

**AREA SOURCE EMISSIONS FOR C/Y 2002  
FROM MUNICIPAL WASTE DISPOSAL (BIODEGRADATION)  
IN THE SCAQMD AIR BASIN**

**CES NO. 57281**

**DESCRIPTION OF CATEGORY**

This area source category estimates migrating organic gas emissions from biodegradable municipal solid waste (MSW) landfill sites. MSW landfills receive primarily household and/or commercial waste. Current practice of landfill operation is to spread the waste in layers upon receiving, and then to compact and cover it with soil. The compacted layers compose the cells of the landfill. Once buried, the waste decomposes biologically and chemically, and produces solid, liquid, and gaseous products. Gas collection wells are installed in the cells to gather the gaseous product, LFG (LFG). LFG formation can be explained by four principal phases; Aerobic Phase, Anaerobic Non-Methanogenic Phase, Anaerobic Methanogenic Unsteady State Phase, Anaerobic Methanogenic Steady State Phase.

In SCAQMD all landfill sites are permitted by the District for their gas collection systems and control systems. Emissions from such landfill sites are reported to the District through AER program and considered as point source. Hence, this area source takes account of remaining emissions, which are not captured by the gas collection systems.

**EMISSION CHARACTERISTICS AND CONTROL**

Emissions from MSW landfills are commonly associated with a number of different emission points including

- Landfill surface,
- Cracks in soil cover surfaces,
- On-site structures including gas collection system, and
- Venting from collection system.

Organic gas emissions from MSW landfills have been tightly controlled by means of the District's Best Available Control Technology (BACT). The BACT for LFG collection system includes horizontal and vertical gas collection lines and appropriate LFG disposal system with stand-by flares. The efficiency of the LFG collection system is estimated to be approximately 90%.

Presently LFG control and treatment technologies include combustion of the gas and purification of the gas. Combustion technique options include those that destroy organics without energy recovery, such as flares, and those that recover energy from the destruction of organics, such as, gas turbines, internal combustion engines, boilers, etc. The BACT is also required to minimize the emissions from LFG combustion.

## EMISSION DATA AVAILABILITY

In SCAB, organic gas emissions from MSW landfills have been carefully evaluated by the District staffs on a permit by permit basis, and the emission data have been stored in the District permit databases. Facilities with greater than three tons per year of any criteria pollutant emission limits are required to report their actual emissions including permitted and non-permitted emissions through the District's Annual Emission Report (AER) program. In 01/02, all landfill sites, which are equipped with LFG collection systems, had filed the AER reports with collected LFG amounts and actual emissions.

The District Rule 1150.1 in conjunction with the Federal regulation (40CFR Part 60 Subpart WWW) mandates frequent/continuous monitoring on landfill sites and requires landfill operators to report the emission monitoring results to the District on a quarterly basis.

## METHODOLOGY AND ASSUMPTIONS

### 1) Assumptions

- a All facilities subject to this category have valid permits for their processes, comply with all applicable District regulations and individual permit conditions, and maintain their process equipment in good condition.
- b In-phase refuse has been deposited in landfills since 1957, since most refuse prior to 1957 was incinerated.
- c The rate of refuse generation per capita is assumed constant for the period of 1957 through 2002.
- d The average emission factors for SCAQMD landfills are 972.0 tons of CH<sub>4</sub>/year per 10<sup>6</sup> tons of refuse, and 13.6 tons of ROG/year per 10<sup>6</sup> tons of refuse.
  - i) TOG emission rate is 985.6 ton/year per 10<sup>6</sup> tons of refuse
  - ii) Methane gas emission rate is 972.0 ton/year per 10<sup>6</sup> tons of refuse
  - iii) ROG emission rate is 13.6 ton/year per 10<sup>6</sup> tons of refuse
- e Median value of CH<sub>4</sub> content in LFG is estimated to be 42.5%.
- f Organic gases emitted from incomplete combustion of LFG are negligible.
- g Uncontrolled ROG emissions from non-AER landfill sites are negligible.
- h Reduction of refuse due to incineration in SCAQMD is negligible when compared to the total amount of in-phase refuse.
- i Any emission reported to the District AER system is considered as point source and excluded from this area source category.

### 2) Refuse Generation Rate

According to the 1982 AQMD's "Report of the Task Force for Landfill Gas Emissions", the in-phase refuse generation rates per capita in SCAQMD are as follows:

**Table 1 – Per Capita Refuse Generation Rates in SCAQMD**

| County         | Range (lbs/day) | Median Value (lbs/day) | Median Value (tons/yr) |
|----------------|-----------------|------------------------|------------------------|
| Los Angeles    | 6.8 - 8.4       | 7.6                    | 1.39                   |
| Orange         | 9.6 - 11.8      | 10.7                   | 1.95                   |
| Riverside      | 6.0 - 7.4       | 6.7                    | 1.22                   |
| San Bernardino | 5.8 - 7.2       | 6.5                    | 1.19                   |

Note: 1999 Statewide Waste Characterization Study indicates lower per capita refuse generation rate – 0.41 ton/yr. But, our analysis indicates that the above referenced generation rates are more representative of our basin.

### 3) Refuse Deposit

Using the above-mentioned refuse generation rate per capita and population data by county from the US Census Bureau, total amount of refuse added to MSW landfills since 1998 was calculated as shown below.

**Table 2 – Cumulative Population and Refuse Deposit in 1998 thru 2002**

| Population by County  | 1997 Census | 2002 Census Estimates | Cumulative Population in 98 - 02* | Refuse Deposit in 98-02 (10 <sup>6</sup> Tons) |
|-----------------------|-------------|-----------------------|-----------------------------------|--|
| Los Angeles           | 9,619,722   | 9,572,437             | 47,056,755                        | 65.4   |
| Orange                | 2,682,821   | 2,956,992             | 14,236,615                        | 27.8   |
| Riverside (SCAB)      | 1,112,112   | 1,294,381             | 6,107,370                         | 7.5  |
| Riverside (SSAB)      | 297,221     | 345,934               | 1,632,250                         | 2.0  |
| Riverside (MDAB)      | 15,476      | 18,012                | 84,985                            | 0.1  |
| San Bernardino (SCAB) | 1,254,807   | 1,413,868             | 6,751,215                         | 8.0  |

\* Cumulative Population is a sum of all annual populations from 1998 thru 2002 taking into account of annual population increases.

Table 3 lists total refuse deposit as of 2002 by county, which is a sum of the total refuse deposit as of 1997 and the additional refuse deposit from 98 thru 02. Also shown in the table is the estimated total TOG generation in 2002 by county. The TOG generation estimate was derived from applying the TOG generation rate of 985.6 ton/MM ton refuse in the District's "Report of the Task Force for Landfill Gas Emissions" to the total refuse deposit as of 2002.

**Table 3 – Total Refuse Deposit and Estimated TOG Generation**

| County            | Total Refuse in 1997 (10 <sup>6</sup> tons) | Refuse Deposited in 98-02 (10 <sup>6</sup> Tons) | Total Refuse Deposit thru 2002 (10 <sup>6</sup> tons) | Est. TOG Generation in 2002 (tons/yr) |
|-------------------|---|--|---|---------------------------------------|
| Los Angeles       | 424.7                                       | 65.4   | 490.1   | 483,051.3                             |
| Orange            | 138.3                                       | 27.8   | 166.1   | 163,670.1                             |
| Riverside (SCAB)  | 27.3  | 7.5  | 34.8  | 34,250.6                              |
| Riverside (SSAB)  | 7.3   | 2.0  | 9.3   | 9,157.5                               |
| Riverside (MDAB)  | 0.8   | 0.1  | 0.9   | 890.7                                 |
| San Bernardino    | 39.9  | 8.0  | 47.9  | 47,243.7                              |
| <b>SCAB Total</b> | <b>638.3</b>                                | <b>110.8</b>                                     | <b>749.1</b>  | <b>738,263.9</b>                      |

## 4) Net TOG/ROG Emissions

In order to calculate the net area source emissions from landfills, it is necessary to estimate the total TOG emission that have been collected in the LFG collection systems. Since TOG emissions collected are not reported in AER, it is estimated from the total LFG usage reported in 02-03 AER, which is a summation of all the LFG usage reported in Form B1, B2 and E1 with fuel\_id 5 – Landfill Gas. Apply the following equations to estimate the net TOG emissions and net ROG emissions:

- CH<sub>4</sub> Collected = LFG Usage (mmcf) x CH<sub>4</sub> Content (42.5%) x 0.04178 lbs/ft<sup>3</sup> ÷ 2000 lbs/ton
- TOG Collected = CH<sub>4</sub> Collected (tons/yr) x 985.6 (tons/10<sup>6</sup> tons refuse) ÷ 972 (tons/10<sup>6</sup> tons refuse)
- Net TOG Emission = TOG Generated in 2002 (tons/yr) - TOG Collected (tons/yr)
- Net ROG Emission = Net TOG Emission (tons/yr) x 13.6 (tons/10<sup>6</sup> tons refuse) ÷ 985.6 (tons/10<sup>6</sup> tons refuse)

**Table 4 – Net TOG/ROG Emissions**

| County      | LFG Collected (mmcf/yr) | (a) CH <sub>4</sub> Collected (tons/yr) | (b) TOG Collected (tons/yr) | (c) Net TOG Emissions (tons/yr) | (d) Net ROG Emissions (tons/yr) |
|-------------|-------------------------|---|-----------------------------|---------------------------------|---------------------------------|
| Los Angeles | 43,102.3                | 382,673.0                               | 388,027.3                   | 95,024.0                        | 1,311.2                         |
| Orange      | 9,302.8                 | 82,592.2                                | 83,747.8                    | 79,922.3                        | 1,102.8                         |

|                   |                 |                |                  |                   |                |
|-------------------|-----------------|----------------|------------------|-------------------|----------------|
| Riverside (SCAB)  | 147.4           | 1,308.3        | 1,326.6          | 32,923.9          | 454.3          |
| Riverside (SSAB)  | 0               | 0              | 0                | 9,157.5           | 126.4          |
| Riverside (MDAB)  | 0               | 0              | 0                | 890.7             | 12.3           |
| San Bernardino    | 30,915.7        | 274,477.5      | 278,317.9        | (231,074.2)       | (3,188.5)      |
| <b>AQMD Total</b> | <b>83,468.2</b> | <b>741,051</b> | <b>751,419.6</b> | <b>(13,155.8)</b> | <b>(181.5)</b> |

Therefore, the emissions of ROG and TOG from this area source category are summarized as follows:

| <b>Current Estimates</b>    | <b>ROG</b> | <b>TOG</b> |
|-----------------------------|------------|------------|
| <b>Emissions (tons/yr)</b>  | (181.5)    | (13,155.8) |
| <b>Emissions (tons/day)</b> | (0.5)      | (36.04)    |

As shown above, the analysis yielded net negative emissions for ROG and TOG, meaning that area source ROG emissions from landfills are virtually zero. This is due to increased collection capacities in landfills in the South Coast Basin, especially in San Bernardino.

Total landfill gas usage reported in the 02-03 AER increased by 32% compared to 1997 while 18% more refuses have been added in the landfills within the AQMD (District) during the same period. San Bernardino landfills are the main driver behind this notable increase in the LFG usage. San Bernardino landfills did not even report emissions in 1997 because their emission levels were below 3 tons. Mr. Marc Rodabaugh in SB County SWMD stated that in late 90's, San Bernardino landfills went through major expansions of their landfill gas collection systems increasing their capacities by 50 – 100%. With the added collection capacities from their expansions, SB landfills reported 30,000 mmcf of LFG usage in 2002-2003 collectively. Due to this sharp increase in usage, unreported ROG emissions (the overall – the AER reported) from landfills in the District are calculated to be zero – the actual calculation came out to be slightly negative.

## REFERENCES

1. EPA Publication AP-40, Ap-42 5<sup>th</sup> Edition
2. SCAQMD, 1997 Area Source Report (CES 57281)
3. SCAQMD, BACT Guidelines
4. SCAQMD, 1982 Report of the Task Force, LFG Emissions
5. US Census Bureau, 2002 County Population Estimates
6. Personal Communication, Mr. Marc Rodabaugh, SB County SWMD