DEPARTMENT OF
ECOLOGY
State of Washington

Quality Assurance Project Plan

Washington State Compost Facilities

Nuisance Odors and Air Toxics from Composting

Discrete Ambient and Source Air Sampling

June 4, 2013

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Publication Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

The plan for this study is available on Ecology's website at:
https://fortress.wa.gov/publications/SummaryPages/1307028.html

Author and Contact Information

John Cleary
P.O. Box 47600
Waste 2 Resources Program
Washington State Department of Ecology
Olympia, WA 98504-7710

This plan was prepared by a licensed civil engineer. A signed and stamped copy of the report is available upon request.

For more information contact: Communications Consultant, phone 360-407-6834.

Washington State Department of Ecology - www.ecy.wa.gov/

o Headquarters, Olympia	360-407-6000
o Northwest Regional Office, Bellevue	425-649-7000
o Southwest Regional Office, Olympia	360-407-6300
o Central Regional Office, Yakima	509-575-2490
o Eastern Regional Office, Spokane	509-329-3400

Quality Assurance Project Plan

Washington State Compost Facilities
Nuisance Odors and Air Toxics from Composting
Discrete Ambient and Source Air Sampling

June 4, 2013

Approved by:

Signature:	Date:
John Cleary, Author / Engineer, W2R	
Signature:	Date:
Wayne Krafft, Author's Section Manager, W2R	
Signature:	Date:
Richard Hibbard, Ecology Air Quality Engineer	
Signature:	Date:
Bill Kammin, Ecology Quality Assurance Officer	

Signatures are not available on the Internet version.
W2R: Waste 2 Resources Program
EIM: Environmental Information Management database

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Abstract

W2R proposes this work to create enforceable emission standards and monitoring methods for odors and air toxics at compost sites. The monitoring procedure will be used for air quality and solid waste permitting, technical assistance and policy development.

There are growing public complaints and concerns with air emissions from compost sites. Both nuisance odors and toxics are regulated air emissions, yet the regulations fail to specify the odor nuisance level and means of monitoring odors. Nuisance odors and toxic air emissions from compost sites vary by feedstock, weather and processing. Whether an odor is a nuisance may vary among people exposed. Toxics may not have odors, and odors may not be toxic.

The proposed work includes collecting air and flow rate samples from twelve locations at one compost facility. The sample locations include: one upwind, one downwind, two in the community where data shows high odor complaints, two from the feedstock area, two from the biofilter, two samples from Phase I and two samples from Phase II. Phase I includes the first two weeks of composting and has the highest oxygen demand, temperatures, biological activity and odor potential. Phase II includes compost curing and has decreasing oxygen demands, temperatures and odor potential. The samples will be analyzed for ammonia, aldehydes, sulfur, volatile organic compounds (VOCs) and total odors. Ecology will also use field screening devices to see if odors can be monitored to prevent offsite nuisance complaints.

Ecology will find a site wide odor and toxic emission rate similar to sites regulated by air permits. Ecology will estimate the site wide emission by summing assumed process emissions based on this sampling effort. Then, Ecology will use air models to find the odor emission threshold that causes an offsite nuisance. Last, Ecology staff will produce a report on odor and toxic emission rates and field screening methods for different compost process areas.

Background

In June 2011, Ecology sampled compost emissions at two compost facilities; one facility on the west side and one on the east side of Washington. Both facilities volunteered to have Ecology sample at their sites. Because of the limited samples collected in this screening, results cannot be used to conclude that a site has an odor or toxicity problem. However, the results do give Ecology a snap-shot of what may be happening at large facilities that compost food waste and yard debris. It also provides baseline information which may inform the compost rule revision, and will help guide further study.

Results from the June 2011 sampling event are consistent with research, showing that compost emissions are highest in the first two weeks after arriving onsite because Feedstocks have the highest nutrient concentrations and energy at delivery. Figure 1 below shows the method used for the June 2011 emission sampling event.

Figure 1 - Flux chamber emission sampler

Composting stabilizes organic material by enhancing aerobic breakdown to more stable compounds. Composting may not have created the odors and toxics found; the odors may have been brought onsite from materials waiting for pickup. But, once onsite the facilities need to control the odors and toxics from the feedstocks.

The listed toxics found above de minimus in the June 2011 event are ammonia and the volatile organic compounds benzene, ethylbenzene, formaldehyde, acetaldehyde, and the semi-volatile organic compound naphthalene. Benzene and ethylbenzene likely did not result from the composting process, but may have been brought in on feedstocks and resulted from leaky mowers or shredders. Acetaldehyde is a compound created when food waste decomposes. The odor result for the covered compost pile and primary biofilter at the west side site were unexpectedly high. The odor from the biofilter sample may be due to the fact that the biofilter was in the first month of use. Emission rates may be compared to published emission rates for other compost facilities. But, emissions vary from each site due to feedstocks, processing methods and weather patterns.

Both facilities use best available control technology (BACT) to control toxics and odors according to air permits. Strong odors and relatively high levels of toxics were not always measured in the same samples. Also, relatively high ammonia results were not always found with other elevated toxics. The results provided in this report are statistically insufficient to conclude that an odor or toxic problem exists.

The results in micrograms per cubic meter (ug/m^3) were multiplied by the flow rates at the location sampled to get a theoretical mass loading rate to the atmosphere. The mass loading rates were multiplied by the surface area of the composting process that the sample represents. See the table below for the mass loading rates.

Advection and diffusion will impact pollutant fate and transport. For this study, Ecology intends to sample locations with average pile flow rates. The pile does not have uniform emissions across its surface area so it will be pre sampled for flow rate at 10 locations. Pollutant sampling will be performed at the three areas that have flow rates closest to the average flow rate generated in the pre sampling exercise. The purpose of selecting the sampling locations using this approach is to aid in the quantification of horizontal emissions when considering advection. For more information on advection and diffusion please see https://ceprofs.civil.tamu.edu/ssocolofsky/cven489/Downloads/Book/Socolofsky_Jirka.pdf .

The results do not reflect total emissions for the facilities sampled or emissions from other facilities. Extrapolating a one hour, seasonal peak sampling event to a daily or annual mass loading rate across an entire process area is very rough estimate. The quantity and composition of feedstocks changes drastically throughout the year. Some compost facilities may not even take in feedstocks during the winter months.

Project Description

The purpose of the study is to guide regulation and technical assistance on composting emissions. The compost facility selected receives roughly 36 inches of average yearly precipitation. A team from Ecology and a subcontractor will conduct the sampling. The sampling will include air emissions sampling using a regulatory approved sampling approach, regulatory approved analytical methods. This effort will be coordinated with Puget Sound Clean Air Agency in an effort to address odor issues at compost facilities statewide.

The primary goal of the program is to identify odor and toxic air emissions from different compost processes, the facility property line and adjacent community. Since limited information is available on emissions of specific chemical compounds and odor from compost facilities, the focus of this work includes assessing odors and individual air compounds emitted from these facilities. Using the sample data, we will develop a facility emission and model those emissions from the facility. Ecology will use the modeled results to advise odor limits so that they don’t become a nuisance or health risk to surrounding areas. Waste streams coming into these facilities include: yard wastes, greenwaste, and/or food waste (residential and commercial).

Site History

Cedar Grove Composting (Everett, Washington)

Cedar Grove operates a compost facility in Everett that includes positively aerated heaps with a micropore membrane (Gore) gas treatment and negatively aerated feedstocks in a building with gas treatment through a conventional biofilter. They receive and process: yard waste or green waste, and residential and commercial food waste. These processes produce compost that is screened and sold as product. Other air emission sources on site include a tipping floor of un-ground feedstocks, ground feedstocks, and a leachate collection lagoon. The processes targeted for testing include:

- Phase I Gore Cover on newly formed piles (early heap)
- Biofilter for Primary
- Phase II compost piles (mid-cycle heaps)
- Upwind and downwind property lines
- Offsite community
- Secondary testing locations include: Tipping Floor Feedstocks (un-ground) or Ground Feedstocks Pile, Finished compost pile and the stormwater lagoon.

Conceptual Site Model

The conceptual site model (CSM) provides a conceptual understanding of the potential for odor and compound emissions based on what is known about the sources, release mechanisms, migration pathways, exposure pathways, and potential receptors. The CSM is described below.

Sources and Release Mechanisms

The primary emission points of odorous gas-phase emissions are likely to be:

- receivables stockpiles,
- feedstock piles as prepared for composting,
- composting and curing areas,

- biofilters or emission control devices,
- finished compost piles, and
- leachate lagoons.

Compost leachate at the Cedar Grove Everett facility is stored onsite in an above ground storage tank until re-use when forming the Phase I heaps.

Migration Pathways

Gas-phase migration from the area sources via air dispersion to offsite receptors describes the potential air migration pathway from the area emission sources on site to offsite receptors.

Exposure Pathways to Potential Receptors

The primary exposure pathway, if complete, from an emission source at a compost facility to a potential receptor is by ambient, airborne migration.

7.0 REPORTING

The flux chamber emission data will be evaluated by comparing the field data as reported by the laboratory to QC qualifiers, and all data will be qualified for data use as is appropriate. After data review, the qualified data will be reported in a Technical Memorandum documenting the field testing activities, results, and summary statements regarding the reported data. All data will be reported in spreadsheets intended for data use and processing. The Technical Memorandum will be written as a stand-alone document, complete with copies of all original field data and notes, and all laboratory data.

Organization and Schedule

Table 1 lists the people involved in this project. All are employees of the Washington State Department of Ecology. Table 2 presents the proposed schedule for this project.

Table 1. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
John Cleary, PE W2R Program Phone: 509-329-3531	Project Manager/ Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Clint Bowman Air Quality Program Phone: 360-407-6815	Air Modeler	Models air emission profiles for facilities and records information.
Peter Christiansen Section Manager W2R Program Phone: 425-649-7076	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Wayne Krafft W2R Section Manager Phone: 509-329-3466	Section Manager for the Project Manager	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP. Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Wayne Krafft W2R Section Manager Phone: 509-329-3466	Acting Director	Approves the final QAPP.
Richard Hibbard Phone: (360) 407-6896	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
QAPP: Quality Assurance Project Plan

Table 2. Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work	Due date	Lead staff
Field work completed	May 2013	John Cleary, PE
Laboratory analyses completed	July 2013	
Final report		

Author lead / Support staff	John Cleary
Schedule	
Draft due to supervisor	June 2013
Draft due to client/peer reviewer	June 2013
Final (all reviews done) due to publications coordinator (Joan)	July 2013
Final report due on web	August 2013

* All data entered into EIM by the lead person for this task.

** Data verified to be entered correctly by a different person; any QA issues identified. Allow one month for this step in your schedule.

*** All QA issues identified in the previous step are fixed (usually by the original entry person); EIM Checklist signed off and submitted to Gayla Lord (who then enters the "EIM Completed" date in the tracking system). Allow one month for this step. Normally the final EIM completion date is no later than the final report publication date.

**** If you set a *Final report due on web"* date of June or December, the report needs to be to Joan 5 **weeks** before June 30
or December 31. For all other months, reports are due to Joan **4 weeks** before the final report due date.

Quality Objectives

The program focus is on obtaining data of acceptable quality to meet the program objectives.

Data Quality Objective #1:
Collect USEPA flux chamber data on existing and key (significant) area sources found on site for odor and gas-phase compounds of acceptable quality to support decisions regarding the detection of odor emissions and compounds suspected as a potential risk to health. Since the number of sample locations included in the program are very limited given the many different and complex sources found on these sites, this is not a comprehensive source assessment. The flux data are indicated as 'detailed screening level data' (in-depth technologies used on a limited frequency basis). It is anticipated that the flux chamber results will provide the basis for the level of odor emissions and identification of gas-phase compounds from these area sources.

Data Quality Objective #2:
Collect USEPA flux chamber data that meet the quality control objectives for field sample collection and laboratory analysis of the collected flux samples.

Sampling Process Design (Experimental Design)

The primary goal of the program is to identify types and quantities of air emissions and their associated odors, from different compost facilities, processes at facilities, and perhaps components of processes found at compost facilities. Since limited information is available on emissions of specific chemical compounds and odor from compost facilities, the focus of this work will include assessing odors and individual air compounds emitted from these facilities. The goal of this effort is to assess whether compost odors are a health risk to surrounding areas, or if these air emissions amount to an odor nuisance. Few studies exist that connect compost odors to specific chemical compounds. Waste streams coming into these facilities include: yard wastes or greenwaste and food waste (residential and commercial).

The data collection approach for the assessment consists of collecting co-located ambient air and source flux data. Ambient air testing will include collecting 'grab' air samples in evacuated stainless steel canisters at points of interest. Flux chamber samples will be pulled from the USEPA flux chamber using the appropriate sample collection technique for the method, both grab and integrated sample collection techniques. The scope of work is provided in Table 1.

The sample collection strategy for flux chamber testing will assess VOCs/odor at multiple locations at the compost facility. The scope of work for flux chamber testing is summarized in Table 1. A detailed description of the flux chamber testing methods and equipment is provided in Appendix A.

Sample Collection Strategy

Ecology will conduct a fast turn-around air emissions testing effort that simulates air sampling efforts that have been conducted on other west coast compost facilities. Ecology intends this effort to serve as a baseline of data and information for subsequent air emission screenings. Additional sampling of emissions and solid and liquid materials from these compost locations is anticipated, and related and specific sampling plans are being developed.

The technical effort for the program will include:

- Site inspection and information collection activity
- Preparation of field test equipment
- Field testing including the collection of flux samples
- Sample chain-of-custody/QC sample collection
- Sample shipping
- Sample analysis
- Laboratory reporting
- Qualification and reporting of results

The processes targeted for testing include:

- Biofilter for tipping floor building
- Gore Cover on Phase I Composting (early or mid-cycle heap)
- Phase II Composting
- Upwind and downwind property lines
- Offsite community
- Alternative locations include stormwater pond, biofilter for the grinder or the finished compost pile.

The Cedar Grove Composting facility in Everett does not have a leachate pond. Instead, leachate is collected in an above ground storage tank and reused onsite.

Specific sample collection information regarding process test locations and strategy is provided below for the west side facility:

Table 3 Sample Collection and Location Information

Compost Area Source	**Assessment Approach**	**Comment**
Gore Cover on Compost	Standard Flux Chamber	Top, center of pile
Biofilter for Primary ASP	SCAQMD Modified Flux Chamber	Representative zone of filter; 6" stack
Phase II Compost Heaps	Standard Flux Chamber	Top, center of pile
Property Boundaries	Standard Lung Sampler	Upwind and downwind, ambient samples, time weighted samples
Adjacent community sampling	Standard Lung Sampler	Areas of frequent nuisance odor complaints, ambient samples, time weighted samples

Sample Replicate	Replicate media collection	Collect at any source
Media Blank	Pure reagent in sample media	Collect any time, any where

Sampling Procedures

The list of field equipment and expendable supplies for the proposed field testing is provided below. All sampling media (prepared as per method specifications) are to be provided by the contract laboratories (Environmental Analytical Services including stainless steel, Summa polished sample canisters and sorbent materials, and Odor Science & Engineering Tedlar bags). The laboratory typically provides the sampling media for these methods and conducts blank testing to insure proper laboratory service. Ecology will supply all other sampling equipment and expendable supplies.

Ecology will supply the flux chamber systems that will be required for this effort. A complete flux chamber system shall include the following:

- US EPA flux chamber as per EPA design including stainless steel Swage-lock fittings as modified by the SCAQMD Rule 1133- two systems
- Support cooler with a mounted rotometer (0-to-5 liter per minute),
- Brass, 2-stage regulator for bottled air (CGA 590 fitting for air and 1/4" Swage-lock (male) adaptor fitting per chamber,
- Four, ten foot, 1/4" Teflon line with female fittings,
- 1/4" Teflon air inlet/outlet support lines- 25' and 12'
- Type K thermocouple wires (2, 12') and temperature readout,
- Decontamination supplies including Alconox soap, paper towels, and wash water,
- Two (2) bottles of ultra high purity air (size #150) with 10% helium trace gas,
- Purge pump for sample line purging,
- Hot wire anemometer,
- Decompression lung for Tedlar bag sample collection,
- Cardboard boxes or plastic tubs for shipping,
- Two sets of impellers, batter, and coolers for operating impeller mixing in the chambers,
- REA/Synsidine colorimetric tube detection pump and detection tubes for ammonia,
- Two bottle dollies for the compressed air cylinders,
- Set of 2", 4", and 6" extension stacks for the flux chambers,

Flux Chamber Testing

Direct air emission measurements will be conducted using the USEPA-recommended surface emission isolation flux chamber (USEPA, 1986). The flux chamber provides a direct measurement of the subsurface contaminant flux at the soil-air interface. In evaluating vapor intrusion, flux chamber results represent an additional line of evidence for evaluating subsurface contamination (CalEPA/DTSC, 2005). Flux chamber air samples will be analyzed by the same methods as those used for the ambient air samples (USEPA Method TO-15 and USEPA Method TO-11A for some samples).

Measurement Procedures

The area source emission measurements will be made by using the South Coast Air Quality Management District (SCAQMD) modified USEPA surface emissions isolation flux chamber. This technology is used to directly measure the air emissions from selected area sources as identified above and is described as a continuously stirred tank reactor that uses a sweep gas (pure air) added to the chamber at a fixed rate, the chamber is equilibrated, and after equilibration, air samples are collected from the flux chamber. The USEPA technology was modified and tested for use with high advective flow sources such as those found at compost sites. A trace gas is added to the sweep air, and advective flow is determined by the recovery of the trace gas from the chamber. This technology is a tested, validated, documented, and regulatory approved technology for assessing air emissions from area sources. The data obtained from this type of testing are 'flux' data, which express mass transfer per time per a given surface area. These data are considered an engineering unit, and can be used to estimate emissions (mass per time) from those areas tested.

The analytical schedule for the air emissions testing is described below. It includes ammonia, speciated reduced sulfur compounds, aldehyde compounds, a long list (about 80) of volatile organic compounds (VOCs) and olfactory odor.

Table 4 Analytical Methods

Analyte	Method	Sample Container
Ammonia	ASTM D 4490	Colorometric tube
Total Sulfur Compounds	USEPA Method 15	1 liter tedlar bag
Aldehyde Compounds (acetaldehyde, formaldehyde, 10 aldehydes total)	USEPA Method TO-11	DNPH coated solid sorbent tube
Volatile Organic Compounds (VOCs, full scan, 80 compounds) and TICs (about 20)	USEPA Method TO-15, Full Scan	6 liter canister
VOCs; lower level short list (10 compounds or less)	USEPA Method TO-15, SIM	Same 6 liter canister
Odor Thresholds	St. Croix Sensory, Inc.	10 liter tedlar bag

Quality Control Procedures

Field

QUALITY CONTROL

Quality control (QC) procedures that are used to assure the quality of data obtained from ambient air and flux chamber sampling are listed and described below.

QUALITY CONTROL FOR FLUX CHAMBER TESTING

USEPA recommends that a flow meter be used to introduce the sweep air at rate of roughly 5.0 liters per minute (l/min) which requires calibration (i.e., multipoint calibration using a primary standard current for the year). The rotometer used as part of the emission measurement test should not be used for other applications, insuring the clean operation of the air introduction system. Operation of the chamber should follow the specific protocol for use described in the USEPA User's Guide. This includes using a 5.0 l/min sweep air flow rate for a minimum of 5 residence times to achieve equilibration prior to sample collection. Other sampling quality control procedures are listed below.

- Field Blank Sample -- Field blank samples are obtained by placing the clean chamber on a clean surface that does not emit the gas species of interest. This sample includes all sources of sample collection and analytical system contamination or is the representative 'baseline' of the sample collection and analytical system. The chamber is operated as described for the collection of site samples, and field blank samples (or instrument response) are collected. The frequency of field blank samples is a minimum of 5%, or one per trip. A field blank sample will be collected at the onset of testing (i.e., pre-use blank test). Field blank concentrations will be used to establish the system baseline. The field blank for the ambient air sampling program is obtained by filling a Summa canister with ultrahigh purity air. This is also known as a media blank sample.

- Replicate Sample – Replicate samples are used to establish the precision of the sample collection and analytical system. Replicate samples are obtained by collecting a replicate sample immediately after a sample is collected from the flux chamber and analyzing both the field sample and the field replicate sample. Likewise, the replicate sample for the air sampling program is a second sample system co-located with an ambient air sample. The frequency of replicate sample collection is 5% or one per trip. The criteria for acceptable field precision is ±50% relative percent difference (RPD). Replicate samples will be collected for both the flux chamber and the ambient air sample collection protocols.

- Specific Method Performance -- Specific method QC is conducted as per analytical method requirements. Typically this includes laboratory blanks, species recovery, and adherence to other method performance objectives such as calibration and retention time identifications.

- Sample Management -- Sample management is defined by the specific sampling method used to satisfy the program objectives. Sample management typically includes all activities involving the recording, preserving, storing, handling, and shipping of the field samples.

Data qualifiers that will be used to assist in data usage include: J- estimated value or below method reporting limit (MRL); B- value found in blank sample and baseline corrected; and E- value found at level that exceeds calibration range. Laboratory recovery and precision data, as well as field precision data, will be used to qualify data usage for the site flux chamber and ambient air sampling programs.

Deviation in schedule or frequency of QC activities will require corrective action, including documentation of corrective action in the field notebook and notifying the project manager.

Laboratory

Laboratory Blank -- A blank sample is analyzed by the laboratory operating the instrument as described in the analytical method protocol. This is performed by the laboratory injecting clean air into the operating GC/MS system and does not involve sample collection or sample collection media. The frequency of blank sample analysis is a minimum of 5 blanks analyzed per 100 samples (5%) or one blank per every batch (regardless of batch size). Blank levels will be used to establish the baseline of the analytical system.

Table 5 Laboratory QC Criteria for the TO-15 Method.

Parameter	EAS TO-15 Modified
BFB Tune	Daily (24 hour) 12 hours if Required
Tuning Criteria with BFB	TO-15 Tune Criteria
Initial Calibration	Five points minimum See Table 13.7b 90% compounds meet criteria
Calibration Check Sample (CCS)	After Initial Calibration Same Percent RSD as Initial Calibration
Continuing Calibration Verification (CCV)	Daily (24 hours), 90% compounds meet criteria

Internal Standard (IS)	Pentafluorobenzene 1,4-Difluorobenzene RT < 0.5 min daily std. Response 60% to 140%
Surrogate	Toluene-d8 70-130% recovery
Method Blank	Humidified Air <RL
Laboratory Control Spike	1 per Daily Analytical Batch 70-130% for LCS list
Duplicate Lab Control Duplicate Sample Duplicate	Duplicate with each 20 samples <30% for LCS spike list

A table of the quality control criteria for TO-15 Method individual compounds is provided in the Appendix.

Table 6 Laboratory QC procedures for USEPA Method TO-11

Parameter	EAS TO-11A Modified	TO-11A Method
Initial Calibration	5 points minimum RT determined and a bracket value is established	Method specifies standards run in triplicate. RT <2% RSD. Method criteria 0.999 correlation coefficient. Minimum every 6 months
Calibration Check Sample (CCS)	With Initial calibration curve	Second Source calibration check run after initial calibration curve 85-115% recovery
Continuing Calibration Verification (CCV)	Daily (24 hours) Mid range standard	10% precision on replicate <15% D for calibration verifications
Method Blank	Less than LOQ A cartridge blank is analyzed for the method blank.	Average Blank Subtraction
Laboratory Control Spike	1 per Daily Batch	Not Specified
Duplicate Lab Control Dup Sample Dup	Duplicate with each 20 samples	50% of sampling events should have a collocated sample. <20% D
Holding Times	Extract 14 days; analyze within 30 days.	Extract 14 days from sampling date

Table 7 Laboratory QC criteria for USEPA Method TO-11

Analyte	**MDL Ug**	**LOQ ug**	**Criteria**		
			ICAL CCV %D	**LCS %R**	**Duplicate %RPD**
Formaldehyde	0.08	0.12	<20	75-125	<25
Acetaldehyde	0.08	0.16	<20	75-125	<25
Acrolein (2)	0.08	0.16	<30	70-130	<30
Acetone	0.25	0.25	<30	70-130	<30
Propionaldehyde	0.08	0.16	<20	75-125	<25
Butyraldehyde (1) Methyl ethyl ketone	0.08 0.08	0.16 0.16	<30		
Benzaldehyde	0.08	0.16	<20	75-125	<25
Valeraldehyde	0.12	0.24	<30	70-130	<30
Cyclohexanone	0.16	0.32	<30	70-130	<30
Hexaldehyde	0.12	0.24	<30	70-130	<30

(1) Butyraldehyde and methyl ethyl ketone (MEK) coelute and are not included in the LCS

(2) Acrolein derivative is unstable in some samples.

Table 8 Laboratory QC Criteria for EPA Method 14.

Parameter	**EAS EPA 14 Modified**
Initial Calibration	3-point minimum initial calibration for 20 compound list.
Calibration Check Sample (CCS)	Secondary source H2S calibration standard
Continuing Calibration Verification (CCV)	Daily (24 hours) Calibration Verification performed at the beginning and end of each daily analytical batch.
Method Blank	<3x MDL
Laboratory Control Spike	1 per Daily Batch
Duplicate Lab Control Duplicate Sample	With each 20 samples
Holding Times Silico Canister	Tedlar Bag: 72 hours 7 days

Audits and Reports

The flux chamber emission data will be evaluated by comparing the field data as reported by the laboratory to QC qualifiers, and all data will be qualified for data use as is appropriate. After data review, the qualified data will be reported in a Technical Memorandum documenting the field testing activities, results, and summary statements regarding the reported data. All data will be reported in spread sheets intended for data use and processing. The Technical Memorandum will be written as a stand-alone document, compete with copies of all original field data and notes, and all laboratory data.

Data Verification and Validation

Data Verification

Data Verification is a process wherein the data is checked for accuracy and inconsistencies after data migration is done. It helps to determine whether data was accurately translated when data is transported from one source, such as the laboratory report or field notes, to another. The data for the compost emission sampling such as will be proof read to confirm the data entered against the original document. Proof reading will include highlighting paper copies to ensure a thorough and complete review.

Data Validation

Data validation checks that data are valid, sensible, reasonable, and secure before they are processed. The following data validation methods may be used:

- Limit check

  Data will be checked for one limit only, upper OR lower, e.g., data should not be greater than 2 (<=2).

- Logic check

  Checks that an input does not yield a logical error, e.g., an input value should not be 0 when there will be a number that divides it somewhere in a program

- Allowed character checks

  Checks that ascertain that only expected characters are present in a field. For example a numeric field may only allow the digits 0-9, the decimal point and perhaps a minus sign or commas. A text field such as a personal name might disallow characters such as < and >, as they could be evidence of a markup-based error.

- Batch totals

  Check for missing records. Numerical fields may be added together for all records in a batch. The batch total is entered and the computer checks that the total is correct, e.g., add the 'Total Ammonia' field of a number of sample locations together.

Data Quality (Usability) Assessment

Data Quality Assessment is used to assess the type, quantity, and quality of data in order to verify that the planning objectives, Quality Assurance Project Plan components, and sample collection procedures were satisfied and that the data are suitable for its intended purpose. Data Quality Assessment is a five-step procedure for determining statistically whether or not a data set is suitable for its intended purpose. This assessment is a scientific and statistical evaluation of data to determine if it is of the type, quantity, and quality needed and may be performed either during a project to check the process of data collection or at the end of a project to check if objectives were met.

There is limited data on compost air emissions. The data set from this sampling event will be small. As more data is gathered, the data will be checked statistically for usability. For this sampling event, the usability assessment will include comparing the data to published data sets.

References

Adams, D.T., et al, "Measurement of Biogenic Sulfur-Containing Gas Emissions from Soils and Vegetation." Presented at the 1st Annual Meeting of the ALCA, Houston, Texas, June 25-30, 1978.

USEPA, 1986. Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber- User's Guide, EPA 600/8-86-008 (NTIS PB86-223161), February.

USEPA, 1990. Procedures for Conducting Air Pathway Analysis for Superfund Activities, Interim Final Documents, Volume 2- Estimation of Baseline Air Emissions at Superfund Sites, EPA-450/1-89-002a (NTIS PB90-270588), August. [confirm this does not hurt us]

USEPA, 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. EPA-600/4-84-041, April 1999.

Winegar, E.D., L.H. Keith editors, Sampling and Analysis of Airborne Pollutants, C.E. Schmidt, Chapter 3, "Theory and Applications of the US EPA Recommended Surface Emission Isolation Flux Chamber for Measuring Emission Rates of Volatile and Semivolatile Species." Lewis Publishers, Ann Arbor, Michigan, 1993.

Zimmerman, Pat. "Procedures for Conducting Hydrocarbon Emission Inventories of Biogenic Sources and Some Results of Recent Investigations." Presented at the 1977 EPA Emissions Inventory/Factor Workshop, Raleigh, North Carolina, September 13-15, 1977.

Appendices

Appendix A. Laboratory Analytical Compound Lists

Table 9 EPA Method TO-15 compounds analyzed

	CAS	Compound	MDL ppbV	RL ppbv	MDL ug/m3	RL ug/m3
1	75-71-8	Dichlorodifluoromethane	0.4	0.7	2	4
2	**67-56-1**	**Methanol**	**1.1**	**2.1**	**1**	**3**
3	74-87-3	Chloromethane	0.4	0.7	1	1
4	76-14-2	Freon 114	0.4	0.7	3	5
5	75-01-4	Vinyl chloride	0.4	0.7	1	2
6	106-99-0	1,3-Butadiene	0.4	0.7	1	2
7	74-83-9	Bromomethane	0.4	0.7	1	3
8	75-00-3	Chloroethane	0.4	0.7	1	2
9	**64-17-5**	**Ethanol**	**1.1**	**2.1**	**2**	**4**
10	**107-02-8**	**Acrolein**	**0.4**	**0.7**	**1**	**2**
11	75-69-4	Trichlorofluoromethane	0.4	0.7	2	4
12	**75-05-8**	**Acetonitrile**	**0.7**	**1.4**	**1**	**2**
13	67-64-1	Acetone	0.4	0.7	1	2
14	**67-63-0**	**2-propanol**	**0.4**	**0.7**	**1**	**2**
15	75-65-0	t-Butanol	0.2	0.4	1	1
16	4227-95-6	Methyl iodide	0.2	0.4	1	2
17	75-35-4	1,1-Dichloroethene	0.4	0.7	1	3
18	107-13-1	Acrylonitrile	0.4	0.7	1	2
19	76-13-1	Freon 113	0.4	0.7	3	5
20	107-05-1	Allyl chloride	0.4	0.7	1	2
21	75-09-2	Methylene Chloride	0.4	0.7	1	2
22	75-15-0	Carbon disulfide	0.4	0.7	1	2
23	156-60-5	trans-1,2-Dichloroethene	0.2	0.4	1	1
24	1634-04-4	Methyl tert butyl ether	0.2	0.4	1	1
25	107-12-0	Propionitrile	0.4	0.7	1	2
26	75-34-3	1,1-Dichloroethane	0.4	0.7	1	3
27	637-92-3	Ethyl-tert-Butyl Ether	0.4	0.7	1	3
28	108-05-4	Vinyl acetate	0.4	0.7	1	3
29	78-93-3	2-Butanone	0.4	0.7	1	2
30	108-20-3	Diisopropyl ether	0.2	0.4	1	1
31	110-54-3	Hexane	0.2	0.4	1	1
32	126-98-7	Methacrylonitrile	0.4	0.7	1	2
33	141-78-6	Ethyl acetate	0.4	0.7	1	3
34	74-97-5	Bromochloromethane	0.2	0.4	1	2
35	**96-33-3**	**Methyl Acrylate**	**0.4**	**0.7**	**1**	**3**
36	109-99-9	Tetrahydrofuran	0.4	0.7	1	2

	CAS	Compound	MDL ppbV	RL ppbv	MDL ug/m3	RL ug/m3
37	78-83-1	Isobutyl alcohol	0.4	0.7	1	2
38	156-59-2	cis-1,2-Dichloroethene	0.4	0.7	1	3
39	594-20-7	2,2-Dichloropropane	0.4	0.7	2	3
40	67-66-3	Chloroform	0.4	0.7	2	3
41	71-55-6	1,1,1-Trichloroethane	0.4	0.7	2	4
42	107-06-2	1,2-Dichloroethane	0.4	0.7	1	3
43	563-58-6	1,1-Dichloropropene	0.2	0.4	1	2
44	110-82-7	Cyclohexane	0.2	0.4	1	1
45	71-43-2	Benzene	0.4	0.7	1	2
46	56-23-5	Carbon tetrachloride	0.4	0.7	2	5
47	540-84-1	2,2,4-Trimethylpentane	0.2	0.4	1	2
48	142-82-5	n-Heptane	0.2	0.4	1	1
49	78-87-5	1,2-Dichloropropane	0.4	0.7	2	3
50	123-91-1	1,4 Dioxane	0.7	1.4	3	5
51	74-95-3	Dibromomethane	0.2	0.4	1	3
52	79-01-6	Trichloroethene	0.4	0.7	2	4
53	75-27-4	Bromodichloromethane	0.2	0.4	1	2
54	80-62-6	Methyl methacrylate	0.2	0.4	1	1
55	108-10-1	4-Methyl-1-pentanone	0.2	0.4	1	1
56	10061-01-5	cis-1,3-Dichloropropene	0.4	0.7	2	3
57	108-88-3	Toluene	0.4	0.7	1	3
58	10061-02-6	trans-1,3-Dichloropropene	0.4	0.7	2	3
59	79-00-5	1,1,2-Trichloroethane	0.4	0.7	2	4
60	97-63-2	Ethyl methacrylate	0.2	0.4	1	2
61	591-78-6	2-Hexanone	0.2	0.4	1	1
62	142-28-9	1,3-Dichloropropane	0.2	0.4	1	2
63	111-65-9	Octane	0.2	0.4	1	2
64	124-48-1	Dibromochloromethane	0.2	0.4	2	3
65	106-93-4	1,2-Dibromoethane	0.4	0.7	3	6
66	127-18-4	Tetrachloroethene	0.2	0.4	1	2
67	108-90-7	Chlorobenzene	0.4	0.7	2	3
68	630-20-6	1,1,1,2-Tetrachloroethane	0.2	0.4	1	2
69	100-41-4	Ethylbenzene	0.4	0.7	2	3
70	1330-20-7	m,p-Xylene	0.4	0.7	2	3
71	111-84-2	Nonane	0.2	0.4	1	2
72	100-42-5	Styrene	0.4	0.7	2	3
73	75-25-2	Bromoform	0.1	0.2	1	2
74	95-47-6	o-Xylene	0.4	0.7	2	3
75	79-34-5	1,1,2,2-Tetrachloroethane	0.2	0.4	1	2

	CAS	Compound	MDL ppbV	RL ppbv	MDL ug/m3	RL ug/m3
76	96-18-4	1,2,3-Trichloropropane	0.2	0.4	1	2
77	**110-57-6**	**t-1,4-Dichloro-2-butene**	**0.2**	**0.4**	**1**	**2**
78	95-49-8	2-Chlorotoluene	0.2	0.4	1	2
79	106-43-4	4-Chlorotolueme	0.2	0.4	1	2
80	103-65-1	n-Propylbenzene	0.2	0.4	1	2
81	98-82-8	Isopropylbenzene	0.2	0.4	1	2
82	622-96-8	4-Ethyltoluene	0.2	0.4	1	2
83	108-67-8	1,3,5-Trimethylbenzene	0.4	0.7	2	4
84	124-18-5	Decane	0.2	0.4	1	2
85	98-06-6	tert-butyl benzene	0.2	0.4	1	2
86	95-63-6	1,2,4-Trimethylbenzene	0.4	0.7	2	4
87	538-93-2	i-Butylbenzene	0.2	0.4	1	2
88	135-98-8	sec-butylbenzene	0.2	0.4	1	2
89	541-73-1	1,3-Dichlorobenzene	0.2	0.4	1	2
90	99-87-6	Isopropyltoluene	0.2	0.4	1	2
91	100-44-7	Benzyl chloride	0.2	0.4	1	2
92	106-46-7	1,4-Dichlorobenzene	0.2	0.4	1	2
93	104-51-8	n-Butylbenzene	0.2	0.4	1	2
94	95-50-1	1,2-Dichlorobenzene	0.2	0.4	1	2
95	**96-12-8**	**1,2-Dibromo-3-chloropropane**	**0.2**	**0.4**	**2**	**3**
96	**78-00-2**	**Tetraethyl lead**	**0.1**	**0.2**	**1**	**2**
97	120-82-1	1,2,4-Trichlorobenzene	0.4	0.7	3	6
98	91-20-3	Naphthalene	0.1	0.2	1	1
99	**87-61-6**	**1,2,3-Trichlorobenzene**	**0.2**	**0.4**	**1**	**3**
100	87-68-3	Hexachlorobutadiene	0.4	0.7	4	8

Table 10 Modified USEPA Method 14 Compound List.

Analyte	**MDL ppbV**	**LOQ ppbV**	**Criteria**		
			ICAL/ CCV %D	**LCS %R**	**Duplicate %RPD**
Hydrogen Sulfide	1	5	<30	70-130	<30
Carbonyl Sulfide	1	5	<30	70-130	<30
Methyl Mercaptan	1	5	<30	70-130	<30
Ethyl Mercaptan	1	5	<30	70-130	<30
Dimethyl Sulfide	1	5	<30	70-130	<30
Carbon Disulfide	1	5	<30	70-130	<30
i-Propyl Mercaptan	1	5	<30	70-130	<30
Ethyl Methyl Sulfide	1	5	<30	70-130	<30
n-Propyl Mercaptan	1	5	<30	70-130	<30
Thiophene	1	5	<30	70-130	<30
Isobutyl Mercaptan	1	5	<30	70-130	<30
Diethyl Sulfide	1	5	<30	70-130	<30
t-Butyl Mercaptan	1	5	<30	70-130	<30
n-Butyl Mercaptan	1	5	<30	70-130	<30
Dimethyl Disulfide	1	5	<30	70-130	<30
3-Methylthiophene	1	5	<30	70-130	<30
Tetrahydrothiophene	1	5	<30	70-130	<30
2,5-Dimethylthiophene	1	5	<30	70-130	<30
Diethyl Disulfide	1	5	<30	70-130	<30
2-Ethylthiophene	1	5	<30	70-130	<30

Table 11 TO-15 Method QC criteria are given below.

Component	**Initial Calibration %D**	**CCV %D**	**LCS %R**	**Precision %D**
Freon 12	<30%	<30%	70-130	<30%
Chloromethane	<30%	<30%	70-130	<30%
Freon 114	<30%	<30%	70-130	<30%
Vinyl chloride	<30%	<30%	**70-130**	**<30%**
Bromomethane	<30%	<30%	70-130	<30%
Chloroethane	<30%	<30%	70-130	<30%
Trichlorofluoromethane	<30%	<30%	70-130	<30%
1,1-Dichloroethene	<30%	<30%	**70-130**	**<30%**
Dichloromethane	<30%	<30%	70-130	<30%
Freon 113	<30%	<30%	70-130	<30%
1,1-Dichloroethane	<30%	<30%	70-130	<30%
c-1,2-Dichloroethene	<30%	<30%	70-130	<30%

Component	**Initial Calibration %D**	**CCV %D**	**LCS %R**	**Precision %D**
Chloroform	<30%	<30%	**70-130**	**<30%**
1,2-Dichloroethane	<30%	<30%	**70-130**	**<30%**
1,1,1-Trichloroethane	<30%	<30%	**70-130**	**<30%**
Benzene	<30%	<30%	**70-130**	**<30%**
Carbon Tetrachloride	<30%	<30%	**70-130**	**<30%**
1,2-Dichloropropane	<30%	<30%	70-130	<30%
Trichloroethene	<30%	<30%	**70-130**	**<30%**
c-1,3-Dichloropropene	<30%	<30%	70-130	<30%
t-1,3-Dichloropropene	<30%	<30%	70-130	<30%
1,1,2-Trichloroethane	<30%	<30%	70-130	<30%
Toluene	<30%	<30%	**70-130**	**<30%**
1,2-Dibromoethane	<30%	<30%	70-130	<30%
Tetrachloroethene	<30%	<30%	**70-130**	**<30%**
Chlorobenzene	<30%	<30%	**70-130**	**<30%**
Ethylbenzene	<30%	<30%	**70-130**	**<30%**
m & p-Xylenes	<30%	<30%	**70-130**	**<30%**
Styrene	<30%	<30%	70-130	<30%
o-Xylene	<30%	<30%	**70-130**	**<30%**
1,1,2,2-Tetrachloroethane	<30%	<30%	70-130	<30%
1,3,5-Trimethylbenzene	<30%	<30%	**70-130**	**<30%**
1,2,4-Trimethylbenzene	<30%	<30%	70-130	<30%
1,3-Dichlorobenzene	<30%	<30%	70-130	<30%
1,4-Dichlorobenzene	<30%	<30%	70-130	<30%
1,2-Dichlorobenzene	<30%	<30%	70-130	<30%
1,2,4-Trichlorobenzene	<30%	<30%	70-130	<30%
Hexachlorobutadiene	<50%	<50%	50-150	<50%
1,3-Butadiene	<40%	<40%	60-140	<40%
2-Butanone	<40%	<40%	60-140	<40%
Acetone	<40%	<40%	60-140	<40%
Carbon Disulfide	<40%	<40%	60-140	<40%
3-Chloroprene	<40%	<40%	60-140	<40%
Bromoform	<40%	<40%	60-140	<40%
Methyl isobutyl ketone	<40%	<40%	60-140	<40%
2-Hexanone	<40%	<40%	60-140	<40%
Bromodichloromethane	<40%	<40%	60-140	<40%
Dibromochloromethane	<40%	<40%	60-140	<40%
Vinyl acetate	<40%	<40%	60-140	<40%
t-1,2-Dichloroethene	<40%	<40%	60-140	<40%
Benzylchloride	<50%	<50%	50-150	<50%
4-Ethyltoluene	<40%	<40%	60-140	<40%
Methyl t-butyl ether	<40%	<40%	60-140	<40%
Cyclohexane	<40%	<40%	60-140	<40%

Component	**Initial Calibration %D**	**CCV %D**	**LCS %R**	**Precision %D**
2,2-Dichloropropane	<40%	<40%	60-140	<40%
Hexane	<40%	<40%	60-140	<40%
Methacrylonitrile	<40%	<40%	60-140	<40%
Heptane	<40%	<40%	60-140	<40%
n-Propylbenzene	<40%	<40%	60-140	<40%
Isopropylbenzene	<40%	<40%	60-140	<40%
2,2,4-Trimethylpentane	<40%	<40%	60-140	<40%
TO-15 Extended Compounds				
1,1,1,2-Tetrachloroethane	<40%	<40%	60-140	<40%
Bromochloromethane	<40%	<40%	60-140	<40%
Ethyl acetate	<40%	<40%	60-140	<40%
Octane	<40%	<40%	60-140	<40%
Nonane	<40%	<40%	60-140	<40%
Decane	<40%	<40%	60-140	<40%
1,1-Dichloropropene	<40%	<40%	60-140	<40%
1,2,3 Trichloropropane	<40%	<40%	60-140	<40%
1,3-Dichloropropane	<40%	<40%	60-140	<40%
Dibromomethane	<40%	<40%	60-140	<40%
Methyl methacrylate	<40%	<40%	60-140	<40%
1,4-Dioxane	<40%	<40%	60-140	<40%
Di-isopropyl ether	<40%	<40%	60-140	<40%
Isobutyl Alcohol	<40%	<40%	60-140	<40%
n-Butylbenzene	<40%	<40%	60-140	<40%
sec-Butylbenzene	<40%	<40%	60-140	<40%
tert-butylbenzene	<40%	<40%	60-140	<40%
i-Butylbenzene	<40%	<40%	60-140	<40%
p-Isopropyltoluene	<40%	<40%	60-140	<40%
Tetrahydrofuran	<40%	<40%	60-140	<40%
t-Butanol	<40%	<40%	60-140	<40%
2-Chlorotoluene	<40%	<40%	60-140	<40%
4-Chlorotoluene	<40%	<40%	60-140	<40%
2-Propanol (Isopropanol)	<40%	<40%	60-140	<40%

Appendix B. Background and Operation of the Surface Emission Isolation Flux Chamber

This section briefly describes the background and operation of the USEPA-recommended flux chamber. This device is used to measure the emission rates from surfaces emitting gas species (USEPA, 1986).

The use of enclosures (chambers) for assessing emission rates was first reported in the literature by Zimmerman (Zimmerman, 1977) and Adams (Adams, 1978). The basic approach uses an enclosure or chamber of some design to isolate a surface emitting gas species. The chamber must be well characterized and qualify as a continuously stirred reactor. Clean sweep air is added to the chamber at a controlled, fixed rate, and the contents are sampled and analyzed for species of concern. The emission rate (ER) of species i, with the units of micrograms per minute per square meter (ug/m^2 min), is calculated by knowing the sweep air flow rate, Q (m^3/min), species concentration Yi, (ug/m^3), and surface area, A (m^2) as follows:

$$ERi = (Q)\ (Yi)\ /\ (A) \qquad \text{Equation 1}$$

This emission assessment approach has been used on a variety of solid and liquid surfaces and for a variety of species (Winegar, 1995). Assessment of surface emissions of VOCs can be accomplished by using the USEPA Method TO-15 (USEPA) in conjunction with the flux chamber for sub-part per billion by volume (ppbv) sensitivity.

The development of the current USEPA-recommended flux chamber method began with the need to assess the emissions of air toxics at uncontrolled hazardous waste sites (Superfund sites) as part of remedial investigation efforts. Literature on direct measurement technologies was used to develop flux chambers of different sizes, shapes, and construction materials. After several site assessment reports became available presenting this technology, the USEPA became interested in using the approach to characterize fugitive emissions from controlled treatment, storage, and disposal facilities (TSDFs). This interest lead to a study where the most promising direct, indirect, and predictive modeling technologies were evaluated by conducting side-by-side emission rate assessments at Tads. The results of this study demonstrated the advantages of the flux chamber measurement technology when compared to the other assessment technologies. Further interest lead to the redesign and parametric evaluation of the flux chamber as described in the USEPA Users Guide (USEPA, 1986), which also provides the results of the chamber evaluation and recommended operating protocols. The USEPA flux chamber represents the best compromise in design, construction materials, and suitability for different types of applications.

Test data indicate that the flux chamber is a reliable assessment technology. Precision is reported at ±5 percent and accuracy is ±30 percent (USEPA, 1986). The recovery studies conducted on 40 hydrocarbons (alkanes, alkenes, aromatics, halogenated, sulfur containing, cyclic) averaged 103 percent (USEPA, 1986). The emission rate measured with the flux chamber is used as the source term for characterizing indoor and outdoor air concentrations of VOCs originating from the subsurface.

Modifications to the USEPA flux chamber as used to assess air emissions from area sources at compost sites with a significant advective flow include: diffuse air ring for inlet gas with trace gas, 10% helium trace gas in the sweep air for assessing advective flow, an internal impeller for added mixing in the chamber, and a stack of various diameters and lengths in order to increase the mixing and residence time in the flux chamber prior to mixing.

Appendix C. Flux Chamber Sampling Protocol

The flux chamber can be used on any liquid or solid surface. The only requirement regarding application is that there must be access to the surface for testing. The most critical issue regarding application is that the location and number of locations for testing be sufficient so that these data can be used to meet the program objectives. The USEPA Users Guide provides guidance that relies on the area involved and the homogeneity of the source; or the coefficient of variation of these emission data for determining representative testing (USEPA, 1986). However, for this application, locations for testing will be selected over areas where compounds are known to have high concentrations in the subsurface or in areas of special interest, or represent scientific rather than randomly based flux data. Test locations have been generally identified, however, exact test locations will be determined in the field.

The operation of the flux chamber involves: 1) identifying the test area; 2) initiating sweep gas flow rate to the flux chamber; 3) operating the chamber for at least five residence times; 4) collecting exhaust gas for analysis and/or recording instrument response; 5) decontaminating the chamber; and 6) relocating the measurement equipment to the next test area. The specific operating protocol for soil surfaces is given below.

1) Locate the flux chamber, sweep gas, sample collection equipment, and field documents at the test location.

2) Document site information, location information, equipment information, name of sampler, date, and time on the Field Data Sheet.

3) Select the exact test location and seal the chamber by pushing the edge into the soil surface or the bottom seal system. The chamber should be sealed along the base preventing air infiltration.

4) Initiate the sweep gas flow rate and set the rotometer at 5.0 liters per minute. Constant sweep gas flow rate is critical. Record time.

5) Collect instrument background data (thermocouples, site description) and record data.

6) Connect the purge pump. A total of 5.0 liters per minute is added to the chamber and the gas not sampled is exhausted out the pressure equalization port in the top of the chamber. The chamber is operated at near atmospheric pressure. Do not exceed an exhaust gas sample/purge rate of 2.5 liters per minute. This will prevent entraining of ambient air into the chamber and maintain an exhaust rate of at least 2.5 liters per minute out of the pressure equalization port.

7) Operate the chamber sweep air flow rate at 5.0 liters per minute and record data every residence time (6 minutes) for five residence times or 30 minutes. Record data. The chamber is at steady-state.

8) Interface the evacuated canister or decompression lung or sorbent tube to the purged sample line and initiate sample collection. Do not exceed a collection rate of 2.5 liters per minute at any time. This will prevent unwanted dilution of chamber exhaust gas by ambient air. Complete sample collection as per media; seal the media.

9) Label samples, record sample collection or real-time monitoring data on the data sheet.

10) Store the collected sampling media in the appropriate sample shipping container.

11) Document sample collection in field master log book.

12) Discontinue the flux measurement, shut off the sweep air, remove chamber and secure equipment.

13) Decontaminate the chamber where contact was made with the soil using a clean paper towel and water (if needed). Purge the sample lines with sweep gas (5 liters/minute) for 2 minutes.

14) Relocate equipment to the next test location and follow steps 1) through 14).

Grab samples using canisters will be collected from the exhaust line of the flux chamber at steady-state conditions for speciation by gas chromatography. Sampling rate will be maintained at less than 2.5 l/min. Canisters will collected by interfacing the canister using the 1/4" Swage-lock fittings, cracking the valve, and collecting a 3.2 liter or 6 liter sample over a 3 minute time period. Tedlar bag samples will be collected by interfacing the Tedlar bag in the decompression lung with silicone tubing to the bag and collecting a sample at less than 2.5 l/min. Integrated sample collection will use as calibrate personal sampling pump to pull a known volume of sample gas through the sampling media. The pumps are calibrated before and after sample collection, and the sample volume pulled is recorded on the integrated sample collection data form.

Appendix D. Glossary, Acronyms, and Abbreviations

Glossary

Ambient: Background or away from point sources of contamination.

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either:
(1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

90th percentile: A statistical number obtained from a distribution of a data set, above which 10% of the data exists and below which 90% of the data exists.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
i.e.	In other words
MQO	Measurement quality objective
QA	Quality assurance
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SRM	Standard reference materials
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cms	cubic meters per second, a unit of flow
cy	cubic yards
dw	dry weight
ft	feet
g	gram, a unit of mass
kcfs	1000 cubic feet per second
kg	kilograms, a unit of mass equal to 1,000 grams

kg/d	kilograms per day
km	kilometer, a unit of length equal to 1,000 meters
lb	pounds
l/s	liters per second (0.03531 cubic foot per second)
m	meter
mg	milligram
mgd	million gallons per day
mg/d	milligrams per day
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mg/L/hr	milligrams per liter per hour
mL	milliliters
mm	millimeter
mmol	millimole or one-thousandth of a mole
mole	an International System of Units (IS) unit of matter
ng/g	nanograms per gram (parts per billion)
ng/Kg	nanograms per kilogram (parts per trillion)
ng/L	nanograms per liter (parts per trillion)
NTU	nephelometric turbidity units
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
psu	practical salinity units
s.u.	standard units
T	tons (2,000 lbs)
Tpy	ton per year
ug/g	micrograms per gram (parts per million)
ug/Kg	micrograms per kilogram (parts per billion)
ug/L	micrograms per liter (parts per billion)
um	micrometer
uM	micromolar (a chemistry unit)
umhos/cm	micromhos per centimeter
uS/cm	microsiemens per centimeter, a unit of conductivity
ww	wet weight