Appendix G. Waste Management

Overview

GHG emissions from waste management include:

- Solid waste management – 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);
- Solid waste combustion – CH_4, CO_2, and N_2O emissions from the combustion of solid waste in incinerators or waste to energy plants; and
- Wastewater management – CH_4 and N_2O from municipal wastewater and CH_4 from industrial wastewater (WW) treatment facilities.

Inventory and Reference Case Projections

Solid Waste Management

For solid waste management, we used the U.S. EPA SGIT and the U.S. EPA Landfill Methane Outreach Program (LMOP) landfills database[1] as starting points to estimate emissions. The LMOP data serve as input data to estimate annual waste emplacement for each landfill needed by SGIT. SGIT then estimates CH_4 generation for each landfill site. Additional post-processing outside of SGIT to account for controls is then performed to estimate CH_4 emissions.

Since the LMOP database contained information on only the Anchorage LF, CCS contacted DEC staff to gather additional information on solid waste landfills and other solid waste management issues, including waste combustion.[2] From these contacts, CCS learned that there are approximately 300 small landfills in Alaska. About 250 of these are considered Class III sites that accept less than 5 tons per day (tpd). The other 50 are Class II sites that accept between 5 and 20 tpd. For the Class III sites, half of the waste accepted is assumed to be open burned. Most of these community sites have been in operation since the 1960s, if not earlier.

The only landfill site currently controlled in AK is the Anchorage site, which collects and flares the methane generated. A partial collection system has been installed at the Juneau LF, however the amount of methane has not been sufficient for flaring. Hence, this site and all of the other landfills in AK are considered in this analysis to be uncontrolled. The Class III sites and the Class II sites were combined for the purposes of emissions modeling. To estimate waste in place at these sites, CCS assumed that each Class II site accepted 12.5 tpd and that each site operated 5 days per week. Class III sites were assumed to accept 2.5 tpd at each site for 5 days per week. Half of the waste at Class III sites is assumed to be open burned on-site. All sites were assumed to be open since the 1960s (waste emplaced much more than about 30 years ago is not expected to be producing significant amounts of methane). The table below provides a summary of the data used as input to SGIT for modeling emissions.

[1] LMOP database is available at: http://www.epa.gov/lmop/proj/index.htm. Updated version of the database provided by Rachel Goldstein, Program Manager, EPA Landfill Methane Outreach Program, October 2006. The only AK site represented in the database was the Anchorage Regional LF.

[2] Doug Buteyn and Ed Emswiler, ADEC, Solid Waste Division, personal communications with S. Roe, CCS, December 2006 – January 2007.

Table G1. Summary of Municipal Solid Waste Landfill Data

Site Name	Operating Years	Average Waste Emplacement Rate (tons/yr)	Control
Anchorage Regional LF	1987 - Present	350,000	Flare
Juneau LF[a]	2004 - Present	23,400	None
Class II LFs (50 sites)	1960's - Present	162,500	None
Class III LFs (250 sites)	1960's - Present	81,250	None

[a] Prior to 2004, combustible waste was incinerated and is accounted for under the waste combustion sector. A collection and flare system is in place; however, currently the methane is mostly being vented.

The estimated average annual disposal rates for each landfill were used in SGIT for all years that the landfills were operating (Class II and III landfills were each modeled as a single site). CCS performed two different runs of SGIT to estimate emissions from municipal solid waste (MSW) landfills: (1) uncontrolled landfills; (2) landfills with a landfill gas collection system and flare (the Anchorage site). The other landfill category that CCS commonly models is sites with landfill gas to energy (LFGTE) plants. There are none of these currently operating in Alaska.

After obtaining the methane generation data from SGIT, CCS performed some post-processing of the methane emissions to account for landfill gas controls (flared sites) and to project the emissions through 2020. For the controlled landfills, CCS assumed that the overall methane collection and control efficiency is 75%.[3] Of the methane not captured by a landfill gas collection system, it is further assumed that 10% is oxidized before being emitted to the atmosphere (consistent with the SGIT default). This assumption for oxidation is also used for the methane emitted from uncontrolled sites.

Growth rates were estimated by using the historic (1995-2005) growth rates of emissions in both the controlled and uncontrolled landfill categories. The annual growth rates are: 2.9% for uncontrolled sites and 9.0% for flared site (Anchorage). The higher growth rate for Anchorage is driven by the fact that this is a relatively young site (<20 years), which is receiving a fairly large amount of waste annually (350,000 tons).

For industrial waste landfills, SGIT calculates emissions based on an assumption that industrial waste is emplaced at a selected fraction of municipal solid waste emplaced (the default is based on national data and is 7% of municipal solid waste emplaced). Due to the lack of a substantial industrial base in Alaska, CCS assumed that any industrial waste emplaced in solid waste landfills is captured in the municipal solid waste emplacement estimates described above. Hence, there are no emissions estimated for the industrial waste landfills sector.

[3] As per EPA's AP-42 Section on Municipal Solid Waste Landfills: http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf.

Solid Waste Combustion

Information from ADEC contacts was used to construct estimates from municipal solid waste combustion that occurred during the 2000 – 2005 time-frame.[4] Solid waste combustion addressed here includes both the controlled combustion of municipal solid waste in incinerators, as well as open municipal solid waste combustion occurring at community landfills. For controlled combustion, prior to 2000, the SGIT default activity data were used.[5] From 2000-2005, information provided by ADEC staff were used (the 2002 estimates were used to represent 2000 to 2003 activity; 2004 and 2005 activity were estimated by subtracting the throughput for the Juneau facility, which closed in 2004).

The mass of controlled waste combustion was added to the estimate described under the landfills section above for open burning at Class III landfill sites (81,250 tons/yr) to estimate total waste combustion emissions. This value for open burning was used for all years due to availability of data. The table below shows the total waste mass estimates per year.

Table G2. Summary of Municipal Solid Waste Combustion Data (tons)

Combustion Category	1990	1995	2000	2005
Controlled Burning	45,990	75,000	111,360	90,401
Open Burning	81,250	81,250	81,250	81,250
Totals	**127,240**	**156,250**	**192,610**	**171,651**

SGIT does not use different methods (emission factors) for open and controlled burning. Therefore, the total waste estimates above were used as input to SGIT to estimate emissions. ADEC also provided some data for sewage sludge incineration. Most of the carbon in sewage sludge is of biological origin, and therefore the associated CO_2 emissions would not be incorporated into this GHG inventory. While we would expect some emissions of methane and nitrous oxide from these sources, CCS believes that the emissions would be negligible.

Emissions for the solid waste combustion sector were forecast based on Alaska's forecasted population growth from 2005-2020 (0.69%/yr).[6]

Wastewater Management

GHG emissions from municipal and industrial wastewater treatment were also estimated. For municipal wastewater treatment, emissions are calculated in EPA's SGIT 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 SGIT default values are shown in Table G3

[4] Controlled burning - Alice Edwards, ADEC, personal communication and data file provided to S. Roe, CCS, January 2007. Open burning – Doug Buteyn, ADEC, personal communication with S. Roe, CCS, December 2006.
[5] SGIT reference for solid waste combustion data appears to be *Biocycle*, "Annual Survey of Municipal Waste Management Practices: State of Garbage in America", date not provided.
[6] Alaska Department of Labor and Workforce Development, "Workforce Information," Home, Population & Census, Estimates & Projections, Population Data Tables, "Alaska Population Projections (2005-2029)," Select "February 2005 issue of Alaska Economic Trends," in PDF file named "feb05.pdf"(Projections for Alaska population 2005–2029, Table 5. Population Growth Projections Alaska 2005–2029, Medium Population Values in Table 5 used for forecast).

below. Emissions for the municipal wastewater management sector were forecast based on Alaska's forecasted population growth from 2005-2020 (0.69%/yr).

For industrial wastewater emissions, SGIT provides default assumptions and emission factors for three industrial sectors: Fruits & Vegetables, Red Meat & Poultry, and Pulp & Paper. According to ADEC contacts and the Dun & Bradstreet database, there aren't currently any large operations in these industry sectors that would be expected to have their own treatment systems. According to the contact at the Alyeska Valdez Marine terminal, the Valdez ballast water treatment facility does not emit CH_4 emissions.[7]

Emissions of methane are also expected to occur from fish processing waste dumped at sea.[8] Again, CCS attempted to gather information on this issue; however no emissions-related information was identified. Presumably, methane emissions would also occur from waste treatment conducted on-shore; however, CCS is not aware of any data or emissions estimation methods to address this potential source category.

Table G3. SGIT Key Default Values for Municipal Wastewater Treatment

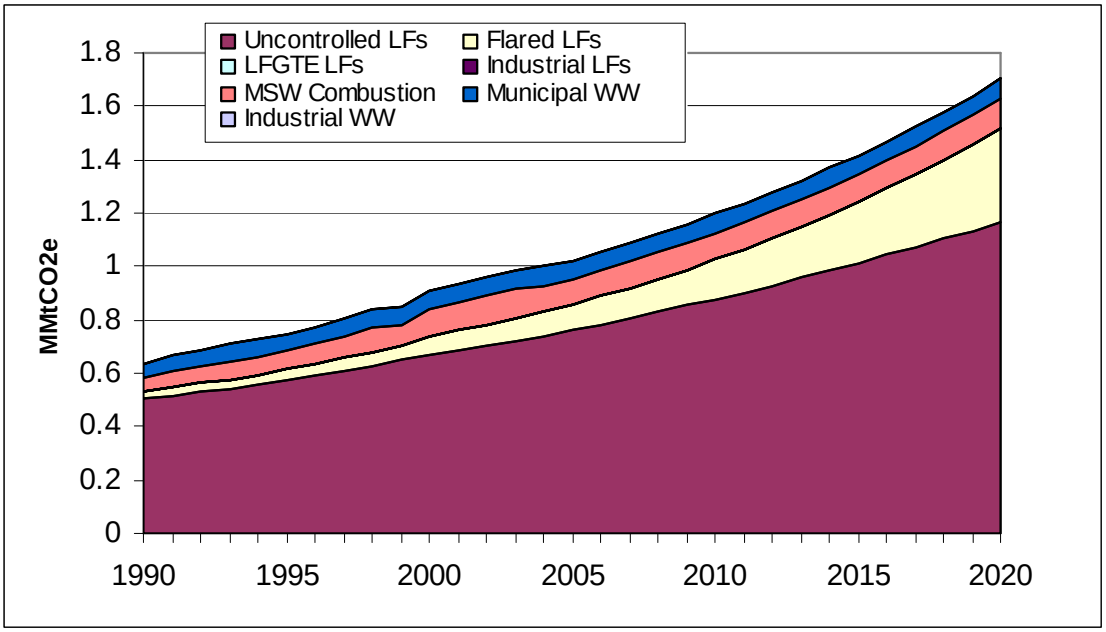
Variable	Value
BOD	0.065 kg /day-person
Amount of BOD anaerobically treated	16.25%
CH_4 emission factor	0.6 kg/kg BOD
Alaska residents not on septic	75%
Water treatment N_2O emission factor	4.0 g N_20/person-yr
Biosolids emission Factor	0.01 kg N_2O-N/kg sewage-N
Source: U.S. EPA State Inventory Tool – Wastewater Module; methodology and factors taken from U.S. EPA, Emission Inventory Improvement Program, Volume 8, Chapter 12, October 1999: www.epa.gov/ttn/chief/eiip/techreport/volume08/.	

Figure G1 shows the emission estimates for the waste management sector. Overall, the sector accounts for 1.0 $MMtCO_2e$ in 2005. By 2020, emissions are expected to grow to 1.7 $MMtCO_2e$/yr. The growth in emissions is driven by the solid waste management sector, in particular uncontrolled and flared landfills. In 2005, 75% of the emissions were contributed by the uncontrolled landfills sector. By 2020, the contribution from these sites is expected to be about 70%. For flared LFs (the Anchorage Regional LF), the contribution to the sector total was about 9% in 2005 growing to over 20% by 2020.

As described above, no emissions are estimated historically or in the future for the LFGTE or industrial LF categories. Any industrial solid waste that is generated is assumed to be captured within the municipal solid waste estimates. No LFGTE sites currently operate in Alaska.

[7] Brad Thomas, Alyeska Valdez Marine Terminal, personal communication with Steve Roe, CCS, January, 2007.
[8] An estimate from the early 1990's is that about 1.7 million metric tons of fish waste is generated in Alaska. The amount generated and treated on-shore versus at sea was not provided (*Pollution Prevention Opportunities in the Fish Processing Industry*, Pacific Northwest Pollution Prevention Research Center, 1993).

Figure G1. Alaska GHG Emissions from Waste Management



Notes: LF – landfill; WW – wastewater; LFGTE – landfill gas to energy; historic and future emissions for the LFGTE landfill and industrial solid waste landfill categories were estimated to be zero in AK. Sources of information to estimate emissions for the industrial WW treatment category could not be obtained for incorporation into this assessment.

The wastewater treatment sector is estimated to contribute 7% of the sector emissions in 2005 and less than 5% of the total by 2020. Note that these estimates currently only include the municipal wastewater treatment sector. Data and methods were not identified to incorporate industrial wastewater treatment emissions into this assessment (including fish processing waste).

Key Uncertainties

The methods used to model landfill gas emissions do not adequately account for the points in time when controls were applied at individual sites. Hence, for landfills, the historical emissions are less certain than current emissions and future emissions for this reason (since each site that is currently controlled was modeled as always being controlled, the historic emissions are low as a result; for Alaska, this is only an issue with the Anchorage LF). The modeling also does not account for uncontrolled sites that will need to apply controls during the period of analysis due to triggering requirements of the federal New Source Performance Standards/Emission Guidelines. As noted above, the available data do not cover all of the open and closed landfills in Alaska. Rough estimates were developed for approximately 50 Class II and 250 Class III landfills in the state. Hence, the estimates presented here should be viewed as order of magnitude estimates.

The waste combustion estimates should also be viewed as order of magnitude estimates given the availability of data. The estimates are based on assumptions that 50% of the waste at 250 Class III sites is open burned. National default waste composition profiles are used to estimate the CO_2e emissions for this activity, which might not adequately reflect the types of waste being open burned. No significant changes in controlled waste burning (in municipal waste

combustors) are assumed for the future. Growth overall in waste combustion emissions is assumed to track population growth.

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

For industrial wastewater treatment, data and estimation methods were lacking for this assessment. Emissions are expected from the treatment of fish processing waste; however no information was identified to develop emission estimates.