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# EIQ Form 2.0 Landfill Information Application

## Instructions for Form 780-1583

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This form should be used if a facility is a landfill or has a landfill on the premises. In order to complete the form, you must download and open the *Landfill Spreadsheet* available on the department's forms Web page [www.dnr.mo.gov/forms/index.html](http://www.dnr.mo.gov/forms/index.html).

The spreadsheet calculates both fugitive and controlled emissions of individual pollutants, totals and emission factors. After entering site-specific information and data, the spreadsheet will provide a printable version of Form 2.0L along with the *2. T Hazardous Air Pollutant Worksheet*. These completed forms are to be submitted with the facility's Emissions Inventory Questionnaire.

Use one *Form 2.0 Emission Unit Information* for the fugitive emissions, and another *Form 2.0 Emission Unit Information* for emissions from the control device. The Source Classification Code, or SCC, for the fugitive emissions should be 50100402, and the emission factor units are lb/acre. The SCC for emissions from a flare is 50100410, and the emission factor units are lb/mmcf or million cubic feet. Please call your regulatory agency for SCCs and emission factor units for other types of control devices.

Complete the Facility Name, County Number, Plant Number and Year of Data fields at the top. The Emission Unit Number, SCC and Segment Number, will be the same as those indicated on the Form 2.0, which must accompany this form.

### Landfill Information

**Type of Landfill** - put an "X" in the block that most accurately describes the landfill.

- **New** - A new Municipal Solid Waste, or MSW, landfill is a landfill for which construction, modification, or reconstruction commenced on or after May 30, 1991, or that began accepting waste on or after that date.
- **Existing** - An existing MSW landfill is a landfill for which construction, reconstruction or modification commenced before May 30, 1991, has accepted waste anytime since Nov. 8, 1987, or has additional design capacity available for future waste deposition. An existing MSW landfill may be active (currently accepting waste, or have additional capacity available to accept waste) or may be closed (no longer accepting waste nor having available capacity for future waste deposition). Closed landfills that have accepted waste after Nov. 8, 1987 are considered existing landfills.
- **Closed** - A closed landfill has gone through closure procedures with the Missouri Department of Natural Resources' Solid Waste Management Program or EPA.

**If closed, the date of last waste accepted** - If the landfill is not currently accepting waste, put the date of the last waste accepted.

**Time since Landfill Closure (yrs) c** - The amount of time since closure of the landfill in years. For active landfills c = 0. This should be calculated in the same manner as the age of the landfill.

**Time since Initial Refuse Placement (yrs) t** - Enter time since the initial refuse placement in years.

**Example:** If the landfill opened in March 1992 and started accepting waste in June 1992 and is currently accepting waste, the age of the landfill for the 1996 emission year would be:

$$\text{December 1996} - \text{June 1992} = 4 \text{ years and } 7 \text{ months} = 4 + (7/12) = 4.583 \text{ years}$$

**Used EPA's Software (Landgem) or Used DNR Microsoft® Excel® Spreadsheet** -

Put an "X" in the appropriate box and attach a summary of the Landgem report or a copy of the spreadsheet.

**Type of Control** - Put an "X" in the block that most accurately describes the control equipment present at the landfill. According to the New Source Performance Standard, or NSPS, the state plan has three options for the control of collected MSW landfill emissions by using control devices:

- **Flare** - An open flare designed and operated in accordance with the parameters established in 40 CFR Part 60.18.
- **Control System** - A control system designed and operated to reduce Non-Methane Organic Carbon, or NMOC, by 98 weight percent.
- **Enclosed Combustor** - An enclosed combustor designed and operated to reduce the outlet NMOC concentration to 20 parts per million as hexane by volume, dry basis at 3 percent oxygen, or less.
- **None** - No controls installed.

**Capture Efficiency** - This is the capture efficiency for the landfill gas collection system. The default is 75 percent. Documentation must be supplied if a higher percentage of collection is used.

**Destruction Efficiency** - The destruction efficiency for the control indicated.

**Landfill Design Capacity** - The maximum amount of waste (volume) that the landfill will be able to accept in cubic meters ( $m^3$ ). To convert the maximum amount of waste from cubic yards to cubic meters, use the following equation:

$$\text{cubicmeters} = (\text{cubicyards}) \left( 0.76458 \frac{m^3}{yds^3} \right)$$

**Average Annual Refuse Acceptance Rate (Mg/yr) R** - Site-specific landfill information is generally available for the average refuse acceptance rate. When refuse acceptance rate information is scant or unknown, R can be determined by dividing the refuse in place by the amount of time that the landfill was accepting waste. Nondegradable refuse should be subtracted from the mass of the acceptance rate to prevent overestimation of methane generation. The average annual acceptance rate should only be estimated by the above method when there is inadequate information available on the actual average acceptance rate.

To convert the amount of waste from tons to megagrams, use the following equation.

$$\text{Megagrams} = (\text{Tons}) \left( 0.90718 \frac{\text{Mg}}{\text{Tons}} \right)$$

**Mass of solid waste in the landfill (Mg)** - The amount of degradable solid waste accepted into the landfill. The mass of nondegradable solid waste should be subtracted from the total mass of solid waste accepted into the landfill to calculate this value. For the emission year, this would be the mass of solid waste accepted into the landfill from the initial refuse placement until December 31 of the reporting year.

**Nondegradable waste** is any waste that does not decompose through chemical breakdown or microbiological activity. Examples are, but are not limited to, concrete, municipal waste combustor ash and metals.

**Acres of Landfill** - Estimate the acres of land currently in the landfill.

**Gas sent off-site (mmcf)** - If any landfill gas is sent off-site for use at another facility, record the amount sent. This number will be subtracted from the amount of landfill gas sent to the control device.

### Calculation of Emissions

To calculate the methane generation rate - QCH<sub>4</sub> - (m<sup>3</sup>/yr), use the following equation:

$$QCH_4 = LR(e^{-kc} - e^{-kt})$$

Where:

- QCH<sub>4</sub> = Methane generation rate m<sup>3</sup>/yr
- L = Methane generation potential m<sup>3</sup> CH<sub>4</sub>/Mg refuse
- R = Average annual refuse acceptance rate during active life, Mg/yr
- e = Base log, unitless
- k = Methane generation rate constant, /yr
- c = Time since landfill closure
- t = Time since the initial refuse placement

The values for k and L are 0.04 /yr and 125 m<sup>3</sup>/Mg, respectively.

**Methane Generation Rate (mmcf)** - Multiply the methane generation rate in m<sup>3</sup>/yr by 0.0000352 mmcf/m<sup>3</sup> to convert to mmcf/yr.

**SO<sub>2</sub> Emissions** - SO<sub>2</sub> is a combustion product from landfill gas controls. To calculate SO<sub>2</sub> emissions, use the following equation:

$$1.82(QCH_4) \left( \frac{46.9 \text{ ppmv}}{1000000} \right) \left( \frac{32}{(0.00008205)(1000)(298)} \right) \left( \frac{\text{CollectionEffncy}}{100} \right) (2) \left( \frac{2.2046 \text{ lb.}}{\text{kg}} \right) = UmS$$

**Where:**

- UmS = Controlled mass emissions of SO<sub>2</sub>, lb./year.
- 46.9 ppmv = Default concentration of total reduced sulfur compounds
- 32 = Molecular weight of sulfur
- 2 = Ratio of the molecular weight of SO<sub>2</sub> to the molecular weight of S.

If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

**HCL Emissions:** HCl is also a combustion product for landfill gas controls. To calculate HCl emissions, use the following equation:

$$1.82(QCH_4) \left( \frac{42.0 \text{ ppmv}}{1000000} \right) \left( \frac{35}{24.4509} \right) \left( \frac{\text{CollectionEffncy}}{100} \right) (1.03) \left( \frac{\text{ControlEff}}{100} \right) \left( \frac{2.2046 \text{ lb.}}{\text{kg}} \right) = UmHCl$$

**Where:**

- UmHCl = Controlled mass emissions of HCl, lb/yr.
- 42.0 ppmv = Default concentration of total chloride.
- 35 = Molecular weight of chloride.
- 24.4509 = (0.00008205)(1000)(298).
- 1.03 = Ratio of the molecular weight of HCl to the molecular weight of Cl

If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

The next step is to calculate emissions for individual pollutants, fugitive and controlled and add them together according to category:

- Only Hazardous Air Pollutants, or HAPs.
- HAPs and Volatile Organic Compounds, or VOCs.
- Only Volatile Organic Compounds.

To use AP-42 default values, continue with the instructions on this page. To use site specific information, turn to page 2.0L-7.

In order to complete the form, you must download and open the *Landfill Spreadsheet* available on the department's forms Web page at [www.dnr.mo.gov/forms/index.html](http://www.dnr.mo.gov/forms/index.html). The *Landfill Emissions Spreadsheet* instructions list the molecular weight, default concentration or ppmv, and the Non-Methane Organic Carbon, or NMOC, factor for the pollutants required to be reported. The Chemical Abstract Service, or CAS, Number is also listed for those pollutants required to be reported on the *Form 2T Hazardous Air Pollutant Worksheet*.

The individual pollutant mass emissions must be calculated for each of the HAPs in Part A and Part B. The HAPs that are VOCs must be reported as VOCs and not as HAPs on Form 2.0. Form 2.T must be completed with the mass emissions of each HAP listed in Part A and Part B. The chemicals that are only VOCs appear in Part C.

**Note:** The individual mass emissions of the chemicals in Part C do not have to be listed on any form.

When all of these values are calculated, the uncontrolled emissions as HAPs can be obtained from the Form 2.T. The uncontrolled emissions as VOCs can be obtained by adding the VOC emissions from 2.T and those calculated from the chemicals on Part C. To calculate the mass emissions of each pollutant on the spreadsheet, use the following equation: (AP-42 Equation (3)):

$$I_{NMOC} = (1.82)(QCH_4)(Default\ Concentration)(I_{NMOC}\ Factor)(1 \times 10^6)$$

**Where:**

$I_{NMOC}$	= Individual mass emissions for a specific chemical (lbs/yr)
$QCH_4$	= Methane Generation Rate $m^3/yr$
Default Concentration	= The value in ppmv for a specific chemical
$I_{NMOC}$ Factor	= Values for specific chemicals

**Example:** If  $QCH_4 = 3,000,000\ m^3/year$ , the emissions for 111 Trichloroethane would be  $(1.82)(3,000,000\ m^3/yr)(0.48\ ppmv)(12.02\ lb/m^3)(1 \times 10^6) = 31.5\ lb/yr$ .

**NMOC (VOC) Fugitive Emissions** - The total emission of the pollutants listed in Part B and Part C of the *Landfill Emissions Spreadsheet*, multiplied by the percentage of landfill gas not collected. For example, if the total emissions for Part B are 12,000 pounds, the total for Part C are 2,000 pounds, and the collection efficiency is 75 percent, the NMOC (VOC) for fugitive emissions is:  $(12,000 + 2,000)(0.25) = 3,500$  pounds.

**NMOC (HAP only) Fugitive Emissions** - The total emission of the pollutants listed in Part A of the *Landfill Emissions Spreadsheet* multiplied by the percentage of landfill gas not collected. For example, if the total emissions for Part A are 1000 pounds, and the collection efficiency is 75 percent, the NMOC (HAP only) for fugitive emissions are:  $(1,000)(0.25) = 250$  pounds.

**NMOC (VOC) Collected, Uncontrolled** - The total emission of the pollutants listed in Part B and Part C of the *Landfill Emissions Spreadsheet*, multiplied by the percentage of landfill gas collected. For example, if the total emissions for Part B are 12,000 pounds, the total for Part C are 2,000 pounds, and the collection efficiency is 75 percent, the NMOC (VOC) for collected, uncontrolled emissions are:  $(12,000 + 2,000)(0.75) = 10,500$  pounds. If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

**NMOC (HAP only) Collected, Uncontrolled** - The total emission of the pollutants listed in Part A of the *Landfill Emissions Spreadsheet*, multiplied by the percentage of landfill gas collected. If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

**NMOC (VOC) Emissions from Control** - The total emission of the pollutants listed in Part B and Part C of the *Landfill Emissions Spreadsheet*, multiplied by the percentage of landfill gas collected, and multiplied by the percentage not controlled.

**Example:** If the total emissions for Part B are 12,000 pounds, the total for Part C are 2,000 pounds, the collection efficiency is 75 percent, and the control efficiency is 98 percent, the NMOC (VOC) emissions from control are:  $(12,000 + 2,000) (0.75)(.02) = 210$  pounds.

If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

**NMOC (HAP only) Emissions from Control** - The total emission of the pollutants listed in Part A of the *Landfill Emissions Spreadsheet*, multiplied by the percentage of landfill gas collected, and multiplied by the percentage not controlled, plus the HCl emissions calculated above. If any landfill gas is collected and sent off-site, those emissions should be subtracted from this amount.

**Calculation of Emission Factors**

**VOC Fugitive Emission Factor** - The NMOC (VOC) Fugitive Emissions (lbs.) divided by the Acres of Landfill.

**HAP Fugitive Emission Factor** - The NMOC (HAP only) Fugitive Emissions (lbs.) divided by the Acres of Landfill.

**VOC to Control Emission Factor** - The NMOC (VOC) Collected, Uncontrolled (lbs.) divided by the Methane Generation Rate (mmcf).

**HAP to Control Emission Factor** - The NMOC (HAP only) Collected, Uncontrolled (lbs.) divided by the Methane Generation Rate (mmcf).

**To use site specific information:** If a site-specific total pollutant concentration is available (as measured by EPA Reference Method 25C), it must be corrected for air infiltration into the collected landfill gas before it can be combined with the estimated landfill gas emissions to estimate total NMOC emissions. The pollutant concentration is adjusted for air infiltration by assuming that Carbon Dioxide and Methane are the primary (100 percent) constituents of landfill gas, by the following equation:

$$\frac{C_P(ppmv)(1 \times 10^6)}{C_{CO_2}(ppmv) + C_{CH_4}(ppmv)} = C_P ppmv \text{ (corrected for air infiltration)}$$

**Where:**

- $C_P$  = Concentration of pollutant P in landfill gas
- $C_{CO_2}$  = CO2 concentration in landfill gas, ppmv
- $C_{CH_4}$  = CH4 concentration in landfill gas, ppmv
- $1 \times 10^6$  = Constant used to correct NMOC concentration to units of ppmv

Values for  $C_{CO_2}$  and  $C_{CH_4}$  can usually be found in the source test report for the particular landfill along with the total NMOC concentration data.

To estimate the emissions of a particular pollutant, use the following equation:

$$QP = \frac{1.82QCH_4(CP)}{(1 \times 10^6)}$$

**Where:**

- QP = Emission rate of a particular pollutant, m<sup>3</sup>/yr
- QCH<sub>4</sub> = CH<sub>4</sub> generation rate, m<sup>3</sup>/yr
- CP = Concentration of P in landfill gas, ppmv
- 1.82 = Multiplication factor

The estimate the mass emissions per year of each pollutant, use the following equation:

$$UM_P = Q_P \left[ \frac{(MW_P)(1atm)}{(0.00008205m^3 - atm / gmol - ^\circ K)(1000g / kg)(273 + T^\circ K)} \right] \left( \frac{2.2046lbs}{1kg} \right)$$

**Where:**

- UM<sub>P</sub> = Uncontrolled mass emissions of pollutant P (lbs/yr)
- Q = NMOC emission rate of P (m<sup>3</sup>/yr)
- MW<sub>P</sub> = Molecular weight of P, g/gmol
- T = Temperature of landfill gas (°C)
- 2.2046 = Conversion factor from kilograms to pounds

This equation assumes that the operating pressure of the system is approximately one atmosphere. If the temperature of the landfill gas is not known, a temperature of 25°C is recommended.

The individual pollutant mass emissions must be calculated for each of the HAPs in Part A and Part B. The HAPs that are VOCs must be reported as VOCs and not as HAPs on Form 2.0. Form 2.T must be completed with the mass emissions of each HAP listed in Part A and Part B. The chemicals that are only VOCs appear in Part C.

**Note:** The individual mass emissions of the chemicals in Part C do not have to be listed on any form. When all of these values are calculated, the uncontrolled emissions as HAPs can be obtained from the Form 2.T. The uncontrolled emissions as VOCs can be obtained by adding the VOC emissions from 2.T and those calculated from the chemicals on Part C.

After calculating the mass emissions of each pollutant listed on the *Landfill Emissions Spreadsheet* return to NMOC (VOC) Fugitive Emissions page 2.0L-5.

**For More Information**

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