

# 2011-2023 Greenhouse Gas Reporting Program Sector Profile: Waste

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## WASTE SECTOR

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All emissions presented here are as of 8/16/2024 and exclude biogenic carbon dioxide (CO<sub>2</sub>). All greenhouse gas (GHG) emission data displayed in units of carbon dioxide equivalent (CO<sub>2</sub>e) reflect the global warming potential (GWP) values from Table A-1 of 40 CFR 98, which is generally based on the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4).

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### Highlights

- The most prevalent greenhouse gas (GHG) emitted by the Waste Sector is methane (CH<sub>4</sub>), and Municipal Solid Waste (MSW) landfills are the largest emitter of CH<sub>4</sub> in this sector.
- Reported emissions from the Waste Sector have decreased by 13.1% since 2011, though the decrease during this time frame was not constant for any of the waste subsectors.
- The decrease in emissions is primarily driven by methodological changes to the emission calculation procedures for MSW landfills that were implemented in 2013 and 2016.
- The three states with the most CH<sub>4</sub> emissions from MSW landfills (and across the Waste Sector) are Texas, California, and Florida. The three states with the largest number of MSW landfills are Texas, California, and Illinois.
- Seventy-five percent of the MSW landfills that reported in 2023 have landfill gas collection and control systems (GCCSs), compared to approximately 1.0% of industrial waste landfills.

### About this Sector

The Waste Sector comprises MSW landfills, industrial waste landfills, industrial wastewater treatment systems, and solid waste combustion at waste-to-energy facilities.

- **MSW landfills** are landfills that dispose or have disposed of MSW. MSW includes, among other components, solid-phase household, commercial/retail, and institutional wastes. MSW landfills may also dispose of non-MSW wastes, including construction and demolition debris and other inert materials. This subsector excludes dedicated industrial, hazardous waste, and construction and demolition landfills. An MSW landfill comprises the landfill, the landfill GCCS, and combustion devices that are used to control landfill gas emissions.
- **Industrial waste landfills** are landfills that accept or have accepted primarily industrial wastes. This subsector excludes landfills that accept hazardous waste and those that receive only construction and demolition or other inert wastes. An industrial waste landfill includes the landfill, the landfill GCCS, and combustion devices that are used to control landfill gas emissions. Approximately 1% of facilities reporting under this Subpart have landfill GCCSs. The organic composition of waste streams disposed of at industrial landfills tends to be similar over time, leading to a relatively consistent emission rate, while the waste streams at MSW landfills may fluctuate seasonally and/or annually.
- **Industrial wastewater treatment systems** comprise of anaerobic lagoons, reactors, and anaerobic sludge digesters at facilities that perform pulp and paper manufacturing, food processing, ethanol production, and petroleum refining. This subsector does not include anaerobic processes used to treat wastewater and wastewater treatment sludge at other industrial facilities. It also does not include emissions from municipal wastewater treatment

plants, separate treatment of sanitary wastewater at industrial facilities, oil and/or water separators, or aerobic and anoxic treatment of industrial wastewater.

- **Solid waste combustion at waste-to-energy facilities** comprise of combustors and incinerators at facilities under North American Industry Classification System (NAICS) code 562213 that burn non-hazardous solid waste either to recover energy or to reduce the volume of waste.

## Who Reports?

For Reporting Year (RY) 2023, 1453 facilities in the Waste Sector reported emissions of 99.8 million metric tons (MMT) CO<sub>2</sub>e. In 2023, the Waste Sector represented 19.3% of the facilities reporting direct emissions to the Greenhouse Gas Reporting Program (GHGRP) and 1.6% of total U.S. direct emissions.<sup>1</sup> Table 1 includes details of the applicability of each source category, their corresponding reporting schedules, and estimates of the percent of facilities and emissions covered by the GHGRP.<sup>2</sup> Table 2 shows the number of GHGRP reporters by source category and year.

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<sup>1</sup> Total U.S. GHG emissions for 2022 were 6,343 MMT CO<sub>2</sub>e, as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022. EPA 430-R-24-004. U.S. Environmental Protection Agency. April 11, 2024. Available: <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>.

<sup>2</sup> Note: Values in Table 1 do not change significantly from year to year, so percentages in Table 1 are updated every five years. Table 1 was last updated in 2021.

**Table 1: Waste Sector - Reporting Schedule and GHGRP Coverage by Subpart (2023)<sup>a</sup>**

| Subpart | Source Category                 | Applicability   | First Reporting Year | Estimated % of Industry Emissions Covered |
|---------|---------------------------------|---|----------------------|---|
| C       | Solid Waste Combustion          | <ul style="list-style-type: none"> <li>Facilities that reported only under subpart C (Stationary Fuel Combustion) and reported NAICS code 562213 (Solid Waste Combustors and Incinerators).</li> <li>Such facilities that emit &gt; 25,000 metric tons CO<sub>2</sub>e/year.</li> </ul> | 2010                 | 81.3% <sup>b</sup>                        |
| HH      | MSW Landfills                   | <ul style="list-style-type: none"> <li>Facilities that accepted waste after January 1, 1980.</li> <li>Such facilities that generate CH<sub>4</sub> that is equivalent to &gt; 25,000 metric tons CO<sub>2</sub>e/year.</li> </ul>   | 2010                 | 68.4% <sup>c</sup>                        |
| II      | Industrial Wastewater Treatment | <ul style="list-style-type: none"> <li>Facilities that operate an anaerobic process to treat industrial wastewater and/or industrial wastewater treatment sludge at a specified process.</li> <li>Such facilities that emit &gt; 25,000 metric tons CO<sub>2</sub>e/year.</li> </ul>    | 2010                 | 29.2% <sup>d</sup>                        |
| TT      | Industrial Waste Landfills      | <ul style="list-style-type: none"> <li>Facilities that accepted primarily industrial waste after January 1, 1980, and have a design capacity &gt; 300,000 metric tons.</li> <li>Such facilities that emit &gt; 25,000 metric tons CO<sub>2</sub>e/year.</li> </ul>                      | 2011                 | 36.5% <sup>e</sup>                        |

a. Estimate of total industry emissions for all percentages is from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022. EPA 430-R-24-004. U.S. Environmental Protection Agency. April 11, 2024. Available: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022> (hereinafter “EPA Emissions Estimate”).

b. Emissions were estimated to be 12.7 MMT CO<sub>2</sub>e (Table 3-27: CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O Emissions from the Incineration of Waste (EPA Emissions Estimate, page 3-59)).

c. Emissions were estimated to be 100.9 MMT CO<sub>2</sub>e (Table 7-3: CH<sub>4</sub> Emissions from Landfills (EPA Emissions Estimate, page 7-7)).

d. Emissions were estimated to be 7.2 MMT CO<sub>2</sub>e (Table 7-19: Total Industrial Wastewater CH<sub>4</sub> Emissions by Sector (EPA Emissions Estimate, page 7-32)).

e. These emission estimates are based on nationwide estimated amounts of annual waste generation and are not facility-specific emission estimates. Emissions were estimated to be 18.9 MMT CO<sub>2</sub>e (Table 7-3: CH<sub>4</sub> Emissions from Landfills (EPA Emissions Estimate, page 7-7)).

**Table 2: Waste Sector – Number of Reporters (2011–2023)<sup>a</sup>**

| Source Category        | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Total Waste Sector     | 1,645 | 1,652 | 1,638 | 1,631 | 1,549 | 1,514 | 1,506 | 1,506 | 1,484 | 1,478 | 1,466 | 1,459 | 1,453 |
| Municipal Landfills    | 1,240 | 1,252 | 1,240 | 1,237 | 1,168 | 1,145 | 1,140 | 1,139 | 1,131 | 1,132 | 1,131 | 1,129 | 1,125 |
| Industrial Landfills   | 176   | 176   | 176   | 178   | 175   | 172   | 172   | 171   | 170   | 168   | 168   | 163   | 162   |
| Wastewater Treatment   | 169   | 162   | 161   | 156   | 149   | 141   | 139   | 141   | 129   | 126   | 115   | 115   | 118   |
| Solid Waste Combustion | 68    | 69    | 68    | 67    | 64    | 63    | 62    | 62    | 61    | 59    | 58    | 58    | 54    |

<sup>a</sup> The total number of reporters may be less than the sum of the number of reporters in each individual source category because some facilities contain more than one source category.

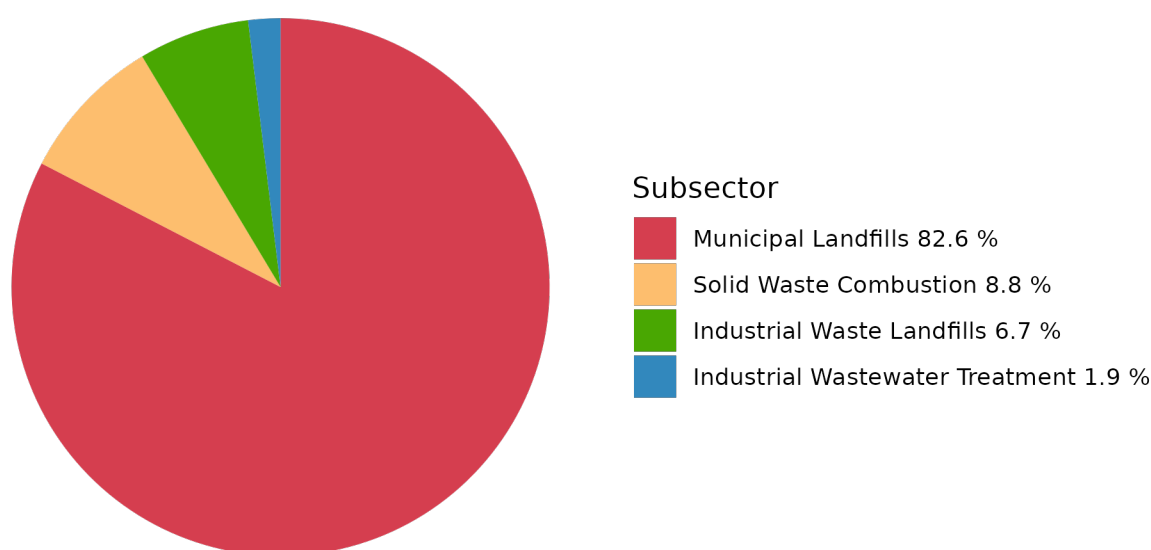
MSW landfills made up the majority of Waste Sector reporters for all reporting years. The number of reporters for MSW landfills decreased by 115 facilities between 2011 and 2023. This decrease is a result of facilities that qualified to discontinue reporting (off-ramping from the program).<sup>3</sup> Between 2011 and 2023, the number of reporters for industrial wastewater treatment decreased by 51. The number of reporters for industrial waste landfills had a net decrease of 14 facilities from 2011 to 2023. The number of solid waste combustion facilities decreased by 14 facilities from 2011 to 2023.

<sup>3</sup> See FAQ: When is a Facility Eligible to Stop Reporting? Available: <http://www.ccdsupport.com/confluence/pages/viewpage.action?pageId=243139271>.

## Reported Emissions

Methane (CH<sub>4</sub>) is the primary GHG reported by MSW landfills, industrial waste landfills, and industrial wastewater treatment facilities. Methane is generated by the anaerobic decomposition of organic waste in landfills and in anaerobic wastewater treatment systems. Landfill gas typically contains approximately 50% CH<sub>4</sub>, 50% CO<sub>2</sub>, and less than 1% non-methane organic compounds. Industrial wastewater treatment gas contains about 65 to 70% CH<sub>4</sub>, 25 to 30% CO<sub>2</sub>, and small amounts of N<sub>2</sub>, H<sub>2</sub>, and other gases. Figure 1 shows the breakdown of emissions by subsector in reporting year 2023.

**Figure 1: 2023 Total Reported Emissions from Waste, by Subsector**

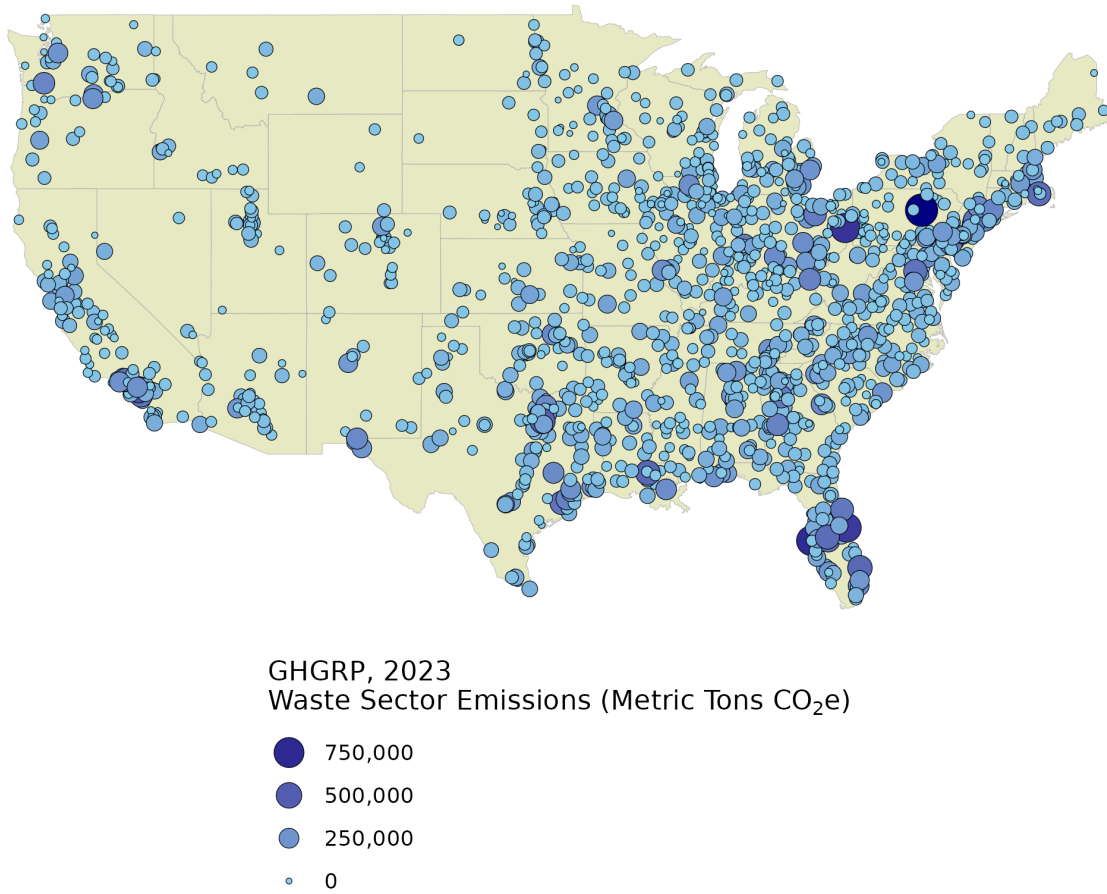


Biogenic CO<sub>2</sub> emissions result primarily from the combustion of landfill gas, MSW, and other biogenic fuels in reciprocating internal engines, municipal waste combustors, and other combustion units.

Figures 2 through 6 show the location and range of emissions in the contiguous United States for the entire Waste Sector (Figure 2) and each subsector individually (Figures 3 through 6). Sizes of each circle correspond to a specified range of emissions in metric tons (MT) of CO<sub>2</sub>e reported by that particular facility. Many large industrial waste landfills are in southeastern states and along the coastline of the Gulf of Mexico, which is also where numerous petroleum refineries, pulp and paper, and chemical manufacturing facilities are located. Locations of industrial wastewater treatment facilities are driven primarily by the location of ethanol facilities, which account for more than half of all industrial wastewater treatment reporters and tend to be in the Midwest. Seventy-seven percent of solid waste combustors are in the northeastern states and in Florida, and the remaining facilities are in the Midwest and western states (Figure 6).

Readers can identify the largest emitting facilities by visiting the Facility Level Information on GreenHouse gases Tool (FLIGHT) website (<https://ghgdata.epa.gov/ghgp/main.do#>).

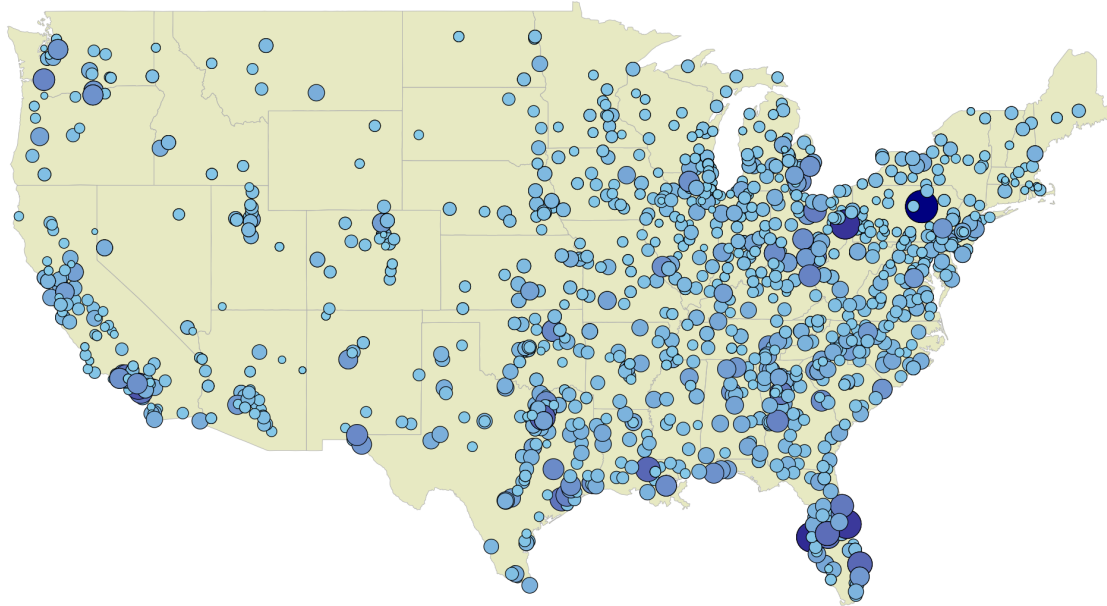
**Figure 2: Location and Relative Emissions for Facilities Reporting in the Waste Sector (2023)**



*Note: Each circle on the map corresponds to a facility reporting in the Waste Sector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.*



**Figure 3: Location and Relative Emissions for Facilities Reporting in the MSW Landfill Subsector (2023)**

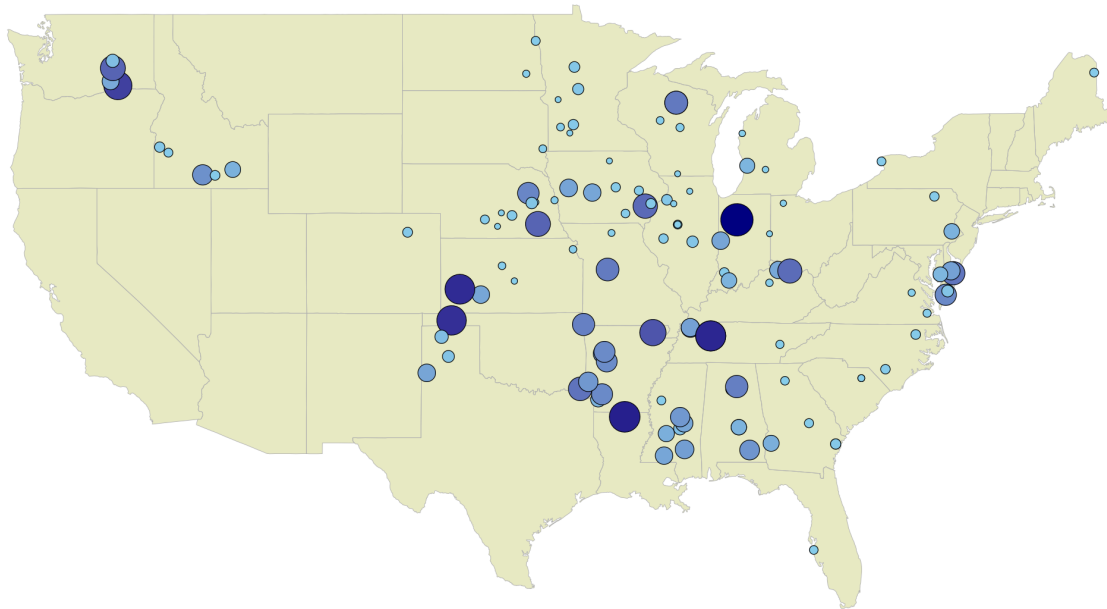


GHGRP, 2023  
MSW Landfill Subsector Emissions (Metric Tons CO<sub>2</sub>e)

- 750,000
- 500,000
- 250,000

*Note: Each circle on the map corresponds to a facility reporting in the MWS Landfill subsector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.*

**Figure 4: Location and Relative Emissions for Facilities Reporting in the Industrial Wastewater Treatment Subsector (2023)**

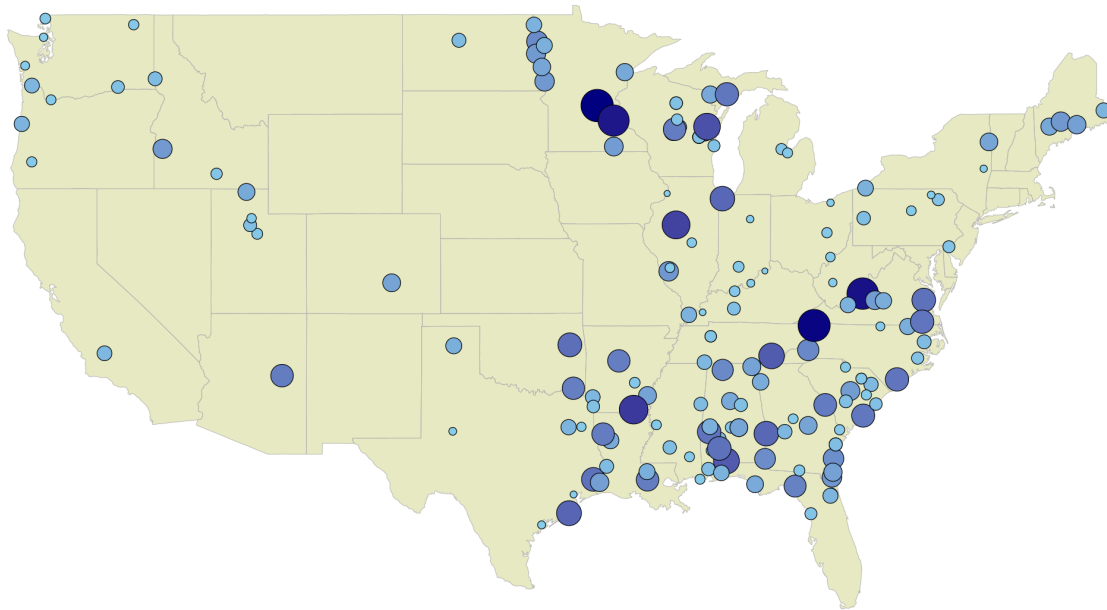


GHGRP, 2023  
Industrial Wastewater Treatment Subsector Emissions (Metric Tons CO<sub>2</sub>e)

- 100,000
- 75,000
- 50,000
- 25,000
- 0

*Note: Each circle on the map corresponds to a facility reporting in the Industrial Wastewater Treatment subsector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.*

**Figure 5: Location and Relative Emissions for Facilities Reporting in the Industrial Waste Landfill Subsector (2023)**

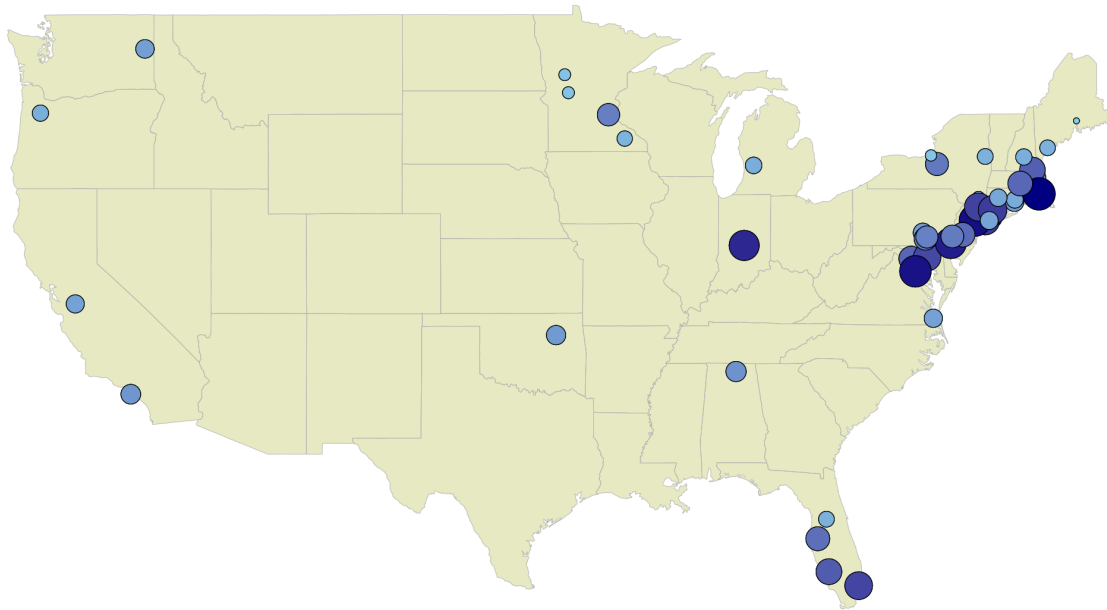


GHGRP, 2023  
Industrial Waste Landfill Subsector Emissions (Metric Tons CO<sub>2</sub>e)



*Note: Each circle on the map corresponds to a facility reporting in the Industrial Waste Landfill subsector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.*

**Figure 6: Location and Relative Emissions for Facilities Reporting in the Solid Waste Combustion Subsector (2023)**



GHGRP, 2023  
Solid Waste Combustion Subsector Emissions (Metric Tons CO<sub>2</sub>e)

- 400,000
- 300,000
- 200,000
- 100,000

*Note: Each circle on the map corresponds to a facility reporting in the Solid Waste Combustion subsector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.*

## Waste Sector: Emissions Trends, 2011 to 2023

Total emissions reported to the GHGRP by the Waste Sector decreased from 114.9 MMT CO<sub>2</sub>e in 2011 to 99.8 MMT CO<sub>2</sub>e in 2023 (approximately -13.2%). The decrease in emissions is likely due to the notable 11.7% drop in reporters (in 2023 there were approximately 192 fewer reporters than in 2011), along with a drop in emissions from MSW landfills.

Over 80 percent of emissions from the waste sector come from MSW landfills. Reported emissions from MSW landfills decreased from 93.8 MMT CO<sub>2</sub>e in 2011 to 82.4 MMT CO<sub>2</sub>e in 2023 (approximately -12.2%). The decrease in reported emissions is due to several factors, including a reduction in the number of reporters (in 2023 there were approximately 115 fewer reporters than in 2011), along with changes to the rule for calculating methane emissions from MSW landfills. Starting in reporting year 2013, MSW landfills are allowed to assume that a higher percentage of methane generated by the landfill is oxidized to CO<sub>2</sub> as it passes through the landfill soil cover, resulting in lower reported methane emissions. Additionally, landfills are provided two equations for calculating annual methane emissions and are given the choice of which results that best represent the emissions from the landfill to report each year. More landfills choosing to report the lower of the two estimates is likely contributing to lower reported emissions. Another factor that may be contributing to lower emissions is a reduction in degradable waste disposed in MSW landfills since 2011.<sup>4</sup>

In addition to MSW landfills, reported emissions also decreased from the other waste subsectors. Emissions reported by industrial waste landfills decreased 24.7% between 2011 and 2023 while emissions reported by solid waste combustors decreased 8.3% during this time, and wastewater treatment facilities dropped 26.9%. Table 3 shows emissions by subsector and Table 4 shows biogenic CO<sub>2</sub> emissions.

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<sup>4</sup> EPA, Advancing Sustainable Materials Management: Facts and Figures 2018. December 2020. Available online at: [https://www.epa.gov/sites/production/files/2020-11/documents/2018\\_tables\\_and\\_figures\\_fnl\\_508.pdf](https://www.epa.gov/sites/production/files/2020-11/documents/2018_tables_and_figures_fnl_508.pdf).

**Table 3: Waste Sector – Emissions (MMT CO<sub>2</sub>e) by Subsector (2011–2023)<sup>a, b</sup>**

| Source Category        | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022 | 2023 |
|------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| Total Waste Sector     | 114.9 | 115.0 | 111.3 | 111.9 | 110.0 | 106.4 | 104.5 | 106.7 | 108.2 | 103.8 | 101.7 | 99.7 | 99.8 |
| Municipal Landfills    | 93.8  | 94.4  | 91.2  | 90.8  | 89.6  | 86.4  | 85.9  | 87.7  | 89.4  | 85.0  | 83.1  | 81.6 | 82.4 |
| Solid Waste Combustion | 9.6   | 9.8   | 10.0  | 9.9   | 10.1  | 10.2  | 9.2   | 9.5   | 9.2   | 9.3   | 9.3   | 9.1  | 8.8  |
| Industrial Landfills   | 8.9   | 8.7   | 8.0   | 8.5   | 8.3   | 7.9   | 7.5   | 7.4   | 7.4   | 7.4   | 7.5   | 6.9  | 6.7  |
| Wastewater Treatment   | 2.6   | 2.1   | 2.2   | 2.6   | 2.1   | 2.0   | 1.9   | 2.1   | 2.1   | 2.1   | 1.9   | 2.1  | 1.9  |

<sup>a</sup> Biogenic emissions of CO<sub>2</sub> are not included in the CO<sub>2</sub>e emissions in this table. As landfill gas recovered from MSW landfills and industrial waste landfills is considered biogenic, CO<sub>2</sub> emissions from the combustion of landfill gas are not included in the CO<sub>2</sub>e emissions in this table. Biogenic CO<sub>2</sub> emissions from the combustion of the biogenic fraction of MSW are also not included in the CO<sub>2</sub>e emissions in this table.

<sup>b</sup> Totals may not sum due to independent rounding.

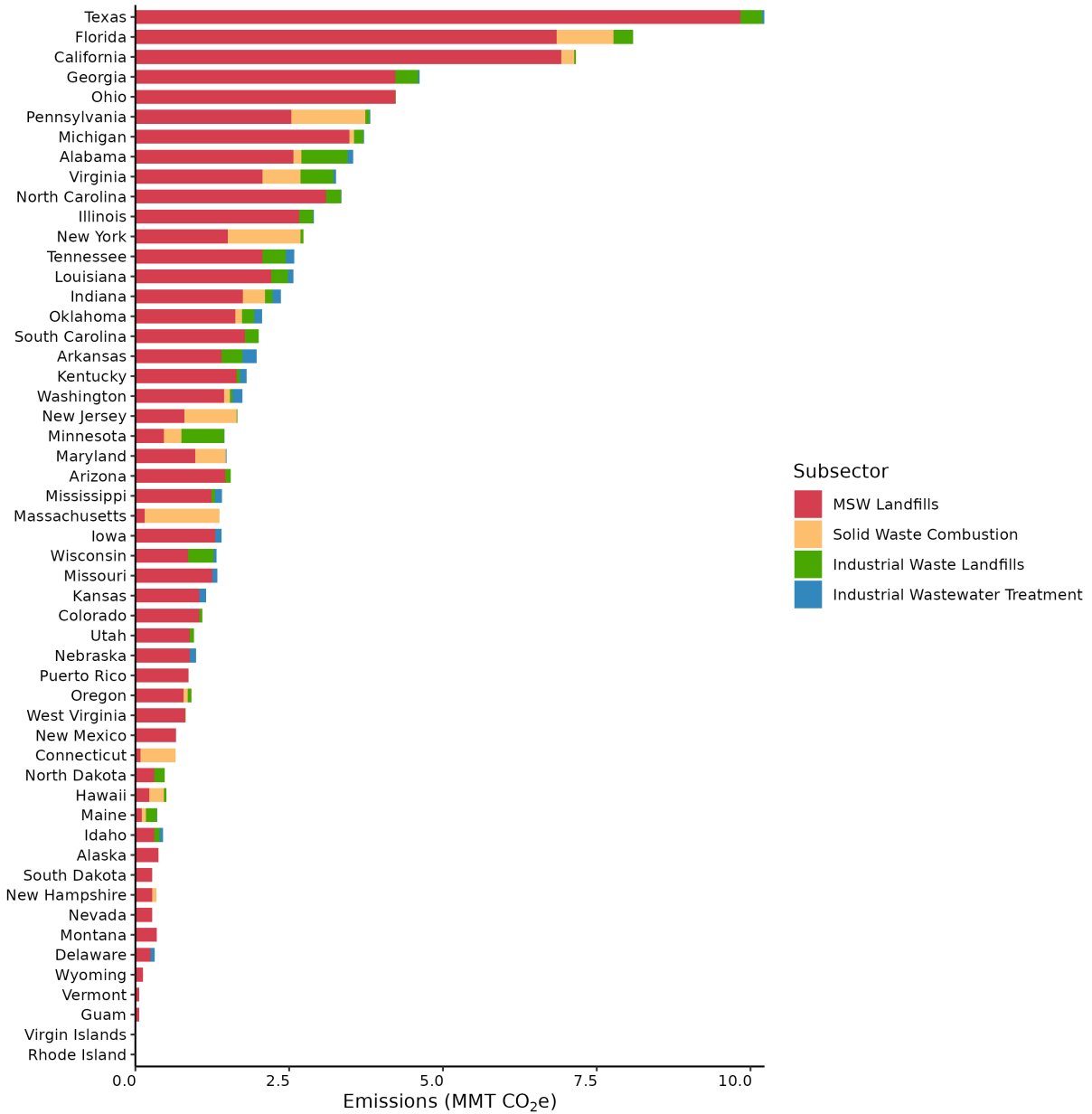
**Table 4: Waste Sector - Biogenic CO<sub>2</sub> Emissions (MMT CO<sub>2</sub>e) (2011-2023)<sup>a</sup>**

| Waste Sector                             | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total biogenic CO <sub>2</sub> emissions | 18.8 | 18.5 | 18.2 | 17.8 | 17.6 | 17.5 | 17.7 | 17.8 | 17.7 | 17.3 | 17.2 | 16.3 | 15.2 |
| Solid Waste Combustion                   | 14.7 | 14.4 | 14.3 | 14.0 | 13.7 | 13.5 | 13.7 | 13.7 | 13.5 | 13.3 | 13.1 | 12.6 | 11.8 |
| Municipal Landfills                      | 4.1  | 4.1  | 3.9  | 3.8  | 3.9  | 4.0  | 4.0  | 4.0  | 4.2  | 4.0  | 4.1  | 3.7  | 3.4  |

<sup>a</sup> Totals may not sum due to independent rounding.

Figure 7 shows the GHGRP direct emissions from the Waste Sector by state and subsector in 2023. In 2023 the three states with the most methane emissions from the Waste Sector are Texas, Florida, and California.

**Figure 7: Direct Emissions by State from the Waste Sector (2023)<sup>a</sup>**



<sup>a</sup> Represents total emissions reported to the GHGRP from this sector. States not shown had no Waste Sector emissions reported to the GHGRP in 2023. Access the most recent data using FLIGHT. [Click here to view the most recent data using FLIGHT.](#)

Table 5 shows the emissions by GHG emitted. Table 6 breaks down emissions by Waste Sector processes and fuel combustion.

**Table 5: Waste Sector - Emissions (MMT CO<sub>2</sub>e) by GHG (2011-2023)<sup>a</sup>**

| Waste Sector               | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Number of Facilities       | 1,645 | 1,652 | 1,638 | 1,631 | 1,549 | 1,514 | 1,506 | 1,506 | 1,484 | 1,478 | 1,466 | 1,459 | 1,453 |
| Total Emissions            | 114.9 | 115   | 111.3 | 111.9 | 110   | 106.4 | 104.5 | 106.7 | 108.2 | 103.8 | 101.7 | 99.7  | 99.8  |
| <b>Carbon Dioxide</b>      |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Industrial Landfills       | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| MSW Landfills              | 1.0   | 1.0   | 1.1   | 1.2   | 1.3   | 1.4   | 1.4   | 1.5   | 1.4   | 1.5   | 1.1   | 1.3   | 1.5   |
| Solid Waste Combustion     | 9.1   | 9.3   | 9.4   | 9.4   | 9.6   | 9.7   | 8.7   | 9.0   | 8.8   | 8.8   | 8.8   | 8.6   | 8.3   |
| Wastewater Treatment       | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
| <b>Methane</b>             |       |       |       |       |       |       |       |       |       |       |       |       |       |
| Industrial Landfills       | 8.9   | 8.7   | 8.0   | 8.5   | 8.3   | 7.9   | 7.5   | 7.4   | 7.4   | 7.4   | 7.5   | 6.9   | 6.7   |
| MSW Landfills              | 92.8  | 93.4  | 90.0  | 89.6  | 88.3  | 84.9  | 84.5  | 86.2  | 88.0  | 83.5  | 81.9  | 80.3  | 80.9  |
| Solid Waste Combustion     | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   | 0.2   |
| Wastewater Treatment       | 2.6   | 2.1   | 2.2   | 2.6   | 2.1   | 2.0   | 1.9   | 2.1   | 2.1   | 2.1   | 1.9   | 2.1   | 1.9   |
| <b>Nitrous Oxide</b>       |       |       |       |       |       |       |       |       |       |       |       |       |       |
| MSW Landfills <sup>b</sup> | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| Solid Waste Combustion     | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   | 0.3   |

<sup>a</sup> Totals may not sum due to independent rounding.

<sup>b</sup> Emissions shown for CO<sub>2</sub> and N<sub>2</sub>O result from the combustion of fossil fuels and the non-biogenic portion of MSW that is combusted.



**Table 6: Waste Sector – Emissions (MMT CO<sub>2</sub>e) from Waste Sector Processes and Fuel Combustion (2011-2023)<sup>a,b,c</sup>**

| Waste Sector                            | 2011        | 2012        | 2013        | 2014        | 2015        | 2016        | 2017        | 2018        | 2019        | 2020        | 2021        | 2022        | 2023        |
|---|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <b>MSW Landfills</b>                    | <b>93.8</b> | <b>94.3</b> | <b>91.2</b> | <b>90.8</b> | <b>89.6</b> | <b>86.4</b> | <b>85.9</b> | <b>87.7</b> | <b>89.4</b> | <b>85.0</b> | <b>83.1</b> | <b>81.6</b> | <b>82.4</b> |
| Fuel Combustion                         | 1.1         | 1.0         | 1.2         | 1.2         | 1.3         | 1.5         | 1.4         | 1.5         | 1.4         | 1.6         | 1.2         | 1.4         | 1.5         |
| Waste Sector Processes                  | 92.7        | 93.3        | 90.0        | 89.6        | 88.3        | 84.9        | 84.5        | 86.1        | 88.0        | 83.5        | 81.9        | 80.2        | 80.9        |
| <b>Industrial Wastewater Treatment</b>  | <b>2.6</b>  | <b>2.1</b>  | <b>2.2</b>  | <b>2.6</b>  | <b>2.1</b>  | <b>2.0</b>  | <b>1.9</b>  | <b>2.1</b>  | <b>2.1</b>  | <b>2.1</b>  | <b>1.9</b>  | <b>2.1</b>  | <b>1.9</b>  |
| Industrial Wastewater Treatment Process | 2.6         | 2.1         | 2.2         | 2.6         | 2.1         | 2.0         | 1.9         | 2.1         | 2.1         | 2.1         | 1.9         | 2.1         | 1.9         |
| <b>Solid Waste Combustion</b>           | <b>9.6</b>  | <b>9.8</b>  | <b>10.0</b> | <b>9.9</b>  | <b>10.1</b> | <b>10.2</b> | <b>9.2</b>  | <b>9.5</b>  | <b>9.2</b>  | <b>9.3</b>  | <b>9.3</b>  | <b>9.1</b>  | <b>8.8</b>  |
| Fuel Combustion                         | 9.6         | 9.8         | 10.0        | 9.9         | 10.1        | 10.2        | 9.2         | 9.5         | 9.2         | 9.3         | 9.3         | 9.1         | 8.8         |
| <b>Industrial Waste Landfills</b>       | <b>8.9</b>  | <b>8.7</b>  | <b>8.0</b>  | <b>8.5</b>  | <b>8.3</b>  | <b>7.9</b>  | <b>7.5</b>  | <b>7.4</b>  | <b>7.4</b>  | <b>7.4</b>  | <b>7.5</b>  | <b>6.9</b>  | <b>6.7</b>  |
| Waste Sector Processes                  | 8.9         | 8.7         | 8.0         | 8.5         | 8.3         | 7.9         | 7.5         | 7.4         | 7.4         | 7.4         | 7.5         | 6.9         | 6.6         |

<sup>a</sup> These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported (e.g., those below the reporting threshold).

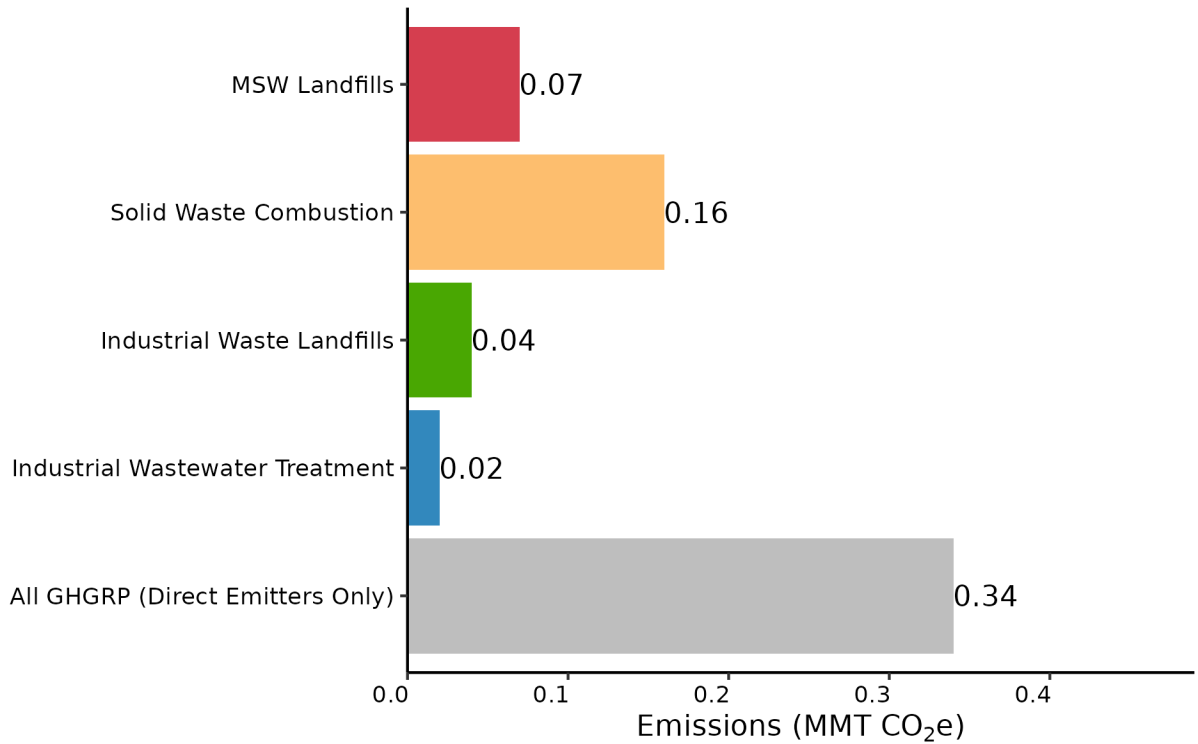
<sup>b</sup> Totals may not sum due to independent rounding.

<sup>c</sup> Emissions from fuel combustion are defined here as emissions reported under Subpart C.

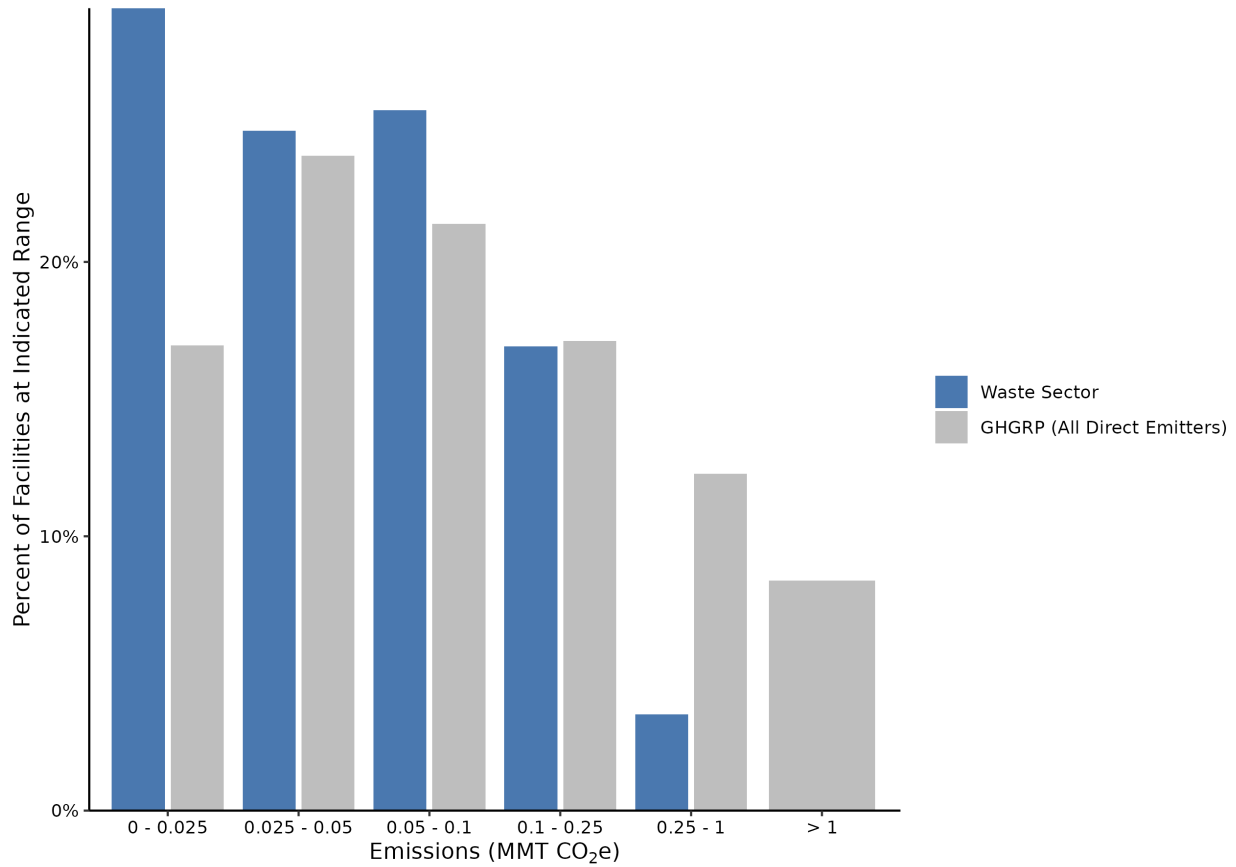
Figure 8 shows the average emissions per reporter from the waste subsectors compared with average emissions from all GHGRP reporters. Figure 9 and Table 7 show the percentage and number of reporters within each emission range, respectively.

### Average and Range of Emissions per Reporter

**Figure 8: Average Emissions per Reporter from the Waste Sector (2023)**



**Figure 9: Percentage of Facilities in the Waste Sector at Various Emissions Ranges (2023)**



**Table 7: Waste Sector – Number of Facilities by Emissions Range in MMT CO<sub>2</sub>e (2023)**

| Waste Sector           | 0 - 0.025 | 0.025 - 0.05 | 0.05 - 0.1 | 0.1 - 0.25 | 0.25 - 1 |
|------------------------|-----------|--------------|------------|------------|----------|
| Industrial Landfills   | 80        | 37           | 29         | 16         | 0        |
| MSW Landfills          | 259       | 304          | 317        | 204        | 41       |
| Solid Waste Combustion | 2         | 4            | 13         | 25         | 10       |
| Wastewater Treatment   | 90        | 17           | 10         | 1          | 0        |

## MSW Landfill Details

Table 8 shows the characteristics of MSW landfills in 2023, and Table 9 shows emissions by type of MSW landfill.

**Table 8: Characteristics of MSW Landfills in 2011-2023**

| Operational Characteristic                 | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  | 2021  | 2022  | 2023  |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Number of reporting facilities             | 1,240 | 1,252 | 1,240 | 1,237 | 1,168 | 1,145 | 1,140 | 1,139 | 1,131 | 1,132 | 1,131 | 1,129 | 1,125 |
| Number of open landfills                   | 958   | 964   | 968   | 969   | 945   | 940   | 942   | 945   | 947   | 946   | 938   | 935   | 933   |
| Number of closed landfills                 | 282   | 288   | 272   | 268   | 223   | 205   | 198   | 194   | 184   | 186   | 193   | 194   | 192   |
| Number of landfills with gas collection    | 914   | 926   | 926   | 923   | 864   | 850   | 847   | 849   | 832   | 837   | 834   | 842   | 845   |
| Number of landfills without gas collection | 326   | 326   | 314   | 314   | 304   | 295   | 293   | 290   | 299   | 295   | 297   | 287   | 280   |

MSW landfills are required to report under Subpart HH if their methane generation value meets or exceeds 25,000 MT of CO<sub>2</sub>e. However, these facilities can cease reporting if their emissions are under 25,000 MT CO<sub>2</sub>e for five consecutive years, or under 15,000 MT CO<sub>2</sub>e for three consecutive years.

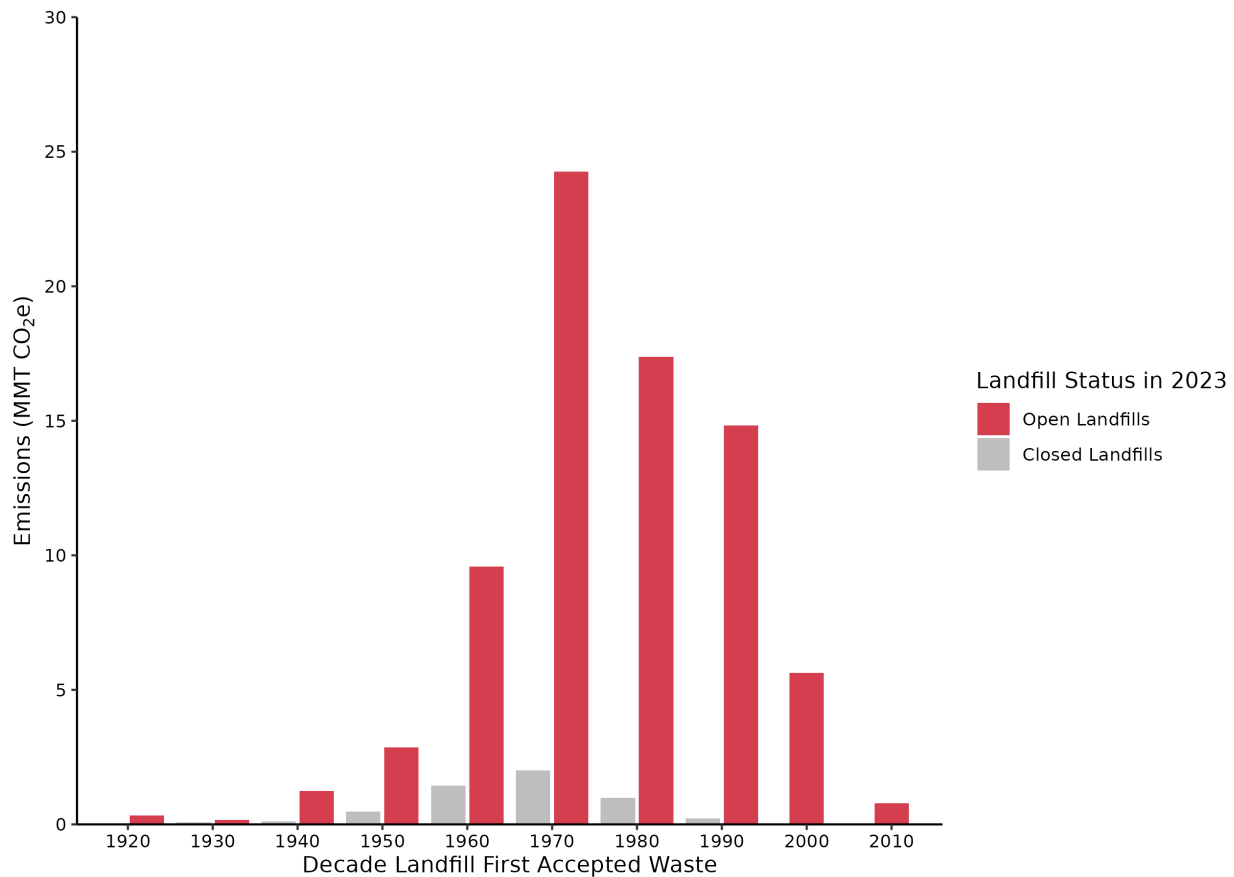
**Table 9: Direct Emissions by Type of MSW Landfill in 2011-2023 (MMT CO<sub>2</sub>e)<sup>a</sup>**

| Operational Characteristics                    | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total Emissions                                | 93.8 | 94.4 | 91.2 | 90.8 | 89.6 | 86.4 | 85.9 | 87.7 | 89.4 | 85.0 | 83.1 | 81.6 | 82.4 |
| Total emissions for closed landfills           | 9.3  | 9.3  | 8.5  | 8.4  | 7.7  | 6.8  | 5.8  | 5.4  | 5.1  | 5.0  | 5.0  | 5.5  | 5.3  |
| Total emissions for open landfills             | 84.5 | 85.1 | 82.6 | 82.4 | 81.9 | 79.6 | 80.2 | 82.3 | 84.3 | 80.0 | 78.1 | 76.2 | 77.1 |
| Emissions for landfills without gas collection | 23.6 | 23.5 | 22.0 | 21.7 | 21.6 | 21.1 | 20.3 | 20.8 | 21.5 | 21.6 | 21.3 | 20.7 | 20.5 |
| Emissions for landfills with gas collection    | 70.2 | 70.9 | 69.2 | 69.2 | 68.0 | 65.2 | 65.6 | 66.9 | 67.9 | 63.4 | 61.8 | 61.0 | 61.9 |

<sup>a</sup> Totals may not sum due to independent rounding.

Figure 10 displays total methane emissions (in MMT CO<sub>2</sub>e) and the operational status of the landfill (i.e., open and closed) in 2023, grouped by the decade the landfill first accepted waste. The Waste Sector is unique because emissions in the current RY are heavily impacted by the quantity of waste already in place at the landfills and the age of that waste (i.e., the year, or decade in this case, that the waste was first disposed of in the landfill). Figure 10 shows that most emissions in the current reporting year result from landfills that first accepted waste between the 1970s and 1990s, and are still open in 2023. The largest number of reporting landfills first opened and started accepting waste in the 1970s. More than 300 of these landfills still accept waste in 2023, which explains why the 1970s era landfills contributed the most to current methane emissions.

**Figure 10: MSW Landfill Emissions (2023)**



## Industrial Wastewater Treatment Details

Table 10 shows facility counts and emissions by NAICS codes.

**Table 10: Major NAICS Codes and Emissions for Industrial Wastewater Treatment in 2023<sup>a</sup>**

| Major NAICS Code                                       | Industry                             | Facility Count | Facility Percent | Emissions (MMT CO <sub>2</sub> e) | Emissions Percent |
|--|--------------------------------------|----------------|------------------|-----------------------------------|-------------------|
| 3114   | Fruits and vegetables                | 14             | 11.97%           | 0.15                              | 7.66%             |
| 3116, 112340   | Meat and poultry                     | 66             | 56.41%           | 1.54                              | 79.85%            |
| 221112, 311221, 311222, 312120, 312140, 325193, 325199 | Ethanol                              | 26             | 22.22%           | <0.05                             | 1.03%             |
| 322110, 322121, 322130                                 | Pulp and paper                       | 9              | 7.69%            | 0.22                              | 11.42%            |
| 311512   | Creamery Butter Manufacturing        | 1              | 0.85%            | <0.05                             | 0.02%             |
| 311224   | Soybean and Other Oilseed Processing | 1              | 0.85%            | <0.05                             | 0.01%             |
| Total  | -                                    | 117            | 100%             | 1.93                              | 100%              |

<sup>a</sup> Totals may not sum due to independent rounding.

## Industrial Waste Landfill Details

Tables 11 and 12 show additional details on the industrial landfill subsector.

**Table 11: Characteristics of Industrial Waste Landfills in 2011–2023**

| Data                                       | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Number of reporting facilities             | 176  | 176  | 176  | 178  | 174  | 172  | 172  | 171  | 170  | 168  | 168  | 163  | 162  |
| Number of open landfills                   | 144  | 142  | 140  | 143  | 141  | 140  | 138  | 136  | 139  | 136  | 134  | 132  | 130  |
| Number of closed landfills                 | 32   | 34   | 36   | 35   | 33   | 32   | 34   | 35   | 31   | 32   | 34   | 31   | 32   |
| Number of landfills with gas collection    | 2    | 2    | 2    | 2    | 1    | 1    | 1    | 1    | 1    | 1    | 2    | 2    | 2    |
| Number of landfills without gas collection | 174  | 174  | 174  | 176  | 173  | 171  | 171  | 170  | 169  | 167  | 166  | 161  | 160  |

**Table 12: Methane Emissions for Industrial Waste Landfills in 2011–2023 (MMT CO<sub>2</sub>e)<sup>a</sup>**

| Data   | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Total Emissions                                      | 8.9  | 8.7  | 8.0  | 8.5  | 8.3  | 7.9  | 7.5  | 7.4  | 7.4  | 7.4  | 7.5  | 6.9  | 6.7  |
| Total emissions for closed landfills                 | 0.8  | 0.7  | 0.7  | 0.6  | 0.6  | 0.5  | 0.5  | 0.5  | 0.4  | 0.4  | 0.4  | 0.4  | 0.4  |
| Total emissions for open landfills                   | 8.1  | 8.0  | 7.4  | 7.9  | 7.7  | 7.4  | 6.9  | 6.9  | 7.0  | 7.0  | 7.0  | 6.5  | 6.3  |
| Total emissions for landfills without gas collection | 8.5  | 8.3  | 7.6  | 8.0  | 7.9  | 7.8  | 7.4  | 7.4  | 7.4  | 7.4  | 7.3  | 6.6  | 6.4  |
| Total emissions for landfills with gas collection    | 0.4  | 0.4  | 0.4  | 0.5  | 0.3  | 0.1  | 0.1  | 0.0  | 0.0  | 0.0  | 0.2  | 0.2  | 0.2  |

<sup>a</sup> Totals may not sum due to independent rounding.

Figure 11 displays total methane emissions (in MMT CO<sub>2</sub>e) and the operational status of industrial waste landfills in 2023 (i.e., open and closed) by the decade the landfill first accepted waste. The majority of 2023 emissions result from landfills that first accepted waste between the 1960s and 1980s, and are still open in 2023. There are significantly more open landfills than closed landfills contributing to total emissions in the current RY. Forty-five of the landfills that opened in the 1960s were still accepting waste in 2023, which is why emissions from landfills that opened in that decade are higher than in other decades.

**Figure 11: Industrial Waste Landfill Emissions (2023)**

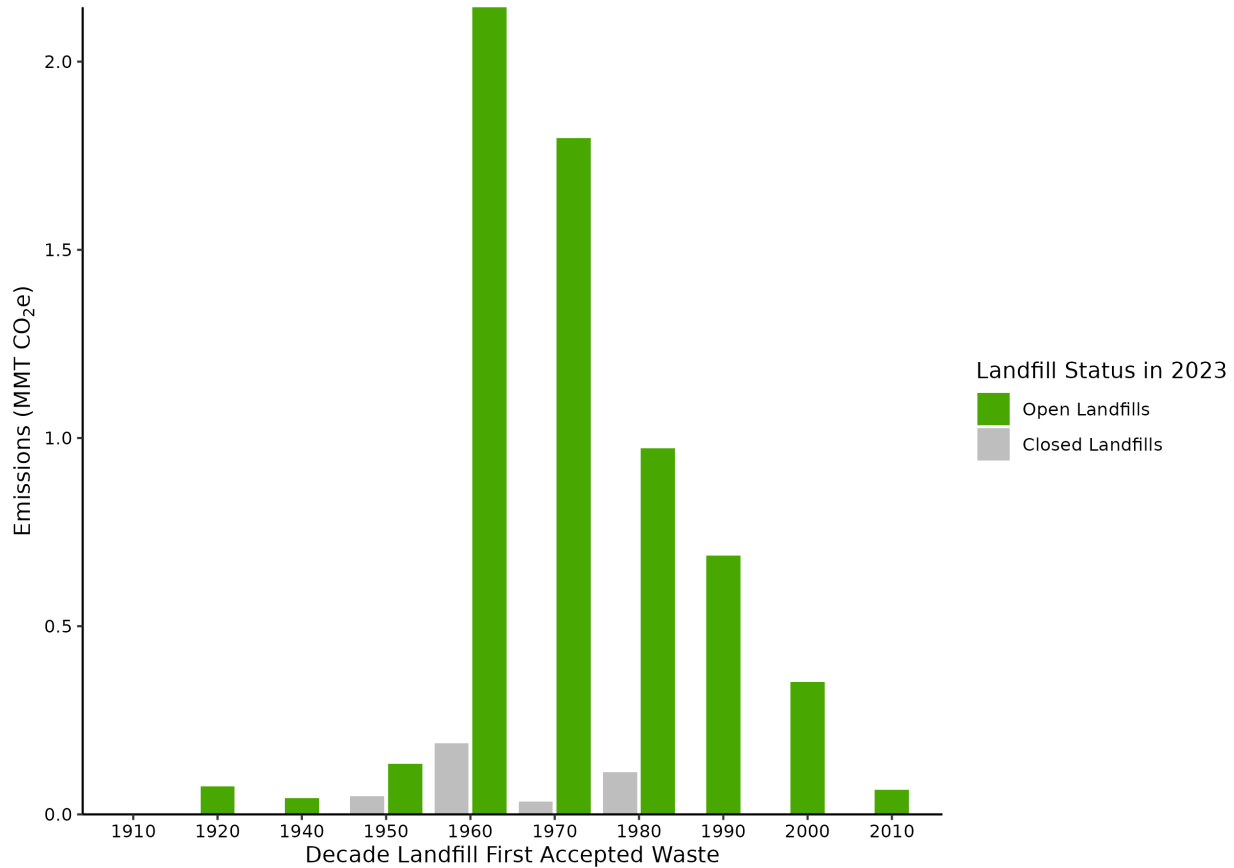


Table 13 shows total emissions in the industrial waste landfill subsector and the number of facilities (unique and combined) grouped by major NAICS code.



**Table 13: Major NAICS Code Groups Represented by Reporting Industrial Waste Landfills (2023)<sup>a</sup>**

| Major NAICS Code | NAICS Code Description                    | Combined Facility Count | Unique Facility Count | Percent of Total Facilities | Emissions (MMT CO <sub>2</sub> e) | Percent of Total Emissions |
|------------------|---|-------------------------|-----------------------|-----------------------------|-----------------------------------|----------------------------|
| 212              | Mining (except oil and gas)               | 1                       | 1                     | 0.6%                        | 0.0                               | 0.2%                       |
| 221              | Utilities                                 | 6                       | 5                     | 3.1%                        | 0.2                               | 2.6%                       |
| 311              | Food manufacturing                        | 11                      | 11                    | 6.8%                        | 0.4                               | 5.6%                       |
| 321              | Wood product manufacturing                | 4                       | 2                     | 1.2%                        | 0.0                               | 0.1%                       |
| 322              | Paper manufacturing                       | 108                     | 89                    | 54.9%                       | 4.1                               | 61.1%                      |
| 324              | Petroleum and coal products manufacturing | 5                       | 5                     | 3.1%                        | 0.0                               | 0.7%                       |
| 325              | Chemical manufacturing                    | 29                      | 17                    | 10.5%                       | 0.5                               | 7.7%                       |
| 327              | Nonmetallic mineral product manufacturing | 1                       | NA                    | NA%                         | NA                                | NA%                        |
| 331              | Primary metal manufacturing               | 17                      | 16                    | 9.9%                        | 0.6                               | 8.5%                       |
| 332              | Fabricated metal product manufacturing    | 2                       | 1                     | 0.6%                        | 0.0                               | 0%                         |
| 531              | Real Estate                               | 2                       | 1                     | 0.6%                        | 0.0                               | 0.6%                       |
| 562              | Waste management and remediation services | 15                      | 14                    | 8.6%                        | 0.8                               | 12.8%                      |
| Total            | -   | 201                     | 162                   | 100%                        | 6.7                               | 100%                       |

<sup>a</sup> Facilities may report multiple NAICS codes based on operations conducted at their facilities. The counts presented in this column include all facilities that reported the relevant NAICS code as a primary, secondary, or additional NAICS code.

<sup>b</sup> The data presented in this column represent the total emissions for facilities that reported the relevant NAICS code as their primary code so as not to double-count emissions. This column does not sum emissions from facilities that reported their respective NAICS codes as secondary or additional.

<sup>c</sup> No facilities reported NAICS code 327 as their primary business.

The majority of industrial facilities that report emissions under the industrial waste landfill subsector have dedicated onsite landfills. These landfills are presumed to only accept waste generated by that particular facility. Some industrial waste landfills are not associated with any particular industrial sector (i.e., NAICS code 562), and these facilities accept mixed industrial waste from various industries.

Paper manufacturing facilities contributed the majority of industrial waste landfill emissions in 2023 (4.07 MMT CO<sub>2</sub>e or 61.1%). Waste management and remediation services facilities (0.85 MMT

CO<sub>2</sub>e or 12.8%) and primary metal manufacturing sector facilities (0.57 MMT CO<sub>2</sub>e or 8.5%) comprise the next largest shares.

## Calculation Methods Available for Use

Facilities in the Waste Sector emit methane from the decomposition of organic matter in wastes and emit CO<sub>2</sub>, CH<sub>4</sub>, and nitrous oxide from the combustion of solid wastes, captured methane, and other fuels.

## Emission Calculation Methodology from Stationary Fuel Combustion Units

For MSW and industrial landfills, emissions from the combustion of any collected biogas are included with emissions for the landfill facility if the landfill is not co-located with a process in another industry sector that is covered by the reporting rule (e.g., a petroleum refinery or pulp and paper facility). If the landfill is co-located, then the combustion emissions are included with the emissions from the co-located industry sector. For industrial wastewater, combustion emissions are included with the emissions from the pulp and paper, ethanol manufacturing, food processing, or petroleum refining industry sector, as appropriate. The calculation methodology for stationary fuel combustion sources (Subpart C) is explained [here](#).

## Emission Calculation Methodologies for Process Emissions Sources

**MSW Landfill Emission Calculation Methodology** Because there is no internationally agreed-upon and cost-effective approach to directly measure the amount of CH<sub>4</sub> emitted from landfills, the emissions estimation methodology uses a combination of gas measurements, models, and calculations. The calculation procedure for MSW landfills depends on whether the landfill has an active landfill GCCS.

- **Landfills without a GCCS.** MSW landfills without an active landfill GCCS must calculate CH<sub>4</sub> generation using a first-order decay model for CH<sub>4</sub> generation in the landfill (Equation HH-1 of the rule, which is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5). Equation HH-1 uses the quantities and types of wastes disposed in the landfill, a default or measured CH<sub>4</sub> fraction in the landfill gas, and other characteristics of the landfill as model inputs. The CH<sub>4</sub> generation is corrected using Equation HH-5 to account for CH<sub>4</sub> that oxidizes (and therefore is not emitted) as it passes through the landfill cover material.
- **Landfills with an active GCCS.** MSW landfills with an active GCCS must calculate emissions using Equations HH-6 and HH-8 of the rule, and specify which method they consider most accurate for their facility. FLIGHT displays emissions from both methods but uses the facility-specified value to calculate total emissions from the MSW landfills subsector. If the facility does not specify which equation to use, FLIGHT uses the higher value.
  - Equation HH-6 estimates emissions using the modeled CH<sub>4</sub> generation rate (Equation HH-1, described above) minus the measured amount of CH<sub>4</sub> recovered and destroyed. CH<sub>4</sub> generated in excess of the measured CH<sub>4</sub> recovery is corrected to account for CH<sub>4</sub> oxidation in the landfill cover material.

- Equation HH-8 estimates emissions based on the measured quantity of methane recovered for destruction and an estimated landfill gas collection efficiency, which varies by type of landfill cover material used. This equation back-calculates the quantity of uncollected gas, which is then corrected to account for methane oxidation in the landfill cover material. Emissions from the gas collected and intended for destruction are estimated based on the CH<sub>4</sub> destruction efficiency of the combustion device.

The values resulting from Equations HH-6 and HH-8 may vary significantly, depending on the characteristics of the landfill. For example, the amount of recovered methane can vary by year, and the landfill gas collection efficiency will change yearly for open landfills. The collection efficiency will change yearly because it is estimated using an area-weighted approach that is dependent on the surface area of each stage of cover (daily, intermediate, or final). While Equation HH-8 incorporates more site-specific information, it might not provide the most accurate GHG emission estimate for every landfill due to the many variables that affect landfill GHG emissions.

Until 2013, all landfills were required to use a methane oxidation fraction of 0.10 in their methane emission equations. In 2013, a rule change allowed for the use of different default methane oxidation fractions each year if the facility opted to calculate its landfill methane flux using the provided methodology. A default value of 0.10 must be used if the facility chooses not to calculate landfill methane flux. The results of the methane flux calculations, combined with the extent of soil cover at the landfill, direct the reporter to the appropriate oxidation fraction to use. The methane oxidation fraction values available for use are 0.0, 0.10, 0.25, and 0.35. Using a higher oxidation fraction value results in lower methane emissions than when a lower oxidation fraction value is used.

Beginning in 2013, facilities were required to report the oxidation fraction used for each relevant emission equation. Table 14 shows the oxidation fraction value used in each equation. Approximately 47.5% of facilities without a GCCS used the higher oxidation fractions of 0.25 or 0.35, and 2.1% used a value of zero. A larger percentage of facilities with landfill gas collection (59.2% - 80.9%) used the higher oxidation values of 0.25 or 0.35, while approximately 0.6% used a value of zero.

**Table 14: MSW Landfills – Methane Oxidation Fraction Values Used by MSW Landfills (2023)<sup>a</sup>**

| Oxidation Factor<br>Default Value | Without GCCS |             | With GCCS         |             |            |             |                   |             |            |             |
|-----------------------------------|--------------|-------------|-------------------|-------------|------------|-------------|-------------------|-------------|------------|-------------|
|                                   | HH-5         |             | HH-5 <sup>b</sup> |             | HH-6       |             | HH-7 <sup>b</sup> |             | HH-8       |             |
|                                   | Count        | %           | Count             | %           | Count      | %           | Count             | %           | Count      | %           |
| 0                                 | 6            | 2.1%        | 5                 | 0.6%        | 5          | 0.6%        | 5                 | 0.6%        | 5          | 0.6%        |
| 0.1                               | 141          | 50.4%       | 340               | 40.2%       | 204        | 24.1%       | 260               | 30.8%       | 156        | 18.5%       |
| 0.25                              | 121          | 43.2%       | 488               | 57.8%       | 519        | 61.4%       | 524               | 62%         | 398        | 47.1%       |
| 0.35                              | 12           | 4.3%        | 12                | 1.4%        | 117        | 13.8%       | 56                | 6.6%        | 286        | 33.8%       |
| <b>Total</b>                      | <b>280</b>   | <b>100%</b> | <b>845</b>        | <b>100%</b> | <b>845</b> | <b>100%</b> | <b>845</b>        | <b>100%</b> | <b>845</b> | <b>100%</b> |

<sup>a</sup> Totals may not sum due to independent rounding.

<sup>b</sup> Landfills with GCCSs must report landfill gas generation using both Equations HH-5 and HH-7, in addition to calculating emissions using both Equations HH-6 and HH-8.

Table 15 presents the number of facilities with a GCCS and the calculation method used (either Equation HH-6 or HH-8) for each RY. Facilities may use the equation they feel is most appropriate based on their facility operations. Most facilities used Equation HH-8 in each of the ten reporting years. Equation HH-8 is based on the measured quantity of recovered methane, while Equation HH-6 is based on the amount of modeled methane generation.

**Table 15: MSW Landfills – Use of Equation HH-6 versus HH-8 by RY**

|                                    | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
|------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Facilities with a GCCS             | 926  | 926  | 923  | 864  | 850  | 847  | 849  | 832  | 837  | 833  | 841  | 844  |
| Facilities that used Equation HH-6 | 347  | 276  | 284  | 273  | 272  | 266  | 282  | 260  | 242  | 226  | 224  | 223  |
| Facilities that used Equation HH-8 | 578  | 650  | 639  | 591  | 578  | 581  | 567  | 572  | 595  | 607  | 617  | 621  |

**Industrial Wastewater Treatment Calculation Methodology** The calculation procedure of industrial wastewater treatment depends on whether biogas is recovered from the anaerobic reactor(s) or lagoon(s) operating at the facility. All anaerobic sludge digesters are assumed to recover biogas. The methodology for sludge digesters does not include calculating CH<sub>4</sub> generation using chemical oxygen demand (COD) or the five-day biochemical oxygen demand (BOD<sub>5</sub>), because it is assumed that all generated methane is recovered.

- **No biogas recovery.** All facilities with anaerobic reactors or lagoons calculate emissions using measurements of the volume of wastewater, measurements of the average weekly concentration of either COD or BOD<sub>5</sub>, and a default methane conversion factor. All methane generated during the process is emitted (Equation II-3).
- **With biogas recovery.** All facilities with anaerobic reactors, lagoons, or sludge digesters that recover biogas calculate emissions using measurements of the flow of recovered

biogas; methane concentration, temperature, pressure, and moisture; and default values for biogas collection efficiency and methane destruction efficiency. Equation II-4 determines the amount of methane recovered in the process and Equation II-5 uses the collection efficiency to estimate the amount of methane that leaks out of equipment. Equation II-6 determines total methane emissions by summing methane leakage and methane not destroyed in the destruction device.

Solid waste combustion facilities must report under Subpart C, and the reporter generally must use one of four calculation methodologies (tiers) to calculate CO<sub>2</sub> emissions depending on fuel type and unit size. The calculation methodologies for Subpart C are explained in more detail [here](#). Units that are not subject to Subpart D but are required by states to monitor emissions according to Part 75 can report CO<sub>2</sub> emissions under Subpart C using Part 75 calculation methods and monitoring data that they already collect under Part 75 (e.g., heat input and fuel use). Methane and nitrous oxide mass emissions are also required to be reported for fuels that are included in Table C-2 of Part 98 and are calculated using either an estimated or measured fuel quantity, default or measured HHV, and default emission factors.

## Data Verification and Analysis

As a part of the reporting and verification process, EPA evaluates annual GHG reports with electronic checks and staff review as needed. EPA contacts facilities regarding potential substantive errors and facilities resubmit reports as errors are identified. Additional information on EPA's verification process is available [here](#).

## Other Information

EPA's Landfill Methane Outreach Program (LMOP) is a voluntary assistance program that promotes the reduction of CH<sub>4</sub> emissions from landfills by encouraging the recovery and beneficial use of landfill gas as an energy resource. By joining LMOP, companies, state agencies, organizations, landfill operators, and communities gain access to a vast network of industry experts and practitioners, as well as various technical and marketing resources that can help with landfill gas energy project development. LMOP maintains a list of candidate landfills where available data indicate that installing a landfill gas-to-energy project is likely to provide financial benefits. LMOP defines a candidate landfill as one that is accepting waste or has been closed for five years or less; has at least one million tons of waste; and does not have an operational, under-construction, or planned landfill gas-to-energy project.

EPA's U.S. Greenhouse Gas Inventory (hereafter referred to as the Inventory) estimates total U.S. GHG emissions from Waste Sector sources. National-level emissions presented in the Inventory report differ from the total emissions reported to the GHGRP for several reasons:

- The Inventory accounts for emissions from all facilities in a given sector. The GHGRP, on the other hand, includes only those facilities that meet the reporting thresholds. The coverage and the emissions methodologies differ between the two programs (see Table 3 for estimated coverage across the Waste Sector).
- The Inventory estimates for MSW landfills are a combination of top-down and bottom-up estimates for certain years in the Inventory time series, representing national emissions that are intended to be inclusive of all facilities within a given sector. The 1990–2017 Inventory for MSW landfills incorporated directly reported CH<sub>4</sub> emissions from facilities

reporting to the GHGRP (for years 2010 to 2017), with a scale-up factor to account for emissions from MSW landfills that do not meet GHGRP's reporting threshold.<sup>5</sup>

- The Inventory estimate for industrial waste landfill emissions includes only the pulp and paper and food and beverage sector facilities, whereas subpart TT of the GHGRP covers many more industries. Due to a lack of industrial waste disposal data for all facilities within each industrial sector, the inventory uses proxy data (i.e., annual production data multiplied by a disposal factor) to estimate the amount of waste disposed of by the pulp and paper and food and beverage sectors. The GHGRP uses a bottom-up calculation approach and requires facilities to report the amount of waste disposed.
- The Inventory estimate for industrial wastewater treatment includes aerobic ponds with anaerobic portions, but under the GHGRP, only emissions from strictly anaerobic processes are required to be reported.
- The Inventory does not capture emissions from wastewater sludge digesters or CH<sub>4</sub> recovered from anaerobic treatment processes, while the GHGRP does.

## Glossary

**Anaerobic process** refers to a procedure in which organic matter in wastewater, wastewater treatment sludge, or other material is degraded by micro-organisms in the absence of oxygen, resulting in the generation of CO<sub>2</sub> and CH<sub>4</sub>. This source category consists of the following: anaerobic reactors, anaerobic lagoons, anaerobic sludge digesters, and biogas destruction devices (e.g., burners, boilers, turbines, flares, or other devices) (40 CFR Part 98.350).

**Biogenic CO<sub>2</sub> emissions** means CO<sub>2</sub> released from the combustion or decomposition of biologically based materials other than fossil fuels.

**Continuous emission monitoring system** or CEMS means the total equipment required to sample, analyze, measure, and provide, by means of readings recorded at least once every 15 minutes, a permanent record of gas concentrations, pollutant emission rates, or gas volumetric flow rates from stationary sources (40 CFR Part 98.6).

**Ethanol production** means an operation that produces ethanol from the fermentation of sugar, starch, grain, or cellulosic biomass feedstocks; or the production of ethanol synthetically from petrochemical feedstocks, such as ethylene or other chemicals.

**FLIGHT** refers to EPA's GHG data publication tool, named the Facility Level Information on GreenHouse gases Tool (<https://ghgdata.epa.gov/ghgp/main.do#>).

**Food processing** means an operation used to manufacture or process meat, poultry, fruits, and/or vegetables as defined under NAICS 3116 (Meat Product Manufacturing) or NAICS 3114 (Fruit and Vegetable Preserving and Specialty Food Manufacturing). For information on NAICS codes, see <http://www.census.gov/eos/www/naics/>.

**GCCS** means a landfill's gas collection and control system.

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<sup>5</sup> Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017. EPA 430-R-19-001. U.S. Environmental Protection Agency. April 14, 2021. Available: <https://www.epa.gov/ghgemissions/overview-greenhouse-gases.6456.7>.

**GHGRP** means EPA's Greenhouse Gas Reporting Program (40 CFR Part 98).

**GHGRP vs. GHG Inventory:** EPA's Greenhouse Gas Reporting Program (GHGRP) collects and disseminates annual GHG data from individual facilities and suppliers across the U.S. economy. EPA also develops the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory) to track total national emissions of GHGs to meet U.S. government commitments to the United Nations Framework Convention on Climate Change. The GHGRP and Inventory datasets are complementary; however, there are also important differences in the data and approach. For more information, please see <https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-usinventory-greenhouse-gas-emissions-and-sinks>.

**IPCC AR4** refers to the Fourth Assessment Report by the Intergovernmental Panel on Climate Change. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K. and A. Reisinger. (eds.)]. IPCC, Geneva, Switzerland, 2007. The AR4 values also can be found in the current version of Table A-1 in Subpart A of 40 CFR Part 98.

**Industrial wastewater** means water containing wastes from an industrial process. Industrial wastewater includes water that comes into direct contact with or results from the storage, production, or use of any raw material, intermediate product, finished product, by-product, or waste product. Examples of industrial wastewater include, but are not limited to, paper mill white water, wastewater from equipment cleaning, wastewater from air pollution control devices, rinse water, contaminated stormwater, and contaminated cooling water.

**Industrial waste landfill** means any landfill other than a MSW landfill, a Resource Conservation and Recovery Act (RCRA) Subtitle C hazardous waste landfill, or a Toxic Substances Control Act hazardous waste landfill, in which industrial solid waste, such as RCRA Subtitle D wastes (nonhazardous industrial solid waste, defined in §257.2 of this chapter), commercial solid wastes, or conditionally exempt small quantity generator wastes, is placed. An industrial waste landfill includes all disposal areas at the facility.

**Industrial wastewater treatment sludge** means solid or semi-solid material resulting from the treatment of industrial wastewater, including, but not limited to, biosolids, screenings, grit, scum, and settled solids.

**Landfill Methane Outreach Program** or LMOP is a voluntary assistance program run by EPA to help reduce CH<sub>4</sub> emissions from landfills by encouraging the recovery and beneficial use of landfill gas as an energy resource (<http://www.epa.gov/lmop/>).

**MT** means metric tons.

**MMT** means million metric tons.

**Municipal solid waste landfill**, as defined by the GHGRP, means an entire disposal facility in a contiguous geographical space where household waste is placed in or on land. An MSW landfill may also receive other types of RCRA Subtitle D wastes (40 CFR 257.2) such as commercial solid waste, nonhazardous sludge, conditionally exempt small quantity generator waste, and industrial solid waste. Portions of an MSW landfill may be separated by access roads, public roadways, or other public right-of-ways. An MSW landfill may be publicly or privately owned (40 CFR Part 98.6).

**NAICS** means the North American Industry Classification System, the standard used by federal statistical agencies to classify business establishments into industrial categories for collecting and publishing statistical data related to the U.S. economy.

**Wastewater treatment systems** are the collection of all processes that treat or remove pollutants and contaminants, such as soluble organic matter, suspended solids, pathogenic organisms, and chemicals from wastewater prior to its reuse or discharge from the facility.