Duplicate samples will be analyzed to check for sampling and analytical reproducibility. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. The matrix spike will include the COPC-TALs identified in Table A-1. Laboratory spiking levels will be at the same concentration as the field sample. All matrix spikes will be performed in duplicate and will hereinafter be referred to as matrix spike/matrix spike duplicate (MS/MSD) samples. MS/MSDs will be collected for every 20 or fewer investigative samples. Soil and gas MS/MSD samples require no extra volume for VOAs or extractable organics. Split/collocated samples will be collected for five percent of the gaseous samples. These collected samples will be analyzed offsite as a check on the on-site laboratory efforts.

The number of duplicate, field blank, equipment blank, trip blank, and split samples to be collected are listed in Table B-3.

The level of QC effort for testing on the organics target analyte list (volatiles and semi-volatiles) will be equivalent to the protocols of "Laboratory Data Validation Functional Guidelines for Evaluating Organic/Pesticides and PCBs Analyses" EPA-540/R/94/090-092. The level of QC effort for testing of methane and NMOC in air samples will conform to the protocols from the National Institute for Occupational Safety and Health (NIOSH) "Manual of Analytical Methods," Third Edition, U.S. Department of Health and Human Services, August 1994.

Table B-3. Guidelines for Minimum QA/QC Samples for Field Sampling Programs.

Media	Duplicates/ Replicates	Field Blanks	Equipment Blanks	Trip Blanks	Split Samples	MS/MSDs
Soil, Sediment, Solids	5%	None	None	None	None	None
Gases	5%	One per reagent per sampling event, per media lot	One per sampling event	5%	5%	5%
Calibration/ Neat Source Material	One per 20 samples	One per reagent per sampling event	One per sampling event	None	None	None

Note: Laboratory blanks are method-specific and are not included in this table.

The QC level of effort for the field measurement of methane and NMOCs consists of pre-measurement calibration and a post-measurement verification using standard reference materials. This procedure will be performed twice a day for each day of screening level analyses. The QC effort for field measurements will include twice daily calibration of the instrument using mixtures of gas in cylinders. The calibration gases will include UHP-air, methane, and ethane in air. Dilution probes will be used to verify that calibration between 0 and 500 ppm is maintained. Scott Speciality Gases or similar commercial suppliers will provide the calibration gases and a certificate of analysis will be obtained for each lot used.

The fundamental QA objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical methods being used and the targets presented in Tables A-5, A-6, and A-7.

Laboratory results will be assessed for compliance with required precision, accuracy, and sensitivity as described below.

Precision

Precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD for organic analysis. The relative percent difference (RPD) will be calculated for each pair of duplicate analysis using the equation

$$RPD = \frac{S - D}{(S + D)/2} \times 100$$

Where: S = First sample value (original or MS value) and
D = Second sample value (duplicate or MSD value).

Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 20 analytical samples.

Accuracy

Accuracy of laboratory results will be assessed for compliance with the established QC criteria using the analytical results of method blanks, reagent/preparation blank, MS/MSD samples and field blanks. Blank contamination is an indicator of systemic contamination, and it may alter the detection limits that can be achieved by the analytical methods. The analytical results of the various blanks will not be used to alter the quantitative results. The percent recovery (%R) of matrix spike samples will be calculated using the equation

$$\%R = \frac{A - B}{C} \times 100$$

Where: A = The analyte concentration determined experimentally from the spiked sample,
B = The background level determined by a separate analysis of the unspiked sample, and
C = The amount of the spike added.

Accuracy in the field is assessed through the use of field and trip blanks and through the adherence to all sample handling, preservation, and holding times. Onsite analyses will be validated via collocated/split samples being sent to an offsite analytical laboratory at a rate of one collocated sample per 20 samples analyzed onsite.

Sensitivity

Achieving method detection limits depends on instrumental sensitivity and matrix effects. Therefore, it is important to monitor the instrumental sensitivity to ensure data quality through constant instrument performance. The instrumental sensitivity will be monitored through the analysis of method blank, calibration check sample, and laboratory control samples, and so forth.

The usefulness of sampling and analysis data also depends on whether they meet the criteria for completeness, representativeness, and comparability. The QA objectives are that all measurements be representative of the medium or operation being tested and that all data resulting from sampling and analysis be comparable. Wherever possible, sampling and analysis by reference methods and standard reporting units specified by the analytical method will be used to aid in ensuring that QA objectives are met.

COMPLETENESS is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. It is expected that the analytical laboratory will provide data meeting QC acceptance criteria of 80 percent or more for all samples tested. Following completion of the analytical testing, the percent completeness will be calculated by the equation

$$\text{Completeness (\%):} = \frac{(\text{number of valid data})}{\left(\begin{array}{c}\text{number of samples collected}\\ \text{for each parameter analyzed}\end{array}\right)} \times 100$$

Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. Field completeness for this project will be greater than 80 percent.

REPRESENTATIVENESS expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that depends on the proper design of the sampling program and proper laboratory protocol. The sampling network will be designed to provide data representative of site conditions. During development of the sampling network, consideration will be given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the Superfund program. The rationale of the sampling network is discussed in detail in Section B.1. Representativeness will be satisfied by ensuring that proper sampling technique are used, proper analytical procedure are followed, and holding times of the samples are not exceeded in the laboratory. Representativeness depends on the proper design of the sampling program and will be satisfied by ensuring that the site-specific QAPP is followed and that proper sampling techniques are used. Representativeness is determined through completion of the DQO Process presented in Section A7. Representativeness will be assessed by the analysis of duplicated samples, and Table A-4 indicates how many duplicate samples are to be evaluated. The duplicate sample locations will be identified in the site-specific QAPPS.

COMPARABILITY expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data. These new analytical data, however, may not be directly comparable to existing data because of a difference in procedures and QA objectives. Comparability depends on the proper design of the sampling program and will be satisfied by ensuring that the site-specific QAPP is followed and that proper sampling techniques are used.

Field data will be assessed by the QC officer. The QC officer will review the field results for compliance with the established QC criteria. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproducibility by obtaining multiple readings of a single sample.

B.6 Instrument/Equipment Testing, Inspection and Maintenance Requirements

The nature of the project activities requires periodic inspections to ensure that they are being completed in accordance with applicable regulations and project/contract requirements. Inspections are typically completed by the QA officer and other designated project personnel. The nature and frequency of inspections is a function of project activities; preparation, initial, follow-up, and final inspections are typically conducted. Results of inspections will be summarized, and inspection reports will be provided to the TOM on a regular basis. Recommendations for correcting deficiencies identified during inspections are developed by the Project Manager and discussed with the TOM.

Equipment used in the field is calibrated by the manufacturer or calibration is checked in-house prior to use. Calibration of the equipment is verified in accordance with the manufacturer recommendations and whenever repairs are made after a malfunction has been noted. The Field Team leader maintains a list of certificates for each piece of equipment being used. Maintenance records

of equipment adjustments and repairs are kept in equipment maintenance logs. These records include the date and description of the maintenance performed.

A preparatory inspection will be performed, at the request of the TOM, prior to initiation of field activities. The preparatory inspections will include:

- Review of task order requirements,
- Review and approval of plans and other submittals,
- Verification of control testing procedures and schedules,
- Examination of all materials and equipment to ensure that approved submittals conform to design specifications and are promptly stored,
- Review of activity hazard assessments to ensure appropriate levels of health and safety,
- Verification of construction tolerances and workmanship standards,
- Verification of adequacy of any required preliminary activities including an inspection of the work area,
- Discussion of QC procedures that required levels of workmanship and inspection criteria on site with project staff concentrating on the work plan and impending activities,
- Review of preparatory inspection notes and verification of the status of preparatory activities,
- Verification of procedures and schedules for control testing,
- Evaluation of the results of any control testing,
- Examination of the quality of the workmanship of construction (where appropriate),
- Review of the safety procedures in accordance with the site Safety and Health Plan including equipment required and upgrade/downgrade criteria, and
- Review of project submittals and proposed activities for omissions or dimensional errors.

Follow-up/Final Inspections

Follow-up inspections will be performed at the request of the TOM to ensure continued compliance with the project contract requirements. These inspections encompass:

- Verifying control test results,
- Examining the quality of workmanship of construction (where appropriate),
- Reviewing project submittals relating to project closeout.

Any nonconforming items will be documented in a nonconformance report. Figure B-3 presents an example nonconformance report. Corrective actions to noted deficiencies will be required unless a variance from the specifications is approved by the TOM.

Field equipment for a site will be identified in the site-specific QAPP. Specific preventive maintenance procedures to be followed for field equipment are those recommended by the manufacturer.

Field instruments will be checked and calibrated in the warehouse before they are shipped or carried to the field. These instruments will be checked and calibrated daily before use. Additionally, calibration checks will be performed after every 20 samples and will be documented on the Field Meter/Calibration Log Sheets.

Nonconformance Report

Date _____ Project _____

Project _____

Description of Nonconformance:

_____

_____

_____

_____

Inspector _____ Date _____

Corrective Action Required:

_____

_____

_____

Prepared by:

Name: _____ Date _____

To be verified by:

Name: _____ Date _____

Corrective Action Executed:

_____

_____

_____

Executed by:

Name: _____ Date _____

Inspected by:

Name: _____ Date _____

Approved by:

Name: _____ Date _____

Follow up _____

Name: _____ Date _____

Figure B-3. Example Nonconformance Report.

Critical spare parts such as tape, papers, diaphragms, and batteries will be kept on the site to minimize instrument downtime. Backup instruments and equipment will be available on site or within one-day shipment to avoid delays in the field schedule. Table B-4 presents routine preventive maintenance schedules for common field monitoring equipment.

Table B-4. Routine Preventative Maintenance Procedures and Schedules for Field Monitoring Equipment.

Instrument	Activity	Frequency
Combustible Gas and O_2 Alarm	Charge battery pack	As needed
	Clean sample inlet filter	Each time recharged
Photoionization Detector	Clean probe	Each use
	Clean lamp	As needed
	Check for proper operation and response	Daily
Flame Ionization Detector	Recharge battery pack	After each use
	Recharge hydrogen tank with zero hydrogen to 1500 - 2000 psi	As needed
	Check for proper operation and response	Daily
Water Level Indicator	Replace batteries	As needed
	Keep tape and probe free from contamination	Before and after each use

A routine preventive maintenance program is conducted by the analytical laboratory as part of a QA/QC program to minimize the occurrence of instrument failure and other system malfunctions. The analytical laboratory is expected to have an internal group or equipment manufacturer's service contract to perform routine scheduled maintenance and to repair or to coordinate with the vendor for the repair of all instruments. All laboratory instruments will be maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance must be carried out on a regular scheduled basis and be documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance will be provided under a repair and maintenance contract with qualified representatives. Project-specific equipment lists will be included in the site-specific QAPP.

B.7 Instrument Calibration and Frequency

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment that will be used for conducting field tests and laboratory analyses. These instruments and equipment should be calibrated prior to each use or on a scheduled periodic basis. The Field Team Leader is responsible for assuring that calibrations are current and documented.

Whenever possible, widely accepted calibration methods, such as those published by ASTM or U.S. EPA or those provided by manufacturers, will be adopted for both field and laboratory analytical instrumentation. At a minimum, calibration methods will take into consideration the type of equipment to be calibrated, reference equipment, and standards to be used. Equipment will be calibrated

using reference equipment and standards having known relationship to nationally recognized standards (e.g., NIST) or accepted values of natural physical constants. If national standards do not exist, the basis for the reference standard or calibration will be documented.

Reference equipment will be used only for calibration and will be stored separately from functioning, measuring, and testing equipment to prevent inadvertent use. In general, reference equipment will be at least 4 to 10 times as accurate as the equipment being calibrated.

All continuing calibrations are performed in the field prior to instrument use. Every calibration is recorded in the maintenance logbook for each instrument. QC check standards from separate sources will be used to check initial calibration and acceptance and rejection criteria. When the difference between the continuing calibrations and the QC check standards exceeds plus or minus 20 percent, use of the instrument will be suspended until corrective actions are taken or until it is determined that a greater variance will be allowed. The acceptance/rejection criteria can only be revised by approval of the laboratory manger and the TOM. Vapor meters will be calibrated daily with one span gas. All analytical instrumentation will utilize continuing calibration standards in addition to the initial calibration curve. These will be run at varying concentrations including low, mid, and high range to ensure continuation of the curve.

Calibration procedures and frequency specified by the method will be used by the field analytical laboratory. When the field laboratory is used only for screening purposes, however, a less-stringent approach to calibration can be used—for example, using three concentration levels instead of five. The option will be specified and documented in the project-specific QAPP.

All certified gas standards will be provided by Scott Specialty Gases, Inc., or a similar supplier. The VOC standard will contain at least 20 COPC-TAL compounds each at approximately 1 ppmv in helium. Helium is used to avoid problems associated with conducting the fixed gas (CO_2, N_2, O_2) analyses. The initial calibration will be performed by varying the volume of the standard; volumes of 1, 5, 25, 50, and 100 mL of the 1 ppmv standard result in a calibration curve of 1, 5, 25, 50, and 100 nL, respectively. Daily calibration check standards will be obtained by analyzing the 25-nL standard. The initial calibration response factor report and the continuing calibration reports will be provided with the laboratory report.

Stock standards should be purchased in a high pressure cylinder blend that is designed to minimize vapor phase interactions and maximize long-term stability. The standards would be blended into the working range by taking known aliquots using density-based calculations. Density-based calculations are used to determine the prescribed amounts and final concentrations.

To prepare internal standards (IS) the prescribed amounts of neat material and 50 µL of water are spiked into a Tedlar bag containing 10.0 L of nitrogen. The contents of the Tedlar bag are transferred into an evacuated 6 L Summa canister, pressurized, and diluted. A 1.0 mL of the internal standard blend is injected into the canister interface as each standard, blank, and sample is being loaded. The final concentration is 25 ppbv for each of the following:

bromochloromethane
chlorobenzene-d_5
1,4 -difluorobenzene

The internal standards' retention times for the blanks and samples must be within ±0.5 min (30 s) of the retention times in the continuing calibration check. In addition, the IS area must be within ±40 percent of the continuous calibration verification's (CCV's) IS area for the blanks and samples. A warning limit of ±30 percent is used to investigate possible mis-injection of the IS. If the ISs for the blank do not pass the acceptance criteria, the system is inspected and the blank reanalyzed. Analyses are discontinued until the blank meets the IS criteria.

If the ISs in a sample do not pass the acceptance criteria, the sample must be reanalyzed unless obvious matrix interference is documented. If the ISs are within limits in the re-analysis, the second analysis will be reported. If the ISs are out-of-limits a second time, then the data is reported from the first analysis and the matrix effect narrated in the laboratory narrative included with the report.

A humidified blank (less than 20% relative humidity at 25 °C) is analyzed after each CCV sample run: (1) At the beginning of the analytical shift or sequence (when an initial calibration is not being performed); (2) every 12 hr of analyses or every 20 samples, whichever comes first; and (3) at the end of the analytical sequence. A blank is also analyzed in the event saturation-level concentrations are incurred to demonstrate that contamination does not exist in the chromatographic system.

The acceptance criteria for the concentration of each target analyte in each blank must be less than the greater of (1) the reliable detection limit (RDL) for the target analyte; (2) the method reporting limit (MRL) when the MRL is not greater than 5% of the project and analyte specific action level, (3) 5 % of the analyte concentration detected in each associated field samples; and (4) 10% of the action level. Environmental sample detections greater than the MRL but less than 10 times the corresponding blank detections should be qualified. The following definitions and procedures are used to quantify the acceptance criteria.

The RDL is the upper 95% upper confidence limit of the method detection limit (MDL). The MDL is the minimum concentration of a substance that is significantly greater than zero (an analytical blank) at the 99% limit of confidence and is determined using the procedure described in 40 CFR, Part 136, Appendix B.

The MRL is the threshold or censoring limit below which target analyte concentrations are reported as " < MRL" where "MRL" is the numerical value of the method reporting limit. The MRL is usually established by contract and is based on the laboratory's limits of identification (LOIs), method quantitation limits (MQLs), or project-specific action levels. The MRL for undetected analytes should not be less than the LOI or RDL and must not be greater than the action level.

The LOI is the lowest concentration of analyte that can be detected with 99% confidence; that is, the LOI is the concentration at which the probability of a false negative is 1%. The LOI is adjusted for method specific factors (e.g., sample size) and may be approximated as twice the detection limit. The LOI may be set equal to about two times the MDL (e.g., if it is assumed that the standard deviation is not strongly dependent upon concentration).

The MQL is the concentration of an analyte in a sample that is equivalent to the concentration of the lowest initial calibration standard adjusted for method specified sample weights and volumes (e.g.,

extraction volumes and dilutions). Typically, MQLs are equal to or greater than the lowest initial calibration standard and are at least five times greater than the MDL. MQLs must also be less than project-specific action levels. It is usually desirable for the MQL to be equal to some fraction of the project's action levels (e.g., one half or one third of the action levels).

A duplicate sample analysis will be performed on 10 percent of the samples at the laboratory. The relative percent difference between the two analyses must be less than or equal to 25 percent for all compounds detected at greater that 5 times the detection limit. If this limit is exceeded, the sample will be re-analyzed a third time. If the limit is exceeded again, the cause is investigated and the system brought back to working order. If no problem is found in the system, the data will be flagged to note the non-conforming event.

A mid-level spike (laboratory control sample using a subset of the independent source standard) is analyzed daily prior to sample analysis. If the site specific criteria are not meet, the system is checked and the standard re-analyzed. In the event that the criteria cannot be met, the instrument is recalibrated.

The calibration for meta and para-xylenes will be performed using only the meta-xylene isomer because the two isomers co-elute on the GC column and have identical ion spectra and response factors. The IS mix will consist of bromochloromethane, 1,4-difluorobenzene and chlorobenzene-d_5, each at approximately 1 ppmv. Twenty-five mL of the internal standard mix, equivalent to a 25-nL standard, will be added to all samples and standards. The targeted standard concentrations and quantitation ions that will be used are listed in Table B- 5.

Mass spectrometer tuning will be performed and checked daily. Seven mL of p-bromo-fluorobenzene (BFB) at 1 ppmv, equivalent to about 50 ng of BFB, will be analyzed to validate the mass spectrometer tuning. The specific mass number that the instrument will be tuned to is laboratory specific. This number will be provided in the site-specific QAPP.

VOCs in the samples will be identified and quantitated using ChemStation software. This software uses reconstructed and extracted ion chromatograms matched with retention time windows to identify and quantify target compounds. The report prints the identified compound, calculated concentration, mass spectra (both raw and background subtracted), quantitation, and qualifier ion chromatograms. The spectra of all non-target compounds with a peak area of at least 20 percent of the nearest internal standard in the total ion chromatogram will be compared to the NIST Mass Spectral Database. The summaries will contain the best match provided by the computer search algorithm and an estimated amount for each tentatively identified compound. The tentatively identified compounds produced by this automated search will be found in the library search compound (LSC) report.

Table B-5. Target Calibration Concentrations and Quantitation Ions for COPCs.

Compound	Quant. Ion	Concentration
Working Calibration Standard		
1,1-Dichloroethane	63	1.00 ppmv
1,2-Dichloroethane	62	1.00 ppmv
1,1,1-Trichloroethane (methyl chloroform)	97	1.00 ppmv
1,1,2-Trichloroethane	97	1.00 ppmv
1,1-Dichloroethene (vinylidene chloride)	61	1.00 ppmv
cis-1,2-Dichloroethene	96	1.00 ppmv
trans-1,2-Dichloroethene (ethylene Dichloride)	96	1.00 ppmv
Acylonitrite	53	1.00 ppmv
Benzene	78	1.00 ppmv
Carbon Terrachloride	117	1.00 ppmv
Chlorobenzene	112	1.00 ppmv
Chloroethane (ethyl chloride)	64	1.00 ppmv
Chloroform	83	1.00 ppmv
Chloromethane (methyl chloride)	50	1.00 ppmv
Dichlorobenzene	146	1.00 ppmv
Dichlorodifluoroethane	85	1.00 ppmv
Ethylbenzene	91	1.00 ppmv
Ethyl chloride	64	1.00 ppmv
Ethylene Dibromide	107	1.00 ppmv
Methylene Chloride	49	1.00 ppmv
Tetrachloroethene (Perchloroethylene)	166	1.00 ppmv
Toluene	92	1.00 ppmv
Trichloroethene (Trichloroethylene)	130	1.00 ppmv
Vinyl chloride	62	1.00 ppmv
M - Xylene	91	1.00 ppmv
o-Xylene	91	1.00 ppmv
P-xylene	91	1.00 ppmv
Internal Standard		
Bromochloromethane	128	1.00 ppmv
1,4-Difluorobenzene	114	1.00 ppmv
Chlorobenzene-d_5	117	1.00 ppmv
Tuning Standard		
4-Bromofluorobenzene	N/A	1.00 ppmv

Detection limits are determined by analyzing a low level standard (1 to 5 µg/ml). The limit of quantitation (*LOQ*) for each sample analyzed via TO-15 is calculated using

$$LOQ = (OC)(DF)$$

Where: LOQ = Results (parts per billion by volume in sample),
OC = parts per billion by volume on-column from the MDL
DF = Dilution factor

The target compound results will be calculated using

$$R_C = \left(\frac{A_C}{A_{IS}}\right)\left(\frac{C_{IS}}{I_{CAL-RRF}}\right)$$

Where R_C = Results concentration (parts per billion by volume on-column),
A_C = Area of compound in sample,
A_{IS} = Area of internal standard in sample,
C_{IS} = Concentration of the internal standard (ppbv), and
$I_{CAL\text{-}RRF}$ = Initial calibration relative response factor.

Then

$$R = (R_C)(DF)$$

Where R = Results (parts per billion by volume in sample)
DF = Dilution factor.

Dilution factor includes canister pressurization dilution and any subsequent dilution required to ensure all results are within the instrument calibration range.

An OVA will be used to screen the landfill for methane and non-methane organic carbon vapors. This instrument will be calibrated using methane and ethane in air standards. An initial calibration using zero air and two upscale standards (500 to 100,000 ppmv) will be completed twice each field day. Following this calibration, the OVA will be single-point checked daily with a mid-level (100 to 500 ppmv) methane or ethane standard as appropriate.

The following QA/QC procedures will be performed for this project.

- The Agilent GC/MS will be tuned daily for perfluorotributylamine (PFTBA) to meet abundance criteria for p-bromofluorobenzene as listed in EPA Method 624. Tuning results will be included in the calibration data section. The tune will be adjusted when necessary.
- Initial calibrations will be performed. All compounds must meet the acceptance criteria of having a correlation coefficient greater than 0.95.
- Continuing calibrations will be performed. All compounds must meet the acceptance criteria

of having a percent difference (%D) of less than or equal to ±25 percent.

- Five instrument blanks will be analyzed after the calibration standard(s) and before samples will be analyzed. Blank analyses will be performed after samples with high VOC concentrations to check for carryover and to ensure that the GC/MS system was clean.
- Sample container blanks will be collected daily and analyzed for the COPC-TAL.
- Known concentrations of the gas standards will be used to generate a 2-point calibration for nitrogen and oxygen, and a single-point calibration for carbon dioxide. A Scott Specialty Gas standard, containing 15 percent methane, 5.01 percent oxygen, 4.99 percent nitrogen, and 49,600 ppm carbon dioxide will be used for the level 1 calibration. Ambient air, with a concentration of 20.950 percent oxygen and 78.080 percent nitrogen (Reference: Handbook of Chemistry and Physics) will be used for the Level 2 calibration for oxygen and nitrogen. A Scott Specialty Gas standard containing 10,100 ppm carbon dioxide will be used as a check standard to validate the carbon dioxide calibration. The procedure may be changed to a single-point calibration for oxygen and nitrogen using ambient air as the standard and the 10,100 ppm carbon dioxide standard if the oxygen and nitrogen content of all of the initial samples are very close to the amounts found in ambient air and samples containing the most carbon dioxide had levels relatively close to the 10,100 ppm carbon dioxide standard.
- Approximately 5 percent duplicate samples will be collected and analyzed.
- Approximately 5 percent split replicate analyses will be performed.
- Periodically throughout each sampling day (once every 20 samples at least), calibration standards will be injected and the performance of the instrument noted. The instrument will be recalibrated as required.
- To ensure the system is clean prior to analysis, the columns will be baked over night prior to each day of analysis. Ambient air samples will be analyzed after each initial calibration.

Target compound results will be reported in tabular form. Analytical results will be reported in parts per billion by volume.

The calibration package for each day of analysis will be included in an appendix to the laboratory report. This package will include copies of the injection logbook, BFB tune, and the initial and the continuing calibration quantitation report. The quantitation report will list the retention time, quantitation ion, peak area, and amount in nano liter. Amounts listed on these quantitation reports will be generated by using the linear regression plot of the initial calibration. The calibration plots will also be included in an appendix. Quantitation reports for the blanks and samples will also be found in an appendix. Quantitation will only be interpolated between calibration standards. Extrapolation below or above the calibration standard will not be done. The lower calibration standard will be at the MDL as established by the individual laboratory. The COC forms will be in an appendix.

The following is a list of the QA/QC flags that may be used in qualifying the results:

A - Assumed volume for the method blank,
B - Concentration less than three times the reported blank result,
C - Compound calibration relative standard deviation (RSD) greater than 30 percent (concentrations calculated by average response factor only),
D - Compound calibration check relative percent deviation greater than 25 percent,

E - Concentration exceeded highest calibration level,
J - Below quantitation limit,
U - Not detected at or below the LOQ,
I - Concentrations are estimated due to interference, and
R - Data unusable, narrative provided in summary report.

A formal calibration program is essential for verifying that the instruments and equipment are working properly and are capable of producing quality data.

The two basic types of calibrations are periodic and operational. Periodic calibration is usually applied to apparatus such as thermometers, balances, ovens, and pipettes that do not directly produce an analytical result. Periodic calibrations are performed on a specific time schedule regardless of the frequency of use of the apparatus. Operational calibration applies to analytical instruments and manual analyses. Operational calibrations precede each use of the instrument and are performed during use at frequencies defined in the test method. Each participating laboratory is expected to have a QA plan that addresses operational and periodic calibrations, maintenance, and documentation procedures and requirements.

Bench analysts are responsible for ensuring that their analyses are performed under valid calibrations.

- Balances
  A qualified and experienced technician will examine and calibrate if needed, analytical and top-loader balances annually. Calibration will be verified daily or before each use.
- Refrigerators and Freezers
  The temperature of refrigerators and freezers used for storing samples and extracts must be monitored daily. Nongaseous samples must be stored at 4±2 °C. Organic standards are maintained at -10 to -20 °C. Summa cannister will be stored at ambient temperatures.
- Ovens
  The temperatures of ovens used for sample analysis must be monitored daily.
- Thermometers
  Thermometers must be checked upon receipt and annually thereafter against a NIST-traceable thermometer over the range at which they are to be used. Those differing more than 2°C from true are returned (if new) or discarded.
- Micro pipettes
  Micro pipettes are used for preparing dilutions of calibration solutions and samples and for adding reagents and spiking solutions during analysis. Micro pipettes must be calibrated upon receipt, monthly thereafter, and after maintenance. The pipette is repaired or discarded if its delivery volume is greater than ±5 percent of the true value.

Equipment that fails calibration or becomes inoperable during use will be removed from service, segregated to prevent inadvertent use, and tagged to indicate it is out of calibration. Such equipment will be repaired and recalibrated to the satisfaction of the field team supervisor, as appropriate. Equipment that cannot be repaired must be replaced. Results of activities performed using equipment that has failed recalibration will be evaluated by the involved QA personnel or site supervisor, as appropriate. The results of the evaluation will be documented and appropriate personnel will be notified. Scheduled calibration of measuring and test equipment does not relieve any personnel of the

responsibility of using properly functioning equipment. If an equipment malfunction is suspected, the device will be tagged and removed from service or recalibrated as needed.

Records will be prepared and maintained by the individual laboratory in accordance with its QA plan, for each piece of calibrated measuring and test equipment and each piece of reference equipment, to indicate that established calibration procedures have been followed. Records for equipment used only for a specific project will be maintained in the project files.

B.8 Inspection and Acceptance Requirements for Supplies and Consumables

It is the responsibility of the equipment and supply manager to secure all the equipment, supplies, and consumables necessary to conduct the monitoring, sampling, and analytical methods described in Sections B.1 through B.4. Each of the participants in this study will have a document system that is designed to assure that equipment and supply specifications are developed in accordance with the methods and procedures needed to meet the project objectives. The system should:

- Determine technical and quality requirements for all supplies and consumables by evaluating task order requirements, applicable or relevant and appropriate technical requirements, contract requirements, and other issues or documents identified.
- Determine if acceptance testing should be performed based on findings of the technical review.
- Determine acceptability of leased, rented, or purchased items based on findings of the quality review.
- Arrange and documenting acceptance testing, if required.
- Handle any nonconforming items.
- Procure equipment, supplies, and consumables that meet established technical and quality requirements.
- Track and verify the quality of the required equipment, supplies, and consumables.
- Maintain required documentation to ensure the quality and adequate technical performance of all equipment, supplies, and consumables.

Prior to mobilizing, a packing list of the equipment and consumables being used at the site for field sampling, monitoring, or on-site analysis will be sent to the QC officer for review and approval. The list will include as appropriate:

- Size, type, and number of sample containers,
- Model number(s) of instruments being used for screening the landfill for methane and NMOC contaminants,
- Quantities and characteristics of calibration and span gases or solutions,
- Quantities and characteristics of spiking material, and
- Log book assignments by person and serial number.

The QC officer will compare the list of equipment and consumables to those required by the methods and the QAPP.

B.9 Indirect Measurements

Sources of previously collected data and other information must be clearly identified to establish acceptance criteria for use of such data as well as limitations resulting from uncertainty in its quality. Information that is nonrepresentative and possibly biased and is used uncritically may lead to decision errors. Acquired data may include but are not limited to

- Data from handbooks,
- Historical information,
- Computerized databases,
- Site-specific parameters, and
- Maps, drawings, photographs.

Indirect measurement data must be developed to support data QA objectives. Acceptance criteria for each collection of data for use has been determined with respect to

- **Representativeness.** To be assessed qualitatively by verifying that the site-specific information was developed in a systematic and documented manner. Comparability is being ensured by the use of the same reporting units and normalization of the information. Comparison of the laboratory and monitoring data generated by this project with historical data is not a significant factor.
- **Bias.** To be assessed by checking the available records for statements concerning bias. For example, if the percent recovery for matrix spike samples has been used to indicate that the historically reported concentrations for chemicals of potential concern are biased low, the decision to exclude a chemical from the site-specific COPC-TAL would be erroneous, and the risk would be underestimated. Similarly, if the reported concentration data is biased high, the decision to include a specific COPC on the TAL would be erroneous and resources spent on unnecessary sampling and analysis would be wasted. Site-specific COPC-TAL will be established prior to mobility for field work. Time and budget constraints will be a dominant factor in selecting the COPC-TAL.
- **Precision.** To be assessed by checking the available records for statements concerning precision. If the relative standard deviation or coefficient of variance for the historical data used to characterize the COPC concentrations is high, the number of samples or the density of the sample grid could be erroneous, and an inadequate number of samples would be collected. Similarly, if the precision is low, the number of samples and the density of the sample grid would need to be increased, and the costs for sampling and analysis would be increased unnecessarily. The sample density will be established prior to mobility for field work. Time and budget constraints will be the dominant factor in selecting the number of samples to be collected and analyzed.
- **Qualifiers.** To be assessed by checking the available records for statements concerning the usability and limitations of the results. Clearly, any data that has been previously rejected will not be used. Absent clear indications that the data quality is questionable or must be restricted, the data will be used as if it is correct and the best available.
- **Summarization.** The data will be summarized and normalized to the extent reasonable and possible. Normalization will be achieved by using common units of measure. The data quality objective achieved would be compared to the objectives for accuracy, precision, completeness, and detection limits specified herein.

Use of indirect data will be limited when found to not meet acceptance criteria. The impact of results on DQOs with respect to the environmental decision will be reviewed to determine requirements for qualification or replacement of results.

B.10 Data Management

This section describes the procedures and criteria for recording, validating, and reporting data. Several types of data will be generated and reported during this program. As part of the QC effort, the field team leader and the QC officer will verify that persons responsible for data entry (electronic and manual) are being careful. Periodic observations will be made to assure that accurate data recording is achieved. The electronic data will be in the form of digital data files created by the data acquisition system. Backup copies of the electronic files will be created daily. The integrity of the raw data files is to be maintained, so all data manipulation will be performed on a copy of the raw data file.

Much of the data will be generated on site; therefore, these parameters will be recorded and validated on a semi-continuous basis during the monitoring program. This activity will consist of ensuring that data calibrations are kept current, that data are continuously recorded in the proper format, and that any problems are properly and expeditiously recorded. An on-site computer will be used to help process and archive the data produced during the field sampling effort. The site-specific QAPP will identify the type of computer and software needed to interface with the instrumentation being used in the field. Data loggers will be used to the extent possible in order to minimize data entry errors. This will help ensure that all the samples scheduled are collected and that the data collected during this program is properly handled.

Following field collection of data, all electronic data collected will be stored in a central project file server for security and retrieval in its original form (as collected) and in its modified form (following data validation and reevaluation). Those items not in electronic form will be filed in a central project filing system at the contractor's project office and in accordance with the contract agreement between the EPA and contractor that authorizes the work.

Analytical Data Handling

Specific data recording and validation resulting from analytical procedures as described in Sections B.2 through B.4 will be recorded by the generating laboratory and will be included with the laboratory report and records being stored by the contractor. These records will be available upon request of the TOM for a period of 3 years.

On-Site Data Handling

The data generated while on site will all be real-time or semi real-time; care must be exercised to ensure that all the data are being properly recorded and that accurate records are kept of all on-site activities. All on-site data will be kept on formatted data sheets and in bound logbooks. Where possible, instrument data loggers will be used that can then be downloaded through an RS-232 port directly into the on-site computer system. Logbook entries will be made in ink, and separate notebooks or notebook sections will be set aside for the various parameters. All supporting data generated will be well documented regarding where the data were collected, the landfill section, grid number or vent identification number or identifier, time and date the data were collected, and any other supporting documentation. Microsoft Office software is the platform of choice for recording and archiving electronic field data. The field team leader and the QC officer will verify that persons responsible for data entry are being careful. Periodic observations will be made to assure that accurate data recording is being achieved. The field team leader or the QC officer will determine twice a day

if corrective actions are required.

The on-site data validation procedures focus mainly on ensuring good accurate data collection and identification. In addition, instrument calibration will be regularly checked and compared with previous calibration data to determine if there is any change or drift in these data. Duplicate sample measurements will be evaluated to ensure that the instruments are operating properly and reproducibly. If discrepancies in instrument operation are noted, the data will be flagged accordingly.

ELEMENT C. ASSESSMENT AND OVERSIGHT

The purpose of assessment is to ensure that the QAPP is implemented as prescribed. This section addresses tools and procedures for assessing the effectiveness of implementation of the project and associated QA/QC.

C.1 Assessments and Response Actions

Performance and system audits of both field and laboratory activities may be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the QAPP. The audits of field and laboratory activities include two separate independent parts: internal and external audits.

Internal audits of field activities (sampling and measurements) will be conducted by the contractor's QA officer. The audits will include examination of field sampling records, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, COC, and so forth. These audits will occur during the first two days of the field work being completed on a site-by-site basis of the project to verify that all established procedures are followed. Upon detection of a deficiency, the auditor has the authority to stop work being conducted with the notification of the project manager and TOM in order to determine and implement corrective action. Follow-up audits will be conducted to correct deficiencies and to verify that QA procedures are maintained throughout the project. The audits will involve review of field measurement records, instrumentation calibration records, and sample documentation. A summary of general considerations for field audits is presented in Figure C-1.

External field audits may be conducted by the U.S. EPA Office of Research and Development National Risk Management Research Laboratory's Air Pollution Prevention and Control Division. These audits may be conducted anytime during the field operations. These audits may or may not be announced and are at the discretion of the U.S. EPA. External field audits will be conducted according to the field activity information presented in the QAPP.

I. Sample Collection
- Work Plan Adherence
- Proper Documentation
  - Sample matrix
  - Location
  - Volume
  - Analysis requested
  - COC

II. Sample Storage and Shipment
- Proper Containers and Preservative
- Samples Refrigerated/Iced

III. Decontamination
- Equipment
  - Protective
  - Sampling
  - Large (backhoes, drill rigs, etc.)
- Proper Solutions Used
- Disposal Procedure

IV. Safety
- Proper Level of Protective Clothing
- Site Health and Safety Plan Present
- Monitoring Equipment
- First Aid Accessibility

V. Quality Control
- DQOs
- SOPs for Sampling
- Work Plan Availability
- Weather Conditions Affecting Sample Quality

Figure C-1. Field QA/QC Audit Outline.

The **internal performance** and **system audits** of an analytical laboratory may be conducted by the contractor's QA officer or authorized QA chemist. Internal performance and system audits are not currently anticipated. The system audits may be conducted on an as-requested basis if QC problems are suspected and will include examination of laboratory documentation on sample receiving, sample log-in, sample storage, COC procedure, sample preparation and analysis, instrument operating records, and so forth. Blind replicate QC samples may be collected and submitted to the laboratory concurrently with the project samples. The QA officer will evaluate the analytical results of these blind performance samples to ensure the laboratories maintain acceptable performance. A summary of general considerations for laboratory audits is presented in Figure C-2. Upon detection of a deficiency, the auditor has the authority to stop work being conducted with the notification of the project manager and TOM in order to determine and implement corrective action.

I. Sample Receipt
   - COC
   - Adequate Facilities

II. Sample Storage
   - Controlled Access
   - Proximity to Chemical Storage
   - Physical Conditions
   - Holding Times

III. Sample Work and Analysis
   - SOPs
   - Adequate Facilities
     - Organized work space
     - Proper ventilation
     - Minimized contamination
   - Notebooks
   - Logbooks
     - Sample and standard preparation
     - Instruments - sample analysis
     - Calibration - tune
     - Check samples
     - Balance
     - Temperature

IV. QC Samples
   - Blanks
   - Spikes
   - Duplicates
   - Surrogates
   - Control charts

V. Lab Organization
   - Internal QA Program
     - Written QA Plan
     - Internal Audit
   - Data Handling and Review
   - Data File Storage
     - Hard Copies
     - Other Media
   - Lab Capacity

Figure C-2. Laboratory QA/QC Audit General Considerations.

Corrective actions may be required for two classes of problems: analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for completing a Nonconformance Report and notifying the project manager. If the problem is analytical in nature, information on these problems will be promptly communicated to the QA officer. Implementation of corrective action will be confirmed in writing through the same channels and by completing a Corrective Action Report. Figure C-3 presents a sample corrective action report.

Any nonconformance with the established QC procedures in the site-specific QAPP will be identified and corrected. The project manager, TOM, laboratory manager or RPM or their designee will issue a Nonconformance Report for each nonconforming condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings to the field team manager. If corrective actions are insufficient, work may be stopped by stop-work order by the project manager, laboratory manager or the TOM.

Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the project manager or designee. This manager will be responsible for assessing the suspected problems in consultation with the project QA officer on making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the manager.

The project manager will be responsible for ensuring that corrective action for nonconformances are initiated by:

- Evaluating all reported nonconformances,
- Controlling additional work on nonconforming items,
- Determining disposition or action to be taken,
- Maintaining a log of nonconformances,
- Reviewing nonconformance reports and corrective actions taken, and
- Ensuring nonconformance reports are included in the final site documentation in project files.

If appropriate, the project manager will ensure that no additional work dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include:

- Repeating the measurement to check the error,
- Checking for all proper adjustments for ambient conditions such as temperature,

Corrective Action Report

Date: _____ Job Name: _____
Name: _____ Title: _____

Description of Problem:

_____
_____
_____
_____
_____

Reported to:
Name: _____ Title: _____

Corrective Action:

_____
_____
_____
_____
_____

Reviewed and Implemented by:
Name: _____ Title: _____

Six-Week Follow-up Performed by:
Name: _____ Title: _____

cc: project manager
QA officer
Project Activity Log

Figure C-3. Sample Corrective Action Report.

- Checking the batteries,
- Recalibrating,
- Checking the calibration,
- Replacing the instrument or measuring devices, or
- Stopping work (if necessary).

The laboratory manager or his designee is responsible for all on-site activities of the project team. In this role, the laboratory manager is required to adjust the activities and schedule to accommodate site-specific needs. When it becomes necessary to modify a QAPP, the responsible person notifies the TOM of the anticipated change and implements the necessary changes after obtaining the approval of the TOM. The change in the program will be documented on a field change request (FCR) signed by the initiators and the project manager. The FCR for each document will be numbered serially. The FCR shall be referenced in the field team manager's log book, and they will be transported to the project record office for filing and storage. Figure C-4 presents a sample FCR. The TOM must approve the change in writing, if feasible, or verbally prior to field implementation. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The project manager is responsible for controlling, tracking, and implementing the identified changes. Reports on all changes will be distributed to all affected parties, which includes the TOM, laboratory manager, contractor project manager, and the contractor QA officer.

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is dependent on the analysis and the event. Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the warning or acceptable windows for precision and accuracy;
- Blanks contain target analytes above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA Department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors and checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager, or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the QA department.

The contractor QA officer also may request corrective action for any contractual nonconformance identified by audits or data validation. The TOM may request corrective action by the laboratories for any nonconformances identified in the data validation process through the ERTC manager. Corrective action may include:

- Re-analyzing the samples, if holding time criteria permits,
- Resampling and analyzing,
- Evaluating and amending sampling procedures or evaluating and amending analytical procedures, or
- Accepting data and acknowledging the level of uncertainty.

E_Q

Field Change Request

Date:_____ Project No._____

Project Name:_____

Description of Change:
_____
_____
_____
_____

Initiator:_____ Date:_____

Reason for Change:
_____
_____
_____
_____

Approvals:

Field Team Leader: _____ Date: _____

QA officer: _____ Date: _____

Project manager: _____ Date: _____

Owner Representative: _____ Date: _____

Figure C-4. Sample Field Change Request.

If resampling is deemed necessary due to laboratory problems, the project manager must identify the necessary approach including cost recovery for the additional sampling effort.

C.2 QA Reports to Management

Periodic reports will be submitted by the QA officer. Table C-1 lists all QA reports to management.

Table C-1. QA Reports to Management.

Report	Frequency	Distribution	Comments
Progress	Monthly	TOM, Laboratory Manager, RPM, EPA QC Manager	Contains QA section where monthly activities are listed and includes any audits performed during the month and proposed corrective actions.
Quarterly QA	Quarterly	TOM, Laboratory Manager, EPA QC Manager	Summarizes status report of corrective actions initiated during the quarter.
Performance Self-Evaluation	As needed	TOM, Laboratory Manager, EPA QC Manager	Contains QA section outlining performance on all sites.
Lab Audit	As needed	TOM, Laboratory Manager, EPA QC Manager	Audit findings report including list of audit exceptions and rating of the laboratory following an on-site systems audit.
Data Validation	As needed	Laboratory Manager, TOM, RPM, EPA-QC Manager	Report summarizes the findings from the validation of a data package submitted by the subcontracted laboratory.

ELEMENT D. DATA VALIDATION AND USE

Data are reviewed and validated by the contractor's QA officer using the laboratory data validation guidelines established by the U.S. EPA in the reference titled "Laboratory Data Validation Functional Guidelines for Evaluating Organic/Pesticides and PCB's analyses" EPA/540/R94/090-092. Additional criteria may be deemed necessary by the EPA on a site-specific basis. These additional requirements will be listed in a site-specific QAPP, if needed.

D.1 Validation and Verification Methods

All samples collected at a project site will be analyzed on site or sent to the analytical laboratory that has been selected by ERTC in accordance with existing contract procedures.

The analytical laboratory will perform in-house analytical data reduction and verification under the direction of the laboratory manager. The laboratory QA officer is responsible for assessing data quality and advising of any data that were rated "preliminary" or "unacceptable" or other notations

that would caution the data user of possible unreliability. Data reduction, validation, and reporting by the laboratory(ies) will be conducted as follows:

- Raw data produced by the analyst is turned over to the respective area supervisor;
- The area supervisor reviews the data for attainment of QC criteria as outlined in established EPA methods and for overall reasonableness;
- Upon acceptance of the raw data by the area supervisor, a computerized report is generated and sent to the laboratory QA officer;
- The laboratory QA officer completes a thorough audit of reports at a frequency of one in ten, and an audit of every report for consistency;
- The QA officer and subject area supervisors decide whether any sample reanalysis is required; and
- Upon acceptance of the preliminary reports by the QA officer, final reports will be generated and signed by the laboratory project manager. The laboratory package shall be presented in the same order in which the samples were analyzed.

Data packages will be organized in accordance with the data package checklist and the data package inventory list (Figures D-1 and D-2). Then, data will be sent to the contractor project management office for data validation.

The contractor QA chemist will conduct a systematic review of the data to verify compliance with established QC criteria based on the spike, duplicate, and blank results provided by the laboratory. An evaluation of data accuracy, precision, sensitivity, and completeness based on criteria in Section B will be performed and presented in the site report.

The data review will identify any out-of-control data points and data omissions and interacts with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the TOM based on the extent of the deficiencies and their importance in the overall context of the project.

Validation will be accomplished by comparing the contents of the data packages and QA/QC results to the requirements contained in Office of Solid Waste and Emergency Response Directive 9360.4-01. Raw data such as GC/MS ion abundance chromatograms, GC chromatograms, and mass spectra, data reports, and data station printouts will be examined to ensure that reported results are accurate. The contractor QA officer will be responsible for this.

The quality of analytical data used throughout a project is determined by assessing the data usability and evaluating the compliance of the data with the analytical protocol. This is determined by assessing quantitative and qualitative quality control measures. Analytical data validation is a rigorous qualitative and quantitative assessment of the reported analytical data and provides an indication of the overall data quality for use in the decision making process. The data quality assessment is based on both an evaluation of the compliance to the method performance, reporting, and quality control criteria as well as on evaluation and interpretation of the QC measured and their impact on the usability of the results.

E_Q

DATA PACKAGE CHECKLIST

C.O.C.#_____ Laboratory:_____

I. GENERAL

_____ 1. All enclosed pages are legible, sequentially numbered, and easily identifiable.
_____ 2. There are no yellow sticky notes, tablet sheets, or other undocumented forms in the data package.
_____ 3. All required documents, including a completed chain of custody form are enclosed.
_____ 4. The data package is divided into sections that are clearly labeled for each analyte or method.

II. NOTEBOOK PAGES

_____ 5. All copies of notebook pages are identified by notebook number (if applicable) and page number.
_____ 6. All units are clearly defined.
_____ 7. Each page has been signed and dated by the analyst and reviewer.
_____ 8. All written explanations have all of the necessary information included and may stand alone as written.

III. CERTIFICATE OF ANALYSIS

_____ 9. The report sheet has been signed and dated by both the reviewer and the analyst.

IV. RAW DATA

_____ 10. All raw data (chromatograms, quant lists, other instrument output, etc.) has been labeled properly, signed, and dated by the analyst.

V. CORRECTIONS

_____ 11. No white-out or correction tape has been used on any raw data.
_____ 12. All cross-outs consist of only a single line, and have been initialed and dated.
_____ 13. All cross-outs have a **legitimate, sufficient, documented explanation**.

I have checked this report and data package to make certain that the above conditions are in compliance with the assigned data quality objective.

_____

Name Title Date

Data were obtained while the analytical process was in-control and met the agreed upon data quality objectives.

_____

Project Manager Date

Figure D-1. Data Package List.

E_Q

DATA PACKAGE DOCUMENT INVENTORY LIST

C.O.C.#_____ **Laboratory:**_____

If the listed document is in the data package, initial and indicate the page of the associated item:

Document	Page #	Initial
Narrative		
Review sign-off sheet		
Chain-of-custody sheet		
Methods used		
Sample results report form		
QA/QC results report form		
Copy of extraction and logbook pages		
Extraction / sample preparation bench sheets		
DFTPP 12 hour tuning and mass calibration report(s)		
BFB 12 hour tuning and mass calibration report(s)		
Initial calibration raw data		
Continuing calibration raw data		
Raw data for field, QC, and blank samples		
Check-standard results		
Chromatogram with peak indicated, dated and initialed		
Expanded scale blow-up of manually integrated peak		
Unknown report, library search, best-fit spectra		
Raw data for quantitated analytes		
Serial Dilutions		
Standard Methods		
Interference Check Standard		
Example calculations		

For Items that are not applicable note as N/A

I have checked this report and certify that the above items are present in the data package and are found on the associated page number.

_____ _____ _____

Name Title Date

Figure D-2. Data Package Document Inventory List

QA Level IA is a term to describe a data package standard that has neither definitive identification of pollutants nor definitive quantitation of their concentration level. It is used to determine a quick preliminary assessment of site contamination.

QA Level IB is a term to describe a data package standard that requires additional deliverables and further review of the data than a QA Level IA package. Laboratory precision and accuracy data are evaluated (through the use of summary forms) in this level to provide results that can be semiquantitative. It is used for analyte-specific site assessments.

The QC chemist is responsible for

- Reviewing faxed preliminary laboratory data to verify that requested methods were used, appropriate detection limits were achieved, sample identifications are correct, and the data was reported on time;
- Verifying completeness of package and reviewing calibration data, QC sample results, raw data (if applicable), and any problems identified by the laboratory;
- Contacting laboratory to recover items not found in the preliminary data check and maintaining communication with the laboratory as the need arises throughout the data validation procedure;
- Performing the data validation as outlined in Section 6.0 of this document and completing the Data Validation Checklist; and
- Completing the Validation Report that details and summarizes the findings of the data validation.

D.1.1 QA Level IA Data Validation

Once a final data package is received by the contractor, the QC chemist separates the package into sections and notes if any items are missing.

If items are missing from the data package, the laboratory is notified, and the missing items are requested to be sent the next business day.

Once the package is complete, the following items are reviewed:

- Chain-of-custody information,
- Sample results summary,
- Method references,
- Dates of extraction and analysis,
- Calibration summaries, and
- Surrogate recoveries.

The sample result certificates are copied and the originals are forwarded to the project manager along with a cover letter identifying the results of the QA IA validation.

D.1.2 QA Level IB Data Validation

All criteria in the QA Level IA Data Validation are reviewed; however, the following items in the data package are also evaluated:

- Matrix spike and matrix spike duplicate results,
- Sample duplicate results,

- Laboratory control sample results,
- Tuning criteria (if applicable),
- Internal standards results (if applicable),
- Method blank summaries, and
- Interference check sample results (if applicable).

The sample result certificates are copied and the originals are forwarded to the project manager along with a cover letter identifying the results of the QA IB validation.

Included in data validation of a sample set is an assessment of COC and associated field QC samples. COC must be maintained from point of sampling through laboratory analysis. Both field and laboratory COCs are reviewed and certified by the validator. Field QC samples are also reviewed, verified, and reported in the validation report. Field QC sample acceptance criteria are presented in Section B.

All data generated for the sites will be in a format organized to facilitate data review and evaluation. The computerized data set will include the data flags determined by data validation. The data flags will include such items as: (1) concentration below required detection limit, (2) estimated concentration due to poor spike recovery, and (3) concentration of chemicals also found in laboratory bank. The data reviewer comments will indicate that the data are: (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to out-of-control QC results.

The data set will be presented to the TOM and available for controlled access by the project manager and authorized personnel using a site-specific project number. The complete data set will be incorporated into the final site report.

D.2 Reconciliation with User Requirements

The purpose of data reconciliation is to determine if the data qualitative and quantitative are of the right type, quantity, and quality to support their intended use. To that end, evaluations will be performed by the contractor's data reduction and information specialist to reconcile data with the requirements defined by project specifications.

The data quality assessment (DQA) process is used to reconcile results with DQOs. By using the DQA process, decisions or estimates can be made with the desired confidence, and sampling design performance over a wide range of performance outcomes can be determined.

The DQA process involves five steps that begins with a review of the planning documentation and ends with an answer to the question posed during the planning phase of the study. These steps roughly parallel the actions of an environmental statistician when analyzing a set of data. The five steps are briefly summarized as follows:

1. Review the DQOs and Sampling Design Review the DQO outputs to ensure that they are still applicable. If DQOs have not been developed, specify DQOs before evaluating the data (e.g., for environmental decisions, define the statistical hypothesis and specify tolerable limits on decision errors; for estimation problems, define an acceptable confidence or probability interval

width). Review the sampling design and data collection documentation for consistency with the DQOs.

2. Conduct a Preliminary Data Review Review QA reports, calculate basic statistics, and generate graphs of the data. Use this information to learn about the structure of the data and identify patterns, relationships, or potential anomalies.
3. Select the Statistical Test Select the most appropriate procedure for summarizing and analyzing the data, based on the review of the DQOs, the sampling design, and the preliminary data review. Identify the key underlying assumptions that must hold for the statistical procedures to be valid.
4. Verify the Assumptions Verify the assumptions of the statistical test and evaluate whether the underlying assumptions hold or whether departures are acceptable, given the actual data and other information about the study.
5. Draw Conclusions from the Data. Perform the calculations required for the statistical test and document the influences drawn as a result of these calculations. If the design is to be used again, evaluate the performance of the sampling design.

These five steps are presented in a linear sequence, but the DQA process is by its very nature iterative. For example, if the preliminary data review reveals patterns or anomalies in the data set that are inconsistent with the DQOs, then some aspects of the study planning may have to be reconciled in Step 1. Likewise, if the underlying assumptions of the statistical test are not supported by the data, then previous steps of the DQA process may have to be revisited. The strength of the DQA process is that it is designed to promote an understanding of how well the data satisfy their intended use by processing it in a logical and efficient manner.

Nevertheless, it should be emphasized that the DQA process cannot absolutely prove that one has or has not achieved the DQOs set forth during the planning phase of a study. This situation occurs because a decision maker can never know the true value of the item of interest. Data collection only provides the investigators with an estimate of this, not its true value. Further, because analytical methods are not perfect, they too can only provide an estimate of the true value of an environmental sample. Because investigators make a decision based on estimated and not true values, they run the risk of making a wrong decision (decision error) about the item of interest.

For this project, the qualitative objectives are to determine if LFG controls are needed. This generic QAPP and the site-specific QAPPs result from the systematic planning process and contain information needed to carry out the data gathering and meet the DQOs. Combined with the likely variability of emissions and the proximity to off site structures, the threshold of what will qualify as significant will be determined by the RPM. Based on these premises, quantitative objectives are established for critical measurements in terms of data quality indicators goals for accuracy, precision, and completeness. The target acceptance criteria for these indicators are included in Tables A-5, A-6, and A-7.

APPENDIX A

SITE I SPECIFIC QAPP

(TO BE DEVELOPED BY THE RPM)

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/R-05/123b		

4. TITLE AND SUBTITLE	5. REPORT DATE
Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities: Appendix C	September 2005
	6. PERFORMING ORGANIZATION CODE
7. AUTHORS	8. PERFORMING ORGANIZATION REPORT NO.
Thomas Robertson and Josh Dunbar	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT NO.
Environmental Quality Management, Inc. 3325 Durham-Chapel Hill Boulevard Durham, North Carolina 27707-2646	11. CONTRACT/GRANT NO. 68-C-00-186, Task Order 3
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
U. S. EPA, Office of Research and Development Air Pollution Prevention and Control Division Research Triangle Park, North Carolina 27711	Final: 14. SPONSORING AGENCY CODE EPA/600/13

15. SUPPLEMENTARY NOTES

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16. ABSTRACT

The report provides guidance to superfund remedial project managers, on-scene coordinators, facility owners, and potentially responsible parties for conducting an air pathway analysis for landfill gas emissions under the Comprehensive Environmental Response, Compensation, and Liability Act, Superfund Amendments and Reauthorization Act, and the Resource Conservation and Recovery Act. The document provides procedures and a set of tools for evaluating LFG emissions to ambient air, subsurface vapor migration due to landfill gas pressure gradients, and subsurface vapor intrusion into buildings. The air pathway analysis is used to evaluate the inhalation risks to offsite receptors as well as the hazards of both onsite and offsite methane explosions and landfill fires Summary examples of the application of these procedures and tools to three Superfund sites are included.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Pollution Control	13B
Landfills	Stationary Sources	13C
Emissions		14G
Methane		07C
Organic Compounds		
Toxic Chemicals		07D

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