Appendix D:
Written Comments Submitted by Small Entity Representatives in 2015

Small Business Advocacy Review Panel on EPA's Planned Proposed Rules
Standards of Performance for Municipal Solid Waste Landfills and Review of Emissions Guidelines for Municipal Solid Waste Landfills

For the April 14, 2015 Panel outreach meeting, the following SERs submitted four sets of written comments, which are provided in this appendix:

- Todd Green, American Environmental Landfill
- Curt Publow, Decatur Hills, Inc.
- Matt Stutz, Weaver Consultants Group on behalf of Ponca City, Oklahoma
- Anne Germain, Environmental Industry Associations on behalf of Caroline County, Maryland
    - Cosigned: Michael E. Michels, Cornerstone Environmental Group on behalf of Riverview, Michigan
    - Cosigned: Alek M. Orloff, Alpine Waste & Recycling
    - Cosigned: Kimberly Smelker, Granger Waste Services

American Environmental Landfill
212 N. 177th West Avenue
Sand Springs, Oklahoma 74063

April 28, 2015

Ms. Caryn Muellerleile (via email)
Office of Policy
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Comments on SBAR Outreach Briefing
Municipal Solid Waste Landfills Emission Guidelines
American Environmental Landfill

Dear Ms. Muellerleile

The American Environmental Landfill (AEL) is providing written comments in response to the Small Business Advocacy Review (SBAR) outreach briefing held on April 14, 2015 for the *Emission Guidelines (EG) for Municipal Solid Waste (MSW) Landfills.* AEL has been selected as a Small Entity Representative (SER) to participate in the SBAR review panel process. Provided herein is a brief background on AEL and our written comments.

FACILITY BACKGROUND

The AEL facility is an MSW landfill located in Sand Springs, Oklahoma, currently subject to the New Source Performance Standards (NSPS) for MSW landfills. Based on the draft rule language, the landfill will be subject to the EG once finalized. The landfill has a permitted design capacity of 12,350,000 megagrams (Mg) and encompasses approximately 222 acres, with approximately 182 acres permitted for waste disposal.

A gas collection and control system (GCCS) was initially installed by Tulsa LFG, LLC (Tulsa LFG) in 2008 as part of a landfill gas (LFG) extraction and beneficial use project. In December 2009, the AEL reported facility emissions of nonmethane organic compounds (NMOCs) above 50 Mg per year (Mg/yr), initiating the requirement to install and operate an NSPS-compliant GCCS by May 2012. In 2010, Tulsa LFG submitted a construction permit application requesting authorization to install a LFG to energy plant consisting of a gas treatment process, where the LFG is compressed, chilled, and dehydrated; LFG fired electric generator sets, and supporting infrastructure at the AEL. The gas to energy plant was installed and began commercial operation in February 2013.

WRITTEN COMMENTS

AEL has had the opportunity to review the comments submitted by the National Waste & Recycling Association (NW&RA) in response to the SBAR outreach briefing. We support these comments which include concerns that owners and operators have, particularly for small businesses like AEL, in regards to the proposed rule and justification for suggested changes.

In particular, we agree that EPA should: 1) maintain the current nonmethane organic compound (NMOC) emissions threshold of 50 Mg/yr, 2) retain the current approach for surface emissions monitoring, 3) modify wellhead standards to eliminate temperature, and oxygen/nitrogen monitoring requirements, and 4) adopt non-numeric requirements for LFG treatment standards. Supporting discussions specific to these issues is provided in the following section. Other topics are covered in the NW&RA comments that we support.

NMOC Emissions Threshold

Reducing the NMOC emission threshold will only prolong the amount of time AEL is required to operate the GCCS after the landfill closes and gas production declines. Operation of a GCCS at a closed landfill, where reduced gas quality and quantity can be expected, has been shown to be a significant economic burden. It becomes increasingly more difficult for gas wells to meet the wellfield operating standards, and facilities frequently have to combust supplemental fuels to maintain flare operations. While this is not a burden that would affect AEL in the next few years, it would certainly impact operations and costs in the future; Therefore, AEL does not support the lowering of the NMOC emission threshold.

Expanding Surface Emission Monitoring (SEM) Requirements

AEL understands the rational for proposed restrictions on SEM events during high wind and precipitation conditions, which may reduce the effectiveness of monitoring; however, the rule language should allow for alternatives on a site specific basis. AEL does not currently understand the rational for changing the SEM pattern and requiring both an instantaneous and integrated monitoring requirement. Both of these changes, either by themselves or combined, will be an increased compliance burden on the landfill, and there has been no data provided to support that enhanced SEM is more effective compared to the additional costs.

Wellhead Operating Standards

AEL agrees with industry's recommendation to remove the wellhead performance standards for temperature and oxygen/nitrogen. The current requirements require monthly monitoring of temperature, and oxygen or nitrogen, and initial corrective actions within 5 calendar days, with a subsequent corrective action 15 days later, and expansion of the gas system within 120 days if the first two corrective actions are not successful. These requirements result in an overly burdensome compliance exercise that does not result in NMOC reductions and generally does not result in expansion of the GCCS. In some instances, the wellhead standards are actually obstacles to effective GCCS operation, which can increase LFG emissions.

It is our understanding that the wellhead performance standards for temperature and oxygen/nitrogen were included in NSPS to prevent landfill fires. However, the limits specified in the NSPS are not always appropriate. High oxygen levels can be a signal that waste in the vicinity of the well is old and that LFG production is on the decline; not indicative of a fire. For wells installed in non-producing areas, complying with the wellhead standards can be difficult. Furthermore, waste naturally degrades at varying temperatures, some of which occurs above the NSPS wellhead standard. AEL has specifically experienced this issue at our site and has several wells that naturally operate above 55°C (131°F) with no indication of fire in the vicinity of the well. It should be the responsibility of the landfill/gas system owner/operator to ensure the system is operated to prevent a fire and not a requirement of NSPS or EG.

Gas Treatment Definition

The GCCS installed at the AEL incorporates a gas treatment system where the LFG is compressed, chilled, and dehydrated. The gas treatment system currently meets the definition of gas treatment as provided in guidance documents from the EPA; therefore, AEL is supportive of maintaining the existing definition with no numeric requirements on how the equipment operates. If the EG adopts numeric requirements for LFG treatment, this will likely require a modification/redesign of the existing equipment to achieve those levels. We would also have to install, maintain and operate continuous monitoring equipment to demonstrate these criteria are met during operation of the system. This would result in an increased expense and compliance burden on our facility.

In addition, the gas treatment system is not an emission point, but rather a physical process where the LFG is prepared for combustion in LFG-fired generator sets. In the case of AEL, the LFG-fired generator set is the emissions point for the LFG. The operation of the generator set in accordance with the applicable NSPS and National Emission Standards for Hazardous Air Pollutants (NESHAP) (in this case the Reciprocating Internal Combustion Engine [RICE] Maximum Achievable Control Technology [MACT] and the NSPS for spark ignition engines), ensures that the appropriate reduction in emissions occurs. Specifying numerical criteria for equipment to qualify as gas treatment will not affect the resulting emissions from the generator sets or from any other part of the GCCS. Therefore, incorporating numerical criteria into the EG will only be an increased burden with no measureable improvement in emissions.

We appreciate your consideration of these comments. If you have any questions, please feel free to contact myself at (918) 245-7786.

Sincerely,

Todd Green
General Manager

DECATUR HILLS, INC.

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April 28, 2015

Caryn Muellerleile (via e-mail)
Office of Policy
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

RE: Comments on the Municipal Solid Waste Landfills Emissions Guidelines

Dear Ms. Muellerleile:

As a Small Entity Representative (SER), Decatur Hills, Inc. (DHI) is pleased to have the opportunity to participate in the development of rules and regulations that affect our industry, specifically the proposed *Municipal Solid Waste (MSW) Landfills Emission Guidelines (EG).* We worked in collaboration with other SERs to develop the comments that are being submitted by the National Waste & Recycling Association (NWRA) and Alpine Waste & Recycling.

DHI fully supports these comments which explain many of the ways that the proposed EG would affect landfill owners and operators, with a particular emphasis on small entities, including small commercial and municipal stakeholders.

We believe that the proposal outlined in the previously referenced comments will benefit our facility with greater clarity, which is essential to the long-term planning for our facility, as well as the flexibility to react to site-specific conditions to effectively manage our gas collection and control system in a way that is effective, practical, and affordable.

If you have any questions about these comments, please contact Curt Publow, at 317-270-5543 or via e-mail cpublow@bestway-disposal.com.

Very truly yours,

Decatur Hills, Inc.

Weaver
Consultants
Group

April 28, 2015

Caryn Muellerleile (via e-mail)
Office of Policy
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

RE: Comments on the Municipal Solid Waste Landfills Emissions Guidelines

Dear Ms. Muellerleile:

The purpose of this letter is to submit comments on the briefing materials for the *Municipal Solid Waste (MSW) Landfills Emission Guidelines (EG)* , which was presented at the April 14, 2015 SBAR outreach meeting with the Small Entity Representatives (SERs). As a SER, I am pleased to offer the following comments and appreciate the EPA's willingness to carefully consider how proposed changes to the MSW EG will affect small entities.

General Comments

The current EG rule has served the industry for many years, and many small entities have established business models that account for the possible costs associated with expanding over the current design capacity threshold. Given the limited cash flow and resources of a small entity, even small changes in timing, duration, or applicability associated with landfill gas control have significant effects on the viability of small entities. For example, above and beyond the capital costs for installing a landfill gas collection and control system (GCCS), are the costs associated with installing the need electrical infrastructure to power blowers, the additional electrical costs, and the staff needed to operate, maintain, monitor, and comply. Considering these costs, small entities must carefully consider possible landfill expansions and/or increase in waste acceptance fees. As such, it is requested that applicability and current thresholds not be changed at this time

In order to help promote consistency across state lines, we recommended that with any proposed changes to the EG that the EPA also prepare the Federal Implementation Plan (FIP) for the EG at the same time. This will allow states without too much variation, to use the FIP as a model for their SIP.

The following address each of the items as they were presented at the April 14, 2015 meeting.

Specific Comments

Size and emission thresholds – For the reasons discussed above, the size and emission thresholds should remain unchanged. Certainly, lowering the size and emission threshold will have some additional benefit of reducing NMOCs and methane; however, the cost and burden is too great. In the EPA's Economic Impact Analysis (EIA) (docket ID Number EPA-HQ-OAR-2003-0215-0045) and the preamble discussion and the *Air Emissions from Municipal Solid Waste Landfills – Background Information for Final Standards and Guidelines*, EPA-453/R-94-021 (BID) for the 1996 NSPS support the design capacity of 2.5 million megagrams (Mg) and 2.5 million cubic meters (m^3). The current threshold continues to ensure that the rule will achieve the maximum level of potential emissions reductions cost-effectively. The current design capacity threshold of 2.5 million Mg and 2.5 million cubic meters, remains appropriate because there has been no change in the circumstances underlying EPA's original standard.

If EPA lowered the design capacity, the additional sites brought into the program would be smaller, older, and predominantly closed landfills with far less capacity for LFG generation and far less potential for achieving emissions reductions, particularly if they are unable to support an active gas collection system. Closed landfills have no revenue stream to support new regulatory requirements beyond those anticipated in the closure plan. Furthermore, regulating those sites would disproportionately affect small facilities.

It was discussed in the meeting that the EPA also is considering reducing the NMOC emissions threshold from the current 50 Mg/yr to 40 or 34 Mg/yr.

Similar to changes in the design capacity, there is concern that lowering the emissions threshold will only have a slight reduction in NMOCs with a substantial impact on costs and regulatory burden. EPA found that reducing the NMOC threshold would increase cost of control by more than 26 percent while reducing NMOC emissions by only 13 percent (79 Fed. Reg. 41809).

It is important to note that the cost increase is much higher than what was presented in the EPA's cost/benefit. The EPA's analysis did not assess the consequence of lowering the NMOC threshold for older and closed landfills with declining gas production. If EPA proposed to reduce the NMOC threshold in the EG, older and closed landfills would bear significant economic burden. Reducing the emissions threshold from 50 to 40 Mg/yr NMOC will further delay the point at which a closed landfill can petition to remove controls, exacerbating a situation that is already occurring at the higher threshold. As landfill gas declines over time, some wells will not produce sufficient levels of LFG to maintain the wellhead oxygen/nitrogen operational levels when subjected to continuous vacuum. If EPA finalizes a lower NMOC threshold, this problem will become more pronounced. Many closed landfills struggle to maintain sufficient gas flow to operate their control systems under the 50 Mg/yr threshold. At the lower 40 Mg/yr threshold, landfill owner/operators will need to use increasing amounts of fossil fuel to maintain flare operation as well as the extra energy costs to run blowers. This increases GHG emissions, which is highly counterproductive.

Lowering the size and emission threshold would have the most direct and significant impact to small entities, and given that EPA has not demonstrated that the current threshold is no longer appropriate; the current threshold should be maintained.

Alternative Emissions Threshold Determination (Tier 4) – We support the development of a Tier 4 method. We see real value in the current SEM requirements and would recommend that SEM become more incorporated as a valuable method in determining the timing of the removal as well as the installation of a GCCS. Incorporating SEM into the process of determining when a GCCS must be installed, removed, and/or decommissioned will provide for a more site specific and data driven approach to making the decision about when landfill gas emissions need to be controlled. Given that landfills are faced with different climates, waste acceptance, and cover soil materials, the use of a SEM method as a key tool would mean that determining the need for a GCCS will be based on actual site specific information.

Small entities requested that EPA consider adding a more flexible option that would allow landfill owners/operators to perform SEM to show that surface emissions at a site remain low even where the modeled emission rate shows a threshold exceedance.

By simply relying on a single Tier 1 or Tier 2 test, many sites have and could in the future be required install a GCCS when the site conditions do not warrant control. With Tier 2 testing, a site specific NMOC concentration is determined. This concentration is then used in a mathematical methane generation model which is then used to estimate projected NMOC generation. However, experience has shown that the difference between a mathematical model of potential generation and actual emissions can be substantial. By incorporating the use of SEM procedures in determining the need for installing or decommissioning or removing a GCCS, wasteful spending, consumption of resources, and power could greatly be minimized while the environment will remain fully protected.

We recommend that implementation of "Tier 4" not be a sequential procedure, but rather that it be a method that could be employed instead of a Tier 1 or Tier 2 test or at any point following a Tier 1 or Tier 2 test in which the NMOCs have been calculated to be greater than the NMOC threshold and prior to the required installation of the GCCS. In addition, we propose that this method also be used in determining when to remove the NSPS requirements for all or portions of an existing GCCS. This approach to using "Tier 4" would enable SEM to gather site-specific information at a landfill or area of a landfill to determine if the actual data supports the need for a GCCS.

EPA's briefing package for the SBAR indicates that corrective action might not be allowed if a landfill uses the Tier 4 option. This would be counterproductive and undermine the usefulness of the tiered approach. It is also inconsistent with the California Landfill Methane Rule, which allows a landfill owner/operator to take steps to remediate a methane exceedance such as adjustments to the gas collection system or cover repairs. If those actions correct the exceedance as documented with re-monitoring, then a new or expanded GCCS would be unnecessary. Should a site owner/operator be unable to remediate an exceedance, the site will be required to prepare a GCCS design plan within one year of the initial Tier 4 SEM exceedance, and within 30 months of the initial exceedance a GCCS would be installed within the monitored area.

The addition of a Tier 4 method has all the benefits of protecting the environment, providing for site specific conditions that vary across the country, and reduce unnecessary use of resources and costs.

Enhanced surface monitoring – We recommend that the surface emissions monitoring (SEM) requirements not be changed. EPA asked for the SER's comments on three provisions in the California Air Resources Board's (CARB) Final Regulation -- Methane Emissions from MSW Landfills (CA LMR) including: 1) reducing the interval for the walking pattern from 30 meters (98 ft.) to 25 ft.; 2) adding an integrated methane concentration measurement; and 3) allowing sampling only when the average wind speed is five miles per hour or lower, or the instantaneous wind speed is below 10 miles per hour.

In response, we support the study by SCS Engineers commissioned by Waste Management and Republic Services which compared the level of effort, costs, and monitoring results associated with implementing the CA LMR at public and private landfills to the SEM requirements in subpart WWW.

The study found that reducing the walking pattern interval for instantaneous monitoring from 30 meters (98 ft) to 25 ft did not deliver commensurate benefits. There is an extraordinary amount of costs to detect exceedances at merely a fraction of additional acres monitored. Similarly, there is a significant amount of cost and burden associated with integrated monitoring, with insignificant results. These increased monitoring costs would place a significant burden on both large and small entities, but particularly for small local governments that own and operate landfills.

Given that the SEM takes place with a probe near the surface, the effect of wind speed is minimal. Adding wind speed parameters will make it very costly if not impossible to be able to perform SEM at some sites. The intent of SEM is to determine if and when additional collection devices are needed. If there is sufficient surface emissions occurring to warrant the installation of a collection device, the wind speed at ground level will not be an issue and it will be detected. It is understood that surface emissions from isolated small cracks or crevices in the landfill surface may not get detected at higher wind speeds; however, as previously mentioned, the intent is to find the areas with sufficient amount of LFG escaping that it would warrant collection devices. The current SEM program and requirements have been proven with years of experience as proof, that surface emissions are being detected and corrected

Please note that by adding a wind speed requirement, there will be additional recording keeping, monitoring, and reporting burdens. It is highly likely that during a SEM event, the monitoring would need to be postponed or rescheduled with changes in wind speed. In most cases the SEM is contracted to a third party, the added cost of having to postpone or reschedule SEM due wind speed will create an additional cost burden.

Adding a wind speed requirement would fall in to the category of adding costs and burden without adding benefits and as a SER it is recommend that a wind speed parameter not be included in the proposed EG.

Wellhead operating standards – As has been stated in previous comment letters, it is recommended that EPA remove the temperature and oxygen/nitrogen wellhead operating parameters from the NSPS and EG rules. Members of the landfill sector have provided these comments to EPA and state agencies over the past several years with the proposed amendments to the NSPS. It has been identified that there are many problems with the wellhead parameters that make their implementation counterproductive to optimizing gas collection, system performance and methane emissions reduction.

First, the oxygen/nitrogen and temperature wellhead parameters are poor indicators of the presence of landfill fires or of inhibited decomposition. Oxygen is rarely seen in a gas well, particularly when the system is recovering sufficient gas and producing stable gas flows. When greater than five percent oxygen is detected in a well, the most common problem is a collapsed or pinched well, or a loose fitting or coupling that allows atmospheric air to enter the well. Alternatively, where the landfill owner/operator is implementing early gas collection using shallow horizontal collectors or the leachate collection system, air can easily be pulled into the collectors, causing a temporary increase in oxygen until more waste is placed over the collectors ceasing air intrusion.

None of these examples would cause or contribute to a landfill fire, but they are the most typical circumstances for high oxygen readings in a wellhead.

The temperature of flowing LFG varies widely under normal landfill conditions. Landfill gas is generated by a biological reaction and the greater the intensity of this reaction, the greater the heat produced by the biological activity. Therefore, some newly installed gas wells exhibit elevated temperatures naturally. In order to reduce temperature to meet compliance, the gas flow to the well must be turned off or significantly reduced. This undermines the optimal operation of the system and reduces the overall quantity of landfill gas collected. Although the regulations offer landfill owners the opportunity to establish a higher operating value (HOV) for the well, these alternatives are often ignored or denied by the agencies. Some regulatory agencies claim they are unable to authorize an HOV and simply tell the landfill operator to expand the system, completely ignoring the fact that expansion of the well field will not alleviate the elevated temperature.

Second, the wellhead parameters present barriers to implementing early collection of landfill gas. Many landfill owners/operators understand the environmental benefits of reducing odors and methane emissions by using interim gas collection practices prior to the point at which the landfill is producing enough LFG to warrant a full GCCS. Two such practices include connecting to the leachate collection system and installing horizontal collectors. However, many NSPS/EG sites do not take advantage of these practices solely because of compliance issues with the wellhead operating requirements.

Based on nearly two decades of experience with operating gas collection systems, the landfill sector urges EPA to remove the temperature and oxygen/nitrogen wellhead parameters, and instead rely on negative pressure and SEM to ensure proper operation of the gas collection system. Some states are concerned about landfill safety should the parameters be removed, while other states are supportive of their removal. Although states can always maintain the parameters within their state plans for EG implementation, it is recommended that EPA provide guidance through model rule language. In addition, EPA can provide guidance to the states regarding the problems posed by inflexible adherence to the parameters as good measures of system performance. If states desire to maintain the parameters, EPA might suggest streamlined approaches to approval of HOVs and alternative timelines for corrective action to reduce administrative burdens on the state environmental agencies and the regulated community.

Landfill gas treatment – As a small entity interested in the possible conversion of landfill gas to energy, we need to have all barriers removed that are not directly associated with protection of the environment. As such, we recommend not changing the current definition of treatment by adding numerical requirements and monitoring. The proposed change would be a burden, with no corresponding environmental benefit, that would adversely affect the ability to install and operate a landfill gas to energy facility.

The treatment systems are not a source of emissions. Unlike on-site flaring or combustion of landfill gas, the treatment of landfill gas does not itself control emissions of NMOCs or HAPs and does not produce emissions that are vented to the atmosphere. Instead, treatment is a physical process that filters particulate matter from the gas stream and knocks out moisture in preparation for combustion. Any post combustion of treated landfill gas will be permitted and approved as part of the facility's air permitting. For example, there are already NSPS and NESHAP requirements for engines, boilers, and turbines in addition to local and state permitting requirements. Therefore, the protection of the environment will be maintained and regulated at the point of combustion or release and should not be placed on the treatment equipment.

EPA needs to consider the loss of valuable renewable energy projects that displace fossil fuel powered electrical generation, provide a reliable source of base load energy, and assist in meeting EPA's and states' greenhouse gas reduction goals before proposing requirements that will impact such projects.

Organics management – Encouraging or possibly mandating organics diversion was discussed in the meeting. This should not be mandated or even encouraged in this proposed rulemaking. There is no evidence to support that organics diversion from landfills is more protective of the environment. In fact to the contrary, it has been shown that organic diversion to composting has an increase effect in greenhouse gas and volatile organic emissions. Landfills are highly regulated and controlled facilities that are designed to handle waste materials. The diversion of waste away from controlled landfills to facilities that are less regulated or controlled has the potential to create a myriad of environmental concerns.

I appreciate the opportunity to provide these comments and to serve as SER. In addition to the comments presented in this letter, I support the comments presented by the National Waste and Recycling Association. Should you have any questions, please contact me at mstutz@wcgrp.com or at 817-735-9770.

Sincerely,
Weaver Consultants Group, LLC

Matt K. Stutz, P.E.
Principal/LFG & Air Quality Services

April 28, 2015

Caryn Muellerleile (via e-mail)
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U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460

RE: Comments on the Municipal Solid Waste Landfills Emissions Guidelines

Dear Ms. Muellerleile:

As a Small Entity Representatives (SER), we are pleased to offer the following comments to the briefing materials on *Municipal Solid Waste (MSW) Landfills Emission Guidelines (EG)*. The briefing materials provided a much more focused approach to the MSW EG than the advanced notice of proposed rulemaking (ANPRM) issued last year. As such, these comments focus on addressing the issues contained in the Small Business Advocacy (SBAR) Outreach Briefing and discussed at the April 14 meeting with the SERs.

General Comments

Emissions reductions by the solid waste and recycling sector have been significant. According to EPA's U.S. GHG Emissions Inventory, landfills reduced methane emissions by 38.4% between 1990 and 2013, and many of the emissions reductions are a result of the current *New Source Performance Standards (NSPS) and EG for MSW Landfills.* MSW landfills are one of the only sectors that can claim direct GHG emissions reductions of this magnitude. This demonstrates that the NSPS and EG works well in effectively controlling landfill emissions. Further, the emissions reductions achieved to date have been at a reasonable cost[1].

Should EPA choose to finalize changes to the applicability thresholds associated with landfill size or NMOC threshold, an increasing number of smaller, older mostly closed landfills will be swept into regulation under the EG. The cost burden for compliance e.g., installing a landfill gas system is significantly greater for a small facility than for a large one, especially if the facility is closed and generates no revenue. For example, a significant cost can be incurred simply to mobilize a drill rig. For a facility that installs many wells, the mobilization costs can be distributed over the costs of the wells. For smaller facilities with fewer wells, the individual well cost is greater. Another example is the appropriate level of staffing to address these

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[1] EPA has available recently published information on the efficacy of the Landfill NSPS standards and has discretion to determine, pursuant to section 111(b) of the Clean Air Act, that eight year review is not appropriate for new sources. The Clean Air Act does not mandate eight year review for existing sources. See CAA Section 111(d).

rules and the operation of a GCCS. Larger operations can distribute personnel effectively over multiple sites for efficient and cost effective measures. Smaller operations having one or two sites must either contract services at a premium, or have internal personnel that are justified on a part-time basis. These examples can be carried forward on almost every component of the landfill gas collection and control system: from design, through permitting and construction, to monitoring and operations. Therefore, when considering the burden on small entities, the costs will be significant.

In addition, the considerations, which led to the landfill size and non-methane organic compound (NMOC) applicability thresholds that were in force during the original rulemaking, are unchanged. Therefore, it does not appear that there is any need to modify the rule for additional emissions reductions.

Specific Comments

1. *Federal plan or model rule language* – When the EG was originally promulgated in 1996, states had nine months (December 12, 1996) to submit their State Plans. For many states, EPA extended the State Plan deadline twice giving them until July 31, 1998. For entities without timely State Plans, EPA finalized Federal Plan GGG on November 8, 1999, nearly 3.5 years after the EG was originally promulgated. Unlike 1996 when most landfills were subject to the NSPS, this time most landfills will be subject to the EG. Therefore, it is especially important to ensure smooth transition from promulgation to adoption of a plan. Given the state/local agency resource constraints to prepare state plans, many may opt to simply wait 3.5 years for the Federal Plan. Alternatively, if model rule language is developed when the rule is promulgated, states may use it as a template for State Plans. This will significantly reduce burden on state/local agencies and ultimately the EPA as well as provide consistency across the country. It will also reduce burden on the regulated community that operate in more than one jurisdiction. Therefore, we strongly recommend that EPA develop a Federal Plan or model rule language for states to use in developing their state plans.

   By developing a model Federal Plan or a template for an approvable State Plan at this point in the rulemaking process, EPA would reduce considerable additional burden on the states. EPA would also reduce confusion over regulatory interpretation and inconsistent application of requirements across the states. The existing inconsistency of implementation of the NSPS across states and even EPA Regions creates significant workload and administrative burden for regulators and the regulated community alike. The burden is even greater for small entities that lack staff or consultant resources to manage these implementation problems.

   We note that when EPA promulgated the EG Rule in 1996, it provided regulatory language that outlined how a state could develop an approvable plan by linking emission guidelines requirements to the applicability thresholds, collection and control requirements, design plan requirements, NMOC thresholds, test methods and procedures, reporting and recordkeeping requirements and compliance timelines found in the NSPS. Many states chose to simply adopt the NSPS requirements by reference into their State Plans for the EG. EPA appears to desire a similar linkage between the revised NSPS and revised EG, so a model Federal Plan or State Plan template could be developed in the same manner.

2. *Methane as the regulated pollutant* – In the ANPRM, EPA sought input "on the extent to which methane should be addressed under the revised emissions guidelines" as well as "potential implementation issues associated with any adjustments that could be made to the current rule framework or any alternative frameworks that may achieve a larger fraction of methane emission reductions from existing landfills than the current performance based standard of a well-designed and well-operated GCCS." (79 Fed. Reg. 41781).

   Direct regulation of methane is unlikely to affect the structure of or benefits of the Landfill EG. Landfill gas is composed of roughly 50% methane, 50% carbon dioxide and 1% NMOC (79 Fed. Reg. 41777). The current Best System for Emissions Reduction (BSER) is based on the well-designed and well-operated landfill gas collection system, and a control system for collected LFG that achieves 98% reduction of NMOC (79 Fed. Reg. 41803). This system of BSER is effective for <u>all components of LFG</u>, notwithstanding that EPA identified NMOC as surrogate for LFG in the initial Subpart WWW/EG rulemaking in 1996 (79 Fed. Reg. 48100). In essence, by collecting one compound, you collect them all. Collection systems are not designed or constructed specific to one compound or another. Therefore, adding methane as a pollutant under the Landfill NSPS/EG will not further reduce methane emissions, because they have already been addressed as a component of LFG, and are inseparable from the NMOCs in the LFG. There would be simply no environmental benefit to regulating methane directly. EPA has not demonstrated nor even suggested that there is a more effective way to address methane emissions than already established via the EG's regulation of landfill gas emissions as a whole. It does not appear that there is any more effective or feasible manner in which to reduce methane emissions from landfills than through a well-designed and well-operated landfill gas collection system and control of collected gas to a 98% reduction standard for NMOC, which EPA has reaffirmed is BSER. EPA previously noted, the design and operational standards are appropriate because there is no technically feasible technology available to measure the landfill gas available for collection in comparison to the amount actually collected (56 Fed. Reg. 24484). The same types of collection and control systems reviewed in 1996 continue to be prominently used to reduce landfill gas emissions today and the design and operational standards continue to be robust. Without such a showing, regulation of methane makes no sense. Additionally, regulated entities have made significant investments to design, develop, and install control systems to meet the current 98% NMOC destruction criteria. Re-configuring these existing systems, if possible, in order to target a different pollutant would impose unnecessary financial burdens without any significant reduction in emissions.

Direct regulation of methane would create administrative burden and legal uncertainty for landfills. First, methane emissions are not typically identified as a separate pollutant in landfills' Title V permits; regulation of methane under the EG, as separate from the current regulation of NMOC emissions, could create uncertainty and delay within state permitting programs. Further, given that certain state programs may seek to be more stringent than the NSPS standard, especially with respect to NSPS-based monitoring, recordkeeping and reporting requirements based on state authority, there is an unknown but significant potential for additional burden, misapplication of regulatory requirements and technical difficulty that may arise in this context.

Second, the direct regulation of methane would certainly result in further confusion with respect to EPA's regulation of greenhouse gases under the Prevention of Signification (PSD) program.

Given the foregoing, revisions to the existing rule should maintain the well-designed and well-operated landfill gas collection and control of the collected gas to a 98% reduction of NMOC to demonstrate compliance. The best format for the standard remains a combination of design and operational standards, as currently contained in Subparts Cc and WWW.

3. *Regulatory Proposal Options (Size & NMOC emissions threshold)* – The briefing materials indicate that EPA is considering reducing the NMOC emissions threshold from the current 50 Mg/yr to 40 Mg/yr or possibly 34 Mg/yr. The SERs find this surprising. In the proposed NSPS EPA chose to reduce the NMOC threshold to 40 Mg/yr, and while the Agency sought comment on reducing the threshold in the ANPRM for the emissions guidelines, EPA did not offer a particular threshold level for comment.

   It is important to recognize that decisions regarding the existing design capacity and NMOC threshold for potential landfill emissions are derived using conservative modeling assumptions because it is not technically feasible to measure the amount of gas available for collection. It was on this basis that EPA concluded that it was necessary to establish a design and operation standard for gas collection systems instead of a standard of performance. EPA even recognizes that the default values to determine when a landfill could exceed the threshold and be required to install controls are conservatively high (79 Fed. Reg. 41805). Because of this any emission benefits would be significantly overstated and would result in significant capital expenditures with marginal emissions reductions.

   By lowering the design capacity, the additional sites brought into the program would be smaller, older, and predominantly closed landfills with far less capacity for LFG generation and far less potential for achieving emissions reductions, particularly if they are unable to support an active gas collection system. EPA considered this in the *Air Emissions from Municipal Solid Waste Landfills – Background Information for Final Standards and Guidelines,* EPA-453/R-94-021 (BID) where it was estimated that the 2.5 million Mg/m^3 threshold would capture 85 percent of NMOC emissions potential, while exempting 90 percent of existing small landfills. EPA noted in 1996 the trend towards development of a smaller number of large, new landfills, and this trend has become more pronounced in the last two decades. Closed landfills have no revenue stream to support new regulatory requirements, nor was there the need to consider these types of future costs during the actual operating life of the facility beyond those regulatory conditions anticipated in the closure and post-closure plans. Furthermore, this form of retroactive regulations of those closed or near closed sites would disproportionately affect small facilities.

Reducing the emissions threshold from 50 to as low as 34 Mg/yr NMOC will further delay the point at which a closed landfill can petition to remove controls, exacerbating a situation that is already occurring at the higher threshold. As LFG generation declines over time, some wells will not produce sufficient levels of LFG to maintain the wellhead oxygen/nitrogen operational levels when subjected to continuous vacuum. If EPA finalizes a lower NMOC threshold, this problem will become more pronounced. Many closed landfills struggle to maintain sufficient gas flow to operate their control systems under the 50 Mg/year threshold. At the lower 35 or 40 Mg threshold, landfill owner/operators will need to use increasing amounts of fossil fuel to maintain flare operation. This increases GHG emissions, which is highly counterproductive.

There have been no changes in the circumstances underlying EPA's original standard. EPA has not demonstrated that the current standards are no longer appropriate so no revisions are needed. Any reduction will not result in significant additional emission reductions and thus could impose an unnecessary burden for little or no benefit which will impact mostly closed landfills that do not generate revenue. Many of these landfills are owned by municipalities that would need to pass these costs on to their communities.

4. *Alternative Emissions Threshold Determination (Tier 4)* – Small entities previously requested a more flexible option that would allow landfill owner/operators to perform surface emissions monitoring (SEM) to demonstrate that emissions remain low despite modeled emissions showing a threshold exceedance.

   We support a Tier 4 utilizing the SEM results and recommend that it be available at any point in the life of a landfill, to determine when the GCCS installation requirements are triggered. A Tier 4 method is appropriate because the existing methods of determining when a GCCS system is required are overly conservative or as in the case of the Tier 3 method not even used due to the expense and operational challenges. The existing Tier 1 modeling which every site must use often over predicts the generation of landfill gas and underestimates the amount of methane oxidation that occurs in daily and intermediate cover. A Tier 2 calculation for site specific NMOC concentration emissions is also available; however the site specific concentration is then used in a conservative mathematical methane generation model that only provides a prediction of potential landfill gas generation. We support Tier 4 being allowed out of sequence or instead of Tiers 1-3.

A key benefit of the SEM option is that it incentivizes sites to implement methane reduction practices such as upgrading cover or installing interim gas collection (horizontal pipes, tie-in to leachate collection system) as quickly as possible. These practices can be implemented far more quickly and cost-effectively than designing, constructing and installing a GCCS. Further, based on the fill progression plan, it may be better for GCCS operations if temporary, interim control measures are allowed followed by a final system when conditions warrant.

A second important benefit is that the SEM results will reflect the differences in gas generation as a result of different climates. These differences are lost in the default Tier 1 calculations and an exacerbated in Tier 2. As stated previously above, EPA has even recognized that the default values are conservatively high for when a landfill triggers installation of a GCCS. A Tier 4 approach would allow the landfill owner/operator to quickly determine whether remedial work with the cover will correct the emissions exceedance or whether installation of the gas collection system is warranted. This will prevent installing a GCCS prematurely at a landfill that would be costly and difficult to operate because the gas quality and quantity are not sufficient due to the conservative model used for triggering a GCCS installation. In dry climate where the model defaults overestimate LFG generation, and NMOC concentrations tend to be higher, GCCS requirements are triggered at landfills where SEM requirements can easily be met in the absence of a GCCS. For smaller sites, this could mean the difference between an interim GCCS followed by a final system versus a one-time installation that serves both functions poorly.

We suggest implementing Tier 4 SEM as follows: The owner/operator would follow the Tier 4 SEM utilizing the same SEM methods currently established in subpart WWW. If during this monitoring event no exceedance of 500 ppm over background is detected, then the installation of a GCCS will not be required and quarterly SEM testing will be performed thereafter until the landfill or area of the landfill is closed. Closed portions of an active landfill may also be reviewed using the SEM approach; however, if no SEM exceedances are detected, those closed areas will no longer be required to be tested as a part of any subsequent Tier 4 SEM events. States would review and verify the use of Tier 4 in the same manner that they review and verify quarterly surface emissions monitoring and threshold determinations under the current Subpart WWW.

EPA’s briefing package for the SBAR indicates that corrective action might not be allowed if a landfill uses the Tier 4 option. This would be counterproductive and undermine the usefulness of the tiered approach. It is also inconsistent with the California Landfill Methane Rule, which allows a landfill owner/operator to take steps to remediate a methane exceedance such as adjustments to the gas collection system or cover repairs. If those actions correct the exceedance as documented with re-monitoring, then a new or expanded GCCS would be unnecessary. Should a site owner/operator be unable to remediate an exceedance, the site will be required to prepare a GCCS design plan within one year of the initial Tier 4 SEM exceedance, and within 30-months of the initial exceedance a GCCS would be installed within the monitored area.

5. *Enhanced surface monitoring* – EPA asked for the SER's comments on three provisions in the California Air Resources Board's (CARB) Final Regulation -- Methane Emissions from MSW Landfills (CA LMR) including: 1) reducing the interval for the walking pattern from 30 meters (98 ft.) to 25 ft.; 2) adding an integrated methane concentration measurement; and 3) allowing sampling only when the average wind speed is five miles per hour or lower, or the instantaneous wind speed is below 10 miles per hour.

   In response, the SERs would point EPA to the study by SCS Engineers commissioned by Waste Management and Republic comparing the level of effort, costs and monitoring results associated with implementing the CA LMR at public and private landfills to the SEM requirements in subpart WWW. A copy of this study was provided to EPA[2]

   SCS analyzed data from 72 California landfills regulated under the CA LMR, which took effect in mid-2011. Because CA LMR requirements are more stringent than the NSPS, after mid-2011, the landfills subject to the NSPS (42) in the dataset followed LMR requirements and reported the relevant data to the State of California and EPA, as appropriate. SCS obtained the aggregate NSPS monitoring results by reviewing quarterly monitoring reports developed from up to two years (8 quarters) prior to implementation of the CA LMR (3rd quarter 2009 through mid-2011). Of the total 72 landfills in the study, 41 were publicly-owned and 31 privately-owned. Small entities own or operate at least seven of the studied landfills. The study focused, however, on the 42 NSPS landfills looking at pre and post CA LMR surface emission monitoring programs.

   The study found that reducing the walking pattern interval for instantaneous monitoring from 30 meters (98 ft) to 25 (ft) and monitoring all penetrations did not deliver commensurate benefits. In the two years before CA LMR, exceedances were detected at only 1.6% of all acres monitored and only 2.7% of all monitored penetrations. Only 1.2% of all exceedances were unable to be remedied by simple cover repair or collection system adjustments within the first 20 days, thus triggering the 120-day GCCS expansion requirement. All of these exceedances occurred at one landfill, which subsequently expanded its GCCS.

   In the 30 months since CA LMR implementation, the increased density of the required monitoring resulted in detection of more exceedances during the

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[2] SCS Engineers, A Comparison of Monitoring Results for California Landfills under the New Source Performance Standards and the California Landfill Methane Rule, October 2014.

surface walking. Exceedances were detected at 4.4% of acres monitored, yet the vast majority were easily remedied with cover repairs and did not require installation or expansion of GCCS. Importantly, only two additional landfills were required to expand their GCCS under the CA LMR.

Under the CA LMR program the number of penetrations monitored increased by 84%, but exceedances were detected at only 1.1% of the additional penetrations monitored. It appears that the effort expended to monitor every penetration at a landfill is far less effective in finding exceedances than the more targeted approach of monitoring penetrations when there is a visual or olfactory indication of a problem.

EPA's cost analysis for implementing the enhanced monitoring regime (see Table 5, 79 Fed. Reg. 41823) indicates that adopting the CA LMR approach in the proposed NSPS would increase monitoring costs by more than seven times (from a total annual cost of $50,000 to $362,900) for using a walking pattern that is four times as dense. Further, EPA's recent cost estimates for EG sites indicate incremental annual cost per landfill of $71,400, which is more than 7 times the current estimated SEM costs for an EG site (see Slide 12 of SBAR Outreach Briefing). This is an extraordinary amount of money to spend detecting exceedances at merely an additional 2.8% of acres monitored, while increasing gas collection at only two landfills, at most, based on the SCS analysis. The increased monitoring costs would place a significant burden on both large and small entities, but particularly for small local governments that own and operate landfills. The burden is further exacerbated for owners/operators of closed landfills which have no sources of revenue to offset the incremental costs.

Because the current NSPS/EG does not require integrated monitoring, it is not possible to conduct a before- and after- CA LMR comparison. The available data, however, indicate that integrated exceedances were detected in 2.1% of the grids monitored, and one-half of one percent (0.5%) of grids monitored were required to expand. Furthermore, EPA reviewed and rejected integrated surface monitoring in developing the 1996 NSPS for landfills, and there appears to be no reason to alter that conclusion. Given the additional cost burden associated with integrated monitoring, and the modest results, we oppose adopting this approach under the proposed NSPS.

6. *Wellhead operating standards* - The regulated community, including small entities, recommended that EPA maintain the monthly monitoring requirement but remove the temperature and oxygen/nitrogen wellhead operating parameters from the NSPS and EG rules. The sector recommended that EPA instead rely on maintaining the wellhead pressure standard and quarterly SEM to assure the proper operation of the GCCS. Members of the landfill sector have provided these comments to EPA and state agencies over the last eight years as EPA has contemplated amendments to the NSPS.

In the 1996 NSPS preamble (61 Fed. Reg. at 9912) EPA described the requirement for SEM and the maintenance of negative pressure at all wells, except under specified conditions, as the means to ensure proper collection system design and operation. The wellhead operating parameters for temperature and oxygen/nitrogen were described simply as indicators for determining potential air intrusion; they were not promulgated to ensure proper collection system operation or to determine compliance. Nonetheless, the indicators have been applied in the same manner as compliance standards by several state agencies.

The sector identified many challenges with the wellhead parameters that make their implementation counterproductive to optimizing gas collection, system performance and methane emissions reduction.

First, the oxygen/nitrogen and temperature wellhead parameters are poor indicators of the presence of landfill fires or of inhibited decomposition. Oxygen is rarely seen in a gas well, particularly when the system is recovering sufficient gas and producing stable gas flows. When greater than five percent oxygen is detected in a well the most common problem is a collapsed or pinched well, or a loose fitting or coupling that allows atmospheric air to enter the well. Alternatively, where the landfill owner/operator is implementing early gas collection using shallow horizontal collectors or the leachate collection system, air can easily be pulled into the collectors, causing a temporary increase in oxygen until more waste is placed over the collectors ceasing air intrusion, thereby discouraging earlier activation of the horizontal collection system. None of these examples would cause or contribute to a landfill fire, but they are the most typical circumstances for high oxygen readings in a wellhead.

The temperature of flowing LFG varies widely under normal landfill conditions. Landfill gas is generated by a biological reaction and the greater the intensity of this reaction, the greater the heat produced by the biological activity. Therefore, some newly installed gas wells exhibit elevated temperatures naturally. In order to reduce temperature to meet NSPS compliance, the gas flow to the well must be turned off or significantly reduced. This undermines the optimal operation of the system and reduces the overall quantity of landfill gas collected.
Although Subpart WWW offers landfill owners the opportunity to establish a higher operating value (HOV) for the well, these alternatives are often ignored or denied by the agencies. Some regulatory agencies claim they are unable to authorize an HOV and simply tell the landfill operator to expand the system at a significant and unnecessary cost, completely ignoring the fact that expansion of the well field will not alleviate the elevated temperature. Recently an agency denied temperature HOV simply because the methane was not between 40 and 50% (see ADI Number 1400009, http://cfpub.epa.gov/adi/pdf/adi-nsps-1400009.pdf.). The agency's interpretation is arbitrary, actually prevents sites from implementing early collection BMPs (i.e., tie-in to leachate collection system) and denies operating flexibility for non-producing wells in closed areas. Further this determination appears to conflict with previous determination that

allow for higher oxygen at wells with low methane quality (see ADI Number 0800040 and http://cfpub.epa.gov/adi/pdf/adi-nsps-0800040.pdf)

In addition to HOV requests and determinations, landfill owner and operators also request alternative timelines to complete expansion or corrective actions other than expansion. As with HOV requests, the amount of paperwork can be burdensome and time necessary to obtain an agency response or denial of a request can place a facility in compliance limbo. Most recently, the agency determinations have changed course and are denying sufficient time to determine the root cause of the exceedance and identify necessary repairs based on "EPA Guidance" (see 2/3/14 and 4/3/14 agency correspondence attached). A facility cannot realistically diagnose the reason for the exceedance in 15 days in all cases, yet the agency automatically denies requests based solely on this criterion. In addition, agencies are also denying requests if the landfill cannot provide "substantial reasons beyond the control of the facility owner or operator as to why the exceedances are not completed within 15 days." This written EPA Guidance is burdensome and counter-productive to proper diagnostics and operation of the GCCS. Further, this EPA Guidance was never formally published for stakeholder review and comment or communicated to stakeholders; it just appeared in recent agency determinations.

Sites and agencies spend an enormous amount of resources preparing, processing and justifying HOV and alternative timeline requests and responses. In many cases sites are forced to reduce gas extraction to meet wellhead operating parameters as agencies threaten NSPS violations. It becomes a "Catch-22" of either risking compliance with agency directives or expanding the system in a manner, which will not alleviate the wellhead parameter issue, runs counter to proper operation of the GCCS, and in many cases increases the exceedances. As part of our previous comments, we provided examples of agency correspondence on HOV requests and subsequent approvals and denials. We have attached additional examples for your review that illustrate paperwork burden and but also the amount of time it takes to get an agency response.

Second, the wellhead parameters present barriers to implementing early collection of landfill gas. Many landfill owners/operators understand the environmental benefits of reducing odors and methane emissions by using interim gas collection practices prior to the point at which the landfill is producing enough LFG to warrant a full GCCS. Two such practices include connecting to the leachate collection system and installing horizontal collectors. These early activated systems require a maximum flexibility of design, installation and operation in order to deal with the changing decomposition rate, fill operations and potential early moisture conditions. However, many NSPS/EG sites do not take advantage of these practices solely because of compliance issues with the wellhead operating requirements. Horizontal collectors and leachate systems are effective at capturing early gas production, but often have difficulty meeting NSPS wellhead operational parameters.

Despite the environmental benefits of early gas collection, only a few states have accommodated early collection systems with flexible alternatives to the wellhead operating parameters. However, too few agencies are willing to review and grant such flexibilities for various reasons including lack of resources, conflicting determinations from EPA and lack of personnel who understand landfill operations.

Based on nearly three decades of experience with operating gas collection systems, the landfill sector urges EPA to remove the temperature and oxygen/nitrogen wellhead parameters, and instead rely on negative pressure and SEM to ensure proper operation of the gas collection system. Some states are concerned about landfill safety should the parameters be removed, while other states are supportive of their removal. California did not include temperature and oxygen/nitrogen wellhead parameters in its Landfill Methane Rule. In addition, several local California air management districts (South Coast, Bay Area AQMD) promulgated landfill rules prior to 40 CFR WWW. These air basin rules do not include temperature and oxygen/nitrogen wellhead parameters. Over the last 20 years, no negative impact to safety or the environment can be associated with lack of temperature and oxygen/nitrogen wellhead parameters in the air basin rules or the recent California landfill methane rule.

Although states can always maintain the parameters within their state plans for EG implementation, we recommend EPA provide clear direction to agencies through model rule language. In addition, EPA can provide guidance to the states regarding the problems posed by inflexible adherence to the parameters as good measures of system performance. If states desire to maintain the parameters, EPA might suggest streamlined approaches to approval of HOVs and alternative timelines for corrective action to reduce administrative burdens on the state environmental agencies and the regulated community.

Note that the oxygen and temperature requirements were not included in the CA LMR, based on CARB's review of similar experiences as detailed above.

7. *Landfill gas treatment* –The landfill sector has been implementing beneficial, landfill gas-to-energy (LFGTE) projects long before the Landfill NSPS was implemented. After more than two decades of successful operation of LFGTE projects, it was disappointing that EPA was considering prescriptive LFG treatment requirements not required in manufacturer's specifications for proper operation of our engines, turbines, or other end use equipment. The docket for the proposed NSPS did not provide any analysis or demonstration of the emissions reductions that would occur from the proposed changes to treatment requirements, and provided little detail regarding a cost analysis. The only analysis found in the docket was a 2005 memorandum, nearly a decade old, evaluating Jenbacher and Waukesha engines, and Solar turbines. Not only have the engine manufacturer's updated their operating specifications for the engines since 2005, but the engines are not widely used within the landfill industry and

are thus not relevant to a review of operational requirements for beneficial LFGTE projects.

In addition, treatment systems are not an emissions source. Because treatment systems are not an emission source, additional requirements will not result in any emission reductions. Given the above, we suggest that these requirements are unnecessary. After all, treatment systems merely optimize the characteristics of the gas to match the specifications required by the end-use activity for which it is intended.

Unlike on-site flaring or combustion of landfill gas, the treatment of landfill gas does not itself control emissions of NMOCs or HAPs and does not produce emissions that are vented to the atmosphere. Instead, treatment is a physical process that filters particulate matter from the gas stream and knocks out moisture in preparation for combustion. In light of the physical properties of landfill gas, the treatment system may be equipped with emergency or safety vents for non-routine emissions. For any such vent, the Landfill NSPS requires 98% control of NMOC or an outlet concentration of less than 20 ppmvd at 3% oxygen, consistent with control device, emission standards established there under. *See* 40 CFR §60752(b)(2)(iii)(C). Under the currently effective regulations, EPA did not establish any emission limit or operating requirements that would apply to the treatment process itself, correctly reflecting that landfill gas treatment does not produce emissions that may be monitored or subjected to specific operating parameters. The CAA defines standard of performance to mean a "standard for *emission* of air pollutants." 42 U.S.C. § 7411(a)(1). Moreover, the central thrust of Part 60 is to require owners and operators to "maintain and operate any affected facility, including associated air pollution control equipment, in a manner consistent with good air pollution control practice *for minimizing emissions."* 40 CFR § 60.11(d). Given that EPA has already determined that the routing of collected gas to a treatment system is an effective alternative to a control device, and since no emissions occur from the treatment process, no additional requirements for such treatment are warranted.

The landfill sector is very concerned that the costs of implementing the proposed treatment and monitoring requirements will be so great that many existing LFGTE projects will be forced to shut down and few new projects will be feasible. Chiller installation is expected to cost $500,000 with an additional $150,000 cost for continuous emissions monitors, instrumentation and controls. Operation and maintenance of the equipment is at least $60,000 per year and typical electricity costs are another $60,000 per year. These enormous expenditures will significantly burden small public and private entities and most importantly, will provide no additional emissions reductions.

EPA needs to consider the loss of valuable renewable energy projects that displace fossil fuel powered electrical generation, provide a reliable source of base load energy, and assist in meeting EPA's and states' greenhouse gas reduction goals before proposing requirements that will significantly impact such projects.

Instead of meeting a numerical standard, EPA can implement a work practice standard that includes manufacturer or end user specifications outlined in a project-specific Preventive Maintenance Plan (PMP). By tying treatment requirements to either end-user or manufacturer specifications that are documented in a PMP, EPA and the delegated states will have verifiable records of proper operation. PMPs are used in a variety of environmental programs that are premised on proper operation of equipment, such as pollution control devices. The PMP provides a system for documenting management and maintenance practices that protect equipment; maintain warranties; document contractual obligations to third-party users of the treated LFG; and afford regulatory staff an ongoing mechanism for oversight. Typically, states require that a copy of the PMP and all maintenance records be available on site for inspection and/or have identified elements that must be periodically reported to the state agency. A number of states have issued guidance that outlines required elements of an acceptable PMP.

As EPA noted in the preamble discussion of the alternative approach to treatment, the owner/operator of a LFG beneficial use project has a significant interest in ensuring that project devices receive only properly treated LFG that meets the manufacturer's specifications for the device. This will ensure efficient operation of the project, reduce long-term maintenance costs, or provide assurance to end-users of the LFG that it meets their specifications for quality and composition. A "one-size-fits-all" approach to setting LFG treatment standards cannot accommodate the variety of end uses or combustion/conversion technologies available. A PMP can incorporate the specificity needed to ensure that LFG is properly treated for its end use, and can provide an enforceable recordkeeping mechanism to ensure regulators of the same.

Numeric standards coupled with continuous monitoring and recordkeeping are highly counterproductive, and would punish first movers who pioneered LFG beneficial use projects, and might endanger their continued operation due to the inordinate costs of installing unnecessary treatment equipment. The economic viability of some projects has already been compromised. If the Agency pursues numeric standards for treatment system in the NSPS and/or EG, the result will be destabilization in the renewable energy from LFG sector.

8. *Organics management* – As discussed, EPA's WARM model establishes landfill with GCCS and energy recovery to produce fewer greenhouse gases than composting facilities. Indeed, there are other numerous reports demonstrating higher, uncontrolled emissions including volatile organic compounds (VOC) from composting facilities. See attached documents for more information. Therefore, we do not recommend that the rule take either approach proposed in the briefing.

9. *Installation and expansion and removal of the GCCS* – The existing GCCS installation and expansion timeframes should be maintained. In particular, reducing the five-year timeframe for active areas of the landfill can lead to personnel safety concerns, as well as frequent damage to the system from heavy equipment and normal waste filling operations. Furthermore, early installation of gas collection equipment can cause increased waste settlement, which in turn affects gas header and piping alignment. This results in system disruptions and downtimes due to the need for frequent repairs. Finally, permitting a GCCS can be a lengthy process. A construction permit is required prior to initiating construction of a GCCS. While EPA assumes that sites can obtain permits within six months of application, permitting often takes more time. Depending upon the size and location of the project, the air permitting process for the control devices could extend several months to two years <u>after</u> the permit application is submitted. Since the facility cannot commence construction of the GCCS (i.e., excavation, delivery of equipment) until the final permit has been issued, permitting can cause unforeseen delays.

10. We also recommend that EPA also consider the criteria and timing of when a GCCS can be capped or removed. At that time, additional environmental benefits could be realized by clarifying that the GCCS does not have to be capped and removed when the criteria are met. Instead landfill owners should be allowed to operate the GCCS but no longer be required to comply with the NSPS requirements. Some landfills may still want to intermittently operate the gas system but the rule language could be misconstrued to not allow on-going but intermittent operation.

    The difficulties associated with operating a landfill gas collection and control system on low gas flow also suggest that EPA should reconsider its one-size-fits-all requirement that such systems must operate for a minimum of 15 years. The only reason continued operation of those systems is appropriate for closed landfills at all is to ensure emissions are minimized until the generation of landfill gas slows enough to warrant a discontinuation of control efforts, regardless of how long the system has actually been in operation. The 15-year requirement has also led to confusion and inconsistent interpretations among some states due to the lack of clarity regarding when the 15-year clock should start. EPA needs to reconsider the need for an arbitrary 15-year requirement for continued operation of controls on a closed landfill. As an alternative, EPA could at least clarify that requirement by providing clear guidance regarding when the 15-year clock should begin to run.

    The change in the NMOC threshold discussed above will be even more significant for landfills once they are closed and seeking to shutdown the controls system and exit the NSPS program. At a lower 34 - 40 Mg threshold, landfill owner/operators will need to use increasing amounts of fossil fuel to maintain flare operation. This increases GHG emissions, which is counterproductive. Because EPA does not plan to change the criteria for determining when a GCCS may be capped or removed, and those criteria currently require emissions to drop below the same threshold that triggers the need for the system, EPA's decision to lower that threshold from 50 Mg/yr will have significant implications for the closure of landfills.

Even under the current threshold of 50 Mg/yr, many closed landfills struggle to maintain sufficient gas flow to continue operating their control systems. At a lower threshold, operation of a control system will become even more difficult and likely much more expensive, as landfills will be forced to make even more costly modifications to the system just to keep it running on such a low flow of gas.

The below listed small entities appreciate the opportunity to provide these comments. Should you have any questions, please contact Anne Germain at agermain@wasterecycling.org or Alek Orloff at aorloff@alpinewaste.com.

Very truly yours,

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Attachments

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

Compost VOC Emission Factors

September 15, 2010

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I. Introduction

This report provides the basis for the District's organic material composting volatile organic compound (VOC) emission factors (EFs). The organic material composting EFs contain the following categories: green waste, food waste, and grape pomace. However, the focus will be on green waste, since the San Joaquin Valley's inventory of organic material compost is primarily green waste. The EFs will be used for Rule 4566 (*Organic Material Management*) development and permitting applications in the San Joaquin Valley. These organic material composting EFs are not applicable to biosolids, animal manure, or poultry litter, which have been attributed a separate EF.

Accurate emission factors are required for the proper implementation of applicable air quality regulations and also for the evaluation of appropriate technologies and practices to reduce emissions. The VOC EFs proposed in this report are based on a detailed review of the available science. As would be the case with EFs for other sources, the District's EF should reflect the best scientific information that is currently available.

The District composting EFs are summarized below.

Table 1: Summary of District Composting EFs.

Compost Type	Stockpile (lb-VOC/wet ton/day)	Windrow EF Per composting cycle (lb-VOC/wet ton)
Green Waste, Food Waste, Grape Pomace	1.063	5.71
Co-Composting Biosolids, Animal Manure, Poultry Litter	-	1.78

II. Background

A. Air Quality

The San Joaquin Valley air basin has an inland Mediterranean climate characterized by hot, dry summers and cool, foggy winters. The San Joaquin Valley is surrounded by mountains on the east, west, and south sides. This creates stagnant air patterns that trap pollution, particularly in the south of the San Joaquin Valley. Additionally, the sunshine and hot weather, which are prevalent in the summer, lead to the formation of ozone (photochemical smog). Because of the San Joaquin Valley's geographic and meteorological conditions, it is extremely sensitive to increases in emissions and experiences some of the worst air quality in the nation.

The San Joaquin Valley Air Basin is now classified as an extreme non-attainment area for the health-based, Federal eight-hour ozone standard because of the inability to reach attainment of the standard by the earlier serious and severe classification attainment dates. The air basin is also classified as a non-attainment area for the Federal PM-2.5 (ultra-fine particulate matter) standard.

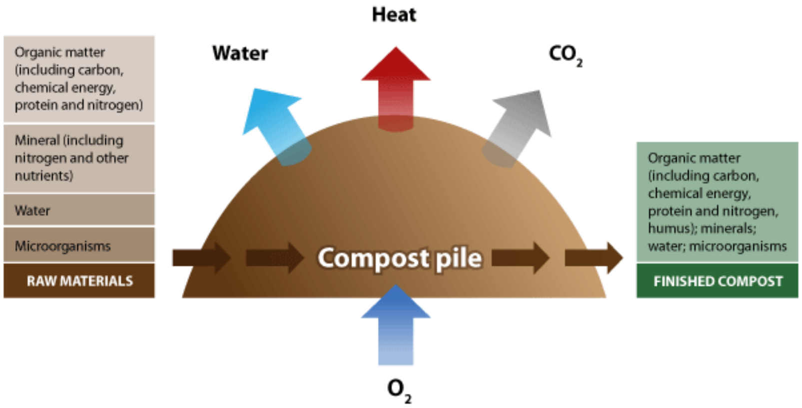
B. Composting

Compost operations can be sources of smog-forming VOCs, fine particulate matter, ammonia (NH_3), and greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4). The emissions are directly emitted from the decomposition of organic material in the San Joaquin Valley. Composting is a process that involves the biological break down of organic matter, typically into marketable products (soil amendments, animal bedding, and alternative daily cover at landfills). Composting uses wastes from a wide-variety of sources, such as curb-side green waste, landscaping, agricultural processing, crop harvesting, food consumption, and forest management.

There are two general categories of composting, aerobic and anaerobic:

Aerobic composting is the decomposition of organic material by microbiological organisms (microbes) in the presence of oxygen (O_2). This oxidation process theoretically results in CO_2, water (H_2O), and organic matter, including nitrates, sulphates and other minerals. Figure 1 below is a visual presentation of theoretic aerobic composting:

Figure 1: Aerobic Compost. (1)



Anaerobic composting is the decomposition of organic matter by microbes in the absence of O_2. During this digestion process, a gas primarily composed of CH_4 and CO_2, known as biogas, waste gas or digester gas is produced. Biogas also consists of nitrogen (N_2), O_2, NH_3, hydrogen sulfide (H_2S), and various VOCs. However, these additional products are generated in relatively small amounts when compared to the amount of CH_4 and CO_2 produced.

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[1] http://www.londonfoodrecycling.co.uk

C. Purpose of the San Joaquin Valley Air Pollution Control District

The San Joaquin Valley Air District is a public health agency whose mission is to improve the health and quality of life for all Valley residents through efficient, effective and entrepreneurial air quality management strategies. To protect the health of Valley residents, the District works toward achieving attainment with health-based ambient air quality standards as required under State and Federal law. To achieve this goal, the District develops and adopts air quality attainment plans that include control measures aimed at further reducing emissions from a broad range of sources, commercial, industrial, and agricultural.

As mandated by Federal Law, the San Joaquin Valley Air District adopted its 8-hr ozone attainment plan to demonstrate how the Valley would reach attainment with the Federal eight-hour ozone standard. In developing the ozone attainment plan every feasible measure to reduce emissions of ozone precursors (VOC and NOx) was explored. Green waste composting was a control measured identified in the ozone plan. As such, plans to develop Rule 4566 (*Organic Material Management*) are in place. However, even though the District will be requiring every practical VOC and NOx control, and will be relying on the state and federal governments to significantly reduce emissions from mobile sources of pollution, the San Joaquin Valley will still need the development and adoption of future, not-yet-developed, clean air technologies to reach attainment by the 2023 deadline. Achieving the goal of attainment with air quality standards will require continued contributions from all industries, businesses, and individuals in the San Joaquin Valley.

D. Permitting Requirements

A critical tool that the air districts use to limit increases in emissions of air pollutants and to assure compliance with air quality regulations is the issuance of conditional construction and operating permits to commercial, industrial, and agricultural sources of air pollution. Since the 1970s, the San Joaquin Valley Air Pollution Control District and its predecessors have issued tens of thousands of conditional permits that are being used to assure compliance with air pollution control requirements throughout the Valley. District permits address the requirements of federal standards, state regulations, and District rules that specifically apply to a source of air pollution. New and modified sources of air pollution are also subject to the more protective requirements of “New Source Review”, which are determined on a case-by-case basis and are also included in the permit. Permit holders, District Inspectors, and others use these District permits, rather than directly reference the complex and voluminous underlying regulations, to verify compliance with applicable air quality requirements.

For new sources, the District begins permitting them as we become aware of their emissions. The permitting threshold for these types of operations is 2 lb-pollutant/day. Currently the District quantifies VOC and NH_3 emissions to composting operations. Therefore, any organic material composting operation which has the potential to emit more than 2 lbs of either VOC or NH_3 per day is subject to District permitting.

III. EF Determination Analysis

Many factors, which are related, affect the composting process that makes it difficult to scientifically analyze composting from an air emissions standpoint. The major factors affecting compost are oxygen, moisture, seasonal temperature fluctuation, temperature increases resulting from microbial respiration, nutrients (especially carbon and nitrogen), feedstock variability and pH. As such, the District will rely heavily on actual test data for this emission factor determination.

A. Green Waste Composting EFs

The chosen EFs are based on the available source test data for organic material composting sites. The District contracted a review of this data to Charles E. Schmidt with the goal of establishing green waste EFs for rule making purposes. The report was intended to identify the tests that utilized appropriate sampling and analytical methods and that were statistically relevant. As a result, the following report was prepared: "Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review", by Thomas R. Card and Charles E. Schmidt, June 2008 (see the Appendix A for the full report). This report will be referred to as the "green waste report" hereafter within this document.

The tests were based on the concept of flux emissions escaping the green waste piles. In this context, flux means the rate of mass flow of fluid gases through a given surface area. For example, the flux emissions may be measured in units of mg-VOC/min-m^2. Knowing the total composting period of time, surface pile area, and pile mass, the flux emission factors may be converted to typical EFs used for permitting and rule making, such as in units of lb-VOC/ton. The flux emissions were primarily sampled using the SCAQMD Modified USEPA surface emission isolation flux chamber method, and analyzed using SCAQMD Method 25.3 for total VOCs.

Table 5.1 of the green waste report summarizes the most relevant green waste composting data. The relevant test locations identified in Table 5.1 are Site X, CIWMB Modesto, NorCal, CIWMB Tierra Verde, and two at SCAQMD Inland. Since the compilation of the green waste report, another relevant test was performed at the Northern Recycling Zamora Compost Facility. This test was also conducted by Card and Schmidt. The summary is contained in Tables 2 and 3 below.

1.) Green Waste Stockpile EF

The green waste EFs shown in the Table 2 below are based on a one day stockpile period. While a one day stockpiling period may not be how every facility in the SJV operates, the EF can be applied on a case-by-case basis when stockpiling time periods are known. Also of note, the source test reports do not show the Table 2 numbers directly. The source tests each reported the stockpile EF based on their own site-specific stockpile period. For example, the Northern Recycling Zamora stockpile test assumed the EF for a 90-day stockpile time. The Northern Recycling Zamora stockpile sampling was performed on days 1 and 7, which is representative of normal SJV stockpiling. To arrive at the 90-day stockpile EF, it was assumed the average rates measured on days 1 and 7 were emitted for 90 days. The District reduced the EF to a one-day basis for this EF report. Each of the other stockpile EFs were normalized to a one day basis as well.

Table 2: Green Waste Stockpile VOC EF

Site	Sampling Age of Material	Season Samples Taken	EF (lb-VOC/wet ton/day)
Northern Recycling Zamora	Day 1 & Day 7	Spring	0.126
NorCal Jepson Prairie (Vacaville)	Day 1	Summer	0.422
SCAQMD Inland	Day 2	Fall	0.907
SCAQMD Inland	Day 2	Fall	2.798
Average			1.063

The District surveyed the green waste composting facilities in the San Joaquin Valley. The result of the survey indicates an average stockpile time of 3.85 days, and ranged from 0-21 days. The Site X stockpile EF was based on sampling at day 45, and is not representative of stockpiling in the San Joaquin Valley. As such, the Site X stockpile test was not included in the stockpile EF. The test at CIWMB (Modesto) contained no stockpile data and does not factor into the green waste stockpile EF. The test at CIWMB Tierra Verde contained no uncontrolled stockpile data and does not factor into the green waste stockpile EF.

2.) Green Waste Windrow EF

Table 3: Green Waste Windrow VOC EF

Site	Sampling Age of Material	Season Samples Taken	EF (lb-VOC/wet ton/day)
CIWMB (Modesto)	Over the Active + Curing Phase (days not sampled were interpolated)	Spring	0.85*
Site X		Summer	6.30
NorCal Jepson Prairie (Vacaville)		Fall	5.65
Northern Recycling (Zamora)		Fall	10.03
Average			5.71

*1.54 was identified in the green waste report after a recalculation to better represent other sites; however, 0.85 was the actual value reported from this test site and will be used in the EF determination.

The test results for CIWMB Tierra Verde indicate the testing was performed for other management strategies, not a typical baseline facility; therefore, does not factor into the green waste windrow EF. The two test results for SCAQMD Inland indicate the windrows tested were extremely small; therefore, does not factor into the green waste windrow EF.

Please note, the values are based on the input material (as wet tons), not finished material. The green waste windrow composting EF is based on a typical active + curing phase composting life cycle (minimum 60 days). The active-phase has been defined at a minimum 22 days for District purposes. The District has also examined the VOC profile split over the course of a windrow cycle. The results are summarized below.

Table 4: Green Waste Windrow VOC EF Active-Phase vs Curing-Phase.

Windrow Phase	Overall EF Active + Curing (lb-VOC/wet ton)	VOC Profile Split (%)	Phase EF (lb-VOC/wet ton)
Active-Phase	5.71	90%	5.14
Curing-Phase		10%	0.57

B. Food Waste Composting EFs

The District has not been able to identify an emission factor for uncontrolled food waste composting. Source tests from controlled composting operations have yielded emission factors ranging from 3.4 lb VOC per ton food waste composted (micropore cover) to 37.1 lb VOC per ton food waste composted (Ag Bag). In addition to the wide range of values observed, it is also unlikely that emissions from a covered system would accurately represent emissions from the open windrow commonly used by facilities in the District. This is because covered systems offer many process control advantages including weather protection and water retention.

Source testing was conducted at the City of Modesto compost facility as a field test study for the California Integrated Waste Management Board (CIWMB). Two goals of this test were to determine VOC emissions from green waste composting and food waste composting. The food waste composting windrows contained approximately 15% food waste (from local food processing plants (e.g. peppers, tomatoes, peaches, and syrup) and 85% ground green waste. The resulting EFs were 0.85 lb-VOC/ton and 1.95 lb-VOC/ton for green waste and food waste respectively. As predicted, the food waste EF was higher than the green waste EF, 2.3 times higher for this test site. Since the average green waste EF has been established at 5.71 lb-VOC/ton, the District considers the food waste EF to be too low to be usable as a stand-alone food waste composting EF since it would be lower than the green waste EF. However, if more data were to become available for food waste composting, the food waste EF from the City of Modesto test site may be used in combination with the new data.

For these reasons, the District will use the green waste composting emission factor to represent this feed stock until a more representative emission factor can be identified.

C. Grape Pomace Composting EFs

The District has not been able to identify an emission factor for grape pomace composting. Therefore, the District will use the green waste composting emission factor to represent this feed stock until a more data is available.

D. Biosolids, Animal Manure, Poultry Litter Composting EFs

Biosolids and animal manure composting emission factors were taken from source tests conducted by the South Coast Air Quality Management District (SCAQMD) in support of their Rule 1133 (Emission Reductions from Composting and Related Operations). These emission factors were calculated as an average of emissions from three co-composting facilities (SCAQMD, 2002) as presented in the Table below.

The District has not been able to identify an emission factor for poultry litter composting. The District will use the biosolids composting emission factor to represent this feed stock until a more representative emission factor can be identified.

Table 5: Biosolids, Animal Manure, and Poultry Litter EFs.

Summary of Co-Composting Emission Factors Developed by SCAQMD		
Location	Emission Factors (lb/wet-ton)	
	VOC	NH_3
RECYC Inc	0.53	2.70
EKO Systems	1.70	3.28
San Joaquin Composting	3.12	2.81
Average	1.78	2.93

Summary

The District composting EFs are summarized below.

Table 6: Summary of District Composting EFs.

Compost Type	Stockpile (lb-VOC/wet ton/day)	Windrow EF Per composting cycle (lb-VOC/wet ton)
Green Waste, Food Waste, Grape Pomace	1.063	5.71
Co-Composting Biosolids, Animal Manure, Poultry Litter	-	1.78

Appendices

Appendix A: "Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review", by Thomas R. Card and Charles E. Schmidt, June 2008
Appendix B: Comments and Responses to the "Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review"
Appendix C: "Northern Recycling Zamora Compost Facility Air Emissions Source Test", by Thomas R. Card and Charles E. Schmidt, May 2009

Appendix A

"Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review", by Thomas R. Card and Charles E. Schmidt, June 2008

San Joaquin Valley
Air Pollution Control District

Organic Material Composting and Drying
focusing on

Greenwaste Compost

Air Emissions Data Review

Report

June 2008

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Figure ES 2 The effect of pile temperature on VOC emissions (from Hentz et al 1996).
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Figure 4.2 Range of area to volume ratios for typical windrow cross-section dimensions.
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Appendices

A SJVAPCD Reference Table and Complete Report Reviews
B Technical Memorandum – Recalculating CIWMB Modesto Emissions
C Confidential Site X Emissions Report

Executive Summary

Useful information regarding air emissions from compost sites can be obtained by assessing the flux (mass transfer from the test surface) of hydrocarbon compounds and other compounds such as ammonia, and then expressing these data as emission factors. An emission factor is obtained by taking representative flux data for an operable unit at a compost site, such as a greenwaste in windrow, multiplying the average flux from the windrow by the surface area of the windrow, and generating an emission factor (mass emitted per time per source). These data can be expressed on a per ton basis, and the site air emissions can be obtained by summing the emission per operable unit, which are obtained by multiplying the mass or surface area of each unit by the respective emission factor. As such, the goal of any air pathway analysis intended to assess air emissions from a compost facility, is to obtain representative emission factor data.

The focus of this research effort is to provide to the District a report of relevant and useful emission factors that can be used in the regulatory process to assess air emissions from a variety of compost facilities. Compost emission factor data from 14 reports were reviewed and prioritized for data quality and completeness. These data consisted of emissions test data from greenwaste, biosolids-greenwaste co-composting, and food waste. All the reports were summarized and critiqued with the individual critiques attached in this report's appendix. A summary table was prepared by San Joaquin Valley Air Pollution Control District (SJVAPCD) staff and is provided in the same attachment.

This report is focused on total VOC emissions as measured by South Coast Air Quality Management District (SCAQMD) Method 25.3. This method is a comprehensive total VOC method and is generally not comparable to other total VOC methods including USEPA Method 25 series and USEPA Method TO-12. Ammonia and some methane data is reported as well, but in general is not discussed further. All VOC data reported here, unless otherwise noted, is VOC per SCAQMD Method 25.3.

The green waste composting data was looked at specifically for data that would be both complete and accurate enough to provide a rule making basis. Three data sets were found to be both complete enough and used the appropriate sampling an analytical methods to generate full site emissions. However, one of the data sets did not have stockpile emissions.

The data from these greenwaste composting sites is summarized below in Table ES 1. The data are averaged for reference only with no implication that the average is representative of green waste compost emissions for the SJVAPCD jurisdiction. The California Integrated Waste Management Board's (CIWMB) values are from their Modesto report and were recalculated to be more comparative to the other data (see attached Technical Memorandum). The emission factor was calculated by taking the total process emissions and dividing that by the mass of material that was in the compost process. For most situations, a facility can estimate their annual emissions using these factors by multiplying the factor times the total annual throughput (compost substrate and amendment). All mass values are for input, not output. There is normally significant mass loss during the composting process.

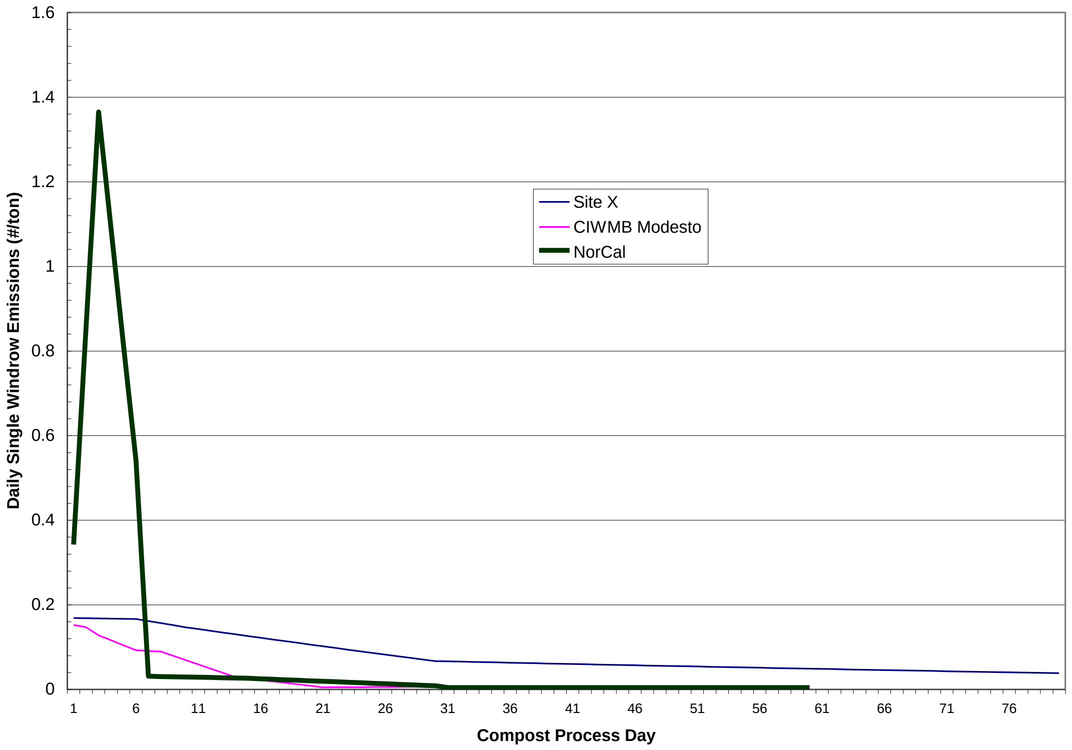
Table ES 1 Summary of greenwaste composting full site VOC emission data (#/ton of feedstock).

Source	Site X	CIWMB	NorCal	Average
Stockpile	7.76		2.95	5.36
Windrow	6.30	1.54	5.65	4.50
Total	14.06		8.60	9.85

These data are even more diverse than this table may indicate. Figure ES-1 shows the daily compost windrow emissions for each of these data sets. The NorCal profile particularly shows a unique characteristic initial cycle VOC spike.

There were other important data sets. The CIWMB Tierra Verde data shows the likely range of unit flux values that will be encountered in California green waste composting facilities. These values bracket the data from the three complete sites suggesting that the complete sites may represent the likely working range of emissions from these types of sites.

Figure ES 1 VOC emission profile for each of the three complete data sets (#VOC/ton feedstock per compost day).



SCAQMD emission factors, currently the only official regulatory values, are briefly discussed noting that they mostly represent stockpile emissions and not compost emissions. The compost emissions from their data appear unrealistically low and are significantly outside the bounds of all the other data sets.

The most relevant food waste composting data was from only one site and provided emissions for various covered compost technologies. The food waste compost technologies were Ag-Bag®, Compostex®, and micropore covers. These cover technologies are described in more detail in the report text. Food waste windrow emission factors ranged from 1.7 to 36.7 pounds VOC per ton of throughput. Food waste stockpile emission factors ranged from 0.42 to 1.8 pounds VOC per ton of throughput.

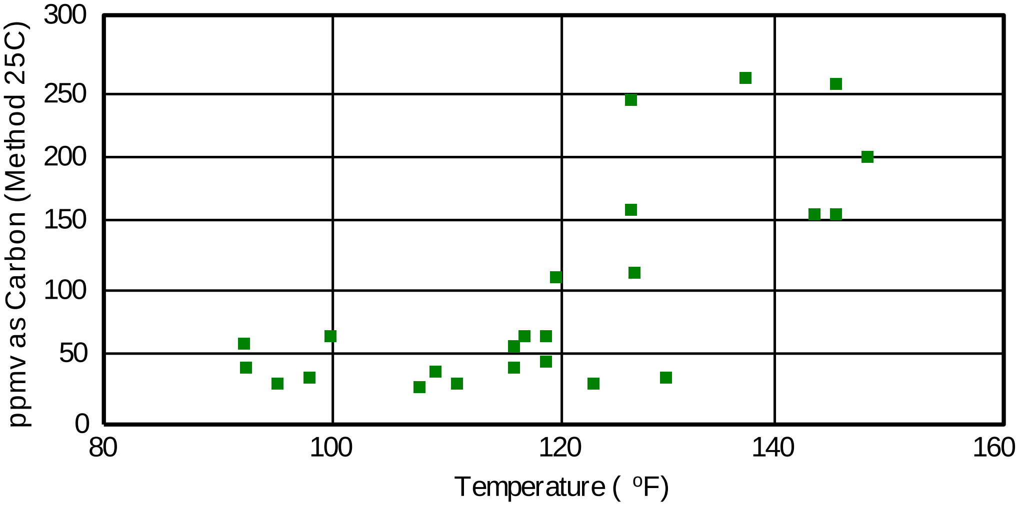
The most relevant biosolids composting data came from two sites. A third site (Las Virgenes) was reported but did not present complete system emissions. One of the sites (LACSD) reported data from both on top of, and underneath, a micropore cover system. The under the cover measured emissions are likely not representative of a normal uncovered process because the affect that the cover has temperature and moisture. In addition, this was a pilot scale facility. The other site was a compliance test for a very large aerated static pile biosolids facility near Bakersfield. The biosolids composting emission factors ranged from 0.2 to 3.7 pounds VOC per ton of total (biosolids plus amendment) throughput.

There is some discussion in this report as to why there is a large variability of emissions found in the compost industry. There are several reasons for this:

- Regional differences is feed stock materials processed at compost facilities
- Seasonal differences in feed stock materials
- Seasonal metrological differences
- Differences in operating procedures and facility management practices
- Size and age of feedstock piles
- Size, shape and orientation of windrows to dominant wind direction
- Solid waste handling equipment
- Control of parameters in the composting process such as aeration or mixing, water content, and temperature
- Compost composition, specifically ratio of carbon-to-nitrogen

The most significant sources of variability in emission factors is likely mostly due to windrow size, feedstock characteristics, waste pile and windrow temperature, and operating characteristics. There was not sufficient data to determine the magnitude of most of these variables, including seasonal emissions variability. Said another way, it is not possible to generate seasonal emission factors for these sources. Seasonal variability likely has both a temperature and feedstock component, which further complicates the determination of emission factor as a function of variable. There has been some previous work showing that the carbon–nitrogen ratio significantly affects air emissions, but again, insufficient information is available to define this effect. Temperature has been studied and there are some data available showing increased air emissions or greater emission factors with increased compost temperature as shown below. This figure shows how temperature affected VOC emissions from an aerated static pile composting biosolids in Philadelphia (Hentz *et al* 1996).

Figure ES 2 The effect of pile temperature on VOC emissions (from Hentz et al 1996).



The data set can not at this time be used to assess the impact of these variable on emission factors or compost site air emissions expressed on an annual basis. However, these limited data do justify the range of emission factors reported herein.

In summary, this report serves to:

1) Present the status quo of the industry air emission data base for the Central Valley;
2) Define the range of emission factors measured;
3) Define the key variables that effect air emissions from compost facilities;
4) Describe current and recommended testing protocols used to assess air emissions at compost facilities;
5) Provide an annotated bibliography of the relevant research with commentary on testing protocols, frequency of sample collection, analytical method, and emission factor generation; and
6) Present the emission factors supported by the data base.

1.0 Introduction

This report provides a comprehensive review of greenwaste composting air emissions data with focus on total hydrocarbon and ammonia emissions. Methane emissions are also presented to a limited extent. The report also presents some limited data on composting biosolids and food waste.

All raw data and original data reports were provided by San Joaquin Valley Air Pollution Control District (SJVAPCD) Staff. Since the method of analysis of total hydrocarbon is regulatory important, and SJVAPCD has adopted South Coast Air Quality Management District (SCAQMD) Method 25.3 as their standard, data is limited to recently tested California sources.

2.0 Background

The air emissions assessment of composting operations is both complicated and resource intensive. Composting can take place either in windrows or in aerated static piles (ASP). Windrows are naturally ventilated and normally mechanically turned on a process schedule. Typical compost windrow dimensions are 3 to 7 feet high, 8 to 20 feet wide, and 50 to 500 feet long. ASP's are large piles that are 8 to 16 feet high with plan form areas of 2,500 to 25,000 ft^2. They are normally underlain with an air distribution system that provides air by either suction or pressure. There also are some hybrid technologies that use a cover on a windrow that also have forced air ventilation systems. Most, if not all, greenwaste in California is composted in windrows that are mechanically turned.

A normal compost cycle lasts from 45 to 90 days. Most greenwaste is on a 60 day cycle. The first half of the cycle can be designated as composting and the last half as curing.

In addition to the windrows, there are also material stockpiles on composting sites that store feedstock and product. The size of these stockpiles is widely variable and is a significant factor in overall site emissions variability.

The emissions from these facilities are difficult to quantify. The emissions from a windrow change daily over the compost cycle. Testing is conducted using approved area source assessment technologies with the goal of collecting representative flux data (mass per time-area) that can be used to calculate emission factors for sources found on compost sites, or operable units (e.g., feed stock piles, windrows, product piles, etc.) Emission factors from operable units or sources are expressed as emissions per ton of materials received, and these data are used to estimate emissions (mass per time) for the facility on an annual basis.

Figure 2.1 shows a daily emissions profile from windrow greenwaste composting. In order to generate this curve, the windrow has to be sampled on several of the 60 process days. As shown on the curve, this sampling should be more intensive at the start of the compost cycle because most of the emissions occur at the start of the cycle and the daily emissions are the most temporally variable. In windrows that are less well mixed there can be significant spatial variability as well. For each compost day, from 2-to-8 individual samples should be taken to assure that the spatial variability is accommodated.

Emissions from these sources tend to be variable. The likely important factors in variability are seasonal temperatures, feedstock variability (regionally and seasonally), and operating parameters. Not a lot is known about how these factors affect emissions. The only quantitative data available are the affects that pile temperature has on VOC emissions. Figure 2.2 shows how temperature affected VOC emissions from an aerated static pile composting biosolids in Philadelphia (Hentz *et al* 1996).

Figure 2.1 Example daily emissions from a greenwaste composting windrow (VOC and ammonia).

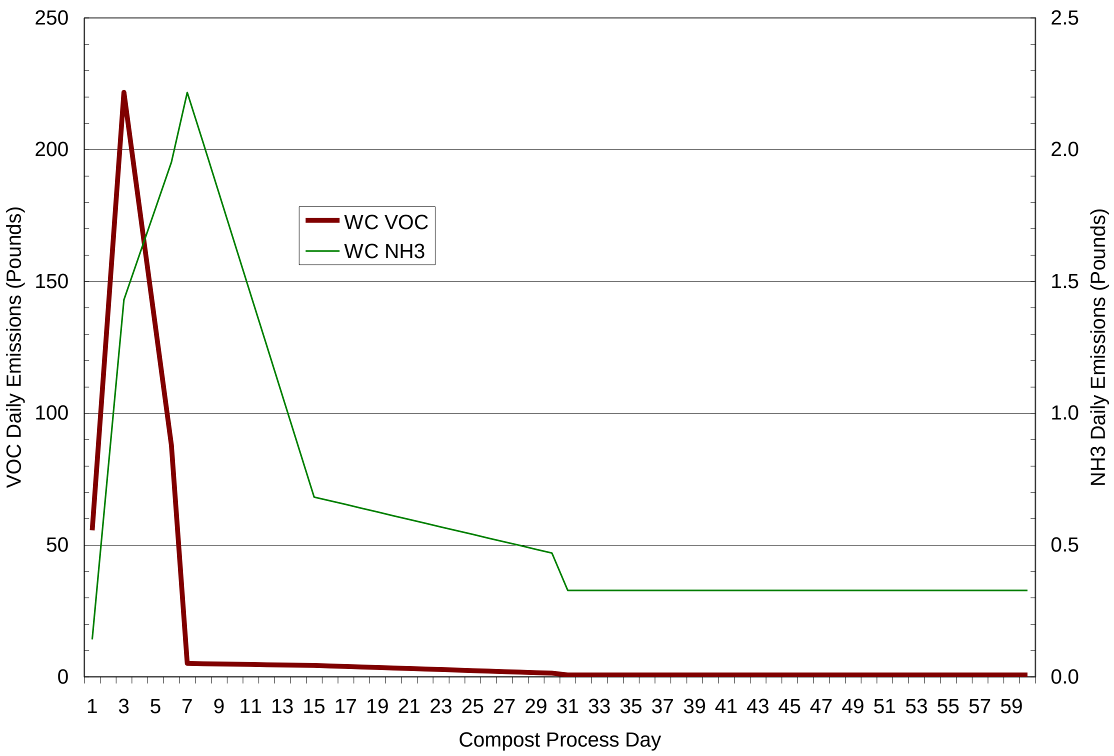
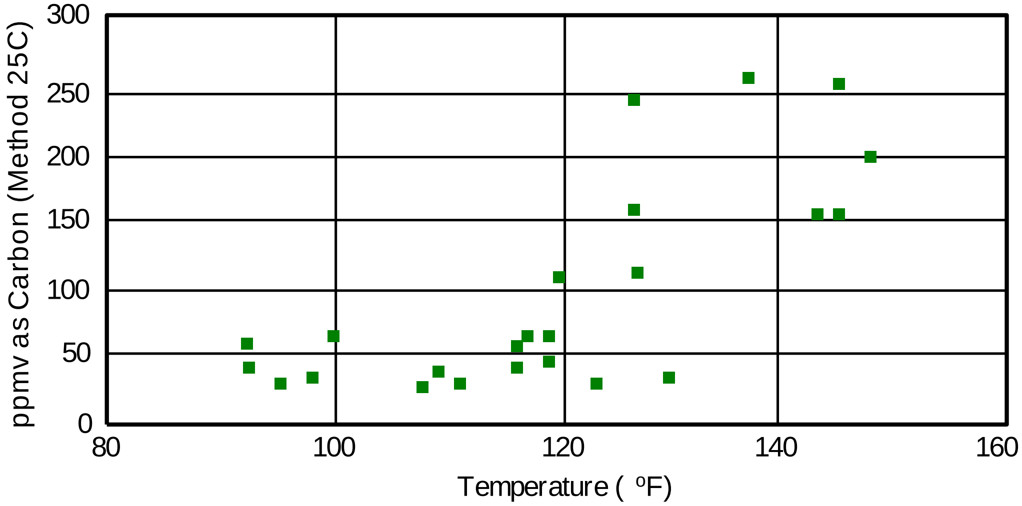


Figure 2.2 The effect of pile temperature on VOC emissions (from Hentz et al 1996).



3.0 Data Evaluation Methodology

This section covers the methodology for the sampling phase of the air emissions assessment and how the data sets were evaluated.

Target Species

The selection of target species was evaluated as best representing VOC emissions. For compost sites, all work was compared to SCAQMD Method 25.3 since it has been shown that this method is capable of collecting and analyzing for all condensable and volatile hydrocarbon species believed to exist on greenwaste, food waste, and biosolids compost facilities. Data representativeness will be discounted in the review for other methods, including SCAQMD 25.1 and USEPA Method TO-15 as compared to SCAQMD Method 25.3.

Sample Collection Methods

As demonstrated by the SCAQMD and indicated in Rule 1133, the preferred method for sample collection or assessment of compound emissions from sources at compost sites is the SCAQMD Modified USEPA surface emission isolation flux chamber technology. All the research reviewed used this technology except one, and this work (Hanaford Compost Site) was discounted as non-applicable and non-representative. On occasion, the USEPA technology was used without the SCAQMD modification, in which case a bias in emission may have been encountered.

Analytical Methods

The appropriate analytical methods for this research are SCAQMD Method 25.3 for VOCs (or total non-methane non-ethane organic compounds) and SCAQMD Method 207.1 for ammonia. Other methods fall short and are identified as such.

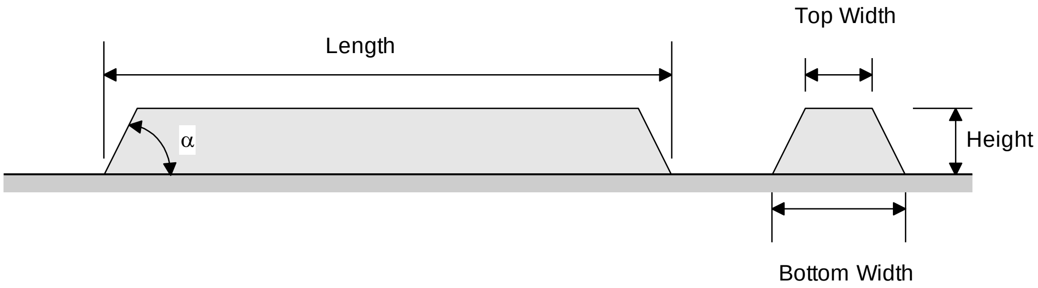
4.0 Emission Factor Development

Once the unit flux data has been obtained, the full cycle emissions are then estimated by the following procedures.

4.1 Compost Pile Configuration

Compost pile dimensions have a high degree of variability. However, they all match the shape shown in Figure 4.1. The key property for the configuration is the surface area to volume ratio. Figure 4.2 shows how this varies for different cross sections. There is over a factor of two difference in surface area to volume ratio between shallow and deep windrows. For the same unit surface flux rate, the smaller row will have twice the emissions on a per ton input basis.

Figure 4.1. – Compost Windrow Configuration.



Mensuration formulas

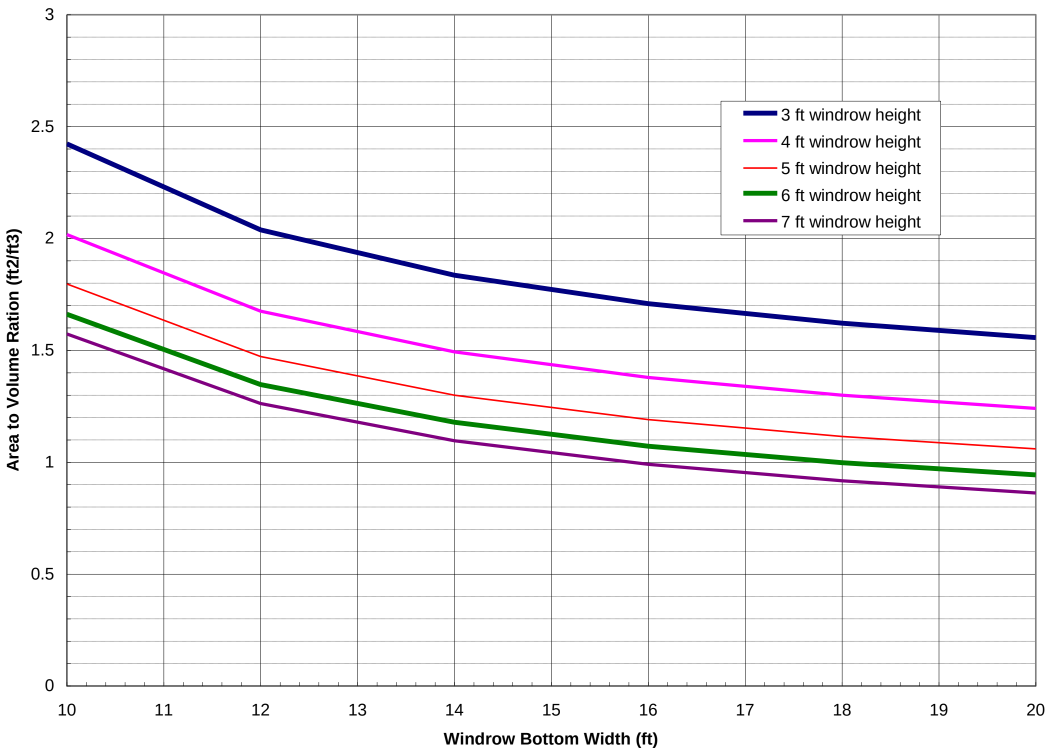
$$S = \frac{p_1 + p_2}{2} s + A_2$$

$$V = \frac{h(A_1 + A_2 + \sqrt{A_1 A_2})}{3}$$

$$s = \sqrt{h^2 + ((W_B - W_T)/2)^2}$$

where S = total surface area, p_1 = bottom perimeter, p_2 = top perimeter, s = slant height, V=volume, h=vertical height, A_1 = bottom area, A_2 = top area, α = bottom angle

Figure 4.2. – Range of area to volume ratios for typical windrow cross-section dimensions.



4.2 Full Compost Cycle Simulation

The unit emission data should be extended to estimate emissions from the full compost cycle using linear interpolation and averaging. Full cycle emissions for each day of the compost process, should then added and the sum of the individual daily emissions should be totalized. The emission factor consists of the full total cycle emissions (in pounds) divided by the incoming feedstock weight (in tons).

4.5 Emissions from Feedstock and Product Storage

The emissions from feedstock and product storage typically are calculated by taking unit flux data (apportioned to different types of materials) and multiplying by the average annual storage surface area. For some data sets, there was more area in storage than in windrows.

5.0 Most Relevant Green Waste Compost Data

This section presents the data found to be most relevant in characterizing greenwaste emissions in the State of California. Table 5.1 presents a summary of this data in both an emission factor and unit emission rate form. The paragraphs below discuss the data points in detail.

Table 5.1 Summary of most relevant green waste composting data.

			VOC							NH3						
			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)		
Location	Material	Activity	(#/ton)	Peak	Avg	Min	Peak	Avg	Min	(#/ton)	Peak	Avg	Min	Peak	Avg	Min
Site X	Landscape Waste	Stockpiles	7.76	186	111	37	2.30	1.38	0.46	0.03	0.62	0.39	0.16	0.01	0.00	0.002
		Windrows	6.30	23	11	3	0.29	0.13	0.04	2.34	26.56	12.07	0.20	0.33	0.15	0.003
		Total	14.06							2.37						
CIWMB Modesto		Windrows	1.54	42	9	0.1	0.51	0.11	0.001							
NorCal		Stockpiles	2.95	110	54	4	1.36	0.66	0.046	0.08	2.1	1.21	0.61	0.03	0.01	0.008
		Windrows	5.65	376	73	1	4.65	0.90	0.010	0.54	7.29	1.68	0.22	0.09	0.02	0.003
		Total	8.60							0.62						
CIWMB TV		Mix HCN		124	42	2	1.53	0.52	0.02							
		Mix LCN		443	110	1	5.48	1.36	0.02							
		UnMix HCN		23	6	1	0.28	0.07	0.01							
		UnMix LCN		38	10	1	0.47	0.13	0.01							
SCAQMD Inland Summer		Stockpiles	4.75		24			0.30		0.01		6.55			0.081	
		Windrows	0.3		6			0.08		1.31		0.32			0.004	
		Total	5.05							1.32						
SCAQMD Inland Winter		Stockpiles	1.96		20			0.25		0.29		2.67			0.033	
		Windrows	0.5		6			0.08		0.03		0.32			0.004	
		Total	2.47							0.32						

5.1 Confidential Site (Site X)

This is the most recent data set, taken in the Spring of 2008. This is a confidential source composting greenwaste in the SJVAPCD. The data set consists of about 20 measurements, all collected with the newly modified SCAQMD flux method and acceptable laboratory method and practice. This site had large stockpiles with about one half the emissions coming from the stockpiles. The stockpiles had about 50% of the surface area as the windrows. The windrow emissions from this site were about an order of magnitude (10 times) the emissions measured by the SCAQMD in 2001, but were not the highest measured of this data group. The site was very well operated with significant attention to process control. This site uses very small windrows with a high surface area to volume ratio.

5.2 California Integrated Waste Management Board (CIWMB) Modesto

This data set was taken in 2006 using the current state of the art methods for that time. The emission factor in this table (1.5 # VOC per ton) was recalculated to better represent the other projects and is about twice the factor presented in their report (see attached TM). Note that the average unit flux value is the same as Site X (about 10 mg/min-m^2), but the emissions are a factor of 4 lower. This is due to a combination of the larger windrows used on this site and the rapid fall off of emissions after initial composting. This was also a well run site. The data set consisted of 36 measurements.

5.3 NorCal Waste Systems

This site is located near Vacaville, CA. The data was taken in 2006. It is a well operated site with larger windrows. The data set consisted of a total of 12 measurements, which is a small number for use in estimating life-cycle emissions. This site had VOC emissions that were about four times greater than the CIWMB Modesto report. The average flux rate was about eight times higher.

5.4 CIWMB Tierra Verde

This data was not sufficient to develop a full site emission factor. What it does provide is a range of unit flux rates for the various process management strategies tested, including carbon/nitrogen ratio and mixing. These average unit flux values, ranging from 6 to 100 mg/min-m^2, completely bracket the previous data sets and appear to provide a valid range of emission rates for the greenwaste composting process. However, the data are insufficient to draw specific conclusions about mixing because there could be high emissions from either handling or stockpiling compost from the non-mixed process.

5.5 SCAQMD Data

The SCAQMD data are provided purely for reference. However, it should be noted that the windrow emissions are extremely small (5 times lower than CIWMB Modesto) and most of the emission factor is from stockpiles. The windrow data is derived from a total of four measurements.

5.6 Discussion

Figure 5.1 presents the daily emission profile for VOC for the three sites that had complete data. Note that the NorCal emissions are dominated by a severe emissions peak that occurred early in the process followed by lower emissions that the other sources immediately after the peak.

Table 5.2 presents a summary of the valid data points with the average value shown. This does not imply that the average value is representative, is only shown for reference.

Table 5.2 Summary of greenwaste VOC emission factors (#/ton feedstock).

Source	Site X	CIWMB	NorCal	Average
Stockpile	7.76		2.95	5.36
Windrow	6.30	1.54	5.65	4.50
Total	14.06		8.60	9.85

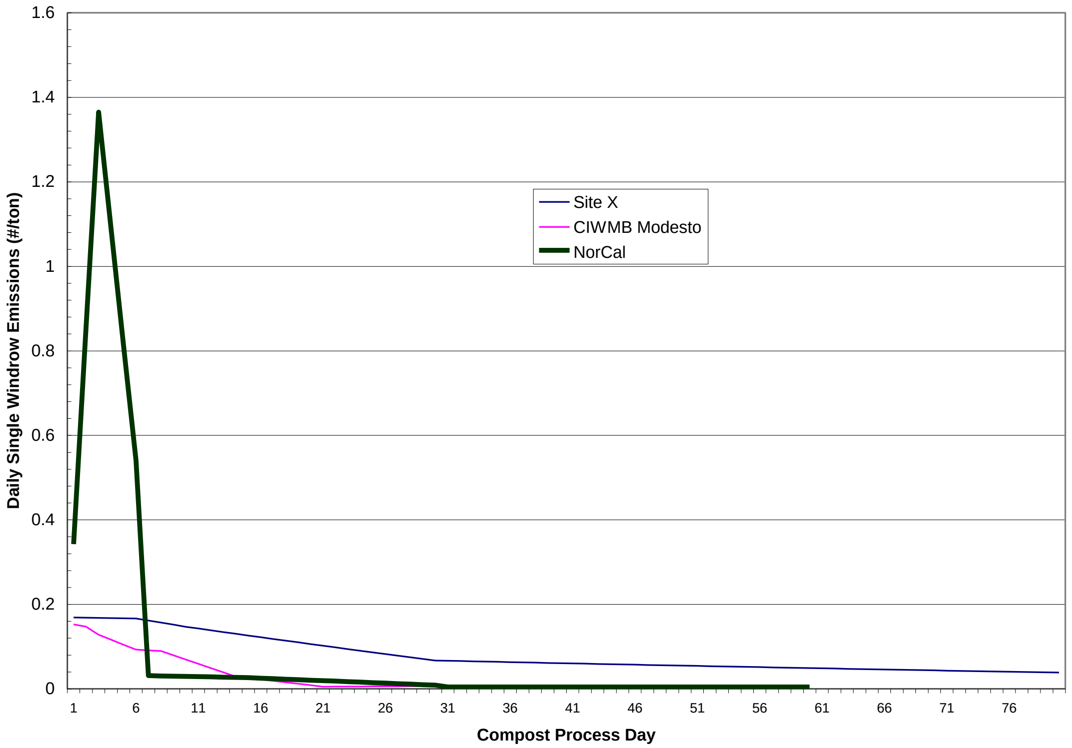


Figure 5.1 Daily VOC emissions profile from Site X, CIWMB Modesto, and NorCal.

6.0 Most Relevant Food Waste Compost Data

This section presents the data found to be most relevant in characterizing food waste emissions in the State of California. Table 6.1 presents a summary of this data in both an emission factor and unit emission rate form. The paragraphs below discuss the data points in detail.

All the food waste data was taken from the NorCal site near Vacaville, CA. The emissions data consists of very comprehensive tests on four food waste composting technologies. All the data utilized SCAQMD Method 25.3 and used the current state of the art flux chamber techniques at the time of the sampling.

The first technology tested was the use of the AgBag® vessel reactor. This consists of a polyethylene bag encapsulated compost windrow that has a small amount of forced air (100 – 300 cfm) into it. The bag is vented by small (5 cm dia) port placed every 20 feet along the bags length on each side. The compost cycle consists of 30 days in the bag and then 30 days of curing out of the bag. During the cure phase, the windrow is mixed every three days using the standard Rotoshredder/Scarab windrow mixer.

The second technology used was the Compostex cover technology. This consists of a standard windrow that is placed and mixed, then covered with the Compostex®

polypropylene cover. The cover is very porous, but does supply insulation and some water retention.

Table 6.1 Summary of most relevant food waste composting data.

			VOC							NH3						
			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)		
Location	**Technology**	**Activity**	**(#/ton)**	**Peak**	**Avg**	**Min**	**Peak**	**Avg**	**Min**	**(#/ton)**	**Peak**	**Avg**	**Min**	**Peak**	**Avg**	**Min**
NorCal	AgBag	Stockpile	0.42	9	4	0.5	0.12	0.06	0.01	0.02	1.05	0.39	0.03	0.01	0.01	0.000
		Windrow	36.7	9,603	1,729	1	119	21.38	0.01	0.7	98.84	13.82	0.01	1.22	0.17	0.000
		Total	37.1							0.7						
	Compostex	Stockpile	1.5	31	12	0.33	0.38	0.15	0.00	0.002	0.02	0.01	0.01	0.000	0.000	0.000
		Windrow	25.4	899	143	0.4	11.11	1.76	0.01	8.1	173	12	0.01	2.14	0.15	0.000
		Total	26.9							8.1						
	Micropore 30	Stockpile	1.8	27	13	8	0.34	0.17	0.10	0.1	6.48	1.45	0.10	0.08	0.02	0.001
		Windrow	9.0	195	32	0.1	2.41	0.39	0.00	14.1	370	21.3	0.00	4.57	0.26	0.000
		Total	10.8							14.2						
	Micropore 45	Stockpile	1.7	27	13	8	0.34	0.17	0.10	0.1	6	1	0.1	0.08	0.02	0.001
		Windrow	1.7	622	33	0.1	7.70	0.40	0.00	1.3	56.4	2.87	0.00	0.70	0.04	0.000
		Total	3.4							1.4						

The last two technologies were micropore covers. These covers are expanded polytetrafluoroethylene (PTFE) membranes encased in a polyester protective covering. The pore size of the PTFE membrane is controlled to maximize oxygen transfer while minimizing water vapor loss. This pore size is a barrier to most non-methane hydrocarbons but not in general to ammonia. The cover provides an opportunity for superior process control due to weather protection and moisture control. The covering system is substantially more costly than the Compostex$^{®}$ system. For the micropore cover system, two cases were evaluated. The first case was for covering the windrow for 30 days, followed by a 30 day uncovered cure period. The second case was for covering the windrow for 45 days, followed by a 15 day cure period. Both cure periods had mechanical mixing every three days. While covered, the micropore windrow received about 300 cfm of forced air on a 10 minute on/20 minute off cycle.

There is really no baseline/no control data for food waste. All the data consists of some level of control technology. The micropore cover system provides the highest level of control at the highest cost. From a regulatory standpoint at NorCal, the AgBag technology was considered baseline. Note that for food waste, better process control that lowers VOC emissions may actually increase ammonia emissions.

7.0 Most Relevant Biosolids Compost Data

This section presents the data found to be most relevant in characterizing biosolids composting emissions in the State of California. Table 7.1 presents a summary of this data in both an emission factor and unit emission rate form. The paragraphs below discuss the data points in detail.

Table7.1 Summary of most relevant biosolids composting data.

			VOC							NH3						
			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)		
Location	Technology	Activity	(#/ton)	Peak	Avg	Min	Peak	Avg	Min	(#/ton)	Peak	Avg	Min	Peak	Avg	Min
LACSD/ Cedar Grove	Uncovered	ASP	3.7	74	15	0.3	0.92	0.46	0.00	4.6	200	27.94	1.56	2.47	1.24	0.019
	Micropore	ASP	0.2	21	2.9	0.3	0.26	0.13	0.003	1.8	279	17.72	1.40	3.44	1.73	0.02
SKIC	ASP/Biofilter	Whole Site	0.2	3.0	0.8	0.2	0.04	0.010	0.002	0.1	5	1.81	0.18	0.06	0.02	0.002
SCAQMD Las Virgenes		Biofilter In	0.8		3.1			0.04		0.7		2.9			0.04	

There were only four biosolids data sets that utilized a VOC test method (SCAQMD 25.1/25.3) that would provide meaningful regulatory data for SJVAPCD. All biosolids composting utilizes some bulking agent or amendment that is almost always greenwaste. So essentially almost all biosolids composting is co-composting with greenwaste.

Three data sets do not really represent baseline/uncontrolled emissions. The Cedar Grove data set utilized an under-the-cover measurement to establish control efficiency for a micropore cover system. The micropore cover does influence the entire compost process so even the under the cover measurement is likely lower in emissions than an uncovered pile or windrow. The Las Virgenes data is from a compost structure, so it represents the uncontrolled emissions from composting in a building, not outdoor composting.

The SKIC data set is from a compliance test at the South Kern Industrial Complex near Bakersfield. The facility was a very large aerated static pile (ASP) facility that had induced air flow controlled by biofilters.

The Cedar Grove data is from the test of a micropore cover for Los Angeles County Sanitation District's biosolids from the Joint Water Pollution Control Plant in Carson, CA. The actual test occurred in Everett, Washington at a facility that was designed to compost greenwaste under micropore covers. As mentioned earlier, under the cover measurements were utilized to estimate cover control efficiency. However, it is unlikely that an uncovered system would perform even as well as the under the cover micropore system. This is because the micropore system offers many process control advantages including weather protection and water retention.

8.0 References

Hentz Jr, L. H., W. E. Toffey, and C. E. Schmidt. 1996. **Understanding the Synergy Between Composting and Air Emissions.** BioCycle. 37(3):67-75.

Appendix A
SJVAPCD Literature Table and Individual Report Summaries

TECHNICAL MEMORANDUM

Date: May 9 2008
To: SJAQMD Staff
From: CE Schmidt

RE: Annotated Bibliography in Support of the SJVAPCD Greenwaste Baseline Composting Document

The core documents collected and reviewed by the SJVAPCD staff supporting the baseline document preparation as foundational to the proposed Rule 4566 have been reviewed with a focus on: project objective, sample collection technology, analytical methodology, and representativeness of the reported and tabulated flux or emission rate data. Each of the research reports has been reviewed, and an annotated bibliography has been prepared, and is contained herein.

The purpose of this effort was to provide council to the SJVAPCD staff with regard to using the available information regarding the compost industry in rule making. A companion document has been prepared in a similar vein with regard to the flux data use in these documents, emission calculation algorithm and assumptions used in the process, and the overall usability of the emission rate data. These two documents, constitutes the contracted support to the SJVAPCD staff for the purpose of rule making.

The annotated bibliographies are provided as an attachment to this memorandum.

Note that three studies have been added to the reference list for your review.

CE Schmidt

SUMMARY OF ANNOTATED BIBLIOGRAPHY ATTACHMENTS

SITE: Cedar Grove Composting, Everett, WA;
TITLE: "Full Scale Evaluation of Gore Technology On LACSD Biosolids at Cedar Grove Composting, Everett, WA"

SITE: Inland Composting and Organic Recycling Facility, Colton, CA; City of LA Anchorage Green Material Facility, San Pedro, CA; City of LA Van Norman Green Material Mulching Facility, San Fernando Valley, CA, and Scholl Canyon Landfill Site (alternative daily cover application)
TITLE: "Air Emissions Tests Conducted at Green Material Processing Facilities"

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA
TITLE: "Air Emissions Source Test- Emissions Evaluation of Complete Compost Cycle VOC and Ammonia Emissions"

SITE: City of Modesto Compost Facility, Modesto, CA
TITLE: "Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley"

SITE: Inland Empire Composting, Colton, CA
TITLE: "Ammonia and Volatile Organic Compound (VOC) Emissions From A Greenwaste Composting Facility "

SITE: Westlake Farms Co-Composting Facility, Stratford, CA
TITLE: "Assessment of Volatile Organic Compound and Ammonia Emissions from a Bulking Agent Stockpile"

SITE: Intravia Rock and Sand, Inc. Upland, CA
TITLE: "Ammonia and Volatile Organic Compound (VOC) Emissions From A Non-Curbside Greenwaste Chipping and Grinding Facility "

SITE: Rancho Las Virgenes Municipal Water District, Calabasas, CA
TITLE: "Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound Emissions from Composting Operations "

SITE: Little Hanaford Farms, Centralaia, WA
TITLE: "Technical Support Document Little Hanaford Farms"

SITE: EKO Systems, Corona, CA
TITLE: "Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound (TGNMOC) Emissions From Composting Operations "

SITE: San Joaquin Composting, Inc, Lost Hills, CA
TITLE: “Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound (TGNMOC) Emissions From Composting Operations ”

SITE: Tierra Verde Industries, Irvine, CA
TITLE: “Technical Report- Best Management Practices for Greenwaste Composting Operations: Air Emissions Tests vs. Feedstock Controls and Aeration Techniques”

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA
TITLE: “Jepson Prairie Organics Facility Compostex Cover System- Air Emissions Report”

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA
TITLE: “Jepson Prairie Organics Facility Micropore Cover System- Air Emissions Report”

SITE: South Kern Industrial Complex (SKIC) LLC, Taft, CA
TITLE: “SKIC Air Emissions Compliance Report”

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Biosolids

SITE: Cedar Grove Composting, Everett, WA

PAPER TITLE: "Full Scale Evaluation of Gore Technology On LACSD Biosolids at Cedar Grove Composting, Everett, WA"

AUTHORS: Tom Card, CE Schmidt

DATE: August, 2007 (testing conducted 01/07 to 03/07)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions for biosolids composting using the Gore micropore/ASP cover system, and to determine the control efficiency for the cover system.

FACILITY OPERATIONS:

Cedar Grove composting utilizes a three-phase compost operation with a 28 day active phase (covered), a 13 day maturation phase (covered) and a 14 day cure phase (uncovered).

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-14/GC-ECD for the tracer SF6.

SCOPE OF WORK:

Over 100 flux measurements conducted over a 43-day time period. Test locations were selected to represent side and top of pile with test locations, and top and side under the cover test locations. Testing was conducted on head space under the cover, from flux chambers under the cover, on the cover (top and side locations), during phase transitions and mixed compost, on cover seams, and repeat testing on different portions of the covered compost.,

Phase 1, Day 2- three flux tests on cover per round per day, two rounds, two buried flux
Phase 1, Day 4- Same, plus full replicate tests

Phase 1, Day 7- Same
Phase1, Day 14- Same
Phase 1,Day 28- Same
Transition P1/P2- breakdown compost, mixed compost, covered compost tests; multiple
Phase 2, Day 1- Same as covered
Phase 2, Day 13- Same as covered
Phase 3, Day 1- Same as covered

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.
QC data indicated overall acceptable method performance.

FINDINGS:

Biosolids Uncontrolled test pile)- 1.8 #VOC/ton and 4.0 #NH3/ton

Fugitive Emissions with Gore Cover- 0.2 #VOC/ton and 1.8 #NH3/ton

Note- Uncontrolled emissions, as well as the control efficiency estimate reference measurements taken from two flux chambers under the cover during the life-cycle testing effort.

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, with the exception that recent SCAQMD Modified USEPA flux chamber techniques were not used (redesigned sweep air inlet system and stack testing in extended stack), although the flow rates were probably low enough so that the sample collection technique was not biased.

COMMENTS:

Climatic conditions may have influenced the composting operations, in particular the beginning of the cycle. The LACSCD biosolids arrived in a semi-frozen state, and this may have hampered complete mixing of the biosolids with bulking agent, and delayed the starting of the composting process. The cool winter weather with light precipitation for the area probably had little effect on the composting operations. The testing effort was not hampered by the weather.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Greenwaste

SITE: Inland Composting and Organic Recycling Facility, Colton, CA; City of LA Anchorage Green Material Facility, San Pedro, CA; City of LA Van Norman Green Material Mulching Facility, San Fernando Valley, CA, and Scholl Canyon Landfill Site (alternative daily cover application)

PAPER TITLE: "Air Emissions Tests Conducted at Green Material Processing Facilities"

AUTHORS: CIWMB Brenda Smyth, CE Schmidt

DATE: February 22, 2002 (testing conducted 12/03/01, 12/06/01, and 12/07/01)

PROJECT OBJECTIVE:

Evaluate baseline VOC and ammonia emissions for greenwaste composting operations in the SCAQMD.

FACILITY OPERATIONS:

All three compost facilities receive, grind, static pile compost, and screen product in similar fashion. The landfill uses greenwaste mulch as alternative daily cover.

TARGET SPECIES:

Methane, ethane, CO2, CO, and Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

USEPA surface emission isolation flux chamber, standard chamber. Side-by-side open path optical remote sensing by SCAQMD at the Inland Empire

ANALYTICAL METHODS:

NMAM 6015 for ammonia, EPA Method 25C for methane and TNMHC, Method TO-15 for VOC species, and SCQAMD Method 25.3 for condensable and non-condensable organic compounds (by SCAQMD Lab).

SCOPE OF WORK:

Inland Composting and Organics Recycling Facility
14 Flux chamber tests: raw greenwaste, Day 17 compost, Day 45 compost, Day 90 overs material, screened product fines.
Anchorage Facility
18 Flux chamber tests: Day 1 compost, Day 3 compost, and Day 7 compost, Day 14 compost, Day 28 compost, Day 80 compost, Day 90 overs.

Van Norman Facility
24 Flux chamber tests: Day 1 compost, Day 3 compost, Day 5 compost (raw, coarse mulch, fine mulch, superfine mulch)

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank samples reported; no replicate samples.
QC data indicated overall acceptable method performance.

FINDINGS:

Greenwaste- 0.186 #VOC/hr-1000ft2 and 0.002 #NH3/hr-1,000ft2 (mean values for the collective data set).

Note- The frequency of testing is limited in that there are many different area sources in a compost cycle and life cycle emission estimates must include operational considerations, spatial variability, and time-dependent emissions per source. 54 data points collected at three different facilities does not constitute a robust program.

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, with the exception that recent SCAQMD Modified USEPA flux chamber techniques were not used (redesigned sweep air inlet system and stack testing in extended stack), although the flow rates were probably low enough so that the sample collection technique was not biased. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

The results of these test show much lower ammonia emissions and lower VOC emissions from facilities located in the SCAQMD area compared the SCAQMD published values of 0.224 #VOC/hr-1,000ft2 and 0.091 #NH3/hr-1,000ft2 from the Inland Empire site. This is suggested to be related to the difference in seasonal flux and the analytical methods: higher emissions in the summer and more compound detection with SCAQMD Method 25.3 as compared to Method 25C.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Food Waste with Ag Bag Cover and Greenwaste

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA

PAPER TITLE: "Air Emissions Source Test- Emissions Evaluation of Complete Compost Cycle VOC and Ammonia Emissions"

AUTHORS: Tom Card, CE Schmidt

DATE: May, 2006 (testing conducted 08/23/05 to 08/25/05)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia site wide baseline emissions for food waste composting using the Ag Bag cover system and the static greenwaste windrow compost system.

FACILITY OPERATIONS:

Jepson Prairie Organics Compost facility utilizes a two-phase compost operation with a 30-day active phase (food waste in the Ag Bag, covered) and ASP system, and a 30 day cure phase (uncovered).

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-14/GC-ECD for the tracer SF6.

SCOPE OF WORK:

Over 46 flux measurements conducted over a 3-day time period. Test locations were selected to represent Ag Bag ports, and the side and top of curing or greenwaste piles. Receiving and finish was also tested.

Food Waste/Ag Bag
Phase 1 Compost, Day 1- Two flux tests on bag ports
Phase 1, Compost, Day 4- Same
Phase 1, Compost, Day 5- Same
Phase 1, Compost, Day 8- Same
Phase 1, Compost, Day 10- Same

Phase 1, Compost, Day 22- Same
Phase 1, Compost, Day 30- Same
Phase 2, Cure, Day 0 unmixed, one flux test
Phase 2, Cure, Day 3, unmixed and mixed- three flux tests
Phase 2, Cure, Day 7- unmixed, one flux test
Phase 2, Cure, Day 10, unmixed and mixed- two flux tests
Phase 2, Cure, Day 13- one flux test
Phase 2, Cure, Day 19, unmixed and mixed- two flux tests
Phase 2, Cure, Day 25- one flux test
Phase 2, Cure, Day 31, unmixed and mixed- two flux tests
Finish- three flux tests

Greenwaste Static Pile
Phase 1, Compost, Day 3- one flux test
Phase 1, Compost, Day 6- Same
Phase 1, Compost, Day 7- three flux tests
Phase 1, Compost, Day 15- one flux test
Phase 1, Compost, Day 30- Same
Phase 2, Cure, Day 50 unmixed, one flux test
Finish- three flux tests

Phase 3, Day 1- Same as covered

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.
QC data indicated overall acceptable method performance.

FINDINGS:

Food Waste in Ag Bag- 37 #VOC/ton and 0.7 #NH3/ton

Static Pile Greenwaste Composting- 14 #VOC/ton and 0.5 #NH3/ton

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, with the exception that recent SCAQMD Modified USEPA flux chamber techniques were not used (redesigned sweep air inlet system and stack testing in extended stack), although the flow rates were probably low enough so that the sample collection technique was not biased.

COMMENTS:

The Ag Bag showed very low emissions during the in-vessel phase with little emissions from the open ports and little effect by the blower fans. Most of the emissions occurred during the curing phase. The greenwaste static pile was occasionally watered and mixed.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Greenwaste and Greenwaste with Food Waste

SITE: City of Modesto Compost Facility, Modesto, CA

PAPER TITLE: "Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley"

AUTHORS: Brenda Smyth, Fatih Buksonamez, CE Schmidt

DATE: October 31, 2007 (testing conducted 10/19/06 to 12/14/06)

PROJECT OBJECTIVE:

Evaluate baseline VOC emissions during greenwaste composting and greenwaste that includes food waste, and to assess VOC emissions reduction potential of Best Management Practices (BMP) including application of a finished compost blanket on top of the greenwaste windrow and application of two chemical additives to greenwaste windrow.

FACILITY OPERATIONS:

City of Modesto- 250 to 300 tons of greenwaste per day, some paper and residential food waste; 30 acre site with maximum 500 tons per day capacity. Greenwaste source is residential, landscape business, and municipal pruning. The process is static composting in windrows: greenwaste is tipped on a concrete pad, processed in a grinder, shaped in windrows, and mixed by Scarab-type turner approx. once per week with infrequent watering.

TARGET SPECIES:

Methane, ethane, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with CO used as a tracer species.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3.

SCOPE OF WORK:

Over 100 flux measurements conducted over a 57-day time period. Test locations were selected to represent bottom, middle and top of pile with test locations selected by real time instrument data.

Greenwaste (control test pile)

Day 1- Three-to-four flux tests per pile per day
Day 2- Same
Day 3- Same
Day 6- Same
Day 8- Same
Day 14- Same
Day 21- Same
Day 30- Same
Day 44- Same
Day 57- Same
Greenwaste with 15% food waste- Same

Greenwaste capped with finished compost blanket- Same

Greenwaste inoculated with two chemical additives- Same

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank samples reported; no replicate samples.
QC data indicated overall acceptable method performance.

FINDINGS:

Greenwaste (control test pile)- 0.8 to 0.9 #VOC/ton

Greenwaste with 15% food waste- 1.3 to 2.6 #VOC/ton

Greenwaste capped with finished compost blanket- 0.1 to 0.4 #VOC/ton

Greenwaste inoculated with two chemical additives- 0.5 to 0.6 #VOC/ton

Note- surface area of vented sources estimated at 10% for all piles except biofilter finish-covered pile, which was estimated by screening to be 1% to 2%. Fall season and frequent site watering my have influenced the flux data.

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, with the exception that recent SCAQMD Modified USEPA flux chamber techniques were not used (redesigned sweep air inlet system and stack testing in extended stack), although the flow rates were probably low enough so that the sample collection technique was not biased. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

None.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Greenwaste

SITE: Inland Empire Composting, Colton, CA

PAPER TITLE: "Ammonia and Volatile Organic Compound (VOC) Emissions From A Greenwaste Composting Facility "

AUTHORS: SCAQMD, Wayne Stredwick

DATE: Testing conducted 09/27/01 and 10/04/01)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions during greenwaste composting including: tipping pile, static piles, and windrows.

FACILITY OPERATIONS:

The site processes 350 tons of greenwaste per day. The waste is received and stored up to two days, stored in a static pile after grinding for up to 14 days, placed in windrow for up to 45 days and screened. The process is static composting in windrows: greenwaste is tipped on a concrete pad, processed in a grinder, shaped in windrows, and mixed by Scarab-type turner approx. once per week with infrequent watering.

TARGET SPECIES:

Methane, ethane, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with helium used as a tracer species and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3 and SCAQMD Method 207.1.

SCOPE OF WORK:

Over 30 flux measurements conducted over a two-day time period.
Tipping pile- 10 tests; 0-2 day old tested.
Static piles- 10 tests; 7 day old tested.
Windrow- 10 tests; day 7 and day 30 tested.

QC DATA:

It is not known if a work plan was prepared or is available.

Blank samples and replicate sample data were not reported or commented on, with the exception of problems encountered. Note that all 25.3 samples were taken in duplicate as per the method.

FINDINGS:

	Ammonia	**Methane**	**TNMNEOC**
	(lb/hr-1000ft2)	(lb/hr-1000ft2)	(lb/hr-1000ft2)
Tipping Pile	0.091	0.079	0.368
Static, Fines and ADC Pile	0.071	0.024	0.226
Windrow	0.004	0.005	0.079
Site Total (lb/ton)	1.32 #/ton	0.83 #/ton	5.05 #/ton

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed including the SCAQMD Modified USEPA flux chamber technique. No discussion was provided about specific surface area testing, designation of sub area per type of source, and no QC data was provided. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

None.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Bulking Agent Stockpile

SITE: Westlake Farms Co-Composting Facility, Stratford, CA

PAPER TITLE: "Assessment of Volatile Organic Compound and Ammonia Emissions from a Bulking Agent Stockpile"

AUTHORS: LACSD, CH2MHill, Tom Card, CE Schmidt

DATE: April 27, 2005 (testing conducted 03/24/ 2005)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions for the Westlake Farms Co-Composting site bulking agent, shredded almond wood waste (orchard waste).

FACILITY OPERATIONS:

The Westlake Farms Co-Composting facility ATC includes utilizing orchard waste as a bulking agent for a negative ASP/biofilter biosolids composting operation. The emissions from the bulking agent are part of the site emissions estimate.

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), ammonia, and total hydrocarbon species.

SAMPLE COLLECTION METHODS:

USEPA surface emission isolation flux chamber (standard chamber design- no significant advective flow from the source) and tracer recovery (CO).

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-12. Real time instrument data was used to select sample collection from test locations (FID/PID) and CO tracer recovery.

SCOPE OF WORK:

Eight flux measurements were conducted over a 1-day time period, where four of the eight locations were selected for sample collection by Methods 25.3 and 207.1. All screening data was similar, and based on field screening data the two highest flux and the two lowest flux locations were selected for testing.

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.

QC data indicated overall acceptable method performance.

FINDINGS:

Static Pile Flux- 0.00000073 #VOC/hr,ft-1 and 0.0000000079 #NH3/hr,ft-1

Advective flow was calibrated based on a field test that generated recovery of CO tracer (36%) from a thin layer of wood chips divorced from the static pile (not composting).

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed. The SCAQMD Modified USEPA flux chamber techniques were not used given that advective flow was not anticipated. All data were at or below MDL for the methods and the emissions could potentially overestimate the emissions from the source based on demonstrated adsorption of the CO tracer species. The non-detect TO-14 results supported the very low/non-detect Method 25.3 results.

COMMENTS:

The flux from the orchard waste showed very low VOC and even lower ammonia emissions.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Greenwaste

SITE: Intravia Rock and Sand, Inc. Upland, CA

PAPER TITLE: "Ammonia and Volatile Organic Compound (VOC) Emissions From A Non-Curbside Greenwaste Chipping and Grinding Facility "

AUTHORS: SCAQMD, Mei Wang

DATE: Testing conducted 07/12/02)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions during greenwaste composting including: tipping pile, static piles, and windrows.

FACILITY OPERATIONS:

The site receives non-curbside greenwaste, stores the wastes, grinds the waste, and ships the waste off site. Composting is not conducted on site. The material stays on site for about 30 days. Little information was available regarding the site operations.

TARGET SPECIES:

Methane, ethane, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with helium used as a tracer species and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3 and SCAQMD Method 207.1.

SCOPE OF WORK:

Over 20 flux measurements conducted over a one-day time period.
Tipping pile- 10 tests.
Ground material pile- 10 tests.

QC DATA:

It is not known if a work plan was prepared or is available.
Blank samples and replicate sample data were not reported or commented on. Note that all 25.3 samples were taken in duplicate as per the method.

FINDINGS:

	Ammonia	**Methane**	**TNMNEOC**
	(lb/hr-1000ft2)	(lb/hr-1000ft2)	(lb/hr-1000ft2)
Tipping Pile	0.0030	0.0029	0.228
Ground Piles	0.0006	0.0097	0.153
Site Total (lb/ton)	0.017 #/ton	0.058 #/ton	1.5 #/ton

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed including the SCAQMD Modified USEPA flux chamber technique. No discussion was provided about specific surface area testing, designation of sub area per type of source, and no QC data was provided. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

None.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Biosolids Bulked with Wood Chips

SITE: Rancho Las Virgenes Municipal Water District, Calabasas, CA

PAPER TITLE: "Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound Emissions from Composting Operations "

AUTHORS: SCAQMD, Carey Willoughby

DATE: Testing conducted 12/19/95 and 12/20/95)

PROJECT OBJECTIVE:

Verify the flux chamber sampling method for assessing emission from compost operations, and evaluate air emissions from the biosolids compost operations.
Method verification was accomplished by flux testing on the compost in an enclosed building, then comparing those emissions to the mass loading on the biofilter inlet line from the enclosure.

FACILITY OPERATIONS:

The site receives dewatered biosolids, mixes the biosolid waste with wood chips, constructs windrows on subsurface vents in an enclosure structure, supplies positive air flow to the piles for 45 days, and collects the enclosure air and runs the air through a biofiltration system.

TARGET SPECIES:

Methane, Total non-methane organic carbon (condensable and volatile) with helium used as a tracer species and ammonia, CO2, O2, amines, and organic sulfur compounds.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.1, SCAQMD Method 207.1, and non-specified methods for total amines and organic sulfur.

SCOPE OF WORK:

Over 34 flux measurements conducted over a two-day time period.
Flux chamber testing on compost windrows in one cell or area, 17 locations per day, two days.
Simultaneous biofilter (replicate) inlet testing for the facility.

QC DATA:
It is not known if a work plan was prepared or is available.
Blank samples and replicate sample data were not reported or commented on.

FINDINGS:

Source	**Ammonia**	**Methane**	**TNMOC**	**CS**
	(lb/hr-1000ft2)	(lb/hr-1000ft2)	(lb/hr-1000ft2)	(lb/hr-1000ft2)
Inlet Sampling	0.036	0.025	0.038	0.038
Flux Chamber on Compost	0.012	NA	NA	NA
Site Total (lb/ton)	0.70 #/ton	0.50 #/ton	0.76 #/ton	0.69

CONCLUSIONS:
The appropriate sample collection and analytical techniques were employed including the SCAQMD Modified USEPA flux chamber technique. No discussion was provided about specific surface area testing, designation of sub area per type of source, and no QC data was provided. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

The conclusion from the technical team indicated that the USEPA flux chamber method, for a variety of reasons, was 'the preferred method' for estimating and comparing emissions from compost sites.

COMMENTS:
None.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Waste material- not specified

SITE: Little Hanaford Farms, Centralaia, WA

PAPER TITLE: "Technical Support Document Little Hanaford Farms"

AUTHORS: Clint Lamoreaux, Southwest Clean Air Agency

DATE: April, 2005 (testing conducted 08/04)

PROJECT OBJECTIVE:

Comply with permit requirements.

FACILITY OPERATIONS:

75,000 Ton per year static pile windrow composting operation that receives solid waste of unspecified type and origin and produces compost and soil amendments.

TARGET SPECIES:

Eight amines plus ammonia, two sulfur compounds, and eight oxygenated compounds are listed. No total VOC.

SAMPLE COLLECTION METHODS:

None specified.

ANALYTICAL METHODS:

None specified.

SCOPE OF WORK:

None provided. Emission rate data provided as final number for amines, two sulfur compounds, ammonia, and a short list of oxygenated compounds. Sample collection technique not specified. Sample count and sampling strategy not specified. Analytical method not specified.

QC DATA:

None provided.

FINDINGS:

VOC Emissions factor- 0.10 #VOC/ton and 0.062#NH3/ton

Note- No method information, scope of work or test data was provided. These findings provide no useful information. Discount this reference.

CONCLUSIONS:

No useful information is provided. Discount this reference.

COMMENTS:

You have to be kidding me!

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Biosolids (20%) and Manure (80%)

SITE: EKO Systems, Corona, CA

PAPER TITLE: "Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound (TGNMOC) Emissions From Composting Operations "

AUTHORS: SCAQMD, Carey Willoughby

DATE: Testing conducted 11/16/95, 01/24, and 01/26/96

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions during greenwaste composting by testing three different ages of compost; Day 2, Day 20 and Day 50. Based in temperature, the peak emission was expected on Day 20.

FACILITY OPERATIONS:

The site receives biosolids and manure and produces compost by static pile windrow (50 day compost cycle) and a non-specified curing phase in larger piles. No mention was made regarding bulking agent, although it is likely that bedding or fiber was present in the manure.

TARGET SPECIES:

Methane, O2, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with helium used as a tracer species, total sulfur compounds, ammonia and amines.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer, mixing fan) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.1, Amines, Sulfur Compounds, and SCAQMD Method 207.1.

SCOPE OF WORK:

Nine sampling points per source (Day 2, 20, 50) prior to turning and five sampling points post turning per source. Note- number of samples is not specified, and the SCAQMD often collects composite samples. It is possible that only six composite samples were collected per these 42 flux tests (9 x 3 plus 5 x 3).

QC DATA:

It is not known if a work plan was prepared or is available.
Blank samples and replicate sample data were not reported or commented on. Note that all 25.3 samples were taken in duplicate as per the method.

FINDINGS:

Compounds	**Emission Factor**
	(lb/ton)
Ammonia	3.28
Amines	<0.0003
Methane	2.23
TGNMOC	1.7
Total Sulfur Compounds	0.015

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed including the SCAQMD Modified USEPA flux chamber technique. No discussion was provided about specific surface area testing, designation of sub area per type of source, and no QC data was provided. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

None.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Biosolids (50%) and Greenwaste (50%)

SITE: San Joaquin Composting, Inc, Lost Hills, CA

PAPER TITLE: "Characterization of Ammonia, Total Amine, Organic Sulfur Compound, and Total Non-Methane Organic Compound (TGNMOC) Emissions From Composting Operations "

AUTHORS: SCAQMD, Carey Willoughby

DATE: Testing conducted 02/15/96, 03/01/96, and 03/11/96

PROJECT OBJECTIVE:

Evaluate VOC and ammonia emissions during greenwaste composting by testing three different ages of compost; Day3, Day 45 and Day 57. Based in temperature, the peak emission was expected on Day 45.

FACILITY OPERATIONS:

The site receives biosolids and manure and produces compost by static pile windrow (50 day compost cycle) and a non-specified curing phase in larger piles. No mention was made regarding bulking agent, although it is likely that bedding or fiber was present in the manure.

TARGET SPECIES:

Methane, O2, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with helium used as a tracer species, total sulfur compounds, ammonia and amines.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer, mixing fan) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.1, Amines, Sulfur Compounds, and SCAQMD Method 207.1.

SCOPE OF WORK:

Nine sampling points per source (Day 3, 45, 57) prior to turning and five sampling points post turning per source. Note- number of samples is not specified, and the SCAQMD often collects composite samples. It is possible that only six composite samples were collected per these 42 flux tests (9 x 3 plus 5 x 3). These locations were screened with an FID and these field data may have been used to select locations for sample collection, either composite or discrete samples.

QC DATA:

It is not known if a work plan was prepared or is available.
Blank samples and replicate sample data were not reported or commented on.

FINDINGS:

Compounds	**Emission Factor**
	(lb/ton)
Ammonia	2.81
Amines	0.19
Methane	33.49
TGNMOC	3.1
Total Sulfur Compounds	0.22

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed including the SCAQMD Modified USEPA flux chamber technique. No discussion was provided about specific surface area testing, designation of sub area per type of source, and no QC data was provided. The use of the flux data, estimate of surface area, and representativeness of the emissions estimate should be reviewed.

COMMENTS:

The compost site had experienced heavy rain prior the Day 3 testing resulting in higher emissions as per the authors. The greenwaste stockpile combusted during the 03/11/96 testing event.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Greenwaste Engineering Evaluation (Not Life Cycle)

SITE: Tierra Verde Industries, Irvine, CA

PAPER TITLE: "Technical Report- Best Management Practices for Greenwaste Composting Operations: Air Emissions Tests vs. Feedstock Controls and Aeration Techniques"

AUTHORS: Brenda Smyth, CE Schmidt

DATE: July 29, 2003 (testing conducted 10/29-30/02, 11/06-07/02, and 02/04-05/03)

PROJECT OBJECTIVE:

Evaluate baseline air emissions from feedstock blends (C:N) and aeration techniques and to determine how changing these variables affects air emissions from the compost.

FACILITY OPERATIONS:

Engineering evaluations were performed on four, custom-made windrow piles. Two piles were made with higher C:N and two with lower C:N. One of each type of blends were mechanically aerated while the others were not mixed at all. The resulting matrix was as follows: low C:N aerated and low C:N non-aerated; and high C:N aerated and high C:N non-aerated. Aeration was facilitated by turning three times per week. Of the 100 day cycle, testing was conduced on Day 3 and 4, and Day 11 and 12, and Day 101 and 102.

TARGET SPECIES:

Methane, ethane, CO2, CO, and Total non-methane organic carbon (condensable and volatile) with CO used as a tracer species.

SAMPLE COLLECTION METHODS:

Standard USEPA Flux Chamber (bottom and sides) and SCAQMD Modified (6" port, CO tracer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD 207.1, and ASTM Odor.

SCOPE OF WORK:

52 Flux measurements conducted over a 103-day time period. Test locations were selected to represent bottom, middle and top of pile with the top test location typically replicated.

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank samples and replicate samples reported in Tech Memo. QC data indicated overall acceptable method performance.

FINDINGS:

Ammonia emissions were generally below method detection limit.

VOC emissions by Method 25.3:

Test Pile	#VOC per day/ton
Static, Low C:N	0.055
Turned, Low C:N	0.848
Static, High C:N	0.038
Turned, High C:N	0.240
Total	0.247

CONCLUSIONS:

VOC emissions decreased with increasing C:N. Higher VOC emissions were observed for turned versus non-turned piles. VOC emissions peaked during the first week. It was not possible to determine if static verses turned piles were higher or lower VOC emitters. Life cycle for turned compost is shorter that static compost.

COMMENTS:

The engineering evaluation of C:N ratio and aeration provide useful operational information, but life-cycle emission factor data is difficult to extract from these data. Note that only one 6” diameter exhaust port chamber was used (top location) and a standard chamber was used for the middle and bottom-side locations. Although a tracer gas was used (CO), a bias in sampling could have resulted from back pressure in the standard chamber as related to advective flow.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Food Waste with Compostex Cover

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA

PAPER TITLE: "Jepson Prairie Organics Facility Compostex Cover System- Air Emissions Report"

AUTHORS: Tom Card, CE Schmidt

DATE: April 2008, (testing conducted 02/05-07/08)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia site wide baseline emissions for food waste composting using the Compostex Cover System.

FACILITY OPERATIONS:

Jepson Prairie Organics Compost facility utilizes the Compostex cover system. The compost operation includes food waste grinding, mixing with a greenwaste bulking agent, a 45-day active compost phase (food waste covered) and a cure phase (uncovered).

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer with modified air introduction system and stack testing approach and mixer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-14/GC-ECD for the tracer SF6 (verification on tracer study).

SCOPE OF WORK:

Over 71 flux measurements conducted over a 3-day time period. Test locations were selected to represent the life-cycle emissions from the operations including uncovering, mixing, and time-dependent emissions post mixing. Receiving and finish was also tested.

Feedstock as received and aged	2 Flux tests- fresh and 24 hours old
Compost Day 1, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 3, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 7, covered	4 Flux tests, (T1, T2, S1, S2)

Variability Test, Day 7	4 Flux tests, (T1, T2, S1, S2)
Compost Day 15, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 28, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 28, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Compost Day 28, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Curing Day 45, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Variability Test, Day 45	4 Flux tests, (T1, T2, S1, S2)
Curing Day 55, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Curing Day 55, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Finish Product- post screening	4 Flux tests- 2 fresh, 2 aged
Blank testing	9 Flux tests
Replicate testing	8 Flux tests
TOTAL	71 Flux tests

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.
QC data indicated overall acceptable method performance.

FINDINGS:

Food Waste with Compostex- 27 #VOC/ton and 8.1 #NH3/ton

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, including the recent, validated modifications to the SCAQMD Rule 1133 recommended procedure (6” port, 10% helium tracer). The modifications included the redesigned sweep air inlet system and stack testing in extended stack, backup tracer, and internal mixer. Data was collected without an adverse affect from high winds.

COMMENTS:

The Compostex cover system showed a reduced air emissions for VOC (27 #VOC/ton versus 37 #VOC/ton) as compared to the historic Ag Bag compost system, but higher ammonia emissions (8.1 #NH3/ton versus 1.0 #NH#/ton). The robust assessment produced representative life-cycle emissions from the Compostex cover system on food waste at this site.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Food Waste with Compostex Cover

SITE: Jepson Prairie Organics Compost Facility, Vacaville, CA

PAPER TITLE: "Jepson Prairie Organics Facility Micropore Cover System- Air Emissions Report"

AUTHORS: Tom Card, CE Schmidt

DATE: April 2008, (testing conducted 01/17/08 – 02/15/08)

PROJECT OBJECTIVE:

Evaluate VOC and ammonia site wide baseline emissions for food waste composting using the Micropore Cover System; 30 day and 45 day covered operations

FACILITY OPERATIONS:

Jepson Prairie Organics Compost facility typically utilizes the Compostex cover system, and a test was conducted using micropore fabric with forced air (Mor and GE covers). The micropore test used a compost operation that included food waste grinding, mixing with a greenwaste bulking agent, a 30-day and a 45-day active compost phase (food waste covered with micropore) and a cure phase (uncovered).

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer with modified air introduction system and stack testing approach and mixer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-14/GC-ECD for the tracer SF6 (verification on tracer study).

SCOPE OF WORK:

95 Flux measurements were conducted over multiple field trips. Test locations were selected to represent the life-cycle emissions from the operations including uncovering, mixing, and time-dependent emissions post mixing. Receiving and finish was also tested.

Feedstock as received and aged	2 Flux tests- fresh and 24 hours old

Compost Day 1, covered	4 Flux tests, (T1, T2, S1, S2)
Variability Test, Day 1, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 8, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 18, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 31, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 31, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Compost Day 32, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1; T1, S1)
Compost Day 45, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 45, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Compost Day 45, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Compost Day 46, uncovered and unmixed	4 Flux tests, (T1, T2, S1, S2)
Compost Day 46, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Compost Day 55, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Compost Day 58, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 58, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, S1, T1, S1)
Compost Day 60, covered	4 Flux tests, (T1, T2, S1, S2)
Variability Test, Day 60, covered	4 Flux tests, (T1, T2, S1, S2)
Compost Day 60, Mix Decay (hr 1, hr 4)	4 Flux tests, (T1, T2, S1, S2)
Finish Product- post screening	4 Flux tests- 2 fresh, 2 aged
Blank testing	9 Flux tests
Replicate testing	8 Flux tests
TOTAL	95 Flux tests

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.
QC data indicated overall acceptable method performance.

FINDINGS:

Food Waste with 30-Day Micropore Cover- 11 #VOC/ton and 14 #NH3/ton
Food Waste with 45-Day Micropore Cover- 3.4 #VOC/ton and 114 #NH3/ton

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, including the recent, validated modifications to the SCAQMD Rule 1133 recommended procedure (6" port, 10% helium tracer). The modifications included the redesigned sweep air inlet system and stack testing in extended stack, backup tracer, and internal mixer. Data was collected without an adverse affect from high winds.

COMMENTS:

The 30-Day Micropore cover system showed a reduced air emissions for VOCs (11 #VOC/ton versus 27 #VOC/ton) as compared to the baseline Compostex cover system, but higher ammonia emissions (14 #NH3/ton versus 8.1 #NH#/ton). And, the 30-Day Micropore cover system showed a reduced air emissions for VOCs (3.4 #VOC/ton versus 11 #VOC/ton) as compared to the 30-Day Micropore cover system, and also lower ammonia emissions (1.4 #NH3/ton versus 14 #NH#/ton). The robust assessment produced representative life-cycle emissions from the Micropore cover system on food waste at this site.

SJVAPCD ANNOTATED BIBLIOGRAPHY FACT SHEET

COMPOST TYPE: Biosolids

SITE: South Kern Industrial Complex (SKIC) LLC, Taft, CA

PAPER TITLE: "SKIC Air Emissions Compliance Report"

AUTHORS: Tom Card, CE Schmidt

DATE: January 2008, (testing conducted 08/08-12/07 and 12/04-06/08)

PROJECT OBJECTIVE:

Determine the air emissions of VOCs and ammonia from the primary and secondary ASPs and the biofilters (mixing building, primary, and secondary biofilters); and determine the control efficiency of the biofilters for both VOCs and ammonia.

FACILITY OPERATIONS:

SKIC operates a co-composting facility that uses aerated static pile and biofilters. The biosolids are received in a building, mixed with greenwaste bulking agent, heap piled, placed in primary composting under negative aeration via subsurface ventilation and covered with a layer of finish biosolids (30 days), broke-down and transported to secondary curing which is also under negative aeration via subsurface ventilation but not covered with finish, screened, and sold as product. Gases collected from the mixing building, primary and secondary are routed though separate biofiltration consisting of wood chip media maintained by irrigation.

TARGET SPECIES:

Methane, ethane, CO2, CO, Total non-methane organic carbon (condensable and volatile), and ammonia.

SAMPLE COLLECTION METHODS:

SCAQMD Modified (6" port, 10% helium tracer with modified air introduction system and stack testing approach and mixer) USEPA surface emission isolation flux chamber.

ANALYTICAL METHODS:

SCQAMD Method 25.3, SCAQMD Method 207.1, and USEPA Method TO-14/GC-ECD for the tracer SF6 (verification on tracer study).

SCOPE OF WORK:

Approximately 103flux or stack measurements were conducted over two field trips. The primary composting and biofilter was tested in August and the secondary and biofilter along with the mixing building biofilter was tested in December. Test locations were selected to represent the life-cycle emissions from the operations. Biofilter inlet testing included triplicate stack testing in order to establish inlet concentrations and flow rates into the biofilters for destruction efficiency determinations.

Process	**Stack Tests**	**Flux Locations**
Primary Composting		
Compost Surface- Day 5, 11, 16	None	9
Secondary Composting		
Compost Surface- Day 22, 28, 36	None	9
Mixing Building Biofilter		
Biofilter In	3 + 3	None
Biofilter Surface- 16 cell grid	None	16
Primary Biofilter		
Biofilter In	3	None
Biofilter Surface- 16 cell grid	None	16
Secondary Biofilter		
Biofilter In	3	None
Biofilter Surface- 16 cell grid	None	16

QC DATA:

Work plan was prepared and is available.
Adequate frequency of blank, replicate, and repeat samples are reported.
QC data indicated overall acceptable method performance.

FINDINGS:

Facility Emissions- 0.31 #VOC/ton and 0.14 #NH3/ton

Biofilter Destruction Efficiency; VOCs- 88% to 97%, NH3- 81% to 97%

CONCLUSIONS:

The appropriate sample collection and analytical techniques were employed, including the recent, validated modifications to the SCAQMD Rule 1133 recommended procedure (6" port, 10% helium tracer). The modifications included the redesigned sweep air inlet system and stack testing in extended stack, backup tracer, and internal mixer. Data was collected without an adverse affect from high winds.

COMMENTS:

The ASP composting system complete with biofilter blanket on primary composting, negative aeration and biofilter control, and secondary curing negative aeration and biofilter control shows low emissions of VOCs and ammonia. Destruction efficiencies for both VOCs and ammonia from maintained wood chip biofiltration range from 81% to 97% or these species. The robust assessment produced representative life-cycle emissions from the negative ASP system and biofiltration control.

Appendix B
Technical Memorandum
CIWMB Modesto Data Recalculation

Technical MEMORANDUM Environmental Management Consulting
41125 278th Way SE, Enumclaw, WA 98022 USA
Phone: 360-802-5540 Fax: 360-802-5541
E-Mail: trcard@earthlink.net

TO: Chuck Schmidt

FROM: Tom Card

DATE: June 19, 2008

SUBJECT: CIWMB Modesto Composting Report Analysis

An analysis has been made of the California Integrated Waste Management Board's (CIWMB) report entitled **Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley**. It was not possible to reproduce the calculations in the report to verify their accuracy. Instead, the emissions are recalculated using the quantitative and written descriptions of the site and the testing procedures. There can be many reasons why this calculation is different than the report's calculation. Those differences are discussed in detail below.

Table 1 summarizes the results of this analysis compared to the report's findings. The South Coast Air Quality Management District (SCAQMD) emission factor is presented for comparative purposes.

Table 1. Preliminary Results

Source	VOC (#/ton mix)
Recalculation of CIWMB Results	1.5
CIWMB Report	0.6 - 0.7
SCAQMD Emssion Factor	3.8

Basis of Recalculation

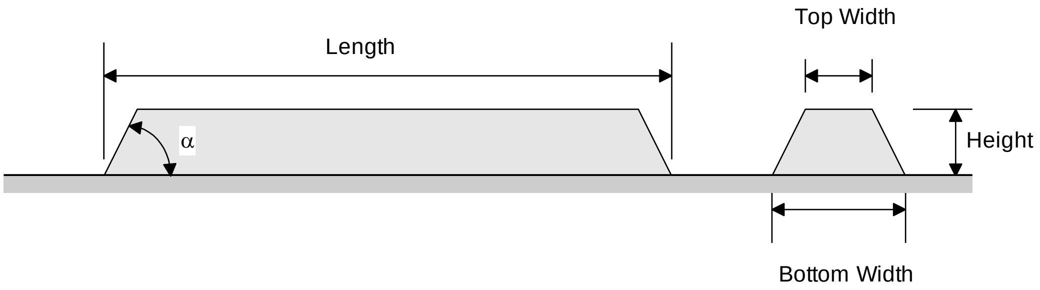
VOC Species

This report calculated VOC emissions as methane with no method bias factor applied. The SCAQMD presents VOC emissions as hexane carbon and includes a method bias factor. This report did not present the VOC data in this manner since most jurisdictions report VOC as methane with no method bias factor.

Compost Process

The compost process tested was greenwaste in windrows. The compost was placed in the windrow and mixed eleven times over a 60 day cycle. No attempt was made in the CIWMB report to quantify immediate mixing emissions. Previous work has shown that mixing emissions are irrelevant in well mixed aerobic windrows, but mixing emissions dominate in poorly mixed and poorly vented windrows. Based on the descriptions and data in the report, this windrow likely trends to the former condition. Figure 1 presents the windrow configuration that this report assumed along with the mensuration formulas used. Table 2 presents the windrow calculated data.

Figure 1. Assumed Windrow Configuration and Mensuration Formulas



Mensuration formulas

$$S = \frac{p_1 + p_2}{2} s + A_2$$

$$V = \frac{h(A_1 + A_2 + \sqrt{A_1 A_2})}{3}$$

$$s = \sqrt{h^2 + ((W_B - W_T)/2)^2}$$

where S = total surface area, p_1 = bottom perimeter, p_2 = top perimeter, s = slant height, V=volume, h=vertical height, A_1 = bottom area, A_2 = top area, α = bottom angle

The CIWMB reported the surface area as 206.4 m^2. This report calculates the surface area as 212 m^2. The CIWMB reports the initial bulk density as 360 kg/m^3. This report calculates the density as 510 kg/m^3. The density difference is significant and could be one of the primary causes of the differences in results. The CIWMB number is significantly lower than any density value for greenwaste compost seen by this author. The compost windrow normally shrinks during the cycle. This shrinkage was not incorporated in this calculation, but based on the emissions profile (late cycle emissions go to essentially zero) this should not have significant impact.

The compost windrow was sampled typically at two locations on the top of the windrow, on the middle of the side and at the bottom of the side. Figure 2 is taken directly out of the CIWMB report to show the portions of the windrow that these samples represent. Table 3 shows this report's allocation of the surface areas compared to the CIWMB allocation of surface areas. It was not possible to determine how the CIWMB calculated their area ratios.

Compost Venting

Compost often cracks and develops vent channels so that a large portion of the vent air goes through few channels. The CIWMB report discussed the phenomena extensively. However, the data suggest that the vent channels had no more emissions than the rest of the top surface. Many of the non-vented top surfaces had emissions exceeding the vented surfaces, which suggests that for the added volumetric flow even the field instrument screening data are not good indicators of VOC flux or emissions. Therefore, for this report all top surface values are averaged

Table 2. Windrow Dimensions and Capacities

Property	Units	Value
Length	ft	102.0
Height	ft	6.8
Bottom Width	ft	14.4
Top Width	ft	5.6
Top Length	ft	93
alpha	R	1.00
	o	57
Top Perimeter	ft	198
Top Area	ft2	522
Bottom Perimeter	ft	233
Bottom Area	ft2	1,469
Slant height	ft	8.1
Surface Area	ft2	2,265
	m2	212
Volume	ft3	6,497
	yd3	241
	m3	184
Conversion Factors	ft2/m2	10.7
	ft3/yd3	27
	ft3/m3	35.31
Top Area Ratio		0.230
Mass	Tons	103
Density	*#/yd3*	856
	kg/m3	509

Figure 2. CIWMB Windrow Cross Section (Figure 1. from the CIWMB report).

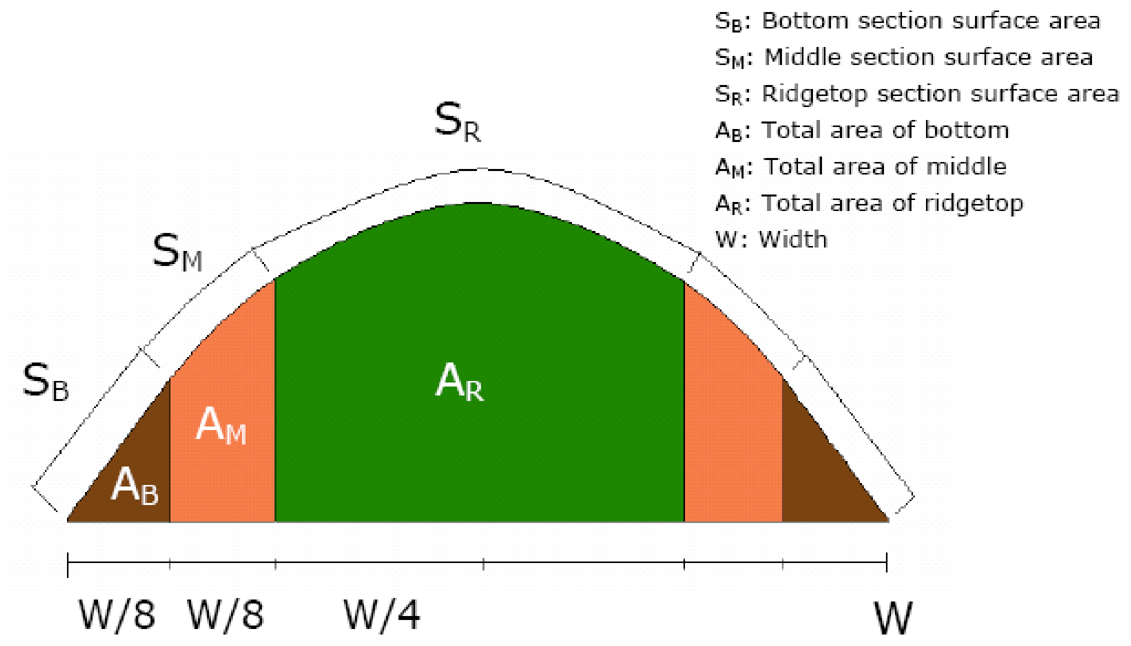


Figure 1. Sampling Segments of Windrows

Table 3. Comparison of Surface Area Allocations.

Source	Top	Middle	Side
This Report	0.5	0.25	0.25
CIWMB Report	0.26	0.37	0.37

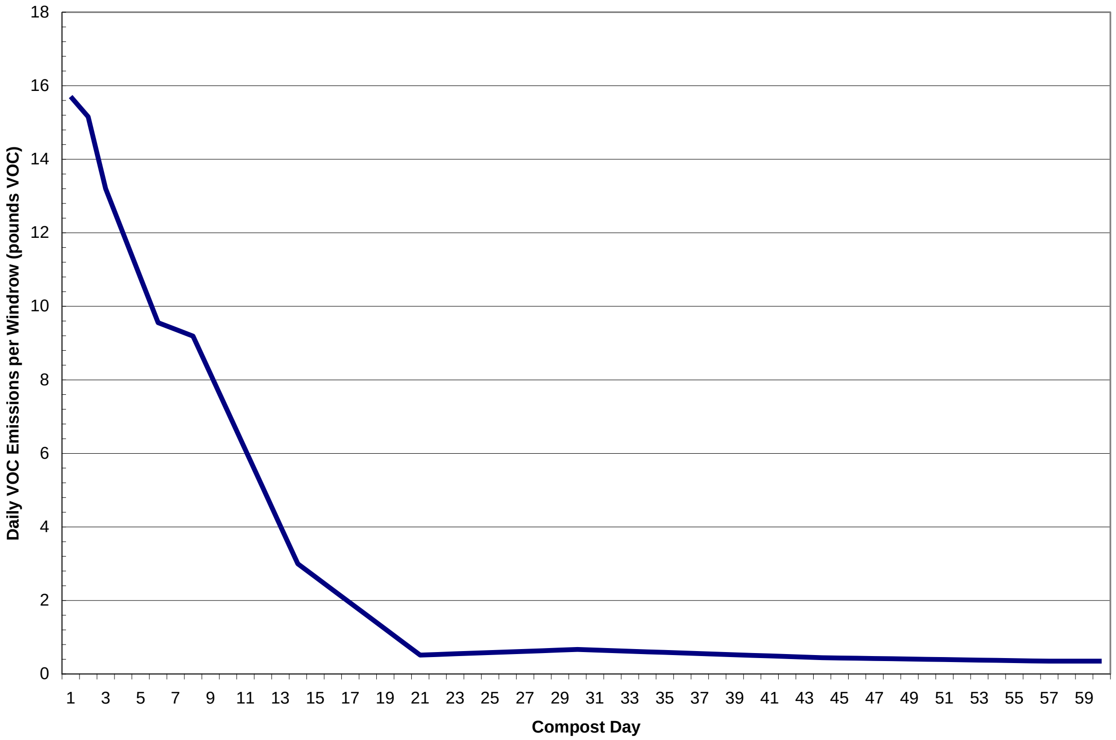
Emission Factor Calculation

Table 4. presents a simulated full 60 day compost cycle emissions based on the CIWMB data. The highlighted values are measured unit emissions, the rest of the data is linearly interpolated from the measured data. Figure 3 shows the daily emissions profile.

Table 4. Simulated VOC Emissions Profile.

Compost Day	Weighting Factors					Unit Flux (mg/min-m2)					Surface Area (m2)	Emissions VOC (#)
	RH	RL	Mid	Bot	Total	RH	RL	Mid	Bot	Total		
1	0.25	0.25	0.25	0.25	1.00	19.05	34.78	2.71	36.93	23.4	212	15.7
2	0.25	0.25	0.25	0.25	1.00	30.16	38.95	1.96	19.13	22.5	212	15.2
3	0.25	0.25	0.25	0.25	1.00	34.44	41.58	1.21	1.34	19.6	212	13.2
4	0.25	0.25	0.25	0.25	1.00	31.23	38.12	0.94	1.04	17.8	212	12.0
5	0.25	0.25	0.25	0.25	1.00	28.01	34.66	0.68	0.75	16.0	212	10.8
6	0.25	0.25	0.25	0.25	1.00	24.80	31.20	0.41	0.46	14.2	212	9.6
7	0.25	0.25	0.25	0.25	1.00	22.76	27.74	3.49	1.79	13.9	212	9.4
8	0.25	0.25	0.25	0.25	1.00	20.71	24.28	6.57	3.13	13.7	212	9.2
9	0.25	0.25	0.25	0.25	1.00	19.52	20.83	5.54	2.67	12.1	212	8.2
10	0.25	0.25	0.25	0.25	1.00	18.33	17.37	4.51	2.20	10.6	212	7.1
11	0.25	0.25	0.25	0.25	1.00	17.14	13.91	3.48	1.73	9.1	212	6.1
12	0.25	0.25	0.25	0.25	1.00	15.95	10.45	2.45	1.27	7.5	212	5.1
13	0.25	0.25	0.25	0.25	1.00	14.76	6.99	1.42	0.80	6.0	212	4.0
14	0.25	0.25	0.25	0.25	1.00	13.57	3.53	0.39	0.34	4.5	212	3.0
15	0.25	0.25	0.25	0.25	1.00	11.83	3.21	0.35	0.33	3.9	212	2.6
16	0.25	0.25	0.25	0.25	1.00	10.10	2.89	0.30	0.32	3.4	212	2.3
17	0.25	0.25	0.25	0.25	1.00	8.36	2.57	0.26	0.30	2.9	212	1.9
18	0.25	0.25	0.25	0.25	1.00	6.63	2.25	0.22	0.29	2.3	212	1.6
19	0.25	0.25	0.25	0.25	1.00	4.89	1.93	0.18	0.28	1.8	212	1.2
20	0.25	0.25	0.25	0.25	1.00	3.15	1.60	0.14	0.27	1.3	212	0.9
21	0.25	0.25	0.25	0.25	1.00	1.42	1.28	0.10	0.26	0.8	212	0.5
22	0.25	0.25	0.25	0.25	1.00	1.44	1.38	0.09	0.24	0.8	212	0.5
23	0.25	0.25	0.25	0.25	1.00	1.46	1.48	0.09	0.22	0.8	212	0.5
24	0.25	0.25	0.25	0.25	1.00	1.48	1.58	0.09	0.20	0.8	212	0.6
25	0.25	0.25	0.25	0.25	1.00	1.51	1.68	0.09	0.19	0.9	212	0.6
26	0.25	0.25	0.25	0.25	1.00	1.53	1.77	0.09	0.17	0.9	212	0.6
27	0.25	0.25	0.25	0.25	1.00	1.55	1.87	0.09	0.15	0.9	212	0.6
28	0.25	0.25	0.25	0.25	1.00	1.57	1.97	0.09	0.13	0.9	212	0.6
29	0.25	0.25	0.25	0.25	1.00	1.59	2.07	0.09	0.11	1.0	212	0.6
30	0.25	0.25	0.25	0.25	1.00	1.62	2.17	0.09	0.10	1.0	212	0.7
31	0.25	0.25	0.25	0.25	1.00	1.62	2.05	0.10	0.10	1.0	212	0.6
32	0.25	0.25	0.25	0.25	1.00	1.63	1.92	0.11	0.10	0.9	212	0.6
33	0.25	0.25	0.25	0.25	1.00	1.64	1.80	0.13	0.10	0.9	212	0.6
34	0.25	0.25	0.25	0.25	1.00	1.65	1.68	0.14	0.11	0.9	212	0.6
35	0.25	0.25	0.25	0.25	1.00	1.66	1.56	0.15	0.11	0.9	212	0.6
36	0.25	0.25	0.25	0.25	1.00	1.67	1.44	0.17	0.11	0.8	212	0.6
37	0.25	0.25	0.25	0.25	1.00	1.68	1.32	0.18	0.11	0.8	212	0.6
38	0.25	0.25	0.25	0.25	1.00	1.69	1.20	0.20	0.12	0.8	212	0.5
39	0.25	0.25	0.25	0.25	1.00	1.70	1.08	0.21	0.12	0.8	212	0.5
40	0.25	0.25	0.25	0.25	1.00	1.71	0.96	0.22	0.12	0.8	212	0.5
41	0.25	0.25	0.25	0.25	1.00	1.72	0.84	0.24	0.12	0.7	212	0.5
42	0.25	0.25	0.25	0.25	1.00	1.73	0.72	0.25	0.12	0.7	212	0.5
43	0.25	0.25	0.25	0.25	1.00	1.73	0.60	0.26	0.13	0.7	212	0.5
44	0.25	0.25	0.25	0.25	1.00	1.74	0.48	0.28	0.13	0.7	212	0.4
45	0.25	0.25	0.25	0.25	1.00	1.64	0.55	0.27	0.13	0.6	212	0.4
46	0.25	0.25	0.25	0.25	1.00	1.54	0.62	0.26	0.13	0.6	212	0.4
47	0.25	0.25	0.25	0.25	1.00	1.43	0.68	0.25	0.14	0.6	212	0.4
48	0.25	0.25	0.25	0.25	1.00	1.33	0.75	0.24	0.14	0.6	212	0.4
49	0.25	0.25	0.25	0.25	1.00	1.22	0.82	0.23	0.14	0.6	212	0.4
50	0.25	0.25	0.25	0.25	1.00	1.12	0.89	0.22	0.14	0.6	212	0.4
51	0.25	0.25	0.25	0.25	1.00	1.01	0.96	0.21	0.14	0.6	212	0.4
52	0.25	0.25	0.25	0.25	1.00	0.91	1.02	0.20	0.15	0.6	212	0.4
53	0.25	0.25	0.25	0.25	1.00	0.81	1.09	0.19	0.15	0.6	212	0.4
54	0.25	0.25	0.25	0.25	1.00	0.70	1.16	0.18	0.15	0.5	212	0.4
55	0.25	0.25	0.25	0.25	1.00	0.60	1.23	0.18	0.15	0.5	212	0.4
56	0.25	0.25	0.25	0.25	1.00	0.49	1.30	0.17	0.15	0.5	212	0.4
57	0.25	0.25	0.25	0.25	1.00	0.39	1.37	0.16	0.16	0.5	212	0.3
58	0.25	0.25	0.25	0.25	1.00	0.39	1.37	0.16	0.16	0.5	212	0.3
59	0.25	0.25	0.25	0.25	1.00	0.39	1.37	0.16	0.16	0.5	212	0.3
60	0.25	0.25	0.25	0.25	1.00	0.39	1.37	0.16	0.16	0.5	212	0.3
												159
											Emission Factor (#/ton)	1.5

Figure 3. Simulated VOC Emissions Profile.



Summary

An independent analysis of the Modesto flux data as supplied in the CE Schmidt Technical Memorandum was conducted. The emission estimate reported in the CIWMB report could not be duplicated, and the differences in assumptions, especially those that may be more significant have been identified and discussed. All things considered, the independent recalculation of the Modesto site emission factors are surprisingly similar to the CIWMB emission factors. This recalculation, again considering the differences and the similarity of the independently derived emission factors indicates that:

- Assumptions thought to be significant probably have less of an influence on the emission factor development process;

- The similarity in the emission factor estimates clearly establishes the ‘ball park’ for greenwaste emissions as those representing a site complying with a given site operations plan with regular maintenance and inspection. In other words, these data may represent sites that are capable of maintaining lower VOC emissions while producing an acceptable compost product.

- Given that the accuracy and precision specifications for flux chamber testing with GC analysis is +/- 50%, the data should be viewed as stated below:
  - 0.7 +/- 0.35 Range is 0.35 #/ton to 1.1 #/ton
  - 1.5 +/- 0.75 Range is 0.75 #/ton to 2.3 #/ton

- Note that these ranges overlap indicating no statistical difference in the numbers (0.7 and 1.5)

- Emission factors for the other test piles are not offered at this time.

Appendix C
Technical Memorandum
Site X Emission Report

Technical MEMORANDUM

Environmental Management Consulting
41125 278th Way SE, Enumclaw, WA 98022 USA
Phone: 360-802-5540 Fax: 360-802-5541
E-Mail: trcard@earthlink.net

TO: [redacted]

COPY: Chuck Schmidt

FROM: Tom Card

DATE: April 24, 2008

SUBJECT: Compost Emissions Source Test
Preliminary Results

A preliminary analysis has been made for your site emissions and this memo presents those results. The results are not final yet, but we are not expecting any dramatic changes. However, do not make important decisions regarding these results until they are finalized.

Table 1 summarizes the results for you site and Table 2 provides comparison data (windrow emissions only) from the SCAQMD and a site similar to yours (that must remain confidential). You are about twice the SCAQMD number for VOC and about four times for ammonia. However, you are lower in VOC than a similar tested site. Figure 1 shows the emissions profile for a typical windrow.

One of our concerns regarding the data set is that the flow rate through the flux chambers was about five times higher than we would expect. This is likely due to the wind speed. Unfortunately your site is located in a high wind area and there is not much that can be done to mitigate wind speed.

Table 3 is a list of assumptions made about your operation that have a direct bearing on the emissions estimate. Please review these assumptions and correct them where appropriate.

Table 1. Preliminary Results

	Emissions (pounds per ton received)	
Source	**VOC**	**Ammonia**
Receiving Stockpile	7.76	0.03
Windrows	6.30	2.34
Total	14.06	2.37

Table 2. Comparative Results (Windrow only)

	Emissions (pounds per ton received)	
Source	**VOC**	**Ammonia**
Site X	6.30	2.34
SCAQMD	3.80	0.50
Site Z	[redacted]	[redacted]

Figure 1. Emissions Profile

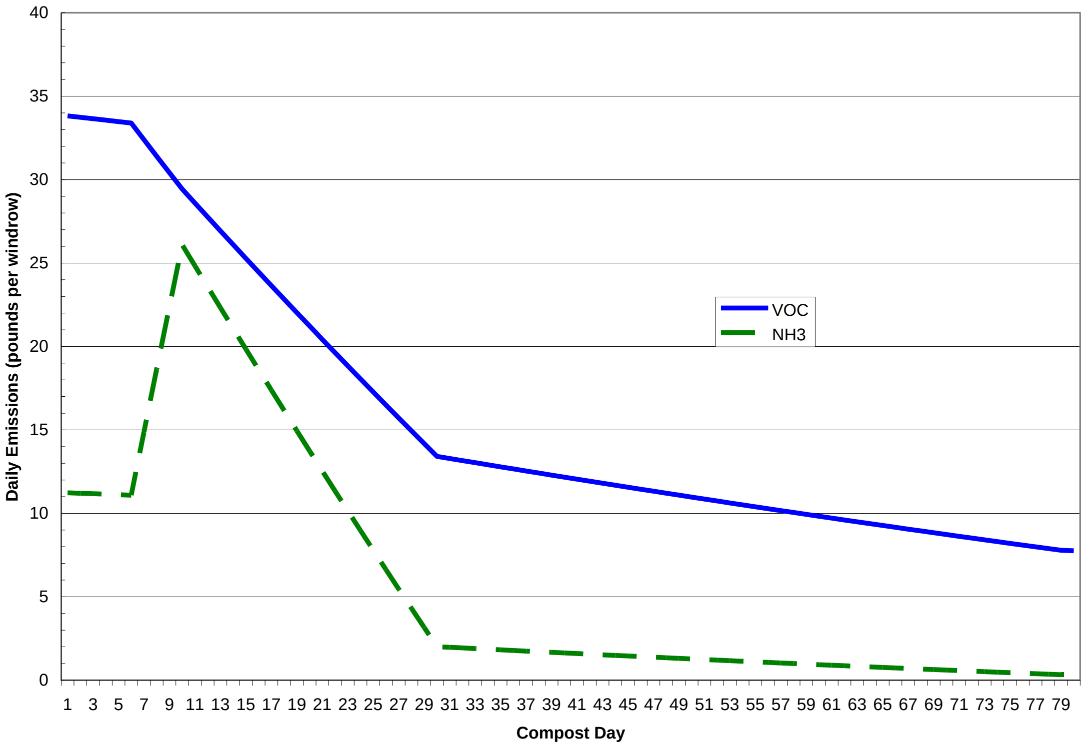


Table 3. Key Assumptions

Item	Value	Units
Average daily throughput	356	Tons
Stockpile density	800	#/yd3
Average stockpile duration	45	days
Mass in windrow	200	tons
Compost cycle duration	80	days

CE Schmidt, Ph.D.
Environmental Consultant

TECHNICAL MEMORANDUM

FLUX CHAMBER SOURCE TESTING OF FUGITIVE AIR EMISSIONS FROM SITE X COMPOST FACILITY

Prepared By:

Mr. Tom Card
Environmental Management Consulting
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Enumclaw, WA 98022

Dr. C.E. Schmidt
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May 7, 2008

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Attachments

A- Emissions Measurement Data Sheets
B- Chain of Custody
C- Lab Reports

References

EXECUTIVE SUMMARY

Field measurements were conducted at the Site X compost facility located in the California Central Valley. Testing was conducted on the pre-compost windrow and compost windrow area sources on site for the purpose of assessing total volatile organic compound (VOC- expressed as total non-methane non-ethane organic compounds by SCAQMD Method 25.3) emissions and ammonia emissions from the composting of greenwaste on site. Although the scope of work was limited by comparison to a full life-cycle emissions assessment, these data provide a good estimate of process emissions as tested.

The testing was conducted on March 10, 2008; the one-day testing effort was conducted on a day with winds running about 13 mph to 14 mph for the duration of the testing activities. Because most information points toward higher air emissions during windy conditions, it is possible that the measured flux data and thus site emission data were influenced by the higher winds resulting in a higher air emissions estimate.

The data collection approach included using the USEPA-recommended flux chamber modified as per the SCAQMD Rule 1133 as approved by recent method improvements, and standard air sample collection methods for VOCs or reactive organic gases, and ammonia. This approach provided data of high quality (accuracy and precision) representative of air emissions of study compounds from the organic composting process and the greenwaste static pile windrow composting process. The testing was scheduled so that fugitive air emissions could be measured at key times in the composting processes studied. The organic composting system was evaluated by collecting fugitive emission samples from the following area sources:

GREENWASTE COMPOSTING OPERATION

Feedstock as received and aged	Not tested
Compost Day 0	2 Flux tests, (T1, S2)
Compost Day 6	2 Flux tests, (T1, S1)
Compost Day 10	4 Flux tests, (T1, T2, S1, S2)
Compost Day 10, 1-hr post mixed	2 Flux tests, (T1, S1)
Compost Day 10, 3-hr post mixed	2 Flux tests, (T1, S1)
Compost Day 10, 5-hr post mixed	2 Flux tests, (T1, S1)

Compost Day 30	2 Flux tests, (T1, S1)
Compost Day 79	2 Flux tests, (T1, S1)
Blank testing	1 Flux test
Replicate testing	1 Flux test
TOTAL	20 Flux tests

Testing was conducted using the USEPA surface emission isolation flux chamber, real time detection for ammonia (screening-level analysis), SCAQMD Method 25.3 for total VOCs, and SCAQMD Method 207.1 for ammonia. The assessment of the test surfaces included screening using real time detection in the field (colorometric tubes for ammonia), and flow conditions in the flux chamber as a result of advective flow from the area sources tested. Advective flow from the windrow composting (gas production and wind) was quantitatively assessed by using a tracer gas (10% helium) in the flux chamber, gas collection in evacuated stainless steel canisters, and analysis off site by gas chromatography/thermal conductivity detection (GC/TCD). The dilution of helium was used to calculate advective flow, and these data were used in the calculation of compound emissions from the test sources.

Note that the recommended SCAQMD method bias factor correction of 1.086 was not applied to these data. There is no scientific justification for applying a specific bias correction factor generated from one laboratory to another laboratory, since a given analytical method bias is unique to that laboratory and not intrinsic to the method.

The data tables generated and reported in this document describe the fugitive air emission from the sources tested on site. These flux data, combined with engineering data that describes the composting operations, can be used to generate a facility emission factor data base and a facility baseline emission estimate for total VOCs and ammonia. The engineering estimate for VOC and ammonia emissions is reported elsewhere.

I. INTRODUCTION

This technical memorandum describes the field testing that was conducted in order to assess air emissions of ammonia, and VOC air emissions from the Site X greenwaste compost facility. Testing was conducted by Dr. C.E. Schmidt , Mr. Tom Card, and Ms. Katie Schmidt on March 10, 2008. Site preparation included arranging for the test piles and providing access to the facility.

The objective of the study was to provide representative, fugitive air emissions of study compounds from the purpose of generating ammonia and VOC emission estimates from the composting of greenwaste at the facility. This was accomplished by selecting representative test locations, and quantitative analysis of air emissions producing representative average air emissions data.

This memorandum includes a discussion of the testing methodology, quality control procedures, results, discussion of the results, and summary statements.

II. TEST METHODOLOGY

Testing for surface flux was conducted using the USEPA recommended Surface Isolation Flux Chamber (USEPA. Radian Corporation, February 1986). Flux chamber sampling was performed on static windrow piles of greenwaste materials as found on site the day of testing.

The operation of the surface flux chamber is given below:

1) Flux chamber, sweep air, sample collection equipment, and field documents were located on-site.

2) The site information, location information, equipment information, date, and proposed time of testing were documented on the Emissions Measurement Field Data Sheet.

3) The exact test location was selected and placed about 0.25” to 0.5” into compost matrix sealing the chamber for surface testing, or on the agricultural bag positioned to achieve a chamber/interface seal. .

4) The sweep air flow rate (ultra high purity air with a carbon monoxide tracer gas additive) was initiated and the rotometer, which stabilizes the flow rate, was set at 5.0 liters per minute. A constant sweep air flow rate was maintained throughout the measurement for each sampling location.

5) Flux chamber data were recorded every residence interval (6 minutes) for five intervals, or 30 minutes.

6) At steady-state (assumed to be greater than 5 residence intervals), the screening by colorimetric tube and real-time instrument was performed. After screening, sample collection was performed by interfacing the sample container (acid impinger, trap and canister, and tedlar bag (if scheduled) sequentially) to the purged, sample line and filling the container with sample gas or collecting the desired sample following sample collection protocols as per the work plan.

7) After sample collection (impinger solution, trap and evacuated canister, and tedlar bag) all sample media was sealed, labeled, and stored as per protocol, and sample collection information was documented on the data sheet.

8) After sampling, the flux measurement was discontinued by shutting off the sweep air,

removing the chamber, and securing the equipment. The chamber was cleaned by dry wipe with a clean paper towel and the sample lines were purged with UHP air.

9) Sampling locations were recorded on the field data sheet. The equipment was then relocated to the next test location and steps 1) through 8) were repeated.

III. QUALITY CONTROL

Control procedures that were used to assure that data of sufficient quality resulted from the flux chamber study are listed and described below. The application and frequency of these procedures were developed to meet the program data quality objectives as described in SCAQMD Rule 1133a with some modifications.

Field Documentation -- A field notebook containing data forms, including sample chain-of-custody (COC) forms, was maintained for the testing program. Attachment A contains the Emission Measurement Data Sheets.

Chain-of-Custody -- COC forms were not used for field data collection. Field data were recorded on the Chain-of-Custody forms provided in Attachment B.

Ammonia Analysis by SCAQMD Method 207.1

Laboratory Spike Recovery- One laboratory spike sample was performed and the recovery of the spike was 101%. These data indicate acceptable method performance.

Calibration – A five point calibration curve was performed for the ammonia method, and the correlation curve was reported within method specification. These data indicate acceptable method performance.

Trip Blank—One trip blank sample was collected and the level reported was <0.004 mg per sample (MDL 0.004 mg) or below method detection. These data indicate acceptable method performance.

Field Replicate Sample Analysis -- One field sample was collected in replicate and analyzed for the project. The RPD values for sample/replicate pair was 12 (QC criteria 50 RPD). These data indicate acceptable method repeatability and method performance.

Total Non-Methane and Non-Ethane Organic Compound Analysis by SCAQMD Method 25.3

Method Quality Control –Method quality control included method blank determinations, and method response to four-point calibration curves. All method QC testing was with method specifications, and these data indicate acceptable method performance.

Field System Blank – One blank samples was analyzed as blind QC sample. TNMNEO levels in the blank sample were less that <1.0 ppmvC for the condensable, volatile and total hydrocarbon analysis (method detection limit 1 ppmvC). These data establish sensitivity for the method (project QC criteria), and indicate acceptable method performance.

Field Replicate Sample – One field sample was collected and analyzed in replicate. In this data set, study compounds detected showed precision within precision criteria for field samples (RPD 50) for the TNMNEO or total VOC concentration. The RPD for the data set was 9.0 indicating acceptable method precision and performance.

Tracer Helium Analysis by GC/TCD

Laboratory Control Spike and QC Duplicate Analysis- Laboratory control spike sample data are not available at this time.

Laboratory Precision– Laboratory QC sample data are not available at this time.

Tracer Recovery Sample- One media blank sample was collected in the field by filling a canister for analysis in order to determine tracer recovery apart from the flux measurement technology or the advective flow from sources. The tracer was recovered from the media blank samples with a value of 105% (QC criteria ±50%, or 50% to 150% recovery). These data indicate acceptable method performance.

Field Replicate Sample – One field sample was collected in replicate. The precision (relative percent difference) for the field replicate sample pair was 0.0, which is less than the QC criteria of 50 RPD. These data indicate acceptable method performance.

IV. RESULTS AND DISCUSSIONS

A summary of the field sample collection for the field testing is shown in Table 1. All field data for the on site surface flux chamber testing (screening for ammonia, temperature), and sample identification information are presented in Table 1. All laboratory data including quality control data are presented in Table 2. These flux data include measured advective flow rate in the flux calculation. Surface flux data are shown in flux units for hydrocarbon emissions (mg/m2,min-1 as methane, ppmvC) and for ammonia (mg/m2,min-1 as ammonia).

Surface flux data for a surface area source are calculated using measured target compound concentrations and flux chamber operating parameter data (sweep air flow rate of 5.0 liters per minute [or 0.005 m3/min] plus advective flow [m3/min], surface area of 0.13 square meters [m^2]). The site emissions can be calculated by multiplying the flux by the surface area of the source. The flux is calculated from the sweep air flow rate Q (cubic meters per minute [m^3/min]), the species concentration Yi (micrograms per cubic meter [mg/m^3)], and exposure to the chamber surface area A (square meters [m^2]), as follows:

$$Fi = (Q)\ (Yi)\ /\ (A)$$

Emission rate of from a given static windrow test pile can be calculated by multiplying unit or average flux data per compound by surface area and reported as a function of area source.

Note that the recommended SCAQMD method bias factor correction of 1.086 was not applied to these data. There is no scientific justification for applying a specific bias correction factor generated from one laboratory to another laboratory, since a given analytical method bias is unique to that laboratory and not intrinsic to the method.

V. SUMMARY

Emission testing was performed on the Site X static windrow, greenwaste compost operations in order to generate an estimate of the facility baseline emissions for VOCs and ammonia. Testing was conducted at key times (compost at different age and under different conditions) in the compost cycle for the purpose of obtaining representative air emissions of ammonia and VOCs from the test piles. The following is a summary of activities and results associated with this objective:

- Surface flux measurements of study compounds were measured on static windrow piles in the compost cycle, from the pre-compost windrow piles to near the end-of-cycle compost (Day 79). Testing was performed using the USEPA recommended surface flux chamber technology as modified by the SCAQMD for advective flow sources at compost sites. This technology quantitatively measures flux at the test surface of study compounds.

- Field and laboratory quality control data indicate acceptable data quality for SCAQMD Method 207.1 (ammonia) and SCAQMD Method 25.3 (organic gases). System blank levels were acceptable, and precision between a sample and replicate field samples was within the RPD criteria of 50. The recovery of the helium tracer QC showed acceptable method performance, and the use of the helium recovery data per sample demonstrated to be a effective and representative approach to assessing volumetric flow from the sources tested.

- Note that the recommended SCAQMD method bias factor correction of 1.086 was not applied to these data. There is no scientific justification for applying a specific bias correction factor generated from one laboratory to another laboratory, since a given analytical method bias is unique to that laboratory and not intrinsic to the method.

- The wind speeds experienced on the day of testing may have affected the emission estimate. It is believed that higher winds generate higher flux and thus air emissions. The winds on the day of testing ranged from 13 mph to 14 mph. This is a high wind area, however, using these test data to represent an annual emissions estimate may result in a bias in the emissions.

- Two samples were collected on a ‘pre-compost’ windrow, meaning that material prepared composting was tested and the pile was not yet included in the life-cycle process. Data from this ‘front-end’ area source, although small in surface area, was used to represent greenwaste material on site prior to entering the composting operations, including the tipping piles, screening piles, and storing piles.

- The flux data can be used to estimate ammonia, and VOC emissions from the test pile surfaces. Emission rate data is obtained by multiplying surface areas of the test piles by the surface area of the test piles.

REFERENCES

USEPA. 1986. "Measurement of Gaseous Emission Rates From Land Surfaces Using an Emission Isolation Flux Chamber, Users Guide." EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, EPA Contract No. 68-02-3889, Work Assignment No. 18, Radian Corporation, February 1986. NTIS # PB 86-223161.

Table 1. Summary of Test Information.

DATE	TIME	SOURCE	COMPOST	Section	TEST LOCATION	NH3	Helium	TRACER	25.3	207.1	IN SURF	IN AIR	OUT SURF	OUT AIR	WINDS	COMMENT
			DAY	PILE		(ppmv)	(%)	SF6	ID	ID	°F	°F	°F	°F	(mph)	
3/10/2008	941	Windrow Compost	10	D-16	Top- T1	10	10.31	1.046	G-101	A-101	63	83	63	61	13	Mixed and water added 3 days prior, pile 4.5' tall, 10' base
3/10/2008	942	Windrow Compost	10	D-16	Top-T2	12	10.22	1.049	G-102	A-102	89	95	84	61	13	Mixed and water added 3 days prior
3/10/2008	942	Windrow Compost	10	D-16	Side- S1	12	10.20	1.058	G-103	A-103	66	92	66	66	13	Mixed and water added 3 days prior
3/10/2008	943	Windrow Compost	10	D-16	Side- S2	4	10.33	1.042	G-104	A-104	58	75	58	62	13	Mixed and water added 3 days prior
3/10/2008	1136	Windrow Compost	6	D-18	Top- T1	28	10.33	1.042	G-105	A-105	64	100	64	68	13	
3/10/2008	1139	Windrow Compost	6	D-18	Side- S1	2	10.31	1.046	G-106	A-106	62	90	62	68	13	
3/10/2008	1144	Windrow Compost- Post Mix Hr-1	10	D-16	Top- T1	8	10.20	1.058	G-107	A-107	66	92	66	70	13	Mixed at 1107
3/10/2008	1148	Windrow Compost- Post Mix Hr-1	10	D-16	Side- S1	12	10.22	1.049	G-108	A-108	125	95	125	68	13	Mixed at 1107
3/10/2008	1250	Windrow Compost- Post Mix Hr-3	10	D-16	Top- T1	10	10.20	1.058	G-111	A-111	65	84	65	76	14	Mixed at 1107
3/10/2008	1343	Windrow Compost- Post Mix Hr-3	10	D-16	Side- S2	20	10.22	1.049	G-112	A-112	60	90	60	77	14	Mixed at 1107
3/10/2008	1351	Windrow Compost	30	E-7	Top- T1	8	10.33	1.042	G-109	A-109	60	104	60	76	ND	Pile 4' tall, 10' wide base
3/10/2008	1351	Windrow Compost	30	E-7	Side- S1	6	10.31	1.046	G-110	A-110	62	92	62	77	ND	
3/10/2008	1535	Windrow Compost- Post Mix Hr-5	10	D-16	Top- T1	8	10.20	1.058	G-113	A-113	63	80	63	75	ND	Mixed at 1107
3/10/2008	1537	Windrow Compost- Post Mix Hr-5	10	D-16	Side-2	16	10.22	1.049	G-114	A-114	66	86	66	77	ND	Mixed at 1107
3/10/2008	1548	Windrow Compost	79	B-10	Top- T1	4	10.31	1.046	G-115	A-115	64	93	64	75	ND	Pile 3.5' tall and 9 ' wide base
3/10/2008	1549	Windrow Compost	79	B-10	Side- S2	2	10.33	1.042	G-116	A-116	70	81	70	76	ND	
3/10/2008	1707	Windrow Compost- Prep Pile	0	C-12	Top- T1	<0.05	10.20	1.058	G-117	A-117	72	82	72	78	ND	
3/10/2008	1715	Windrow Compost- Prep Pile	0	C-12	Side- S1	1	10.20	1.058	G-118	A-118	74	79	74	78	ND	
3/10/2008	1715	Sample Replicate	0	C-12	Side- S1	1	10.20	1.058	G-119	A-119	74	79	74	78	ND	Sample Replicate
3/10/2008	1715	Media Blank	N/A	N/A	N/A	N/A	10.20	1.058	G-120	A-120	N/A	N/A	N/A	N/A	NA	Reagent Blank

Table 2. Summary of Flux Data (mg/m2,min-1).

SOURCE	COMPOST DAY	TEST LOCATION	25.3 ID	207.1 ID	Methane (ppmv)	Ethane (ppmv)	TNMNEO (ppmv)	NMNEO Trap (ppmv)	NMNEO Tank (ppmv)	NH3 (mg)	NH3 Vol (m3)	NH3 (mg/m3)	Helium %
Windrow Compost	10	Top- T1	G-101	A-101	27.4	ND	**12.2**	6.06	6.12	0.365	0.0295	12.4	10.31
Windrow Compost	10	Top-T2	G-102	A-102	16.7	ND	**11.8**	11.2	1.0	0.489	0.0268	18.2	10.22
Windrow Compost	10	Side- S1	G-103	A-103	93	ND	**21.0**	20.1	1.0	0.278	0.0282	9.9	10.20
Windrow Compost	10	Side- S2	G-104	A-104	17.2	ND	**4.25**	3.58	1.0	0.055	0.0248	2.2	10.33
Windrow Compost	6	Top- T1	G-105	A-105	10	ND	**17.7**	17.2	1.0	0.505	0.0311	16.2	10.33
Windrow Compost	6	Side- S1	G-106	A-106	65	ND	**9.94**	9.37	1.0	0.029	0.0303	0.96	10.31
Windrow Compost- Post Mix Hr-1	10	Top- T1	G-107	A-107	14.9	ND	**5.62**	4.89	1.0	0.113	######	3.8	10.20
Windrow Compost- Post Mix Hr-1	10	Side- S1	G-108	A-108	65.7	ND	**10.6**	9.45	1.14	0.239	0.0332	7.2	10.22
Windrow Compost- Post Mix Hr-3	10	Top- T1	G-111	A-111	11.5	ND	**5.77**	5.23	1.0	0.123	0.0271	4.5	10.20
Windrow Compost- Post Mix Hr-3	10	Side- S2	G-112	A-112	48.7	ND	**7.15**	5.65	1.49	0.202	0.0254	8.0	10.22
Windrow Compost	30	Top- T1	G-109	A-109	58.3	ND	**5.97**	5.57	1.0	0.050	0.0130	3.8	10.33
Windrow Compost	30	Side- S1	G-110	A-110	574	ND	**6.65**	5.82	1.0	0.002	0.0103	0.19	10.31
Windrow Compost- Post Mix Hr-5	10	Top- T1	G-113	A-113	19.3	ND	**3.91**	3.34	1.0	0.089	0.0231	3.9	10.20
Windrow Compost- Post Mix Hr-5	10	Side-2	G-114	A-114	42.0	ND	**5.19**	4.14		0.163	0.0219	7.4	10.22
Windrow Compost	79	Top- T1	G-115	A-115	100	ND	**5.41**	2.91		0.011	0.0587	0.19	10.31
Windrow Compost	79	Side- S2	G-116	A-116	79.60	ND	**5.70**	4.27		0.009	0.0588	0.15	10.33
Windrow Compost- Prep Pile	0	Top- T1	G-117	A-117	2.13	ND	**27.6**	27.6	1.0	0.004	0.0509	0.08	10.20
Windrow Compost- Prep Pile	0	Side- S1	G-118	A-118	47.20	ND	**116**	115	1.0	0.013	0.0512	0.25	10.20
Sample Replicate	0	Side- S1	G-119	A-119	46.70	ND	**106**	105	1.0	0.013	0.0605	0.21	10.20
Media Blank	N/A	N/A	G-120	A-120	1.0	ND	**1.0**	1.0	1.0	0.004	0.0540	0.074	10.20

Flux Unit: mg/m2,min-1

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4

Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO

Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3

Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow

Note 5- MDL value used for ND or non-detect for calcuation purposes

Table 2. Summary of Flux Data (mg/m2,min-1).

Trace %	Total Flow (m3/min)	SF6 UHP (ppbv)	SF6 Detect (ppbv)	Methane Flux	TNMNEO Flux	NH3 Flux	SOURCE	TEST LOCATION	COMPOST DAY	COMMENT
0.20	0.2578	N/A	N/A	35.47	**16**	**25**	Windrow Compost	Top- T1	10	
0.27	0.1893	N/A	N/A	15.88	**11**	**27**	Windrow Compost	Top-T2	10	
0.23	0.2217	N/A	N/A	103.58	**23**	**17**	Windrow Compost	Side- S1	10	
0.19	0.2718	N/A	N/A	23.49	**5.8**	**4.6**	Windrow Compost	Side- S2	10	
0.27	0.1913	N/A	N/A	9.49	**17**	**24**	Windrow Compost	Top- T1	6	
0.16	0.3222	N/A	N/A	105.52	**16**	**2.4**	Windrow Compost	Side- S1	6	
0.15	0.3400	N/A	N/A	25.45	**9.6**	**10**	Windrow Compost- Post Mix Hr-1	Top- T1	10	
0.19	0.2689	N/A	N/A	88.76	**14**	**15**	Windrow Compost- Post Mix Hr-1	Side- S1	10	
0.12	0.4250	N/A	N/A	24.55	**12**	**15**	Windrow Compost- Post Mix Hr-3	Top- T1	10	
0.16	0.3194	N/A	N/A	78.13	**11**	**20**	Windrow Compost- Post Mix Hr-3	Side- S2	10	
0.28	0.1845	N/A	N/A	54.02	**5.5**	**5.5**	Windrow Compost	Top- T1	30	
0.24	0.2148	N/A	N/A	619.30	**7.2**	**0.32**	Windrow Compost	Side- S1	30	
0.12	0.4250	N/A	N/A	41.20	**8.3**	**13**	Windrow Compost- Post Mix Hr-5	Top- T1	10	
0.18	0.2839	N/A	N/A	59.89	**7.4**	**16**	Windrow Compost- Post Mix Hr-5	Side-2	10	
0.47	0.1097	N/A	N/A	55.09	**3.0**	**0.16**	Windrow Compost	Top- T1	79	
0.30	0.1722	N/A	N/A	68.84	**4.9**	**0.20**	Windrow Compost	Side- S2	79	
0.19	0.2684	N/A	N/A	2.87	**37**	**0.16**	Windrow Compost- Prep Pile	Top- T1	0	Representative of Tipping Pile/Pre Pile
0.16	0.3188	N/A	N/A	75.57	**186**	**0.62**	Windrow Compost- Prep Pile	Side- S1	0	
0.16	0.3188	N/A	N/A	74.77	**170**	**0.53**	Sample Replicate	Side- S1	0	
10.7	0.005	N/A	N/A	0.025	**0.025**	**0.0028**	Media Blank	N/A	N/A	105 Percent Recovery of He Tracer

MDL Value Used

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4
Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO
Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3
Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow
Note 5- MDL value used for ND or non-detect for calcuation purposes

ATTACHMENT A

EMISSION MEASUREMENT DATA SHEETS

ATTACHMENT B

CHAIN OF CUSTODY

ATTACHMENT C

LABORATORY REPORTS

Appendix B

Comments and Responses to the "Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review"

Responses to Comments on the document entitled "Organic Material Composting and Drying focusing on Greenwaste Compost Air Emissions Data Review", by Thomas R. Card and Charles E. Schmidt, June 2008. This report will be referred to as the "green waste report" hereafter within this document.

Summary of comments from Center on Race, Poverty and the Environment (CRPE) / Committee for a Better Arvin:

CRPE 1: The CIWMB Modesto Study should be excluded from consideration because it did not include emissions from the stockpiles.

Response: The green waste report included separate VOC emission factors for the windrows and the stockpiles. The report averaged the measurement results for each of these two processes separately. The CIWMB Modesto Study measurement was used only in developing the windrow VOC emission factor. The lack of a stockpile emission factor from this study does not affect the VOC emission factor for the windrows.

CRPE 2: The CIWMB Modesto Study should be excluded from consideration because the results are not replicable.

Response: This comment is based on Schmidt's recalculation of the results, and his conclusion that the published results of the Modesto Study are incorrect. The District has reviewed Dr. Schmidt's recalculation, and has determined that there is not enough justification within the analysis to support the recalculation of previously published study results. Therefore, the District will use the originally published emission factor of 0.8 to 0.9 lb-VOC/ton.

CRPE 3: The CIWMB Modesto Study should be excluded from consideration because it did not account for the effect of wind on emissions.

Response: The studies that were chosen for inclusion in the green waste report were the studies that were found to be the most complete and valid for the purpose of generating VOC emission factors for composting operations. Conditions during emission measurements at each of the study sites were representative of conditions during actual operations. It is not possible to determine if wind is expected to have a significant effect on the VOC emission rates or adjust measured emission rates without full speciation of the compounds measured. The studies that were determined to be the most valid, including the CIWMB Modesto Study, used total VOC methods without speciation because total VOC methods have been found to capture a higher proportion of the total VOC emissions when compared to other methods. Additionally, there are currently no validated procedures to adjust the measured rates for differing wind velocities. In conclusion, the District is using the most complete scientific data available to update the composting emission factor. As with other emission factors, the proposed composting VOC emission factor will be periodically updated to incorporate if new scientific information indicates that revisions may be necessary.

CRPE 4: None of the three studies relied upon were conducted during the hotter months in the Central Valley. The Modesto report was conducted between October and December, some of the coldest months of the year in the Central Valley. The studies may underestimate emissions because they did not account for the high summer temperatures common in the Central Valley.

Response: As stated above, the studies that were chosen were the studies that were found to be the most complete and valid for the purpose of generating emission factors.

In regards to the comment that the testing for the Modesto report was conducted in the coldest part of the year, records indicate that the coldest months in the Central Valley are December-February and that the average temperature for October is actually higher than both March and April. It must also be noted that the NorCal study was conducted during August in Vacaville, CA, and records indicate that the average summer temperatures in Vacaville are very similar to summer temperatures found in the Central Valley.

The annual compost VOC emission factor developed from the studies are intended to be representative of average annual emissions rather than peak daily emissions. The studies that were determined to be suitable for developing VOC emission factors are actually very representative of seasonal variation throughout the year with testing performed in the spring (Site X testing in March), autumn to early winter (CIWMB, Modesto testing in October - December), and summer (NorCal testing in August).

Summary of Comments from ERM on behalf of Norcal Waste Systems, Inc. Note that this letter includes comments on both the emission factor report and the rulemaking process. Only those comments on the emission factor report are presented here:

ERM 1: The data is limited.

Response: The District agrees that the data is limited, but the purpose of this report was to find all studies that were robust enough to be considered useful in determining an emission factor. The resulting emission factor is based on the best science available at the time.

ERM 2: Limited duration of testing. Site X only one day of testing. Also, Modesto study was recalculated, and did not include stockpiles.

Response: Regarding the one day of testing at Site X: While all sampling was conducted on one day, piles of different ages were sampled in order to obtain flux measurements throughout the life of a pile. Regarding the recalculation of the Modesto Study and lack of stockpile emissions – see responses to CPRE comments 2 and 1, above.

ERM 3: The emissions data are extremely variable. There appeared to be no attempt to account for temporal variations throughout the composting cycle in deriving "average" emission factors. There is insufficient documentation provided to allow for independent analysis of temporal or spatial factors as they relate to the reported flux rates.

Response: The District agrees that there were limited data available that were complete and valid for developing emission factors given the variability of the source. However, the resulting emission factor is based on the best science available at the time. Each individual study used in the report accounted for the variation throughout the composting process. The individual emission factors from each study referenced in the report were developed from emission measurements for different stages throughout complete composting cycle at each site. Additional information on the time and location of emission measurements is available in the original study reports referenced.

ERM 4: The data from the green waste report should not be averaged for the purpose of developing emission factors for regulatory purposes.

Response: The average emission factors are based on the best science available at the time for calculating VOC emissions from composting.

ERM 5: The data from the green waste report should not be averaged for the purpose of calculating annual emissions. There is insufficient documentation provided in the report to allow for an independent analysis of the data relative to the type of composting operation, throughput, size of piles, and length of composting cycle.

Response: See response to ERM comment 4, above. Additional information on each composting operation is available in the original study reports referenced.

ERM 6: The impact of compost process temperature on emissions should be considered. It is ERM's professional judgment that temperature variations relate more to the time in the composting cycle than seasonal variation in ambient temperature. No information was given in the green waste report as to the location of temperature measurements.

Response: The individual emission factors from each study referenced in the report were developed from emission measurements at different stages throughout the composting cycle at each site, which accounts for temperature variation of the piles during the composting process. Additional information on temperature measurements may be available in the original study reports referenced.

ERM 7: The emissions released during turning of windrows were not addressed in the green waste report.

Response: The District is not aware of any studies that measured emissions released during turning of windrows. If additional information becomes available on emissions released during turning of composting windrows, the District will review this information and incorporate it if appropriate. Based on discussions with Dr. Schmidt, elevated emissions have been measured from windrows immediately after turning but only for a few hours, at most, and would not be significant over the life cycle of well-managed composting operations.

<u>ERM 8:</u> Data presented for Site X as well as the South Coast Air Quality Management District (SCAQMD) data yielded higher emissions from stockpiles than from the windrows, which ERM considers unlikely.

<u>Response:</u> The District surveyed the green waste composting facilities in the San Joaquin Valley. The result of the survey indicates an average stockpile time of 3.85 days, and ranged from 0-21 days. The Site X stockpile EF was based on sampling at day 45, and is not representative of stockpiling in the San Joaquin Valley. The Site X stockpile test will not be included in the stockpile EF since it is not representative of SJV stockpiling. The SCAQMD stockpile data is considered as some of the most relevant green waste composting data available according to the green waste report. The SCAQMD samples were taken on a very representative day 2 stockpile. These emission measurements were conducted under conditions that were representative of conditions found during actual operations and are considered representative of emissions from these operations.

<u>ERM 9:</u> The green waste report states that the Norcal data exhibits a VOC "spike" in emissions during the first few days of composting. It is ERM's experience from green waste compost testing that this is very representative of the typical windrow composting emissions cycle. Source test documentation should be made available and analyzed systematically to ensure proper review of the test data and a statistical analysis of all test data should be performed.

<u>Response:</u> The District agrees that the measured emissions spike may be characteristic of some types of composting operations. Additional source test documentation may be available in the original study reports and from agencies that performed the studies.

<u>ERM 10:</u> The green waste report’s conclusions are based on highly variable and extremely limited data. The green waste report only considered data that were measured using SCAQMD Method 25.3. Data collected by other methods may provide useful relative contributions from the different unit processes and temporal variability. A peer review of the NorCal report prior to issuance may have provided the opportunity to address some of the comments in this letter.

<u>Response:</u> The District agrees that there were limited data available for developing emission factors given the variability of the source. However, the resulting emission factor is based on the best science available at the time. SCAQMD Method 25.3 has been found to capture a higher proportion of the total VOC emissions than the other methods mentioned; therefore, this method was the most appropriate for development of VOC emissions factors. The District acknowledges that data collected by other methods may still be valuable for uses other than development of emission factors. The District agrees that peer review of reports can be valuable and is generally desirable

when time and resource constraints allow. However, the NorCal report was created for another District, the Yolo-Solano APCD, and District source tests are typically not peer reviewed.

Summary of Comments from California Integrated Waste Management Board (CIWMB), now know as Department of Resources Recycling and Recovery (CalRecycle):

CIWMB 1: The green waste report states that the emission factors from each study are averaged for reference only with no implication that the average is representative of green waste compost emissions in the San Joaquin Valley. If the average is not representative of green waste compost emissions, it should not be displayed.

Response: The report does not state that the average emission factors are not representative of green waste compost emissions, but is based on a limited data set from studies suitable for developing emission factors. The average emission factors are presented for reference purposes, per District request, and are based on the best science available at the time to calculate annual emissions from green waste composting. The District will base the final EF on the average of valid, representative test data. As more relevant data becomes available, the EF should be adjusted accordingly.

CIWMB 2: The weighted average of the three studies based on number of samples presents a better starting point for negotiations of the green waste composting emissions factors.

Response: Each study at the different composting sites was found to have sufficient measurements for the purpose of generating valid emission factors; therefore, each study is weighted equally to capture the variability of composting operations. The District used the best scientific information available to develop the green waste composting emission factor and is willing to evaluate and discuss any additional scientific information presented related to the emission factor.

CIWMB 3: The report states "The data are even more diverse than this table may indicate." A reasonable interpretation of this comment and the one above is that there is too little data to formulate an emissions factor applicable to composting facilities in the San Joaquin Valley.

Response: The District understands this comment to refer to the variation in daily emissions throughout the composting cycle, which is not clearly evident when presenting the single overall emission factors for each site. This interpretation is supported by the fact that immediately after this comment the report refers to a figure showing daily compost windrow emissions. Also see responses to ERM comment 1, above.

CIWMB 4: The spike in VOC emissions at the NorCal site may be an outlier since it is based on one flux sample. The District and Dr. Schmidt should review the Day 3 NorCal sampling event to determine whether there are other confounding circumstances.

Response: Other composting studies have also shown an initial increase in emissions during the composting cycle (see referenced report on Tierra Verde Industries composting operation and ERM comment 7, above). There is no indication in the report that the measured emission point was an outlier and comparatively high emissions were also measured on day 6 of the composting operation.

CIWMB 5: Is Figure 2.1 based on actual measured data or is it figurative?

Response: Figure 2.1 of the report is based on actual data from the NorCal composting site.

CIWMB 6: Figure 2.2 appears to be identical to Figure ES 2 on page 4.

Response: The District agrees.

CIWMB 7: We question whether there is enough data to support the contention that smaller windrows increase emissions. It seems more reasonable that emissions will correlate with the amount of materials in the windrow and operational factors and this is the rationale for having an emissions factor. Assuming that similar materials have similar potential emissions, a smaller windrow might have higher emissions earlier in the process but these emissions should trail off more rapidly.

Response: The report states that “For the same unit surface flux rate, the smaller row will have twice the emissions on a per ton input basis.” This is true. As long as the surface flux rates remain the same, smaller windrows will have greater emissions on a per ton basis. However, the District agrees that the flux rate for the smaller windrow would likely decline more rapidly resulting in similar emissions on a per ton basis.

CIWMB 8: We believe we can identify Site X and believe the site receives overflow green waste from San Francisco and the East Bay and may include some food waste. Therefore, it is possible that the Site X data is more representative of food waste composting than green waste composting.

Response: The technical memorandum for the study performed at Site X did not indicate that the composting piles that were tested at the site included food waste. The District’s understanding is that the piles at Site X that were tested did not include food waste. The District but will evaluate any evidence that conclusively demonstrates that this was not the case at the time of testing.

CIWMB 9: The report states that the CIWMB Modesto study consisted of 36 measurements. The CIWMB Modesto data set consists of 100 flux chamber samples and 9 quality control samples.

Response: The District agrees that the complete CIWMB Modesto data set consists of 100 flux chamber samples, including emission measurements from green waste composting, food waste composting, composting with a pseudo-biofilter cover, and composting with chemical additives. Only the 36 emission measurements from uncontrolled green waste composting were considered in this section of the report since the purpose was to evaluate emissions studies for use in developing an emission factor for uncontrolled green waste composting.

CIWMB 10: The report states that there is no baseline data for food waste composting. The CIWMB Modesto study includes an emissions profile for an uncontrolled windrow of 85% green waste and 15% food waste.

Response: The District agrees that the CIWMB Modesto study may provide useful information on VOC emissions from composting operations that include some food waste.

CIWMB 11: We question the assumptions and procedures used to recalculate the emissions reported in the CIWMB Modesto study report.

Response: See response to CPRE comment 2, above.

CIWMB 12: Have the results of the emissions study test at Site X been finalized?

Response: These results have been finalized.

CIWMB 13: What is Site Z and why is that data blacked out?

Response: Site Z is a composting operation in California. The Green waste report only included data that was provided to the District. Site Z was not evaluated in the report because this information was not included in the composting emission studies provided to the District from the responsible government agency. Additionally, the report authors indicated that the emissions information was from an older study and this operation was not considered to be representative of current composting practices.

CIWMB 14: What is the basis for the daily throughput number for Site X? This number appears to be less than we expect.

Response: The basis of this number is information reported from the facility.

CIWMB 15: Table 3 in the report for Site X indicates that the average age of the feedstock piles is 45 days. We believe that this feedstock pile is anaerobic. If anaerobic materials are used to create windrows, initial emissions may be expected to be higher.

Response: While this may be the case, the resulting windrow VOC EF at Site X, 6.30 lb/ton, is very close to the NorCal windrow VOC EF of 5.65 lb/ton, and less than the

Zamora windrow VOC EF of 10.03 lb/ton. As such, the emission measurements at Site X are considered representative of emissions from green waste windrows.

CIWMB 16: We believe the emissions factors developed from the studies at Site X and NorCal are skewed high because of high wind speed, low sample count, inclusion of food waste, and small windrow piles.

Response: See responses to CIWMB comments 7, 8, and 15 and ERM comments 1 and 2, above.

Appendix C

"Northern Recycling Zamora Compost Facility Air Emissions Source Test", by Thomas R. Card and Charles E. Schmidt, May 2009

Northern Recycling
Zamora Compost Facility

Baseline Air Emissions Assessment

Air Emissions Source Test

Evaluation of Complete Compost Cycle VOC and Ammonia Emissions

Report

Revision 2

May 2009

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Executive Summary

This report documents the completed project of assessing baseline air emissions for the new Northern Recycling greenwaste composting facility located near Zamora, California. This report contains the results of two sampling events. The first event was completed in October 2008 and included winery waste in the compost mix. The second event was completed in April 2009 with no winery waste present. USEPA flux chamber samples were taken from actual compost operations to provide unit emissions data that were used to complete the calculation of full scale annual emissions for VOC and ammonia. All sampling and analysis were completed in compliance with the source test protocol document previously submitted to Yolo-Solano APCD.

Emissions were calculated based on a simulation of a full 80 day compost cycle by sampling key process days and interpolating the emissions between those days. Three mixing cycle events were sampled during the first event and mixing was found to be a significant contributor to emissions.

Table ES-1a and ES-1b summarizes the results of this baseline emissions assessment. The measured compost emission factor for compost with winery waste of 16.55 # VOC per ton of composting material is substantially higher than the most comparable previously measured values (5.65 # and 6.3 # VOC per ton compost mix) reported by the San Joaquin Valley APCD (see Table ES-2). The factor without winery waste was 10.03 # VOC per ton of compost mix.

Total site emissions for VOC were 3,030 tons per year with about two thirds of that attributed to the emissions from the feedstock stockpile for compost with winery waste. Total site emissions for VOC were 1,070 tons per year with about one half of that attributed to the emissions from the feedstock stockpile for compost without winery waste. The annual emissions calculations were based on 100,000 tons per year of throughput. No attempt was made in this report to prorate actual annual emissions based on the presence or absence of winery waste.

A concern about this data set are the extremely low ammonia emissions from Event 1 when winery waste was present. The emissions on this site are over an order of magnitude lower than comparable facilities. Most of the ammonia samples were below the method detection limit. The method detection limit for ammonia for this project was typically between 0.2 and 0.4 mg/m3. These are very low detection limits, about a factor of three lower than most SCAQMD Method 207.1 method detection limits. No other comments or explanations are offered for this with the exception that the ammonia sampling and analysis was in full compliance with the QA/QC program and the laboratory samples agreed with the field screening samples. The ammonia emissions without winery waste, however, were essentially the same as other greenwaste compost facilities.

Table ES-1a. – Calculated VOC and NH3 emissions from the feedstock storage, compost cycle, and finished product storage (with winery waste).

		VOC		Ammonia	
Source	Mass on Site (tons)	Emission Factor (pounds/ton)	Total Emissions (Tons/year)	Emission Factor (pounds/ton)	Total Emissions (Tons/year)
Feedstock Storage	27,000	44.03	2,201	0.017	0.94
Composting	20,000	16.55	828	0.011	0.573
Product Storage	3,000	0.02	1.2	0.0004	0.014
Total	50,000		3,030		1.52
Overall Emission Factor (#/ton)		60.61		0.030	

Table ES-1b. – Calculated VOC and NH3 emissions from the feedstock storage, compost cycle, and finished product storage (without winery waste).

		VOC		Ammonia	
Source	Mass on Site (tons)	Emission Factor (pounds/ton)	Total Emissions (Tons/year)	Emission Factor (pounds/ton)	Total Emissions (Tons/year)
Feedstock Storage	27,000	11.34	567	1.643	89.93
Composting	20,000	10.03	502	0.445	22.236
Product Storage	3,000	0.02	1.2	0.0004	0.014
Total	50,000		1,070		112.18
Overall Emission Factor (#/ton)		21.40		2.244	

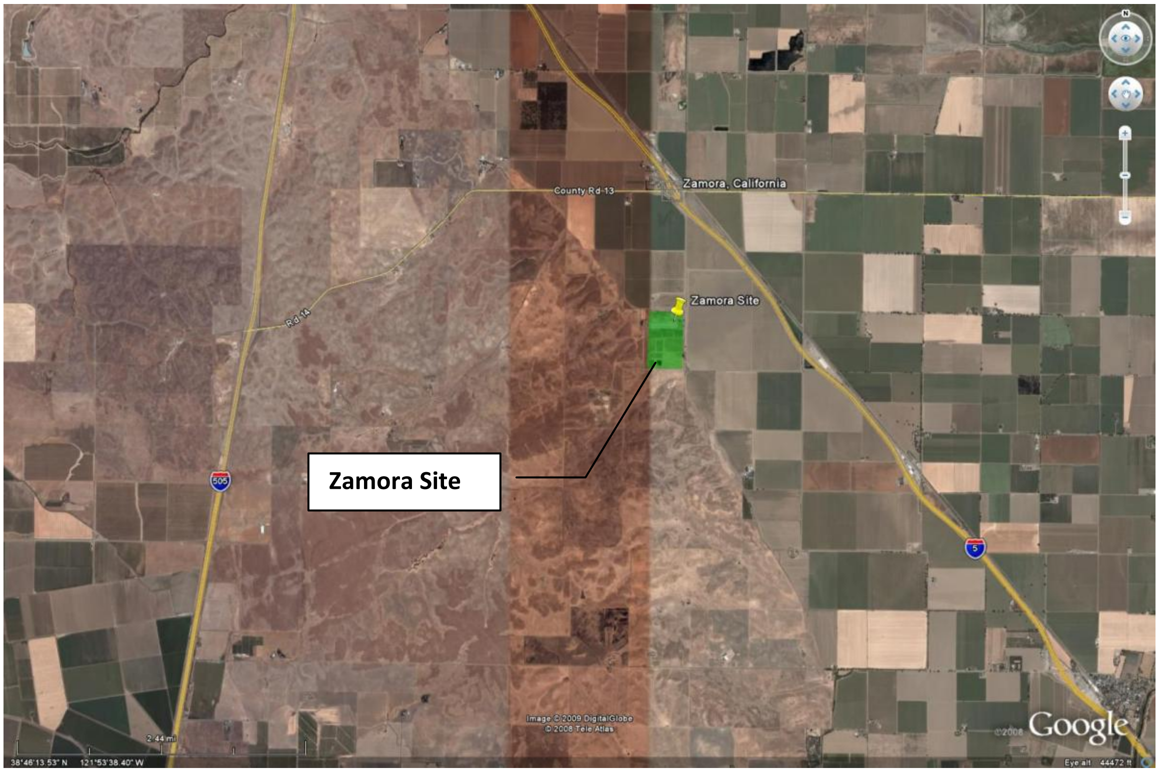
Table ES-2. – Comparative greenwaste compost emissions (from SJVAPCD).

			VOC							NH3						
			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)		
Location	Material	Activity	(#/ton)	Peak	Avg	Min	Peak	Avg	Min	(#/ton)	Peak	Avg	Min	Peak	Avg	Min
Site X	Landscape	Stockpiles	7.76	186	111	37	2.30	1.38	0.46	0.03	0.62	0.39	0.16	0.01	0.00	0.002
	Waste	Windrows	6.30	23	11	3	0.29	0.13	0.04	2.34	26.56	12.07	0.20	0.33	0.15	0.003
		Total	14.06							2.37						
CIWMB		Windrows	1.54	42	9	0.1	0.51	0.11	0.001							
Modesto							`									
NorCal		Stockpiles	2.95	110	54	4	1.36	0.66	0.046	0.08	2.1	1.21	0.61	0.03	0.01	0.008
		Windrows	5.65	376	73	1	4.65	0.90	0.010	0.54	7.29	1.68	0.22	0.09	0.02	0.003
		Total	8.60							0.62						
CIWMB TV		Mix HCN		124	42	2	1.53	0.52	0.02							
		Mix LCN		443	110	1	5.48	1.36	0.02							
		UnMix HCN		23	6	1	0.28	0.07	0.01							
		UnMix LCN		38	10	1	0.47	0.13	0.01							
SCAQMD		Stockpiles	4.75		24			0.30		0.01		6.55			0.081	
Inland		Windrows	0.3		6			0.08		1.31		0.32			0.004	
Summer		Total	5.05							1.32						
SCAQMD		Stockpiles	1.96		20			0.25		0.29		2.67			0.033	
Inland		Windrows	0.5		6			0.08		0.03		0.32			0.004	
Winter		Total	2.47							0.32						

1.0 Introduction

This project directly measured the VOC and ammonia air emissions from greenwaste composting to develop a baseline air emissions value for a full compost/cure cycle plus feedstock and product storage. All compost operations were located at the Northern Recycling Compost Facility in Zamora, CA as shown in Figure 1.1.

Figure 1.1 Site Vicinity Map



2.0 Process Description and Sampling

This is a new compost facility that composts greenwaste material into a high value landscaping material. Compost is received in a stockpile. The stockpiled material is then ground and placed into windrows. The windrows are mechanically mixed approximately 20 times during an 80 day composting cycle. The windrows are then broken down and screened into the final product. The site is permitted to have a total of 50,000 tons of material on site. Table 2.1 shows the amount of material assumed to be on site for the baseline emissions assessment.

Table 2.1 Amount of Material Assumed to be on Site for Baseline Emissions Estimate

Material	Total Tons on Site
Feedstock Storage	27,000
Composting	20,000
Product Storage	3,000
Total Tons	50,000

The sampling and analysis was conducted in compliance with the document entitled PROTOCOL FOR FLUX CHAMBER SOURCE TESTING OF FUGITIVE AIR EMISSIONS FROM THE NORTHERN RECYCLING COMPOST (NRC) ZAMORA FACILITY, plus a supplemental protocol for the second event, that was previously submitted to the Yolo-Solano APCD.

All sampling took place between October 28 and 30, 2008 for the first event (compost with winery waste) and on April 12, 2009 (compost without winery waste). All surface samples were taken using USEPA Surface Isolation Emission Flux Chamber technology per the source test protocol. Total VOC was analyzed per SCAQMD Method 25.3 and ammonia was measured per SCAQMD Method 207.1. The technical memorandum in Appendix C presents a summary of data validation, project documentation, and laboratory methods used for this project.

The following compost operations were sampled:

Event 1

1. Incoming feedstock (12 samples)
2. Compost Day 1 (4 samples)
3. Compost Day 3 (4 samples)
4. Compost Day 3 Mixing Event (4 samples)
5. Compost Day 7 (4 samples)
6. Compost Day 15 (4 samples)
7. Compost Day 15 Mixing Event (4 samples)
8. Compost Day 29 (4 samples)
9. Compost Day 29 Mixing Event (4 samples)
10. Compost Day 63 (4 samples)
11. Finished product (4 samples)

Event 2

1. Incoming feedstock (4 samples)
2. Compost Day 1 (2 samples)
3. Compost Day 5 (4 samples)
4. Compost Day 8 (2 samples)
5. Compost Day 16 (2 samples)
6. Compost Day 31 (2 samples)

3.0 Sampling Results

Figure 3.1a presents of a summary of sampling results for Event 1. The appendix contains complete sampling data. Note that the vast majority of the ammonia data points had no ammonia detected. The typical ammonia detection limit for this project was between 0.2 and 0.4 mg/m^3.

Figure 3.1b presents a summary of sampling results for Event 2. This data was typical or previous greenwaste compost sampling events at other facilities.

Table 3.1a Summary of Event 1 sampling results (compost with winery waste).

SOURCE	TEST CONDITION	VOC Flux	NH3 Flux	COMMENT
Windrow- Day 1	T1	282	0.0131	**Windrow- Day 1**
Windrow- Day 1	T2	79.2	0.0130	
Windrow- Day 1	S1	136	0.0157	
Windrow- Day 1	Replicate	33.5	0.0174	Replicate
Windrow- Day 1	S2	11.2	0.0104	
Windrow- Day 3	T1	453	0.0219	**Windrow- Day 3**
Windrow- Day 3	T2	36.9	0.0227	
Windrow- Day 3	S1	16.1	0.0179	
Windrow- Day 3	S2	35.8	0.0232	
Windrow- Day 3	Post Mix, T1- Hour 0	1631	0.0232	Post Mix, T1- Hour 0
Windrow- Day 3	Post Mix, S1- Hour 0	742	0.0171	Post Mix, S1- Hour 0
Windrow- Day 3	Post Mix, T1- Hour 4	724	0.0187	Post Mix, T1- Hour 4
Windrow- Day 3	Post Mix, S1- Hour 4	254	0.0231	Post Mix, S1- Hour 4
Windrow- Day 7	T1	148	0.108	**Windrow- Day 7**
Windrow- Day 7	T2	764	0.0233	
Windrow- Day 7	S1	4.52	0.0418	
Windrow- Day 7	S2	1.81	0.0245	
Windrow- Day 15	T1	5.72	0.0332	**Windrow- Day 15**
Windrow- Day 15	T2	26.5	0.0401	
Windrow- Day 15	S1	2.36	0.0266	
Windrow- Day 15	S2	2.65	0.0236	
Windrow- Day 15	Replicate	1.30	0.0257	Replicate
Windrow- Day 15	Post Mix, T2- Hour 0	56.0	0.0244	Post Mix, T2- Hour 0
Windrow- Day 15	Post Mix, S2- Hour 0	6.82	0.0250	Post Mix, S2- Hour 0
Windrow- Day 15	Replicate	9.46	0.0246	Replicate
Windrow- Day 15	Post Mix, T2- Hour 4	40.1	0.0252	Post Mix, T2- Hour 4
Windrow- Day 15	Post Mix, S2- Hour 4	6.29	0.0222	Post Mix, S2- Hour 4
Windrow- Day 29	T1	0.454	0.0155	**Windrow- Day 29**
Windrow- Day 29	T2	1.10	0.0192	
Windrow- Day 29	S1	0.645	0.0151	
Windrow- Day 29	S2	0.381	0.00782	
Windrow- Day 29	Post Mix, T2- Hour 0	27.4	0.0301	Post Mix, T2- Hour 0
Windrow- Day 29	Post Mix, S1- Hour 0	4.39	0.0216	Post Mix, S1- Hour 0
Windrow- Day 29	Post Mix, T2- Hour 4	15.4	0.0369	Post Mix, T2- Hour 4
Windrow- Day 29	Post Mix, S1- Hour 4	3.95	0.0245	Post Mix, S1- Hour 4
Windrow- Day 63	T1	0.955	0.0141	**Windrow- Day 63**
Windrow- Day 63	T2	0.671	0.00994	
Windrow- Day 63	S1	0.223	0.0108	
Windrow- Day 63	S2	0.507	0.0137	
Tipping- Old	T1	6.91	0.0290	**Tipping- Old**
Tipping- Old	T2	1.33	0.0229	
Tipping- Old	T3	7.10	0.0241	
Tipping- Old	T4	7.54	0.0204	
Tipping- Middle Age	T1	3.82	0.0387	**Tipping- Middle Age**
Tipping- Middle Age	T2	6.97	0.529	
Tipping- Middle Age	T3	3.13	0.0702	
Tipping- Middle Age	Replicate	2.61	0.0718	Replicate
Tipping- Middle Age	T4	2.40	0.272	**Tipping- New**
Tipping- New	T1	308	0.0399	
Tipping- New	T2	153	0.0452	
Tipping- New	T3	882	0.0202	
Tipping- New	Replicate	848	0.0302	Replicate
Tipping- New	T4	743	0.0293	
Fresh Product- Day 1	T1	1.13	0.0123	**Fresh Product- Day 1**
Fresh Product- Day 1	T2	1.48	0.00687	
Aged Product- Day 60	S1	0.220	0.00876	**Aged Product- Day 60**
Aged Product- Day 60	S2	2.83	0.0400	
QC	Blank	0.139	0.00342	**QC- Blank**
QC	Blank	0.137	0.00342	
QC	Blank	0.112	0.00440	
QC	Blank	0.0929	0.00440	
QC	Blank	0.0736	0.00440	

Flux Unit: mg/m2,min-1

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4

Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO

Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3

Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow

Note 5- MDL value used for ND or non-detect for calculation purposes

Table 3.1b Summary of Event 2 sampling results (compost without winery waste).

SOURCE	TEST CONDITION	VOC Flux	NH3 Flux	COMMENT
Tipping	Day 1, T1	**166**	**16**	Tipping Pile, Day 1
Tipping	Day 1, S1	**14**	**6.7**	Tipping Pile, Day 1
Tipping	Day 7, T1	**17**	**5.7**	Tipping Pile, Day 7
Tipping	Day 7, S1	**7.8**	**4.3**	Tipping Pile, Day 7
Tipping	Replicate	**7.7**	**4.1**	Replicate Sample
Compost	Day 1, S1	**83**	**1.6**	Day 1
Compost	Day 1, T1	**27**	**0.26**	Day 1
Compost	Day 5, S1	**15**	**1.9**	Day 5
Compost	Day 5, T1	**242**	**13**	Day 5
Compost	Day 8, S1	**2.4**	**0.078**	Day 8
Compost	Day 8, T1	**157**	**2.5**	Day 8
Compost	Day 8, S2	**1.5**	**0.26**	Day 8
Compost	Day 8, T2	**131**	**5.0**	Day 8
Compost	Day 16, S1	**1.3**	**0.15**	Day 16
Compost	Day 16, T1	**9.4**	**2.56**	Day 16
Compost	Day 31, S1	**3.0**	**0.17**	Day 31
Compost	Day 31, T1	**1.0**	**0.17**	Day 31
QC	Blank	**0.025**	**0.0031**	99.4% Recovery of helium tracer

Flux Unit: mg/m2,min-1

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4

Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO

Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3

Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow

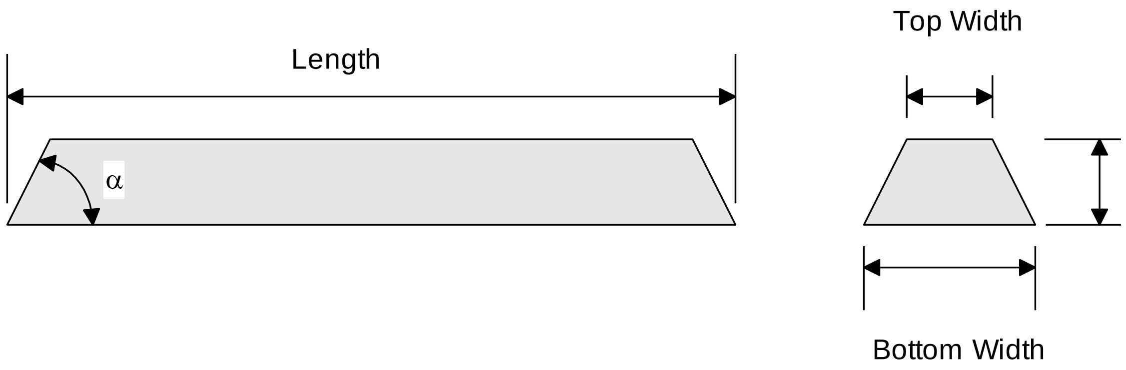
Note 5- MDL value used for ND or non-detect for calculation purposes

4.0 Emissions Calculations

4.1 Compost Pile Configuration

The windrow compost operation consisted of placing ground greenwaste feedstock in a windrow for 80 days. Figure 4.1 shows the typical windrow cross-section for windrow composting as well as the formulas used to compute volume and exposed surface area. Each windrow initially contained about 320 tons of material. Table 4.1 provides the windrow dimensions and calculations.

Figure 4.1. – Compost Windrow Configuration.



Mensuration formulas

$$S = \frac{p_1 + p_2}{2} s + A_2$$

$$V = \frac{h(A_1 + A_2 + \sqrt{A_1 A_2})}{3}$$

$$s = \sqrt{h^2 + ((W_B - W_T)/2)}^2$$

where S = total surface area, p_1 = bottom perimeter, p_2 = top perimeter, s = slant height, V=volume, h=vertical height, A_1 = bottom area, A_2 = top area, α = bottom angle

Table 4.1. – Compost Windrow Dimensions and Calculations.

Property	Units	Value
Length	ft	455
Height	ft	4.5
Bottom Width	ft	14
Top Width	ft	7.0
Top Length	ft	448
alpha	R	0.91
	o	52
Top Perimeter	ft	910
Top Area	ft2	3,136
Bottom Perimeter	ft	938
Bottom Area	ft2	6,370
Slant height	ft	5.7
Surface Area	ft2	8,404
	m2	785
Volume	ft3	20,963
	yd3	776
Conversion Factors	ft2/m2	10.7
	ft3/yd3	27
Top Area Ratio		0.373173
Density	#/yd3	823
	#/ft3	30.5
Mass	#	638,990
	ton	319

4.2 Full Compost Cycle Simulation

The unit emission data was extended to estimate emissions from the full compost cycle using linear interpolation and averaging, as noted in Section 2, above.

Full cycle emissions for each day of the compost process, are then added and the sum of the individual daily emissions are totalized. Consistent with the approved protocol, the emission factor consists of the full total (in pounds) cycle emissions divided by the incoming feedstock weight (in tons). The full site emissions are then calculated be multiplying the annual throughput of material by this calculated emission factor. The simulation data tables are provided in the Appendix.

4.4 Simulated Emissions Profile

Figure 4.2 and 4.3 presents the full cycle emissions profile developed for VOC and ammonia. These emissions profiles were developed using a combination of data averaging and linear interpolation between the data points. The spikes on the graphs are due to mixing events. Three mixing events were measured and mixing was found to be a significant contributor to emissions.

Figure 4.2 Simulated VOC Emissions Profile (per windrow).

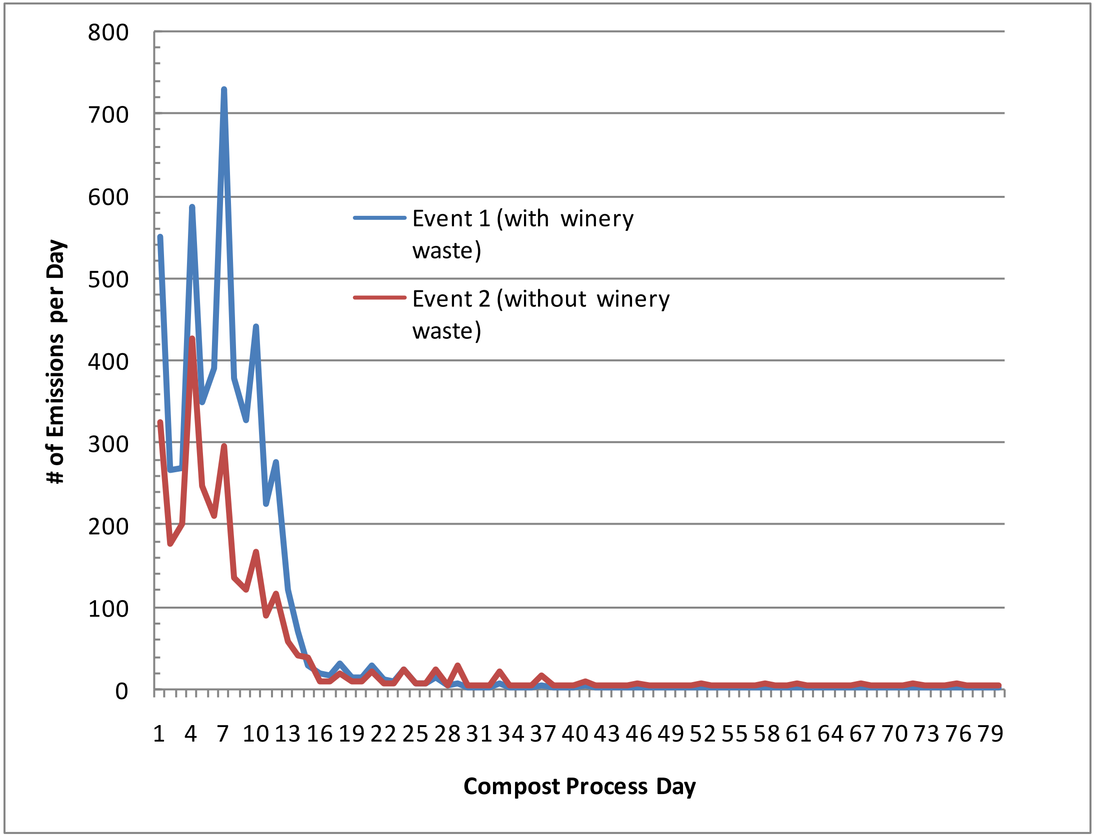
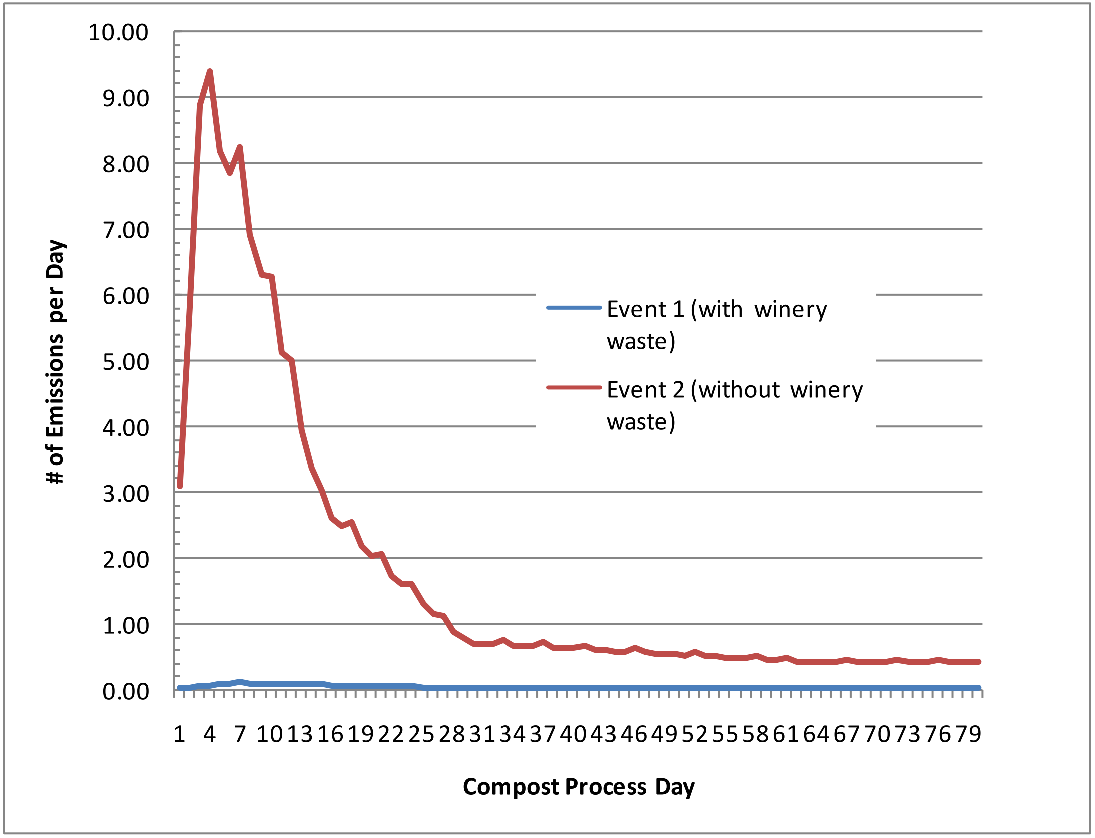


Figure 4.3 Simulated NH_3 Emissions Profile (per windrow).



4.5 Emissions from Feedstock and Product Storage

Table 4.2a, 4.2b, and 4.3 present the VOC and ammonia emission calculations while feedstock is being stored prior to windrowing and from finished compost product storage. The product emissions were assumed to be the same for the winery waste and non-winery waste compost product.

Table 4.2a. – Event 1 Feedstock emission calculations (with winery waste).

Mass	300	tons/day
Density	443	#/yd3
	16.4	#/ft3
Storage Duration	90	day
Total Tons Stored	27,000	tons
Pile Volume	121,896	yd3
	3,291,196	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	577	
Pile Width	300	
Pile Area	173,208	feet
Slant Height	28	
Pile Area	204,560	ft2
	19,118	m2

	VOC	**NH3**	
Unit Emissions	198.74	0.084	mg/min-m2
Total Emissions	5,471,153	2,326	gms/day
	12,063	5.1	pounds/day
	2,201	0.9	tons/year
Emission Factor	44.03	0.01709	pounds/ton

Table 4.2b. – Event 2 Feedstock emission calculations (without winery waste).

Mass	300	tons/day
Density	443	#/yd3
	16.4	#/ft3
Storage Duration	90	day
Total Tons Stored	27,000	tons
Pile Volume	121,896	yd3
	3,291,196	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	577	
Pile Width	300	
Pile Area	173,208	feet
Slant Height	28	
Pile Area	204,560	ft2
	19,118	m2

	VOC	**NH3**	
Unit Emissions	51.19	8.118	mg/min-m2
Total Emissions	1,409,351	223,497	gms/day
	3,107	492.8	pounds/day
	567	89.9	tons/year
Emission Factor	11.34	1.64254	pounds/ton

Table 4.3. – Finished product storage emission calculations (used for both winery and non-winery waste containing compost).

Mass	200	tons/day
Density	1123	#/yd3
	41.6	#/ft3
Storage Duration	15	day
Total Tons Stored	3000	tons
Pile Volume	5,343	yd3
	144,256	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	90	
Pile Width	100	
Pile Area	8,977	feet
Slant Height	28	
Pile Area	15,186	ft2
	1,419	m2

	VOC	**NH3**	
Unit Emissions	1.42	0.017	mg/min-m2
Total Emissions	2,894	35	gms/day
	6	0.08	pounds/day
	1	0.014	tons/year
Emission Factor	0.02	0.00038	pounds/ton

Appendix A

Full Cycle Simulation Table

Table A1a VOC Cycle Simulation Calculations for Event 1

Compost	Unit Flux (mg/min-m2)				UF (mg/m-m2)	Area	Daily Emissions	
Day	Top	Side	Total	Mix		(m2)	(mg)	(#)
1	181	60	105	2.1	221	785	249,958,006	551
2	213	43	107	1	107	785	120,450,583	266
3	245	26	108	1	108	785	121,873,545	269
4	298	20	124	1.9	235	785	266,173,572	587
5	351	15	140	1	140	785	158,309,162	349
6	403	9	156	1	156	785	176,526,971	389
7	456	3	172	1.7	293	785	331,066,126	730
8	401	3	152	1	152	785	171,472,778	378
9	346	3	131	1	131	785	148,200,776	327
10	291	3	110	1.6	177	785	199,886,039	441
11	236	3	90	1	90	785	101,656,773	224
12	181	3	69	1.6	111	785	125,415,633	277
13	126	3	49	1	49	785	55,112,769	122
14	71	3	28	1	28	785	31,840,767	70
15	16	3	8	1.5	11	785	12,853,148	28
16	15	2	7	1	7	785	8,006,131	18
17	14	2	7	1	7	785	7,443,497	16
18	13	2	6	2	12	785	13,761,725	30
19	12	2	6	1	6	785	6,318,228	14
20	11	2	5	1	5	785	5,755,594	13
21	10	2	5	2.5	11	785	12,982,399	29
22	8	2	4	1	4.1	785	4,630,326	10
23	7	1	4	1	3.6	785	4,067,691	9
24	6	1	3	3	9.3	785	10,515,171	23
25	5	1	3	1	2.6	785	2,942,423	6
26	4	1	2	1	2.1	785	2,379,789	5
27	3	1	2	3.5	5.6	785	6,360,040	14
28	2	1	1	1	1.1	785	1,254,520	2.8
29	0.8	0.5	1	4.7	2.9	785	3,251,863	7.2
30	0.78	0.51	0.61	1	0.6	785	689,246	1.5
31	0.78	0.50	0.61	1	0.6	785	686,606	1.5
32	0.78	0.50	0.60	1	0.6	785	683,967	1.5
33	0.78	0.50	0.60	4	2.4	785	2,725,308	6.0
34	0.78	0.49	0.60	1	0.6	785	678,687	1.5
35	0.78	0.49	0.60	1	0.6	785	676,048	1.5
36	0.78	0.48	0.60	1	0.6	785	673,408	1.5
37	0.79	0.48	0.59	3	1.8	785	2,012,305	4.4
38	0.79	0.47	0.59	1	0.6	785	668,129	1.5
39	0.79	0.47	0.59	1	0.6	785	665,489	1.5
40	0.79	0.47	0.59	1	0.6	785	662,849	1.5
41	0.79	0.46	0.58	2	1.2	785	1,320,419	2.9
42	0.79	0.46	0.58	1	0.6	785	657,570	1.4
43	0.79	0.45	0.58	1	0.6	785	654,930	1.4
44	0.79	0.45	0.58	1	0.6	785	652,290	1.4
45	0.79	0.44	0.57	1	0.6	785	649,651	1.4
46	0.80	0.44	0.57	1.5	0.9	785	970,517	2.1
47	0.80	0.43	0.57	1	0.6	785	644,371	1.4
48	0.80	0.43	0.57	1	0.6	785	641,732	1.4
49	0.80	0.43	0.57	1	0.6	785	639,092	1.4
50	0.80	0.42	0.56	1	0.6	785	636,452	1.4
51	0.80	0.42	0.56	1	0.6	785	633,813	1.4
52	0.80	0.41	0.56	1.5	0.8	785	946,759	2.1
53	0.80	0.41	0.56	1	0.6	785	628,533	1.4
54	0.80	0.40	0.55	1	0.6	785	625,894	1.4
55	0.80	0.40	0.55	1	0.6	785	623,254	1.4
56	0.81	0.40	0.55	1	0.5	785	620,614	1.4
57	0.81	0.39	0.55	1	0.5	785	617,974	1.4
58	0.81	0.39	0.54	1.5	0.8	785	923,002	2.0
59	0.81	0.38	0.54	1	0.5	785	612,695	1.4
60	0.81	0.38	0.54	1	0.5	785	610,055	1.3
61	0.81	0.37	0.54	1.5	0.8	785	911,124	2.0
62	0.81	0.37	0.53	1	0.5	785	604,776	1.3
63	0.8	0.4	0.53	1	0.5	785	602,136	1.3
64	0.81	0.37	0.53	1	0.5	785	602,136	1.3
65	0.81	0.37	0.53	1	0.5	785	602,136	1.3
66	0.81	0.37	0.53	1	0.5	785	602,136	1.3
67	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
68	0.81	0.37	0.53	1	0.5	785	602,136	1.3
69	0.81	0.37	0.53	1	0.5	785	602,136	1.3
70	0.81	0.37	0.53	1	0.5	785	602,136	1.3
71	0.81	0.37	0.53	1	0.5	785	602,136	1.3
72	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
73	0.81	0.37	0.53	1	0.5	785	602,136	1.3
74	0.81	0.37	0.53	1	0.5	785	602,136	1.3
75	0.81	0.37	0.53	1	0.5	785	602,136	1.3
76	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
77	0.81	0.37	0.53	1	0.5	785	602,136	1.3
78	0.81	0.37	0.53	1	0.5	785	602,136	1.3
79	0.81	0.37	0.53	1	0.5	785	602,136	1.3
80	0.81	0.37	0.53	1	0.5	785	602,136	1.3
							Total Emissions	5,289
								16.55 #/Ton

Table A1a NH3 Cycle Simulation Calculations for Event 1

Compost	Unit Flux (mg/min-m2)				UF	Area	Daily Emissions	
Day	Top	Side	Total	Mix	(mg/m-m2)	(m2)	(mg)	(#)
1	0.01	0.01	0.01	1.1	0.02	785	17,391	0.04
2	0.02	0.02	0.02	1	0.02	785	19,897	0.04
3	0.02	0.02	0.02	1	0.02	785	23,985	0.05
4	0.03	0.02	0.03	1.1	0.03	785	33,880	0.07
5	0.04	0.03	0.03	1	0.03	785	37,615	0.08
6	0.05	0.03	0.04	1	0.04	785	44,431	0.10
7	0.07	0.03	0.05	1.1	0.05	785	56,370	0.12
8	0.06	0.03	0.04	1	0.04	785	48,999	0.11
9	0.06	0.03	0.04	1	0.04	785	46,752	0.10
10	0.05	0.03	0.04	1.1	0.04	785	48,956	0.11
11	0.05	0.03	0.04	1	0.04	785	42,258	0.09
12	0.05	0.03	0.04	1.1	0.04	785	44,013	0.10
13	0.04	0.03	0.03	1	0.03	785	37,765	0.08
14	0.04	0.03	0.03	1	0.03	785	35,518	0.08
15	0.04	0.03	0.03	1.1	0.03	785	36,598	0.08
16	0.04	0.02	0.03	1	0.03	785	31,996	0.07
17	0.03	0.02	0.03	1	0.03	785	30,720	0.07
18	0.03	0.02	0.03	1.1	0.03	785	32,390	0.07
19	0.03	0.02	0.02	1	0.02	785	28,170	0.06
20	0.03	0.02	0.02	1	0.02	785	26,894	0.06
21	0.03	0.02	0.02	1.1	0.02	785	28,181	0.06
22	0.03	0.02	0.02	1	0.02	785	24,344	0.05
23	0.03	0.02	0.02	1	0.02	785	23,069	0.05
24	0.02	0.02	0.02	1.1	0.02	785	23,973	0.05
25	0.02	0.02	0.02	1	0.02	785	20,518	0.05
26	0.02	0.01	0.02	1	0.02	785	19,243	0.04
27	0.02	0.01	0.02	1.1	0.02	785	19,764	0.04
28	0.02	0.01	0.01	1	0.01	785	16,692	0.04
29	0.02	0.01	0.01	1.1	0.01	785	16,958	0.04
30	0.02	0.01	0.01	1	0.01	785	15,367	0.03
31	0.02	0.01	0.01	1	0.01	785	15,318	0.03
32	0.02	0.01	0.01	1	0.01	785	15,269	0.03
33	0.02	0.01	0.01	1.1	0.01	785	16,742	0.04
34	0.02	0.01	0.01	1	0.01	785	15,171	0.03
35	0.02	0.01	0.01	1	0.01	785	15,122	0.03
36	0.02	0.01	0.01	1	0.01	785	15,072	0.03
37	0.02	0.01	0.01	1.1	0.01	785	16,525	0.04
38	0.02	0.01	0.01	1	0.01	785	14,974	0.03
39	0.02	0.01	0.01	1	0.01	785	14,925	0.03
40	0.02	0.01	0.01	1	0.01	785	14,876	0.03
41	0.02	0.01	0.01	1.1	0.01	785	16,309	0.04
42	0.02	0.01	0.01	1	0.01	785	14,777	0.03
43	0.02	0.01	0.01	1	0.01	785	14,728	0.03
44	0.01	0.01	0.01	1	0.01	785	14,679	0.03
45	0.01	0.01	0.01	1	0.01	785	14,630	0.03
46	0.01	0.01	0.01	1.1	0.01	785	16,038	0.04
47	0.01	0.01	0.01	1	0.01	785	14,531	0.03
48	0.01	0.01	0.01	1	0.01	785	14,482	0.03
49	0.01	0.01	0.01	1	0.01	785	14,433	0.03
50	0.01	0.01	0.01	1	0.01	785	14,384	0.03
51	0.01	0.01	0.01	1	0.01	785	14,334	0.03
52	0.01	0.01	0.01	1.1	0.01	785	15,714	0.03
53	0.01	0.01	0.01	1	0.01	785	14,236	0.03
54	0.01	0.01	0.01	1	0.01	785	14,187	0.03
55	0.01	0.01	0.01	1	0.01	785	14,138	0.03
56	0.01	0.01	0.01	1	0.01	785	14,089	0.03
57	0.01	0.01	0.01	1	0.01	785	14,039	0.03
58	0.01	0.01	0.01	1.1	0.01	785	15,389	0.03
59	0.01	0.01	0.01	1	0.01	785	13,941	0.03
60	0.01	0.01	0.01	1	0.01	785	13,892	0.03
61	0.01	0.01	0.01	1.1	0.01	785	15,227	0.03
62	0.01	0.01	0.01	1	0.01	785	13,793	0.03
63	0.0	0.0	0.01	1	0.01	785	13,744	0.03
64	0.01	0.01	0.01	1	0.01	785	13,744	0.03
65	0.01	0.01	0.01	1	0.01	785	13,744	0.03
66	0.01	0.01	0.01	1	0.01	785	13,744	0.03
67	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
68	0.01	0.01	0.01	1	0.01	785	13,744	0.03
69	0.01	0.01	0.01	1	0.01	785	13,744	0.03
70	0.01	0.01	0.01	1	0.01	785	13,744	0.03
71	0.01	0.01	0.01	1	0.01	785	13,744	0.03
72	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
73	0.01	0.01	0.01	1	0.01	785	13,744	0.03
74	0.01	0.01	0.01	1	0.01	785	13,744	0.03
75	0.01	0.01	0.01	1	0.01	785	13,744	0.03
76	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
77	0.01	0.01	0.01	1	0.01	785	13,744	0.03
78	0.01	0.01	0.01	1	0.01	785	13,744	0.03
79	0.01	0.01	0.01	1	0.01	785	13,744	0.03
80	0.01	0.01	0.01	1	0.01	785	13,744	0.03
							Total Emissions	4
								0.011 #/Ton

Table A1b VOC Cycle Simulation Calculations for Event 2

Compost Day	Unit Flux (mg/min-m2) Top	Side	Total	Mix	UF (mg/m-m2)	Area (m2)	Daily Emissions (mg)	(#)
1	27	83	62	2.1	131	785	147,843,960	326
2	81	66	72	1	72	785	80,987,316	179
3	135	49	81	1	81	785	91,572,747	202
4	188	32	90	1.9	172	785	194,100,537	428
5	242	15	100	1	100	785	112,743,608	249
6	210	11	85	1	85	785	95,912,037	211
7	177	6	70	1.7	119	785	134,436,791	296
8	144	2	55	1	55	785	62,248,894	137
9	127	2	49	1	49	785	55,076,966	121
10	111	2	42	1.6	68	785	76,648,060	169
11	94	2	36	1	36	785	40,733,109	90
12	77	2	30	1.6	47	785	53,697,889	118
13	60	2	23	1	23	785	26,389,252	58
14	43	1	17	1	17	785	19,217,324	42
15	26	1	11	1.5	16	785	18,068,093	40
16	9	1	4	1	4	785	4,873,467	11
17	9	1	4	1	4	785	4,717,702	10
18	8	2	4	2	8	785	9,123,874	20
19	8	2	4	1	4	785	4,406,173	10
20	7	2	4	1	4	785	4,250,408	9
21	7	2	4	2.5	9	785	10,236,608	23
22	6	2	3	1	3.5	785	3,938,879	9
23	5	2	3	1	3.3	785	3,783,114	8
24	5	2	3	3	9.6	785	10,882,048	24
25	4	2	3	1	3.1	785	3,471,585	8
26	4	2	3	1	2.9	785	3,315,820	7
27	3	3	3	3.5	9.8	785	11,060,193	24
28	3	3	3	1	2.7	785	3,004,291	6.6
29	2	3	3	4.7	11.8	785	13,388,072	29.5
30	2	3	2	1	2.4	785	2,692,761	5.9
31	1.04	2.96	2	1	2.2	785	2,536,997	5.6
32	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
33	1.04	2.96	2.24	4	9.0	785	10,147,986	22.4
34	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
35	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
36	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
37	1.04	2.96	2.24	3	6.7	785	7,610,990	16.8
38	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
39	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
40	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
41	1.04	2.96	2.24	2	4.5	785	5,073,993	11.2
42	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
43	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
44	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
45	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
46	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
47	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
48	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
49	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
50	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
51	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
52	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
53	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
54	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
55	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
56	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
57	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
58	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
59	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
60	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
61	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
62	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
63	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
64	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
65	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
66	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
67	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
68	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
69	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
70	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
71	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
72	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
73	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
74	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
75	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
76	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
77	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
78	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
79	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
80	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
							Total Emissions	3,205
								10.03 #/Ton

Table A1b NH3 Cycle Simulation Calculations for Event 2

Compost Day	Unit Flux (mg/min-m2) Top	Side	Total	Mix	UF (mg/m-m2)	Area (m2)	Daily Emissions (mg)	(#)
1	0	2	1.13	1.1	1.24	785	1,406,757	3.10
2	3	2	2.35	1	2.35	785	2,657,139	5.86
3	7	2	3.57	1	3.57	785	4,035,408	8.90
4	10	2	3.43	1.1	3.77	785	4,263,343	9.40
5	13	2	3.29	1	3.29	785	3,716,125	8.19
6	10	1	3.14	1	3.14	785	3,556,483	7.84
7	7	1	3.00	1.1	3.30	785	3,736,525	8.24
8	4	0	2.77	1	2.77	785	3,128,743	6.90
9	4	0	2.53	1	2.53	785	2,860,644	6.31
10	3	0	2.29	1.1	2.52	785	2,851,800	6.29
11	3	0	2.06	1	2.06	785	2,324,447	5.12
12	3	0	1.82	1.1	2.00	785	2,261,983	4.99
13	3	0	1.58	1	1.58	785	1,788,249	3.94
14	3	0	1.34	1	1.34	785	1,520,151	3.35
15	3	0	1.11	1.1	1.22	785	1,377,257	3.04
16	3	0	1.05	1	1.05	785	1,185,635	2.61
17	2	0	0.99	1	0.99	785	1,119,218	2.47
18	2	0	0.93	1.1	1.02	785	1,158,081	2.55
19	2	0	0.87	1	0.87	785	986,384	2.17
20	2	0	0.81	1	0.81	785	919,967	2.03
21	2	0	0.75	1.1	0.83	785	938,905	2.07
22	2	0	0.70	1	0.70	785	787,133	1.74
23	1	0	0.64	1	0.64	785	720,715	1.59
24	1	0	0.58	1.1	0.64	785	719,728	1.59
25	1	0	0.52	1	0.52	785	587,881	1.30
26	1	0	0.46	1	0.46	785	521,464	1.15
27	1	0	0.40	1.1	0.44	785	500,552	1.10
28	1	0	0.34	1	0.34	785	388,630	0.86
29	0	0	0.28	1.1	0.31	785	354,434	0.78
30	0	0	0.28	1	0.28	785	318,295	0.70
31	0.17	0.17	0.28	1	0.28	785	314,376	0.69
32	0.17	0.17	0.27	1	0.27	785	310,458	0.68
33	0.17	0.17	0.27	1.1	0.30	785	337,194	0.74
34	0.17	0.17	0.27	1	0.27	785	302,621	0.67
35	0.17	0.17	0.26	1	0.26	785	298,703	0.66
36	0.17	0.17	0.26	1	0.26	785	294,785	0.65
37	0.17	0.17	0.26	1.1	0.28	785	319,953	0.71
38	0.17	0.17	0.25	1	0.25	785	286,948	0.63
39	0.17	0.17	0.25	1	0.25	785	283,030	0.62
40	0.17	0.17	0.25	1	0.25	785	279,111	0.62
41	0.17	0.17	0.24	1.1	0.27	785	302,712	0.67
42	0.17	0.17	0.24	1	0.24	785	271,275	0.60
43	0.17	0.17	0.24	1	0.24	785	267,356	0.59
44	0.17	0.17	0.23	1	0.23	785	263,438	0.58
45	0.17	0.17	0.23	1	0.23	785	259,520	0.57
46	0.17	0.17	0.23	1.1	0.25	785	281,162	0.62
47	0.17	0.17	0.22	1	0.22	785	251,683	0.55
48	0.17	0.17	0.22	1	0.22	785	247,765	0.55
49	0.17	0.17	0.22	1	0.22	785	243,847	0.54
50	0.17	0.17	0.21	1	0.21	785	239,928	0.53
51	0.17	0.17	0.21	1	0.21	785	236,010	0.52
52	0.17	0.17	0.21	1.1	0.23	785	255,301	0.56
53	0.17	0.17	0.20	1	0.20	785	228,173	0.50
54	0.17	0.17	0.20	1	0.20	785	224,255	0.49
55	0.17	0.17	0.19	1	0.19	785	220,337	0.49
56	0.17	0.17	0.19	1	0.19	785	216,418	0.48
57	0.17	0.17	0.19	1	0.19	785	212,500	0.47
58	0.17	0.17	0.18	1.1	0.20	785	229,440	0.51
59	0.17	0.17	0.18	1	0.18	785	204,663	0.45
60	0.17	0.17	0.18	1	0.18	785	200,745	0.44
61	0.17	0.17	0.17	1.1	0.19	785	216,509	0.48
62	0.17	0.17	0.17	1	0.17	785	192,908	0.43
63	0.17	0.17	0.17	1	0.17	785	188,990	0.42
64	0.17	0.17	0.17	1	0.17	785	188,990	0.42
65	0.17	0.17	0.17	1	0.17	785	188,990	0.42
66	0.17	0.17	0.17	1	0.17	785	188,990	0.42
67	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
68	0.17	0.17	0.17	1	0.17	785	188,990	0.42
69	0.17	0.17	0.17	1	0.17	785	188,990	0.42
70	0.17	0.17	0.17	1	0.17	785	188,990	0.42
71	0.17	0.17	0.17	1	0.17	785	188,990	0.42
72	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
73	0.17	0.17	0.17	1	0.17	785	188,990	0.42
74	0.17	0.17	0.17	1	0.17	785	188,990	0.42
75	0.17	0.17	0.17	1	0.17	785	188,990	0.42
76	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
77	0.17	0.17	0.17	1	0.17	785	188,990	0.42
78	0.17	0.17	0.17	1	0.17	785	188,990	0.42
79	0.17	0.17	0.17	1	0.17	785	188,990	0.42
80	0.17	0.17	0.17	1	0.17	785	188,990	0.42
							Total Emissions	142
								0.445 #/Ton

Appendix B
Photographs

Appendix C
Data Validation Technical Memorandum

California Environmental Protection Agency

AIR RESOURCES BOARD

STAFF REPORT: INITIAL STATEMENT OF REASONS FOR THE PROPOSED REGULATION TO REDUCE METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

Stationary Source Division
Emissions Assessment Branch

May 2009

control devices such as flares to ensure that these devices are operating optimally and meeting the destruction efficiency standards.

3. Wellhead Monitoring

Monthly well monitoring is required to demonstrate that the gas extraction rate for an active gas collection system is sufficient. This requirement (in conjunction with the surface emission standards) helps to minimize groundwater impacts by ensuring that methane is routed through the gas collection system to a gas control device. A negative pressure must be maintained at each wellhead, except under certain conditions (a landfill subsurface fire, fire prevention, repair of the gas collection system, or construction activities). If a positive pressure is measured, the owner or operator must initiate corrective action within five days. If the corrective action is not successful, an expansion of the gas collection may be necessary and must be completed within 120 days of the date the positive pressure was measured.

G. Recordkeeping and Reporting Requirements

In order to assure and monitor compliance with the requirements of the proposed regulation, landfill owners and operators are subject to recordkeeping and reporting requirements. These requirements include maintaining records of a landfill's waste acceptance rates, instantaneous and integrating surfacing sampling measurements, component leak checks, equipment downtime, gas flow rates, and control device destruction efficiency testing. Most records are required to be kept for a five-year period; however, control device records must be maintained for the life of the control device. Some of these recordkeeping items are required to be included in the annual report, which must be submitted annually and cover the period of January 1 through December 31 of each year. Additionally, there are some specific reports that need to be submitted under specific conditions, such as a waste-in-place report for landfills with less than 450,000 tons of waste-in-place or a closure notification report for landfills that are ceasing waste acceptance and closing. Additionally, an equipment removal report is required when a landfill is seeking to decommission the gas collection and control system. These reporting requirements are similar to what is already required in local air district and federal rules for many landfills in California.

III. IMPACTS OF THE PROPOSED REGULATION

A. Emissions and Emissions Reductions

Based on ARB staff's estimate, there would be a reduction of about 0.4 $MMTCO_2E$ due to bringing 14 uncontrolled MSW landfills into compliance with the proposed regulation in 2020. The implementation and enforcement of this proposed regulation for the remaining estimated 204 affected MSW landfills (including those with gas collections systems already installed) is expected to result in an additional estimated emission reduction of 1.1 $MMTCO_2E$ in 2020. This total 1.5 $MMTCO_2E$ emission reduction

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SOURCE TEST REPORT

96-0007/96-0008/96-0009

CONDUCTED AT

San Joaquin Composting, Inc.
Holloway Road
Lost Hills, CA.

CHARACTERIZATION OF AMMONIA, TOTAL AMINE, ORGANIC SULFUR COMPOUND, AND TOTAL NON-METHANE ORGANIC COMPOUND (TGNMOC) EMISSIONS FROM COMPOSTING OPERATIONS

TESTED:	February 15, 1996 March 1 & 11, 1996
ISSUED:	
REPORTED BY:	Carey Willoughby Air Quality Engineer I

REVIEWED BY:

Michael Garibay
Air Quality Engineer II

Arun Roy Chowdhury
Supervising Air Quality Engineer

SOURCE TESTING AND ENGINEERING BRANCH

APPLIED SCIENCE AND TECHNOLOGY

SUMMARY

a. Firm and Mailing Address .... San Joaquin Composting, Inc.
525 N. Shafter Avenue
Shafter, CA, 93263-1505

b. Site Location .... Holloway Road
Lost Hills, Ca.

c. Unit Tested .... Windrow Piles with 3, 45, & 57 day mixes

d. Test Requested by .... Julia Lester, Planning, (909) 396-3162

e. Reason for Test Request............................ Information for the AQMP

f. Date of Test .... February 15, & March 1 & 11, 1996

g. Source Test Performed by......................... Ken Sanchez, David Carrillo, Mike Garibay,
C. Willoughby, Paul Williamson

h. Test Arrangements Made Through............ J. Deatherage, General Manager, (805) 746-6723

h. Test Observed by.. T. L. Allard, Site Manager, (805) 797-2914

RESULTS

3 Day Pile Average Emission Summary

Contaminant	Emissions per Windrow Pile	Emissions per hour per ton of Compost Mix	Emissions per hour per 1000 ft^2 of Compost
Ammonia (pre turning)	1.54 lb/hr	3.09E-03 lb/hr-ton mix	0.155 lb/hr-1000ft^2
Ammonia (post turning)	1.37 lb/hr	2.75E-03 lb/hr-ton mix	0.138 lb/hr-1000ft^2
Ammonia (wtd. avg)	1.54 lb/hr	3.09E-03 lb/hr-ton mix	0.155 lb/hr-1000ft^2
Amines	0.13 lb/hr	2.59E-04 lb/hr-ton mix	1.30E-02 lb/hr-1000ft^2
Total Sulfur Compounds	0.08 lb/hr	1.68E-04 lb/hr-ton mix	8.41E-03 lb/hr-1000ft^2
Methane	36.46 lb/hr	7.29E-02 lb/hr-ton mix	3.65 lb/hr-1000ft^2
TGNMOC	3.29 lb/hr	6.58E-03 lb/hr-ton mix	0.329 lb/hr-1000ft^2

45 Day Pile Average Emission Summary

Contaminant	Emissions per Windrow Pile	Emissions per hour per ton of Compost Mix	Emissions per hour per 1000 ft^2 of Compost
Ammonia (pre turning)	1.41 lb/hr	2.82E-03 lb/hr-ton mix	0.146 lb/hr-1000ft^2
Ammonia (post turning)	1.56 lb/hr	3.11E-03 lb/hr-ton mix	0.162 lb/hr-1000ft^2
Ammonia (wtd. avg.)	1.41 lb/hr	2.83E-03 lb/hr-ton mix	0.146 lb/hr-1000ft^2
Amines	0.04 lb/hr	8.67E-05 lb/hr-ton mix	4.50E-03 lb/hr-1000ft^2
Methane	0.11 lb/hr	2.20E-04 lb/hr-ton mix	1.14E-02 lb/hr-1000ft^2
TGNMOC	0.12 lb/hr	2.36E-04 lb/hr-ton mix	1.23E-02 lb/hr-1000ft^2

57 Day Pile Average Emission Summary

Contaminant	Emissions per Windrow Pile	Emissions per hour per ton of Compost Mix	Emissions per hour per 1000 ft^2 of Compost
Ammonia (pre turning)	0.13 lb/hr	2.66E-04 lb/hr-ton mix	1.42E-02 lb/hr-1000ft^2
Ammonia (post turning)	2.48 lb/hr	4.97E-03 lb/hr-ton mix	2.65E-01 lb/hr-1000ft^2
Ammonia (wtd. avg.)	0.18 lb/hr	3.68E-04 lb/hr-ton mix	1.97E-02 lb/hr-1000ft^2
Amines	<0.003 lb/hr	<6.58E-06 lb/hr-ton mix	<3.51E-04 lb/hr-1000ft^2
Total Sulfur Compounds	0.08 lb/hr	1.58E-04 lb/hr-ton mix	8.43E-03 lb/hr-1000ft^2
Methane	<0.13 lb/hr	<2.67E-04 lb/hr-ton mix	<1.43E-02 lb/hr-1000ft^2
TGNMOC	<0.12 lb/hr	<2.39E-04 lb/hr-ton mix	<1.27E-02 lb/hr-1000ft^2

Average of 3-day, 45-day, & 57-day piles

Contaminant	Emissions per ton of Compost Mix	Emissions per 1000 ft^2 of Compost Surface Area	Emission per hour - ton of Compost Mix
Ammonia	2.81 lb/ton mix	0.107 lb/hr-1000ft^2	2.07E-03 lb/hr-ton
Amines	0.19 lb/ton mix	6.0E-03 lb/hr-1000ft^2	1.17E-04 lb/hr-ton
Total Sulfur Comp.	0.22 lb/ton mix	8.42E-03 lb/hr-1000ft^2	1.63E-04 lb/hr-ton
Methane	33.49 lb/ton mix	1.23 lb/hr-1000ft^2	2.4E-02 lb/hr-ton
TGNMOC	3.12 lb/ton mix	0.11 lb/hr-1000ft^2	2.28E-03 lb/hr-ton

Notes: Total sulfur compounds based on 3-day and 57-day piles only.
Results do not include emissions from curing piles or emissions during actual turning.
Ton of compost mix refers to original mass as measured by Lost Hills before composting.

For emissions of individual sulfur compounds, refer to calculations section.
TGNMOC may be subject to change upon receipt of modified method 25.1 results.

INTRODUCTION

On February 15, 1996, and March 1 & 11, 1996, personnel from the South Coast Air Quality Management District (SCAQMD), conducted source tests at San Joaquin Composting, Inc. The tests are intended to measure the emission profile of the operation over its composting cycle. The tests were conducted on compost piles consisting of a mixture of dewatered sewage sludge and green waste. The ages of the piles were 3 days, 45 days, & 57 days. These compost ages were chosen as beginning and end compost where activity is theoretically beginning and ending, and at peak temperature (45 days) when activity is expected to be greatest. The results presented in this report represent windrow emissions only since sampling for curing pile emissions was not performed.

Since the composting process is specifically designed to optimize agitation for maximum aerobic content verses internal heat and activity, it was imperative that the process be tested in place and undisturbed. The piles are generally turned once to three times per week depending on workload constraints. The tests were scheduled to coincide with the pile turning, so a pile was tested for ammonia emissions before and after turning, and for the remaining pollutants, before turning only. Sampling was not conducted during turning, however, due to sampling difficulties under turning conditions. Previous testing has shown that the emission remain at the elevated emission rate for approximately 90 minutes after turning, after which emissions return to baseline levels. The "before turning" condition is considered as representing baseline emissions.

The test was requested by the SCAQMD Planning Division in order to inventory emissions from sludge composting operations in the South Coast District and evaluate the impact for possible inclusion to the Air Quality Management Plan (AQMP). San Joaquin Composting has volunteered the use of its Lost Hills facility for purposes of testing emissions to the atmosphere

The following is a summary of operating conditions during the tests:
Average Row Height - 5’ (3 Day), 4.5’ (45 Day), 4’ (57 Day)
Average Row Width at Base - 18’
Average Row Width at Top - 8’
Average Row Length - 450’
Compost Temperature - See Table on page 20
Average Pile Surface Area - 9,990 ft^2 (2 Day), 9,630 ft^2 (20 Day), 9,360 ft^2 (50 Day)
Average Pile Compost Volume - 29,250 ft^3 (3 Day), 26,325 ft^3 (45 Day), 23,400 ft^3 (57 Day)
Compost Composition - 50% sludge, 50% green waste (by initial weight)
Total Number of Windrow Piles - 120 - 130
Total Number of Curing Piles - 30 - 40

EQUIPMENT AND PROCESS DESCRIPTION

A variety of wastes can be utilized as compost materials including manure, dewatered sewage sludge, wood chips, agricultural (or other) "green" wastes, and stable wastes. The materials are transported to the compost facilities where they can be mixed with organic bulking agents in order to improve porosity for the aerobic composting process. Bulking agents can be made up of a variety of organic or green wastes. The compost composition is thought to have an impact on emissions since the process is dependent on micro-biological activity and oxygen availability.

During the composting process, bacteria are allowed to decompose the mixture in a combination of aerobic and anaerobic activity. The dominating airborne by-product of aerobic activity is carbon dioxide. Airborne by-products of the anaerobic activity which are largely reduced compounds include relatively large amounts of methane and ammonia, and relatively smaller amounts of amines, hydrogen sulfide, other reduced sulfur compounds, and other hydrocarbons. The anaerobic activity is less desirable due to emissions of toxic and odor-causing compounds. Fugitive dust can be a direct source of PM-10 emissions, particularly during periods of high temperatures, high wind and low humidity.

The heat generated by the exothermic reactions raises the compost's internal temperature to 120-150°F. The heat also serves the purpose of reducing pathogenic activity. For composting, the mixture can be shaped into various configurations. Pile dimensions may vary greatly depending on application. The piles can also be aerated by a number of means.

At the Lost Hills facility, the compost is typically initially composed of 50% digested sewage sludge and 50% green waste by weight. The compost materials are generated predominantly from the Los Angeles area. The green waste is typically composed of municipal tree and shrub trimmings along with backyard waste from curbside recycling. For composting, the mixture is shaped into several windrow piles of a length of 500 ft and a trapezoidal cross-sectional area. The piles shrink in size as they proceed through the composting period due to the bacterial consumption of the organic material. The piles are turned over every one to three times per week using a diesel driven machine known appropriately as a Scarab. The Scarab straddles a pile as it mixes in air with large rotating till type blades as it travels down the length of the pile. The Scarab uses an adjustable hood to reshape the piles into the trapezoidal shape as it makes its 20-45 minute journey down the pile's length. This process continues typically for 57 days depending on space constraints. For space saving purposes the compost is then relocated to larger curing piles of approximately 20 ft height. Aeration is achieved in the curing piles by turning over with a back-hoe. The composting continues to a lesser degree in the curing piles until the desired consistency is achieved for up to six months and is shipped out as product demand dictates.

SAMPLING AND ANALYTICAL PROCEDURES

Compost Composition

A sample of the compost mix was analyzed for nitrate, ammonia, phosphate, minerals, salts, moisture, and bulk density. This analysis was performed by Soil and Plant Laboratory Inc., who performs analyses for the composting industry. Refer to the attached laboratory report for the results of the compost analysis. This analysis may prove useful in emissions evaluations with respect to compost composition.

EPA Emission Isolation Flux Chamber

The procedure for measuring emissions from the compost pile surfaces is a modified form of the procedures found in the US Environmental Protection Agency's (EPA) *Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber User's Guide.*

Under the EPA procedures, gaseous emissions from surface migration are collected from an isolated surface area with an enclosure device called an emission isolation flux chamber. Clean, dry sweep air or nitrogen is introduced to the flux chamber at a fixed, controlled rate (5.0 lit/min recommended) as a carrier where it mixes with the contaminants from the surface migration. The flux chamber encompasses a fixed surface area (1.4 ft^2), and is designed to isolate the surface from phenomena that can influence the air surface interface such as wind speed, other meteorological conditions, or properties of the waste itself. The flux chamber is sunk to a depth of one inch into the surface in order to create a seal between the flux chamber and the surface. The flux chamber and sweep air system is designed such that the contents are well mixed and no internal stratification exists. A probe is located in the flux chamber to extract a gaseous sample for subsequent analysis. The probe is of such a design that the sample represents a composite of various altitudes from within the flux chamber. Sampling is conducted at a rate of lesser than or equal to the sweep air rate. The remainder of the flux chamber contents are allowed to vent through a small opening located strategically on the flux chamber dome. For measuring flux chamber internal temperature, a thermocouple is also located within the flux chamber. Refer to Figure 1 for specifications and exact dimensions of the flux chamber design.

Modifications to the Flux Chamber Method

The Flux Chamber procedure is intended primarily for surface migration from landfills, hazardous waste treatment facilities, and hazardous spill remediation covered under the RCRA and CERCLA acts. The procedure assumes that gaseous emissions from the surface within the chamber area are much less than that of the sweep air rate. Under this assumption, mass emissions of a given contaminant is a product of the measured sample concentration and sweep air rate and reported per unit of surface area. Upon field evaluation of the flux chamber, it was discovered that the surface flux migration rate was more appreciable in the composting operation and could not be ignored as compared to the sweep air rate. The calculation of mass emissions of a given contaminant thus becomes a product of the measured sample concentration, sweep air rate, and surface migration rate. Furthermore this migration rate could not be directly measured due to the discovery that any attempt to employ a measuring device resulted in an impedance of the surface migration.

As an amendment to the EPA procedure, the surface migration rate must be determined. A procedure for calculating surface migration employs a material balance and concentrations taken from the sample analysis of an inert known component initially mixed into the sweep gas (refer to material balance section). For this reason, the sweep gas is composed of 10% helium (balance ultra-pure grade air) as a component to perform the analysis and material balance.

For the purposes of this test, the flux chamber's shell and sample path was constructed entirely of non reactive materials. Since sulfur compounds were measured, this also meant that metals of any kind could not be used in its construction to avoid catalytic decomposition. The following sampling specifications were used during testing:

Sweep Air Type:	10% Helium, 90% Air (99.999 % purity)
Sweep Air Rate:	5.0 lit/min
Bag Sampling Rate:	1.0 lit/min
Ammonia Sampling Rate:	1.0 lit/min
Amines Sampling Rate:	1.0 lit/min

Each sampling run was integrated over several points to insure representativeness. In order to account for general spatial variabilities, the flux chamber samples were drawn and integrated over several points

Modifications to the Flux Chamber Method (Con't.)

along the pile length for an averaging effect. This is also known as composite sampling. A evaluation of methane migration was conducted using a portable Flame Ionization Detector (FID) to determine spatial variations in emissions from the compost (Refer to page 20). The FID was also used to determine flux chamber period of equilibration with surface emissions for each sampling point. Equilibration was indicated by a steady plateau in the methane readings.

A small mixing fan is mounted within the flux chamber to ensure complete mixing within the flux chamber and allow for a homogeneous sample. The fan speed was set at approximately 110 rpm during all sampling and equilibration periods. A bench-top smoke study revealed that at 110 rpm, the fan can perform adequate mixing without affecting vertical surface migration.

Results are reported as concentration (ppm) in the flux chamber and emission rates are calculated in lb/hr-ft^2 of surface area. Final mass emission rates are reported on a per pile and per unit of compost basis using the pile dimensions within the facility. The number of sampling points used in each run and real time FID readings at each sampling point are presented on page 20 as well for statistical considerations. The FID readings are to be used primarily to indicate steady state and degree of point to point variability. For quantification purposes, the FID readings are considered to be less accurate than the sampling methods shown below.

Ammonia Sampling

An ammonia sample was collected during each sampling run from the flux chamber sample line using Draft SCAQMD Method 207.1. The midget sampling train consisted of two midget impingers each filled with 15 ml of 0.1N Sulfuric Acid, an empty bubbler, and a bubbler filled with tared silica gel, as shown in Figure 2. A minimal amount of condensation was observed in the sample line leading to the ammonia train. The impingers and bubblers were contained in an ice bath to condense ammonia, water vapor, and other condensable matter present in the sample stream.

Ammonia Sampling (Con't.)

The samples from the 3 day pile were collected for a period of 18 minutes over six sampling points before turning and 12 minutes over four sampling points after turning at a sampling rate of 1.0 lit/min. The samples taken from the 45 and 57 days piles were each collected for approximately 24 minutes over eight sampling points before turning and 15 minutes over five sampling points after turning at a sampling rate of 1.0 lit/min.

The SCAQMD laboratory analyzed for ammonia deposited in the impingers as ammonium by ion chromatography. Moisture gain was determined volumetrically in the impingers, and gravimetrically in the silica gel. Ammonia concentration in the flux chamber was determined using the ammonia content collected in the impingers, along with the sampling rate and net elapsed sampling time.

A blank field sample train from each of the three sampling days was analyzed in a manner consistent with the above analysis for quality control purposes.

Amines Sampling

An amines sample was collected during each "before turning" sampling run from the flux chamber sample line using the Ninhydrin Method. This method will detect primary and secondary but not tertiary amines which are not expected to be significant. The sampling train consists of two midget impingers, each filled with 10 ml of acidified isopropanol, an empty bubbler, and a bubbler filled with tared silica gel. The silica gel impinger is connected to the vacuum side of a leak-free sample pump and a calibrated rotameter, as shown in Figure 3. The impingers and bubblers were contained in an ice bath to condense amines, water vapor, and other condensable matter present in the sample stream.

The sample was collected for the same time period as the "before turning" ammonia samples at a sampling rate of 1.0 lit/min.

The contents of the impingers were reacted with a 0.2% Ninhydrin (1,2,3 tri-ketohydrindene) in isopropanol reagent to produce "Ruhemann's purple." The SCAQMD laboratory then analyzed for primary and secondary amines using a spectrophotometer and Beer's law. Moisture gain was determined volumetrically in the impingers, and gravimetrically in the silica gel for quality control purposes. Amines concentration in the flux chamber was determined using the amines content collected in the impingers, along with the sampling rate and net elapsed sampling time. The results are reported as n-butyl amine. A blank field sample reagent was analyzed in a manner consistent with the above analysis for quality control purposes.

Integrated Gas Sampling

An integrated gas sample was collected during each "before turning" sampling run from the flux chamber sample line using the vacuum side of a leak-free sample pump and a calibrated rotameter. These samples were collected in Tedlar bags as shown in Figure 4. The contents of the Tedlar bags were analyzed for organic sulfur compounds. Due to the reactivity of the sulfur compounds, that analysis was performed within 4 hours of sampling. The gases were separated by gas chromatography. Selected toxic sulfur compounds were analyzed using a flame photo-ionization detector.

Modified Method 25.1 - Non-Methane Organics

An integrated gas sample was collected during each "before turning" sampling run from the flux chamber using a modified 25.1 sampling apparatus. The apparatus consists of small Teflon impinger containing 5 ml of HPLC grade water connected to a six liter summa polished canister as shown in Figure 5. This method has recently been recognized in the source testing community as the method of choice for low concentration organics. This is the only currently known method of detecting both condensable and gaseous organic emissions with acceptable precision at low concentration. This method is used for non-methane organics concentration below 25 ppm.

Results were reported as Total Gaseous Non-Methane Organic Compounds (TGNMOC). The liquid within the impinges was analyzed with an infrared total carbon analyzer. The contents of the canister were analyzed using the gaseous analytical procedure of existing SCAQMD Method 25.1 by the total combustion analysis (TCA) technique using a flame ionization detector (FID). Since it was discovered after analysis that the concentrations of non-methane organics were all above 25 ppm, the results of the Modified Method 25.1 were discarded in favor of the standard Method 25.1 results (see next section).

Method 25.1 - Non-Methane Organics

Integrated gas samples were taken during each "before turning" sampling run from the flux chamber using SCAQMD Method No. 25.1. Duplicate gas samples were collected in dry ice cooled condensate traps and in nine liter evacuated tanks (Figure 6). This method is used for non-methane organics concentration above 25 ppm.

The contents of the traps and the tanks were analyzed at the SCAQMD laboratory for CO, CO_2, O_2, CH_4 and total gaseous non-methane organic compounds (TGNMOC). CO, CH_4 and TGNMOC concentrations were analyzed by the total combustion analysis (TCA) technique using a flame ionization detector (FID); SCAQMD Method No. 25.1. The O_2 and CO_2 concentrations were determined by gas chromatography (GC) using a thermal conductivity detector (TCD).

Compost Internal Temperature

The compost was monitored with a type “K” thermocouple at various depths in the compost at each of the locations the sampling took place. Results were reported as an average temperature encountered at each location. The results are reported on page 20.

TEST CRITIQUE

The test was conducted under normal operating conditions on a pre-arranged basis.

Refer to “Soil and Plant Laboratory, Inc.” Analysis sheet for compost composition.

Sulfur compounds were not analyzed for the 45 day pile due to staffing difficulties within the SCAQMD laboratory on that day. Results are reported without the contribution of the 45 day pile sulfur compounds.

The "after-turning" sampling does not include emissions while turning but those a few minutes after turning. Emissions during turning were not determined due to difficulties in obtaining representative samples under the turning conditions. The turning process has been observed to cause a strong but short burst of emissions based on the observation of a steam plume and strong odors. Because of this, the estimations developed in the report are assumed to underestimate actual emissions by an unknown amount.

Other factors such as EPA reported potential 20% low bias in the flux chamber method and possible condensation in the sampling lines can also be responsible for a low bias. It should be noted that for

TEST CRITIQUE (Con't)

purposes of establishing emissions baseline estimates and subsequent emissions reduction estimates that a low bias will always occur.

A heavy rain event occurred one or two days before the 3 day pile sampling. This had the effect of increasing both compost mass and moisture content over the original compost mixture, and over the 45 and 57 day piles which were sampled during dryer periods. Higher TGNMOC and methane emissions from the 3 day pile supports the theory that compost moisture has a great effect on emissions and anaerobic activity.

During the March 11 sampling event, some of the material in the green waste stockpile area in the facility was observed to be spontaneously combusting. The "smoldering" effect, according to the facility, was caused by dry high winds from the previous night. This phenomena was observed to generate an indeterminable amount of white smoke which may result in a potential source of direct PM-10 emissions. The effect did not occur on the windrow compost that was sampled.

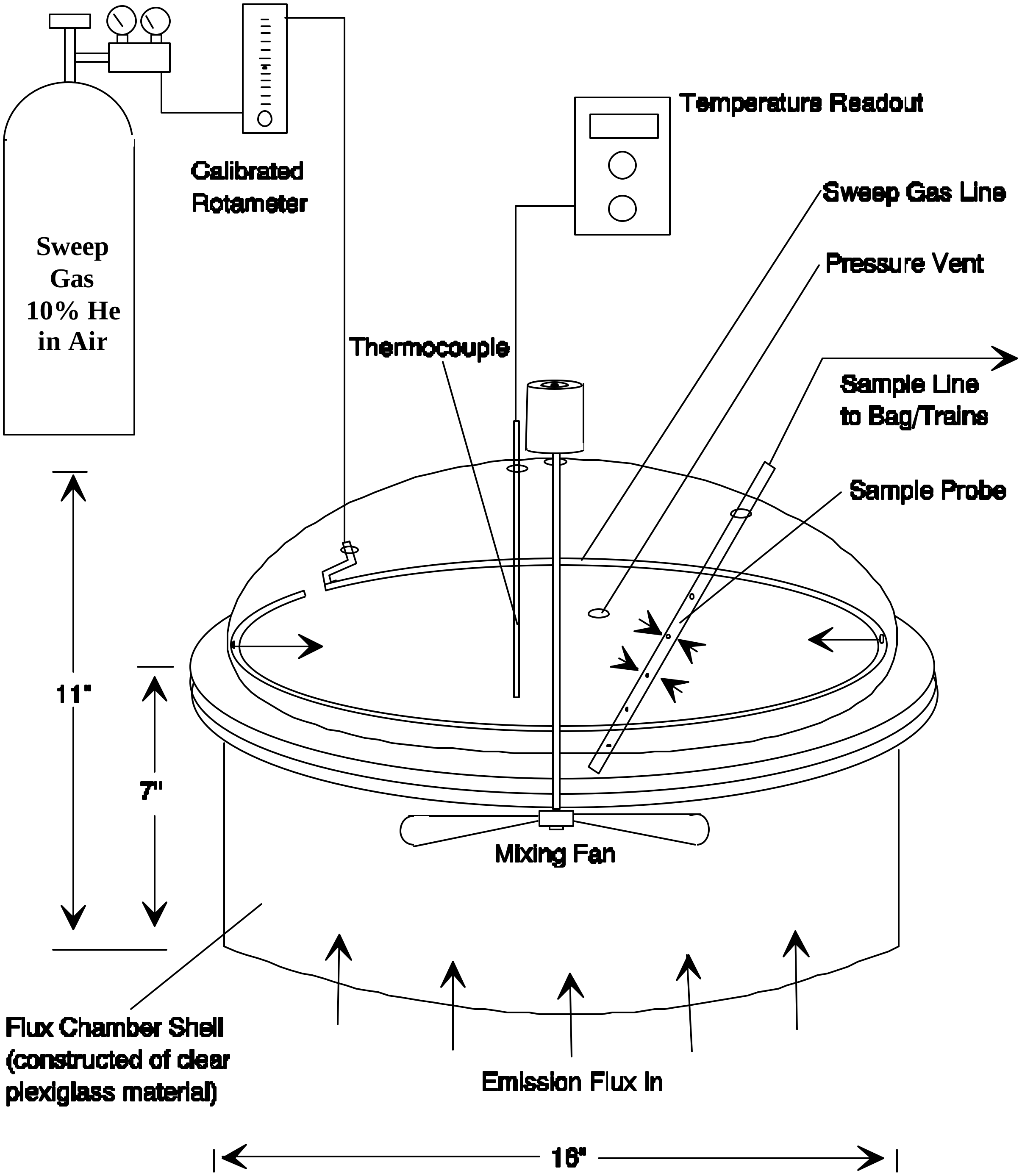


Figure 1 Emission Isolation Flux Chamber

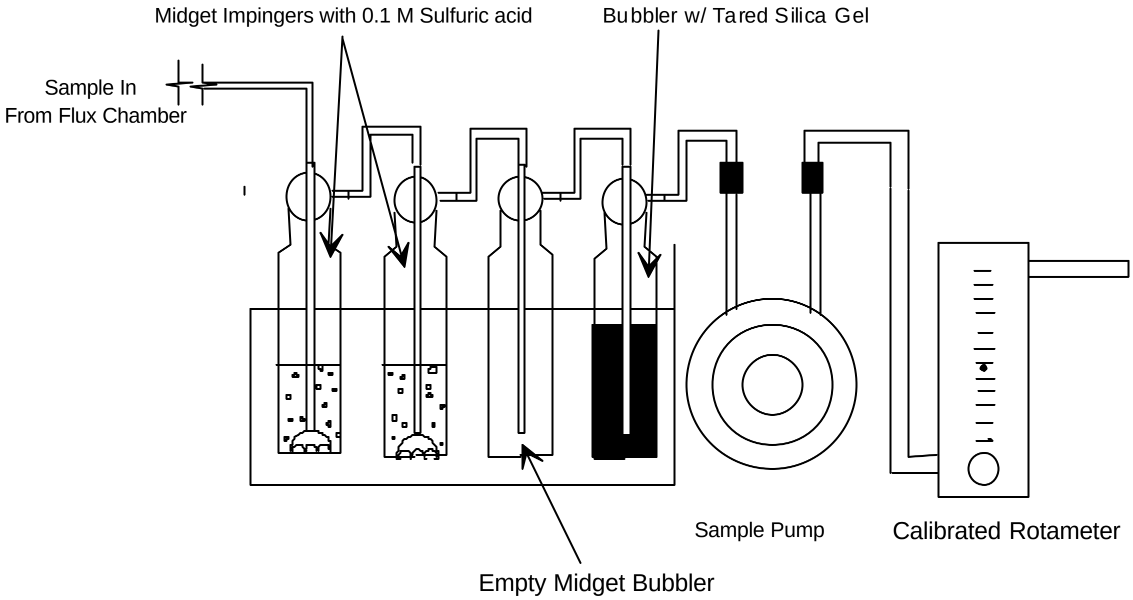


Figure 2 Ammonia Midget Sampling Train

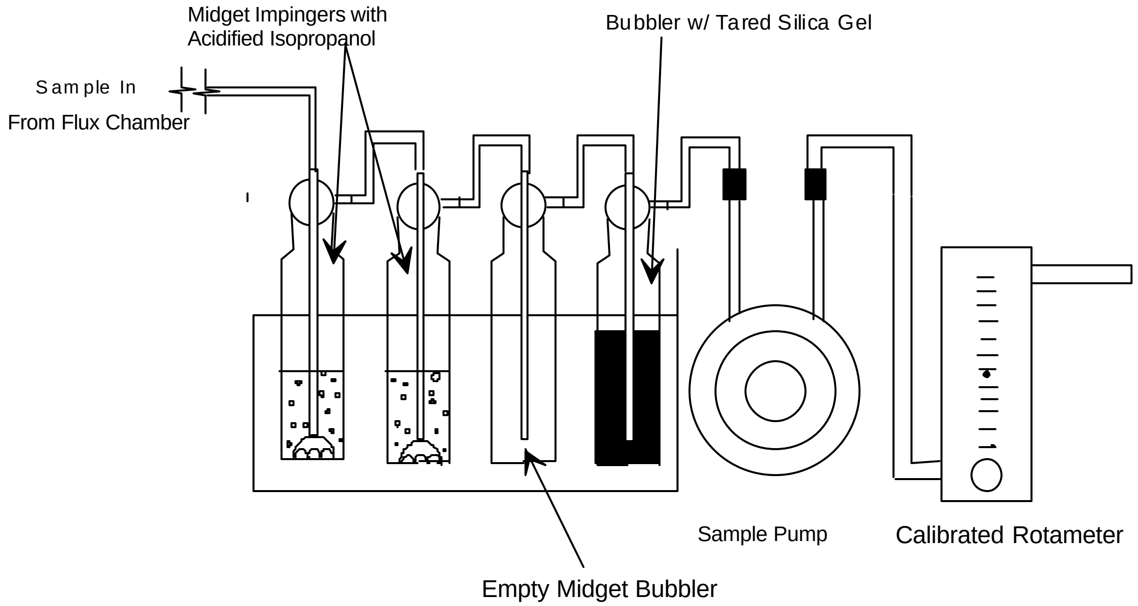


Figure 3 Amines Midget Sampling Train

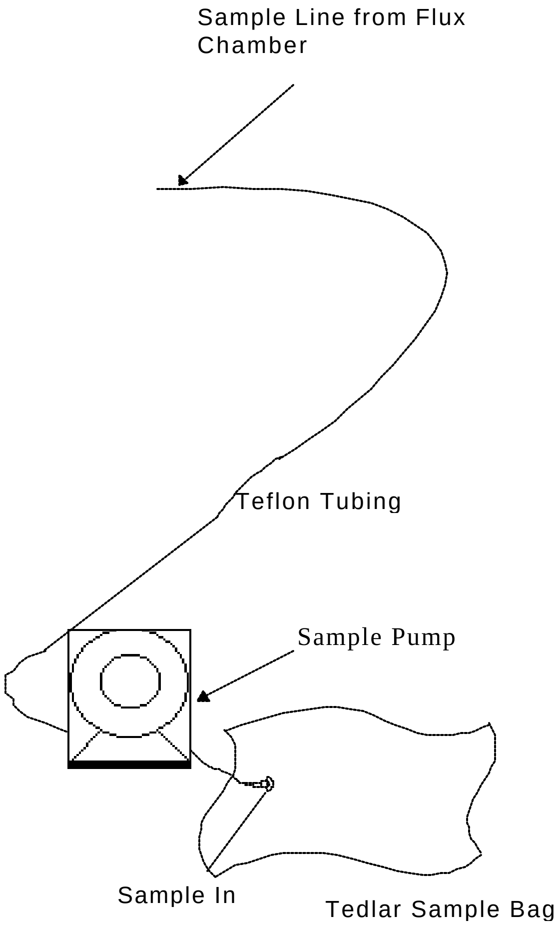


Figure 4 Integrated Gas Sampling Apparatus

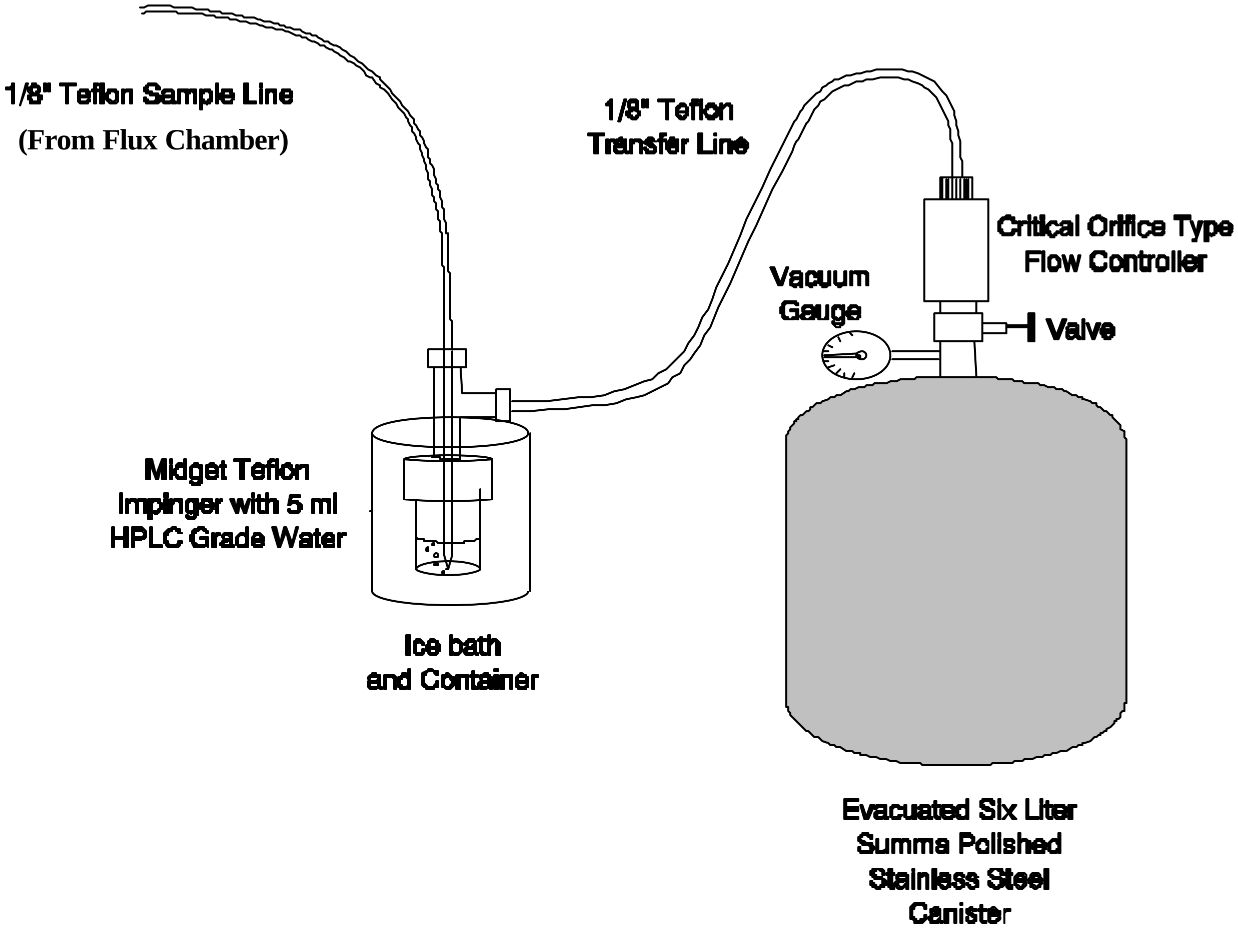


Figure 5 Modified 25.1 Sampling Apparatus

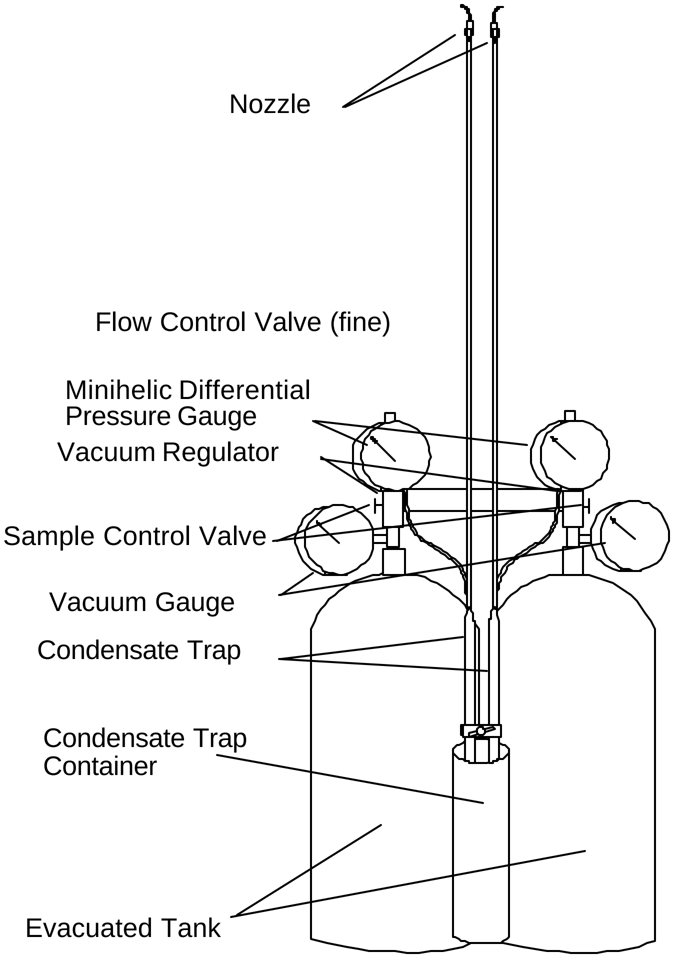


Figure 6 Method 25.1 Sampling Apparatus

Number of Sampling Points, Compost Temp. and FID Readings at Each Sampling Point

Before Turning

3 Day Pile

Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (^{o} F)
1	45	120
2	110	120
3	4,500	99
4	7,000	104
5	2,900	94
6	500	114
7	N/A	N/A
8	N/A	N/A
9	N/A	N/A

45 Day Pile

Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (^{o} F)
1	11	153
2	6	159
3	7	121
4	3	148
5	80	125
6	4	148
7	2.5	159
8	35	153
9	N/A	N/A

57 Day Pile

Sampling Point Zone #	FID Reading (ppm)	Internal Temp. (o F)
1	2.3	137
2	2.1	129
3	2.2	137
4	2	102
5	4	122
6	4.5	90
7	2.5	104
8	2.1	115
9	N/A	N/A

After Turning

3 Day Pile

1	150	97
2	200	100
3	500	110
4	110	119
5	N/A	N/A

45 Day Pile

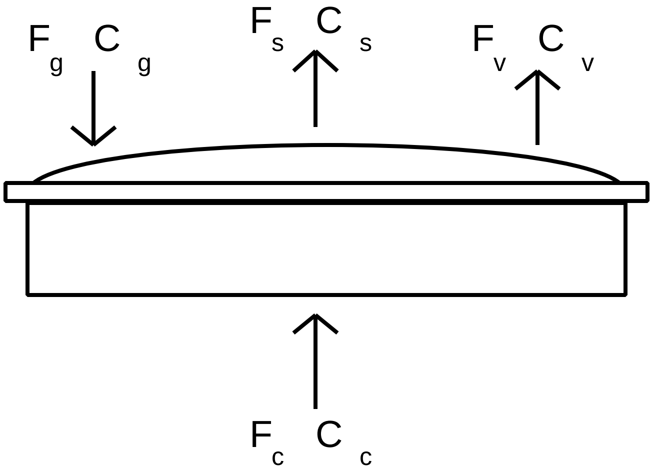
1	20	143
2	110	151
3	18	130
4	11	146
5	5	156

57 Day Pile

1	11	135
2	2	140
3	3	145
4	2	138
5	N/A	N/A

Material Balance for Compost Surface Migration Rate

For calculating the compost surface migration rate, a helium material balance was performed around the flux chamber. Helium was the chosen constituent because of inert properties and its ease of accurate analysis. The material balance is derived as follows:



Where:

F_g = Sweep Gas Flow Rate (measured)

C_g = Sweep Gas Helium Concentration (analyzed)

F_s = Sample Flow Rate (measured)

C_s = Sample Helium Concentration (analyzed)

F_v = Vent Flow Rate (unknown)

C_v = Vent Helium Concentration (assume = C_s)

F_c = Compost Surface Migration Flow Rate (unknown)

C_c = Compost Surface Migration Helium Concentration (assumed zero)

Flow Balance:

$$F_v = F_c + F_g - F_s$$

Helium Balance:

$$F_cC_c + F_gC_g = F_sC_s + F_vC_v$$

Material Balance for Compost Surface Migration Rate (continued)

Substitute:

$C_c = 0$

$C_v = C_s$

F_v = Flow Balance

then:

$$F_gC_g = F_sC_s + (F_c + F_g - F_s)C_s$$

$$F_gC_g - F_cC_s = F_sC_s + F_gC_s - F_sC_s$$

$$F_cC_s = F_gC_g - F_gC_s$$

$$F_c = \frac{F_g(C_g - C_s)}{C_s}$$

EMISSION ESTIMATION CALCULATIONS

Windrow emissions are based on the surface area of the windrows and the results of the flux chamber sampling reported per unit of surface area. The weighted average for ammonia assumes that the windrows emit at the elevated "after turning" emission rate for 90 minutes and that the piles are turned 2.5 times per week. Piles emit “after turning” rates 2.2% of the time. The facility wide emissions do not include curing pile emissions and are calculated using the average of the three windrow ages.

The following data was used for the calculations:
Pile Height - 5’ (3 Day), 4.5’ (45 Day), 4’ (57 Day)
Pile Width at Base - 18’
Pile Width at Top - 8’
Pile Length - 450’
Pile Side Length - 7.1’ (3 Day), 6.7’ (45 Day), 6.4’ (57 Day)
Pile Surface Area - 9,990 ft^2 (3 Day), 9,630 ft^2 (45 Day), 9,360 ft^2 (57 Day)
Avg. Pile Surface Area - 9,660 ft^2
Pile Volume - 29,250 ft^3 (3 Day), 26,325 ft^3 (45 Day), 23,400 ft^3 (57 Day)
Density - 1,200 lb/yd^3 (3 Day), 1,014 lb/yd^3 (45 Day), 972 lb/yd^3 (57 Day)
Mass - 650 tons (3 Days),
Original Pile Mass from Losthills scale - 500 tons*
Total Number of Windrow Piles - 125 - 130
Time in Windrow - 57 Days

NH_3 weighted average = (NH_3 before turning $\ast$ 0.978) + (NH_3 after turning $\ast$ 0.022)

For 3 - Day

NH_3 Weighted Avg. = (1.54E-04 x 0.978) + (1.38E-04 x 0.022) = 1.54E-04 $lb/hr\text{-}ft^2$

For 45 - Day

NH_3 Weighted Avg. = (1.46E-04 x 0.978) + (1.62E-04 x 0.022) = 1.46E-04 $lb/hr\text{-}ft^2$

For 57 - Day

NH_3 Weighted Avg. = (1.42E-05 x 0.978) + (2.65E-04 x 0.022) = 1.97E-05 $lb/hr\text{-}ft^2$

Avg. of Weighted Average = 1.07E-04 $lb/hr\text{-}ft^2$

** Difference between calculated mass at 3 days and measured mass at 0 days can be attributed to moisture gain due to rain event.*

Averages:*

Contaminant	Annual Emissions	Emissions per ton of Compost Mix	Mass Rate per 1000 ft^2 of Compost	Mass Rate per row	Mass Rate per lb/hr-ton
Ammonia	577 ton/year	2.81 lb/ton mix	0.107 lb/hr-1000ft^2	1.03 lb/hr	2.07E-03 lb/hr-ton
Amines	39 ton/year	0.19 lb/ton mix	6.0E-03 lb/hr-1000 ft^2	0.07 lb/hr	1.17E-04 lb/hr-ton
Methane	6,862 ton/year	33.49 lb/ton mix	1.23 lb/hr-1000ft^2	12.24 lb/hr	2.4E-02 lb/hr-ton
TGNMOC	639 ton/year	3.12 lb/ton mix	0.11 lb/hr-1000ft^2	1.14 lb/hr	2.28E-03 lb/hr-ton
Total Sulfur Compounds	45 ton/year	0.22 lb/ton mix	8.42E-03 lb/hr-1000ft^2	0.081 lb/hr	1.63E-04 lb/hr-ton

Ton/Yr = lb/hr ∗ 128 windrow piles ∗ 24 hr/day ∗ 365 day/yr ∗ ton/2,000 lb

Lb/Ton Compost = lb/hr ∗ pile/500 ton ∗ 24 hr/day ∗ 57 day

Lb/Hr-1000 FT^2 = (Avg. lb/hr-ft^2) ∗ 1,000

Lb/Hr = (Avg. lb/hr-ft^2) ∗ (Avg. Pile Surface Area)

Lb/Hr-Ton = (Avg. lb/hr-ft^2) ∗ (Avg. Pile Surface Area) / Original Pile Mass

* Rain event before 3-day pile test. See test critique.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

FEB 3 2014

REPLY TO THE ATTENTION OF:

Ms. Rachelle Maxheimer
Project Manager
Cornerstone Environmental Group, LLC
400 Quadrangle Drive, Suite E
Bolingbrook, Illinois 60440

Re: Roxana Landfill
Request for Higher Operating Values and Alternative Timelines

Dear Ms. Maxheimer:

Thank you for your letters dated August 23, 2013, September 6, 2013, September 19, 2013, September 30, 2013, October 15, 2013, October 16, 2013, October 31, 2013, and December 6, 2013, to the U.S. Environmental Protection Agency, requesting alternative compliance timelines and higher operating values at Roxana Landfill, located in Roxana, Illinois (Roxana). Roxana is subject to the New Source Performance Standards (NSPS) for Municipal Solid Waste Landfills (40 CFR Part 60, Subpart WWW). The NSPS sets forth operational standards and compliance provisions for gas collection and control systems under 40 CFR §§ 60.753 and 60.755.

Regulatory Background

Under the provisions of 40 CFR § 60.753(a), an owner or operator of a landfill subject to Subpart WWW is required to operate a gas collection and control system (GCCS) where waste has been in place for five years or more in active areas or where waste has been in place for two years or more in closed areas that have reached final grade. A number of operating limits for wellheads in the GCCS are specified in 40 CFR § 60.753(b) and 60.753(c). These provisions require that wellheads are operated under negative pressure (except in special circumstances), with a landfill gas temperature less than 55 degrees Celsius (131 degrees F) and with either a nitrogen level less than 20 percent or an oxygen level less than 5 percent.

Per 40 CFR § 60.755(a), an owner or operator of a GCCS subject to these operational limits is required to monitor wellhead pressure, temperature and gas composition on a monthly basis. When an exceedance of any of the operating limits in the rule is noted, the owner or operator must take corrective action to bring the collection system back into compliance. If the exceedance cannot be corrected within 15 days, the gas collection system must be expanded to correct the exceedance within 120 days of the initial exceedance. However, an alternative timeline for correcting the exceedance can be requested from the Administrator for approval.

Per 40 CFR § 60.753(c), the facility may also request a higher oxygen or nitrogen percentage or higher operating temperature at a particular well. The supporting data for a higher operating value request must demonstrate that the elevated operating parameter does not cause fires or significantly inhibit anaerobic decomposition by killing methanogens.

EPA Guidance on Alternative Timeline Requests

A number of Roxana's letters request alternative compliance timelines. Prior to addressing these requests individually, EPA would like to provide background information to you regarding how alternative compliance timeline requests will be processed. This information should inform you in making decisions regarding when and how to make such requests.

As outlined above, the rule requires landfill owners and operators to repair the cause of an operating parameter exceedance within 15 days or to expand the gas collection system within 120 days. In the event that the landfill owner or operator, despite its best efforts, is unable to make the necessary repairs to resolve the exceedance within 15 days, and it believes that an expansion of gas collection is unwarranted, the landfill owner or operator may submit for approval an alternative timeline for correcting the exceedance. In such circumstances, the landfill owner or operator needs to make such a submittal as soon as possible (i.e. as soon as it knows that it will not be able to correct the exceedance in 15 days and it is unwarranted to expand the gas collection system) to avoid being in violation of the rule. Landfill owners or operators should submit an alternative timeline request as soon as possible and communicate the reasons for the exceedance, results of the investigation, and schedule for corrective action. Similarly, if a landfill owner or operator intends to correct an exceedance through gas collection expansion and, despite its best efforts, is unable to complete the expansion project within 120 days, the landfill owner or operator may submit a request for an alternative timeline. A landfill owner or operator should submit the request as soon as it determines that it cannot meet the 120 day deadline to avoid being in violation of the rule.

EPA believes the timeframes and methods required to address exceedances provided for in the rule are sufficient to correct the vast majority of identified exceedances without an alternative timeline. Each situation and request is unique and it is difficult to prescribe what information must be included in a specific request; however, EPA expects that, at a minimum, a request shall include[1]:

- the operating parameter that has exceeded the regulatory limit;
- the date that the exceedance was initially detected;
- a detailed narrative discussion of all steps taken by the landfill owner or operator to

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[1] Ohio Environmental Protection Agency. *Alternative Timeline Requests for Correcting an Exceedance of Temperature, Oxygen or Nitrogen, or Positive Pressure at Landfill Gas Collection Wells, DAPC Engineering Guide #78, DSIWM Guidance Document #1001.* Columbus, Ohio, Ohio Environmental Protection Agency, December 2010.

correct the exceedance within the 15 day period;

- an explanation of why, despite the best efforts of the landfill owner or operator, the corrective action/repair work selected by the landfill owner or operator could not be implemented within 15 days and why the exceedance could not otherwise be corrected within 15 calendar days;
- a summary of the historical data for the well in question (should include a minimum of 6 months of past data, construction specifications for the well, description of the cover in the area, the age and type of waste, and any other information pertinent to the well);
- the following data collected at the well head:
  - temperature of the landfill gas,
  - percentage of the gas that is methane, oxygen, and CO_2,
  - gauge pressure;
- a detailed narrative discussion of the intended corrective measure and the amount of time the owner or operator estimates it will take to accomplish the correction;
- a detailed justification of why the proposed alternative timeline represents the amount of time necessary to implement the proposed corrective action/repair;
- a detailed justification of why an expansion of the gas collection system is unwarranted (if applicable);
- a detailed narrative describing why complying with the timeframes provided for in the rule would result in (1) unreasonable cost of control resulting from plant age, location, or basic process design; (2) physical impossibility of installing necessary control equipment; or (3) other factors specific to the facility that make application of a less stringent compliance time significantly more reasonable.[2]

The request must promptly identify the problem, be very detailed, contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be completed within the prescribed timeframe allowed in the rule, and not be based upon superfluous rationale.

Note that the rule does not provide alternative timelines for diagnosing or identifying the cause of the exceedance or to take time to write a letter. Therefore, no alternative timelines requests can be approved if the root cause of the exceedance has not been determined. If the alternative being requested is already included or offered in the NSPS as an alternative, then there is no need to request this approval from EPA (or its delegate) on an individual basis.

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[2] United States Environmental Protection Agency. *Enabling Document for the New Source Performance Standards and Emission Guideline for Municipal Solid Waste Landfills, EPA -453R/96-004.* Office of Air Quality Planning Standards, Research Triangle Park, NC, February 1999.

Roxana's Requests

August 23, 2013 letter

This letter pertains to gas collection Well 114R. On August 8, 2013, Well 114R exhibited an oxygen concentration of greater than 5 percent. Corrective actions (i.e., wellhead adjustments) were made within 5 days but failed to bring the well into compliance. An inspection conducted within 5 days indicated that the well was pinched and on August 21, 2013, a stinger was installed to open the pinch. At that time, personnel observed that the vacuum line was pinched at the top of the well and it was noted that a new lateral was required. The well was abandoned on August 21, 2013 and exhibited oxygen less than 5 percent but positive pressure on August 23, 2013. Roxana requested an alternative timeline of 60 days from the date of its letter, until October 22, 2013, to install the new lateral.

EPA's Response on the August 23, 2013 letter

EPA will approve your request because the installation of a lateral may be one of those situations that require more than 15 days to complete. However, in your future requests, we ask that you follow the guidelines outlined on pages 2-3 of this letter. Specifically, the request must promptly identify the problem, be very detailed, and contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be completed within the prescribed timeframe allowed in the rule (15 days).

September 6, 2013 letter

This letter pertains to Well 107R. The letter requests a more than 90 day alternative timeline to compile and submit a higher operating temperature request for Well 107R. For the reasons discussed previously in this letter, your request is denied. The rule does not provide alternative timelines for diagnosing or identifying the cause of an exceedance or to take time to write a letter. No alternative timelines requests can be approved if the root cause of the exceedance has not been determined.

EPA is aware that on October 15, 2013, Roxana requested a higher operating temperature for Well 107R. EPA's determination on the higher temperature request is discussed later in this letter.

September 19, 2013 letter

Well 32

On September 4, 2013, Well 32 exhibited an oxygen exceedance of 7 percent. Although Roxana suspected the cause of the exceedance was a broken well casing, the facility needed to do a camera investigation to determine the exact cause. Roxana requested 60 days from the date of its letter, until November 18, 2013 to complete the investigation and repairs and return the well to compliance.

EPA's Response on Well 32

Your request is denied. As noted previously, an alternative timeline request must identify the problem and contain a detailed narrative discussion of the intended corrective measures and the amount of time estimated to accomplish the correction. In addition, the request must contain substantial reasons beyond the control of the facility owner or operator as to why the exceedances could not and cannot be completed within the prescribed timeframe allowed in the rule (15 days).

In addition, the rule does not provide alternative timelines for diagnosing or identifying the cause of an exceedance. Therefore, no alternative timelines requests can be approved if the root cause of the exceedance has not been determined.

EPA trusts that this Well 32's exceedances have been corrected as of this time. EPA will not approve an alternative timeline retroactively for a well that is no longer out of compliance.

Well 115R

On September 4, 2013, Well 115R exhibited positive pressure. Roxana determined the cause of the exceedance to be a pinched vacuum and requested 60 days from the date of its letter, until November 18, 2013, to make repairs and bring the well back into compliance.

EPA's Response on Well 115R

Your request for an alternative timeline until November 18, 2013 is denied. As noted in the EPA guidance section of this letter, an alternative timeline request must not only identify the problem but must also identify what repairs are necessary and contain substantial reasons beyond the control of the facility owner or operator why the repairs could not and cannot be completed within the prescribed timeframe allowed in the rule (15 days).

We trust that by this time, Roxana has corrected the exceedances at Well 115R. EPA will not approve alternative compliance timelines retroactively for wells that have returned to compliance.

Well 119

Well 119 exhibited positive pressure on September 4, 2013. Roxana determined that the cause of the exceedance was a pinched line, initially thought to be 12 feet below the surface but 8 days later found to be 22 feet below the surface. Roxana requested 60 days from the date of its letter, until November 18, 2013 to return this well to compliance.

EPA's Response on Well 119

Your request for an alternative compliance timeline until November 18, 2013 is denied. As noted in the EPA guidance section of this letter, an alternative timeline request must not only identify the problem but must also identify the repairs that are necessary and contain substantial reasons beyond the control of the facility owner or operator why the repairs could not and cannot be completed within the prescribed timeframe allowed in the rule.

We trust that by this time, Roxana has corrected the exceedances at this well. EPA will not approve alternative compliance timelines retroactively for wells that have returned to compliance.

Collector 0TD1

This collector initially exhibited an oxygen exceedance of 13.9 percent on September 4, 2013. Corrective actions in the form of wellhead adjustments were made but the well continued to exhibit oxygen exceedances on September 16, 2013. Roxana requested 60 days from the date of its letter, until November 18, 2013, to make valve adjustments to gradually pull vacuum on this collector to bring it into compliance.

EPA's Response on Collector 0TD1

Your request for an alternative compliance timeline until November 18, 2013 is denied. As noted in the EPA guidance section of this letter, an alternative timeline request must promptly identify the problem, be very detailed, contain a detailed narrative discussion of the intended corrective measure and the amount of time the owner or operator estimates it will take to accomplish the correction, and contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be corrected within the prescribed timeframe allowed in the rule (15 days).

You state that this collector required more time to make valve adjustments but you failed to indicate why 60 days was needed to make such adjustments and why making adjustments over a long period of time would ultimately be successful in correcting the exceedances. Also, EPA believes that a more long term solution to maintaining this collecctor must be established including the possibility of expanding the landfill gas collection system to remedy the exceedance. Due to this concern, you should have provided a detailed analysis of whether an expansion was warranted.

We trust that by this time, Roxana has corrected the exceedances at Collector 0TD1. EPA will not approve alternative compliance timelines retroactively for wells or collectors that have returned to compliance.

September 30, 2013 letter

Well 114R

On August 8, 2013, Well 114R exhibited an oxygen exceedance due to being pinched and on August 21, 2013, a stinger was installed to open the pinch. At that time, personnel observed that the vacuum line was pinched at the top of the well and it was noted that a new lateral was required. The well was abandoned on August 21, 2013 and exhibited oxygen less than 5 percent but positive pressure on August 23, 2013. Roxana requested an alternative timeline of 60 days from the date of the letter, until October 22, 2013, to install the new lateral. On August 28, 2013, a new temporary lateral was installed and the well exhibited negative pressure (and EPA assumes compliant oxygen levels) on September 4, 2013.

On September 16, 2013, this well exhibited another positive pressure incident due to what Roxana claimed was a different compliance issue (vacuum line at Well 120 was pinched due to the above described repairs). Roxana stated that it was planning to conduct a camera investigation on October 3, 2013 and the well continued to exhibit positive pressure on September 30, 2013. Roxana requested 60 days from the date of its letter, until November 30, 2013, to conduct the camera investigation and complete the necessary repairs.

EPA's Response on Well 114R

Based on the information provided in your September 30, 2013 letter, it appears that the September 16, 2013 was a new pressure exceedance. However, your request for an alternative timeline is still denied because the rule does not provide alternative timelines for diagnosing or identifying the cause of an exceedance. Furthermore, Roxana's request fails to promptly identify the problem, provide sufficient detail, or contain a discussion of the intended corrective measures and the amount of time the owner or operator estimates it will take to accomplish the correction, In addition, the request fails to provide substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be corrected within the prescribed timeframe allowed in the rule (15 days).

Well 120

Well 120 initially exhibited a positive pressure exceedance during the September 16, 2013 monitoring event. Roxana determined that the cause of the exceedance was a pinched vacuum line and a camera investigation was scheduled for October 3, 2013 to locate the pinch and verify the cause of the exceedance. Roxana stated that a new vacuum line would be required. Well 120 was re-monitored on September 30, 2013 and continued to exhibit positive pressure.

EPA's Response on Well 120

Your request for a 60 day alternative timeline is denied. As noted previously, an alternative compliance timeline request letter must identify the problem and contain a detailed narrative discussion of the intended corrective measures and the amount of time estimated to accomplish the correction. In addition, the request must contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be completed within the prescribed timeframe allowed in the rule.

LCR CO12

Leachate Cleanout Riser (LCR) CO12 exhibited an oxygen exceedance of 13.4 percent during the September 16, 2013 monitoring event. According to Roxana, because the engineered purpose of LCR CO12 is to convey liquids, the liquid level varies and the gas quality is poor. Due to the shallow depth of the LCR, air intrusion from the surface can occur intermittently as more pressure is applied. Roxana requested 60 days from the date of its letter, until November 30, 2013 to gradually apply vacuum to control odor issues.

EPA's Response on LCR CO12

As you know, EPA has determined that in the case of LCRs which are engineered to convey liquids, the owner or operator of the landfill may follow an alternative operating procedure if certain conditions are met. The procedure is outlined in a June 12, 2008 letter from EPA to Livingston Landfill, a copy of which you attached to your October 15, 2013 request letter. This alternative procedure can be used when the risers are sealed to prevent uncontrolled landfill gas emissions to the atmosphere and when the capacity of the LCR is not needed to meet the 500 ppm methane surface concentration limit in 40 CFR Part 60, Subpart WWW.

Since EPA has already approved an alternative procedure for LCRs that meet certain criteria, EPA will approve Roxana 60 days to gradually apply vacuum to bring LCR C012 into compliance. In the alternative, Roxana may apply the procedure outlined in the Livingston letter to LCR CO12 if it meets the requirements. Roxana must inform the Illinois Environmental Protection Agency (IEPA) through the NSPS reporting that the alternative procedure is being used.

October 15, 2013 Letter

LFG Collector 107R

Collector 107R began exhibiting temperatures at or above 131 degrees F during the July 25, 2013 monitoring event. Roxana attributed the high temperatures at Collector 107R to the nature of the accelerated decomposition that is occurring near this collector and requested a higher operating temperature of 140 degrees F.

EPA's Response on LFG Collector 107R

In the October 15, 2013 letter, you attached operating data for the period from January to

September 2013. The monitoring data shows that the highest temperature reached during that time period was 134 degrees F. In a subsequent letter, dated December 6, 2013, you indicated that the temperature was now reaching 136 degrees F. Gas quality has been good (40-60 percent methane), oxygen low (less than 5 percent), and carbon monoxide concentrations measured 0 ppm.

The high methane and low oxygen indicate that anaerobic decomposition is still occurring and the low CO indicates that there is no subsurface oxidation. EPA will therefore approve a higher operating temperature of 140 degrees F which means the collector must operate at less than 140 degrees F.

LCR CO13

LCR CO13 began exhibiting oxygen exceedances on May 23, 2013. For each monitoring event where CO13 exhibited oxygen exceedances, Roxana attempted corrective actions but has only achieved intermittent compliance with the oxygen concentration standard. Roxana attempted to find the cause of the exceedances and determined that increasing vacuum to pull more gas increased oxygen and decreased methane percentages. In addition, Roxana has conducted inspections of LCR CO13 and found no indications of degradation to the collector's engineered components, visible emissions, cracked cover and/or dying vegetation. Roxana believes the high oxygen concentrations are due to the presence of liquid in LCR CO13.

In the October 15, 2013 letter, Roxana included a letter from EPA approving an alternative operating procedure approved for certain LCRs installed at Livingston Landfill in Illinois. Roxana would like to use the same operating procedure for LCR CO13 in lieu of disconnecting the collector.

EPA's Response on LCR CO13

According to Roxana, the engineered design and purpose of LCR CO13 is to convey liquids and provide a mechanism for inspection of the leachate collection system. Roxana connected LCR CO13 as a best management practice to control odors and the collector was not constructed or connected to the GCCS to meet the 500 ppm surface concentration limit in the NSPS. The constructed design of LCR CO13 includes a blind flange seal to prevent emissions to the atmosphere.

Since Roxana meets the criteria in the alternative operating procedure letter, EPA approves Roxana's use of the procedure for LCR CO13. Roxana should inform IEPA through the NSPS reporting process that LCR CO13 is operating under the approved operating procedure.

October 16, 2013 letter

Collector 8R

An oxygen exceedence occurred during the October 1, 2013 monitoring event. According to Roxana, the cause of the exceedance was a sag in the remote lateral causing it to hold liquid. Roxana believed the lateral needed to be re-graded or replaced depending on the depth and location of the sag which would be determined during further investigation. Roxana requested 60 days from the date of its letter, until December 15, 2013, to determine what repairs were needed and to return the well to compliance.

EPA's Response on Collector 8R

EPA will approve your request because the replacement of a lateral may be one of those situations that require more than 15 days to complete. However, in your future requests, we ask that you follow the guidelines outlined on pages 2-3 of this letter by providing a detailed narrative discussion of the intended corrective measures and the amount of time estimated to accomplish the corrections as well as an explanation of why the corrective actions could not be completed within 15 days.

Collector 22R2

An oxygen exccedance occurred during the October 1, 2013 monitoring event. Corrective actions including well head adjustments to close the valve to prevent air intrusion, well field balancing and inspections of the well head and casing were made within five days of the initial exceedance. Roxana stated that the exceedances were caused by collectors in the area influencing Collector 22R2. You believed that additional time would remedy the situation and requested 60 days from the date of your letter, until December 15, 2013, to allow the well to return to compliance.

EPA's Response on Collector 22R2

Your request for an alternative compliance timeline until December 15, 2013 is denied. As noted previously, an alternative timeline request must identify the problem and contain a detailed narrative discussion of the intended corrective measures and the amount of time estimated to accomplish the correction. In addition, the request must contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be corrected within the prescribed timeframe allowed in the rule. Your letter basically requests a waiting period for the well to return to compliance on its own, which is insufficient.

We trust that by this time, Roxana has corrected the exceedances at Collector 22R2. EPA will not approve alternative compliance timelines retroactively for wells that have returned to compliance.

October 31, 2013 letter

This letter pertains to Well 208. Well 208 exhibited a temperature of 136 degrees F on October 17, 2013. Corrective actions were taken within 5 days but the well's temperature measured 135 degrees F on October 29, 2013. Roxana stated that due to the gas quality generated by the nature of the wastes at or near the well's location, the well has experienced intermittent temperatures minimally above the 131 degrees F threshold. On July 29, 2013, a carbon monoxide sample was analyzed, indicating a concentration of 100 ppm. Roxana stated that the site was continuing to gather information to determine if a higher operating value (HOV) request should be submitted. Roxana asked for 60 days from the date of its letter, until December 31, 2013 to submit the HOV request, take additional CO samples and continue to make adjustments to the well.

EPA's Response on Well 208

Your request for an alternative compliance timeline until December 31, 2013 is denied. The rule does not provide alternative timelines for diagnosing or identifying the cause of the exceedance or to take time to write a letter. Therefore, no alternative timelines requests can be approved if the root cause of the exceedance has not been determined. In addition, an alternative compliance timeline request letter must identify the problem and provide substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be corrected within the prescribed timeframe allowed in the rule (15 days).

We trust that by this time, Roxana has corrected the exceedances at this well. EPA will not approve alternative compliance timelines retroactively for wells that have returned to compliance.

December 6, 2013 letter

This letter pertains to Well 205R and Well 107R. Well 107R was addressed previously in this letter.

Regarding Well 205R, a positive pressure of 38.40 inches of water was recorded during the November 22, 2013 monitoring event. Corrective actions consisting of well adjustments were made and inspections of the well head and casing were made within 5 days. According to Roxana, the exceedance was due to a pinched vacuum line from active filling in the area. Roxana planned a camera investigation to determine the severity of the pinch and confirm what repairs were needed. Roxana requested 90 days from the date of its letter, until March 6, 2014, to return Well 205R to compliance.

EPA's Response on Well 205R

Your request for an alternative timeline until March 6, 2014 is denied. As noted previously, an alternative timeline request must identify the problem and contain a detailed narrative discussion of the intended corrective measures and the amount of time estimated to accomplish the correction. In addition, the request must contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be corrected within the prescribed timeframe allowed in the rule (15 days).

If you have any questions regarding this letter, feel free to contact Linda H. Rosen, of my staff, at (312) 886-6810, or rosen.linda@epa.gov.

Sincerely,

Sara Breneman

Sara Brenemann
Chief
Air Enforcement and Compliance Assurance Branch

cc: Eric Jones, Acting Manager
Bureau of Air – Compliance and Enforcement Section
Illinois Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

APR - 3 2014

REPLY TO THE ATTENTION OF:

RECEIVED
APR 15 2014
By

Roderic S. Stipe, CHMM, QEP
District Manager
Waste Management of Illinois, Inc.
Closed Site Management Group
720 East Butterfield Road
Lombard, Illinois 60148

Re: Settler's Hill Recycling & Disposal Facility/Midway Landfill
Request for Alternative Compliance Timeline
Wells S189R, M006, M022, M026, M045, and M047

Dear Mr. Stipe:

Thank you for your February 5 and March 5, 2014 letters to the U.S. Environmental Protection Agency, requesting alternative compliance timelines for several wells at Settler's Hill Recycling and Disposal Facility and the Midway Landfill (Settler's Hill/Midway Landfill), co-located in close proximity to each other in Geneva Township, Kane County, Illinois.

The Settler's Hill/Midway Landfill is subject to the New Source Performance Standards for Municipal Solid Waste Landfills, 40 C.F.R. Part 60, Subpart WWW. The Waste Management of Illinois, Inc. (WMIL) letters request alternative timelines to correct operational parameter exceedances at the following wells: S189R, M006, M022, M026, M045, and M047.

Regulatory Background

Under the provisions of 40 C.F.R. § 60.753(a), an owner or operator of a landfill subject to 40 C.F.R. Part 60, Subpart WWW is required to operate a gas collection and control system (GCCS) where waste has been in place for five years or more in active areas or where waste has been in place for two years or more in closed areas that have reached final grade. A number of operating limits for wellheads in the GCCS are specified in 40 C.F.R. § 60.753(b) and 60.753(c). These provisions require that wellheads are operated under negative pressure (except in special circumstances), with a landfill gas temperature less than 55 degrees Celsius (131 degrees F) and with either a nitrogen level less than 20 percent or an oxygen level less than 5 percent.

Per 40 C.F.R. § 60.755(a), an owner or operator of a GCCS subject to these operational limits is required to monitor wellhead pressure, temperature and gas composition on a monthly basis. If an exceedance of any of the operating limits in the rule is noted, the owner or operator must initiate action to correct the exceedance within 5 days. If the exceedance cannot be corrected within 15 days, the gas collection system must be expanded to correct the exceedance within 120 days of the initial exceedance. However, an alternative timeline for correcting the exceedance can be requested from the Administrator for approval.

EPA Guidance on Alternative Timeline Requests

The Settler's Hill/Midway letters request alternative timelines to correct oxygen and pressure exceedances. Prior to addressing these requests specifically, EPA would like to provide background information to you regarding how alternative compliance timeline requests will be processed. This information should inform you in making decisions regarding when and how to make such requests.

As outlined above, the rule requires landfill owners and operators to repair the cause of an operating parameter exceedance within 15 days or to expand the gas collection system within 120 days. In the event that the landfill owner or operator, despite its best efforts, is unable to make the necessary repairs to resolve the exceedance within 15 days, and it believes that an expansion of gas collection is unwarranted, the landfill owner or operator may submit for approval an alternative timeline for correcting the exceedance. In such circumstances, the landfill owner or operator needs to make such a submittal as soon as possible (i.e. as soon as it knows that it will not be able to correct the exceedance in 15 days and it is unwarranted to expand the gas collection system) to avoid being in violation of the rule. Landfill owners or operators should submit an alternative timeline request as soon as possible and communicate the reasons for the exceedance, results of the investigation, and schedule for corrective action.

Similarly, if a landfill owner or operator intends to correct an exceedance through gas collection expansion and, despite its best efforts, is unable to complete the expansion project within 120 days, the landfill owner or operator may submit a request for an alternative timeline. A landfill owner or operator should submit the request as soon as it determines that it cannot meet the 120 day deadline to avoid being in violation of the rule.

EPA believes the timeframes and methods required to address exceedances provided for in the rule are sufficient to correct the vast majority of identified exceedances without an alternative timeline. Each situation and request is unique and it is difficult to prescribe what information must be included in a specific request; however, EPA expects that, at a minimum, a request shall include[1]:

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[1] Ohio Environmental Protection Agency. *Alternative Timeline Requests for Correcting an Exceedance of Temperature, Oxygen or Nitrogen, or Positive Pressure at Landfill Gas Collection Wells, DAPC Engineering Guide #78, DSIWM Guidance Document #1001.* Columbus, Ohio, Ohio Environmental Protection Agency, December 2010.

- the operating parameter that has exceeded the regulatory limit;
- the date that the exceedance was initially detected;
- a detailed narrative discussion of all steps taken by the landfill owner or operator to correct the exceedance within the 15 day period;
- an explanation of why, despite the best efforts of the landfill owner or operator, the corrective action/repair work selected by the landfill owner or operator could not be implemented within 15 days and why the exceedance could not otherwise be corrected within 15 calendar days;
- a summary of the historical data for the well in question (should include a minimum of 6 months of past data, construction specifications for the well, description of the cover in the area, the age and type of waste, and any other information pertinent to the well);
- the following data collected at the well head:
  - temperature of the landfill gas,
  - percentage of the gas that is methane, oxygen, and CO_2,
  - gauge pressure;
- a detailed narrative discussion of the intended corrective measure and the amount of time the owner or operator estimates it will take to accomplish the correction;
- a detailed justification of why the proposed alternative timeline represents the amount of time necessary to implement the proposed corrective action/repair;
- a detailed justification of why an expansion of the gas collection system is unwarranted (if applicable);
- a detailed narrative describing why complying with the timeframes provided for in the rule would result in (1) unreasonable cost of control resulting from plant age, location, or basic process design; (2) physical impossibility of installing necessary control equipment; or (3) other factors specific to the facility that make application of a less stringent compliance time significantly more reasonable.[2]

The request must promptly identify the problem, be very detailed, contain substantial reasons beyond the control of the facility owner or operator why the exceedances could not and cannot be completed within the prescribed timeframe allowed in the rule, and not be based upon superfluous rationale.

Note that the rule does not provide alternative timelines for diagnosing or identifying the cause of the exceedance or to take time to write a letter. Therefore, no alternative timelines requests can be approved if the root cause of the exceedance has not been determined. If the alternative being requested is already included or offered in the NSPS as an alternative, then there is no need to request this approval from EPA (or its delegate) on an individual basis.

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[2] United States Environmental Protection Agency. *Enabling Document for the New Source Performance Standards and Emission Guideline for Municipal Solid Waste Landfills, EPA -453R/96-004.* Office of Air Quality Planning Standards, Research Triangle Park, NC, February 1999.

Settler's Hill/Midway's Request for S189R

Well S189R first exhibited a higher oxygen value of 18.5 percent on January 21, 2014. After adjustments failed, facility personnel visually inspected the well, the wellhead, the vacuum riser, and the landfill cover in the vicinity of the well but found no apparent reason for the air infiltration. At this point, senior landfill gas management personnel inspected the well and reviewed its monitoring history and, based on similar experiences, speculated that a break may have occurred in the vacuum riser serving the well. It was suspected that a 90 degree elbow where the lateral becomes the vertical, may have separated or cracked. In early February, WMIL personnel planned to use a cable-fed camera to inspect the vacuum riser pipe to determine if this hypothesis could be confirmed.

WMIL stated that if it was determined that the riser pipe had failed, corrective action would necessitate excavation. WMIL expected that the winter freeze would make it difficult to perform the excavation necessary to access the 90 degree elbow and to achieve the equipment performance specifications required to weld HDPE. Therefore, Settler's/Midway requested an alternative compliance timeline of 120 days or until May 21, 2014 to correct higher oxygen values at S189R.

EPA's Determination on S189R

As stated under the "EPA Guidance" section of this letter, the rule does not provide alternative timelines for diagnosing or identifying the cause of the exceedance. Therefore, no alternative timelines requests can be approved if the root cause of the exceedance has not been determined.

EPA does not believe your letter sufficiently identifies a root cause of the oxygen exceedance at S189R. Therefore your request for an alternative timeline is denied. If you have further information at this point to identify the reason for the air infiltration, EPA would be happy to re-consider your request. EPA suggests that in the future, any necessary camera inspections be done sooner in the process of diagnosing problems so that a definitive diagnosis can be made within 15 days of an exceedance.

Settler's Hill/Midway Request M006, M022, M026, M045 and M047

These wells exhibited positive pressure on February 18 and 19, 2014. You determined that the cause of the positive pressure was frozen condensate that had accumulated in two of several sumps used to collect liquid from the system piping. Ice blockage in the hose lines slowed liquid removal and accumulating liquid froze in the sump preventing the vacuum flow from being distributed through some header pipes.

WMIL believes that once ambient temperatures rise above freezing for a few days (less than one week), enough ice will melt to allow the remaining ice to be cleared from the hoses and check valves to restore pump operations. Settler's Hill/Midways is requesting

30 days, until April 4, 2014, to remove the ice from the frozen sumps and bring wells M006, M022, M026, M045, and M045 back to a negative pressure condition.

EPA's Determination on M006, M022, M026, M045, and M045

EPA considers your request reasonable. EPA will grant you an alternative timeline to bring the subject wells into compliance. The alternative timeline will expire within 5 consecutive days of the average temperature being above 32 degrees Fahrenheit, or April 4, 2014, whichever comes first. If the problem persists, the facility may be in violation.

If you have any questions about this letter, please contact Ms. Linda H. Rosen, of my staff, at (312) 886-6810, or at rosen.linda@epa.gov.

Sincerely,

Sara Brenemann

Sara Brenemann
Chief
Air Enforcement and Compliance Assurance Branch

cc: Eric Jones, Manager
Bureau of Air – Compliance Unit
Illinois Environmental Protection Agency

Northern Recycling
Zamora Compost Facility

Baseline Air Emissions Assessment

Air Emissions Source Test

Evaluation of Complete Compost Cycle VOC and Ammonia Emissions

Report

Revision 2

May 2009

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Executive Summary

This report documents the completed project of assessing baseline air emissions for the new Northern Recycling greenwaste composting facility located near Zamora, California. This report contains the results of two sampling events. The first event was completed in October 2008 and included winery waste in the compost mix. The second event was completed in April 2009 with no winery waste present. USEPA flux chamber samples were taken from actual compost operations to provide unit emissions data that were used to complete the calculation of full scale annual emissions for VOC and ammonia. All sampling and analysis were completed in compliance with the source test protocol document previously submitted to Yolo-Solano APCD.

Emissions were calculated based on a simulation of a full 80 day compost cycle by sampling key process days and interpolating the emissions between those days. Three mixing cycle events were sampled during the first event and mixing was found to be a significant contributor to emissions.

Table ES-1a and ES-1b summarizes the results of this baseline emissions assessment. The measured compost emission factor for compost with winery waste of 16.55 # VOC per ton of composting material is substantially higher than the most comparable previously measured values (5.65 # and 6.3 # VOC per ton compost mix) reported by the San Joaquin Valley APCD (see Table ES-2). The factor without winery waste was 10.03 # VOC per ton of compost mix.

Total site emissions for VOC were 3,030 tons per year with about two thirds of that attributed to the emissions from the feedstock stockpile for compost with winery waste. Total site emissions for VOC were 1,070 tons per year with about one half of that attributed to the emissions from the feedstock stockpile for compost without winery waste. The annual emissions calculations were based on 100,000 tons per year of throughput. No attempt was made in this report to prorate actual annual emissions based on the presence or absence of winery waste.

A concern about this data set are the extremely low ammonia emissions from Event 1 when winery waste was present. The emissions on this site are over an order of magnitude lower than comparable facilities. Most of the ammonia samples were below the method detection limit. The method detection limit for ammonia for this project was typically between 0.2 and 0.4 mg/m3. These are very low detection limits, about a factor of three lower than most SCAQMD Method 207.1 method detection limits. No other comments or explanations are offered for this with the exception that the ammonia sampling and analysis was in full compliance with the QA/QC program and the laboratory samples agreed with the field screening samples. The ammonia emissions without winery waste, however, were essentially the same as other greenwaste compost facilities.

Table ES-1a. – Calculated VOC and NH3 emissions from the feedstock storage, compost cycle, and finished product storage (with winery waste).

		VOC		Ammonia	
Source	**Mass on Site (tons)**	**Emission Factor (pounds/ton)**	**Total Emissions (Tons/year)**	**Emission Factor (pounds/ton)**	**Total Emissions (Tons/year)**
Feedstock Storage	27,000	44.03	2,201	0.017	0.94
Composting	20,000	16.55	828	0.011	0.573
Product Storage	3,000	0.02	1.2	0.0004	0.014
Total	50,000		3,030		1.52
Overall Emission Factor (#/ton)		60.61		0.030	

Table ES-1b. – Calculated VOC and NH3 emissions from the feedstock storage, compost cycle, and finished product storage (without winery waste).

		VOC		Ammonia	
Source	**Mass on Site (tons)**	**Emission Factor (pounds/ton)**	**Total Emissions (Tons/year)**	**Emission Factor (pounds/ton)**	**Total Emissions (Tons/year)**
Feedstock Storage	27,000	11.34	567	1.643	89.93
Composting	20,000	10.03	502	0.445	22.236
Product Storage	3,000	0.02	1.2	0.0004	0.014
Total	50,000		1,070		112.18
Overall Emission Factor (#/ton)		21.40		2.244	

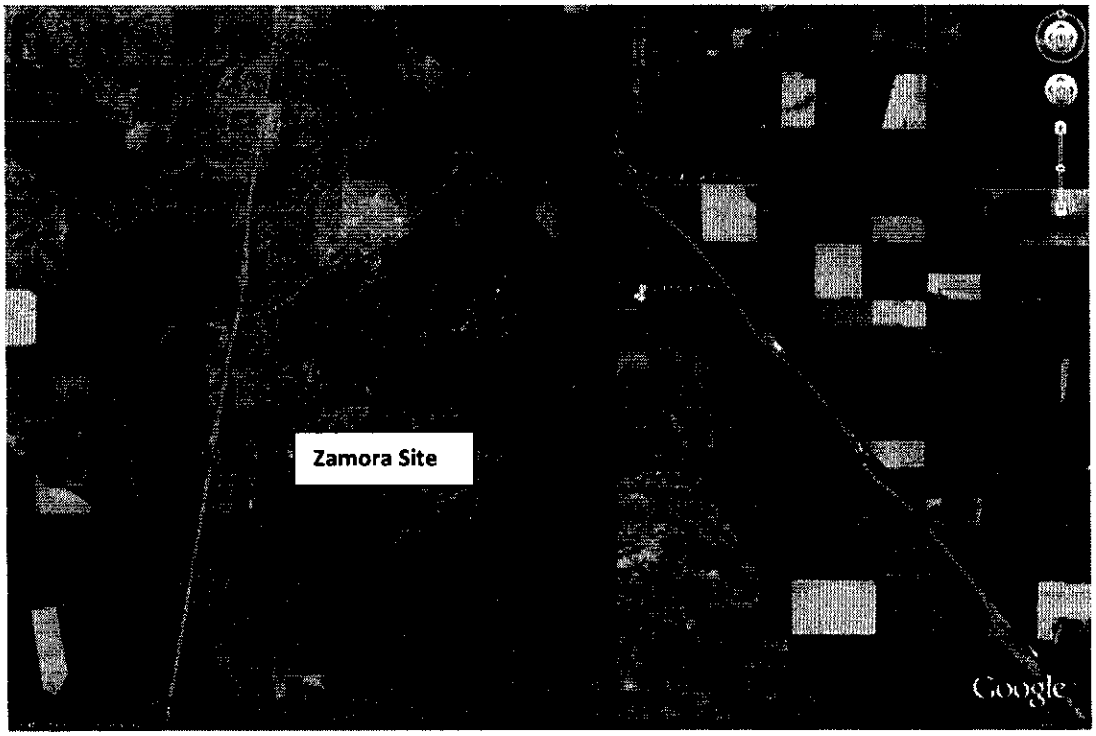
Table ES-2. – Comparative greenwaste compost emissions (from SJVAPCD).

			VOC							NH3						
			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)			EF	Unit Flux (mg/min-m2)			Unit Flux (#/hr-1,000ft2)		
Location	Material	Activity	(#/ton)	Peak	Avg	Min	Peak	Avg	Min	(#/ton)	Peak	Avg	Min	Peak	Avg	Min
Site X	Landscape Waste	Stockpiles	7.76	186	111	37	2.30	1.38	0.46	0.03	0.62	0.39	0.16	0.01	0.00	0.002
		Windrows	6.30	23	11	3	0.29	0.13	0.04	2.34	26.56	12.07	0.20	0.33	0.15	0.003
		Total	14.06							2.37						
CIWMB Modesto		Windrows	1.54	42	9	0.1	0.51	0.11	0.001							
NorCal		Stockpiles	2.95	110	54	4	1.36	0.66	0.046	0.08	2.1	1.21	0.61	0.03	0.01	0.008
		Windrows	5.65	376	73	1	4.65	0.90	0.010	0.54	7.29	1.68	0.22	0.09	0.02	0.003
		Total	8.60							0.62						
CIWMB TV		Mix HCN		124	42	2	1.53	0.52	0.02							
		Mix LCN		443	110	1	5.48	1.36	0.02							
		UnMix HCN		23	6	1	0.28	0.07	0.01							
		UnMix LCN		38	10	1	0.47	0.13	0.01							
SCAQMD Inland Summer		Stockpiles	4.75		24			0.30		0.01		6.55			0.081	
		Windrows	0.3		6			0.08		1.31		0.32			0.004	
		Total	5.05							1.32						
SCAQMD Inland Winter		Stockpiles	1.96		20			0.25		0.29		2.67			0.033	
		Windrows	0.5		6			0.08		0.03		0.32			0.004	
		Total	2.47							0.32						

1.0 Introduction

This project directly measured the VOC and ammonia air emissions from greenwaste composting to develop a baseline air emissions value for a full compost/cure cycle plus feedstock and product storage. All compost operations were located at the Northern Recycling Compost Facility in Zamora, CA as shown in Figure 1.1.

Figure 1.1 Site Vicinity Map



2.0 Process Description and Sampling

This is a new compost facility that composts greenwaste material into a high value landscaping material. Compost is received in a stockpile. The stockpiled material is then ground and placed into windrows. The windrows are mechanically mixed approximately 20 times during an 80 day composting cycle. The windrows are then broken down and screened into the final product. The site is permitted to have a total of 50,000 tons of material on site. Table 2.1 shows the amount of material assumed to be on site for the baseline emissions assessment.

Table 2.1 Amount of Material Assumed to be on Site for Baseline Emissions Estimate

Material	Total Tons on Site
Feedstock Storage	27,000
Composting	20,000
Product Storage	3,000
Total Tons	50,000

The sampling and analysis was conducted in compliance with the document entitled PROTOCOL FOR FLUX CHAMBER SOURCE TESTING OF FUGITIVE AIR EMISSIONS FROM THE NORTHERN RECYCLING COMPOST (NRC) ZAMORA FACILITY, plus a supplemental protocol for the second event, that was previously submitted to the Yolo-Solano APCD.

All sampling took place between October 28 and 30, 2008 for the first event (compost with winery waste) and on April 12, 2009 (compost without winery waste). All surface samples were taken using USEPA Surface Isolation Emission Flux Chamber technology per the source test protocol. Total VOC was analyzed per SCAQMD Method 25.3 and ammonia was measured per SCAQMD Method 207.1. The technical memorandum in Appendix C presents a summary of data validation, project documentation, and laboratory methods used for this project.

The following compost operations were sampled:

Event 1

1. Incoming feedstock (12 samples)
2. Compost Day 1 (4 samples)
3. Compost Day 3 (4 samples)
4. Compost Day 3 Mixing Event (4 samples)
5. Compost Day 7 (4 samples)
6. Compost Day 15 (4 samples)
7. Compost Day 15 Mixing Event (4 samples)
8. Compost Day 29 (4 samples)
9. Compost Day 29 Mixing Event (4 samples)
10. Compost Day 63 (4 samples)
11. Finished product (4 samples)

Event 2

1. Incoming feedstock (4 samples)
2. Compost Day 1 (2 samples)
3. Compost Day 5 (4 samples)
4. Compost Day 8 (2 samples)
5. Compost Day 16 (2 samples)
6. Compost Day 31 (2 samples)

3.0 Sampling Results

Figure 3.1a presents of a summary of sampling results for Event 1. The appendix contains complete sampling data. Note that the vast majority of the ammonia data points had no ammonia detected. The typical ammonia detection limit for this project was between 0.2 and 0.4 mg/m^3.

Figure 3.1b presents a summary of sampling results for Event 2. This data was typical or previous greenwaste compost sampling events at other facilities.

Table 3.1a Summary of Event 1 sampling results (compost with winery waste).

SOURCE	TEST CONDITION	VOC Flux	NH3 Flux	COMMENT
Windrow- Day 1	T1	282	0.0131	**Windrow- Day 1**
Windrow- Day 1	T2	79.2	0.0130	
Windrow- Day 1	S1	136	0.0187	
Windrow- Day 1	Replicate	33.6	0.0174	Replicate
Windrow- Day 1	S2	11.2	0.0104	
Windrow- Day 3	T1	463	0.0219	**Windrow- Day 3**
Windrow- Day 3	T2	36.9	0.0227	
Windrow- Day 3	S1	16.1	0.0179	
Windrow- Day 3	S2	35.8	0.0232	
Windrow- Day 3	Post Mix, T1- Hour 0	1631	0.0232	Post Mix, T1- Hour 0
Windrow- Day 3	Post Mix, S1- Hour 0	742	0.0171	Post Mix, S1- Hour 0
Windrow- Day 3	Post Mix, T1- Hour 4	724	0.0187	Post Mix, T1- Hour 4
Windrow- Day 3	Post Mix, S1- Hour 4	254	0.0231	Post Mix, S1- Hour 4
Windrow- Day 7	T1	148	0.108	**Windrow- Day 7**
Windrow- Day 7	T2	764	0.0233	
Windrow- Day 7	S1	4.62	0.0418	
Windrow- Day 7	S2	1.81	0.0246	
Windrow- Day 15	T1	5.72	0.0332	**Windrow- Day 15**
Windrow- Day 15	T2	26.5	0.0401	
Windrow- Day 15	S1	2.36	0.0266	
Windrow- Day 15	S2	2.65	0.0236	
Windrow- Day 15	Replicate	1.30	0.0267	Replicate
Windrow- Day 15	Post Mix, T2- Hour 0	56.0	0.0244	Post Mix, T2- Hour 0
Windrow- Day 15	Post Mix, S2- Hour 0	6.82	0.0260	Post Mix, S2- Hour 0
Windrow- Day 15	Replicate	9.46	0.0246	Replicate
Windrow- Day 15	Post Mix, T2- Hour 4	40.1	0.0262	Post Mix, T2- Hour 4
Windrow- Day 15	Post Mix, S2- Hour 4	6.29	0.0222	Post Mix, S2- Hour 4
Windrow- Day 29	T1	0.454	0.0186	**Windrow- Day 29**
Windrow- Day 29	T2	1.10	0.0192	
Windrow- Day 29	S1	0.645	0.0151	
Windrow- Day 29	S2	0.381	0.00782	
Windrow- Day 29	Post Mix, T2- Hour 0	27.4	0.0301	Post Mix, T2- Hour 0
Windrow- Day 29	Post Mix, S1- Hour 0	4.39	0.0216	Post Mix, S1- Hour 0
Windrow- Day 29	Post Mix, T2- Hour 4	15.4	0.0369	Post Mix, T2- Hour 4
Windrow- Day 29	Post Mix, S1- Hour 4	3.95	0.0246	Post Mix, S1- Hour 4
Windrow- Day 63	T1	0.955	0.0141	**Windrow- Day 63**
Windrow- Day 63	T2	0.671	0.00994	
Windrow- Day 63	S1	0.223	0.0108	
Windrow- Day 63	S2	0.507	0.0137	
Tipping- Old	T1	6.91	0.0290	**Tipping- Old**
Tipping- Old	T2	1.33	0.0229	
Tipping- Old	T3	7.10	0.0241	
Tipping- Old	T4	7.54	0.0204	
Tipping- Middle Age	T1	3.82	0.0387	**Tipping- Middle Age**
Tipping- Middle Age	T2	6.97	0.529	
Tipping- Middle Age	T3	3.13	0.0702	
Tipping- Middle Age	Replicate	2.61	0.0718	Replicate
Tipping- Middle Age	T4	2.40	0.272	**Tipping- New**
Tipping- New	T1	308	0.0399	
Tipping- New	T2	163	0.0452	
Tipping- New	T3	882	0.0202	
Tipping- New	Replicate	848	0.0302	Replicate
Tipping- New	T4	743	0.0293	
Fresh Product- Day	T1	1.13	0.0123	**Fresh Product- Day 1**
Fresh Product- Day	T2	1.48	0.00687	
Aged Product- Day 6	S1	0.220	0.00876	**Aged Product- Day 60**
Aged Product- Day 6	S2	2.83	0.0400	
QC	Blank	0.139	0.00342	**QC- Blank**
QC	Blank	0.137	0.00342	
QC	Blank	0.112	0.00440	
QC	Blank	0.0929	0.00440	
QC	Blank	0.0736	0.00440	

Flux Unit: mg/m2,min-1

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4

Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO

Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3

Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow

Note 5- MDL value used for ND or non-detect for calculation purposes

Table 3.1b Summary of Event 2 sampling results (compost without winery waste).

SOURCE	TEST CONDITION	VOC	NH3	COMMENT
		Flux	Flux	
Tipping	Day 1, T1	166	16	Tipping Pile, Day 1
Tipping	Day 1, S1	14	6.7	Tipping Pile, Day 1
Tipping	Day 7, T1	17	5.7	Tipping Pile, Day 7
Tipping	Day 7, S1	7.8	4.3	Tipping Pile, Day 7
Tipping	Replicate	7.7	4.1	Replicate Sample
Compost	Day 1, S1	83	1.6	Day 1
Compost	Day 1, T1	27	0.26	Day 1
Compost	Day 5, S1	15	1.9	Day 5
Compost	Day 5, T1	242	13	Day 5
Compost	Day 8, S1	2.4	0.078	Day 8
Compost	Day 8, T1	157	2.5	Day 8
Compost	Day 8, S2	1.5	0.26	Day 8
Compost	Day 8, T2	131	5.0	Day 8
Compost	Day 16, S1	1.3	0.15	Day 16
Compost	Day 16, T1	9.4	2.56	Day 16
Compost	Day 31, S1	3.0	0.17	Day 31
Compost	Day 31, T1	1.0	0.17	Day 31
QC	Blank	0.025	0.0031	99.4% Recovery of helium tracer

Flux Unit: mg/m2,min-1

Note 1- Methane Flux = (CH4 ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 CH4

Note 2- TNMNEO Flux = (TNMNEO ppmv)(0.653)(m3/min)/0.13 = mg/m2,min-1 TNMNEO

Note 3- Ammonia Flux = (NH3 mg/m3)(m3/min)/(0.13 m2) = mg/m2,min-1 NH3

Note 4- Total Flow = (Helium %/Helium % recovered)(0.005 m3/min) = m3/min total flow

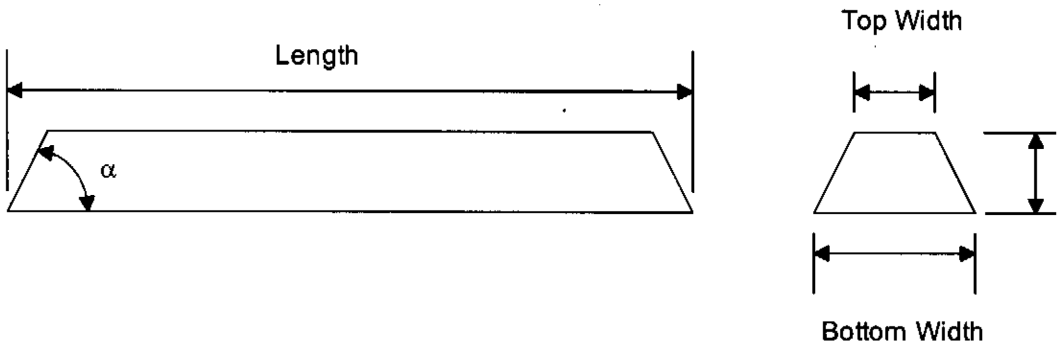
Note 5- MDL value used for ND or non-detect for calculation purposes

4.0 Emissions Calculations

4.1 Compost Pile Configuration

The windrow compost operation consisted of placing ground greenwaste feedstock in a windrow for 80 days. Figure 4.1 shows the typical windrow cross-section for windrow composting as well as the formulas used to compute volume and exposed surface area. Each windrow initially contained about 320 tons of material. Table 4.1 provides the windrow dimensions and calculations.

Figure 4.1. – Compost Windrow Configuration.



Mensuration formulas

$$S = \frac{p_1 + p_2}{2} s + A_2$$

$$V = \frac{h(A_1 + A_2 + \sqrt{A_1 A_2})}{3}$$

$$s = \sqrt{h^2 + ((W_B - W_T)/2)^2}$$

where S = total surface area, p_1 = bottom
perimeter, p_2 = top perimeter, s = slant height,
V=volume, h=vertical height, A_1 = bottom area,
A_2 = top area, α = bottom angle

Table 4.1. – Compost Windrow Dimensions and Calculations.

Property	Units	Value
Length	ft	455
Height	ft	4.5
Bottom Width	ft	14
Top Width	ft	7.0
Top Length	ft	448
alpha	R	0.91
	o	52
Top Perimeter	ft	910
Top Area	ft2	3,136
Bottom Perimeter	ft	938
Bottom Area	ft2	6,370
Slant height	ft	5.7
Surface Area	ft2	8,404
	m2	785
Volume	ft3	20,963
	yd3	776
Conversion Factors	ft2/m2	10.7
	ft3/yd3	27
Top Area Ratio		0.373173
Density	#/yd3	823
	#/ft3	30.5
Mass	#	638,990
	ton	319

4.2 Full Compost Cycle Simulation

The unit emission data was extended to estimate emissions from the full compost cycle using linear interpolation and averaging, as noted in Section 2, above.

Full cycle emissions for each day of the compost process, are then added and the sum of the individual daily emissions are totalized. Consistent with the approved protocol, the emission factor consists of the full total (in pounds) cycle emissions divided by the incoming feedstock weight (in tons). The full site emissions are then calculated be multiplying the annual throughput of material by this calculated emission factor. The simulation data tables are provided in the Appendix.

4.4 Simulated Emissions Profile

Figure 4.2 and 4.3 presents the full cycle emissions profile developed for VOC and ammonia. These emissions profiles were developed using a combination of data averaging and linear interpolation between the data points. The spikes on the graphs are due to mixing events. Three mixing events were measured and mixing was found to be a significant contributor to emissions.

Figure 4.2 Simulated VOC Emissions Profile (per windrow).

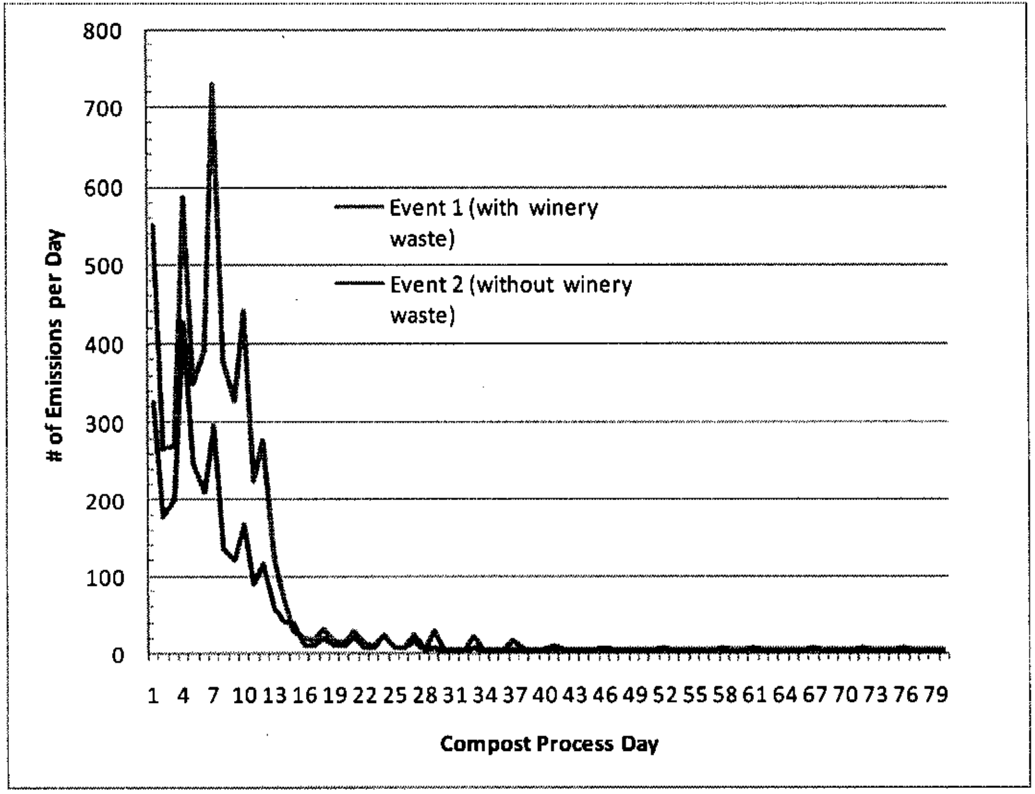
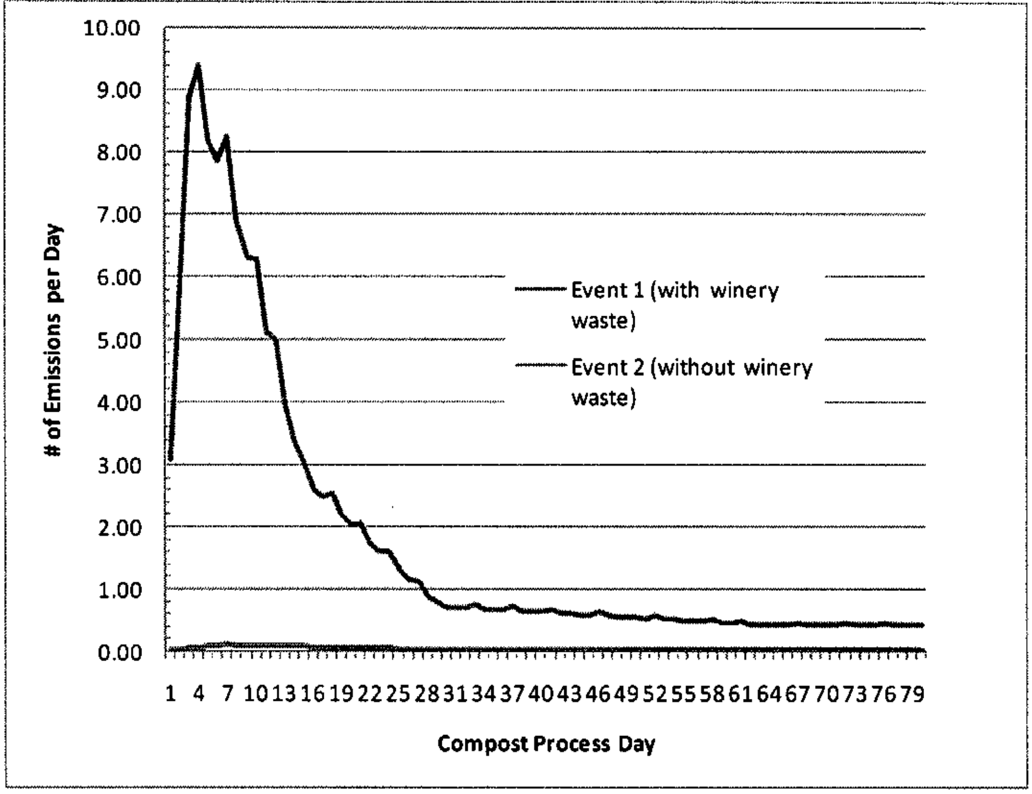


Figure 4.3 Simulated NH_3 Emissions Profile (per windrow).



4.5 Emissions from Feedstock and Product Storage

Table 4.2a, 4.2b, and 4.3 present the VOC and ammonia emission calculations while feedstock is being stored prior to windrowing and from finished compost product storage. The product emissions were assumed to be the same for the winery waste and non-winery waste compost product.

Table 4.2a. – Event 1 Feedstock emission calculations (with winery waste).

Mass	300	tons/day
Density	443	#/yd3
	16.4	#/ft3
Storage Duration	90	day
Total Tons Stored	27,000	tons
Pile Volume	121,896	yd3
	3,291,196	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	577	
Pile Width	300	
Pile Area	173,208	feet
Slant Height	28	
Pile Area	204,560	ft2
	19,118	m2

	VOC	NH3	
Unit Emissions	198.74	0.084	mg/min-m2
Total Emissions	5,471,153	2,326	gms/day
	12,063	5.1	pounds/day
	2,201	0.9	tons/year
Emission Factor	44.03	0.01709	pounds/ton

Table 4.2b. – Event 2 Feedstock emission calculations (without winery waste).

Mass	300	tons/day
Density	443	#/yd3
	16.4	#/ft3
Storage Duration	90	day
Total Tons Stored	27,000	tons
Pile Volume	121,896	yd3
	3,291,196	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	577	
Pile Width	300	
Pile Area	173,208	feet
Slant Height	28	
Pile Area	204,560	ft2
	19,118	m2

	VOC	NH3	
Unit Emissions	51.19	8.118	mg/min-m2
Total Emissions	1,409,351	223,497	gms/day
	3,107	492.8	pounds/day
	567	89.9	tons/year
Emission Factor	11.34	1.64254	pounds/ton

Table 4.3. – Finished product storage emission calculations (used for both winery and non-winery waste containing compost).

Mass	200	tons/day
Density	1123	#/yd3
	41.6	#/ft3
Storage Duration	15	day
Total Tons Stored	3000	tons
Pile Volume	5,343	yd3
	144,256	ft3
Pile shape	Frustrum	
Pile Height	20	feet
Pile Length	90	
Pile Width	100	
Pile Area	8,977	feet
Slant Height	28	
Pile Area	15,186	ft2
	1,419	m2

	VOC	NH3	
Unit Emissions	1.42	0.017	mg/min-m2
Total Emissions	2,894	35	gms/day
	6	0.08	pounds/day
	1	0.014	tons/year
Emission Factor	0.02	0.00038	pounds/ton

Appendix A

Full Cycle Simulation Table

Table A1a VOC Cycle Simulation Calculations for Event 1

Compost	Unit Flux (mg/min-m2)				UF	Area	Daily Emissions	
Day	Top	Side	Total	Mix	(mg/m-m2)	(m2)	(mg)	(#)
1	181	60	105	2.1	221	785	249,958,006	551
2	213	43	107	1	107	785	120,450,583	266
3	245	26	108	1	108	785	121,873,645	269
4	298	20	124	1.9	235	785	266,173,572	587
5	351	15	140	1	140	785	158,309,162	349
6	403	9	156	1	156	785	176,526,971	389
7	456	3	172	1.7	293	785	331,066,126	730
8	401	3	152	1	152	785	171,472,778	378
9	346	3	131	1	131	785	148,200,776	327
10	291	3	110	1.6	177	785	199,886,039	441
11	236	3	90	1	90	785	101,656,773	224
12	181	3	69	1.6	111	785	125,415,633	277
13	126	3	49	1	49	785	55,112,769	122
14	71	3	28	1	28	785	31,840,767	70
15	16	3	8	1.5	11	785	12,853,148	28
16	15	2	7	1	7	785	8,006,131	18
17	14	2	7	1	7	785	7,443,497	16
18	13	2	6	2	12	785	13,761,725	30
19	12	2	6	1	6	785	6,318,228	14
20	11	2	5	1	5	785	5,755,594	13
21	10	2	5	2.5	11	785	12,982,399	29
22	8	2	4	1	4.1	785	4,630,326	10
23	7	1	4	1	3.6	785	4,067,691	9
24	6	1	3	3	9.3	785	10,515,171	23
25	5	1	3	1	2.6	785	2,942,423	6
26	4	1	2	1	2.1	785	2,379,789	5
27	3	1	2	3.5	5.6	785	6,360,040	14
28	2	1	1	1	1.1	785	1,254,520	2.8
29	0.8	0.5	1	4.7	2.9	785	3,251,863	7.2
30	0.78	0.51	0.61	1	0.6	785	689,246	1.5
31	0.78	0.50	0.61	1	0.6	785	686,606	1.5
32	0.78	0.50	0.60	1	0.6	785	683,967	1.5
33	0.78	0.50	0.60	4	2.4	785	2,725,308	6.0
34	0.78	0.49	0.60	1	0.6	785	678,687	1.5
35	0.78	0.49	0.60	1	0.6	785	676,048	1.5
36	0.78	0.48	0.60	1	0.6	785	673,408	1.5
37	0.79	0.48	0.59	3	1.8	785	2,012,305	4.4
38	0.79	0.47	0.59	1	0.6	785	668,129	1.5
39	0.79	0.47	0.59	1	0.6	785	665,489	1.5
40	0.79	0.47	0.59	1	0.6	785	662,849	1.5
41	0.79	0.46	0.58	2	1.2	785	1,320,419	2.9
42	0.79	0.46	0.58	1	0.6	785	657,570	1.4
43	0.79	0.45	0.58	1	0.6	785	654,930	1.4
44	0.79	0.45	0.58	1	0.6	785	652,290	1.4
45	0.79	0.44	0.57	1	0.6	785	649,651	1.4
46	0.80	0.44	0.57	1.5	0.9	785	970,517	2.1
47	0.80	0.43	0.57	1	0.6	785	644,371	1.4
48	0.80	0.43	0.57	1	0.6	785	641,732	1.4
49	0.80	0.43	0.57	1	0.6	785	639,092	1.4
50	0.80	0.42	0.56	1	0.6	785	636,452	1.4
51	0.80	0.42	0.56	1	0.6	785	633,813	1.4
52	0.80	0.41	0.56	1.5	0.8	785	946,759	2.1
53	0.80	0.41	0.56	1	0.6	785	628,533	1.4
54	0.80	0.40	0.55	1	0.6	785	625,894	1.4
55	0.80	0.40	0.55	1	0.6	785	623,254	1.4
56	0.81	0.40	0.55	1	0.5	785	620,614	1.4
57	0.81	0.39	0.55	1	0.5	785	617,974	1.4
58	0.81	0.39	0.54	1.5	0.8	785	923,002	2.0
59	0.81	0.38	0.54	1	0.5	785	612,695	1.4
60	0.81	0.38	0.54	1	0.5	785	610,055	1.3
61	0.81	0.37	0.54	1.5	0.8	785	911,124	2.0
62	0.81	0.37	0.53	1	0.5	785	604,776	1.3
63	0.8	0.4	0.53	1	0.5	785	602,136	1.3
64	0.81	0.37	0.53	1	0.5	785	602,136	1.3
65	0.81	0.37	0.53	1	0.5	785	602,136	1.3
66	0.81	0.37	0.53	1	0.5	785	602,136	1.3
67	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
68	0.81	0.37	0.53	1	0.5	785	602,136	1.3
69	0.81	0.37	0.53	1	0.5	785	602,136	1.3
70	0.81	0.37	0.53	1	0.5	785	602,136	1.3
71	0.81	0.37	0.53	1	0.5	785	602,136	1.3
72	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
73	0.81	0.37	0.53	1	0.5	785	602,136	1.3
74	0.81	0.37	0.53	1	0.5	785	602,136	1.3
75	0.81	0.37	0.53	1	0.5	785	602,136	1.3
76	0.81	0.37	0.53	1.5	0.8	785	903,205	2.0
77	0.81	0.37	0.53	1	0.5	785	602,136	1.3
78	0.81	0.37	0.53	1	0.5	785	602,136	1.3
79	0.81	0.37	0.53	1	0.6	785	602,136	1.3
80	0.81	0.37	0.53	1	0.5	785	602,136	1.3
							Total Emissions	5,289
								16.55 #/Ton

Table A1a NH3 Cycle Simulation Calculations for Event 1

Compost	Unit Flux (mg/min-m2)				UF	Area	Daily Emissions	
Day	Top	Side	Total	Mix	(mg/m-m2)	(m2)	(mg)	(#)
1	0.01	0.01	0.01	1.1	0.02	785	17,391	0.04
2	0.02	0.02	0.02	1	0.02	785	19,897	0.04
3	0.02	0.02	0.02	1	0.02	785	23,985	0.05
4	0.03	0.02	0.03	1.1	0.03	785	33,880	0.07
5	0.04	0.03	0.03	1	0.03	785	37,615	0.08
6	0.05	0.03	0.04	1	0.04	785	44,431	0.10
7	0.07	0.03	0.05	1.1	0.05	785	56,370	0.12
8	0.06	0.03	0.04	1	0.04	785	48,999	0.11
9	0.06	0.03	0.04	1	0.04	785	46,752	0.10
10	0.05	0.03	0.04	1.1	0.04	785	48,956	0.11
11	0.05	0.03	0.04	1	0.04	785	42,258	0.09
12	0.05	0.03	0.04	1.1	0.04	785	44,013	0.10
13	0.04	0.03	0.03	1	0.03	785	37,765	0.08
14	0.04	0.03	0.03	1	0.03	785	35,518	0.08
15	0.04	0.03	0.03	1.1	0.03	785	36,598	0.08
16	0.04	0.02	0.03	1	0.03	785	31,996	0.07
17	0.03	0.02	0.03	1	0.03	785	30,720	0.07
18	0.03	0.02	0.03	1.1	0.03	785	32,390	0.07
19	0.03	0.02	0.02	1	0.02	785	28,170	0.06
20	0.03	0.02	0.02	1	0.02	785	26,894	0.06
21	0.03	0.02	0.02	1.1	0.02	785	28,181	0.06
22	0.03	0.02	0.02	1	0.02	785	24,344	0.06
23	0.03	0.02	0.02	1	0.02	785	23,069	0.05
24	0.02	0.02	0.02	1.1	0.02	785	23,973	0.05
25	0.02	0.02	0.02	1	0.02	785	20,518	0.05
26	0.02	0.01	0.02	1	0.02	785	19,243	0.04
27	0.02	0.01	0.02	1.1	0.02	785	19,764	0.04
28	0.02	0.01	0.01	1	0.01	785	16,692	0.04
29	0.02	0.01	0.01	1.1	0.01	785	16,958	0.04
30	0.02	0.01	0.01	1	0.01	785	15,367	0.03
31	0.02	0.01	0.01	1	0.01	785	15,318	0.03
32	0.02	0.01	0.01	1	0.01	785	15,269	0.03
33	0.02	0.01	0.01	1.1	0.01	785	16,742	0.04
34	0.02	0.01	0.01	1	0.01	785	15,171	0.03
35	0.02	0.01	0.01	1	0.01	785	15,122	0.03
36	0.02	0.01	0.01	1	0.01	785	15,072	0.03
37	0.02	0.01	0.01	1.1	0.01	785	16,525	0.04
38	0.02	0.01	0.01	1	0.01	785	14,974	0.03
39	0.02	0.01	0.01	1	0.01	785	14,925	0.03
40	0.02	0.01	0.01	1	0.01	785	14,876	0.03
41	0.02	0.01	0.01	1.1	0.01	785	16,309	0.04
42	0.02	0.01	0.01	1	0.01	785	14,777	0.03
43	0.02	0.01	0.01	1	0.01	785	14,728	0.03
44	0.01	0.01	0.01	1	0.01	785	14,679	0.03
45	0.01	0.01	0.01	1	0.01	785	14,630	0.03
46	0.01	0.01	0.01	1.1	0.01	785	16,038	0.04
47	0.01	0.01	0.01	1	0.01	785	14,531	0.03
48	0.01	0.01	0.01	1	0.01	785	14,482	0.03
49	0.01	0.01	0.01	1	0.01	785	14,433	0.03
50	0.01	0.01	0.01	1	0.01	785	14,384	0.03
51	0.01	0.01	0.01	1	0.01	785	14,334	0.03
52	0.01	0.01	0.01	1.1	0.01	785	15,714	0.03
53	0.01	0.01	0.01	1	0.01	785	14,236	0.03
54	0.01	0.01	0.01	1	0.01	785	14,187	0.03
55	0.01	0.01	0.01	1	0.01	785	14,138	0.03
56	0.01	0.01	0.01	1	0.01	785	14,089	0.03
57	0.01	0.01	0.01	1	0.01	785	14,039	0.03
58	0.01	0.01	0.01	1.1	0.01	785	15,389	0.03
59	0.01	0.01	0.01	1	0.01	785	13,941	0.03
60	0.01	0.01	0.01	1	0.01	785	13,892	0.03
61	0.01	0.01	0.01	1.1	0.01	785	15,227	0.03
62	0.01	0.01	0.01	1	0.01	785	13,793	0.03
63	0.0	0.0	0.01	1	0.01	785	13,744	0.03
64	0.01	0.01	0.01	1	0.01	785	13,744	0.03
65	0.01	0.01	0.01	1	0.01	785	13,744	0.03
66	0.01	0.01	0.01	1	0.01	785	13,744	0.03
67	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
68	0.01	0.01	0.01	1	0.01	785	13,744	0.03
69	0.01	0.01	0.01	1	0.01	785	13,744	0.03
70	0.01	0.01	0.01	1	0.01	785	13,744	0.03
71	0.01	0.01	0.01	1	0.01	785	13,744	0.03
72	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
73	0.01	0.01	0.01	1	0.01	785	13,744	0.03
74	0.01	0.01	0.01	1	0.01	785	13,744	0.03
75	0.01	0.01	0.01	1	0.01	785	13,744	0.03
76	0.01	0.01	0.01	1.1	0.01	785	15,119	0.03
77	0.01	0.01	0.01	1	0.01	785	13,744	0.03
78	0.01	0.01	0.01	1	0.01	785	13,744	0.03
79	0.01	0.01	0.01	1	0.01	785	13,744	0.03
80	0.01	0.01	0.01	1	0.01	785	13,744	0.03
							Total Emissions	4
								0.011 #/Ton

Table A1b VOC Cycle Simulation Calculations for Event 2

Compost	Unit Flux (mg/min-m2)				UF	Area	Daily Emissions	
Day	Top	Side	Total	Mix	(mg/m-m2)	(m2)	(mg)	(#)
1	27	83	62	2.1	131	785	147,843,960	326
2	81	66	72	1	72	785	80,987,316	179
3	135	49	81	1	81	785	91,572,747	202
4	188	32	90	1.9	172	785	194,100,537	428
5	242	15	100	1	100	785	112,743,608	249
6	210	11	85	1	85	785	95,912,037	211
7	177	6	70	1.7	119	785	134,436,791	296
8	144	2	55	1	55	785	62,248,894	137
9	127	2	49	1	49	785	55,076,966	121
10	111	2	42	1.6	68	785	76,648,060	169
11	94	2	36	1	36	785	40,733,109	90
12	77	2	30	1.6	47	785	53,697,889	118
13	60	2	23	1	23	785	26,389,252	58
14	43	1	17	1	17	785	19,217,324	42
15	26	1	11	1.5	16	785	18,068,093	40
16	9	1	4	1	4	785	4,873,467	11
17	9	1	4	1	4	785	4,717,702	10
18	8	2	4	2	8	785	9,123,874	20
19	8	2	4	1	4	785	4,406,173	10
20	7	2	4	1	4	785	4,250,408	9
21	7	2	4	2.5	9	785	10,236,608	23
22	6	2	3	1	3.5	785	3,938,879	9
23	5	2	3	1	3.3	785	3,783,114	8
24	5	2	3	3	9.6	785	10,882,048	24
25	4	2	3	1	3.1	785	3,471,585	8
26	4	2	3	1	2.9	785	3,315,820	7
27	3	3	3	3.5	9.8	785	11,060,193	24
28	3	3	3	1	2.7	785	3,004,291	6.6
29	2	3	3	4.7	11.8	785	13,388,072	29.5
30	2	3	2	1	2.4	785	2,692,761	5.9
31	1.04	2.96	2	1	2.2	785	2,536,997	5.6
32	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
33	1.04	2.96	2.24	4	9.0	785	10,147,986	22.4
34	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
35	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
36	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
37	1.04	2.96	2.24	3	6.7	785	7,610,990	16.8
38	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
39	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
40	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
41	1.04	2.96	2.24	2	4.5	785	5,073,993	11.2
42	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
43	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
44	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
45	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
46	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
47	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
48	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
49	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
50	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
51	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
52	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
53	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
54	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
55	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
56	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
57	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
58	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
59	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
60	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
61	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
62	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
63	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
64	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
65	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
66	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
67	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
68	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
69	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
70	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
71	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
72	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
73	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
74	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
75	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
76	1.04	2.96	2.24	1.5	3.4	785	3,805,495	8.4
77	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
78	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
79	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
80	1.04	2.96	2.24	1	2.2	785	2,536,997	5.6
							Total Emissions	3,205
								10.03 #/Ton

Table A1b NH3 Cycle Simulation Calculations for Event 2

Compost Day	Unit Flux (mg/min-m2)			Mix	UF (mg/m-m2)	Area (m2)	Daily Emissions	
	Top	Side	Total				(mg)	(#)
1	0	2	1.13	1.1	1.24	785	1,406,757	3.10
2	3	2	2.35	1	2.35	785	2,657,139	5.86
3	7	2	3.57	1	3.57	785	4,035,408	8.90
4	10	2	3.43	1.1	3.77	785	4,263,343	9.40
5	13	2	3.29	1	3.29	785	3,716,125	8.19
6	10	1	3.14	1	3.14	785	3,556,483	7.84
7	7	1	3.00	1.1	3.30	785	3,736,525	8.24
8	4	0	2.77	1	2.77	785	3,128,743	6.90
9	4	0	2.53	1	2.53	785	2,860,644	6.31
10	3	0	2.29	1.1	2.52	785	2,851,800	6.29
11	3	0	2.06	1	2.06	785	2,324,447	5.12
12	3	0	1.82	1.1	2.00	785	2,261,983	4.99
13	3	0	1.58	1	1.58	785	1,788,249	3.94
14	3	0	1.34	1	1.34	785	1,520,151	3.35
15	3	0	1.11	1.1	1.22	785	1,377,257	3.04
16	3	0	1.05	1	1.05	785	1,185,635	2.61
17	2	0	0.99	1	0.99	785	1,119,218	2.47
18	2	0	0.93	1.1	1.02	785	1,158,081	2.55
19	2	0	0.87	1	0.87	785	986,384	2.17
20	2	0	0.81	1	0.81	785	919,967	2.03
21	2	0	0.75	1.1	0.83	785	938,905	2.07
22	2	0	0.70	1	0.70	785	787,133	1.74
23	1	0	0.64	1	0.64	785	720,715	1.59
24	1	0	0.58	1.1	0.64	785	719,728	1.59
25	1	0	0.52	1	0.52	785	587,881	1.30
26	1	0	0.46	1	0.46	785	521,464	1.15
27	1	0	0.40	1.1	0.44	785	500,552	1.10
28	1	0	0.34	1	0.34	785	388,630	0.86
29	0	0	0.28	1.1	0.31	785	354,434	0.78
30	0	0	0.28	1	0.28	785	318,295	0.70
31	0.17	0.17	0.28	1	0.28	785	314,376	0.69
32	0.17	0.17	0.27	1	0.27	785	310,458	0.68
33	0.17	0.17	0.27	1.1	0.30	785	337,194	0.74
34	0.17	0.17	0.27	1	0.27	785	302,621	0.67
35	0.17	0.17	0.26	1	0.26	785	298,703	0.66
36	0.17	0.17	0.26	1	0.26	785	294,785	0.65
37	0.17	0.17	0.26	1.1	0.28	785	319,953	0.71
38	0.17	0.17	0.25	1	0.25	785	286,948	0.63
39	0.17	0.17	0.25	1	0.25	785	283,030	0.62
40	0.17	0.17	0.25	1	0.25	785	279,111	0.62
41	0.17	0.17	0.24	1.1	0.27	785	302,712	0.67
42	0.17	0.17	0.24	1	0.24	785	271,275	0.60
43	0.17	0.17	0.24	1	0.24	785	267,356	0.59
44	0.17	0.17	0.23	1	0.23	785	263,438	0.58
45	0.17	0.17	0.23	1	0.23	785	259,520	0.57
46	0.17	0.17	0.23	1.1	0.25	785	281,162	0.62
47	0.17	0.17	0.22	1	0.22	785	251,683	0.55
48	0.17	0.17	0.22	1	0.22	785	247,765	0.55
49	0.17	0.17	0.22	1	0.22	785	243,847	0.54
50	0.17	0.17	0.21	1	0.21	785	239,928	0.53
51	0.17	0.17	0.21	1	0.21	785	236,010	0.52
52	0.17	0.17	0.21	1.1	0.23	785	255,301	0.56
53	0.17	0.17	0.20	1	0.20	785	228,173	0.50
54	0.17	0.17	0.20	1	0.20	785	224,255	0.49
55	0.17	0.17	0.19	1	0.19	785	220,337	0.49
56	0.17	0.17	0.19	1	0.19	785	216,418	0.48
57	0.17	0.17	0.19	1	0.19	785	212,500	0.47
58	0.17	0.17	0.18	1.1	0.20	785	229,440	0.51
59	0.17	0.17	0.18	1	0.18	785	204,663	0.45
60	0.17	0.17	0.18	1	0.18	785	200,745	0.44
61	0.17	0.17	0.17	1.1	0.19	785	216,509	0.48
62	0.17	0.17	0.17	1	0.17	785	192,908	0.43
63	0.17	0.17	0.17	1	0.17	785	188,990	0.42
64	0.17	0.17	0.17	1	0.17	785	188,990	0.42
65	0.17	0.17	0.17	1	0.17	785	188,990	0.42
66	0.17	0.17	0.17	1	0.17	785	188,990	0.42
67	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
68	0.17	0.17	0.17	1	0.17	785	188,990	0.42
69	0.17	0.17	0.17	1	0.17	785	188,990	0.42
70	0.17	0.17	0.17	1	0.17	785	188,990	0.42
71	0.17	0.17	0.17	1	0.17	785	188,990	0.42
72	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
73	0.17	0.17	0.17	1	0.17	785	188,990	0.42
74	0.17	0.17	0.17	1	0.17	785	188,990	0.42
75	0.17	0.17	0.17	1	0.17	785	188,990	0.42
76	0.17	0.17	0.17	1.1	0.18	785	207,889	0.46
77	0.17	0.17	0.17	1	0.17	785	188,990	0.42
78	0.17	0.17	0.17	1	0.17	785	188,990	0.42
79	0.17	0.17	0.17	1	0.17	785	188,990	0.42
80	0.17	0.17	0.17	1	0.17	785	188,990	0.42
							Total Emissions	142
								0.445 #/Ton

Appendix B
Photographs

Appendix C
Data Validation Technical Memorandum