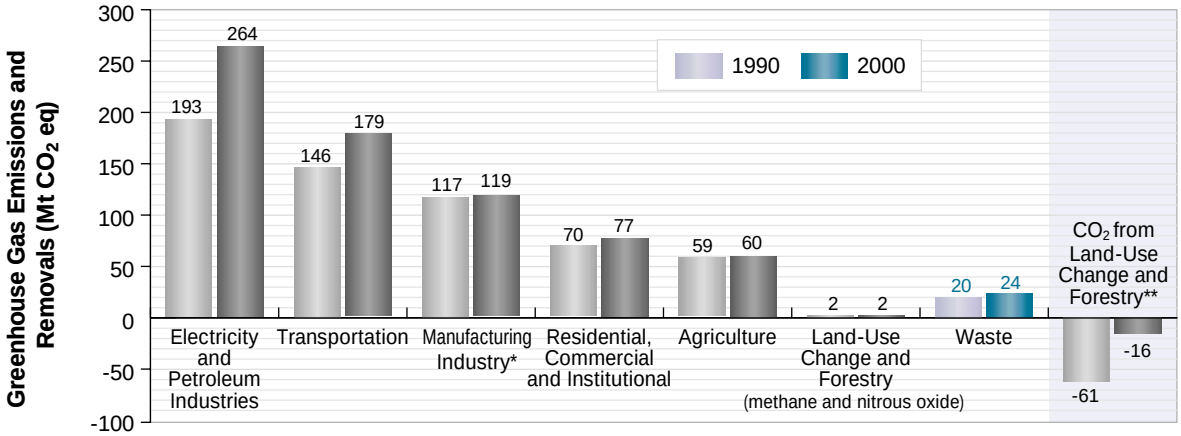
Waste: 1990-2000

The Waste sector of the Canadian Greenhouse Gas Inventory (CGHGI) includes the contribution to greenhouse gas emissions from solid waste disposal on land, wastewater handling and waste incineration.

- *In 2000*, greenhouse gas emissions from the Waste sector totalled 24 megatonnes carbon dioxide equivalent* (Mt CO_2 eq), representing about 3% of Canada's total emissions (726 Mt) in 2000. The primary source of emissions is from solid waste disposal on land, which contributed 93% of the total sector emissions, with much smaller contributions from wastewater handling and waste incineration (6% and 1%, respectively). The majority of emissions were methane (CH_4), at 23 Mt, with the remainder being composed of nitrous oxide (N_2O) (1 Mt) and carbon dioxide (0.3 Mt).
- *Between 1990 and 2000*, waste-related emissions rose by 21%, of which 96% of the increase is attributable to a rise in landfill emissions. Waste incineration and wastewater handling emissions increased 10% and 11%, respectively, and generally follow the national population trend. Although emissions from solid waste disposal on land rose 22%, increasing landfill gas capture decreased the rate of emission growth from landfills in the early to middle 1990s.

*Unless otherwise indicated, all emissions are reported in Mt CO_2 eq. For brevity, this has been shortened to Mt. This concept provides a relative measure of the impacts of different greenhouse gases on global warming, with the effect of carbon dioxide being equal to one.

Figure 1 Canadian Greenhouse Gas Emissions and Removals, 1990 and 2000



*Value illustrated includes emissions due to Solvent and Other Product Use

**Carbon dioxide emissions from the Land-Use Change and Forestry sector are not included in the national inventory totals.

Canada's Waste Sector

The major sources of greenhouse gas emissions in the Waste sector are solid waste disposal in landfills, wastewater handling and waste incineration. These emissions consist almost completely of methane; in fact, methane emissions comprised 95% of the total emissions in this sector in 2000.

Much of the waste treated or disposed is biomass-based. The carbon dioxide emissions attributable to such wastes are not included in the national inventory totals, but are accounted for when measuring changes in carbon in the Agriculture and Land-Use Change and Forestry sectors. In theory, there are no net emissions if the biomass is sustainably produced and consumed. This assumes that, on an annual basis, the carbon dioxide emitted from the decomposition of food is consumed in growing the next year's crop. Carbon dioxide emissions from the disposal of paper and wood are not included in the Waste sector, but are accounted for in the Land-Use Change and Forestry sector.

The Greenhouse Gas Inventory allocates emissions from the Waste sector within the following three categories:

1. Solid Waste Disposal on Land
2. Wastewater Handling
3. Waste Incineration

The Canadian Greenhouse Gas Inventory (CGHGI)

The Canadian Greenhouse Gas Inventory is developed, compiled, and reported annually by the Greenhouse Gas Division of Environment Canada, and utilizes methods and models developed in-house by engineering and scientific staff, as well as published data, data developed by industry, or methods developed by the Intergovernmental Panel on Climate Change (IPCC, 1997).

The greenhouse gases that have been estimated in the national inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

The inventory uses an internationally agreed to reporting format that groups emissions and removals into the following six sectors: Energy, Industrial Processes, Solvent and Other Product Use, Agriculture, Land-Use Change and Forestry, and Waste. The 2000 Trends Fact Sheet Series, while presenting the latest information on Canadian greenhouse gas emissions and removals derived from the latest national inventory, uses a modified sector approach to facilitate the use of information by the public.

Waste Sector Emission Trends: 1990 to 2000

Greenhouse gas emissions from the Waste sector totalled 24 Mt, representing 3% of Canada's total emissions in 2000. Waste-related emissions rose by 21% since 1990, of which 96% of this increase is attributable to increases in landfill emissions. Figure 2 compares the changes in emissions among the Waste sector categories for 1990 and 2000.

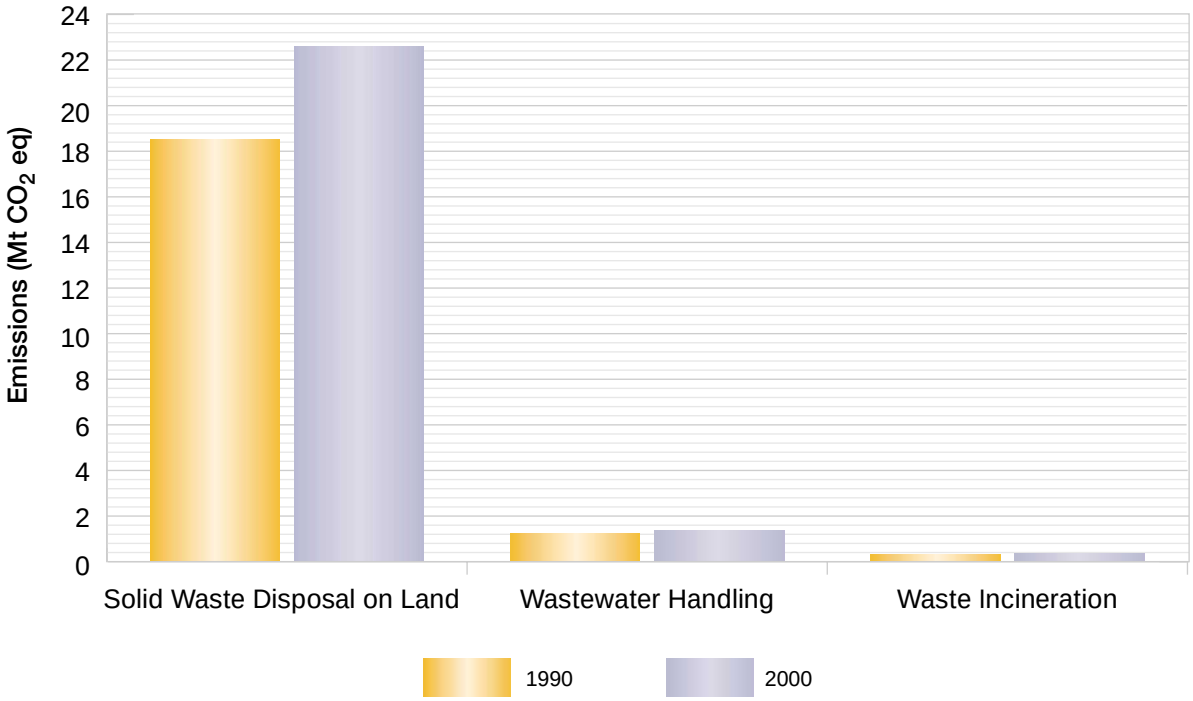
In 2000, Solid Waste Disposal on Land accounted for about 93% of the emissions in this sector, while Municipal Wastewater and Incinerated Material derived from fossil-fuel products are minor contributing categories (6% and 1%, respectively). Of the sector's 24 Mt of emissions, 23 Mt were composed of methane.

Solid Waste Disposal on Land

Emissions from Solid Waste Disposal on Land were 23 Mt in 2000, an increase of 22% since 1990. Solid waste disposal on land was the second largest source category of methane emissions in Canada, accounting for 25% of the national total for methane.

Emissions are estimated for two types of landfills in Canada: municipal solid waste (MSW) landfills and forest industry landfills. Most waste disposal on Canadian land occurs in municipally managed or privately owned landfills. Very few, if any, unmanaged waste disposal sites exist; therefore, it has been assumed that all waste is disposed of in managed facilities. Residential, institutional, commercial, industrial, construction and demolition wastes are disposed of in MSW landfills. Forestry industry landfills are privately owned and typically operated by forest industries such as saw mills and pulp and paper mills. These industries used the landfills to dispose of surplus wood residue such as bark sawdust and wood shavings. Today, forest industry landfilling is restricted to the diposal of wastewater sludges and boiler ash.

Figure 2 Greenhouse Gas Emission Trends in the Waste Sector by Subcategory, 1990 and 2000



In Canada, there are well over ten thousand landfill sites (Levelton,1991). Landfill gas, which is composed mainly of methane and carbon dioxide, is produced by the anaerobic decomposition of organic wastes. The first phase of this process typically begins after waste has been in a landfill for ten to fifty days. Although the majority of methane and carbon dioxide is generated within twenty years of landfilling, emissions can continue for one hundred years or more (Levelton, 1991). This means that emissions estimated in any one year are not only the result of landfilled waste from the previous year, but also from waste that was landfilled decades earlier.

The generation of methane from MSW landfills has increased since 1990 (Figure 3), however, more landfill gas is now being captured and combusted. Landfill gas capture is not typically practised at forest industry landfills due to low decomposition rates.

The net methane emissions from landfills are determined from the following equation:

Total methane from landfills = methane produced - methane captured

Table 1 provides a breakdown of methane emissions originating from both MSW and forest industry landfills for the period 1990 to 2000. Net emissions from MSW landfills have increased 22% since 1990 and for all years represent over 90% of the total emissions in this category. Compared with MSW landfills, forest industry landfills are a minor source of methane emissions. Emissions from forest industry landfills rose 21% over the period, largely due to the cumulative effect of emissions from historical deposits.

A more detailed breakdown of emissions associated with MSW landfills is given in Figure 3. As indicated above, landfill gas recovery is practised at a number of MSW landfills in Canada. As of December 1999, 42 landfills conducted landfill gas recovery programs (Environment Canada, 2000). Of the 27 Mt of methane generated in MSW landfills in 2000,

22% (5.9 Mt) of this methane was captured, resulting in net emissions of 21 Mt to the atmosphere. Over the entire 1990 to 2000 period, landfill gas capture increased 33%.

In spite of this trend, net methane emissions from landfills increased 22% over the decade, mainly due to emission contributions from waste that was landfilled years to decades earlier.

Table 1 Methane Emission Trends from Landfills, 1990 to 2000 (Mt CO_2 eq)

Year	Municipal Solid Waste[1]	Wood Waste	Total Emissions
1990	17	1.5	19
1991	18	1.6	19
1992	18	1.6	20
1993	18	1.7	20
1994	19	1.7	20
1995	19	1.8	20
1996	19	1.8	20
1997	19	1.9	21
1998	20	1.9	21
1999	20	1.8	22
2000	21	1.8	23

Note: Due to rounding, individual values may not add up to the totals.

[1] Emissions from MSW landfills represent net emissions (total emissions generated, less emissions that were captured through landfill gas capture programs).

Figure 3 Methane Generation, Capture and Net Emission Trends from MSW Landfills, 1990 to 2000

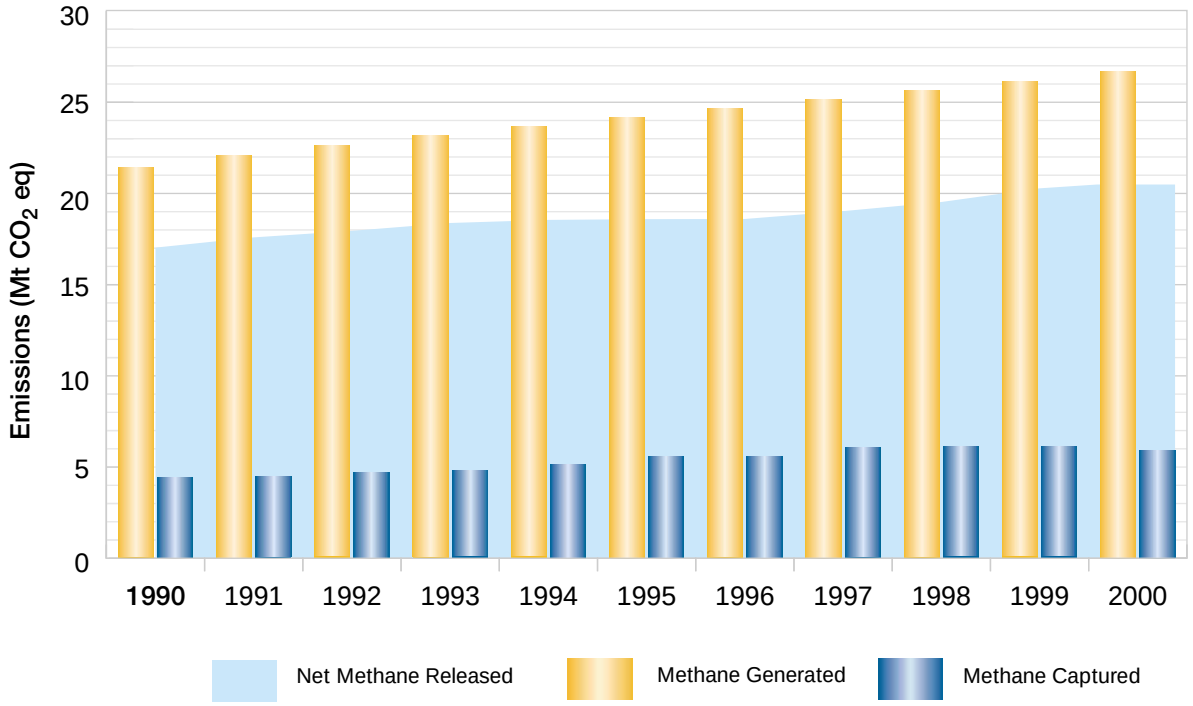


Table 2 Greenhouse Gas Emission Trends for Wastewater Treatment, 1990 to 2000 (Mt CO_2 eq)

Year	Methane	Nitrous Oxide	Total
1990	0.36	0.87	1.2
1991	0.36	0.88	1.2
1992	0.36	0.89	1.3
1993	0.37	0.90	1.3
1994	0.37	0.91	1.3
1995	0.38	0.92	1.3
1996	0.38	0.93	1.3
1997	0.39	0.94	1.3
1998	0.39	0.95	1.3
1999	0.40	0.95	1.3
2000	0.40	0.96	1.4

Note: Due to rounding, individual values may not add up to the totals.

Wastewater Handling

Emissions from wastewater handling totalled 1.4 Mt in 2000, an increase of 11% since 1990. The emissions have essentially followed the same trend as Canada's population during this period.

Municipal wastewater can be aerobically or anaerobically treated. When wastewater is treated anaerobically, methane is produced. Emissions from aerobic systems are assumed to be negligible. Both types of systems generate nitrous oxide through the nitrification and denitrification of sewage nitrogen (IPCC, 1997). Carbon dioxide is also generated by both types of treatment but, as discussed earlier, carbon dioxide emissions originating from the decomposition of food are not inventoried.

Waste Incineration

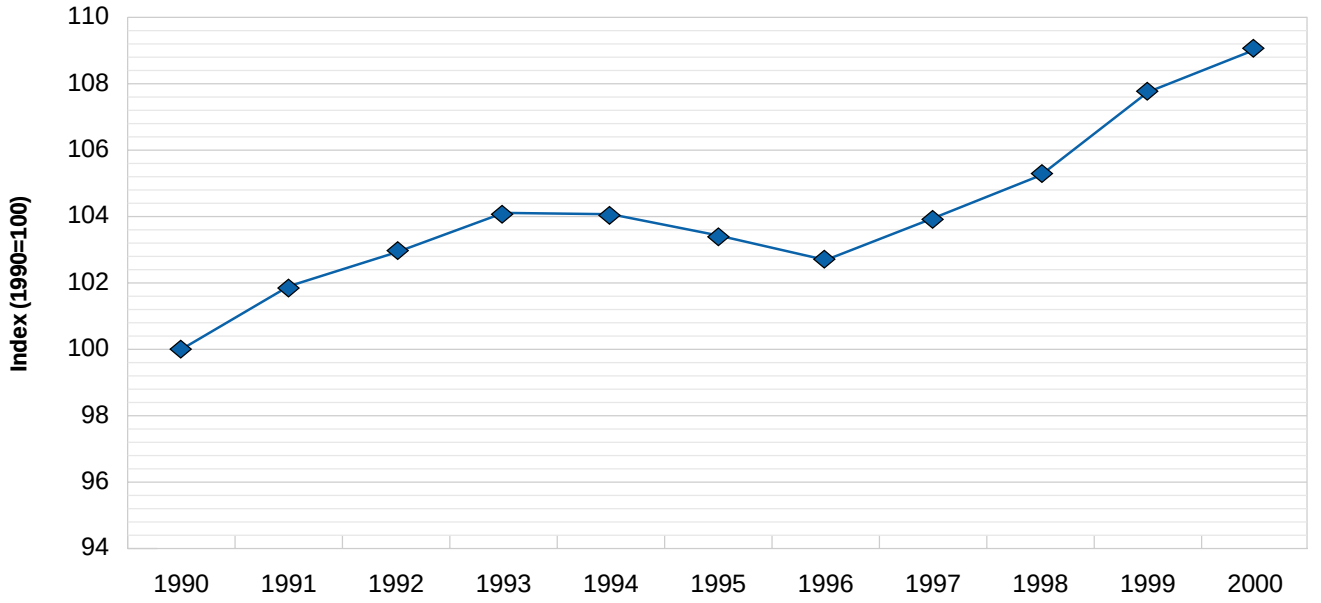
Emissions from both MSW and sewage sludge incineration are included in the inventory. While emissions from waste incineration were a minor source of greenhouse gases in 2000 (0.3 Mt) emissions from this category have increased by nearly 10% since 1990, the majority from MSW incineration. In common with emissions from wastewater handling, waste incineration emissions mirror the trends in population growth in Canada.

Several municipalities in Canada utilize incinerators to reduce the quantity of MSW sent to landfills and to reduce the amount of sewage sludge requiring land application. The greenhouse gas emissions from incinerators depend on factors such as: the amount of waste incinerated, the composition of the waste, the carbon content of the non-biomass waste, and the facilities' operating conditions.

Waste Emissions Per Capita

Waste emissions per capita increased 9% from 1990 to 2000, primarily due to the increasing emissions from landfills (Figure 4). Growth in emissions exceeded population increases during this period because material that was landfilled in past decades is still contributing to methane production today. The decline in per capita growth in emissions observed in the mid-1990s is attributable to an increase in methane recovery at landfills, which rose 33% between 1990 and 2000.

Figure 4 Per Capita Greenhouse Gas Emissions Trend for Waste, 1990 to 2000



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