SCS ENGINEERS







Air Modeling Report

Odor-Causing Substances

Western Regional Sanitary Landfill

Placer County, California

Presented to:

Western Placer Waste Management Authority (WPWMA)

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Auburn, California 95603
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September, 2007
File No. 01203013.04 Task 5

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1 INTRODUCTION

This Air Modeling Report of Odor-Causing Substances has been prepared by SCS Engineers (SCS) on behalf of Western Placer Waste Management Authority (WPWMA) at the Western Regional Sanitary Landfill (WRSL) in Placer County, California (the “project site”, Figure 1).

The report contained herein provides an air modeling assessment of non-methane organic compounds (NMOCs) and hydrogen sulfide (H_2S) for the existing municipal solid waste (MSW) landfill and the landfill gas (LFG) collection and control components (2 flares, 2 engines), and NMOCs, H_2S, and ammonia emissions from the composting facility to quantify potential odor impacts under current conditions. The H_2S and NMOC concentrations were then combined for the composing facility, the MSW landfill, and the LFG collection and control components to obtain a total emission rate for the entire site. Ammonia is not a LFG-derived contaminant, so it was only attributable to composting.

The United States Environmental Protection Agency’s (EPA’s) SCREEN3 air dispersion model was used to determine worst-case exposure point concentrations (EPCs) for several receptors located in the area surrounding the landfill. SCREEN 3 uses a number of conservative assumptions about the air dispersion that do not account for factors that can result in lower EPCs such as intermediate terrain or actual meteorological conditions. The model assumes the meteorological conditions that result in the highest downwind EPCs to simplify the model and to reduce the amount of model input required. As a result, the model tends to overestimate actual EPCs. The EPCs calculated for H_2S, ammonia, and several other NMOCs were then compared with their respective published odor thresholds in order to quantify the possibility of detection of offensive LFG and compost odors from the WRSL.

2 SITE DESCRIPTION AND HISTORY

WRSL is owned and operated by WPWMA. WRSL is located approximately 5.5 miles north-northeast of the city of Roseville, and encompasses an area of 291 acres, of which 231 acres are permitted for disposal activities. WRSL has been operating as a Class II and Class III Waste Management Unit (WMU), and consists of 14 modules (Figure 2). The Class II WMU is comprised of Modules 5, 6, 7, 8, 9, 14, 15, and 16. The Class III WMU is comprised of Modules 1, 2, 10, 11, 12, and 13. Modules 1 and 2 were closed in 1998, and Modules 10 and 11 were closed in 1999. Modules 5 through 9 and 16 are undeveloped.

Solid waste collected in western Placer County is processed at the WPWMA’s Material Recovery Facility (MRF). The MRF receives, separates, processes and markets recyclable materials removed from the waste stream. The facility also processes source separated wood waste, green waste, and inert materials.

Residual waste from the MRF is transported to the WRSL. WRSL is specified as a Class II/Class III non-hazardous site and a private firm, under contract with WPWMA, manages its operation. Hazardous waste from households and Conditionally Exempt Small Quantity Generators is accepted at the Permanent Household Hazardous Waste Facility (PHHWCF), located next to the MRF.

The WRSL's maximum permitted disposal is 1,900 tons per day and currently receives approximately 1,000 tons per day. Based on a 2007 capacity study, WRSL has a total capacity of 36,350,000 cubic yards, used capacity of 12,551,577cubic yards, and remaining capacity of 23,798,423cubic yards. Under current land use and development conditions, WRSL has a projected lifespan extending to 2036.

2.1 LANDFILL GAS COLLECTION AND CONTROL SYSTEM

The existing LFG collection, control, and monitoring system installed at WRSL consists of the following components:

- A system of 48 vertical extraction wells installed in the existing waste mass;
- A total of 8 test wells that are connected to the conveyance system to provide some additional coverage in Module 2;
- A system of 69 vertical extraction wells installed in native soils outside the limit of fill (perimeter system);
- A limited number of horizontal collectors installed in the existing waste mass (Module 13) to help control surface emissions;
- A system of lateral piping which connects the vertical wells and horizontal collectors to a main header system;
- Two main collection headers (one for the perimeter extraction system and one for the infill extraction system) which transports LFG to the blower/flare station;
- A total of 6 sumps for collection of condensate. Three are equipped with automated pumps and three are pumped manually. A 4,300-gallon condensate holding tank is located at the blower/flare station. Condensate is discharged into the public sewer system at the site;
- A blower/flare station with a current flare capacity of approximately 2,500 standard cubic feet per minute (scfm) and two blowers with a capacity of 1,200 scfm each. A 2,500 scfm condensate separator has been installed at the flare station. There is also a 3^{rd} blower with a capacity of 2,500 scfm and a 2^{nd} condensate separator with a capacity of 2,500 scfm;
- A LFG to energy plant that contains a small flare with a capacity of approximately 450 scfm, and two internal combustion engines with a flow rate of 2,149 actual cubic feet per minute (acfm) (Engine 1), and 2,189 acfm (Engine 2), based on actual stack data provided by a February 2007 source test.
- A network of 17 perimeter LFG monitoring probes.

LFG contains hydrogen sulfide, mercaptans, and other sulfur-containing compounds that low odor detection thresholds. LFG also contains several volatile organic compounds (VOCs) that also contribute to odor.

2.2 MATERIALS RECOVERY FACILITY (MRF) AND COMPOST FACILITY

The MRF is designed to recover recyclable materials (including newspaper, cardboard, metals, glass, plastics, green waste, and wood waste) from the trash to reduce the amount of material going to WRSL. The MRF operates under the solid waste facility permit number 31-AA-0001. The permitted area of the MRF includes 5.6 acres located within the WRSL boundary adjacent to the MRF's southern parcel boundary. The maximum tonnage allowed at the MRF is 1,750 tons per day, while the design capacity is 3,850 tons per day.

The MRF processing lines alone divert approximately 25 percent of the solid waste received. Combined with the source-separated wood waste, green waste, and inerts diversion programs, the facility as a whole diverts 35 - 40 percent of the waste received. The County's overall diversion rate, approved by the California Integrated Waste Management Board, is 65 percent.

The MRF is permitted to accept 1,750 tons and 1,014 vehicles per day. Based on current data, the MRF currently receives and processes approximately 1,100 tons per day. The composting facility operates in conjunction with the MRF to produce compost suitable for public use as topsoil amendment. A chipping and grinding operation is also conducted on this site.

Feedstock for the composting and chipping and grinding operations consist of source-separated green waste from commercial and residential haulers and green waste recovered from the MSW sorting process. The composting process is a turned windrow process. The turning provides aeration to minimize odors. The composting and chipping and grinding operations are conducted on concrete pads that were constructed to minimize ponding and graded to drain to properly designed drainage containment ponds. All existing finished product storage areas are concrete pads that drain to properly designed ponds. Drainage facilities are designed so that all contact water and leachate from the compost are directed to a compost retention basin. The facilities were constructed with 75,000 cubic yards of compost storage for processing and finished product storage capacity. Approximately 16,000 tons of feedstock per year is delivered to the composting facility.

Odors similar to LFG have been reported near the MRF. Presumably odors from the MRF are a result of sulfur compounds and VOCs similar to the compounds in LFG. Green waste processing and composting can also produce ammonia emissions, which is also an odorous emission.

3 LFG MODELING

The LFG generation rates for the current landfill for WRSL were estimated using the EPA's LFG Emissions Model (LandGEM). LandGEM calculates the LFG generation based on the waste placed for each year of operation, the decay rate (k), and the ultimate methane generation capacity of the waste (L_0). The waste placement data come from site records, and initial estimates of k and L_0 are based on the average annual rainfall at the site. The k and L_0 values can be further refined based on actual LFG recovery data. The final values of k and L_0 used to model LFG generation at WRSL were 0.05 $year^{-1}$ and 4,000 ft^3/ton, respectively. Complete modeling results are shown in Table 1.

The LFG generation rate is used to calculate the downwind EPCs with higher LFG generation rates resulting in higher EPCs.

4 DISPERSION MODELING FOR AIRBORNE CONCENTRATIONS OF ODOR CAUSING CONSTITUENTS

Emissions from each source (landfill surface, compost facility, 2 flares, and 2 engines) were calculated. Emissions are calculated based on concentrations of compounds found in landfill gas, the modeled LFG generation rates, and the destruction or generation of those compounds in flares and engines. These sources were chosen because they were determined to be likely sources of odor causing compounds. H_2S was considered as representative of LFG and MRF sources. Composting is also a minor contributor of H_2S emissions. Ammonia was considered to be a representative odor compound from composting and green wastes. The results of the emissions calculations are presented in Tables 2a through 2f. To calculate off-site atmospheric concentrations of H_2S, NMOCs, and/or ammonia for the compost facility, the landfill, the two flares, the two engines, and the combination of the six, the EPA-approved SCREEN3 air dispersion model was utilized. SCREEN3 was used to calculate EPCs for these parameters at specified points surrounding the landfill. SCREEN3 is a screening-level model that tends to conservatively overestimate ground level EPCs. Screening level models use conservative simplified inputs and calculations to calculate EPCs and do not use actual meteorological or terrain data. More complex models such as AERMOD are more complicated and time consuming to run and require much more input data, including much more detailed meteorological and terrain data. The default concentrations utilized in the SCREEN3 model are given in Appendix A.

For the air dispersion model, EPCs of H_2S, ammonia, and NMOCs as hexane concentrations were calculated for three different off-site receptors. The receptor distances are as follows:

Off-site Southern Receptor Location	1.52 miles south of landfill center	Southern Housing Development
Off-site Eastern Receptor Location	1.75 miles east of landfill center	Eastern Business Development
Off-site Northern Receptor Location	2.78 miles north of landfill center	Northern Housing Development

These off-site receptor locations represent the nearest residential and/or commercial developments located in the area surrounding the landfill. A description of the procedures of the model and how the model works is presented in Appendix A.

4.1 MODELING RESULTS SUMMARY

Based on the model, combined ammonia concentrations at each of the receptor locations did not exceed the odor threshold limits, showing that the human detection of this constituent may not occur at these locations. There is no odor threshold for total NMOCs, therefore, a comparison to levels known to cause odor cannot be made. However, comparisons were made for several individual compounds in NMOCs, and these were found well below their odor thresholds. The combined H_2S concentration at the northern housing development did not exceed the odor threshold limit (5.0×10^{-4} ppmv); however, the combined H_2S odor threshold limit was exceeded at the eastern and southern receptor locations, as detailed in Figure 4, showing that there is the potential of human detection of this compound at these receptor locations. The highest concentration of combined H_2S encountered at each receptor location is summarized below:

- Southern receptor location – 0.000726 ppmv
- Eastern receptor location – 0.000680 ppmv
- Northern receptor location – 0.000480 ppmv

The SCREEN3 model results are shown in Appendix A. Tables 3a through 3f detail the concentrations of selected compounds from each source at the receptor locations. Tables 4, 5, and 6 show the concentrations of selected compounds at the southern, eastern, and western receptor locations, respectively. Tables 4, 5, and 6 represent the additive emissions of all six sources, which would be considered the worst-case scenario. As shown on tables, the EPCs calculated for the various receptors are displayed in units of $\mu g/m^3$ and ppmv. For comparison purposes, Figures 3, 4, and 5 show H_2S, ammonia, and NMOC concentration profiles at each receptor location based on the results from the air dispersion model.

5 CONCLUSIONS

The modeling results for ammonia, NMOCs, and H_2S are summarized below. These results are predicted values using the conservative SCREEN3 model and are not based on ground level measurements of any compound.

5.1 AMMONIA

The combined ammonia concentration from composting at each receptor location is not expected to be detected by humans, as the ammonia concentrations (0.00352, 0.00301, and 0.00253 ppmv) are lower than the published odor threshold limit of 25 ppm. This does not mean that ammonia will not be detected by the residents and businesses surrounding the landfill. However, odor complaints due to ammonia are not expected. Composting can produce odors from volatile fatty acids and other chemicals as well; however, there are no emission factors or odor thresholds for these chemicals, which prevents any modeling and odor analysis.

5.2 NMOCS

The combined NMOC concentration from all NMOC sources at each receptor location (shown in Figure 5) is also not expected to be detected by humans; however, there is no published odor threshold for total NMOCs. . Figure 5 can be used to show where impacts from organics can be expected. While it is unlikely that any one NMOC will be found above its odor threshold (see Table 6), the combined effect of the total NMOCs could produce effects at the locations on Figure 5.

5.3 HYDROGEN SULFIDE

The combined H_2S from all emission sources at each receptor location summarized on Tables 4 through 6 were compared to the odor threshold for H_2S published by the ATSDR in July, 2006. The odor threshold for H_2S published in the ATSDR report is 0.0005 ppmv. The H_2S concentration at the eastern and southern receptor locations slightly exceeded the odor threshold limit, while the northern receptor location was slightly under the odor threshold. This suggests that odor detections of H_2S are possible at these locations or any other location at similar radii from the site (i.e., greater than 14,520 feet from landfill center).

For comparison purposes, the California chronic reference exposure level (REL) based on potential H_2S toxicity is 0.008 ppm while the acute REL is 0.030 ppm, which is based on an odor threshold. The EPA reference concentration (RFC) for long-term residential exposures (30 years) to H_2S is 0.00071 ppm as reported by the EPA in the Integrated Risk Information System (IRIS) database.

The Occupational Safety and Health Administration (OSHA) H_2S permissible exposure level (PEL) for workplace exposures is 20 ppm, with an allowance for a 50-ppm peak averaged over 10 minutes. The National Institute of Occupational Safety and Health (NIOSH) recommends an 8-hour time-weighted average of 10 ppm.

Please note, however, that the establishment of odor thresholds for chemicals is an inexact science. In most cases, the “offensiveness” of the odor is in the “eye of the beholder.” In a report to the California Air Resources Board, Amoore (1985) reviewed of 26 studies of H_2S odor thresholds and found that the average H_2S odor detection threshold ranged from 0.00007 to 1.4 ppm. The geometric mean of these studies is 0.008 ppm and a geometric standard deviation of 4 (CalEPA, 1999). This means that on average, the odor detection threshold for H_2S is actually higher than the one published in the ATSDR report. If this detection threshold was used for comparison purposes to this study, the concentration of H_2S at all receptor locations would be below the odor detection threshold, indicating that H_2S would not be detected by humans at these locations.

Based on the above information, it is clear that potential H_2S concentrations emitted from WRSL should not produce on- or off-site concentrations in excess of any risk-based or occupational standards for H_2S. The modeled concentrations were multiple orders of magnitude below these thresholds.

Based on review of published odor thresholds, H_2S concentrations at the southern and eastern receptor locations (and possibly to the north) may be detected a concentration slightly above the lowest published odor threshold for H_2S (0.0005 ppmv); however, the concentration of H_2S at these locations are well below the lowest reported odor threshold for other selected publications (0.0081 ppb - Amoore and Hautala, 1983; 0.01–0.3 ppm – Guidotti, 1994). Areas within the boundary for the odor threshold have the greatest chance for odor impacts

DEFAULT PARAMETERS AND PROCEDURES FOR AIR DISPERSION MODELING USING SCREEN3

SCREEN3 was utilized in regulatory default mode for the purposes of this report. The rural (R) terrain model was utilized since the project site is generally located in an undeveloped rural area. For landfill emission sources, the terrain was considered "simple" (i.e., the majority of the receptors are located at a lower elevation than the sources).

All receptors for the emissions were assumed to have a height of 1.5 meters, since it is the worst-case receptor height for surface modeling, which constitutes the majority of LFG emissions. Increasing the receptor height would significantly reduce surface emissions from the landfill and composting facility, while slightly increasing flare emissions. Therefore, total emissions from all sources would be reduced if a receptor height greater than 0.0 were used for surface, composting, and flare modeling.

Surface emissions from the landfill and compost areas were modeled as "area" sources in order to represent the fugitive emissions of LFG through the landfill surface, and compost emissions through the compost piles. The heights of the area sources were assumed to be halfway between the base and the top deck of the landfill and compost piles. The widths and the lengths of the sources were determined by fitting a hypothetical rectangle across the surface of each site. The areas of the rectangle are equal to the total exposed surface area of the landfill and the compost area. The other sources was modeled as "flare" sources representing the flare stations (big and small), and "point" sources, representing the LFG-fired engines at the site (Engines 1 and 2).

SCREEN 3 Distances

	Housing Area to South of Site	Businesses to East of Site	Housing to North of Site
Landfill Surface	2,438 m (7,997 ft)	2,814 m (9,230 ft)	4,468 m (14,655 ft)
Compost Area	2,979 m (9,771 ft)	3,394 m (11,132 ft)	3,915 m (12,841 ft)
Big Flare	3,118 m (10,227 ft)	2,815 m (9,233 ft)	3,791 m (12,434 ft)
Small Flare and Engines 1/2	3,135 m (10,283 ft)	2,772 m (9,092)	3,780 m (12,398ft)

Full meteorology was used in SCREEN3, meaning the model examined a series of atmospheric stability classes and their associated wind speeds to identify the "worst case" meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations). Because SCREEN3 is a simplified screening model, it does not take actual wind direction into account; instead, it calculates concentrations assuming the atmospheric conditions leading to the highest concentrations downwind.

A unit emission rate was used in the model to arrive at unit-specific ground level concentrations. The unit-specific ground level concentrations for each receptor location were multiplied by the emission rates from each of the source areas, and combined to form a worst-case concentration.

Input parameters and assumptions for the SCREEN3 modeling effort for the composting and landfill surface emissions (area sources) included:

Input parameters and assumptions for the SCREEN3 modeling effort for landfill surface emissions as an area source, the flare, and IC engine are presented below.

LF Surface Emissions---

- **Source Type = Area.** Landfill surface emissions were modeled as an area source.

- **Terrain = Rural**. The Landfill and surrounding areas are generally located in an undeveloped rural area.

- **Receptor Terrain = Simple.** Receptors were assumed to be located at or below the mid-level elevation of the landfill height, which is considered reasonable for the WRSL since the landfill surface elevations are generally higher than the surrounding receptor elevations.

- **Receptor Height = 1.5 m.** This is the height at which the nose and mouth are located on an average person.

- **Source Release Height = 25 feet.** The source release height was assumed to be at ½ of the height between the base and top deck of the landfill.

- **Emission Rate = 1.0 gram/sec-m^2 .** The emission rate is used to generate unit ground level receptor concentrations.

- **Landfill Area = 1,425m x 364.34m**

- **Choice of Meteorology-Full Meteorology.** Under the Full Meteorology option, the model examines a series of wind stability classes and their associated wind speeds to identify the "worst case" meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations).

Compost Area Emissions---

- **Source Type = Area.** Compost emissions were modeled as an area source.

- **Terrain = Rural**. The composting location and surrounding areas are generally located in an undeveloped rural area.

- **Receptor Terrain = Simple.** Receptors were assumed to be located at or below the mid-level elevation of the composting area.

- **Receptor Height = 1.5 m.** This is the height at which the nose and mouth are located on an average person.

- **Source Release Height = 3 feet.** The source release height was assumed to be slightly elevated.

- **Emission Rate = 1.0 gram/sec-m^2 .** The emission rate is used to generate unit ground level receptor concentrations.

- **Compost Area = 178.1m x 153.56m**

- **Choice of Meteorology-Full Meteorology.** Under the Full Meteorology option, the model examines a series of wind stability classes and their associated wind speeds to identify the "worst case" meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations).

Big Flare Emissions---

- **Source Type = Flare.**

- **Terrain = Rural**. The Landfill and surrounding areas are generally located in an undeveloped rural area.

- **Terrain = Simple.** This assumed receptors were located below the flare stack.

- **Stack Height = 34 feet.** The height of the landfill flare at the WRSL.

- **Emission Rate = 1.0 gram/sec-m^2 .** The emission rate is used to generate unit ground level receptor concentrations.

- **Total Heat Release Rate = 12.65 MMbtu/min.**

- **Receptor Height = 1.5 m.** This is the height at which the nose and mouth are located on an average person.

- **Choice of Meteorology-Full Meteorology.** Under the Full Meteorology option, the model examines a series of wind stability classes and their associated wind speeds to identify the "worst case" meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations).

Small Flare Emissions---

- **Source Type = Flare.**

- **Terrain = Rural**. The Landfill and surrounding areas are generally located in an undeveloped rural area.

- **Terrain = Simple.** This assumed receptors were located below the flare stack.

- **Stack Height = 30 feet.** The height of the small landfill flare at the WRSL.

- **Emission Rate = 1.0 gram/sec-m^2.** The unit emission rate is used to generate unit ground level receptor concentrations. Ground level concentrations are later calculated based on concentrations calculated using the unit emission rate.

- **Total Heat Release Rate = 2,316,667 btu/min.**

- **Receptor Height = 1.5 m.** This is the height at which the nose and mouth are located on an average person.

- **Choice of Meteorology-Full Meteorology.** Under the Full Meteorology option, the model examines a series of wind stability classes and their associated wind speeds to identify the "worst case" meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations).

Engines 1 and 2 ---

- **Source Type = Point.** The Engine was modeled as a point source.

- **Terrain = Rural**. The Landfill and surrounding areas are generally located in an undeveloped rural area.

- **Terrain = Simple.** This assumed receptors were located below the flare stack.

- **Stack Height = 30 feet.** This is the estimated height of IC engine exhaust stacks.

- **Emission Rate = 1.0 gram/sec-m^2 .** The unit emission rate is used to generate unit ground level receptor concentrations. Ground level concentrations are later calculated based on concentrations calculated using the unit emission rate.

- **Flow Rate = 2,149 acfm (Engine 1), and 2,189 acfm (Engine 2).** This is actual stack data provided by a February 2007 source test.

- **Inside Stack Diameter = 1 foot.** This is the estimated inside stack diameter based on a review of engine specifications.

- **Gas Exit Temperature = 1,603 °F.** This is the estimated exit gas temperature based on a review of engine specifications

- **Ambient Air Temperature = 67.3 °F.** This is a SCREEN3 model default input.

- **Receptor Height = 1.5 meters.** This is the height at which the nose and mouth are located on an average person.

- **Choice of Meteorology-Full Meteorology.** Under the Full Meteorology option, the model examines a series of wind stability classes and their associated wind speeds to identify the “worst case” meteorological conditions (i.e., the combination of wind speed and stability that results in the maximum ground-level concentrations)