

Appendix G. Waste Management

Overview

Greenhouse gas (GHG) emissions from waste management include:

- Solid waste management – methane (CH₄) emissions from municipal and industrial solid waste landfills (LFs), accounting for CH₄ that is flared or captured for energy production (this includes both open and closed landfills)¹;
- Solid waste combustion – CH₄, carbon dioxide (CO₂), and nitrous oxide (N₂O) emissions from the combustion of solid waste in incinerators or at open residential sites (i.e. backyard burn barrels); and
- Wastewater management – CH₄ and N₂O from municipal wastewater (WW) and CH₄ from industrial wastewater treatment facilities.

Inventory and Reference Case Projections

Solid Waste Management

For solid waste management, the United States Environmental Protection Agency's (US EPA) State Inventory Tool (SIT) software was used to estimate emissions. These emissions were based on state population and national average landfilling rates. FL DEP has been contacted to provide state-specific data on waste emplacement and landfill controls. CCS did not apply the SIT assumption that 10% of CH₄ is oxidized as it travels through the surface layers of the landfill due to a lack of information to support this assumption.

Emissions for industrial solid waste landfills were estimated using the SIT default activity data and emission factors. The activity data are based on national data indicating that industrial landfill methane emissions are approximately 7% of municipal solid waste (MSW) emissions nationally. It was assumed that industrial waste emplacement occurs beyond that already addressed in the emplacement rates for MSW sites described above.

The amount of CH₄ captured for flaring and use in landfill gas-to-energy (LFGTE) plants was estimated with SIT defaults that are based on data collected from vendors of flaring equipment, a database of landfill gas-to-energy (LFGTE) projects compiled by the EPA, and a database maintained by the Energy Information Administration (EIA) for the voluntary reporting of greenhouse gases.² The amount of landfill gas flared in Florida may be underestimated if FL flaring and LFGTE controls have been underreported in the EPA and EIA data.

Growth rates were estimated by using the historic (2000-2005) growth rates of total net emissions from landfills. The annual growth rates are 5.0% for MSW landfills and 3.2% for industrial landfills.

¹ CCS acknowledges that N₂O and CH₄ emissions are also produced from the combustion of landfill gas; however, these emissions tend to be negligible for the purposes of developing a state-level inventory for policy analysis.

² See Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2005, Chapter 8 Waste, US EPA, Report #430-R-07-002, April 2007 (<http://epa.gov/climatechange/emissions/usinventoryreport.html>).

Solid Waste Combustion

Sources of solid waste combustion include municipal solid waste (MSW) combustors, medical waste incinerators, and open residential burning. Emissions from municipal solid waste-to-energy combustors, of which Florida has twelve, are not inventoried here but are included in the energy supply sector inventory. Quantities of medical waste incinerated were obtained from FL DEP.³ The historic (1995-2005) growth rate of -1.2% for medical waste incineration was used to estimate future growth rates.

Open burning of MSW at residential sites (e.g. backyard burn barrels) was estimated using the US EPA’s 2002 National Emissions Inventory methodology for calculating the quantity of waste burned at residential sites in Florida.⁴ Emissions from open burning were calculated using SIT emission factors and waste characteristics. The historic (1990-2005) growth rate of -1.7% for residential waste burning was used to estimate future growth rates.

Wastewater Management

GHG emissions from municipal wastewater treatment were also estimated. For municipal WW treatment, emissions are calculated in EPA’s SIT based on state population, assumed biochemical oxygen demand (BOD) and protein consumption per capita, and emission factors for N₂O and CH₄. The key SIT default values are shown in Table G1 below. Municipal wastewater emissions were projected based on the historic growth rate for 1990-2005 for a growth rate of 2.3% per year.

Table G1. SIT Key Default Values for Municipal Wastewater Treatment

Variable	Default Value
BOD	0.09 kilogram (kg) /day-person
Amount of BOD anaerobically treated	16.25%
CH ₄ emission factor	0.6 kg/kg BOD
Florida residents not on septic	75%
Water treatment N ₂ O emission factor	4.0 g N ₂ O/person-yr
Biosolids emission factor	0.01 kg N ₂ O-N/kg sewage-N

Source: US EPA State Greenhouse Gas Inventory Tool (SIT) – Wastewater Module.

For industrial WW treatment emissions, SIT provides default assumptions and emission factors for three industrial sectors: Fruits & Vegetables, Red Meat & Poultry, and Pulp & Paper. The SIT default activity data were used to estimate emissions for red meat production; however, default data were not available for the other sectors (including poultry production). Emissions were projected to 2025 based on the 1990-2005 annual growth rate of -6.9%. See the Key Uncertainties section below for more information on industrial WW treatment.

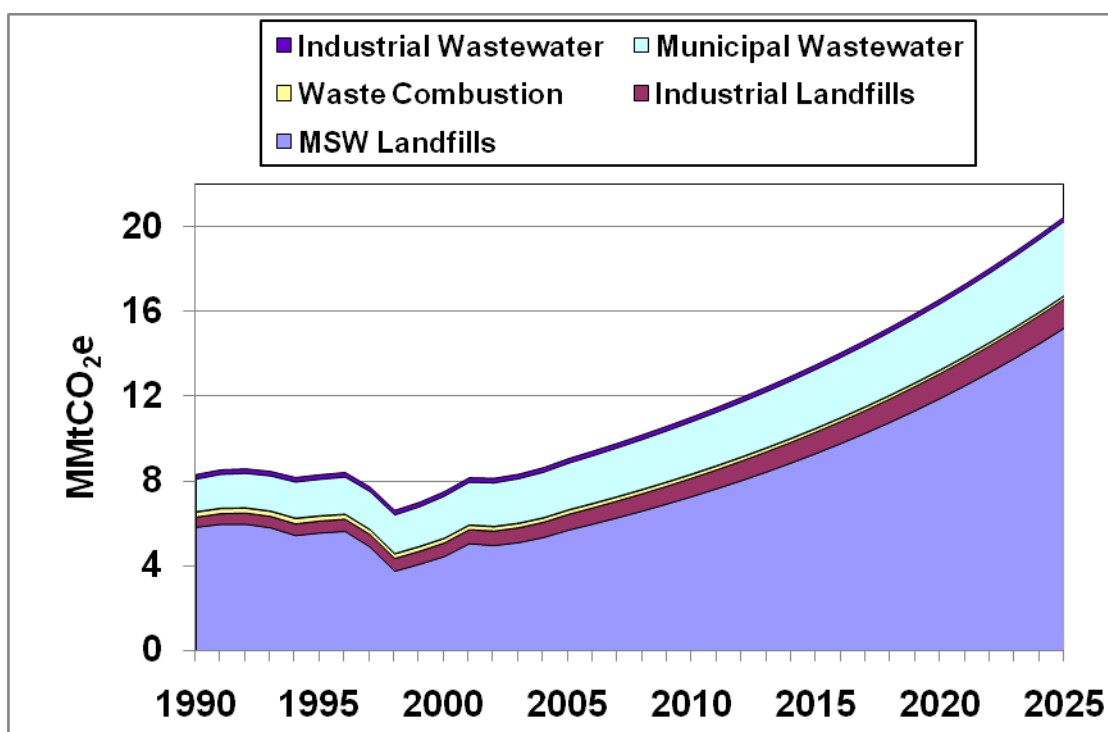
³ Yi Zhu, Florida Department of Environmental Protection, communicated via email to Rachel Anderson, CCS, March 6, 2008.

⁴ EPA, http://ftp.epa.gov/EmisInventory/2002finalnei/documentation/nonpoint/2002nei_final_nonpoint_documentation0206version.pdf.

Results

Figure G1 and Table G2 show the emission estimates for the waste management sector. Overall, the sector accounts for 9.1 MMtCO₂e in 2005, and emissions are estimated to be 20.5 MMtCO₂e/yr in 2025. The largest contributor to waste management emissions is the solid waste sector, in particular, municipal landfills. In 2005, municipal landfills accounted for 63% of total waste management emissions. By 2025, the contribution from these sites is expected to increase to about 74%. Industrial landfills accounted for about 8% of waste management emissions in 2005 and 7% in 2025.

Figure G1. Florida GHG Emissions from Waste Management, 1990-2025



Source: Based on approach described in text.

Table G2. Florida GHG Emissions from Waste Management (MMtCO₂e)

Source	1990	1995	2000	2005	2010	2015	2020	2025
MSW Landfills	5.85	5.59	4.48	5.72	7.31	9.34	11.94	15.26
Industrial Landfills	0.48	0.56	0.64	0.74	0.87	1.01	1.19	1.39
Waste Combustion	0.23	0.22	0.20	0.19	0.17	0.16	0.15	0.14
Municipal Wastewater	1.57	1.75	2.01	2.23	2.50	2.81	3.15	3.54
Industrial Wastewater	0.218	0.218	0.218	0.218	0.218	0.218	0.218	0.218
Total	8.3	8.3	7.5	9.1	11.1	13.5	16.6	20.5

In 2005, about 24% of the waste management sector emissions were contributed by municipal WW treatment systems and 2% were contributed by the industrial WW treatment subsector. Note that these estimates are based on the default parameters listed in Table G1 above, and might not adequately account for emissions, existing controls, or management practices (e.g. anaerobic

digesters served by a flare or other combustion device). By 2025, municipal WW treatment systems are expected to contribute about 17% and industrial WW treatment is expected to contribute about 1% to the waste management sector emissions.

Emissions from waste combustion contributed 2% of waste sector emissions in 2005 and are expected to decrease to 1% by 2025.

Key Uncertainties

Municipal solid waste landfilling emissions were estimated with SIT default data, which are based on a per capita approach to estimating waste tonnage. In addition, this inventory was calculated using default data in all of the historical years for MSW controls. A more accurate approach would involve allocating FL DEP landfill emplacement volumes by the portion of waste going to uncontrolled landfills, landfills with flares, and LFGTE facilities, so that control factors could more accurately be applied. This characterization of emissions by landfill type also provides better information for policy analysis. Since this is a state-level assessment, the methods also do not adequately account for the points in time when controls were applied at individual sites. The modeling also does not account for uncontrolled landfills that will need to apply controls during the period of analysis due to triggering requirements of the federal New Source Performance Standards/Emission Guidelines.

FL DEP has been contacted to provide data on waste emplacement and landfill emissions controls. Also, although waste emplacement data do capture waste imports from other states, additional details will be incorporated as data are available to characterize the emissions from imported waste separately from that generated in-state. Finally, to the extent that any waste is exported out of state for management, the inventory and forecast should attempt to capture these emissions as well. This additional detail on waste import and export will be incorporated based on available data from FL DEP or other sources.

For industrial landfills, emissions were estimated using national defaults (with industrial landfill emissions approximately 7% of MSW emissions). Depending on actual industrial landfill emissions in FL, this could be an over- or underestimate.

SIT MSW defaults including waste composition and emissions factors were used to estimate medical waste incineration emissions in FL. To the extent that the fossil carbon content of medical waste differs from municipal solid waste, this could be an over- or underestimate. Open burning of waste at residential sites was estimated using a US EPA NEI methodology. Depending on actual burn rates, this could be an over- or underestimate. Emissions from open burning of yard waste were not estimated but are expected to be small (only the CH₄ and N₂O emissions would be of interest here, since the CO₂ would be considered to be biogenic).

For the municipal WW treatment sector, the key uncertainties are associated with the application of SIT default values for the parameters listed in Table G1 above (e.g. fraction of the Florida population on septic; fraction of BOD which is anaerobically decomposed). The SIT defaults were derived from national data.

For industrial WW treatment, emissions were only estimated for the red meat industry using default data; default data for fruits and vegetables, poultry, and pulp and paper were not available. Therefore, emissions from industrial WW treatment are likely to be underestimated. FL DEP has been contacted to provide more complete WW treatment data.

This emission inventory for the waste management sector will be revised to address the issues discussed above. In addition, the Florida Action Team and the agriculture, forestry, and waste technical work group will be asked to provide additional data, where available, that can be used to refine this waste management inventory.

This inventory in its current state does not quantify current actions taken by the State of Florida that may lower future emissions. CCS is not aware of any current actions that would have an impact on the emissions forecast.