



Department of  
Environmental  
Conservation

# Waste

## 2021 NYS GREENHOUSE GAS EMISSIONS REPORT

### SECTORAL REPORT #4

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## Format of This Report

This sectoral report provides a detailed explanation of methods, data, and trends for the Waste sector. The accounting used in this sectoral report follows the requirements of the Climate Leadership and Community Protection Act (CLCPA) and is in alignment with the 6 NYCRR Part 496 regulation, “Statewide GHG Emission Limits.” This includes the use of a 20-Year Global Warming Potential metric provided in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC 2013). The organization of this report and specific methodologies are based on guidelines from the IPCC Taskforce on National Greenhouse Gas Inventories (or “IPCC guidelines”) as applied in the U.S. national greenhouse gas emissions report (IPCC 2006 and 2019, EPA 2021a). The accompanying Summary Report provides a comparison with other accounting methods, including by economic sector or using conventional accounting formats. DEC also intends to provide emission values for all years via the Open Data NY platform.

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## Waste

This sectoral report provides information on greenhouse gas emissions associated with the management and treatment of waste materials, broken into solid waste management, biological treatment of solid wastes, waste combustion, and wastewater (Table SR4.1). Most solid wastes are sent to solid waste management facilities (landfills) or combustion facilities. Organic wastes may also be treated through composting or anaerobic digestion, which the IPCC guidelines refers to as the “biological treatment of solid wastes”. Finally, wastewater is either treated on-site in septic systems or collected, treated, and discharged via a centralized wastewater system. Emissions associated with the production, transportation, use, or recycling of materials may be found in the other sectoral reports, such as *Sectoral Report #1: Energy* or *Sectoral Report #2: Industrial Processes and Product Use*.

The organization of information in this report deviates from the IPCC guidelines and U.S. national greenhouse gas inventory in three ways. First, the IPCC guidelines for national governments assign waste combustion emissions to the energy sector as “waste-to-energy”. Although waste combustion facilities produce energy, their primary role in New York is in waste management. Secondly, some of the solid wastes produced in New York are exported to facilities outside of the state for disposal. The IPCC guidelines only consider emissions that occur within the given jurisdiction. However, the exporting of waste represents a potentially large source of emission leakage<sup>1</sup> for New York State, so this report includes emissions from solid wastes sent to landfills and combustion facilities in other states in emission totals. Finally, under the IPCC guidelines for national net emission accounting, the carbon dioxide (CO<sub>2</sub>) produced from waste is considered biogenic and reported separately from other anthropogenic emissions. The same practice is applied in this report in that biogenic CO<sub>2</sub> is also excluded from net emission totals. However, CO<sub>2</sub> emissions associated with the combustion of waste and landfill gas are included as part of gross emission totals (Table SR4.1, Table SR4.2), while emissions associated with natural decomposition are omitted entirely.<sup>2</sup>

An important consideration for the waste sector is that landfills are the dominant source of emissions and these emissions are generated over multiple decades. This means that current emissions are the result of waste deposited in landfills in the past and that waste deposited today will continue to produce emissions through 2050 and beyond. The “methane commitment” of landfilled waste is not quantified in this report. Methane commitment accounting quantifies the total lifetime amount of methane (CH<sub>4</sub>) that could be generated from waste deposited in a landfill each year. The methodology employed in this report uses an emission factor for “CH<sub>4</sub> generation potential” of 100 m<sup>3</sup> per ton MSW (EPA 2020). This is equivalent to 5.71 metric tons CO<sub>2</sub>e per ton MSW using a 20-year Global Warming Potential. CH<sub>4</sub> generation potential does not account for oxidation of CH<sub>4</sub> in the cover layer, or CH<sub>4</sub> destruction via capture systems.

In 2019, total statewide emissions for the waste sector were 45.54mmt CO<sub>2</sub>e GWP20 on a gross basis, which was 12% of all statewide gross emissions (Table SR4.1). Waste sector emissions increased 3 percent from 1990 to 2019. The largest source of emissions in all years was what the IPCC guidelines refer to as “solid waste management” (or landfills). As discussed below, non-CO<sub>2</sub> emissions from composting and solid waste anaerobic digesters (i.e., the biologic treatment of solid wastes) are not estimated in this report and are not expected to contribute emissions at this time. Biogenic CO<sub>2</sub> is omitted in net totals and this includes CO<sub>2</sub> from the combustion of waste and waste gas.

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<sup>1</sup> For example, emission leakage might occur when emissions within a jurisdiction appear to be reduced, but the emission source has just been relocated outside of that jurisdiction.

<sup>2</sup> Per 6 NYCRR Part 496

Importantly, total emissions include those associated with the exporting of waste, which has increased from 1.18mmt CO<sub>2</sub>e in 1990 to 16.05mmt CO<sub>2</sub>e in 2019 (“Exported Waste”, Table SR4.1). DEC seeks comment on whether exported wastes should be excluded from emission totals in the future noting that this represents a form of emission leakage that cannot be legally controlled by New York State (see New York State Climate Action Council Draft Scoping Plan).

**Table SR4.1 Waste Emissions, 1990-2019 (mmt CO<sub>2</sub>e GWP20)**

<b>Emission Category</b>	<b>1990</b>	<b>2005</b>	<b>2015</b>	<b>2016</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>
Solid Waste Management*	34.03	37.97	35.02	35.23	35.82	35.18	35.42
Biological Treatment of Solid Waste	no	ne	ne	ne	ne	ne	ne
Waste Combustion*	4.00	3.46	2.80	2.87	3.22	3.20	3.20
Wastewater	6.41	6.81	7.00	6.99	6.98	6.96	6.93
<b>Gross Total</b>	<b>44.44</b>	<b>48.25</b>	<b>44.82</b>	<b>45.09</b>	<b>46.01</b>	<b>45.33</b>	<b>45.54</b>
<i>% of statewide gross total</i>	<i>11.0%</i>	<i>10.5%</i>	<i>11.0%</i>	<i>11.5%</i>	<i>12.3%</i>	<i>11.7%</i>	<i>12.0%</i>
<b>Net Total</b>	<b>42.13</b>	<b>46.88</b>	<b>43.87</b>	<b>44.16</b>	<b>45.07</b>	<b>44.35</b>	<b>44.56</b>
<i>% of statewide net total</i>	<i>11.7%</i>	<i>11.2%</i>	<i>12.0%</i>	<i>12.6%</i>	<i>13.6%</i>	<i>12.8%</i>	<i>13.2%</i>
Exported Waste	1.18	10.70	15.25	15.50	15.67	15.84	16.05

“no” not occurring; “ne” not estimated; “\*” Includes in-state and out-of-state emission sources

The waste sector is responsible for emissions of CO<sub>2</sub>, CH<sub>4</sub>, and nitrous oxide (N<sub>2</sub>O). CH<sub>4</sub> is the primary greenhouse gas and represented 91% of all waste emissions in 2019 (Table SR4.2). The relative amount of each gas reflects the types of waste management used in New York. CH<sub>4</sub> is primarily associated with solid waste management in landfills, which is the primary method used to manage waste. This is further emphasized when applying a 20-year GWP because CH<sub>4</sub> is shorter lived in the atmosphere than CO<sub>2</sub> and N<sub>2</sub>O.

**Table SR4.2 2019 Waste Emissions by Gas (mmt CO<sub>2</sub>e GWP20)**

<b>Emission Category</b>	<b>CO<sub>2</sub></b>	<b>Biogenic CO<sub>2</sub></b>	<b>CH<sub>4</sub></b>	<b>N<sub>2</sub>O</b>
Solid Waste Management	na	0.52	34.89	na
Biological Treatment of Solid Waste	na	ne	ne	ne
Waste Combustion	2.62	0.45	0.09	0.04
Wastewater	na	na	6.43	0.50
<b>Gross Total</b>	<b>2.62</b>	<b>0.98</b>	<b>41.41</b>	<b>0.54</b>

“ne” not estimated; “na” not applicable

### Solid Waste Management

This IPCC category represents emissions associated with the wastes deposited in landfills. Once deposited in a landfill, wastes are decomposed by aerobic and anaerobic microorganisms, the latter of which produce methane. There are three types of landfills included in this report, municipal solid waste

(MSW) landfills in the state, MSW landfills outside of the state (or exported waste), and industrial landfills. The majority of waste in the United States is managed in MSW landfills. Waste management in the U.S. underwent significant changes in the period leading up to the 1990 baseline year.<sup>3</sup> One of the changes in New York was to replace hundreds of open, unlined waste “dumps” with managed MSW landfills that are subject to state and federal regulations to protect the environment and public health. Over time, landfills have also increasingly adopted technologies to collect and destroy methane such as through landfill-gas-to-energy (LFGTE) or flaring, which converts CH<sub>4</sub> to CO<sub>2</sub> through combustion.

MSW landfills produce significantly more greenhouse gas emissions than industrial landfills in part because industrial landfills contain less organic material. The organic carbon, or plant-based, component of waste is the primary source of emissions and the low-oxygen landfill environment promotes the generation of additional CH<sub>4</sub> as these wastes decay. Organic materials make up a large portion of waste collected from homes and businesses and deposited in MSW landfills.

### *Methodology*

The EPA State Inventory Tool (or SIT, EPA 2020) was used to estimate emissions from waste placed in landfills either in New York or exported to landfills in other states. In keeping with IPCC guidelines, the SIT applies a First Order Decay (FOD) model to estimate emissions generated by a specified volume of waste in a landfill environment. The amount of CH<sub>4</sub> that was oxidized or destroyed was subtracted from the emission estimate. Currently, the SIT uses a FOD model and assumptions based on the EPA LandGEM model. DEC is currently evaluating alternative methods as well as ways to incorporate additional sampling (see Planned Improvements). Some portion of waste deposited in industrial landfills may be organic, but this would be a smaller overall percentage of waste compared to MSW landfills. The EPA SIT estimates the annual emissions of industrial landfill waste as 7% of annual MSW landfill emissions. The industrial landfill emissions were added to MSW landfill emissions to generate total solid waste landfill emissions.

For in-state solid waste management multiple data sources were compiled to generate a full time series. The SIT FOD model assumes that emissions are generated continuously for decades after waste was deposited in a landfill. Hence, annual waste data are needed as far back as 1960 to estimate emissions in 1990. Due to lack of state data, SIT default landfill disposal tonnage values were used for 1960-1985 that are derived from national per capita waste generation rates. Facility-reported tonnage values were used for the period 1986-2018, using interpolation to provide values for any years without data. Historical information was gathered from annual reports of the NY State Assembly (NYS Assembly 2002). SIT default LFGTE and flaring values were used for 1990-2008, and data reported to DEC were used for 2009-2018. A combustion efficiency percentage and CO<sub>2</sub> emission factor were applied to the CH<sub>4</sub> capture data and these emissions are included in the New York landfills totals. Data covering the 2019 period are currently under review. For the purposes of this report, 2018 data were used to fill in for 2019. These values will be updated when data are available.

For this report, additional information was used to estimate emissions from wastes exported out of the state to either landfills or combustion facilities. For example, historical NY State Assembly reports suggest that very little waste was exported prior to the widespread closure of local dumps around 1990 to meet federal standards. However, an increasing volume was exported after 1990. For 1986-2001, waste tonnages were used as reported by the NYS Assembly (NYS Assembly 2002). A combination of data sources was used to estimate the total amount of exported waste after this period, including information

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<sup>3</sup> As described in the New York State Solid Waste Management Plan

collected by DEC from waste transfer facilities, municipal offices, and as shared by other states. DEC has collated data for 2008-2018 and interpolation was used to provide values for 2002-2007. An unknown quantity of waste is exported without passing through a waste transfer facility, i.e., direct-hauled, and likely results in an underestimation of total exported waste tonnage. DEC will continue to seek new information sources to further refine this estimate.

### Results

The estimated total emissions produced by landfills remained relatively stable between 1990 and 2018, when exported waste is included (Table SR4.3). However, if exported wastes are excluded, there would be an appearance of a reduction in total emissions of 60% (from 33.25 to 19.97mmt CO<sub>2e</sub>). This reflects both the diversion of MSW to out of state landfills, and the enhanced adoption of CH<sub>4</sub> capture and destruction systems. Since the SIT method for estimating industrial waste is based on a ratio of MSW landfill emissions, they reflect the same trends as MSW landfills in this analysis.

CO<sub>2</sub> emissions from out-of-state landfills is not included in this report and listed as “na” in the table below. This is due to a lack of data on the CH<sub>4</sub> capture and destruction systems employed at out of state facilities.

**Table SR4.3 Solid Waste Management Emissions by Gas, 1990-2019 (mmt CO<sub>2e</sub> GWP20)**

Gas/Location	1990	2005	2015	2016	2017	2018	2019
<b>CO<sub>2</sub></b>	<b>0.05</b>	<b>0.33</b>	<b>0.51</b>	<b>0.51</b>	<b>0.49</b>	<b>0.52</b>	<b>0.52</b>
New York landfills	0.05	0.33	0.51	0.51	0.49	0.52	0.52
Out of State landfills	na						
<b>CH<sub>4</sub></b>	<b>33.98</b>	<b>37.64</b>	<b>34.51</b>	<b>34.72</b>	<b>35.32</b>	<b>34.65</b>	<b>34.89</b>
New York landfills	33.20	27.55	19.86	19.82	20.26	19.41	19.44
Out of State landfills	0.78	10.10	14.65	14.90	15.07	15.24	15.45
<b>Gross Total</b>	<b>34.03</b>	<b>37.97</b>	<b>35.02</b>	<b>35.23</b>	<b>35.82</b>	<b>35.18</b>	<b>35.42</b>
Exported Waste	0.78	10.10	14.65	14.90	15.07	15.24	15.45

“na” not applicable

### Biological Treatment of Solid Waste

In addition to landfilling, organic solid waste can be treated through composting or anaerobic digestion.<sup>4</sup> The types of solid waste management described in this IPCC category are not considered to be a large source of emissions in New York because they have not been widely adopted to date. However, if new State and federal policies promote adoption of these practices as alternatives to landfilling, their relative contribution to waste sector emissions are expected to increase. Hence, this sector will continue to be monitored (see Planned Improvements).

Like decomposition that naturally occurs in soils, the CO<sub>2</sub> generated from composting organic waste would not be included in greenhouse gas accounting. The emissions of CH<sub>4</sub> and N<sub>2</sub>O are minimal and will

<sup>4</sup> The IPCC guidelines also includes mechanical-biological treatment, but this is not used in New York.

depend on the management of the compost. Current State regulations require large composting facilities to manage organic waste in a way that minimizes these emissions.<sup>5</sup>

Anaerobic digestion is used to accelerate the decomposition of organic waste without oxygen (i.e., in an anaerobic environment), which promotes CH<sub>4</sub> production. The CH<sub>4</sub> may be captured and used for energy production but there is the potential for CH<sub>4</sub> leaks from piping and other sources. There are very few on-site, solid waste anaerobic digestors currently operating in New York. As the number of facilities increases and data become available, the CH<sub>4</sub> emissions from these digestors will be included in the Waste sector. The use of anaerobic digestion at wastewater facilities or farms would be reported elsewhere (i.e., as wastewater or agricultural emission sources). Any emissions resulting from the use of digester gas as an energy fuel, including leakage or “fugitive emissions”, will be reported in the Energy sector.

### Waste Combustion

This category of emissions includes the CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O associated with the combustion of municipal wastes sent to regulated combustion facilities in the state or exported to such facilities outside of the state (Table SR4.4). Wastes combusted in other contexts were not included. As in the case of fuel combustion for energy, the primary greenhouse gas from the combustion of waste is CO<sub>2</sub>. Due to the mixed compositional nature of MSW, the waste contains both organic and fossil-derived carbon (e.g., such as plastics). Emissions therefore include fossil CO<sub>2</sub> and biogenic-CO<sub>2</sub>, the latter of which is deducted when calculating net emission totals. Unlike landfilling, municipal waste combustion was not associated with a large volume of CH<sub>4</sub> because there is no anaerobic decomposition.

### *Methodology*

Emissions for this category were estimated by applying EPA MSW emission factors to the amount of waste combusted, both by in-state and out-of-state facilities (EPA 2021). The SIT was not used because it does not estimate biogenic CO<sub>2</sub>, or emissions from the combustion of organic material. The remaining CO<sub>2</sub> comes from fossil-derived materials, such as plastics, rubbers, and synthetic fibers. For in-state combustion, state data were used for the period 1990-2018, using interpolation to provide values for any years without data. 2018 values were used for 2019 and will be updated when data become available. For out-of-state combustion, facility destination information is only available beginning in 2016. However, as waste disposal contracts with combustors are generally long-term and constant, recent waste tonnage information was used to estimate emissions going back to the year that a facility began operating.

The EPA emission factor for CO<sub>2</sub> includes fossil and biogenic CO<sub>2</sub>, which are both anthropogenic. However, biogenic CO<sub>2</sub> is conventionally excluded, there is not sufficient information to determine their relative contribution. As a planned improvement, DEC is evaluating methods for apportioning CO<sub>2</sub> emissions, particularly for historic time periods in which there may not be a record of waste composition. For this report, the biogenic portion of annual total CO<sub>2</sub> was estimated by subtracting the portion of emissions that were non-biogenic (as estimated in the SIT) from total emissions as estimated using the EPA emission factor for waste combustion (EPA 2021b). The annual ratio of in-state biogenic to non-biogenic CO<sub>2</sub> emissions was applied to out-of-state waste combustion CO<sub>2</sub> emissions. The SIT estimated that in-state waste combustion resulted in 2.16mmt of fossil CO<sub>2</sub> in 2018, which was 87% of total in-state waste combustion CO<sub>2</sub> in that year. The remaining 0.66mmt CO<sub>2</sub> are of biogenic origin.

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<sup>5</sup> 6 NYCRR Part 361

## Results

Waste combustion emissions in 2018, and reported here for 2019 until data becomes available, were 3.2mmt, a reduction of 20% since 1990 (Table SR4.4). The majority of emissions are CO<sub>2</sub> (96%), with some CH<sub>4</sub> and N<sub>2</sub>O from incomplete combustion. Exported wastes are a small portion of total waste combustion emissions and this has not changed appreciably over the timeseries.

**Table SR4.4 Waste Combustion Emissions by Gas, 1990-2019 (mmt CO<sub>2</sub>e GWP20)**

Gas/Location	1990	2005	2015	2016	2017	2018	2019
<b>CO<sub>2</sub></b>	<b>1.58</b>	<b>2.29</b>	<b>2.25</b>	<b>2.33</b>	<b>2.63</b>	<b>2.62</b>	<b>2.62</b>
New York facilities	1.42	1.89	1.77	1.84	2.14	2.13	2.13
Out of State facilities	0.16	0.40	0.48	0.49	0.49	0.49	0.49
<b>Biogenic CO<sub>2</sub></b>	<b>2.26</b>	<b>1.04</b>	<b>0.44</b>	<b>0.42</b>	<b>0.46</b>	<b>0.45</b>	<b>0.45</b>
New York facilities	2.03	0.86	0.35	0.33	0.37	0.37	0.37
Out of State facilities	0.22	0.18	0.09	0.09	0.09	0.09	0.09
<b>CH<sub>4</sub></b>	<b>0.11</b>	<b>0.10</b>	<b>0.08</b>	<b>0.08</b>	<b>0.09</b>	<b>0.09</b>	<b>0.09</b>
New York facilities	0.10	0.08	0.06	0.06	0.07	0.07	0.07
Out of State facilities	0.01	0.02	0.02	0.02	0.02	0.02	0.02
<b>N<sub>2</sub>O</b>	<b>0.05</b>	<b>0.04</b>	<b>0.03</b>	<b>0.03</b>	<b>0.04</b>	<b>0.04</b>	<b>0.04</b>
New York facilities	0.04	0.03	0.03	0.03	0.03	0.03	0.03
Out of State facilities	+	+	+	+	+	+	+
<b>Gross Total</b>	<b>4.00</b>	<b>3.46</b>	<b>2.80</b>	<b>2.87</b>	<b>3.22</b>	<b>3.20</b>	<b>3.20</b>
Exported Waste	0.40	0.60	0.60	0.60	0.60	0.60	0.60

“+” less than 0.01mmt; Note: Totals may not sum due to independent rounding.

## Wastewater

Wastewater can contain liquid organic matter along with suspended solids that can produce greenhouse gases. There are two primary mechanisms for treating wastewater, in on-site septic systems or in a centralized system which accepts domestic and industrial wastewater through sewers, treats it, and then discharges it into aquatic systems. As with solid waste management, the anthropogenic component of wastewater emissions can be mitigated through management. The biogenic CO<sub>2</sub> associated with natural decomposition is not estimated here.

Wastewater treatment practices involve both aerobic and anaerobic decomposition. CH<sub>4</sub> is generated by microorganisms when the organic carbon in wastewater is allowed to decompose under anaerobic conditions. Septic systems treat the solid component of the wastewater anaerobically, producing additional CH<sub>4</sub>. This is less common in centralized systems as the majority of wastewater treatment facilities in New York use aerobic treatment methods. However, anaerobic pockets can develop in these treatment facilities, depending on operational factors. N<sub>2</sub>O production is stimulated by the action of microorganisms on nitrogen compounds that enter wastewater in human waste, kitchen waste, industrial wastewater, and other sources.

## Methodology

The SIT was used with default emission factors to estimate CH<sub>4</sub> and N<sub>2</sub>O production from wastewater (EPA 2020). Inputs used for both gases included the state population (U.S. Census Bureau 2020) and the

fraction of the population with septic wastewater treatment (0.186) based on a national average from the American Housing Survey (U.S. Census Bureau 2017). Septic system CH<sub>4</sub> emissions were calculated by applying a default emission factor of 10.7 g CH<sub>4</sub> per person per day (Leverenz et al. 2010) to the fraction of the state population using septic system wastewater treatment.

For centralized wastewater systems, CH<sub>4</sub> and N<sub>2</sub>O emissions were calculated using the methodology and emission factors from the IPCC guidelines (IPCC 2019, Volume 5, chapters 2 and 6). CH<sub>4</sub> was estimated based on the maximum amount of CH<sub>4</sub> that can be produced from a given quantity of organic matter in wastewater (0.6 kg CH<sub>4</sub> per kg BOD), where biochemical oxygen demand (BOD) was used as a proxy for the amount of organic matter in wastewater. The average amount of organic matter generated per person in the U.S. was assumed to be 0.09 kg BOD per day. A correction factor of 0.1625 was applied to estimate the fraction of wastewater organic matter that was converted anaerobically (EPA 2020). Direct N<sub>2</sub>O emissions from wastewater treatment facilities were estimated assuming production of 4 g N<sub>2</sub>O per person per year. Another emission factor of 0.005 g N<sub>2</sub>O-N generated per g wastewater nitrogen (N) was applied to an estimate of the total N present in both septic and non-septic wastewater. The emission factor was selected under the default assumption that effluent was discharged to an aerobic environment that was not nutrient-impacted or oxygen-impaired. The total N in wastewater was calculated based on the average U.S. protein consumption, the average N content of protein, and a scaling factor (1.75) to account for the presence of N derived from sources other than human waste in wastewater. The most recent national GHG inventory includes improved methods for assessing emissions from wastewater discharge (EPA 2021a). These have not yet been incorporated into the SIT but may be considered in future updates of this report (Planned Improvements).

### Results

Based on this analysis, emissions from wastewater treatment have increased 8% over past 30 years in New York State (Table SR4.5). As this SIT-based analysis is fundamentally linked to census population data, this trend reflects demographic trends. These estimates will likely be refined in future years to reflect additional emission measurements (Planned Improvements).

**Table SR4.5 Wastewater Emissions, 1990-2019 (mmt CO<sub>2</sub>e GWP20)**

	1990	2005	2015	2016	2017	2018	2019
Centralized Wastewater	5.23	5.56	5.71	5.70	5.69	5.67	5.65
Septic Systems	1.18	1.26	1.29	1.29	1.29	1.28	1.28
<b>Gross Total</b>	<b>6.41</b>	<b>6.81</b>	<b>7.00</b>	<b>6.99</b>	<b>6.98</b>	<b>6.96</b>	<b>6.93</b>

### Planned Improvements

Improvements to the waste sector inventory are ongoing. Like the “key categories” prioritized by the IPCC, certain areas of improvement, such as solid waste management, will be prioritized in the near-term because they are expected to have a significant influence on the emission totals and State policy.

#### Solid Waste Management

This report uses the same methodologies used by the U.S. EPA and other governments as recommended by the IPCC guidelines. Future analyses will seek to refine the EPA SIT model and incorporate more information on local climatic conditions, such as precipitation and temperature, as well as sampling data from active landfills. Additionally, data on historic and current waste composition is

needed. Refining the model to incorporate this information will refine estimates and be responsive to potential declines in organic matter content in MSW. Over time, DEC would seek to develop a methodology that accurately portrays statewide emissions and that is consistent with facility-level measurements and top-down data, where available (see *Summary Report*). At this time, facility data are typically focused on gas collection systems and do not include measurements from the entire landfill.

Other areas of future improvements will include further refinements to the estimate of exported waste emissions, industrial landfill emissions, as well as information on the “methane commitment” of landfills.

#### Biological Treatment of Solid Waste

As discussed above, this report does not include emissions from this category because there were not sufficient data, the number of emission sources is small, and current regulations require these sources to be operated in a manner that would limit emissions. However, these emissions will be analyzed in future reports, particularly as more organic waste is diverted from landfills.

#### Waste Combustion

Of primary interest in this category is the composition of waste from organic/biogenic sources versus fossil sources such as plastics. However, this distinction would not affect the estimation of gross emissions. Additionally, the DEC will seek to improve estimates of the share of exported waste sent to out-of-state combustors.

#### Wastewater

Future inventories will incorporate state-specific data to determine the fraction of New Yorkers using septic versus non-septic wastewater management. The current methodology assumes aerobic treatment at centralized wastewater treatment facilities. Methods for separating and accounting aerobic versus anaerobic centralized wastewater treatment will be reviewed. The impact of the water quality (nutrient and eutrophic status) of water bodies that receive wastewater will be incorporated into N<sub>2</sub>O emissions estimates. Finally, the contribution of industrial and commercial wastewater to CH<sub>4</sub> and N<sub>2</sub>O emissions will also be included explicitly when such data are available.

## Abbreviations

AR6	IPCC Sixth Assessment Report
BOD	Biological oxygen demand
CH <sub>4</sub>	Methane
CLCPA	NYS Climate Leadership and Community Protection Act
CO <sub>2</sub>	Carbon dioxide
CO <sub>2</sub> e	Carbon dioxide equivalent
DEC	NYS Department of Environmental Conservation
EPA	U.S. Environmental Protection Agency
FOD	First order decay
GHG	Greenhouse gas
GWP	Global Warming Potential
GWP100	100-Year Global Warming Potential
GWP20	20-Year Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
kg	kilogram
LFGTE	Landfill gas-to-energy
mt	metric tons
mmt	million metric tons
MSW	Municipal solid waste
N	Nitrogen
N <sub>2</sub> O	Nitrous oxide
NA	Not applicable
NE	Not estimated
NO	Not occurring
NYCRR	New York Codes, Rules and Regulations
NYS	New York State
SIT	EPA State Inventory Tool

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