Appendix G. Waste Management

Overview

Greenhouse gas (GHG) emissions from waste management include:

- Solid waste management – methane (CH_4) emissions from municipal and industrial solid waste landfills (LFs), accounting for CH_4 that is flared or captured for energy production (this includes both open and closed landfills);[1]
- Solid waste combustion – CH_4, carbon dioxide (CO_2), and nitrous oxide (N_2O) emissions from the combustion of solid waste in incinerators and waste to energy plants not already accounted for in the electricity generating sector; and
- Wastewater management – CH_4 and N_2O from municipal wastewater (WW) and CH_4 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. CCS did not apply the SIT assumption that 10% of CH_4 is oxidized as it travels through the surface layers of the landfill due to a lack of information to support this assumption. IA Department of Natural Resources (DNR) was contacted to provide state-specific data on waste emplacement and landfill emissions controls, however the state does not maintain landfill records

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 CH_4 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 GHGs.[2] The amount of landfill gas flared in Iowa may be underestimated if IA flaring and LFGTE controls have been underreported to the EPA and EIA.

Growth rates were estimated by using the historic (1995-2005) growth rates of total net emissions from landfills. The annual growth rates are 1.6% for MSW landfills and 1.6% for industrial landfills.

[1] CCS acknowledges that N_2O and CH_4 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 in Iowa include municipal waste combustion, medical waste incinerators and hazardous waste incineration. The Iowa State University power plant in Ames is a waste-to-energy facility that burns refuse. Its emissions are included in the electricity generating sector instead of the waste sector. Annual tonnage incinerated in 2006 was obtained from the IA DNR and this amount was used to estimate amount incinerated for all years in the historical 1990-2005 period. The SIT defaults for emission factors waste characteristics were used. As described under Key Uncertainties below, the SIT emission factors are based on MSW, not medical or hazardous waste, and their use presents a source of uncertainty in the estimates (e.g. medical and hazardous waste could contain significantly different levels of fossil-based carbon than MSW).

Open burning of MSW at residential sites (e.g. backyard burn barrels) also contributes to GHG emissions. The US EPA's 2002 National Emissions Inventory estimates the quantity of waste burned at residential sites in Iowa.[3] Emissions from open burning were calculated using SIT emission factors and waste characteristics. The historic (1990-2005) growth rate of 3.6% for incineration and residential waste combustion combined was used to estimate future growth rates.

Wastewater Management

GHG emissions from municipal wastewater treatment were also estimated. For municipal wastewater 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 N_2O and CH_4. 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 0.6% 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
Iowa residents not on septic	75%
Water treatment N_2O emission factor	4.0 g N_2O/person-yr
Biosolids emission factor	0.01 kg N_2O-N/kg sewage-N

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

For industrial wastewater emissions, SIT provides default assumptions and emission factors for three industrial sectors: Fruits & Vegetables, Red Meat & Poultry, and Pulp & Paper. The SIT

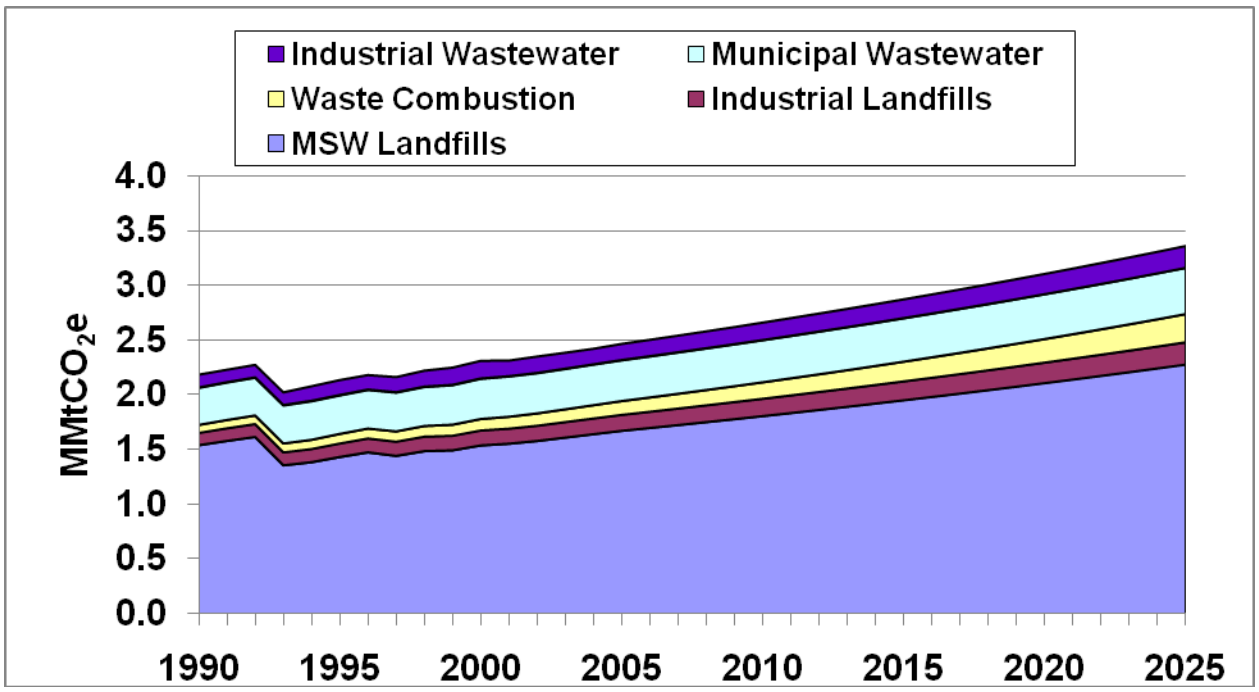
[3] EPA, ftp://ftp.epa.gov/EmisInventory/2002finalnei/documentation/nonpoint/2002nei_final_nonpoint_documentation0206version.pdf.

default activity data were used to estimate emissions for red meat production; however, default data were not available for the other sectors. Emissions were projected to 2025 based on the 1990-2005 annual growth rate of 1.5%. See the Key Uncertainties section below for more information on industrial WW treatment.

Results

Figure G1 and Table G2 show the emission estimates for the waste management sector. Overall, the sector accounts for 2.47 $MMtCO_2e$ in 2005, and emissions are estimated to be 3.36 $MMtCO_2e$/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 68% of total waste management emissions and are expected to remain at 68% by 2025. Industrial landfills accounted for about 6% of waste management emissions in 2005, and remain 6% in 2025.

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



Source: Based on approach described in text.

Table G2. Iowa GHG Emissions from Waste Management ($MMtCO_2e$)

Source	1990	1995	2000	2005	2010	2015	2020	2025
MSW Landfills	1.54	1.43	1.54	1.67	1.80	1.95	2.11	2.28
Industrial Landfills	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21
Waste Combustion	0.07	0.09	0.11	0.13	0.15	0.18	0.22	0.26
Municipal Wastewater	0.34	0.35	0.37	0.37	0.38	0.40	0.41	0.42
Industrial Wastewater	0.12	0.14	0.16	0.15	0.16	0.17	0.19	0.20
Total	**2.18**	**2.13**	**2.31**	**2.47**	**2.66**	**2.88**	**3.11**	**3.36**

In 2005, about 15% of the waste management sector emissions were contributed by municipal wastewater treatment systems and 6% by the industrial wastewater 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, the municipal wastewater treatment subsector is expected to contribute about 13% and industrial wastewater is expected to contribute about 6% to the waste management sector.

Emissions from waste combustion contributed 5% of waste sector emissions in 2005 and are expected to increase to 8% by 2025.

Key Uncertainties

Municipal solid waste emissions were estimated with 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 IA DNR 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. However, IA DNR does not maintain state landfill records so the use of default data is a source of uncertainty. 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.

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 IA, this could be an over- or underestimate.

SIT defaults for waste composition that are optimized for municipal waste were used to estimate medical waste and hazardous combustion and incineration emissions. To the extent that medical and hazardous waste composition is significantly different than municipal waste, the resulting emissions may be a slight under- or overestimate. Facilities that burn refuse as an energy source, such as AgBio Power and the ISU power plant, are not included in the waste sector inventory but are addressed in the commercial fuel source or electricity inventory. 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 CH_4 and N_2O emissions would be of interest here, since the CO_2 would be considered to be biogenic).

For the wastewater 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 Iowa population on septic; fraction of BOD which is anaerobically decomposed). The SIT defaults were derived from national data.

For industrial wastewater, 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 wastewater are likely to be underestimated. IA DNR has been contacted to provide more complete wastewater data.

This emission inventory for the waste management sector will be revised to address the issues discussed above. In addition, the IA Climate Change Advisory Council and the Agriculture, Forestry, and Waste Management Subcommittee 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 Iowa that may lower future emissions.