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LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

AS	Area source
AAFC	Agriculture and Agri-Food Canada
APEI	Air Pollutant Emission Inventory
B(a)p	Benzo(a)pyrene
B(b)f	Benzo(b)fluoranthene
B(k)f	Benzo(k)fluoranthene
CAC	Criteria air contaminant
CANSIM	Canadian Socio-Economic Information Management System
CCME	Canadian Council of Ministers of the Environment
Cd	Cadmium
CEA	Canadian Electricity Association
CEIP	Centre on Emission Inventories and Projections
CEPA	*Canadian Environmental Protection Act*, 1999
CH_4	Methane
CLRTAP	Convention on Long-range Transboundary Air Pollution
CNG	Compressed natural gas
CO	Carbon monoxide
CORINAIR	Core Inventory of Air Emissions in Europe
CPI	Consumer Price Index
D/F	Dioxins and furans
EEA	European Environment Agency
EF	Emission factor
EIIP	Emission Inventory Improvement Program
EMEP	European Monitoring and Evaluation Programme
FVRD	Fraser Valley Regional District
g	Gram
gTEQ	Gram of toxic equivalent
GVRD	Greater Vancouver Regional District

HC	Hydrocarbon
HCB	Hexachlorobenzene
Hg	Mercury
I(cd)p	Indeno(1,2,3-cd)pyrene
ICAO	International Civil Aviation Organization
kg	Kilogram
kt	Kilotonne
LPG	Liquefied petroleum gas
MOVES	Motor Vehicle Emission Simulator
Mt	Megatonne
NAESI	National Agri-Environmental Standards Initiative
NAHARP	National Agri-Environmental Health Analysis and Reporting
NAICS	North American Industry Classification System
NFR	Nomenclature for Reporting
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NPRI	National Pollutant Release Inventory
NRCan	Natural Resources Canada
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PIRD	Pollutant Inventories and Reporting Division
PM	Particulate matter
PM_{10}	Particulate matter less than or equal to 10 microns
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns
POP	Persistent organic pollutant
PS	Point source
QC	Quality control
RESD	Report on Energy Supply-Demand Canada
SO_2	Sulphur dioxide
SOMA	Sulphur Oxides Management Area
SO_x	Sulphur oxides

t	Tonne
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEQ	Toxic equivalent
TPM	Total particulate matter
U.S. EPA	United States Environmental Protection Agency
UNECE	United Nations Economic Commission for Europe
VOC	Volatile organic compound

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EXECUTIVE SUMMARY

Canada's Air Pollutant Emission Inventory (APEI) has been prepared and published by Environment and Climate Change Canada since 1973. The APEI is a comprehensive inventory of emissions of 17 air pollutants at the national and provincial/territorial levels. This inventory serves many purposes including fulfilling Canada's international reporting obligations under the 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) and the associated protocols ratified by Canada for the reduction of emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x), cadmium (Cd), lead (Pb), mercury (Hg), dioxins and furans, and other persistent organic pollutants (POPs). The APEI also supports monitoring and reporting obligations under the Canada–U.S. Air Quality Agreement and the development of air quality management strategies, policies and regulations, informs Canadians about pollutants that affect their health and the environment, and provides data for air quality forecasting models.

The APEI is compiled from many different data sources. Emissions data reporting by individual facilities to Environment and Climate Change Canada's National Pollutant Release Inventory and, to a lesser extent, data provided directly by the provinces are supplemented with well documented, science-based estimation tools and methodologies to quantify total emissions. Together, these data sources provide a comprehensive overview of air pollutant emissions across Canada.

This edition of the APEI reports the most recent estimates of air pollutant emissions for 1990–2015 as of February 2017. The inventory indicates that 14 of the 17 reported air pollutants show reductions compared to historical levels.[1] Specifically:

- Emissions of SO_x were 1.0 million tonnes in 2015, 68% below the emission ceiling of 3.3 million tonnes established under the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes.
- Emissions of NO_x were 1.8 million tonnes in 2015, 19% below the emission ceiling of 2.3 million tonnes established under the 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes.
- In 2015, emissions of Cd, Pb, and Hg were 83%, 76% and 75% below the ceilings established under the 1998 Aarhus Protocol on Heavy Metals.
- In 2015, emissions of all POPs were below ceilings established in the 1998 Aarhus Protocol on Persistent Organic Pollutants, including the four species of polycyclic aromatic hydrocarbons (PAHs) (by 67%), hexachlorobenzene (HCB) (by 91%), and dioxins and furans (by 87%).
- Emissions of non-methane volatile organic compounds (VOCs) and carbon monoxide (CO) decreased by 36% and 54%, respectively, from 1990 to 2015.
- Fine particulate emissions (particulate matter less than or equal to 2.5 microns in diameter (PM2.5)) are decreasing from all sources except from dust from paved and unpaved roads and construction; total $PM_{2.5}$ emissions are now 18% below 1990 levels.

Canada's Air Pollution Emission Trends (1990–2015)

The last year saw no significant change in the general downward trend in pollutant emissions: industrial emissions of SOx continued to decline, largely due to decreasing emissions from the upstream petroleum industry, down 53%, non-ferrous

1 Throughout this report, data are presented as rounded figures. However, all calculations (including percentages) were performed using unrounded data.

smelting and refining, down 71%, and electric power generation (utilities), down 56%.

The adoption of conservation tillage practices in crop production and the use of new fireplace inserts, furnaces and stoves have contributed to a decrease in emissions of $PM_{2.5}$. Although already on the decline, the aluminium industry experienced a large drop in PAH emissions from 2001 to 2010 due to the implementation of new production technologies, such as the introduction of prebaked electrodes to replace continuous casting electrodes. The aluminium industry experienced additional decreases between 2014 and 2015, related to the replacement of old smelting equipment with a modern smelter at the facility that has historically contributed the largest portion of PAH emissions. Emissions of Cd also continued their steady decline, with reductions in emissions from several sources.

A few sources of pollutants exerted a dominant influence in the downward trends in emissions. In particular, decreases in emissions of SO_x, Cd, Pb and Hg from non-ferrous smelting and refining and from mining and rock quarrying industries strongly contributed to the overall downward trends in emissions of these pollutants. In addition, reductions in NO_x emissions from light-duty gasoline trucks and vehicles, as well as in VOC and CO emissions associated with the combustion of gasoline, liquid petroleum gas or compressed natural gas by off-road equipment were instrumental in reducing national emissions of these pollutants.

Improvements in incineration technologies contributed significantly to decreases in emissions of HCB, dioxins and furans.

An exception to the general downward trends described above is the observed increase in emissions of ammonia (NH_3) which were 22% above 1990 levels in 2015. The upward trend in ammonia emissions is driven by fertilizer application and animal production.

Canada's Air Emissions Regulations

Downward trends in emissions of air pollutants reflect the ongoing implementation of a wide range of regulations that restrict or eliminate pollutants in order to improve and maintain air quality in Canada. Regulations specific to air pollutants under the *Canadian Environmental Protection Act*, 1999 (CEPA) include, but are not limited to, the following:

- *Multi-Sector Air Pollutants Regulations* (2016)
- *Export of Substances on the Export Control List Regulations* (amended 2015)
- *On-Road Vehicle and Engine Emission Regulations* (amended 2015)
- *Sulphur in Gasoline Regulations* (amended 2015)
- *Products Containing Mercury Regulations* (2014)
- *Renewable Fuels Regulations* (amended 2013)
- *Off-Road Compression-Ignition Engine Emission Regulations* (amended 2012)
- *Sulphur in Diesel Fuel Regulations* (amended 2012)
- *Benzene in Gasoline Regulations* (amended 2011)
- *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations* (2011)
- *Gasoline Regulations* (amended 2010)
- *Volatile Organic Compound (VOC) Concentration Limits for Automotive Refinishing Products Regulations* (amended 2010)
- *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations* (amended 2009)
- *Off-Road Small Spark-Ignition Engine Emission Regulations* (2003)
- *Gasoline and Gasoline Blend Dispensing Flow Rate Regulations* (2000)
- *Pulp and Paper Mill Effluent Chlorinated Dioxins*

and Furans Regulations (1992)

- *Contaminated Fuel Regulations* (1991)
- *Secondary Lead Smelter Release Regulations* (1991)

All regulations administered under CEPA are available in the registry: www.ec.gc.ca/lcpe-cepa/eng/regulations/?n=54FE5535-1.

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INTRODUCTION

1.1. Background on the APEI

Canada's Air Pollutant Emission Inventory (APEI) is a comprehensive inventory of air pollutant emissions at the national and provincial/territorial levels. The APEI is prepared and published by Environment and Climate Change Canada (ECCC) and serves many purposes, including the following:

- Support to the development of domestic air quality management strategies, policies and regulations;
- Contribute to tracking and quantifying air pollutants according to Canada's domestic and international reporting obligations;
- Inform Canadians about pollutants that affect their health and the environment; and
- Provide data to support air quality forecasting.

The APEI compiles emissions of 17 air pollutants that contribute to smog, acid rain and diminished air quality, including:

- Smog precursors: total particulate matter (TPM), particulate matter (PM) less than or equal to 10 microns (PM_{10}), PM less than or equal to 2.5 microns ($PM_{2.5}$), sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO) and ammonia (NH_3);
- Heavy metals: mercury (Hg), lead (Pb) and cadmium (Cd); and
- Persistent organic pollutants (POPs): dioxins and furans (D/F), four polycyclic aromatic hydrocarbon (PAH) compounds (benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene and indeno[1,2,3-cd]pyrene), and hexachlorobenzene (HCB).

The reporting format for the APEI has been streamlined and reorganized into eleven source categories that better reflect where emissions are taking place (Table 1–1). For example, the former "Industrial" source category has been broken down into three separate source categories: "Ore and Mineral Industries", "Oil and Gas Industry" and "Manufacturing". The eleven source categories are further broken down into 77 sectors and 131 associated subsectors.

The APEI is compiled and published on an annual basis. The time series of annual emissions contained in this report is updated from 1990 to the most recent inventory year in order to indicate the trend in emissions based on the most current methodological estimation approaches and data.

In recent years, facility emissions data captured in the APEI have originated primarily from the National Pollutant Release Inventory (NPRI) and have been supplemented with limited data provided by provincial governments (Alberta, Manitoba, New Brunswick, Newfoundland and Labrador, Ontario and Quebec). For example, Alberta provides additional data for the Upstream Petroleum sector for the pre-2006 years, and Alberta and Newfoundland provide supplementary information for selected sources that are not reported to the NPRI. In addition to supplementing the NPRI with additional data sources as described above, the APEI incorporates emissions estimated by ECCC for sources not reported to the NPRI, for example when an APEI sector includes facilities that are below the NPRI reporting threshold.

Table 1–1 APEI Sector Descriptions

APEI Source/Sector	Sector Descriptions
Ore and Mineral Industries	
Aluminium Industry	Alumina production through bauxite refining, primary aluminium production through smelting and refining and secondary aluminium production in which aluminium is recovered from aluminium-containing scrap.
Asphalt Paving Industry	Asphalt concrete (or hot-mix asphalt) manufacturing. Emissions are from permanent and portable hot-mix asphalt installations.
Cement and Concrete Industry	Entire process of cement production in rotary kilns as wel as the preparation of concrete and ready-mix concrete, lime manufacture and concrete batching and products.
Foundries	Castings of various types of ferro-alloys as well as small iron and steel foundries not associated with integrated iron and steel facilities. The types of foundries included are: open ferrous, electric arc and induction foundries.
Iron and Steel Industries	Steel production, including blast furnaces, basic oxygen furnaces, electric arc furnaces, sintering, direct reduction of iron, hot forming and semi-finishing, coke production.
Iron Ore Industry	Iron ore mining, beneficiation by concentration and sintering into pellets are included.
Mineral Products Industry	Manufacture of brick and related clay products such as pipes, liner and tiles.
Mining and Rock Quarrying	Overburden removal, drilling in rock, blasting, crushing of rock, loading of materials, transporting raw materials by conveyors or haulage trucks, scraping, bulldozing, grading, open storage pile losses and wind erosion from exposed areas.
Non-Ferrous Mining and Smelting Industry	Primary copper and nickel production using pyrometallurgical operations, lead ore crushing, concentrating and metallurgic processing and zinc metal production through electrolytic processes.
Oil And Gas Industry	
Downstream Petroleum Industry	Refining and processing of crude oil to make fuels or other products such as solvents or asphalt.
Petroleum Product Transportation and Distribution	Distribution of fuels from refineries. Includes pipelines, terminals (large distribution facilities), bulk plants (smaller distribution facilities) and natural gas transmission, distribution and storage facilities.
Upstream Petroleum Industry	Drilling, testing and servicing of wells, conventional oil and gas production, in situ and open pit mining, oil sands production, natural gas processing crude oil transmission.
Electric Power Generation (Utilities)	
Coal	Electric power generation from combustion of coal by utilities and by industry for commercial sale and/or private use.
Diesel	Electric power generation from combustion of diesel by utilities and by industry for commercial sale and/or private use.
Natural Gas	Electric power generation from combustion of natural gas by utilities and by industry for commercial sale and/or private use.
Waste Materials	Electric power generation from combustion of waste materials by utilities and by industry for commercial sale and/or private use.
Other Electric Power Generation	Electric power generation from other energy sources by utilities and by industry for commercial sale and/or private use.
Manufacturing	
Abrasives Manufacture	Manufacturing of abrasive grinding wheels, abrasive-coated materials and other abrasive products.
Bakeries	Manufacturing of bakery products, other than for retail sale, including frozen baked products.
Biofuel Production	Production of ethanol for fuel or oils for biodiesel.
Chemicals Industry	Large number of different product industries including fertilizer manufacturing, plastic resins, paints and varnishes, petrochemicals and inorganic chemicals. The raw materials, processes used and products produced are in many cases unique to individual plants.
Electronics	Manufacturing of electronics, such as communications equipment, semiconductors and electronic components, navigational and guidance instruments, electric lamp bulb and parts, transformers, switchgear, relay and industrial control.
Food Preparation	Activities related to food production for human or animal consumption, such as manufacturing of dog and cat food, sugar and confectionery products, frozen food, dairy products, meat products, and tobacco and beverage products; seafood product preparation and packaging; and fruit and vegetable canning, pickling and drying.
Glass Manufacture	Making of glass from sand and cullet as well as the remelting, pressing, blowing or otherwise shaping purchased glass.
Grain Processing	Primary, process, terminal and transfer elevators, as well as manufacturing or processing grain for use in other products.
Metal Fabrication	Activities related to metal fabrication, such as: iron and steel mills and ferro-alloy manufacturing; production of iron and steel pipes and tubes, cold-rolling steel bars, sheets, strips and other steel shapes; steel wire drawing; smelting of non-ferrous metals; copper rolling, drawing, extruding and alloying; forging; stamping; and other metal manufacturing.
Plastics Manufacture	Manufacturing of plastics bags, plastic film and sheet, unlaminated plastic profile shapes, plastic pipes and pipe fittings, laminating plastic profile shapes (plates, sheets and rods), polystyrene foam products, urethane and other foam products, motor vehicle plastic parts, tires, rubber and plastic hose and belting, and other rubber products.
Pulp and Paper Industry	Chemical, mechanical, recycling and semi-chemical mills, including the production of energy through the combustion of spent pulping liquor, biomass and fossil-fuel combustion. Also includes fugitive emissions from wood refining, screening and drying, and various steps in chemical recovery systems.
Textiles	Textile product-related activities, including: fibre, yarn and thread mills manufacturing; textile and fabric finishing; fabric coating; carpet and rug manufacturing; mills, clothing knitting; mills; as well as clothing accessories and othe other clothing manufacturing.
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	Activities related to: vehicle manufacturing, such as manufacturing of motor vehicles plastic parts, engine and power transmission equipment, automobile and light-duty motor vehicles, heavy-duty trucks, truck trailers, motor vehicle brake systems, seating and interior trim, and vehicle parts; urban transit systems; and support activities for rail transportation.
Wood Products	Sawmills, Ppanel board mills (including veneer, plywood, waferboard, particle board and medium-density fiberboard mills), and other wood products manufacturing establishments (including furniture and cabinet makers, wood treating plants, wood pellet mills and Masonite manufacturers).
Other Manufacturing Industries	Manufacturing, food production or processing industries that are not included under a specific industrial sector.
Transportation And Mobile Equipment	
Air transportation	Piston and turbine military, commercial and general aviation (landing and take-off only), and in-flight (cruise) emissions for turbine aircraft.
Heavy-duty diesel vehicles	Diesel vehicles over 3856 kilograms.

Table 1-1 APEI Sector Descriptions (cont'd)

APEI Source/Sector	Sector Descriptions
Transportation And Mobile Equipment (cont'd)	
Heavy-duty gasoline vehicles	Gasoline vehicles over 3856 kilograms.
Heavy-duty LPG/NG vehicles	Propane and natural gas vehicles over 3856 kilograms.
Light-duty diesel trucks	Diesel trucks under 3856 kilograms.
Light-duty diesel vehicles	Dieselvehicles under 3856 kilograms.
Light-duty gasoline trucks	Gasoline trucks under 3856 kilograms.
Light-duty gasoline vehicles	Gasoline vehicles under 3856 kilograms.
Light duty LPG/NG trucks	Propane and natural gas trucks under 3856 kilograms.
Light duty LPG/NG vehicles	Propane and natural gas vehicles under 3856 kilograms.
Marine transportation	Marine craft in anchored, berth and underway phases.
Motorcycles	Motorcycles.
Off-road diesel vehicles and equipment	Off-road vehicles and mobile equipment using diesel fuel in mining, construction, agriculture, commercial purposes, logging, railway maintenance, and airport ground support; and lawn and garden equipment using diesel fuel; and recreational vehicles using diesel fuel.
Off-road gasoline/LPG/CNG vehicles and equipment	Off-road vehicles and mobile equipment using gasoline, liquid petroleum gas, and compressed natural gas in mining, construction, agriculture, commercial purposes, logging, railway maintenance, airport ground support; lawn and garden equipment using gasoline, liquid petroleum gas, or compressed natural gas; and recreational vehicles using gasoline, liquid petroleum gas, and compressed natural gas.
Rail Transportation	Freight and passenger trains, including yard switching activities.
Tire Wear and Brake Lining	Tire and brake lining wear from all categories of road transportation.
Agriculture	
Animal Production	Animal housing, manure storage, and application of manure to the field
Crop Production	Application of synthetic nitrogen fertilizers, tillage, and crop harvesting.
Fuel Use	Stationary combustion sources in agricultural facilities such as space and water heating and crop drying.
Commercial/ Residential/ Institutional	
Cigarette Smoking	Mainstream cigarette smoke, which is directly exhaled by the smoker and sidestream smoke, which is directly released from burning cigarettes.
Commercial and Institutional Fuel Combustion	External combustion sources used for space/water heating in commercial establishments, health and educational institutions and government/public administration facilities.
Commercial Cooking	Cooking meat and french fries in commerical foodservice operations.
Construction Fuel Combustion	Combustion of fossil fuels used for space heating and the heating of construction materials, such as concrete.
Home Firewood Burning	Burning of fuel wood and pellets for space heating and hot water. Includes emissions from fireplaces, wood stoves and wood-fired boilers.
Human	Human respiration, perspiration and dental amalgams.
Marine Cargo Handling	Handling, loading and unloading of materials, goods and merchandise from ships to docks.
Residential Fuel Combustion	Combustion of fossil fuels used for space/water heating in residences.
Service Stations	Fuel transfers and storage at service stations, as well as individuals refueling vehicles and off-road equipment.
Other Miscellaneous Sources	Infant-diapered waste and point source emissions from sectors that are not included elsewhere.
Incineration And Waste	
Crematoriums	Combustion of caskets and human bodies, as well as companion animals.
Industrial and Commercial Incineration	Incineration of waste from industrial, commercial and institutional facilities. The incineration of wood waste is included in other sectors such as pulp and paper, the wood industry and power generation, where it is burned.
Municipal Incineration	Incinerators used to combust municipal solid waste and recover energy.
Waste	Disposal sites used for a variety of wastes, such as domestic, commercial, hazardous, liquid and non-hazardous solid industrial wastes as well as sewage sludge and from on-site burning of residential waste materials in backyard barrels or open-pit burning.
Other Incineration and Utilities	Sewage sludge incineration and other small incinerators.
Paints And Solvents	
Dry Cleaning	Dry cleaning of fabric and leather items.
General Solvent Use	Broad range of applications occurring in residential, commercial, industrial and institutional locations. Industrial applications include uses such as: degreasing, adhesives and sealants, aerosols, blowing agents, and resin manufacturing. The use of consumer and commercial products, pesticides and personal care products are also included.
Printing	Manufacturing or use of printing inks, which includes: flexographic, gravure, letterpress, lithographic and other printing.
Surface Coatings	Broad range of applications and industries, including individuals and companies engaged in the manufacturing or use of paints and coatings.
Dust	
Coal Transportation	Transportation of coal by train or truck.
Construction Operations	Soil disturbance on construction sites (residential, industrial-commercial-institutional (ICI), engineering).
Mine Tailings	Wind erosion at mine tailings ponds located on active and inactive mine sites.
Paved Roads	Re-suspension of particulate matter by vehicles travelling on paved roads.
Unpaved Roads	Re-suspension of particulate matter by vehicles travelling on unpaved roads.
Fires	
Prescribed Forest Burning	Controlled fires used for land management treatments such as reducing logging residues, managing forest production, controlling insects, and minimizing the potential for destructive wildfires. Excludes the burning of agricultural residues.
Structural Fires	Vehicle fires (including trains and airplanes) and fires that burn buildings.

1.2. Reporting Requirements

The first national inventory of air pollutant emissions in Canada was compiled in 1973, with national and provincial/territorial estimates of emissions of CO, SO_x, NO_x, hydrocarbons (HCs) and PM for the year 1970. Since then, air emission estimates for Canada have continued to be published on a regular basis.

The Convention on Long-range Transboundary Air Pollution (CLRTAP) endeavours to limit and, as far as possible, gradually reduce and prevent air pollution. Since 1979 when it was originally signed, the Convention has been extended by eight protocols, seven of which identify measures to be taken by Parties to achieve the Convention's objectives; the eighth protocol concerns financing. Canada has ratified five of the seven measure-specific protocols including,

- the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions (SO_x),
- the 1994 Oslo Protocol on Further Reduction of Sulphur Emissions (also SO_x for a designated "Sulphur Oxides Management Area" [SOMA]),
- the 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides (NO_x),
- the 1998 Aarhus Protocol on Heavy Metals (Cd, Pb and Hg), and
- the 1998 Aarhus Protocol on Persistent Organic Pollutants (including dioxins and furans, four species of PAHs, and HCB, among other POPs).

These protocols set specific emissions reduction targets for sulphur, NO_x, Cd, Pb, Hg, dioxins and furans, and other POPs. Parties are required to report emissions to the United Nations Economic Commission for Europe (UNECE) each year by February 15.

In addition, Canada collects and publishes data on emissions of NH_3, CO, VOCs and three categories of PM (TPM, PM_{10} and $PM_{2.5}$) and voluntarily reports the emissions of these six substances, along with the eleven substances for which there are protocols, to the UNECE annually. Canada has also ratified the 1984 Geneva Protocol on Long-term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe.

Canada and the United States also work jointly to address shared concerns regarding transboundary air pollution. Under the Canada–U.S. Air Quality Agreement, Canada monitors and reports emissions of SO_2, NO_x and VOCs other than methane.

1.3. Environmental Regulations for Air Pollutants

A wide range of regulations restrict or eliminate atmospheric pollutants in order to improve and maintain air quality in Canada. Regulations specific to air pollutants under the *Canadian Environmental Protection Act, 1999* (CEPA) include, but are not limited to, the following:

- *Multi-Sector Air Pollutants Regulations* (2016)
- *Volatile Organic Compound (VOC) Concentration Limits for Automotive Refinishing Products Regulations* (amended 2010)
- *Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations* (amended 2009)
- *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations* (2011)
- *Off-Road Compression-Ignition Engine Emission Regulations* (amended 2012)
- *Off-Road Small Spark-Ignition Engine Emission Regulations* (2003)
- *On-Road Vehicle and Engine Emission Regulations* (amended 2015)

- *Benzene in Gasoline Regulations* (amended 2011)
- *Contaminated Fuel Regulations* (1991)
- *Gasoline and Gasoline Blend Dispensing Flow Rate Regulations* (2000)
- *Gasoline Regulations* (amended 2010)
- *Renewable Fuels Regulations* (amended 2013)
- *Sulphur in Diesel Fuel Regulations* (amended 2012)
- *Sulphur in Gasoline Regulations* (amended 2015)
- *Products Containing Mercury Regulations* (2014)
- *Secondary Lead Smelter Release Regulations* (1991)
- *Export of Substances on the Export Control List Regulations* (amended 2015)
- *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* (1992)

All regulations administered under CEPA are available in the registry: http://www.ec.gc.ca/lcpe-cepa/eng/regulations/default.cfm

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2015 EMISSIONS AND TRENDS

This chapter describes, for each pollutant, the main sources and sectors contributing to the 2015 emissions and to the historical trends. For the purpose of the present inventory, source categories are broken down into sectors (e.g., aluminium industry is a sector within the source category ore and mineral industries) and subsectors (e.g., primary aluminium smelting and refining is a subsector of the aluminium industry sector). A brief description of each sector is provided in Table 1–1.

The contribution of each source category to total emissions of air pollutants varies with substances (Table 2–1).[1] The dust source category is a particularly important source of particulate matter (PM) emissions, accounting for 62% of emissions of total particulate matter less than or equal to 2.5 microns ($PM_{2.5}$). The agriculture source category accounts for most ammonia (NH_3) emissions (94%), while incineration and waste sources account for a significant proportion of hexachlorobenzene (HCB) (62%) and dioxins/furans (D/F) (42%) emissions. The ore and mineral industries account for the largest proportion of sulphur oxides (SO_x) (46%), lead (Pb) (76%) and cadmium (Cd) (70%) emissions. The transportation and mobile equipment source category is the largest emitter of nitrogen oxides (NO_x) (54%) and carbon monoxide (CO) (53%). The oil and gas industry is the largest emitter of volatile organic compounds (VOCs) (37%). The ore and mineral industries and the incineration and waste sources each released about one third (31%) of the total mercury (Hg) emissions. The commercial/residential/institutional source category is a particularly significant source of polycyclic aromatic hydrocarbons (PAHs) (92%).

A few key sources exert a relatively large influence on the emissions of several pollutants or their trends. Among industrial sources, the non-ferrous mining and smelting industry is a major source of SOx (35%), Pb (69%) and Cd (65%). Since 1990, the industry contributed significantly to the downward trends in emissions of these pollutants, as well as emissions of Hg. Over the years, the upstream petroleum industry has become a dominant source of VOC (36%) and NO_x (23%) emissions in Canada, with increasing trends in emissions of both pollutants. In contrast, electric power generation (coal) achieved important reductions in emissions of SO_x, NO_x, VOCs, HCB and Hg. Home firewood burning represents 92% of Canada's PAH emissions and 21% of its CO emissions; it is also the dominant combustion source of $PM_{2.5}$. While transportation and mobile equipment sources remain large contributors to NO_x, VOC and CO emissions, emissions from these sources have decreased significantly since 1990.

The last year saw no significant change in the general downward trends of pollutant emissions. Emissions of SO_x continued to decline, largely due to decreasing emissions from upstream petroleum operations and coal-fired electric power generation. Improved control measures and changes in sulphur levels in fuel resulted in a decrease in $PM_{2.5}$ and D/F emissions from marine transport. Upgrades to the Rio Tinto Alcan smelter in the province of British Columbia resulted in a significant decrease in PAH emissions from the aluminium industry. Emissions of Cd have steadily declined in recent years, with reductions in emissions from several sources.

1 Throughout this report, data are presented as rounded figures. However, all calculations (including percentages) were performed using unrounded data.

The various components of each source category contribute varying proportions of emissions of each pollutant (Table 2–2). For example, within the dust source category, road dust and construction operations are the largest sources of total PM emissions (almost six times greater than agriculture, the next most significant source). The upstream petroleum industry is the largest emitter of VOCs, heavy-duty diesel vehicles are significant emitters of NO_x, and off-road gasoline vehicles and equipment are large contributors of CO.

The subsequent sections of this chapter identify the important sources of emissions for each substance in 2015 and their varying contribution to total emissions over time.

The full time series of national, provincial, and territorial pollutant emissions from 1990 to 2015 are available through the Air Pollutant Emission Inventory Online Data Query Tool, at www.ec.gc.ca/inrp-npri/donnees-data/ap/index.cfm?lang=En.

Table 2–1 2015 Total Air Pollutant Emissions for Canada by Source

Source	Pollutants													
	TPM (kt)	PM_{10} (kt)	$PM_{2.5}$ (kt)	SO_x (kt)	NO_x (kt)	VOC (kt)	CO (kt)	NH_3 (kt)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH (kg)	HCB (g)
Ore and Minerals Industries	240	96	33	480	82	13	520	1.2	120 000	5 400	1 400	7.3	5 400	2 100
Oil and Gas Industry	17	13	10	230	470	690	540	2.2	510	220	74		24	
Electric Power Generation (Utilities)	19	7.3	3.8	250	150	1.6	39	0.38	1 400	130	800	1.9	6	600
Manufacturing	110	43	19	48	74	110	140	12	5 800	580	130	3	110	350
Transportation and Mobile Equipment	52	52	40	18	1 000	310	3 000	7.2	27 000	180	86	10	120	
Agriculture	3 200	1 300	320	9.0	4.0	98	0.90	450	64	76	8.3	0.061	0.32	
Commercial / Residential / Institutional	200	190	180	6.6	82	290	1 200	3.1	3 200	1 100	550	8.6	100 000	
Incineration and Waste	6.4	3.7	2.7	3.6	4.9	14	18	4.3	560	50	1 400	24	690	5 000
Paints and Solvents	0.02	0.02	0.012	<0.0001	0.023	330	0.0004			0.14				
Dust	19 000	5 500	1 000											
Fires	17	15	10	0.04	2.0	5.9	130	0.018				2.2	2 900	
Total	23 000	7 200	1 600	1 100	1 900	1 900	5 600	490	160 000	7 800	4 400	58	110 000	8 100

Notes:
1. Totals may not add up due to rounding.
2. Emissions of pollutants are expressed in either kt, kg, gTEQ or g.
3. This report's rounding protocol is based on an estimated uncertainty of 10–50% for all sectors, for which the protocol indicates rounding to two (2) significant digits.

Table 2–2 2015 Total Air Pollutant Emissions for Canada by Source, Sector and Subsector

Sectors	TPM (t)	PM_{10} (t)	$PM_{2.5}$ (t)	SO_x (t)	NO_x (t)	VOC (t)	CO (t)	NH_3 (t)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH (kg)	HCB (g)
Ore and Mineral Industries	**240 000**	**96 000**	**33 000**	**480 000**	**82 000**	**13 000**	**520 000**	**1 200**	**120 000**	**5 400**	**1 400**	**7.3**	**5 400**	**2100**
Aluminium Industry	5 800	4 100	3 300	57 000	1 100	930	380 000				21		4 900	
Alumina (Bauxite Refining)	150	50	45	1.8	310	25	380							
Primary Aluminium Smelting and Refining	5 600	4 000	3 200	57 000	830	910	380 000				21		4900	
Asphalt Paving Industry	430 00	8 500	1 600	680	1 200	8 500	4 000		1 000	22	22	0.0048	13	
Cement and Concrete Industry	46 000	16 000	7 600	24 000	35 000	450	10 000	480	870	14	300	1.6	2.8	290
Cement Manufacture	2 700	1 900	950	21 000	31 000	370	9 000	480	760	13	300	1.6	2.8	290
Concrete Batching and Products	41 000	13 000	6 200	95	120	76	400		100	0.98				
Lime Manufacture	1 700	940	470	2 200	4 000		1 000		6.5		1.3			
Foundries	6 100	5 700	5 200	48	140	380	49 000		210	21		0.034		23
Die Casting	8.1	5.8	4.3	0.0026	0.43		0.36							
Ferrous Foundries	6 000	5 700	5 200	48	140	380	49 000		140	21		0.034		23
Non-ferrous Foundries	3.2	3	3						61	0.01				
Iron and Steel Industries	7 400	4 200	2 400	22 000	11 000	870	21 000	59	5 500	220	720	5.2	400	1 100
Primary (Blast Furnace and DRI)	6 800	3 800	2 000	20 000	8 800	650	18 000	59	4 300	180	260	1.3	400	140
Secondary (Electric Arc Furnaces)	600	440	340	1 500	2 100	220	3 000	0.67	1 200	33	440	2.9	0.43	830
Steel Recycling	3.4	2.5	2.4				24		13		21	0.99		120
Iron Ore Industry	13 000	3 100	950	12 000	12 000	300	20 000		2 600	83	72	0.0007	20	
Iron Ore Mining	1 100	540	120	220	1 200	18	2 400		3.9	0.4	0.13	0.0007		
Pelletizing	11 000	2 600	830	12 000	11 000	290	18 000		2 600	83	71		20	
Mineral Products Industry	570	510	410	1 300	460	110	620	340			44			
Clay Products	19	15	6.4	150			13							
Other Mineral Products	550	490	400	1 200	460	110	610	340			44			
Mining and Rock Quarrying	120 000	51 000	9 500	1 800	20 000	1 900	13 000	52	780	19	20	0.058	110	17
Coal Mining Industry	33 000	9 800	1 000	650	640	470	250		27		1.8		110	
Metal Mining	15 000	7 500	3 400	870	8 000	460	8 900	47	670	16	16	0.05	0.14	6.5
Potash	6 300	3 300	1 500	25	2 200	610	1 200							
Rock, Sand and Gravel	59 000	29 000	2 900	0.44	560	0.4	160							
Silica Production	210	100	10											
Other Minerals	3 100	1 400	550	280	8 100	370	2 500	4.5	85	2.6	2.3	0.008		11
Non-Ferrous Mining and Smelting Industry	4 900	3 000	2 100	370 000	1 600	67	13 000	280	110 000	5 100	180	0.38	0.32	700
Primary Ni, Cu, Zn, Pb	4 900	2 900	2 100	360 000	1 600	35	13 000	250	110 000	5 100	180	0.38		700
Secondary Pb, Cu	9.2	5.3	4.7	1 500		31			260			0.0016	0.32	
Other Metals	8.4	4.1	4.1		86			37						0.06
Oil and Gas Industry	**17 000**	**13 000**	**10 000**	**230 000**	**470 000**	**690 000**	**540 000**	**2 200**	**510**	**220**	**74**		**24**	
Downstream Petroleum Industry	3 600	2 400	1 400	45 000	17 000	24 000	24 000	68	320	94	49		19	
Petroleum Refining	3 500	2 400	1 400	44 000	17 000	93 00	24 000	68	320	94	49		19	
Refined Petroleum Products Bulk Storage and Distribution	54	5.4	5.4			14 000					<0.01		<0.01	
Other Downstream Petroleum Industry	56	32	19	1 100	830	600	93							
Petroleum Product Transportation and Distribution	100	100	100	49	21 000	1 100	10 000	0.19						
Natural Gas Distribution	13	13	13	29	4 300	390	4 500							
Natural Gas Transmission	84	84	84	20	17 000	690	5 500	0.19						
Petroleum Product Pipelines	2.8	2.8	2.8		80	41								
Upstream Petroleum Industry	13 000	11 000	8 800	190 000	430 000	670 000	510 000	2 200	190	130	25		4.8	
Accidents and Equipment Failures						130 000								
Bitumen and Heavy Oil Upgrading	3 800	2 600	1 800	54 000	31 000	37 000	20 000	1 000	180	48	9.9		4.7	
Disposal and Waste Treatment	22	22	22	0.032	25	45	69	0.34						
Heavy Crude Oil Cold Production	270	270	270	1 600	11 000	28 000	15 000	38						
Light Medium Crude Oil Production	2 700	2 600	2 600	10 000	37 000	370 000	46 000	15						
Natural Gas Production and Processing	2 300	2 300	2 300	97 000	310 000	52 000	390 000	220						
Oil Sands In-Situ Extraction and Processing	690	690	690	19 000	36 000	12 000	24 000	860		63	11			
Oil Sands Mining Extraction and Processing	3 100	1 800	930	130	3 100	14 000	5 900		7.1	17	4		0.14	
Petroleum Liquids Storage	9.1	8.1	7.6		37	5 100								
Petroleum Liquids Transportation	6.6	6.4	6.4		0.44	14 000	2.4							
Well Drilling/Servicing/Testing	220	220	220	6 400	140	1 500	630	0.0075						
Electric Power Generation (Utilities)	**19 000**	**7 300**	**3 800**	**250 000**	**150 000**	**1 600**	**39 000**	**380**	**1 400**	**130**	**800**	**1.9**	**6.1**	**600**
Coal	17 000	6 000	2 800	240 000	110 000	410	16 000	170	810	36	740	1.6		430
Diesel	270	200	190	270	9 100	84	1500							
Natural Gas	550	480	390	2 000	16 000	570	14 000	130	97	52	26	0.01	0.044	150
Waste Materials	53	43	25	53	420	290	690	5.3	7	1.5	10	0.02		4.9
Other Electric Power Generation	950	550	450	7 700	11 000	220	7 200	70	530	44	26	0.2	6	16
Manufacturing	**110 000**	**43 000**	**19 000**	**48 000**	**74 000**	**110 000**	**140 000**	**12 000**	**5 800**	**580**	**130**	**3**	**110**	**350**
Abrasives Manufacture	47	28	15			18						0.015	0	
Bakeries	16	12	6.9	0.0054	0.89	9 100	0.3	0.34						
Biofuel Production	16	9.9	4.6		18	100								
Chemicals Industry	2 900	2 000	1 300	22 000	23 000	10 000	15 000	8 800	27	7.9	15	0.26	25	
Chemical Manufacture	1 600	1 100	880	20 000	8 900	4 600	8 700	82	0.11	0.0024	14	0.26	24	
Fertilizer Production	930	670	290	2 300	8 900	810	3 900	8 700	1.9	4.1	0.97			
Paint and Varnish Manufacturing	10	9.6	5.7		2.9	450	2.5	1.9	15					
Petrochemical Industry	140	120	79	81	4 500	1 200	1 700	0.41	9.3	3.8	0.5		0.26	
Plastics and Synthetic Resins Fabrication	97	65	48	9	360	2 600	240	35			0.016			
Other Chemical Industries	34	25	18	0.015	68	650	490	1.8						
Electronics	0.61	0.59	0.49			20		19	1.9		18			
Food Preparation	3 600	1 800	740	370	2 000	15 000	1 700	360						
Glass Manufacture	190	170	150	630	920	200	300		0.002					
Grain Processing	63 000	17 000	2 800	510	780	3 000	370	5						
Metal Fabrication	690	500	420	8.6	420	4 800	1 600	25	1 900	320	<0.01	0.87		210

Table 2-2 2015 Total Air Pollutant Emissions for Canada by Source, Sector and Subsector (cont'd)

Sectors	TPM (t)	PM_{10} (t)	$PM_{2.5}$ (t)	SO_x (t)	NO_x (t)	VOC (t)	CO (t)	NH_3 (t)	Pb (kg)	Cd (kg)	Hg (kg)	D/F (gTEQ)	PAH (kg)	HCB (g)
Manufacturing (cont'd)	400 000	140 000	63 000	810 000	620 000	860 000	1 200 000	15 000	100 000	6 100	1 500	8.5	24 000	2 300
Grain Processing	63 000	17 000	2 800	510	780	3 000	370	5						
Metal Fabrication	690	500	420	8.6	420	4 800	1 600	25	1 900	320	<0.01	0.87		210
Plastics Manufacture	99	64	59	57	87	12 000	34		4.7					
Pulp and Paper Industry	17 000	11 000	7 600	24 000	30 000	13 000	68 000	1 600	3 400	200	70	1.2	73	140
Textiles	1.6	1.6	1.2	17	8.2	620	0.069							
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	320	250	160	0.014	550	7 700	380	2.3	67				0.021	
Wood Products	18 000	9 700	5 000	630	16 000	33 000	47 000	830	340	54	18	0.65	9.7	0.11
Panel Board Mills	6 500	3 500	2 100	380	9 600	14 000	26 000	310	240	21	5	0.23	2.5	
Sawmills	11 000	5 500	2 500	230	5 900	15 000	20 000	520	94	30	13	0.42	7.2	
Other Wood Products	1 200	660	440	26	440	3 700	980	1.3	6.9	3.4			<0.01	0.11
Other Manufacturing Industries	310	240	170	1.1	160	1 300	580	32	25	0.063	3.4			
Transportation and Mobile Equipment	52 000	52 000	40 000	18 000	1 000 000	310 000	3 000 000	7 200	27 000	180	86	10	120	
Air Transportation	960	960	870	6 100	73 000	6 200	46 000	37	27000				9.4	
Heavy-duty Diesel Vehicles	9 700	9 700	8 900	160	250 000	17 000	66 000	770			<0.01	<0.0001	0.64	
Heavy-duty Gasoline Vehicles	1 100	1 100	980	180	37 000	13 000	400 000	320			<0.01	<0.0001	1.9	
Heavy-duty LPG/NG Vehicles	4.6	4.6	4.1	1.1	200	83	2 100	3.2			<0.01	<0.0001	<0.01	
Light-duty Diesel Trucks	11	11	10	2	1000	950	11 000	9.3			<0.01	<0.0001	<0.01	
Light-duty Diesel Vehicles	14	14	13	3.1	870	760	8 600	17			<0.01	<0.0001	<0.01	
Light-duty Gasoline Trucks	1 200	1 200	1 100	620	60 000	48 000	610 000	2 600			0.012	<0.0001	2.5	
Light-duty Gasoline Vehicles	1 200	1 200	1 000	490	42 000	44 000	470 000	2 700			0.012	<0.0001	2.3	
Light-duty LPG/NG Trucks	0.57	0.57	0.5	0.17	32	29	300	1			<0.01	<0.0001	<0.01	
Light-duty LPG/NG Vehicles	0.024	0.024	0.022	0.0065	0.87	0.98	8.9	0.048			<0.01	<0.0001	<0.01	
Marine Transportation	5 200	5 000	4 600	10 000	240 000	10 000	22 000	300	270	93	2.1	9.1	54	
Motorcycles	21	21	18	3.9	590	1 700	12 000	34			<0.01	<0.0001	0.035	
Off-road Diesel Vehicles and Equipment	14 000	14 000	14 000	160	170 000	19 000	90 000	200						
Off-road Gasoline/LPG/CNG Vehicles and Equipment	4 900	4 700	4 400	82	30 000	140 000	1 200 000	91						
Rail Transportation	3 000	3 000	2 900	450	130 000	6 300	18 000	57	250	84	84	1.4	51	
Tire Wear and Brake Lining	11 000	11 000	1 400											
Agriculture	3 200 000	1 300 000	320 000	9000	4000	98 000	900	450 000	64	76	8.3	0.061	0.32	
Animal Production	35 000	9 900	2 100			98 000		300 000						
Crop Production	3 200 000	1 300 000	320 000					1 500 00						
Fertilizer Application	13000	6200	1800					1 500 00						
Harvesting	230 000	110 000	21 000											
Tillage Practices	870 000	180 000	87 000											
Wind Erosion	2 100 000	1 000 000	210 000											
Fuel Use	780	530	290	9 000	4 000	150	900	44	64	76	8.3	0.061	0.32	
Commercial / Residential / Institutional	200 000	190 000	180 000	6 600	82 000	290 000	1 200 000	3 100	3 200	1 100	550	8.6	100 000	
Cigarette Smoking	410	410	410			6.8	1 900	76	1.1	3	0.11	0.0095	0.53	
Commercial and Institutional Fuel Combustion	2 700	2 500	2 400	3 200	27 000	1 300	1 9000	220	250	460	59	1.3	2.4	
Commercial Cooking	17 000	17 000	16 000			2 400	6 700						120	
Construction Fuel Combustion	130	120	100	350	1 700	20	300	31	6.1	8.6	2.1	0.014	0.19	
Home Firewood Burning	170 000	160 000	160 000	2 800	20 000	230 000	1 200 000	1 800	2 600	150	40	7	100 000	
Human								600			15			
Marine Cargo Handling	420	200	68	88	26				9.8	0.5				
Residential Fuel Combustion	2 800	2 600	2 500	190	34 000	1 800	13 000	380	290	480	79	0.31	3.5	
Service Stations						50 000								
Other Miscellaneous Sources								21			360			
Incineration and Waste	6 400	3 700	2 700	3 600	4 900	14 000	18 000	4300	560	50	1400	24	690	5 000
Crematoriums	7.1	7.1	7.1	14	22	2.4	18		5.5	0.93	280	3.1	<0.01	28
Industrial and Commercial Incineration	13	9.1	7.3	450	530	650	1900	72	310	0.59	0.014			
Municipal Incineration	32	14	13	210	740	210	150	19	150	26	190	0.32		63
Waste	6 200	3 700	2 700	1 300	3 200	13 000	14 000	4 200	88	18	680	21	690	4 900
Landfills	3 900	1 400	390	1.3	320	7 600	1 900	16	9.9	2	280			
Residential Waste Burning	2 200	2 200	2 200	140	820	4 100	11 000	87			160	20	690	4 700
Waste Treatment and Disposal	46	45	34	570	450	350	270		12	2.3	6.4	1		100
Water and Sewage Treatment	69	69	67	590	1 600	680	710	4 100	66	13	230	0.017	0.11	110
Other Incineration and Utilities	120	12	3.3	1 600	390	140	1 900	47	11	4.8	210	<0.0001		
Paints and Solvents	20	20	12	0.003	23	330 000	0.37			0.14				
Dry Cleaning	9.3	9.3	6.1			180								
General Solvent Use						250 000								
Printing	5.7	5.7	5.1	0.003	23	17 000	0.37							
Surface Coatings	5.3	5	1			61 000				0.14				
Dust	19 000 000	5 500 000	1 000 000											
Coal Transportation	990	490	39											
Construction Operations	8 400 000	2 500 000	500 000											
Mine Tailings	33000	2600	660											
Paved Roads	3 000 000	580 000	140 000											
Unpaved Roads	7 600 000	2 400 000	350 000											
Fires	17 000	15 000	10 000	41	2 000	5 900	130 000	180				2.2	2 900	
Prescribed Forest Burning	17 000	15 000	10 000	41	2 000	5700	130 000	170				2.2	2 900	
Structural Fires	210	210	190		27	210	1 100	12						
GRAND TOTAL	23 000 000	7 200 000	1 600 000	1 100 000	1 900 000	1 900 000	5 600 000	490 000	160 000	7 800	4 400	58	1 100 00	8 100

Notes:
1. Totals may not add up due to rounding.
2. PAH includes B(a)p, B(b)f, B(k)f and I(cd)p.

2.1. Particulate Matter Less than or Equal to 2.5 Microns in Diameter ($PM_{2.5}$)

In 2015, approximately 1.6 million tonnes (Mt) of $PM_{2.5}$ were emitted in Canada (Table 2–3). Dust sources accounted for 62% (1.0 Mt) of total $PM_{2.5}$ emissions, with the most important dust sources being construction operations at 31% (500 kt) and dust from unpaved and paved roads at 30% (490 kt). Agricultural sources were the second largest contributor and accounted for 20% (320 kt) of $PM_{2.5}$ emissions, most of which are attributed to crop production (19% or 320 kt of annual $PM_{2.5}$ emissions). In these sectors, PM is largely emitted by non-combustion sources. Commercial/residential/institutional sources accounted for 11% (180 kt) of total $PM_{2.5}$ emissions in 2015, with the most important sector being home firewood burning at 10% (160 kt) of total emissions. All other sources accounted for less than 3% of total $PM_{2.5}$ emissions.

Overall, emissions of $PM_{2.5}$ decreased from 1990 to 2015 (Figure 2-1), despite an increasing trend from construction operations and paved and unpaved roads. The downward trend was influenced predominantly by decreasing emissions from crop production, home firewood burning and other sectors. Decreases in emissions from crop production can be attributed to the adoption of conservation tillage practices. Decreases in home firewood burning are due to the use of new fireplace inserts, furnaces and stoves with improved $PM_{2.5}$ emission controls and combustion efficiencies. Emissions from construction operations tended to decrease until 2002, followed by an increase from 2002 to 2012. $PM_{2.5}$ emissions from paved and unpaved roads followed a more gradual, consistent increasing trend from 1990 to 2002 and remained stable between 2002 and 2015. Emission increases in construction operations were primarily due to growth in construction for the oil and gas industries in Alberta and Saskatchewan. The trend in $PM_{2.5}$ emissions from roads is driven predominantly by the use of unpaved roads in Alberta, Ontario and Quebec.

The most significant changes in $PM_{2.5}$ emissions from 1990 to 2015 include:

- Dust sources: increase of 57% (360 kt)
  - Construction operations: increase of 112% (270 kt)

Figure 2–1 Major Contributors to National $PM_{2.5}$ Trends

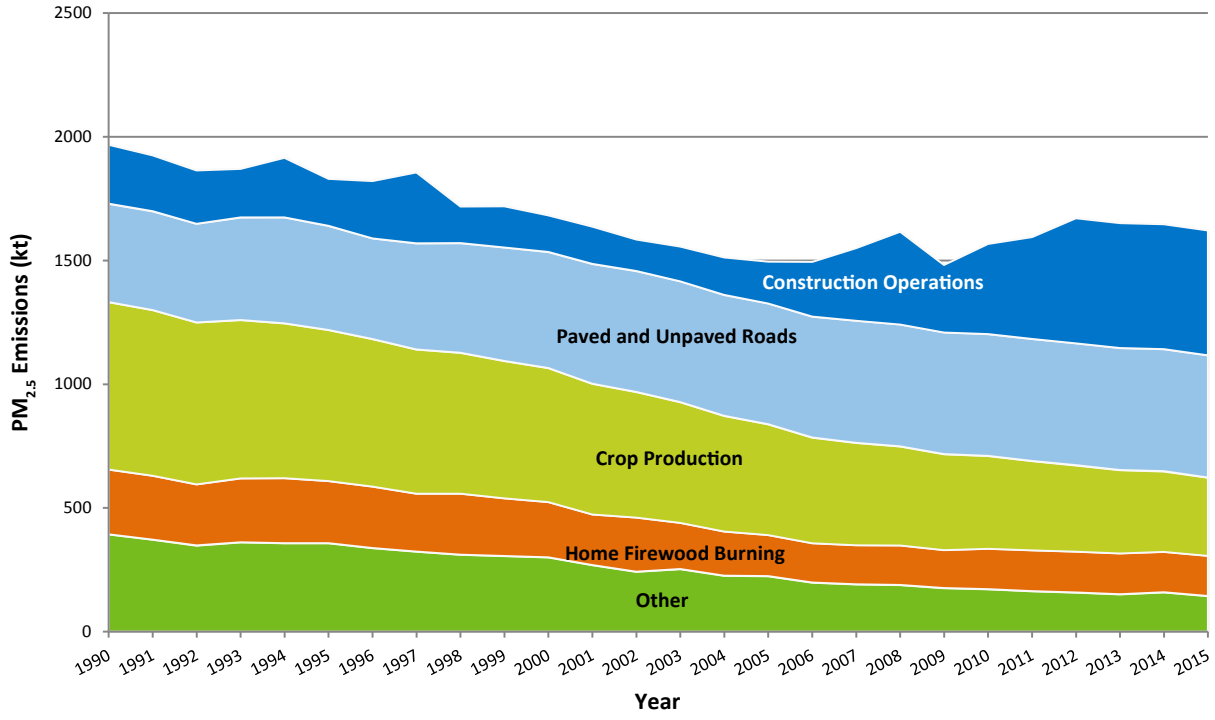


Table 2–3 National Summary of Annual $PM_{2.5}$ Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(tonnes)				
Ore and Mineral Industries	59 000	56 000	45 000	37 000	35 000	35 000	34 000	34 000	33 000
Aluminium Industry	5 400	4 500	4 700	4 600	4 500	4 500	4 100	3 700	3 300
Asphalt Paving Industry	1 900	1 700	1 500	2 000	1 800	1 500	1 400	1 600	1 600
Cement and Concrete Industry	11 000	9 500	12 000	7 500	7 600	8 000	7 600	7 600	7 600
Foundries	6 100	5 100	5 200	5 300	5 200	5 200	5 200	5 200	5 200
Iron and Steel Industries	11 000	9 400	5 100	2 000	2 100	2 600	2 100	2 500	2 400
Iron Ore Industry	1 600	4 500	1 700	1 300	1 100	1 100	1 100	950	950
Mineral Products Industry	1 300	1 200	1 300	450	420	350	450	470	410
Mining and Rock Quarrying	13 000	14 000	9 000	13 000	11 000	9 400	10 000	10 000	9 500
Non-Ferrous Mining and Smelting Industry	8 800	6 000	4 800	1 600	1 900	1 900	1 800	1 900	2 100
Oil and Gas Industry	12 000	13 000	12 000	9 400	9 600	9 600	10 000	12 000	10 000
Downstream Petroleum Industry	5 100	4 900	4 500	2 000	2 000	1 800	1 700	1 600	1 400
Petroleum Product Transportation and Distribution	580	560	420	110	100	100	110	110	100
Upstream Petroleum Industry	6 700	8 000	7 500	7 300	7 500	7 700	8 300	9 800	8 800
Electric Power Generation (Utilities)	48 000	22 000	8 700	5 700	4 300	3 200	3 200	4 000	3 800
Coal	46 000	20 000	5 000	3 200	2 500	2 300	2 200	3 000	2 800
Diesel	260	400	380	380	170	160	160	180	190
Natural Gas	1 100	1 000	1 400	1 700	1 300	440	470	390	390
Waste Materials	7	54	17	15	15	17	16	21	25
Other Electric Power Generation	1 300	730	1 800	350	430	330	340	440	450
Manufacturing	120 000	79 000	44 000	20 000	21 000	20 000	21 000	19 000	19 000
Abrasives Manufacture	390	210	200	5	5.4	7.8	8.1	8.4	15
Bakeries	0.54	0.54	0.43	2.7	2	0.87	0.78	0.76	6.9
Biofuel Production				6.3	4.2	4.3	3.9	4.4	4.6
Chemicals Industry	4 800	4 500	4 000	1 300	1 400	1 500	1 600	1 400	1 300
Electronics	120	39	5.2	0.035	0.46			0.55	0.49
Food Preparation	1 400	2 100	1 700	820	780	730	810	750	740
Glass Manufacture	920	1 300	1 100	240	230	140	140	150	150
Grain Processing	2 200	2 900	2 000	2 500	2 500	2 600	2 400	2 800	2 800
Metal Fabrication	820	1 300	970	790	860	870	790	430	420
Plastics Manufacture	220	220	150	130	160	140	100	90	59
Pulp and Paper Industry	61 000	25 000	17 000	8 200	9 200	8 400	9 000	8 400	7 600
Textiles	16	23	18	3.2	3.4	2.7	2.8	2.5	1.2
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	1 600	1 500	550	260	260	190	180	150	160
Wood Products	37 000	31 000	14 000	5 400	5 300	5 500	5 600	4 600	5 000
Other Manufacturing Industries	6 200	8 800	2 900	210	200	170	190	180	170
Transportation and Mobile Equipment	93 000	94 000	79 000	66 000	59 000	54 000	52 000	50 000	40 000
Air Transportation	640	840	830	750	760	860	880	870	870
Heavy-duty Diesel Vehicles	16 000	15 000	17 000	13 000	12 000	11 000	10 000	9 700	8 900
Heavy-duty Gasoline Vehicles	3 500	2 300	2 100	1 600	1 100	1 100	1 100	1 000	980
Heavy-duty LPG/NG Vehicles	690	760	170	57	8.5	6	3.4	22	4.1
Light-duty Diesel Trucks	14	13	14	10	10	9.8	10	10	10
Light-duty Diesel Vehicles	51	27	17	13	13	13	13	13	13
Light-duty Gasoline Trucks	2 100	2 400	1 600	1 300	1 200	1 200	1 200	1 100	1 100
Light-duty Gasoline Vehicles	5 200	3 600	2 200	1 500	1 300	1 200	1 200	1 100	1 000
Light-duty LPG/NG Trucks	220	97	34	5.8	2	1.3	0.69	0.5	0.5
Light-duty LPG/NG Vehicles	28	14	5.7	0.76	0.11	0.07	0.03	0.023	0.022
Marine Transportation	9 700	13 000	15 000	13 000	13 000	13 000	13 000	13 000	4 600
Motorcycles	23	22	23	21	19	19	19	18	18
Off-road Diesel Vehicles and Equipment	40 000	41 000	29 000	24 000	20 000	17 000	16 000	14 000	14 000
Off-road Gasoline/LPG/CNG Vehicles and Equipment	11 000	8 700	6 300	5 900	5 000	4 600	4 300	4 400	4 400
Rail Transportation	3 600	3 400	3 300	2 600	2 900	2 900	2 800	2 900	2 900
Tire Wear and Brake Lining	770	1 100	1 200	1 300	1 300	1 300	1 400	1 400	1 400
Agriculture	680 000	540 000	450 000	380 000	360 000	350 000	340 000	330 000	320 000
Animal Production	1 700	2 100	2 300	2 000	2 000	2 000	2 000	2 000	2 100
Crop Production	680 000	540 000	450 000	370 000	360 000	350 000	340 000	330 000	320 000
Fuel Use	120	140	130	230	280	270	280	290	290
Commercial / Residential / Institutional	280 000	240 000	190 000	190 000	190 000	190 000	190 000	190 000	180 000
Cigarette Smoking	810	690	530	490	490	480	410	410	410
Commercial and Institutional Fuel Combustion	2 000	2 600	2 600	2 200	2 400	2 200	2 300	2 400	2 400
Commercial Cooking	14 000	15 000	17 000	18 000	17 000	17 000	17 000	16 000	16 000
Construction Fuel Combustion	180	110	160	170	130	100	100	100	100
Home Firewood Burning	260 000	220 000	170 000	160 000	160 000	170 000	160 000	160 000	160 000
Human									
Marine Cargo Handling	180	140	100	40	46	43	75	75	68
Residential Fuel Combustion	2 400	2 500	2 400	2 300	2 500	2 300	2 400	2 500	2 500
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	5 000	4 400	3 700	3 100	2 900	2 700	2 700	2 700	2 700
Crematoriums	4.3	6.6	5.1	5.7	5.9	6.1	6.4	6.6	7.1
Industrial and Commercial Incineration	17	21	21	11	10	7.3	7.3	7.3	7.3
Municipal Incineration	1 700	1 700	860	330	200	77	41	14	13
Waste	3 300	2 700	2 800	2 800	2 700	2 600	2 600	2 700	2 700
Other Incineration and Utilities	2.1	2.1	3.1	3.3	3.3	3.3	3.3	3.3	3.3
Paints and Solvents	3.7	7.1	25	14	22	19	15	11	12
Dry Cleaning	0.32	0.32	0.62	1.2	15	9.4	9.1	4.9	6.1
General Solvent Use									
Printing	3	6.4	23	11	7.3	8.7	5.5	5.5	5.1
Surface Coatings	0.37	0.37	0.94	0.87		0.83	0.78	0.63	1
Dust	640 000	620 000	660 000	860 000	910 000	1 000 000	1 000 000	1 000 000	1 000 000
Coal Transportation	190	170	120	41	40	41	45	42	39
Construction Operations	240 000	150 000	170 000	360 000	410 000	500 000	500 000	500 000	500 000
Mine Tailings	1 200	1 200	580	660	660	660	660	660	660
Paved Roads	110 000	140 000	140 000	140 000	140 000	140 000	140 000	140 000	140 000
Unpaved Roads	280 000	330 000	350 000	350 000	350 000	350 000	350 000	350 000	350 000
Fires	36 000	6 900	4 500	4 200	6 400	7 600	3 200	12 000	10 000
Prescribed Forest Burning	36 000	6 600	4 200	3 900	6 200	7 300	2 900	12 000	10 000
Structural Fires	350	280	250	240	280	280	280	200	190
Grand Total	**2 000 000**	**1 700 000**	**1 500 000**	**1 600 000**	**1 600 000**	**1 700 000**	**1 600 000**	**1 600 000**	**1 600 000**

Note: Totals may not add up due to rounding.

- Dust from paved and unpaved roads: increase of 24% (97 kt)

- Agriculture sources: decrease of 53% (360 kt)
  - Crop production: decrease of 53% (360 kt)
- Commercial/residential/institutional sources: decrease of 35% (97 kt)
  - Home firewood burning: decrease of 38% (100 kt)

2.2. Sulphur Oxides (SO_x)

In 2015, 1.1 Mt of SOx were emitted in Canada (Table 2–4). Ore and mineral industries were the largest contributor, accounting for 46% (480 kt) of national emissions. Approximately 76% (370 kt) of the emissions from this source was attributed to the non-ferrous mining and smelting industry. Electric power generation (utilities) was the second-largest source of SO_x, accounting for 24% (250 kt) of total SO_x emissions, including coal-fired electricity generation at 23% (240 kt). Oil and gas industry sources follow, accounting for 22% (230 kt) of total SOx emissions. The remaining 8% of SO_x emissions were distributed across multiple sources.

Overall, SO_x emissions decreased by 65% (2.0 Mt) between 1990 and 2015 (Figure 2–2). Reductions in emissions from the non-ferrous mining and smelting industry were the largest driver of this downward trend, particularly in the early 1990s, and again from 2008 to 2015. This decrease is attributed to government initiatives to reduce acid rain the installation of new technology or processes at facilities, and the closure of three major smelters in Manitoba, Ontario and Quebec. Emissions from electric power generation significantly decreased from 2003 to 2015, due primarily to decreased coal-fired electricity generation across the country, including the complete phase-out of coal electricity generation in Ontario. Upstream petroleum experienced a gradual decline throughout the time series as a result of a decrease in emissions from bitumen and heavy oil upgrading and natural gas processing, attributed to better emission control technologies.

The most significant decreases in SO_x emissions from 1990 to 2015 include:

- Ore and mineral industries: decrease of 68% (1.0 Mt)
  - Non-ferrous smelting and refining industry: decrease of 71% (900 kt)
- Electric power generation (utilities): decrease of 59% (370 kt)
  - Coal: decrease of 53% (270 kt)

Figure 2–2 Major Contributors to National SO_x Trends

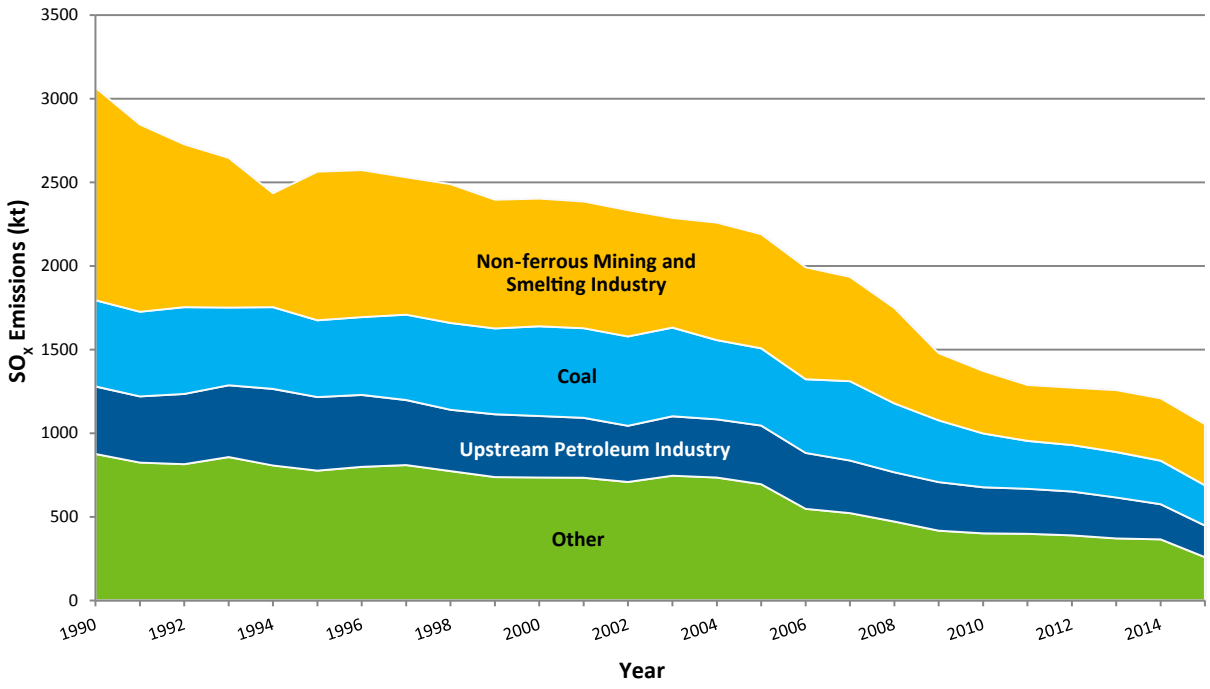


Table 2–4 National Summary of Annual SO_x Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(tonnes)				
Ore and Mineral Industries	1 500 000	920 000	860 000	500 000	470 000	480 000	490 000	490 000	480 000
Aluminium Industry	31 000	48 000	63 000	59 000	65 000	63 000	60 000	55 000	57 000
Asphalt Paving Industry	740	650	720	990	850	620	580	650	680
Cement and Concrete Industry	48 000	44 000	54 000	23 000	22 000	25 000	23 000	20 000	24 000
Foundries	1 300	910	720	49	48	48	48	48	48
Iron and Steel Industries	36 000	29 000	30 000	27 000	29 000	30 000	24 000	24 000	22 000
Iron Ore Industry	59 000	17 000	19 000	15 000	12 000	13 000	11 000	10 000	12 000
Mineral Products Industry	1 600	1 000	1 700	1 200	1 400	1 500	1 800	1 600	1 300
Mining and Rock Quarrying	35 000	11 000	6 300	5 300	5 800	3 000	2 200	2 000	1 800
Non-Ferrous Mining and Smelting Industry	1 300 000	760 000	680 000	370 000	330 000	340 000	370 000	370 000	370 000
Oil and Gas Industry	530 000	510 000	470 000	340 000	330 000	320 000	300 000	260 000	230 000
Downstream Petroleum Industry	130 000	140 000	110 000	61 000	58 000	56 000	56 000	53 000	45 000
Petroleum Product Transportation and Distribution	540	3 800	5 000	380	290	330	82	83	49
Upstream Petroleum Industry	400 000	370 000	350 000	280 000	270 000	260 000	250 000	210 000	190 000
Electric Power Generation (Utilities)	620 000	620 000	530 000	330 000	290 000	280 000	280 000	270 000	250 000
Coal	520 000	540 000	460 000	320 000	290 000	280 000	270 000	260 000	240 000
Diesel	410	420	300	170	56	55	59	110	270
Natural Gas	29 000	20 000	19 000	2 900	680	570	1 300	2 200	2 000
Waste Materials	110	66	52	45	91	97	86	79	53
Other Electric Power Generation	74 000	63 000	46 000	8 500	6 000	5 800	5 100	7 000	7 700
Manufacturing	220 000	160 000	140 000	53 000	53 000	50 000	49 000	53 000	48 000
Abrasives Manufacture	4 000	860	860						
Bakeries	0.053	0.052	0.16	0.0042	0.006	0.0051	0.0064	0.0062	0.0 054
Biofuel Production									
Chemicals Industry	38 000	31 000	35 000	21 000	23 000	20 000	20 000	21 000	22 000
Electronics	1 700	3 000	3 000						
Food Preparation	3 500	4 800	5 200	1 700	1 700	900	740	610	370
Glass Manufacture	2 300	2 800	2 500	600	590	630	630	600	630
Grain Processing	230	210	390	660	700	660	630	470	510
Metal Fabrication	2 300	2 700	2 000	670	200	200	190	9.2	8.6
Plastics Manufacture	1 600	1 000	870	590	620	610	450	390	57
Pulp and Paper Industry	140 000	78 000	62 000	27 000	26 000	26 000	26 000	29 000	24 000
Textiles	380	390	320	52	51	41	31	22	17
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	1 100	1 000	990	380	350	45	150	0.64	0.014
Wood Products	3 000	3 500	3 100	860	640	580	570	640	630
Other Manufacturing Industries	29 000	25 000	23 000	180	24	0.88	0.7	0.79	1.1
Transportation and Mobile Equipment	150 000	170 000	150 000	110 000	120 000	120 000	120 000	120 000	18 000
Air Transportation	5 300	6 600	7 400	4 800	5 100	5 900	6 100	6 100	6 100
Heavy-duty Diesel Vehicles	16 000	6 700	6 100	130	160	160	170	160	160
Heavy-duty Gasoline Vehicles	1 000	2 000	150	140	160	170	180	180	180
Heavy-duty LPG/NG Vehicles	270	1 400	10	2.2	0.96	1	0.51	4.8	1.1
Light-duty Diesel Trucks	180	76	49	1.2	1.5	1.5	1.7	1.9	2
Light-duty Diesel Vehicles	590	140	110	2.2	2.9	2.9	3.1	3.1	3.1
Light-duty Gasoline Trucks	3 400	6 500	500	470	540	590	610	610	620
Light-duty Gasoline Vehicles	7 800	8 600	560	440	490	510	520	500	490
Light-duty LPG/NG Trucks	230	190	10	1.8	0.65	0.42	0.22	0.17	0.17
Light-duty LPG/NG Vehicles	26	32	1.5	0.2	0.033	0.019	0.0081	0.0065	0.0 065
Marine Transportation	80 000	110 000	130 000	110 000	110 000	110 000	110 000	110 000	10 000
Motorcycles	15	25	2.8	2.9	3.3	3.7	3.7	3.7	3.9
Off-road Diesel Vehicles and Equipment	26 000	16 000	7 000	320	240	150	150	150	160
Off-road Gasoline/LPG/CNG Vehicles and Equipment	1 300	1 300	73	79	76	74	74	80	82
Rail Transportation	5 700	5 400	5 000	470	450	450	430	450	450
Tire Wear and Brake Lining									
Agriculture	2 200	1 500	2 900	7 500	9 000	7 900	8 300	9 000	9 000
Animal Production									
Crop Production									
Fuel Use	2 200	1 500	2 900	7 500	9 000	7 900	8 300	9 000	9 000
Commercial / Residential / Institutional	52 000	34 000	36 000	18 000	17 000	13 000	9 400	6 800	6 600
Cigarette Smoking									
Commercial and Institutional Fuel Combustion	19 000	19 000	21 000	6 400	7 500	6 000	3 000	3 300	3 200
Commercial Cooking									
Construction Fuel Combustion	1 900	610	1 400	1 900	690	510	330	350	350
Home Firewood Burning	3 600	3 300	2 700	2 800	2 800	2 900	2 800	2 800	2 800
Human									
Marine Cargo Handling	0.005	0.001					140	140	88
Residential Fuel Combustion	28 000	12 000	11 000	6 900	5 800	3 900	3 000	190	190
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	3 100	2 900	3 000	2 900	3 200	3 100	3 100	3 300	3 600
Crematoriums	5	7	9	11	11	12	12	13	14
Industrial and Commercial Incineration	39	29	24	450	450	450	450	450	450
Municipal Incineration	1 000	730	660	180	220	280	250	190	210
Waste	1 000	1 100	740	580	820	760	740	970	1 300
Other Incineration and Utilities	1 000	1 000	1 500	1 600	1 600	1 600	1 600	1 600	1 600
Paints and Solvents	2.1	1.5	0.63	0.014	0.0 038		0.004	0.004	0.003
Dry Cleaning	0.0 068	0.0 086							
General Solvent Use									
Printing	2	1.5	0.63	0.014	0.0038		0.004	0.004	0.003
Surface Coatings	0.015	0.015							
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	180	28	18	16	27	34	13	53	41
Prescribed Forest Burning	180	28	18	16	27	34	13	53	41
Structural Fires									
Grand Total	**3 100 000**	**2 400 000**	**2 200 000**	**1 400 000**	**1 300 000**	**1 300 000**	**1 300 000**	**1 200 000**	**1 100 000**

Note: Totals may not add up due to rounding.

- Oil and gas industry: decrease of 56% (300 kt)
  - Upstream petroleum industry: decrease of 53% (210 kt)

2.3. Nitrogen Oxides (NO_x)

Approximately 1.9 Mt of NO_x were released in Canada in 2015 (Table 2–5). Transportation and mobile equipment was the largest contributor, accounting for 54% (1.0 Mt) of total NO_x emissions. Within this source category, heavy-duty diesel vehicles, marine transportation, and off-road diesel vehicles and equipment were the largest emitters, collectively contributing 35% (660 kt) of total NO_x emissions. The oil and gas industry accounted for 25% (470 kt) of NO_x emissions in 2015, including the upstream petroleum industry, which accounted for 23% (430 kt) of the national total. Electric power generation (utilities) contributed 8% (150 kt) of NO_x emissions, including coal-fired generation, which contributed 6% (110 kt) of national emissions. The remaining 13% of NO_x emissions were distributed across multiple sources.

From 1990 to 2015, national NO_x emissions decreased by 22% (530 kt) (Figure 2–3). A significant driver of this trend was the consistent reduction in emissions from light-duty gasoline trucks and vehicles across the entire time series, as a result of increasingly stringent vehicle regulations. Emissions from off-road diesel vehicles and equipment decreased more gradually through the same time period, while emissions from heavy-duty diesel vehicles increased from 1990 to 2005, followed by a consistent decreasing trend beginning in 2006. Within electric power generation (utilities), the coal sector contributed to the decreasing trend across the time series, with a gradual decrease in emissions from 1998 to 2015. Finally, the upstream petroleum industry and marine transportation are the only major contributors to NO_x emissions that experienced an increase in emissions across the time series. This increase is attributed to expansion and growth in the petroleum industry and increased marine transportation activity, respectively.

- The most significant changes in NOx emissions from 1990 to 2015 include:
  - Transportation and mobile equipment emissions: decrease of 28% (400 kt)
  - Light-duty gasoline trucks and vehicles: decrease of 67% (210 kt)
  - Off-road diesel vehicles and equipment: decrease of 47% (150 kt)
  - Heavy-duty diesel vehicles: decrease of 19% (60 kt)
  - Marine transportation: increase of 70% (100 kt)

Figure 2–3 Major Contributors to National NO_x Trends

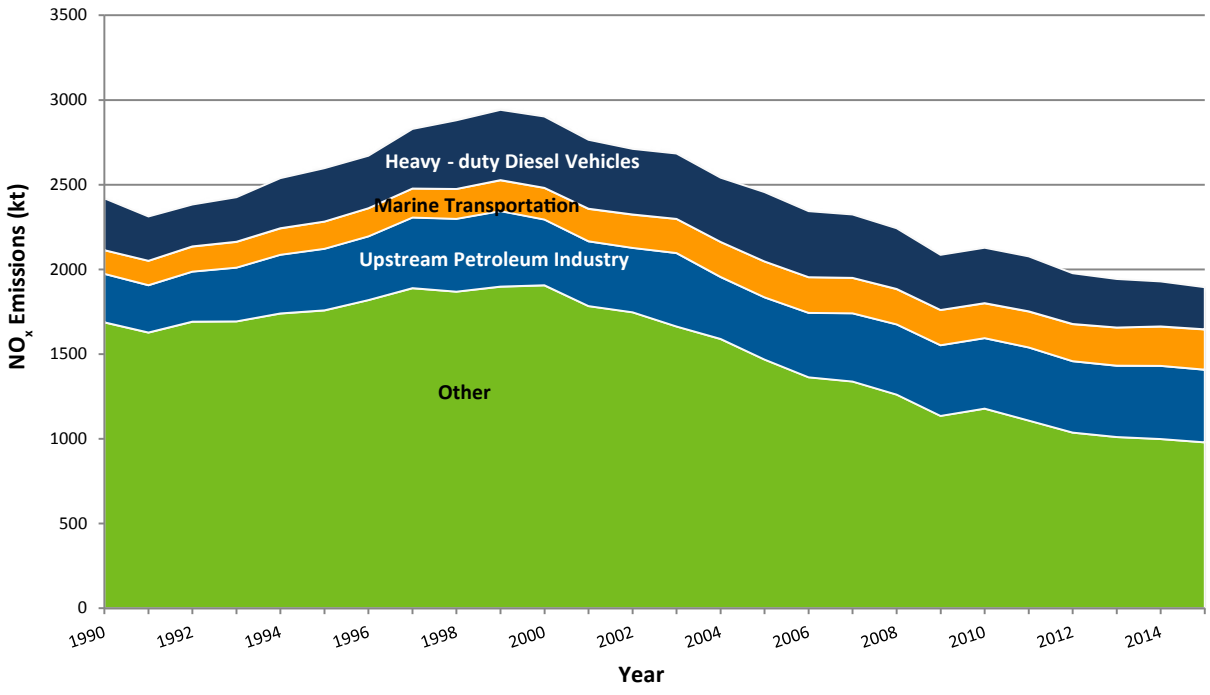


Table 2–5 National Summary of Annual NO_x Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(tonnes)				
Ore and Mineral Industries	110 000	99 000	110 000	85 000	86 000	89 000	83 000	82 000	82 000
Aluminium Industry	1 600	1 400	2 000	1 100	1 100	1 400	1 300	1 200	1 100
Asphalt Paving Industry	1 200	1 100	1 200	1 500	1 300	1 100	1 000	1 200	1 200
Cement and Concrete Industry	42 000	45 000	54 000	33 000	32 000	35 000	32 000	31 000	35 000
Foundries	490	640	530	150	140	140	140	140	140
Iron and Steel Industries	19 000	16 000	13 000	11 000	11 000	12 000	11 000	12 000	11 000
Iron Ore Industry	10 000	10 000	9 800	14 000	13 000	13 000	13 000	12 000	12 000
Mineral Products Industry	1 500	780	1 100	370	370	450	520	540	460
Mining and Rock Quarrying	25 000	21 000	23 000	23 000	24 000	24 000	22 000	23 000	20 000
Non-Ferrous Mining and Smelting Industry	4 300	3 800	2 000	1 600	1 600	1 500	1 600	1 600	1 600
Oil and Gas Industry	340 000	460 000	440 000	460 000	470 000	460 000	460 000	470 000	470 000
Downstream Petroleum Industry	34 000	29 000	29 000	20 000	19 000	19 000	18 000	17 000	17 000
Petroleum Product Transportation and Distribution	24 000	40 000	40 000	24 000	21 000	18 000	20 000	22 000	21 000
Upstream Petroleum Industry	290 000	390 000	370 000	420 000	430 000	420 000	420 000	430 000	430 000
Electric Power Generation (Utilities)	250 000	310 000	250 000	230 000	200 000	170 000	160 000	170 000	150 000
Coal	210 000	230 000	190 000	150 000	130 000	130 000	120 000	130 000	110 000
Diesel	3 000	8 200	7 600	8 500	8 000	7 800	8 000	8 600	9 100
Natural Gas	16 000	45 000	31 000	61 000	49 000	22 000	21 000	18 000	16 000
Waste Materials	240	800	330	350	430	450	370	340	420
Other Electric Power Generation	28 000	28 000	21 000	12 000	11 000	11 000	8 600	11 000	11 000
Manufacturing	190 000	180 000	130 000	68 000	70 000	68 000	69 000	68 000	74 000
Abrasives Manufacture	240	90	74						
Bakeries	4.1	4		0.7	1	0.86	1.1	1	0.89
Biofuel Production				22	19	18	18	17	18
Chemicals Industry	41 000	47 000	36 000	23 000	23 000	24 000	22 000	21 000	23 000
Electronics	150	160	71	0.46					
Food Preparation	2 400	2 900	3 100	1 800	2 000	1 600	1 700	1 700	2 000
Glass Manufacture	7 000	7 400	6 100	940	940	900	920	890	920
Grain Processing	1 400	1 300	1 600	870	850	1 000	950	1 000	780
Metal Fabrication	5 900	9 100	1 500	830	370	350	300	330	420
Plastics Manufacture	1 100	1 100	350	270	260	260	220	180	87
Pulp and Paper Industry	72 000	49 000	41 000	30 000	31 000	29 000	31 000	30 000	30 000
Textiles	120	170	110	42	43	30	33	33	8.2
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	2 300	3 100	1 400	670	630	500	560	540	550
Wood Products	19 000	24 000	21 000	9 600	9 900	11 000	11 000	12 000	16 000
Other Manufacturing Industries	33 000	30 000	21 000	250	190	170	140	140	160
Transportation and Mobile Equipment	1 400 000	1 800 000	1 400 000	1 200 000	1 200 000	1 100 000	1 100 000	1 000 000	1 000 000
Air Transportation	52 000	64 000	67 000	60 000	60 000	69 000	72 000	73 000	73 000
Heavy-duty Diesel Vehicles	310 000	420 000	410 000	330 000	320 000	300 000	290 000	270 000	250 000
Heavy-duty Gasoline Vehicles	62 000	83 000	60 000	45 000	41 000	41 000	40 000	38 000	37 000
Heavy-duty LPG/NG Vehicles	17 000	38 000	4 800	1 300	360	250	140	940	200
Light-duty Diesel Trucks	830	1 500	1 900	1 400	1 300	1 200	1 100	1 100	1 000
Light-duty Diesel Vehicles	2 400	2 300	1 200	1 000	1 100	970	980	920	870
Light-duty Gasoline Trucks	100 000	200 000	130 000	91 000	81 000	75 000	71 000	64 000	60 000
Light-duty Gasoline Vehicles	210 000	230 000	120 000	72 000	62 000	56 000	52 000	46 000	42 000
Light-duty LPG/NG Trucks	9 000	6 700	2 800	430	150	94	48	33	32
Light-duty LPG/NG Vehicles	970	830	300	35	5	3	1.2	0.91	0.87
Marine Transportation	140 000	190 000	210 000	210 000	210 000	220 000	220 000	230 000	240 000
Motorcycles	340	450	530	580	580	590	580	580	590
Off-road Diesel Vehicles and Equipment	320 000	350 000	280 000	250 000	220 000	190 000	180 000	170 000	170 000
Off-road Gasoline/LPG/CNG Vehicles and Equipment	37 000	28 000	23 000	28 000	27 000	27 000	26 000	29 000	30 000
Rail Transportation	160 000	150 000	130 000	110 000	120 000	120 000	120 000	120 000	130 000
Tire Wear and Brake Lining									
Agriculture	2 100	2 200	2 000	3 300	3 900	3 900	4 000	4 000	4 000
Animal Production									
Crop Production									
Fuel Use	2 100	2 200	2 000	3 300	3 900	3 900	4 000	4 000	4 000
Commercial / Residential / Institutional	87 000	90 000	86 000	79 000	83 000	78 000	79 000	82 000	82 000
Cigarette Smoking									
Commercial and Institutional Fuel Combustion	23 000	30 000	30 000	25 000	27 000	25 000	25 000	27 000	27 000
Commercial Cooking									
Construction Fuel Combustion	3 900	2 000	3 000	3 300	2 500	1 700	1 600	1 700	1 700
Home Firewood Burning	25 000	23 000	19 000	20 000	20 000	20 000	20 000	20 000	20 000
Human									
Marine Cargo Handling	0.2	0.059					29	31	26
Residential Fuel Combustion	35 000	35 000	34 000	32 000	34 000	31 000	32 000	34 000	34 000
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	8 200	7 800	8 500	5 100	4 700	4 800	5 300	5 000	4 900
Crematoriums	8.2	12	15	18	18	19	20	21	22
Industrial and Commercial Incineration	62	62	61	530	530	530	530	530	530
Municipal Incineration	1 000	1 100	1 100	1 200	1 100	1 200	1 200	930	740
Waste	6 900	6 400	6 900	3 000	2 600	2 700	3 100	3 100	3 200
Other Incineration and Utilities	250	250	360	390	390	390	390	390	390
Paints and Solvents	110	120	130	29	23	23	23	23	23
Dry Cleaning	1.1	1.6							
General Solvent Use									
Printing	110	120	130	29	23	23	23	23	23
Surface Coatings	0.12	0.12							
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	7 500	1 400	890	790	1 300	1 500	650	2 600	2 000
Prescribed Forest Burning	7 400	1 400	850	750	1 300	1 500	610	2 600	2 000
Structural Fires	49	39	35	34	39	39	39	28	27
Grand Total	**2 400 000**	**2 900 000**	**2 500 000**	**2 100 000**	**2 100 000**	**2 000 000**	**1 900 000**	**1 900 000**	**1 900 000**

Note: Totals may not add up due to rounding.

- Electric power generation (utilities) emissions: decrease of 40% (100 kt)
  - Coal: decrease of 44% (90 kt)
- Oil and gas industry emissions: increase of 36% (120 kt)
  - Upstream petroleum industry: increase of 50% (140 kt)
  - Downstream petroleum industry: decrease of 49% (17 kt)
  - Petroleum product transportation and distribution: decrease of 11 % (3 kt)

2.4. Volatile Organic Compounds (VOCs)

In 2015, approximately 1.9 Mt of VOCs were released in Canada (Table 2–6). The oil and gas industry was the largest contributor at 37% (690 kt) of total emissions (with the upstream petroleum industry emitting 36% (670 kt) of total VOCs). Paints and solvents were the next-largest contributor, accounting for 18% (330 kt) of emissions, with general solvent use accounting for 13% (250 kt) of the national total. Transportation and mobile equipment sources accounted for 17% (310 kt) of emissions, with off-road gasoline, liquefied petroleum gas (LPG) or compressed natural gas (CNG) vehicles and equipment contributing 8% (140 kt) of the national total. Commercial/residential/institutional sources represented 15% (290 kt) of VOC emissions, mainly attributed to home firewood burning (12% or 230 kt). The other contributing VOC sources are manufacturing, agriculture, incineration and waste, ore and mineral industries, and fires. Of these, manufacturing sources accounted for 6% (110 kt) and agricultural sources for 5% (98 kt) of total VOC emissions.

Between 1990 and 2015, VOC emissions decreased by 36% (1.0 Mt) (Figure 2–4). The most significant driver of this trend is a persistent decrease in emissions from off-road gasoline, LPG or CNG vehicles and equipment throughout the time series, due to increasingly stringent regulations on spark-ignition engines. Emissions from light-duty gasoline vehicles and trucks also contributed to this trend, with a consistent decrease in emissions throughout the time series.

Although emissions from most sources decreased, the oil and gas industry experienced an overall increase in emissions between 1990 and 2015. The downstream petroleum industry declined overall in VOC emissions from 1990 to 2006, with emissions remaining relatively stable after that time, but the upstream petroleum industry experienced increased emissions, which were

Figure 2–4 Major Contributors to National VOC Trends

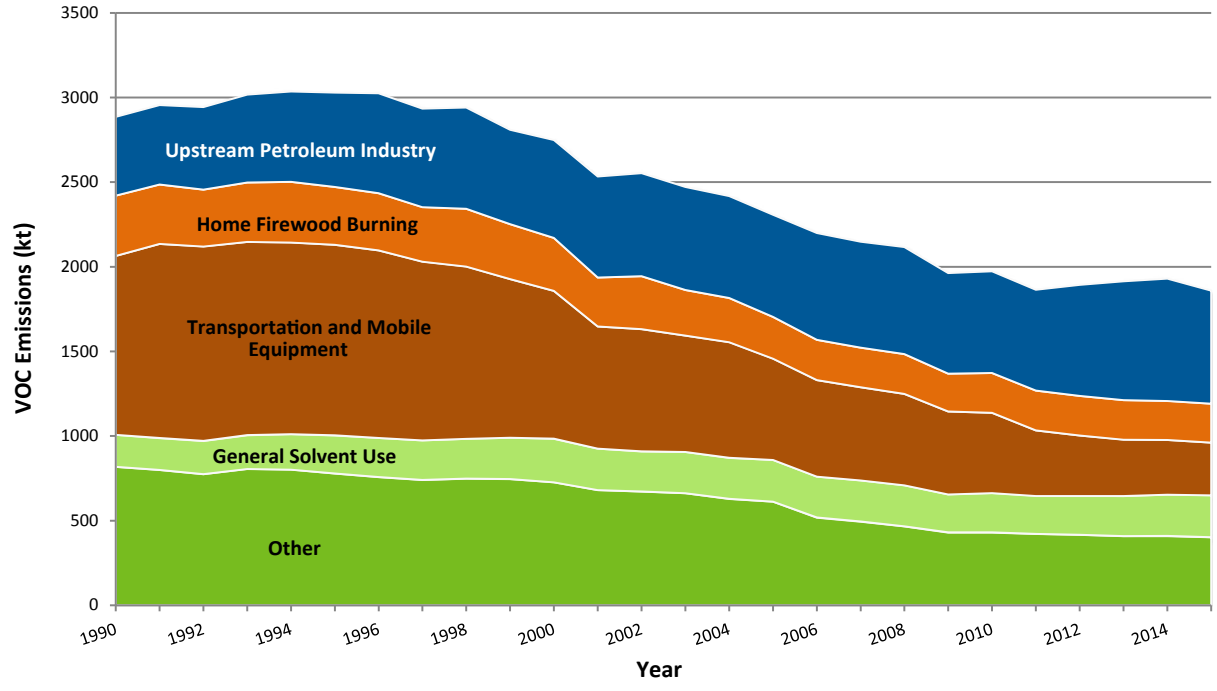


Table 2–6 National Summary of Annual VOC Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(tonnes)				
Ore and Mineral Industries	21 000	20 000	17 000	15 000	16 000	14 000	13 000	13 000	13 000
Aluminium Industry	710	1 100	1 200	1 400	1 500	1 300	1 400	970	930
Asphalt Paving Industry	6 600	6 400	6 100	9 200	9 500	7 900	7 100	8 500	8 500
Cement and Concrete Industry	670	770	1 300	330	370	440	480	460	450
Foundries	1 700	1 100	920	500	560	580	520	450	380
Iron and Steel Industries	5 800	4 200	2 000	1 000	1 400	1 300	920	1 100	870
Iron Ore Industry	570	3 200	1 600	49	38	170	290	320	300
Mineral Products Industry	220	330	280	110	95	74	100	120	110
Mining and Rock Quarrying	4 100	3 200	3 300	2 400	2 600	1 900	1 800	1 600	1 900
Non-Ferrous Mining and Smelting Industry	330	37	52	73	73	65	70	66	67
Oil and Gas Industry	590 000	660 000	660 000	630 000	620 000	680 000	730 000	750 000	690 000
Downstream Petroleum Industry	120 000	76 000	55 000	28 000	27 000	25 000	26 000	24 000	24 000
Petroleum Product Transportation and Distribution	1 800	3 400	2 200	930	1 300	1 100	1 300	1 300	1 100
Upstream Petroleum Industry	470 000	580 000	600 000	600 000	600 000	660 000	700 000	720 000	670 000
Electric Power Generation (Utilities)	2 400	3 200	3 100	2 200	1 900	1 400	1 600	1 600	1 600
Coal	1 300	970	1 300	440	360	380	390	450	410
Diesel	77	280	220	200	54	53	53	46	84
Natural Gas	390	1 100	1 300	1 200	1 200	530	560	550	570
Waste Materials	17	17	4.2	20	15	160	290	300	290
Other Electric Power Generation	630	770	300	300	300	250	290	270	220
Manufacturing	260 000	260 000	190 000	120 000	120 000	120 000	120 000	110 000	110 000
Abrasives Manufacture	1 500	590	610	100	30	90	94	59	18
Bakeries	3 500	4 400	7 400	9 700	8 900	7 700	7 400	8 300	9 100
Biofuel Production				70	97	100	100	98	100
Chemicals Industry	47 000	36 000	25 000	13 000	12 000	11 000	14 000	13 000	10 000
Electronics	1 300	540	320	20	98	41	36	33	20
Food Preparation	10 000	13 000	15 000	18 000	17 000	16 000	15 000	15 000	15 000
Glass Manufacture	2 000	2 300	600	280	260	260	280	240	200
Grain Processing	2 200	2 300	2 200	2 900	2 600	2 600	2 500	3 000	3 000
Metal Fabrication	9 300	14 000	12 000	5 500	5 800	5 500	5 200	4 400	4 800
Plastics Manufacture	14 000	17 000	15 000	12 000	14 000	15 000	13 000	11 000	12 000
Pulp and Paper Industry	27 000	24 000	18 000	18 000	19 000	18 000	16 000	14 000	13 000
Textiles	870	1 500	840	570	700	530	490	570	620
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	21 000	21 000	16 000	7 700	7 600	8 100	8 000	7 500	7 700
Wood Products	110 000	110 000	77 000	34 000	31 000	35 000	36 000	36 000	33 000
Other Manufacturing Industries	11 000	21 000	5 600	1 300	1 300	1 100	1 400	1 300	1 300
Transportation and Mobile Equipment	1 100 000	870 000	600 000	470 000	390 000	360 000	330 000	320 000	310 000
Air Transportation	5 200	6 000	5 400	5 900	5 800	6 400	6 300	6 200	6 200
Heavy-duty Diesel Vehicles	11 000	18 000	25 000	23 000	22 000	21 000	20 000	19 000	17 000
Heavy-duty Gasoline Vehicles	24 000	29 000	22 000	16 000	14 000	14 000	14 000	13 000	13 000
Heavy-duty LPG/NG Vehicles	8 100	13 000	2 600	720	190	120	65	400	83
Light-duty Diesel Trucks	810	990	1 500	1 100	1 100	1 000	1 000	980	950
Light-duty Diesel Vehicles	2 400	1 600	930	800	860	800	790	770	760
Light-duty Gasoline Trucks	94 000	110 000	81 000	64 000	58 000	55 000	53 000	49 000	48 000
Light-duty Gasoline Vehicles	240 000	150 000	95 000	64 000	57 000	53 000	50 000	46 000	44 000
Light-duty LPG/NG Trucks	9 600	4 200	1 800	320	110	74	39	28	29
Light-duty LPG/NG Vehicles	1 300	600	250	33	4.9	3	1.3	0.96	0.98
Marine Transportation	5 800	7 600	8 600	8 500	8 800	9 100	9 400	9 700	10 000
Motorcycles	1 700	1 800	1 800	1 800	1 800	1 800	1 700	1 700	1 700
Off-road Diesel Vehicles and Equipment	52 000	52 000	37 000	30 000	25 000	21 000	20 000	19 000	19 000
Off-road Gasoline/LPG/CNG Vehicles and Equipment	590 000	470 000	310 000	250 000	190 000	170 000	150 000	150 000	140 000
Rail Transportation	6 800	6 300	6 200	5 700	6 200	6 200	6 000	6 200	6 300
Tire Wear and Brake Lining									
Agriculture	94 000	110 000	110 000	100 000	99 000	99 000	99 000	99 000	98 000
Animal Production	94 000	110 000	110 000	100 000	99 000	99 000	99 000	99 000	98 000
Crop Production									
Fuel Use	81	91	78	110	140	150	150	150	150
Commercial / Residential / Institutional	450 000	410 000	330 000	300 000	290 000	290 000	290 000	290 000	290 000
Cigarette Smoking	13	12	8.8	8.1	8.1	8	6.8	6.8	6.8
Commercial and Institutional Fuel Combustion	1 000	1 400	1 400	1 200	1 300	1 200	1 300	1 300	1 300
Commercial Cooking	2 000	2 300	2 500	2 600	2 500	2 500	2 500	2 400	2 400
Construction Fuel Combustion	71	33	49	55	43	21	19	20	20
Home Firewood Burning	360 000	310 000	250 000	240 000	240 000	230 000	230 000	230 000	230 000
Human									
Marine Cargo Handling	0.34	0.92	1.9	19	17	10			
Residential Fuel Combustion	1 500	1 700	1 700	1 600	1 700	1 600	1 700	1 800	1 800
Service Stations	87 000	90 000	81 000	54 000	52 000	50 000	49 000	49 000	50 000
Other Miscellaneous Sources									
Incineration and Waste	17 000	16 000	17 000	14 000	14 000	14 000	14 000	14 000	14 000
Crematoriums	0.95	1.3	1.7	1.9	2	2	2.2	2.2	2.4
Industrial and Commercial Incineration	5	4	7.1	710	650	650	650	650	650
Municipal Incineration	4 000	4 000	3 900	420	380	260	57	230	210
Waste	13 000	12 000	13 000	13 000	13 000	12 000	13 000	13 000	13 000
Other Incineration and Utilities	90	90	130	140	140	140	140	140	140
Paints and Solvents	360 000	400 000	370 000	320 000	300 000	310 000	310 000	320 000	330 000
Dry Cleaning	740	790	200	410	190	190	200	200	180
General Solvent Use	190 000	260 000	250 000	230 000	230 000	230 000	240 000	240 000	250 000
Printing	37 000	48 000	43 000	20 000	20 000	19 000	18 000	17 000	17 000
Surface Coatings	130 000	89 000	77 000	63 000	59 000	60 000	59 000	61 000	61 000
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	41 000	4 200	3 400	2 400	4 200	7 100	2 000	8 100	5 900
Prescribed Forest Burning	40 000	3 900	3 100	2 100	3 900	6 800	1 700	7 900	5 700
Structural Fires	390	310	280	270	310	310	310	220	210
Grand Total	**2 900 000**	**2 700 000**	**2 300 000**	**2 000 000**	**1 900 000**	**1 900 000**	**1 900 000**	**1 900 000**	**1 900 000**

Note: Totals may not add up due to rounding.

more pronounced from 2012 to 2014. This increase is attributed to expansion and growth in the industry. In 2015, VOC emissions from the upstream petroleum industry declined compared to 2014, due to declining conventional production and decreased drilling activity.

The most significant changes in VOC emissions from 1990 to 2015 include:

- Transportation and mobile equipment source emissions: decrease of 71% (790 kt)
  - Off-road gasoline/LPG/CNG vehicles and equipment: decrease of 76% (450kt)
  - Light-duty gasoline vehicles and trucks: decrease of 72% (240 kt)
- Oil and gas industry source emissions: increase of 18% (100 kt)
  - Upstream petroleum industry: increase of 43% (200 kt)
  - Downstream petroleum industry: decrease of 80% (96 kt)

2.5. Carbon Monoxide (CO)

In 2015, approximately 5.6 Mt of CO were released in Canada (Table 2–7). Transportation and mobile equipment accounted for 53% (3.0 Mt) of total emissions, including light-duty gasoline vehicles and trucks at 19% (1.1 Mt) and off-road gasoline/LPG/CNG vehicles and equipment at 22% (1.2 Mt) of total CO emissions. The next-largest contributors are commercial/residential/institutional sources, which in 2015 also accounted for 22% (1.2 Mt) of emissions, mostly due to contributions from home firewood burning. The upstream petroleum industry and aluminium industry were the largest-emitting industrial sectors, accounting for 9% (510 kt) and 7% (380 kt) of CO, respectively.

Between 1990 and 2015, CO emissions decreased by 54% (6.6 Mt) (Figure 2–5). Of the many sectors that contributed to the overall decrease in emissions, two sectors in particular—light-duty gasoline trucks and vehicles, and off-road gasoline/LPG/CNG vehicles and equipment (spark ignition engines)—had the largest impact on emission reductions. The decreasing emission trend in these sectors is due to increasingly stringent engine and vehicle regulations. Emissions from home firewood

Figure 2–5 Major Contributors to National CO Trends

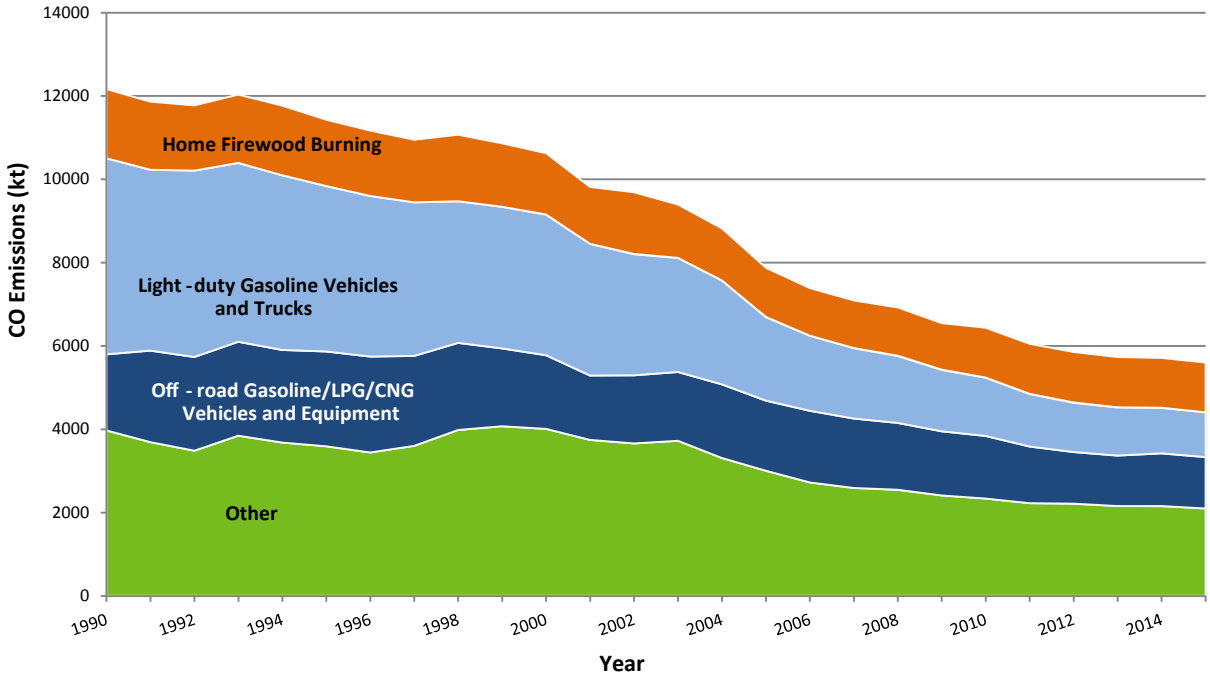


Table 2–7 National Summary of Annual CO Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(tonnes)				
Ore and Mineral Industries	390 000	400 000	500 000	540 000	540 000	550 000	550 000	510 000	520 000
Aluminium Industry	240 000	250 000	310 000	390 000	400 000	400 000	410 000	380 000	380 000
Asphalt Paving Industry	4 200	4 200	4 500	5 500	4 600	3 800	3 700	4 000	4 000
Cement and Concrete Industry	16 000	23 000	27 000	15 000	16 000	18 000	15 000	12 000	10 000
Foundries	55 000	48 000	49 000	50 000	49 000	49 000	49 000	49 000	49 000
Iron and Steel Industries	43 000	48 000	64 000	20 000	21 000	28 000	23 000	24 000	21 000
Iron Ore Industry	18 000	9 600	23 000	24 000	22 000	20 000	20 000	20 000	20 000
Mineral Products Industry	4 000	3 500	3 000	660	630	640	720	640	620
Mining and Rock Quarrying	14 000	14 000	10 000	11 000	14 000	20 000	14 000	15 000	13 000
Non-Ferrous Mining and Smelting Industry	280	360	13 000	22 000	11 000	13 000	11 000	13 000	13 000
Oil and Gas Industry	330 000	440 000	500 000	530 000	540 000	530 000	550 000	540 000	540 000
Downstream Petroleum Industry	21 000	23 000	19 000	24 000	19 000	16 000	42 000	18 000	24 000
Petroleum Product Transportation and Distribution	31 000	14 000	19 000	12 000	11 000	9 300	10 000	11 000	10 000
Upstream Petroleum Industry	280 000	410 000	460 000	490 000	510 000	500 000	500 000	510 000	510 000
Electric Power Generation (Utilities)	49 000	37 000	48 000	44 000	41 000	34 000	35 000	39 000	39 000
Coal	41 000	18 000	25 000	17 000	13 000	9 500	13 000	15 000	16 000
Diesel	360	1 200	740	1 200	1 200	1 100	1 100	1 300	1 500
Natural Gas	3 100	10 000	14 000	20 000	19 000	17 000	15 000	14 000	14 000
Waste Materials	190	820	210	420	410	550	610	780	690
Other Electric Power Generation	4 400	7 200	7 800	6 200	7 900	5 400	4 600	7 800	7 200
Manufacturing	1 300 000	1 100 000	530 000	200 000	170 000	180 000	180 000	160 000	140 000
Abrasives Manufacture	610	240	240						
Bakeries	5.9	5.8	1.2	0.14	0.2	0.17	0.35	0.34	0.3
Biofuel Production				20					
Chemicals Industry	27 000	30 000	18 000	13 000	14 000	13 000	14 000	14 000	15 000
Electronics	27	40	18	1.5					
Food Preparation	1 200	1 400	1 500	1 000	990	1 000	1 000	980	1 700
Glass Manufacture	490	570	690	260	240	260	260	280	300
Grain Processing	1 900	2 700	610	540	390	390	370	390	370
Metal Fabrication	8 800	11 000	8 600	3 000	3 300	3 600	2 800	2 200	1 600
Plastics Manufacture	260	400	270	150	29	31	18	30	34
Pulp and Paper Industry	180 000	150 000	93 000	72 000	77 000	48 000	57 000	64 000	68 000
Textiles	45	78	53	0.02	0.027	0.023	0.057	0.063	0.069
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	3 800	2 100	2 100	1 800	1 900	900	580	590	380
Wood Products	1 100 000	800 000	390 000	110 000	73 000	110 000	100 000	73 000	47 000
Other Manufacturing Industries	31 000	61 000	11 000	650	710	620	610	580	580
Transportation and Mobile Equipment	7 900 000	7 100 000	5 000 000	3 800 000	3 400 000	3 200 000	3 100 000	3 100 000	3 000 000
Air Transportation	60 000	47 000	43 000	46 000	41 000	51 000	49 000	46 000	46 000
Heavy-duty Diesel Vehicles	36 000	64 000	92 000	81 000	82 000	77 000	74 000	70 000	66 000
Heavy-duty Gasoline Vehicles	610 000	1 100 000	830 000	550 000	470 000	460 000	450 000	420 000	400 000
Heavy-duty LPG/NG Vehicles	150 000	340 000	73 000	18 000	4 400	2 900	1 500	9 700	2 100
Light-duty Diesel Trucks	14 000	14 000	19 000	13 000	13 000	11 000	11 000	11 000	11 000
Light-duty Diesel Vehicles	31 000	18 000	9 400	8 300	9 000	8 500	8 700	8 500	8 600
Light-duty Gasoline Trucks	1 700 000	1 600 000	1 100 000	770 000	690 000	650 000	640 000	610 000	610 000
Light-duty Gasoline Vehicles	3 100 000	1 700 000	950 000	630 000	570 000	530 000	510 000	480 000	470 000
Light-duty LPG/NG Trucks	160 000	62 000	23 000	3 600	1 200	780	410	290	300
Light-duty LPG/NG Vehicles	16 000	6 700	2 500	310	43	27	11	8.8	8.9
Marine Transportation	13 000	17 000	19 000	19 000	20 000	20 000	21 000	22 000	22 000
Motorcycles	13 000	14 000	15 000	14 000	13 000	13 000	12 000	12 000	12 000
Off-road Diesel Vehicles and Equipment	220 000	230 000	170 000	150 000	130 000	110 000	100 000	94 000	90 000
Off-road Gasoline/LPG/CNG Vehicles and Equipment	1 800 000	1 800 000	1 700 000	1 500 000	1 400 000	1 200 000	1 200 000	1 300 000	1 200 000
Rail Transportation	16 000	15 000	15 000	16 000	18 000	18 000	17 000	18 000	18 000
Tire Wear and Brake Lining									
Agriculture	630	690	510	700	870	910	910	900	900
Animal Production									
Crop Production									
Fuel Use	630	690	510	700	870	910	910	900	900
Commercial / Residential / Institutional	1 700 000	1 500 000	1 200 000	1 200 000	1 200 000	1 300 000	1 200 000	1 200 000	1 200 000
Cigarette Smoking	3 800	3 300	2 500	2 300	2 300	2 300	1 900	1 900	1 900
Commercial and Institutional Fuel Combustion	15 000	19 000	19 000	17 000	18 000	17 000	18 000	19 000	19 000
Commercial Cooking	5 700	6 400	7 100	7 200	6 900	7 000	6 900	6 700	6 700
Construction Fuel Combustion	670	360	510	550	440	300	290	300	300
Home Firewood Burning	1 700 000	1 500 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000	1 200 000
Human									
Marine Cargo Handling	0.16	0.05							
Residential Fuel Combustion	13 000	13 000	13 000	12 000	13 000	12 000	13 000	13 000	13 000
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	45 000	27 000	25 000	19 000	19 000	18 000	18 000	18 000	18 000
Crematoriums	7.4	11	13	15	15	16	17	18	18
Industrial and Commercial Incineration	31	17	18	1 900	1 900	1 900	1 900	1 900	1 900
Municipal Incineration	9 500	9 000	8 000	750	540	290	200	150	150
Waste	35 000	16 000	15 000	14 000	14 000	14 000	14 000	14 000	14 000
Other Incineration and Utilities	1 200	1 200	1 800	1 900	1 900	1 900	1 900	1 900	1 900
Paints and Solvents	23	73	21	1.9	0.48		0.47	0.46	0.37
Dry Cleaning	0.95	0.81							
General Solvent Use									
Printing	22	72	21	1.9	0.48		0.47	0.46	0.37
Surface Coatings	0.1	0.1							
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	440 000	78 000	52 000	53 000	73 000	92 000	35 000	140 000	130 000
Prescribed Forest Burning	440 000	76 000	51 000	52 000	71 000	90 000	33 000	140 000	130 000
Structural Fires	2 100	1 700	1 500	1 500	1 700	1 700	1 700	1 200	1 100
Grand Total	**12 000 000**	**11 000 000**	**7 900 000**	**6 400 000**	**6 000 000**	**5 800 000**	**5 700 000**	**5 700 000**	**5 600 000**

Note: Totals may not add up due to rounding.

burning gradually decreased across the time series, due to improved combustion efficiency in modern fireplace inserts, stoves and fireplaces and to a decrease in the use of wood as heating fuel.

The most significant changes in CO emissions from 1990 to 2015 include:

- Transportation and mobile equipment emissions: decrease of 62% (4.9 Mt)
  - Light-duty gasoline trucks and vehicles: decrease of 77% (3.6 Mt)
  - Off-road gasoline/LPG/CNG vehicles and equipment: decrease of 33% (0.6 Mt)
- Commercial/residential/institutional emissions: decrease of 27% (470 kt)
- Home firewood burning: decrease of 28% (470 kt)
- Oil and gas industry: increase of 61 % (200 kt)
- Upstream petroleum industry: increase of 79% (220 kt)
- Petroleum product transportation and distribution: decrease of 68% (21 kt)

2.6. Ammonia (NH_3)

In 2015, approximately 490 kt of NH_3 were released in Canada (Table 2–8). NH_3 emissions originated primarily from agriculture, which accounted for 94% (450 kt) of total emissions. All other sectors combined accounted for only 6% of emissions.

From 1990 to 2015, Canada's NH_3 emissions increased by 22% (87 kt) (Figure 2–6). This trend is driven by emissions from animal production and fertilizer application within the agriculture sector. Animal production, which dominates the emissions throughout the time series, experienced a steady increase in emissions from 1990 to 2005, followed by a decrease from 2006 to 2015. Emissions from fertilizer application, however, have been rapidly increasing since 2006, due to an increase in sales and use of synthetic nitrogen fertilizers. All other emission categories decreased by 24% (10 kt).

The most significant changes in NH_3 emissions from 1990 to 2015 include:

- Agriculture: increase of 27% (97 kt)
  - Animal production: increase of 7% (18 kt)
  - Crop production: increase of 102% (78 kt)

Figure 2–6 Major Contributors to National NH_3 Trends

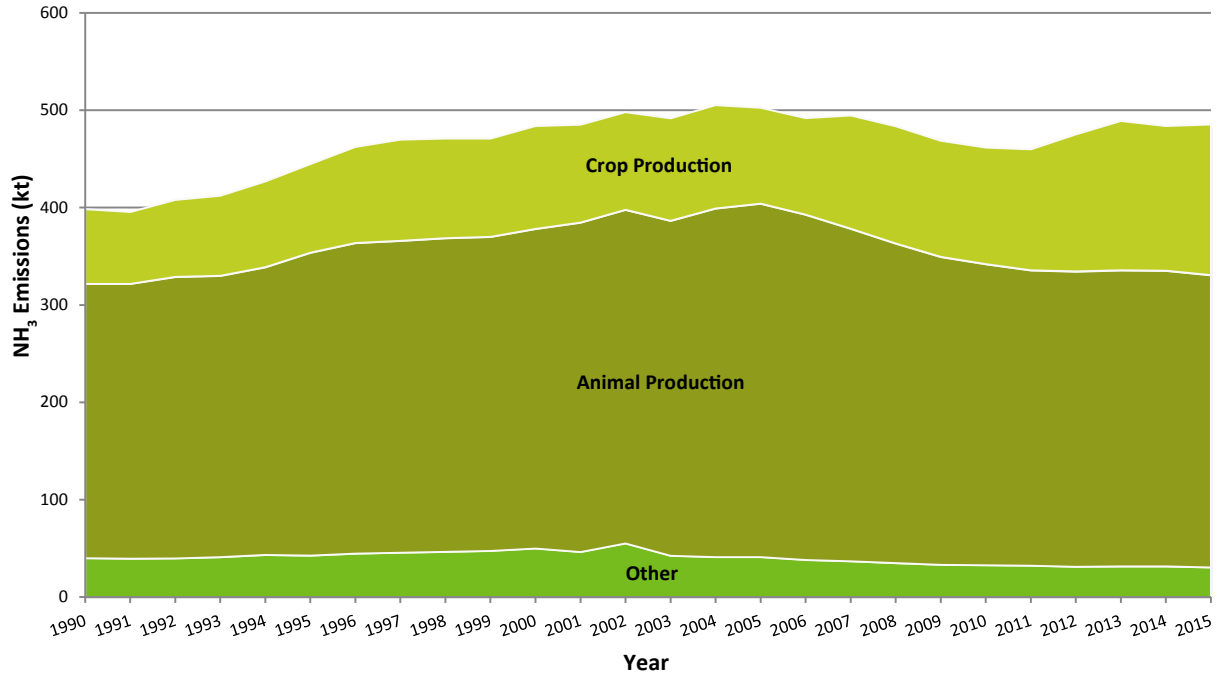


Table 2–8 National Summary of Annual NH_3 Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(kg)				
Ore and Mineral Industries	1 800	2 100	1 100	2 100	1 600	1 100	1 400	1 300	1 200
Aluminium Industry	29	34	13						
Asphalt Paving Industry	0.6	1.3	1.2						
Cement and Concrete Industry	590	620	380	380	320	330	430	440	480
Foundries	12	13	8.5						
Iron and Steel Industries	180	230	83	86	96	91	78	89	59
Iron Ore Industry	160	160	23						
Mineral Products Industry	85	110	97	200	290	230	420	440	340
Mining and Rock Quarrying	510	530	82	1 100	410	67	93	67	52
Non-Ferrous Mining and Smelting Industry	210	440	380	390	460	420	350	300	280
Oil and Gas Industry	640	1 700	3 500	1 900	2 000	2 200	2 600	2 700	2 200
Downstream Petroleum Industry	350	240	110	84	73	75	180	78	68
Petroleum Product Transportation and Distribution	1.1	2.8	3.4	0.59	0.53	0.44	1.8	1.4	0.19
Upstream Petroleum Industry	290	1 400	3 400	1 800	1 900	2 100	2 400	2 600	2 200
Electric Power Generation (Utilities)	770	1 500	950	760	760	340	780	760	380
Coal	65	120	540	40	62	37	580	610	170
Diesel	3.7	6	2.8						
Natural Gas	260	660	140	690	590	200	110	95	130
Waste Materials	61	66	15						5.3
Other Electric Power Generation	380	620	250	29	99	95	82	62	70
Manufacturing	20 000	23 000	17 000	11 000	12 000	12 000	11 000	11 000	12 000
Abrasives Manufacture	0.76	0.76	0.12						
Bakeries	0.11	0.11							0.34
Biofuel Production									
Chemicals Industry	9 800	14 000	11 000	8 900	9 100	9 100	8 500	8 500	8 800
Electronics	31	55	54	25	25	18	17	17	19
Food Preparation	180	310	290	240	230	380	410	380	360
Glass Manufacture	88	110	120						
Grain Processing	6.2	6.7	1.5	1.8	13	15	7.5	7.6	5
Metal Fabrication	93	200	40	30	18	2.8	2.1	2.4	25
Plastics Manufacture	36	37	8.8	0.008					
Pulp and Paper Industry	4 400	3 200	2 300	1 600	1 700	1 700	1 700	1 600	1 600
Textiles	13	28	16	0.0 032					
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	68	150	43	26	15	0.11	0.77		2.3
Wood Products	4 800	4 800	2 700	640	690	730	750	800	830
Other Manufacturing Industries	500	360	170	9.6	9.2	25	21	22	32
Transportation and Mobile Equipment	5 800	12 000	11 000	8 700	8 300	7 800	7 800	7 400	7 200
Air Transportation	29	35	36	32	32	37	38	37	37
Heavy-duty Diesel Vehicles	210	390	570	670	730	740	760	760	770
Heavy-duty Gasoline Vehicles	170	250	270	290	280	300	310	310	320
Heavy-duty LPG/NG Vehicles	62	190	23	6.4	2.4	2.8	1.4	13	3.2
Light-duty Diesel Trucks	2.5	4.5	4.3	5.3	6.3	6.5	7.7	8.5	9.3
Light-duty Diesel Vehicles	11	11	11	12	15	15	16	17	17
Light-duty Gasoline Trucks	1 200	3 700	3 700	3 100	2 900	2 800	2 800	2 600	2 600
Light-duty Gasoline Vehicles	3 500	6 400	5 600	4 000	3 700	3 300	3 200	2 900	2 700
Light-duty LPG/NG Trucks	91	120	80	13	4.2	2.8	1.5	1	1
Light-duty LPG/NG Vehicles	16	23	15	1.9	0.26	0.16	0.066	0.051	0.048
Marine Transportation	160	220	250	250	260	270	280	290	300
Motorcycles	4.6	7.1	12	26	28	30	32	33	34
Off-road Diesel Vehicles and Equipment	170	210	190	200	200	180	190	190	200
Off-road Gasoline/LPG/CNG Vehicles and Equipment	140	110	84	93	87	83	83	90	91
Rail Transportation	51	48	48	49	56	57	55	56	57
Tire Wear and Brake Lining									
Agriculture	360 000	430 000	460 000	430 000	430 000	440 000	460 000	450 000	450 000
Animal Production	280 000	330 000	360 000	310 000	300 000	300 000	300 000	300 000	300 000
Crop Production	77 000	110 000	99 000	120 000	120 000	140 000	150 000	150 000	150 000
Fuel Use	44	41	27	42	51	47	47	44	44
Commercial / Residential / Institutional	3 900	3 600	3 200	3 100	3 200	3 100	3 100	3 100	3 100
Cigarette Smoking	110	110	88	84	88	83	76	76	76
Commercial and Institutional Fuel Combustion	310	340	320	200	220	190	210	220	220
Commercial Cooking									
Construction Fuel Combustion	70	38	54	59	46	32	29	31	31
Home Firewood Burning	2 300	2 100	1 700	1 800	1 800	1 800	1 800	1 800	1 800
Human	470	520	540	570	580	580	590	600	600
Marine Cargo Handling	0.001								
Residential Fuel Combustion	690	560	530	460	460	400	380	380	380
Service Stations									
Other Miscellaneous Sources	21	19	19	21	21	21	21	21	21
Incineration and Waste	5 800	5 800	4 200	4 400	4 400	4 300	4 400	4 500	4 300
Crematoriums									
Industrial and Commercial Incineration	0.048	0.048	0.01	72	72	72	72	72	72
Municipal Incineration	63	66	190	19	19	19	19	19	19
Waste	5 700	5 700	4 000	4 300	4 200	4 100	4 300	4 300	4 200
Other Incineration and Utilities	29	29	43	47	47	47	47	47	47
Paints and Solvents	14	14	0.88	0.056					
Dry Cleaning	0.046	0.046							
General Solvent Use									
Printing	14	14	0.88	0.056					
Surface Coatings	0.08	0.08							
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	1 100	130	100	78	130	210	68	240	180
Prescribed Forest Burning	1 100	110	88	63	110	190	51	230	170
Structural Fires	22	17	16	15	18	18	18	12	12
Grand Total	**400 000**	**480 000**	**500 000**	**460 000**	**460 000**	**480 000**	**490 000**	**480 000**	**490 000**

Note: Totals may not add up due to rounding.

- Other emissions, dominated by manufacturing, incineration and waste, and transportation and mobile equipment sources: decrease of 24% (10 kt).

2.7. Lead (Pb)

In 2015, approximately 160 tonnes (t) of Pb were emitted in Canada (Table 2–9). Ore and mineral industries were the largest contributor at 76% (120 t) of emissions, with the non-ferrous smelting and refining industry accounting for the largest share at 69% (110 t) of total Pb emissions. Transportation and mobile equipment is the second largest contributor at 17% (27 t) of total emissions (almost all of which is from air transportation).

Lead emissions decreased by 87% (1.1 kt) from 1990 to 2015 (Figure 2–7). This trend is almost entirely driven by the non-ferrous mining and smelting industry, where emissions consistently decreased during that period. This decreasing trend can be attributed to the introduction of pollution prevention regulations limiting the concentration of Pb-containing PM emitted into ambient air and the implementation of pollution prevention strategies in operating smelters, along with the closure of outdated smelters. Reductions in emissions from mining and rock quarrying from 1990 to 1998 also influenced the overall trend, as well as slight emission reductions in air transportation across the time series.

The most significant changes in Pb emissions from 1990 to 2015 include:

- Ore and mineral industries: decrease of 89% (1.0 kt)
  - Non-ferrous smelting and refining industry: decrease of 87% (770 t)
  - Mining and rock quarrying: decrease of 100% (200 t)
- Transportation and mobile equipment: decrease of 65% (51 t)
  - Air transportation: decrease of 65% (51 t)

Figure 2–7 Major Contributors to National Pb Trends

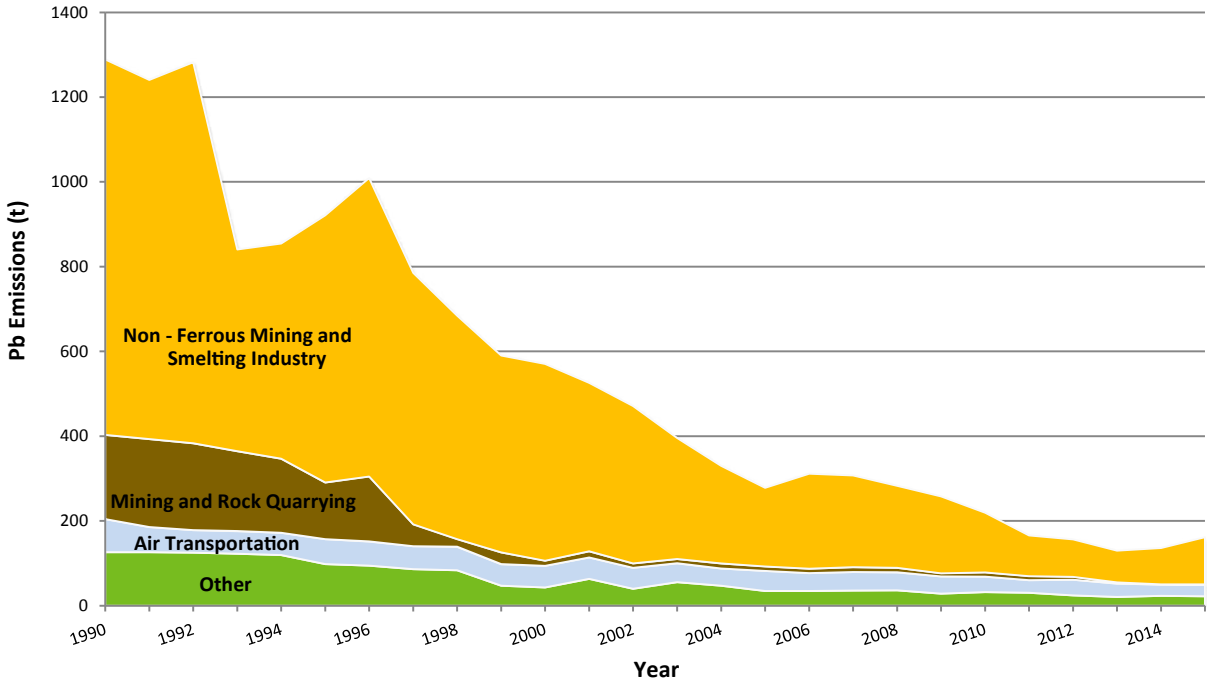


Table 2–9 National Summary of Annual Pb Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(kg)				
Ore and Mineral Industries	1 100 000	480 000	210 000	160 000	120 000	110 000	87 000	97 000	120 000
Aluminium Industry	84	84							
Asphalt Paving Industry	1 400	1 200	1 200	1 300	1 300	990	980	1 000	1 000
Cement and Concrete Industry	550	610	970	620	640	620	530	600	870
Foundries	2 000	2 900	1 500	460	440	430	200	180	210
Iron and Steel Industries	54 000	3 500	5 700	6 300	6 100	6 700	5 200	6 100	5 500
Iron Ore Industry				2 000	1 800	1 900	2 100	2 700	2 600
Mineral Products Industry									
Mining and Rock Quarrying	200 000	12 000	11 000	10 000	9 600	6 900	3 000	730	780
Non-Ferrous Mining and Smelting Industry	890 000	460 000	190 000	140 000	96 000	88 000	75 000	85 000	110 000
Oil and Gas Industry	340	300	720	1 300	940	990	1 100	670	510
Downstream Petroleum Industry	200	81	450	440	330	320	380	300	320
Petroleum Product Transportation and Distribution									
Upstream Petroleum Industry	140	220	260	850	610	660	700	370	190
Electric Power Generation (Utilities)	11 000	14 000	1 600	2 200	2 800	2 600	1 400	1 300	1 400
Coal	8 300	10 000	890	1 500	2 200	2 100	860	690	810
Diesel									
Natural Gas	430	530	69	170	160	89	85	93	97
Waste Materials			10	12	16	9	6.6	21	7
Other Electric Power Generation	2 600	3 200	590	500	450	320	430	490	530
Manufacturing	49 000	14 000	17 000	12 000	11 000	4 700	4 600	6 400	5 800
Abrasives Manufacture									
Bakeries									
Biofuel Production									
Chemicals Industry	12 000	290	1 800	730	74	72	64	29	27
Electronics	2 000	680	57	12	4.9	4.5	4.3	4.1	1.9
Food Preparation									
Glass Manufacture	22	7.4	25	0.57	0.45	0.34	0.3	0.003	0.002
Grain Processing									
Metal Fabrication	28 000	9 400	10 000	8 700	8 800	2 300	2 200	3 600	1 900
Plastics Manufacture	76	26	24	48	35	23	0.034	4.7	4.7
Pulp and Paper Industry	2 100	710	2 400	1 400	1 500	1 300	1 400	2 200	3 400
Textiles		0.38		1.8		0.003			
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	910	310	770	170	95	61	65	67	67
Wood Products	3 500	2 600	1 400	750	480	860	830	530	340
Other Manufacturing Industries	840	290	96	28	24	15	33	32	25
Transportation and Mobile Equipment	79 000	52 000	48 000	37 000	31 000	38 000	32 000	28 000	27 000
Air Transportation	78 000	51 000	47 000	37 000	30 000	37 000	31 000	27 000	27 000
Heavy-duty Diesel Vehicles									
Heavy-duty Gasoline Vehicles									
Heavy-duty LPG/NG Vehicles									
Light-duty Diesel Trucks									
Light-duty Diesel Vehicles									
Light-duty Gasoline Trucks									
Light-duty Gasoline Vehicles									
Light-duty LPG/NG Trucks									
Light-duty LPG/NG Vehicles									
Marine Transportation	600	740	830	630	560	490	420	340	270
Motorcycles									
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation	310	290	290	230	250	250	240	250	250
Tire Wear and Brake Lining									
Agriculture	30	30	26	53	64	59	61	64	64
Animal Production									
Crop Production									
Fuel Use	30	30	26	53	64	59	61	64	64
Commercial / Residential / Institutional	6 300	4 800	4 500	4 100	3 900	4 000	3 500	3 200	3 200
Cigarette Smoking	2.3	1.9	1.5	1.4	1.4	1.3	1.1	1.1	1.1
Commercial and Institutional Fuel Combustion	250	290	420	1 100	920	1 000	510	230	250
Commercial Cooking									
Construction Fuel Combustion	10	4.9	11	14	7.8	7.3	6	6.1	6.1
Home Firewood Burning	3 500	3 200	2 600	2 600	2 700	2 700	2 700	2 600	2 600
Human									
Marine Cargo Handling	2 000	970	1 200	3	9.1	2.9	59	20	9.8
Residential Fuel Combustion	490	400	380	330	340	300	290	290	290
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	200	110	620	920	530	710	540	540	560
Crematoriums	2	2.8	3.6	4.5	4.6	4.7	5	5.2	5.5
Industrial and Commercial Incineration			310	310	310	310	310	310	310
Municipal Incineration	74	29	180	150	150	150	150	150	150
Waste			120	440	56	240	66	69	88
Other Incineration and Utilities	130	77	9.8	11	11	11	11	11	11
Paints and Solvents	4.3	6.3		0.017			0.06	0.0023	
Dry Cleaning									
General Solvent Use									
Printing	4.3	6.3		0.017					
Surface Coatings							0.06	0.0023	
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires									
Prescribed Forest Burning									
Structural Fires									
Grand Total	**1 300 000**	**570 000**	**280 000**	**220 000**	**170 000**	**160 000**	**130 000**	**140 000**	**160 000**

Note: Totals may not add up due to rounding.

2.8. Cadmium (Cd)

Approximately 7.8 t of Cd were released in Canada in 2015 (Table 2–10). Ore and mineral industries accounted for 70% (5.4 t) of national emissions, including the non-ferrous smelting and refining industry at 65% (5.1 t) of the total emissions. Commercial/ residential/ institutional sources contributed 14% (1.1 t) of the total Cd emissions.

From 1990 to 2015, national Cd emissions decreased by 91% (83t) (Figure 2–8). This trend is almost entirely driven by the non-ferrous mining and smelting industry. Emissions in this sector fluctuated greatly between 1990 and 2006, but decreased steadily from 2007 to 2014, followed by a small increase of 0.48 t in 2015. As with Pb emissions, reductions in Cd emissions from this sector are attributed to the closure of outdated smelters and the introduction of pollution prevention regulations. Fluctuations in emissions prior to 2010 are almost entirely driven by emissions from a single smelter in Manitoba.

The most significant changes in Cd emissions from 1990 to 2015 include:

- Ore and mineral industries: decrease of 93% (75 t)
  - Non-ferrous mining and smelting industry: decrease of 94% (73 t)

Figure 2–8 Major Contributors to National Cd Trends

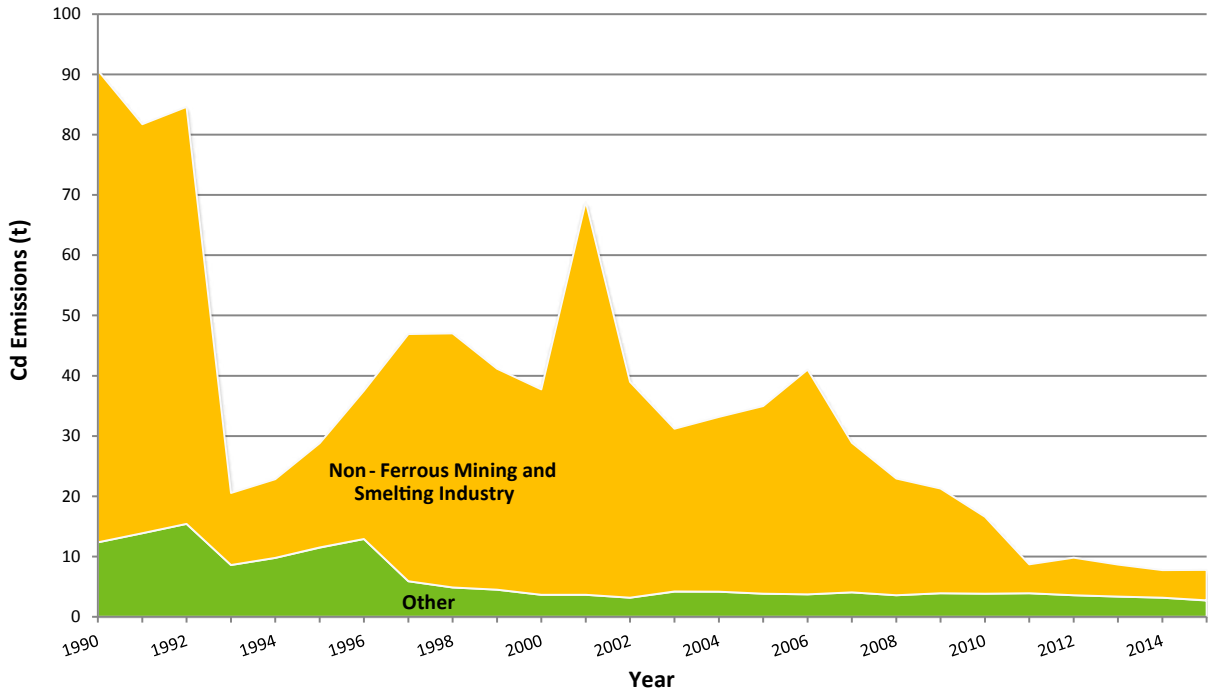


Table 2–10 National Summary of Annual Cd Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(kg)				
Ore and Mineral Industries	81 000	35 000	32 000	13 000	5 400	6 900	6 000	5 400	5 400
Aluminium Industry	0.67	0.98							
Asphalt Paving Industry	26	24	25	29	26	21	21	22	22
Cement and Concrete Industry	46	46	44	29	30	28	16	13	14
Foundries	1.8	1.3	26	0.0 068	8	1.9	1.7	62	21
Iron and Steel Industries	150	160	310	270	240	250	230	300	220
Iron Ore Industry				52	50	58	69	88	83
Mineral Products Industry									
Mining and Rock Quarrying	2 200	280	360	320	290	300	290	320	19
Non-Ferrous Mining and Smelting Industry	78 000	34 000	31 000	13 000	4 800	6 200	5 300	4 600	5 100
Oil and Gas Industry	130	190	190	550	260	270	240	210	220
Downstream Petroleum Industry	110	150	130	120	120	120	100	110	94
Petroleum Product Transportation and Distribution									
Upstream Petroleum Industry	25	38	60	430	140	150	130	110	130
Electric Power Generation (Utilities)	130	130	250	360	750	430	360	120	130
Coal	87	91	170	97	520	360	300	48	36
Diesel									
Natural Gas	29	30	50	220	190	50	47	43	52
Waste Materials			2	2.4	3.3	2	1.4	0.86	1.5
Other Electric Power Generation	14	14	28	40	40	20	20	27	44
Manufacturing	1 200	1 000	940	670	680	680	650	600	580
Abrasives Manufacture									
Bakeries									
Biofuel Production									
Chemicals Industry	140	130	71	7.6	6.4	5.8	6.4	6.1	7.9
Electronics									
Food Preparation									
Glass Manufacture	1.3	1.4	2.6		0.47				
Grain Processing									
Metal Fabrication	470	510	290	390	390	380	340	330	320
Plastics Manufacture	5.2	5.7	3	2	1.4	0.55	0.18		
Pulp and Paper Industry	370	150	320	220	220	210	220	200	200
Textiles									
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	0.73	0.8	1						
Wood Products	130	130	110	47	59	80	83	58	54
Other Manufacturing Industries	76	83	140	2.6	0.089	0.076	0.19	0.68	0.063
Transportation and Mobile Equipment	300	370	410	370	340	300	250	220	180
Air Transportation									
Heavy-duty Diesel Vehicles									
Heavy-duty Gasoline Vehicles									
Heavy-duty LPG/NG Vehicles									
Light-duty Diesel Trucks									
Light-duty Diesel Vehicles									
Light-duty Gasoline Trucks									
Light-duty Gasoline Vehicles									
Light-duty LPG/NG Trucks									
Light-duty LPG/NG Vehicles									
Marine Transportation	190	280	320	290	250	210	170	130	93
Motorcycles									
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation	100	98	95	76	83	84	81	83	84
Tire Wear and Brake Lining									
Agriculture	51	54	57	69	79	85	79	76	76
Animal Production									
Crop Production									
Fuel Use	51	54	57	69	79	85	79	76	76
Commercial / Residential / Institutional	1 100	1 200	1 200	1 100	1 100	1 100	1 100	1 100	1 100
Cigarette Smoking	6	5.1	3.9	3.6	3.6	3.5	3	3	3
Commercial and Institutional Fuel Combustion	340	510	450	430	470	480	450	460	460
Commercial Cooking									
Construction Fuel Combustion	11	7	10	11	8.4	8.6	8.3	8.6	8.6
Home Firewood Burning	200	180	150	150	160	160	160	160	150
Human									
Marine Cargo Handling			47	0.16	0.41	0.077	2.3	1.2	0.5
Residential Fuel Combustion	540	500	490	470	510	480	470	480	480
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	7 000	200	64	56	50	44	54	50	50
Crematoriums	0.34	0.48	0.61	0.75	0.77	0.79	0.83	0.87	0.93
Industrial and Commercial Incineration	200	2	6.2	2.7	2.6	0.59	0.59	0.59	0.59
Municipal Incineration	380	130	33	26	26	26	26	26	26
Waste			19	22	16	12	22	18	18
Other Incineration and Utilities	6 400	70	4.4	4.8	4.8	4.8	4.8	4.8	4.8
Paints and Solvents	1	1		0.013		0.12	0.12	0.12	0.14
Dry Cleaning									
General Solvent Use									
Printing	1	1		0.013					
Surface Coatings						0.12	0.12	0.12	0.14
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires									
Prescribed Forest Burning									
Structural Fires									
Grand Total	**91 000**	**38 000**	**35 000**	**17 000**	**8 700**	**9 800**	**8 700**	**7 700**	**7 800**

Note: Totals may not add up due to rounding.

2.9. Mercury (Hg)

Approximately 4.4 t of Hg were emitted in Canada in 2015 (Table 2–11). Ore and mineral industries accounted for 31% (1.4 t) of Hg in 2015, with iron and steel industries contributing 16% (0.72 t) of the annual total. Incineration and waste sources also accounted for 31% (1.4 t) of Hg in 2015, with the waste sector being the largest contributor at 16% (0.68 t). Electric power generation (utilities) sources accounted for 18% (0.80 t) of 2015 emissions, most of which were emitted from coal-powered electric generation (17% of annual total, 0.74 t).

Between 1990 and 2015, Hg emissions decreased by 88% (31 t) (Figure 2–9). This decrease in emissions is mainly due to a large drop in emissions from the non-ferrous smelting and mining industry from 1990 to 2000, followed by a continued steady decline from 2001 to 2015. Reductions in this sector are mostly due to a facility changing from pyrometallurgical to hydrometallurgical zinc production and, to a smaller extent, to increased emission control measures, such as separation or changing of production materials, improved PM emission controls and fuel switching.

Emissions reductions from waste are also attributable to control measures, while reductions from electric power generation (utilities) are largely due to the closure of coal-fired electricity generation facilities and from the addition of mercury controls to plants. The Canadian Council of Ministers of the Environment (CCME) also developed several Canada-wide standards aimed at reducing the amount of Hg released to the environment, including standards for mercury-containing lamps, dental amalgam waste, and mercury emissions from coal-fired electric power generation plants.

The most significant changes in Hg emissions from 1990 to 2015 include:

- Ore and mineral industry source emissions: decrease of 95% (25 t)
  - Non-ferrous smelting and mining industry: decrease of 99% (25 t)
  - Iron and steel industry: decrease of 24% (0.23 t)
- Incineration and waste source emissions: decrease of 63% (2.3 t)
  - Waste: decrease of 71% (1.7t)
- Electric power generation source emissions: decrease of 65% (1.5t)
  - Coal: decrease of 62% (1.2t)

Figure 2–9 Major Contributors to National Hg Trends

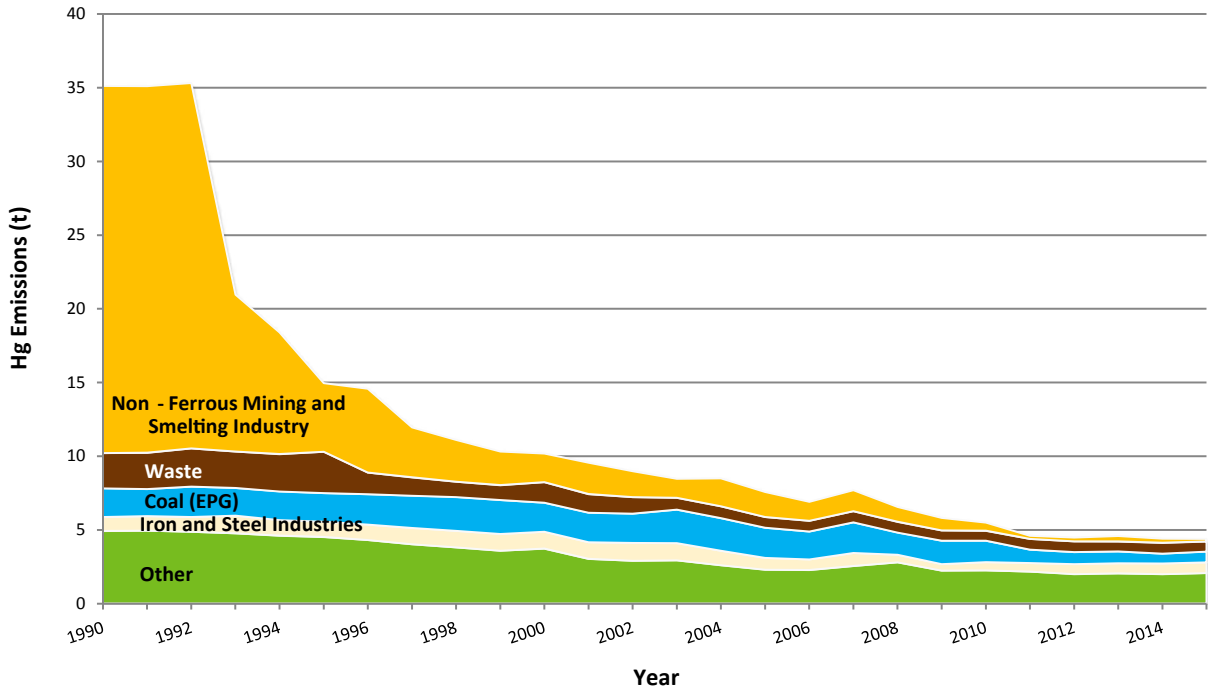


Table 2–11 National Summary of Annual Hg Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(kg)				
Ore and Mineral Industries	27 000	3 700	2 900	1 600	1 200	1 400	1 500	1 400	1 400
Aluminium Industry	18	31	43	22	19	15	21	19	21
Asphalt Paving Industry	24	22	22	28	27	21	20	22	22
Cement and Concrete Industry	460	390	210	310	300	300	310	300	300
Foundries	210	120	4.2						
Iron and Steel Industries	950	1 100	790	560	580	680	700	720	720
Iron Ore Industry	60	60	50	85	100	98	100	74	72
Mineral Products Industry			0.036			<0.01	<0.01		44
Mining and Rock Quarrying	12	12	28	7.3	3.9	5	8.5	20	20
Non-Ferrous Mining and Smelting Industry	25 000	1 900	1 700	540	210	250	360	290	180
Oil and Gas Industry	120	61	83	130	100	100	120	89	74
Downstream Petroleum Industry	110	26	46	55	46	45	48	46	49
Petroleum Product Transportation and Distribution									
Upstream Petroleum Industry	3	36	38	78	59	59	68	44	25
Electric Power Generation (Utilities)	2 300	2 200	2 200	1 600	1 000	860	850	710	800
Coal	1 900	2 000	2 000	1 500	910	810	800	670	740
Diesel									
Natural Gas	11	10	25	56	56	23	23	19	26
Waste Materials	69	110	7.5	5.7	5.3	3.8	1.9	1	10
Other Electric Power Generation	290	62	91	74	40	23	23	28	26
Manufacturing	1 100	1 400	300	150	110	140	130	120	130
Abrasives Manufacture									
Bakeries									
Biofuel Production									
Chemicals Industry	170	82	58	17	16	23	17	18	15
Electronics	380	750	56	17	17	17	17	17	18
Food Preparation	0.14	0.14	0.3	0.04					
Glass Manufacture	28	28	21	12					
Grain Processing									
Metal Fabrication	16	17	17	10	11	11	7.5	<0.01	<0.01
Plastics Manufacture	<0.01	<0.01							
Pulp and Paper Industry	98	130	59	60	42	53	50	60	70
Textiles									
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	0.012	0.012	0.023	0.16					
Wood Products	260	190	90	25	21	31	31	18	18
Other Manufacturing Industries	150	180	4	3.8	3.8	3.4	3.4	3.4	3.4
Transportation and Mobile Equipment	110	100	100	83	89	89	85	86	86
Air Transportation									
Heavy-duty Diesel Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heavy-duty Gasoline Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heavy-duty LPG/NG Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty Diesel Trucks	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty Diesel Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty Gasoline Trucks	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.011	0.011	0.012
Light-duty Gasoline Vehicles	0.012	0.013	0.013	0.013	0.012	0.012	0.012	0.012	0.012
Light-duty LPG/NG Trucks	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty LPG/NG Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Marine Transportation	4.3	6.2	7.2	6.6	5.7	4.8	3.9	3	2.1
Motorcycles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation	100	98	95	76	83	84	81	83	84
Tire Wear and Brake Lining									
Agriculture	2.8	3.4	3.2	6	7.4	7.5	7.8	8.3	8.3
Animal Production									
Crop Production									
Fuel Use	2.8	3.4	3.2	6	7.4	7.5	7.8	8.3	8.3
Commercial / Residential / Institutional	1 100	600	560	540	550	540	540	550	550
Cigarette Smoking	0.21	0.18	0.14	0.13	0.13	0.13	0.11	0.11	0.11
Commercial and Institutional Fuel Combustion	47	61	63	54	58	54	55	59	59
Commercial Cooking									
Construction Fuel Combustion	2.6	1.7	2.6	2.7	2	2.1	2	2.1	2.1
Home Firewood Burning	54	48	40	40	41	41	41	40	40
Human	110	20	15	15	15	15	15	15	15
Marine Cargo Handling			2.8	<0.01					
Residential Fuel Combustion	64	72	72	68	75	69	74	79	79
Service Stations									
Other Miscellaneous Sources	870	390	360	360	360	360	360	360	360
Incineration and Waste	3 700	2 200	1 500	1 400	1 500	1 400	1 300	1 400	1 400
Crematoriums	100	140	180	220	230	230	250	260	280
Industrial and Commercial Incineration	110		120	110	110	0.014	0.014	0.014	0.014
Municipal Incineration	510	350	230	200	200	190	190	190	190
Waste	2 400	1 400	730	680	720	730	680	720	680
Other Incineration and Utilities	580	280	230	210	210	210	210	210	210
Paints and Solvents									
Dry Cleaning									
General Solvent Use									
Printing									
Surface Coatings									
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires									
Prescribed Forest Burning									
Structural Fires									
Grand Total	**35 000**	**10 000**	**7 600**	**5 500**	**4 600**	**4 500**	**4 600**	**4 400**	**4 400**

Note: Totals may not add up due to rounding.

2.10. Dioxins and Furans (D/F)

In 2015, emissions of dioxins and furans (D/F) in Canada were approximately 58 grams of toxicity equivalent (gTEQ) (Table 2–12). Incineration and waste sources accounted for the largest share of these emissions (42% or 24 gTEQ), with the waste sector accounting for 36% (21 gTEQ). Transportation and mobile equipment contributed 18% (10 gTEQ) of 2015 D/F emissions, most of which are attributed to marine transportation, with 16% (9.1 gTEQ). Commercial/residential/institutional sources were also significant contributors (15% and 8.6 gTEQ) with home firewood burning contributing 12% (7.0 gTEQ) of 2015 emissions. Ore and mineral industries collectively accounted for 13% (7.3 gTEQ) of 2015 D/F emissions.

Between 1990 and 2015, D/F emissions decreased by 87% (400 gTEQ) (Figure 2–10). This decrease is due to large reductions in emissions from both municipal incineration and other incineration and utilities. Emissions from other incineration and utilities decreased sharply from 1990 to 1991, followed by a consistent decrease until 2000, after which emissions remained small and relatively constant. Emissions from municipal incineration followed a similar trend, with sharp decreases in 1991, 1999 and 2003, followed by a consistent decline for the rest of the time series. Both of these trends can be attributed to the decline in the use of conical burners for municipal waste incineration in Newfoundland and Labrador.

The most significant changes in D/F emissions from 1990 to 2015 include:

- Incineration and waste source emissions: decrease of 93% (320 gTEQ)
  - Municipal incineration: decrease of over 99% (190 gTEQ)
  - Other incineration and utilities: decrease of 100% (130 gTEQ)
  - Waste: decrease of 9% (1.7 gTEQ)

Figure 2–10 Major Contributors to National D/F Trends

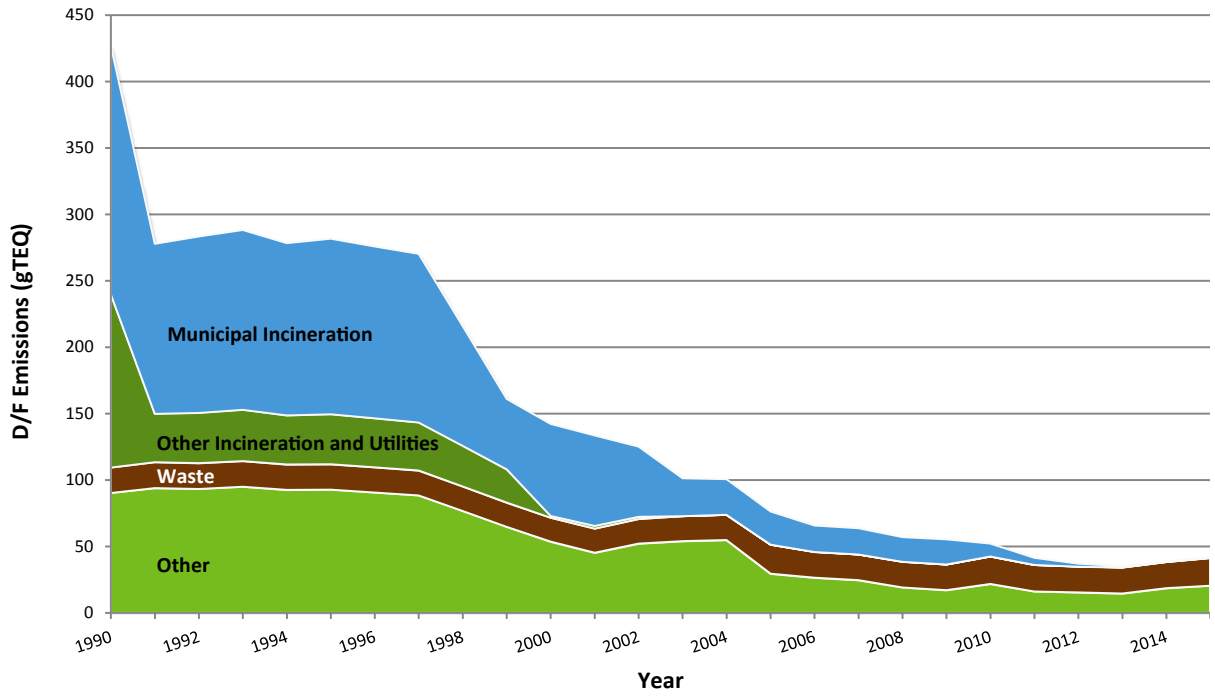


Table 2–12 National Summary of Annual Dioxins/Furans Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(g/TEQ)				
Ore and Mineral Industries	45	27	8.4	5.5	3.6	4.1	3.8	5.5	7.3
Aluminium Industry	2.8	4.1		1.3	0.4				
Asphalt Paving Industry	0.019	0.021	0.013	0.0063	0.0062	0.0048	0.0047	0.0048	0.0048
Cement and Concrete Industry	3	1.8	2.7	0.76	0.4	0.65	0.54	1.9	1.6
Foundries				0.0001	0.01	0.01	0.0001	0.043	0.034
Iron and Steel Industries	35	16	3	2.7	2.3	2.9	2.8	3.2	5.2
Iron Ore Industry								0.0007	0.0007
Mineral Products Industry	0.81	1.2	0.81						
Mining and Rock Quarrying	0	0.14	0.58	0.12	0.056	0.044	0.032	0.046	0.058
Non-Ferrous Mining and Smelting Industry	3.4	3.5	1.3	0.73	0.47	0.48	0.37	0.28	0.38
Oil and Gas Industry									
Downstream Petroleum Industry									
Petroleum Product Transportation and Distribution									
Upstream Petroleum Industry									
Electric Power Generation (Utilities)	3	5.2	3.4	2.5	1.7	1.6	1.7	2.1	1.9
Coal	2.3	4	2	1.9	1.4	1.5	1.5	1.8	1.6
Diesel									
Natural Gas	0.46	0.8	1	0.4	0.0054	0.015	0.02	0.043	0.01
Waste Materials	0.0021	0.0023		0.011	0.022	0.016	0.006	0.012	0.02
Other Electric Power Generation	0.23	0.42	0.43	0.22	0.24	0.13	0.17	0.19	0.2
Manufacturing	20	13	10	8	4	3.3	3.7	3.1	3
Abrasives Manufacture				0.012	0.014	0.015	0.015	0.015	0.015
Bakeries									
Biofuel Production									
Chemicals Industry	2.2	0.097	0.058	0.32	0.35	0.27	0.13	0.27	0.26
Electronics									
Food Preparation									
Glass Manufacture									
Grain Processing									
Metal Fabrication	4.1	5.2	4	1.5	1.3	1.4	1.1	0.91	0.87
Plastics Manufacture									
Pulp and Paper Industry	11	5.2	4.9	2.1	1.2	1	1.8	1.2	1.2
Textiles									
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	0.29	0.36			0.082				
Wood Products	1.8	1.8	1.3	4	1.1	0.6	0.62	0.65	0.65
Other Manufacturing Industries			0.12						
Transportation and Mobile Equipment	21	26	29	22	20	18	15	13	10
Air Transportation									
Heavy-duty Diesel Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Heavy-duty Gasoline Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Heavy-duty LPG/NG Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty Diesel Trucks	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty Diesel Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty Gasoline Trucks	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty Gasoline Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty LPG/NG Trucks	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Light-duty LPG/NG Vehicles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Marine Transportation	20	25	28	21	19	16	14	11	9.1
Motorcycles	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation	1.2	1.2	1.2	1.2	1.4	1.4	1.3	1.4	1.4
Tire Wear and Brake Lining									
Agriculture	0.058	0.054	0.042	0.061	0.073	0.067	0.066	0.061	0.061
Animal Production									
Crop Production									
Fuel Use	0.058	0.054	0.042	0.061	0.073	0.067	0.066	0.061	0.061
Commercial / Residential / Institutional	13	11	9.6	7.7	8	7.8	7.7	7.8	8.6
Cigarette Smoking	0.019	0.016	0.012	0.011	0.011	0.011	0.0095	0.0095	0.0095
Commercial and Institutional Fuel Combustion	0.37	0.36	0.32	0.18	0.48	0.24	0.25	0.44	1.3
Commercial Cooking									
Construction Fuel Combustion	0.068	0.028	0.044	0.053	0.038	0.018	0.012	0.014	0.014
Home Firewood Burning	9	8.2	6.7	7	7.1	7.2	7.1	7.1	7
Human									
Marine Cargo Handling									
Residential Fuel Combustion	1.5	0.55	0.51	0.43	0.42	0.37	0.32	0.31	0.31
Service Stations									
Other Miscellaneous Sources	2	2	2						
Incineration and Waste	350	92	49	33	28	24	23	23	24
Crematoriums	1.1	1.6	2	2.5	2.6	2.7	2.8	2.9	3.1
Industrial and Commercial Incineration	9	1.7	0.19	0.47	0.44				
Municipal Incineration	190	69	25	9.7	5.5	2.2	1	0.33	0.32
Waste	19	18	22	21	20	19	20	20	21
Other Incineration and Utilities	130	1.5	0.007	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Paints and Solvents									
Dry Cleaning									
General Solvent Use									
Printing									
Surface Coatings									
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	7.6	1.5	0.92	0.84	1.4	1.6	0.68	2.8	2.2
Prescribed Forest Burning	7.6	1.5	0.92	0.84	1.4	1.6	0.68	2.8	2.2
Structural Fires									
Grand Total	**460**	**180**	**110**	**80**	**67**	**60**	**56**	**57**	**58**

Note: Totals may not add up due to rounding.

2.11. Polycyclic Aromatic Hydrocarbons (PAHs)

The APEI reports emissions of four PAHs: benzo(a)pyrene (B(a)p), benzo(b)fluoranthene (B(b)f), benzo(k)fluoranthene (B(k)f) and indeno[1,2,3-cd]pyrene (I(1,2,3-cd)p). The analysis presented here is based on the aggregate total of all four substances. In 2015, 110 t of PAHs were emitted in Canada (Table 2–13), with 95% (104 t) attributed to commercial/residential/institutional sources. This is almost entirely due to home firewood burning, which contributed 92% (102 t) of total PAH emissions. The ore and mineral industries contributed almost all the remaining 5% (6 t) of PAH emissions in 2015, notably the aluminium industry with just over 4% (5 t).

From 1990 to 2015, emissions of PAHs decreased by 67% (226 t) (Figure 2–11). This trend is primarily due to emission reductions in the aluminium industry and iron and steel industries. The aluminium industry experienced a large drop in PAH emissions from 2001 to 2010 due to the implementation of new production technologies, such as the introduction of pre-baked electrodes to replace continuous casting electrodes. It experienced additional decreases between 2014 and 2015, related to the replacement of old smelting equipment with a modern smelter at the facility which historically contributed the largest share of PAH emissions.

PAH emissions from iron and steel industries experienced a large drop earlier in the time series, from 1993 to 2006, and remained quite small and constant from 2006 to 2015. Reductions in this sector are a result of effective emission controls on coke ovens and electric arc furnaces.

Home firewood burning dominates PAH emissions throughout the trend. However, this source experienced a more modest 25% (35 t) emission decrease from 1990 to 2015. This can be attributed to a reduction in the use of wood as heating fuel and to the increased use of newer technologies in fireplace inserts, furnaces and stoves that limit the emission of both wood smoke and, as a result, PAHs by improving combustion efficiency.

The most significant changes in PAH emissions from 1990 to 2015 include:

Figure 2–11 Major Contributors to National PAH Trends

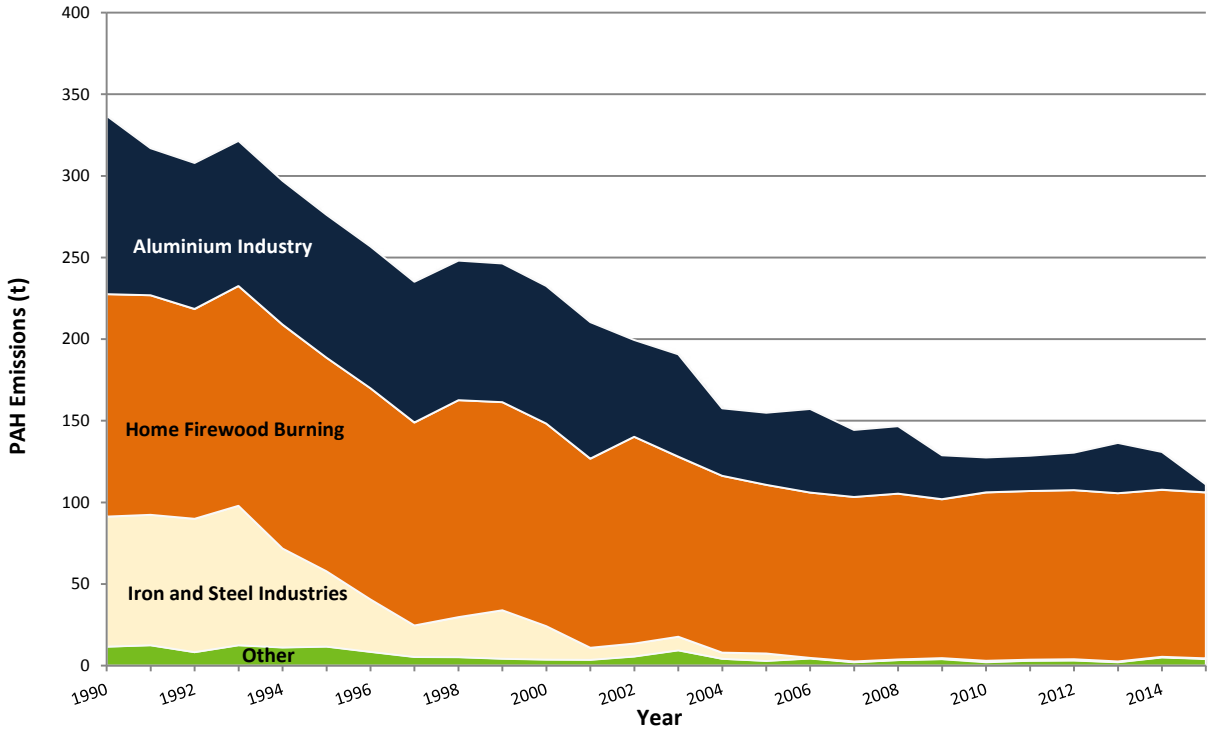


Table 2–13 National Summary of Annual PAH Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(kg)				
Ore and Mineral Industries	190 000	100 000	49 000	22 000	22 000	24 000	32 000	24 000	5 400
Aluminium Industry	110 000	84 000	44 000	21 000	22 000	23 000	31 000	23 000	4 900
Asphalt Paving Industry	14	14	15	18	15	12	12	13	13
Cement and Concrete Industry	17	13	19	0.61	0.77	1.6	1.7	3.1	2.8
Foundries									
Iron and Steel Industries	80 000	20 000	4 500	720	680	740	550	400	400
Iron Ore Industry				21	18	19	18	19	20
Mineral Products Industry									
Mining and Rock Quarrying	0.3	0.5			0.3	0.25	160	250	110
Non-Ferrous Mining and Smelting Industry	1.9	2.8	0.36	0.35	0.33	0.27	0.31	0.31	0.32
Oil and Gas Industry	150	100	45	45	24	28	27	25	24
Downstream Petroleum Industry	150	100	42	37	16	19	18	16	19
Petroleum Product Transportation and Distribution		0.2							
Upstream Petroleum Industry	2.3	3.4	3	7.7	8.4	8.2	9	9.8	4.8
Electric Power Generation (Utilities)	370	340	240	15	14	7.8	6.7	6.4	6.1
Coal	240	230	240	0	<0.01				
Diesel									
Natural Gas	2.9	2.3	0.22	1.3	0.93	0.069	0.032	0.033	0.044
Waste Materials									
Other Electric Power Generation	130	110		14	13	7.7	6.7	6.4	6
Manufacturing	320	300	300	110	100	170	130	170	110
Abrasives Manufacture									
Bakeries									
Biofuel Production									
Chemicals Industry	0.6	20	29	27	28	28	25	24	25
Electronics									
Food Preparation									
Glass Manufacture	<0.01	<0.01							
Grain Processing									
Metal Fabrication	1.1	1.3	8	7.1	4.6	4.1	4.1		
Plastics Manufacture									
Pulp and Paper Industry	110	130	190	55	59	120	91	130	73
Textiles									
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	0.018	0.015				0.015	0.024	0.026	0.021
Wood Products	210	150	72	18	13	12	11	9.7	9.7
Other Manufacturing Industries			2.2						
Transportation and Mobile Equipment	220	240	250	190	180	170	150	140	120
Air Transportation	13	11	7.6	6.9	6.6	8.3	8.5	9.4	9.4
Heavy-duty Diesel Vehicles	0.95	1	1.2	0.93	0.89	0.81	0.76	0.7	0.64
Heavy-duty Gasoline Vehicles	6.2	4.3	4.1	3.2	2.1	2.1	2.1	2	1.9
Heavy-duty LPG/NG Vehicles	1.2	1.4	0.36	0.11	0.017	0.012	<0.01	0.045	<0.01
Light-duty Diesel Trucks	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty Diesel Vehicles	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty Gasoline Trucks	4.6	5.4	3.8	3.1	2.8	2.7	2.7	2.5	2.5
Light-duty Gasoline Vehicles	11	7.7	5	3.5	2.9	2.8	2.7	2.5	2.3
Light-duty LPG/NG Trucks	0.45	0.2	0.078	0.013	<0.01	<0.01	<0.01	<0.01	<0.01
Light-duty LPG/NG Vehicles	0.057	0.028	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Marine Transportation	120	150	170	130	110	97	83	69	54
Motorcycles	0.041	0.039	0.042	0.039	0.036	0.036	0.035	0.034	0.035
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation	63	59	58	46	50	51	49	50	51
Tire Wear and Brake Lining									
Agriculture	0.32	0.31	0.21	0.29	0.36	0.34	0.34	0.32	0.32
Animal Production									
Crop Production									
Fuel Use	0.32	0.31	0.21	0.29	0.36	0.34	0.34	0.32	0.32
Commercial / Residential / Institutional	140 000	120 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Cigarette Smoking	1	0.9	0.68	0.63	0.63	0.62	0.53	0.53	0.53
Commercial and Institutional Fuel Combustion	2.6	3.1	2.9	2.1	2.3	2.1	2.2	2.4	2.4
Commercial Cooking	100	110	120	130	120	120	120	120	120
Construction Fuel Combustion	0.45	0.18	0.42	0.55	0.3	0.25	0.18	0.19	0.19
Home Firewood Burning	140 000	120 000	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Human									
Marine Cargo Handling									
Residential Fuel Combustion	5.3	4.5	4.3	3.8	3.9	3.5	3.4	3.5	3.5
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	670	630	690	720	690	680	680	690	690
Crematoriums	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Industrial and Commercial Incineration									
Municipal Incineration									
Waste	660	630	690	720	690	680	680	690	690
Other Incineration and Utilities	1.5	1.7							
Paints and Solvents									
Dry Cleaning									
General Solvent Use									
Printing									
Surface Coatings									
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires	9 800	2 000	1 200	1 100	1 800	2 000	880	3 600	2 900
Prescribed Forest Burning	9 800	2 000	1 200	1 100	1 800	2 000	880	3 600	2 900
Structural Fires									
Grand Total	**340 000**	**230 000**	**150 000**	**130 000**	**130 000**	**130 000**	**140 000**	**130 000**	**110 000**

Note: Totals may not add up due to rounding.

- Ore and mineral industries source emissions: decrease of 97% (184 t)
  - Aluminium industry: decrease of 96% (104 t)
  - Iron and steel industries: decrease of 99% (79 t)
- Commercial/residential/institutional emissions: decrease of 28% (42 t)
  - Home firewood burning: decrease of 25% (35 t)

2.12. Hexachlorobenzene (HCB)

In 2015, approximately 8.1 kg of HCB were emitted in Canada (Table 2–14). Incineration and waste sources were the largest contributor in 2015 with 62% (5.0 kg) of total emissions, due almost entirely to emissions from the waste sector with 61% (4.9 kg) of HCB emissions. The ore and mineral industries were the second-largest contributor, with 26% (2.1 kg) of total emissions, largely due to iron and steel industries, which represented 14% (1.1 kg) of the national total.

Overall, a 91% (83 kg) decrease in HCB emissions occurred between 1990 and 2015 (Figure 2–12). Most of this decrease is due to a drop in emissions from municipal incineration from 1997 to 2002, followed by further reductions until 2015. This important reduction in emissions is a result of a steady decline in the use of conical burners for municipal waste incineration in Newfoundland and Labrador. Emission reductions were also seen in coal-fired electric power generation from 2000 to 2012 as a result of the phasing out of coal electricity generation in Ontario. HCB emissions from waste remained relatively stable throughout the time series. Starting with the year 2005, emissions of HCB from residential waste burning were included in waste sources, causing a slight increase in emissions.

The most significant changes in HCB emissions from 1990 to 2015 include:

- Incineration and waste emissions: decrease of over 93% (68 kg)
  - Municipal incineration: decrease of over 99% (68 kg)
  - Waste: increase of 8% (0.38 kg)
- Electric power generation (utilities) source emissions: decrease of 95% (10 kg)
  - Coal-fired electricity generation: decrease of 96% (9.9 kg)

Figure 2–12 Major Contributors to National HCB Trends

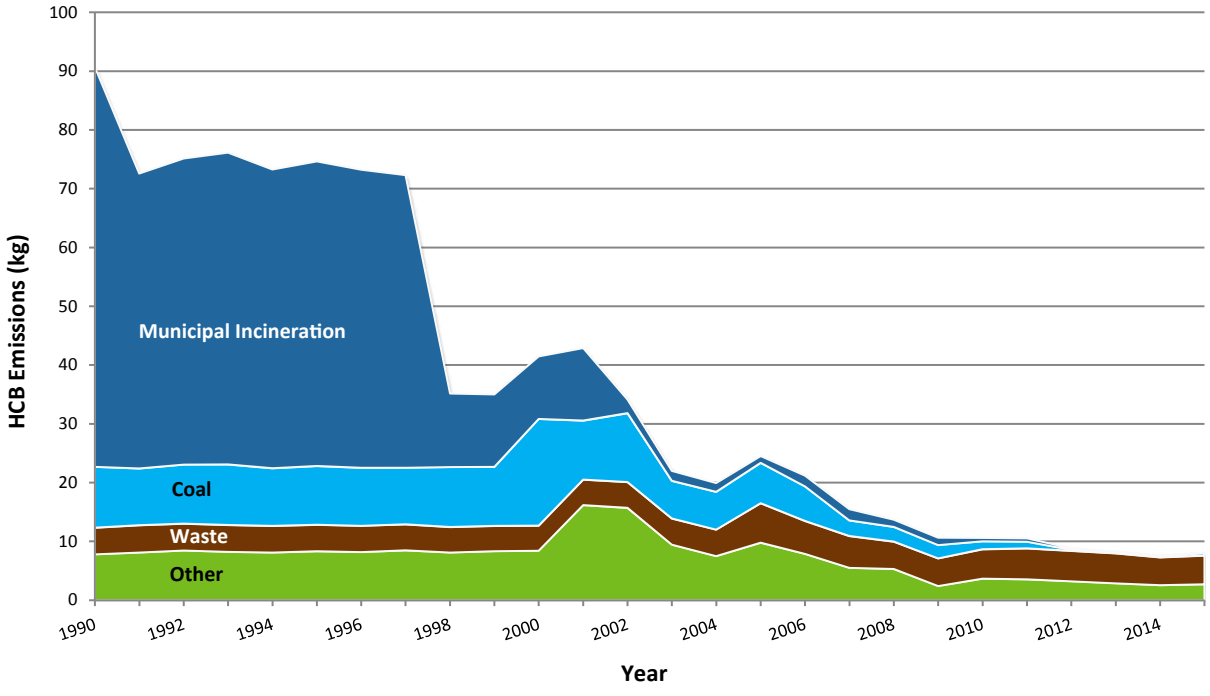


Table 2–14 National Summary of Annual HCB Emissions

Sector	1990	2000	2005	2010	2011	2012	2013	2014	2015
					(g)				
Ore and Mineral Industries	5 500	5 700	8 100	3 100	3 000	2 500	2 300	1 900	2 100
Aluminium Industry				49	48				
Asphalt Paving Industry									
Cement and Concrete Industry	1 600	2 100	880	660	560	420	420	280	290
Foundries					0.01	0.01		29	23
Iron and Steel Industries	1 100	920	1 500	1 500	1 500	1 400	1 100	1 100	1 100
Iron Ore Industry									
Mineral Products Industry									
Mining and Rock Quarrying	13	13	32	12	14	18	13	12	17
Non-Ferrous Mining and Smelting Industry	2 700	2 600	5 600	950	940	660	730	530	700
Oil and Gas Industry	1.3	1.6							
Downstream Petroleum Industry									
Petroleum Product Transportation and Distribution									
Upstream Petroleum Industry	1.3	1.6							
Electric Power Generation (Utilities)	11 000	19 000	7 000	1 500	1 300	370	390	430	600
Coal	10 000	18 000	6 900	1 300	1 100	200	190	240	430
Diesel									
Natural Gas	640	1 100	170	95	140	140	140	140	150
Waste Materials	4.8	1.3		30	50	40	40	30	4.9
Other Electric Power Generation							25	23	16
Manufacturing	1 600	1 500	1 500	300	240	460	330	360	350
Abrasives Manufacture									
Bakeries									
Biofuel Production									
Chemicals Industry	680	330	480						
Electronics									
Food Preparation			3						
Glass Manufacture									
Grain Processing									
Metal Fabrication	460	580	52	120	110	350	230	290	210
Plastics Manufacture									
Pulp and Paper Industry	140	180	310	170	120	120	94	73	140
Textiles									
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	8.8	11		3.3					
Wood Products	340	390	620	6.8	3.4	0.091	1.9	0.26	0.11
Other Manufacturing Industries									
Transportation and Mobile Equipment									
Air Transportation									
Heavy-duty Diesel Vehicles									
Heavy-duty Gasoline Vehicles									
Heavy-duty LPG/NG Vehicles									
Light-duty Diesel Trucks									
Light-duty Diesel Vehicles									
Light-duty Gasoline Trucks									
Light-duty Gasoline Vehicles									
Light-duty LPG/NG Trucks									
Light-duty LPG/NG Vehicles									
Marine Transportation									
Motorcycles									
Off-road Diesel Vehicles and Equipment									
Off-road Gasoline/LPG/CNG Vehicles and Equipment									
Rail Transportation									
Tire Wear and Brake Lining									
Agriculture									
Animal Production									
Crop Production									
Fuel Use									
Commercial / Residential / Institutional	1.6								
Cigarette Smoking									
Commercial and Institutional Fuel Combustion	0.11								
Commercial Cooking									
Construction Fuel Combustion									
Home Firewood Burning									
Human									
Marine Cargo Handling									
Residential Fuel Combustion	1.5								
Service Stations									
Other Miscellaneous Sources									
Incineration and Waste	73 000	15 000	7 900	5 700	5 900	5 500	5 200	4 900	5 000
Crematoriums	10	14	18	22	23	24	25	26	28
Industrial and Commercial Incineration	21	81	14	43	41				
Municipal Incineration	68 000	11 000	1 200	600	580	260	120	97	63
Waste	4 500	4 200	6 700	5 000	5 300	5 200	5 100	4 700	4 900
Other Incineration and Utilities									
Paints and Solvents									
Dry Cleaning									
General Solvent Use									
Printing									
Surface Coatings									
Dust									
Coal Transportation									
Construction Operations									
Mine Tailings									
Paved Roads									
Unpaved Roads									
Fires									
Prescribed Forest Burning									
Structural Fires									
Grand Total	**91 000**	**41 000**	**25 000**	**11 000**	**10 000**	**8 800**	**8 300**	**7 600**	**8 100**

Note: Totals may not add up due to rounding.

3

KEY COMPONENTS OF THE APEI

The Air Pollutant Emission Inventory (APEI) is a comprehensive and detailed inventory of air pollutant emissions in Canada, emitted from two types of sources:

- Point sources, consisting of emissions from relatively large industrial, commercial and institutional facilities; and
- Area sources, including diffuse sources and other sources that are too numerous to be accounted for individually, such as road and non-road vehicles, agricultural activities, construction and solvent use.

The APEI is developed using many sources of information, procedures and emission estimation models. Emissions data reported by individual facilities to ECCC's National Pollutant Release Inventory (NPRI) are supplemented with documented, science-based estimation tools to quantify total emissions. Together, these data sources provide a comprehensive overview of pollutant emissions across Canada.

A compilation framework has been developed that makes use of the best available data, while ensuring that there is no double-counting or omissions. Additional information on the inventory compilation process is provided in Annex 2.

3.1. Estimation of Point Source Emissions

Point sources generally refer to any stationary source that emits pollutants through stacks or other equipment at specific geographical locations. The major source of point source emission data is the National Pollutant Release Inventory (NPRI), which is Canada's legislated, publicly accessible inventory of pollutant releases (to air, water and land), disposals and transfers for recycling. The NPRI has provided point source emissions information on the 17 pollutants included in the APEI for more than 6000 industrial and commercial facilities since 2002 and for heavy metals and persistent organic pollutants since 1994. Prior to 2002, facility-level emissions for the criteria air contaminants were collected and compiled by provincial, territorial and regional environmental authorities across Canada and provided to Environment and Climate Change Canada for compilation of the APEI.

Point source emission data reported to the NPRI are used in the APEI without modifications, except when data quality issues are detected and not addressed during the quality control exercise. The NPRI reporting requirements and thresholds vary by pollutant and, in some cases, by industry. Details on these reporting requirements and thresholds are available on Environment and Climate Change Canada's website at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1.

A distinction is made between reporting facilities and non-reporting facilities. Reporting facilities meet the threshold required to report to the NPRI; non-reporting facilities do not meet these thresholds due to their size or emission levels and therefore are not required to report to the NPRI. Some facilities may only be required to report emissions of certain pollutants. Emissions from non-reporting

facilities or of non-reported pollutants must therefore be estimated to ensure complete coverage.

3.2. Estimation of Area Source Emissions

Area sources are those that are too numerous to be accounted for individually; emissions from these sources are typically inventoried as a group. These include emissions from non-industrial, residential, commercial, transportation and other sources, such as open burning, agricultural activities and construction operations. The APEI considers the following as area sources:

- Any residential, governmental, institutional, or commercial operation that does not report to the NPRI
- On-site solid waste disposal facilities
- Motor vehicles, aircraft, vessels or other transportation equipment or devices
- Other sources, such as open burning, agricultural activities and construction operations

In general, area source emission estimates are calculated from activity data and emission factors.[1] Activity data usually comprise statistical production or process data at the provincial, territorial or national level. This information is typically provided by provincial/territorial agencies federal government departments, industry associations, etc. For each source category, activity data are combined with emission factors to produce provincial/territorial-level emission estimates.

The area source estimation methodologies and emission models used in Canada are often based on those developed by the United States Environmental Protection Agency (U.S. EPA) and are adapted to reflect the Canadian climate, fuels, technologies and practices. Methods used in Canada's APEI are therefore generally consistent with those used in the United States or those recommended in the emission inventory guidebook (EMEP/EEA 2013).

The APEI reports air pollutant emissions from mobile sources such as road vehicles, off-road vehicles and engines. For the current edition of the APEI, an emissions estimation model developed by the U.S. EPA (MOVES) was used (see "on-road vehicles" in Table A2-5 of Annex 2). The emissions for off-road vehicles and engines (such as graders, heavy trucks, outboard motors and lawnmowers) were estimated using the U.S. EPA's NONROAD emission estimation model (see "off-road applications" in Table A2-5 of Annex 2). The parameters in both models were modified to take into account variations in the Canadian vehicle fleet, emission control technologies, types of fuels, vehicle standards, and types of equipment engines and their application in various industries. The emission estimates for civil and international aviation, railways and navigation are estimated using detailed vehicle movement statistics coupled with fuel consumption, engine information, and emission rates by vehicle types.

3.3. Recalculations

Emission recalculation is an essential practice in the maintenance of an up-to-date air pollutant emission inventory. The APEI is continuously updated with improved estimation methodologies, statistics and more recent and appropriate emission factors. As new information and data become available, previous estimates are updated and recalculated to ensure a consistent and comparable trend in emissions. Recalculations of previously reported emission estimates are common in area sources; recalculated point source estimates

1 The U.S. EPA defines an emission factor as "…a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned)."

are occasionally provided by facilities. More information on recalculations is provided in Annex 2.

3.4. Reconciliation

In several sectors, such as the upstream petroleum industry, estimating total emissions involves combining emission estimates provided by facilities with estimates developed by Environment and Climate Change Canada. To ensure that there is no double-counting of emissions and that all emissions are included in the APEI, a comparison and reconciliation of the emission estimates from the various sources is performed for each pollutant, industry sector and geographical region, as appropriate. More information on the reconciliation process is provided in Annex 2.

4

DATA QUALITY CONTROL

Quality control for the inventory takes place in two phases. In Phase 1, quality control is performed on the most recently submitted National Pollutant Release Inventory (NPRI) point source (facility) data, prior to inclusion of the data in the Air Pollutant Emission Inventory (APEI). A summary of the process for the APEI is presented in Section 4.1.

Phase 2 of the quality control occurs after the area and point source emissions are compiled and reconciled to form the APEI. During Phase 2, emissions are verified based on established criteria (a description of this process is provided in Section 4.2).

4.1. Phase 1: Emission Data from Facilities

The quality control process involves a system of documented activities and procedures performed by a dedicated team to identify data outliers, inconsistencies, missing data, inaccuracies and errors. It also includes communications with facilities to resolve identified issues. The quality control process can be adapted so that category-specific or sector-specific quality-control procedures are applied as appropriate.

An essential part of the quality control exercise is identification of missing NPRI facility reports/reporters and the assessment of new reports/reporters, to ensure that the correct data are captured.

The identification of outliers (i.e. reports that significantly depart from comparable NPRI point source data) is of critical importance to ensure the usability of the NPRI point source data. Identification, facility follow-up, and resolution of such issues are also conducted at the earliest stage of the quality control review. The largest impact on the 2015 data was the result of unit errors such as reporting in kilograms instead of tonnes. Such reporting errors were identified and corrected in this year's report.

Potential outliers are defined as any NPRI facility report that:

- has a large year-over-year change; and/or
- contributes an unrealistically high proportion of the total reported quantity of an air pollutant in the current or previous reporting year.

The quality control review also includes analysis of:

- the impact of first-year reporting;
- substances that are no longer reported;
- substance reports with a large change in contribution/impact on the reported total;
- substance reports with identical reported quantities of an air pollutant within a five-year period;
- substance reports with significant variation over a five-year period; and
- facilities assigned to incorrect subsectors.

In the past, a common reporting error related to APEI pollutant reporting was the misreporting of the different-sized fractions of particulate matter (PM). Starting in 2013, data input checks have been implemented in the online data collection, which reduced the frequency of this type of error. Additional quality control checks were performed in 2016 on outstanding issues of particulate matter emissions.

Quality control checks are also performed on facility information. These checks include the verification of reported North American Industry Classification System (NAICS) codes, facility

identification numbers and geographical information (i.e. city, province, address and latitude/longitude).

The quality control team continues to follow up on the few remaining unresolved issues, and any updates to the data will be reflected in the next inventory edition.

4.2. Phase 2: Compiled APEI

The objective of Phase 2 of the quality control process is to identify and verify inconsistencies in the APEI at the subsector level. A series of verification and quality control checks are undertaken on the area source emission estimates of the current year to ensure quality, accuracy and consistency. The following are verified:

- Activity data
- Emission factors
- Unit conversions
- Emission calculations

Phase 2 of the quality control is carried out through the following measures for the compiled APEI:

- Manual verification of the updated emissions data as they are entered in the main trends database;
- Comparison of the emissions to those of the previous year's inventory and to the previous year's trends.

The inventory data is reviewed and any significant changes (+/- 15%) from year to year are identified and explained. The selection of a 15% threshold is based on acceptable fluctuations in industrial activity/production/emissions that generally occur between years. Additionally, any significant changes (+/- 10%) in recalculated emissions are identified and explained. The selection of a 10% threshold is based on acceptable fluctuations in emissions that generally occur when emission factors and facility emission reports are updated.

4.3. Completeness

The reporting of NPRI substances to ECCC remains the primary source of data collection on air pollutant emissions for Canada. Sectors comprising large point sources (e.g. oil refineries, smelters) are well represented by NPRI-reported emissions.

The completeness of the APEI is assessed by the level of inclusion of all known, quantifiable sources of pollutant emissions in the provincial/territorial and national totals that are attributed to anthropogenic activities. Where the reporting of the NPRI point source data does not provide for complete sector coverage, additional estimates are developed by Environment and Climate Change Canada. An overall estimation of completeness in this case is related to the availability and reliability of area source activity data and compilation methodologies.

The development of complementary estimates is not required in sectors where NPRI facility data provide complete coverage of air pollutant emissions (e.g. pulp and paper). Complementary estimates are necessary for those sectors that have facilities not reporting to the NPRI because they do not meet the reporting threshold (e.g. upstream petroleum industry, wood products facilities and foundries), in order to produce a complete inventory of emissions.

Other sources of air pollutants such as residential fuel combustion, transportation or fires, are not subject to reporting to the NPRI, and coverage is assured solely through the calculation of area source emissions.

Although all major sources of air pollutant sources are included in the APEI, a number of sources

are not included in the national inventory such as the burning of agricultural wastes and demolition activities in the construction industry. Home firewood burning estimates have been updated; however, there were no estimates of wood used as fuel for the three Canadian territories (Yukon Territory, Northwest Territories and Nunavut). Residential coal use was not estimated for all provinces because of the lack of publicly available information. In the future, these sectors may be included in the inventory, if activity data become available.

A1

DEFINITIONS OF THE AIR POLLUTANTS

This appendix provides definitions for the 17 air pollutants inventoried by the APEI and listed in Chapter 1. Examples of some major sources are also provided.

A1.1. Criteria Air Contaminants

Particulate Matter (PM)

PM consists of microscopic solid and liquid particles of various origins that remain suspended in air for any length of time. PM includes a broad range of chemical species, such as elemental carbon and organic carbon compounds, oxides of silicon, aluminium and iron, trace metals, sulphates, nitrates and ammonia (NH_3). It is ubiquitous, being emitted from both natural and anthropogenic (human) sources. Emissions of fine PM ($PM_{2.5}$) and its precursor gases originate typically from combustion processes— motor vehicles, industrial processes, vegetative burning and crop production.

Total Particulate Matter (TPM)

TPM includes any PM with a diameter less than 100 microns.[1]

Particulate Matter less than or equal to 10 Microns (PM_{10})

PM_{10} includes any PM with a diameter less than or equal to 10 microns.[2]

Particulate Matter less than or equal to 2.5 Microns ($PM_{2.5}$)

$PM_{2.5}$ includes any PM with a diameter less than or equal to 2.5 microns.

Sulphur Oxides (SO_x)

Sulphur oxides (SO_x) are a family of gases that consist mostly of sulphur dioxide (SO_2), a colourless gas. It can be chemically transformed into acidic pollutants, such as sulphuric acid and sulphates (sulphates are a major component of ambient fine particles). SO_2 is generally a by-product of industrial processes and the burning of fossil fuels, with the main contributors being ore smelting, coal-fired power generators and natural gas processing. SO_2 transformed to sulphuric acid is also the main ingredient of acid rain, which can damage crops, forests and ecosystems.

Nitrogen Oxides (NO_x)

NO_x include nitrogen dioxide (NO_2) and nitrogen oxide (NO); both are reported as NO_2 equivalent. NO_x reacts photochemically with volatile organic compounds (VOCs) in the presence of sunlight to form ground-level ozone. It can also transform into ambient PM (nitrate particles) and is a component of acid rain. NO_x originate from both anthropogenic and natural sources. The main anthropogenic sources are mobile (on-road vehicles), electric power generation and the upstream petroleum industry, and the main natural sources are lightning and soil microbial activity.

Volatile Organic Compounds (VOCs)

VOCs are organic compounds containing one or more carbon atoms that evaporate readily to the

1 TPM includes PM_{10} and $PM_{2.5}$.

2 PM_{10} includes $PM_{2.5}$.

atmosphere and react photochemically to form ground-level ozone.[3] VOCs may condense in the atmosphere to contribute to ambient PM formation. Besides biogenic sources (e.g. vegetation), other major sources include the petroleum industry, mobile sources and solvent use. Some VOCs, such as formaldehyde and benzene, are carcinogenic.

Carbon Monoxide (CO)

CO is a colourless, odourless, tasteless and poisonous gas. CO can have a significant impact on human health. When inhaled, it forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. It also participates to a lesser degree in the formation of ground-level ozone. The principal human source of CO is incomplete combustion of hydrocarbon-based fuels and is emitted primarily from mobile sources (on-road vehicles). Other lesser but significant sources are the wood industry, residential wood heating and forest fires. Ambient CO concentrations are much higher in urban areas due to the number of human sources

Ammonia (NH_3)

Gaseous NH_3, which originates from anthropogenic sources, has been identified as one of the principal precursors to $PM_{2.5}$. Major sources of NH_3 emissions include agricultural fertilizer use, agricultural livestock and synthetic fertilizer manufacturing.

A1.2. Selected Heavy Metals

Lead (Pb)

Lead occurs naturally in the Earth's crust. It is declared as a toxic substance under the Canadian Environmental Protection Act, 1999 (CEPA) and is used extensively in industry to manufacture products such as lead-acid batteries and radiation shields. Metals processing is the major source of incidental Pb emissions to air, with the highest levels of Pb air emissions originating from the non-ferrous smelting and refining industry.

Cadmium (Cd)

Cadmium, declared as toxic under CEPA, is present in the air as a result of anthropogenic activities and natural processes. The largest anthropogenic source is metal production (particularly non-ferrous smelting and refining).

Mercury (Hg)

Mercury is declared as toxic under CEPA. Hg's unique properties are utilized in various consumer products, such as fluorescent lights. When Hg is released to the atmosphere, it can be transported on wind currents, deposited onto land and re-emitted into the atmosphere several times.

A1.3. Persistent Organic Pollutants

Dioxins and Furans

Dioxins and furans are a family of toxic compounds that vary widely in toxicity. Both dioxin and furan "congeners" are expressed in terms of toxic equivalents (TEQs) to the most-toxic form of dioxin: 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). The largest source of dioxins and furans in Canada is the burning of municipal and medical waste. Other major sources include the production of iron and steel, backyard burning of household waste, and fuel combustion for transportation and home heating.

3 Environment and Climate Change Canada's definition of VOCs can be found in the *Canada Gazette*, Part II. Statutory Instruments. Vol. 137, No. 14. Available at: www.publications.gc.ca/site/eng/248253/publication.html.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of organic compounds emitted to the Canadian environment from natural and anthropogenic sources. Comprehensive air emissions information is available for the following four PAHs: benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene and indeno[1,2,3-cd]pyrene. National Pollutant Release Inventory (NPRI) facility-reported data are available for additional PAHs. The largest anthropogenic sources of PAHs released to the atmosphere are residential wood heating and aluminium smelters.

Hexachlorobenzene (HCB)

HCB is a persistent organic pollutant (POP) that is released in trace amounts as a by-product of the manufacture and use of chlorinated solvents and pesticides through long-range transport and deposition, incineration, and other industrial processes.

A2

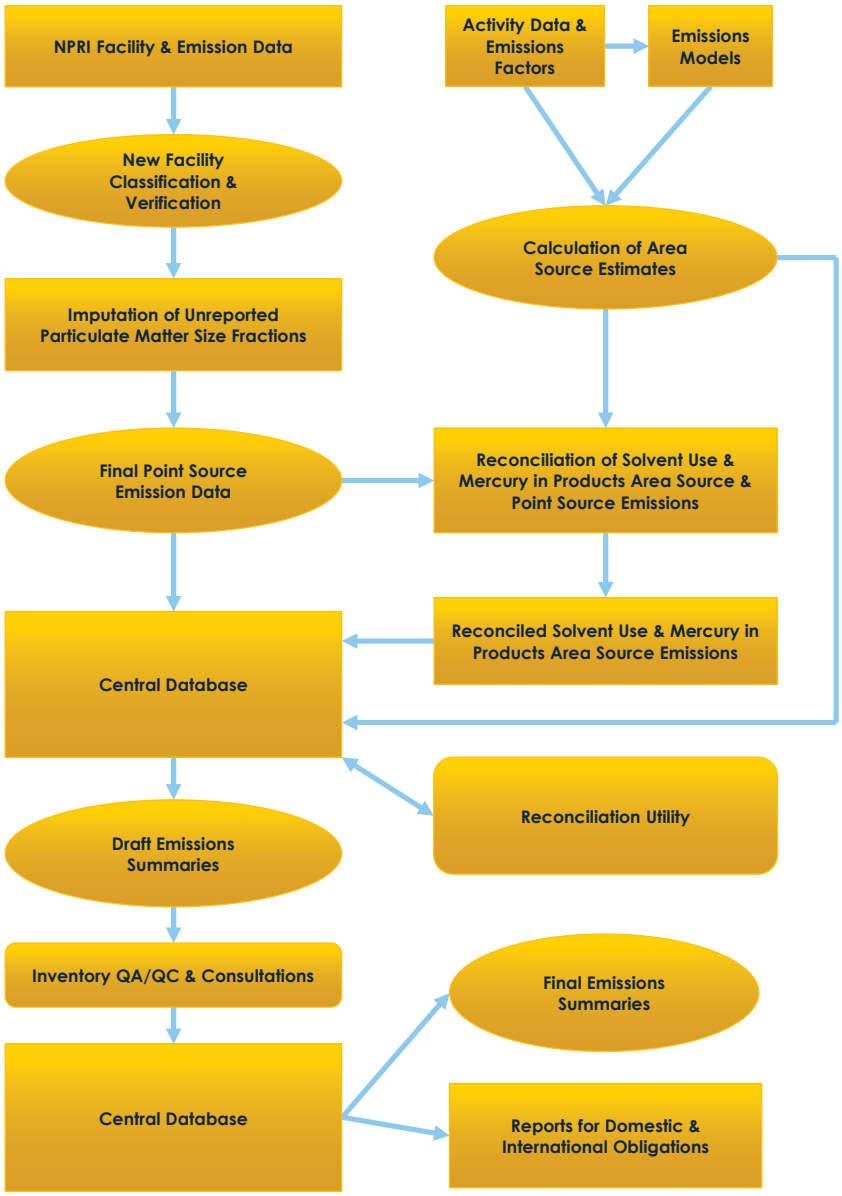
INVENTORY DEVELOPMENT

A2.1. Overview of the Compilation Processs

The process of compiling emission estimates consists of developing estimates for point source and area source emissions and where necessary, reconciling finalized estimates into a central database (Figure A2–1).

First, point source emissions are compiled with the extraction of National Pollutant Release Inventory

Figure A2–1 Overview of the Annual APEI Compilation Process



(NPRI) facility and emissions data from the verified NPRI database. New facilities are identified in the extracted data and classified among the Air Pollutant Emission Inventory (APEI) sector and subsector categories according to the nature of their activities. A quality control process is performed on the point source data prior to its inclusion in the APEI. A summary of this quality control process is presented in Chapter 4. A list of the final point source emissions data is then produced and transferred to a central database.

Area source estimation involves an internal review of the estimation methodologies. Such reviews may include literature searches, the collection and analysis of recent emission factors and activity data, and comparisons with relevant information. Planned improvements to methods or data are implemented, and estimates may be recalculated for part of or the entire time series, as appropriate. Updated area source emission estimates are calculated using new and/or updated activity data. Calculations are typically performed in spreadsheets or database-driven emission models.

The next step in the compilation process is the elimination of any double-counting of emissions between the area source and point source estimates by a process of reconciliation. Reconciliation of the area source emissions with the point source emissions is required for sectors or subsectors when both area source and point source emissions exist (Table A2–1). For example, for 2015, reconciliation was performed for the asphalt paving industry since this subsector had both area source and point source emissions. More information on reconciliation is available in section A2.5.1.

This reconciliation process is performed by an automated database utility following transfer of the area source and point source emissions to the central database. Reconciliation of emissions from wood products, emissions from paints and solvents, and mercury emissions from various sectors is carried out separately.

The final steps in the compilation process involve aggregation all reconciled data in the central database to produce draft emissions summaries for quality assurance/control and consultation purposes. The final emissions database is also used to fulfill Canada's international and domestic reporting obligations.

A2.2. Estimation of the Area Source Emissions

The compilation of area source emissions relies on information such as production data or activity levels for each sector. Calculations of area source emissions are based on the latest data available at the time of compilation. If required, the data are updated the following year.

Table A2–1 lists the area source sectors and subsectors of the APEI and provides the activity data year on which the 2015 area source estimate is based.

The area source estimation methodologies and emission models used in Canada are generally based on those developed by the United States Environmental Protection Agency (U.S. EPA) and are adapted to utilize Canadian data, thereby accounting for differences in climate, fuels, technologies and practices. Methods used in Canada's APEI are therefore generally consistent with those used in the United States or those recommended in the emission inventory guidebook (EMEP/EEA 2013).

Table A2–2 through Table A2–12 summarize, for each source category, the methodologies used to estimate the area source emissions for the entire time series. For each source category, these tables provide a short description of the following:

- the emission sources and pollutants estimated;
- the general inventory approach used; and
- the references for the activity data, emission factors and/or emission models used.

Table A2–1 2015 Air Pollutant Emission Inventory (APEI)

APEI Sectors	Point Source (NPRI)[a]	Area Source (Estimated by EC)	Activity Data Used for Estimation
Ore and Mineral Industries			
Aluminium Industry			
Alumina (Bauxite Refining)	✓		
Primary Aluminium Smelting and Refining	✓		
Asphalt Paving Industry	✓	✓	2014
Cement and Concrete Industry			
Cement Manufacture	✓		
Concrete Batching and Products	✓	✓	2015
Gypsum Product Manufacturing	✓		
Lime Manufacture	✓		
Foundries			
Die Casting	✓		
Ferrous Foundries	✓	✓	2011
Non-ferrous Foundries	✓		
Iron and Steel Industries			
Primary (Blast Furnace and DRI)	✓		
Secondary (Electric Arc Furnaces)	✓	✓	2015
Steel Recycling	✓	✓	2015
Iron Ore Industry			
Iron Ore Mining	✓		
Pelletizing	✓		
Mineral Products Industry			
Clay Products	✓		
Other Mineral Products	✓		
Mining and Rock Quarrying			
Coal Mining Industry	✓		
Metal Mining	✓		
Potash	✓		
Rock, Sand and Gravel	✓	✓	2015
Silica Production		✓	2015
Other Minerals	✓		
Non-Ferrous Mining and Smelting Industry			
Primary Ni, Cu, Zn, Pb	✓		
Secondary Pb, Cu	✓		
Other Metals	✓		
Oil and Gas Industry			
Downstream Petroleum Industry			
Petroleum Refining	✓		
Refined Petroleum Products Bulk Storage and Distribution	✓	✓	2015
Other Downstream Petroleum Industry	✓		
Petroleum Product Transportation and Distribution			
Natural Gas Distribution	✓	✓	2015
Natural Gas Transmission	✓	✓	2015
Petroleum Product Pipelines	✓		
Upstream Petroleum Industry			
Accidents and Equipment Failures		✓	2015
Bitumen and Heavy Oil Upgrading	✓		
Disposal and Waste Treatment		✓	2015
Heavy Crude Oil Cold Production		✓	2015
Light Medium Crude Oil Production[b]	✓	✓	2015
Natural Gas Production and Processing[c]	✓	✓	2015
Oil Sands In-Situ Extraction and Processing	✓	✓	2015
Oil Sands Mining Extraction and Processing	✓		
Petroleum Liquids Storage	✓		
Petroleum Liquids Transportation		✓	2015
Well Drilling/Servicing/Testing		✓	2015
Electric Power Generation (Utilities)			
Coal	✓		
Diesel	✓		
Natural Gas	✓		
Waste Materials	✓		
Other Electric Power Generation	✓		
Manufacturing			
Abrasives Manufacture	✓		
Bakeries	✓	✓	2015
Biofuel Production	✓		
Chemicals Industry			
Chemical Manufacture	✓		
Fertilizer Production	✓		
Paint and Varnish Manufacturing	✓		
Petrochemical Industry	✓		
Plastics and Synthetic Resins Fabrication	✓		
Other Chemical Industries	✓		
Electronics	✓	✓	2015
Food Preparation	✓		
Glass Manufacture	✓		
Grain Processing	✓	✓	2015
Metal Fabrication	✓		

Table A2-1 2015 Air Pollutant Emission Inventory (APEI) (cont'd)

APEI Sectors	Point Source (NPRI)[a]	Area Source(Estimated by EC)	Activity Data Used for Estimation
Manufacturing (cont'd)			
Plastics Manufacture	✓		
Pulp and Paper Industry	✓		
Textiles	✓		
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	✓		
Wood Products[d]			
Panel Board Mills	✓	✓	2014
Sawmills	✓	✓	2014
Other Wood Products	✓		
Other Manufacturing Industries	✓	✓	2008
Transportation and Mobile Equipment			
Air Transportation		✓	2014
Heavy-duty Diesel Vehicles		✓	2014
Heavy-duty Gasoline Vehicles		✓	2014
Heavy-duty LPG/NG Vehicles		✓	
Light-duty Diesel Trucks		✓	2014
Light-duty Diesel Vehicles		✓	2014
Light-duty Gasoline Trucks		✓	2014
Light-duty Gasoline Vehicles		✓	2014
Light-duty LPG/NG Trucks		✓	
Light-duty LPG/NG Vehicles		✓	
Marine Transportation		✓	2014
Motorcycles		✓	2014
Off-road Diesel Vehicles and Equipment		✓	2014
Off-road Gasoline/LPG/CNG Vehicles and Equipment		✓	2014
Rail Transportation		✓	2014
Tire Wear and Brake Lining		✓	2014
Agriculture			
Animal Production		✓	2015
Crop Production			
Fertilizer Application		✓	2015
Harvesting		✓	2015
Tillage Practices		✓	2015
Wind Erosion		✓	2015
Fuel Use	✓	✓	2014
Commercial / Residential / Institutional			
Cigarette Smoking		✓	2013
Commercial and Institutional Fuel Combustion	✓	✓	2014
Commercial Cooking		✓	2014
Construction Fuel Combustion		✓	2014
Home Firewood Burning		✓	2015
Human		✓	2015
Marine Cargo Handling	✓		
Residential Fuel Combustion		✓	2014
Service Stations		✓	2015
Other Miscellaneous Sources		✓	2015
Incineration and Waste			
Crematoriums	✓	✓	2015
Industrial and Commercial Incineration		✓	2011
Municipal Incineration	✓	✓	2011
Waste			
Landfills	✓	✓	2014
Residential Waste Burning		✓	2014
Waste Treatment and Disposal	✓		
Water and Sewage Treatment	✓	✓	2015
Other Incineration and Utilities		✓	2009
Paints and Solvents			
Dry Cleaning	✓	✓	2015
General Solvent Use		✓	2015
Printing	✓	✓	2015
Surface Coatings	✓	✓	2015
Dust			
Coal Transportation		✓	2015
Construction Operations		✓	2012
Mine Tailings		✓	2006
Paved Roads		✓	2002
Unpaved Roads	✓	✓	2002
Fires			
Prescribed Forest Burning		✓	2015
Structural Fires		✓	2015
Mercury in Products[e]		✓	2008

Notes:
✓ denotes yes
a. All point source data were obtained from the 2015 NPRI.
b. Point source data consists of facilities located in Atlantic Canada. For other provinces, it consists of area source data.
c. Point source data consists of facilities located in Atlantic Canada and SO2 emissions from Alberta's natural gas processing facilities.
d. Area source PM emissions for Wood Products were estimated by the Forestry Products group of the Environmental Stewardship Branch at ECCC. All other area source pollutants were estimated by PIRD.
e. Emissions from Hg-containing products were calculated as a separate inventory. Emissions are reported under many sectors, such as Iron and Steel Industries, Municipal Incineration, Human and Landfills. All area source Hg in product emissions continues to be estimated and reported under these sectors.

Table A2–2 Estimation Methodologies for Ore and Mineral Industries

Sector/Subsector	
Asphalt Paving Industry	
Description	*Asphalt Paving Industry* consists of emissions released during asphalt concrete (or hot-mix asphalt) manufacturing. Asphalt concrete manufacturing includes the heating and mixing of asphaltic cement with a mixture of graded aggregates. The sector applies to both permanent or portable hot-mix asphalt installations.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Total usage of asphalt by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	Cutback and emulsion asphalt data to calculate VOC emissions from paving process: SNC/GECO Canada (1981) Asphalt usage data from construction sector: Statistics Canada (2015c)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p: Senes Consultants (2008)* *VOCs* from paving: SNC/GECO Canada (1981)
Concrete Batching & Products (under *Cement and Concrete Industry*)	
Description	*Concrete Batching and Products* include emissions produced by activities at concrete batching plants. Concrete is composed essentially of water, cement, fine aggregate (i.e. sand) and coarse aggregate (i.e. gravel, crushed stone or iron blast furnace slag). Concrete batching plants store, convey, measure and discharge these constituents into trucks for transport to a construction site or process, for use in the manufacturing of concrete pipe, concrete blocks, etc.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, Pb, Cd Total usage of cement by province/territory (using national data with a provincial/territory population distribution), is multiplied by pollutant-specific emission factors.
Activity Data	Cement consumption distribution for the provinces: CANMET (1993) Cement production data: NRCan (2015) Population data for the provinces: Statistics Canada (2015b)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, Pb, Cd*: U.S. EPA (1998); U.S. EPA (1998, 2010a) Emission factors for TPM, PM_{10} and $PM_{2.5}$ emitted by loading mixers and loading trucks: (U.S. EPA 2006). PM_{10} and $PM_{2.5}$ emission factors for sand and aggregate transfer are derived from a weighted combination of TPM emission factors, using information from the U.S. EPA's *PM Calculator* database (2010a) (using SCC 30501101): $EF_{PM10}=0.51*EF_{TPM}$ $EF_{PM2.5}=0.15*EF_{TPM}$
Ferrous Foundries (under *Foundries*)	
Description	*Ferrous Foundries* include facilities that produce castings of various types of ferro-alloys, as well as small iron and steel foundries not associated with integrated iron and steel facilities. The types of foundries found in Canada include open ferrous, electric arc and induction foundries.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO Methodology under review. The area source emissions were last estimated for 2011 and have been carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Rock, Sand and Gravel (under *Mining and Rock Quarrying*)	
Description	*Rock, Sand and Gravel* encompasses emissions from rock quarrying, stone processing, and sand and gravel operations. Rock quarrying activities typically include the following sources: overburden removal, drilling in rock, blasting, loading of materials, transporting raw materials by conveyors or haulage trucks, scraping, bulldozing, grading, open storage pile losses, and wind erosion from exposed areas. Stone processing is categorized into three activities, depending on the size of stone required: crushed stone, pulverized stone and building stone. Sand and gravel deposits are quarried, transported to the plant, and then classified and stockpiled. Processing is accomplished by crushing, screening, washing, blending and stockpiling materials according to product specifications. Products are used for road construction, as an aggregate for asphalt and concrete, and for other construction purposes such as fill and mortar sand. Sand is also used in the glassmaking, foundry and abrasives industries.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$ Total quantity of rock, sand and gravel produced by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	F. Menezes, Natural Resources Canada[1] Confidential provincial production values are estimated with population distributions: Statistics Canada (2016b)
Emission Factors (EF)	TPM, PM_{10}, $PM_{2.5}$: EMEP/EEA (2013)

Table A2-2 Summary of Area Source Estimation Methodologies for Industrial Sources (cont'd)

Sector/Subsector	
Silica Production (under *Mining and Rock Quarrying*)	
Description	*Silica Production* applies to silica sand quarrying and processing mainly for the glass and refining and smelting industries. Industrial sand processing operations are similar to those of construction sand production, with dust emissions originating mainly from crushing and screening operations, especially when grinding to very fine particle sizes. Dry or wet screening and air classification may be carried out to achieve the desired size distribution. Both wet and dry methods of dust control are used, and baghouses are commonly used.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$ Total quantity of silica produced by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	F. Menezes, Natural Resources Canada[2] Confidential provincial production values are estimated with population distributions: Statistics Canada (2016b)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$: EMEP/EEA (2013)*

Notes:
1. Menezes F. 2015. Personal communication (email, dated July 23, 2015), Natural Resources Canada.
2. Menezes F. 2016. Personal communication (email, dated July 20, 2016), Natural Resources Canada.

Table A2–3 Estimation Methodologies for Oil and Gas Industry

Sector/Subsector	
Refined Petroleum Products Bulk Storage and Distribution (under *Downstream Petroleum Industry*)	
Description	*Refined Petroleum Products Bulk Storage and Distribution* covers fugitive VOC emissions from bulk distribution terminals and bulk plants. It includes volatile components of fuels that are emitted as fuel moves from the refinery to the end user whenever tanks are filled or emptied or while tanks are open to the atmosphere, be they large above-ground tanks, tank trucks, or railcars. In addition, the subsector includes emissions that occur from the evaporation of fuels spilled during transfer operations. Only fugitive VOC emissions from bulk plants are estimated as an area source.
General Inventory Method	*Pollutant(s) Estimated:* VOCs Emissions are calculated using the gross sales of gasoline for on-road motor vehicles multiplied by emission factors developed by Tecsult (2006)
Activity Data	Gross sales of gasoline for motor vehicles: Statistics Canada (2015a)
Emission Factors (EF)	Study on gasoline vapour recovery in Stage 1 distribution networks in Canada: Tecsult (2006)
Natural Gas Distribution (under *Petroleum Product Transportation and Distribution*)	
Description	*Natural Gas Distribution* includes emissions from all infrastructure used to distribute natural gas to market. Emissions from related construction activities, ancillary structures and operations (buildings, offices, etc.), and mobile sources are included under the Construction Operations, Commercial Fuel Combustion and Mobile Sources (respectively) of the APEI.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3 Emission estimates are generated with a comprehensive inventory and extrapolated based on production data (Environment Canada 2014, CAPP 2005)
Activity Data	Environment Canada 2014b, AER 2016, BCOGC 2016, CAPP 2016, CNLOPB 2016a, CNLOPB 2016b, CNLOPB 2016c, CNLOPB 2016d, CNLOPB 2016e, SK MOE 2016a, SK MOE 2016b, Statistics Canada 2016e, Statistics Canada 2016f
Emission Factors (EF)	Environment Canada 2014
Natural Gas Transmission (under *Petroleum Product Transportation and Distribution*)	
Description	*Natural Gas Transmission* includes emissions from all infrastructure used to transport natural gas. Emissions from related construction activities, ancillary structures and operations (buildings, offices, etc.) and mobile sources are included under the Construction Operations, Commercial Fuel Combustion and Mobile Sources (respectively) of the APEI.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3 Emission estimates are generated with a comprehensive inventory for 2011 and extrapolated based on production data (Environment Canada 2014, CAPP 2005).
Activity Data	Environment Canada 2014, AER 2016, BCOGC 2016, CAPP 2016, CNLOPB 2016a, CNLOPB 2016b, CNLOPB 2016c, CNLOPB 2016d, CNLOPB 2016e, SK MOE 2016a, SK MOE 2016b, Statistics Canada 2016e, Statistics Canada 2016f
Emission Factors (EF)	Environment Canada 2014
Upstream Petroleum Industry	
Description	*The Upstream Petroleum Industry* includes emissions from all infrastructure used to locate, extract, produce, process/treat and transport liquefied petroleum gas (LPG), condensate, crude oil, heavy oil and in situ crude bitumen to market. It also includes emissions from onshore and offshore facilities, as well as drilling and exploration, conventional oil and gas production, open pit mining and in situ oil sands production, natural gas processing and oil transmission. Specifically, this includes the following subsectors: • Accidents and Equipment Failures • Disposal and Waste Treatment • Heavy Crude Oil Cold Production • Light Medium Crude Oil Production • Natural Gas Production and Processing • Oil Sands In-Situ Extraction and Processing • Petroleum Liquids Transportation • Well Drilling/Servicing/Testing Emissions from related construction activities, ancillary structures and operations (buildings, offices, etc.), and mobile sources are included under the Construction Operations, Commercial and Institutional Fuel Combustion, and Transportation and Mobile Sources (respectively) of the APEI.

Table A2-3 Estimation Methodologies for Oil and Gas Industry (cont'd)

Sector/Subsector	
Upstream Petroleum Industry (cont'd)	
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3 Emission estimates are generated with a comprehensive inventory for 2011 and are extrapolated based on production data (Environment Canada 2014, CAPP 2005).
Activity Data	Environment Canada 2014, AER 2016, BCOGC 2016, CAPP 2016, CNLOPB 2016a, CNLOPB 2016b, CNLOPB 2016c, CNLOPB 2016d, CNLOPB 2016e, SK MOE 2016a, SK MOE 2016b, Statistics Canada 2016e, Statistics Canada 2016fIn addition to the extrapolated estimates, the SO_x estimates for Alberta are adjusted to account for regulations that were developed after the model was originally created. The adjustments are made with both historical provincial data and NPRI data. NPRI data for the Atlantic provinces are used in place of the model estimates due to the complete facility coverage for the region. Additionally, extrapolated estimates for the Oil Sands In-Situ Extraction and Processing facilities are reconciled with NPRI data to eliminate double-counting.
Emission Factors (EF)	Environment Canada 2014

Table A2–4 Estimation Methodologies for Manufacturing

Sector/Subsector	
Bakeries	
Description	*Bakeries* release VOCs during the leavening process of industrial baking. Emissions from products leavened by baking powder (used mainly for pastries) are negligible; however, VOCs are released when yeast is used for leavening. Yeast is used nearly exclusively in the production of bread and bread-like pastries.
General Inventory Method	*Pollutant(s) Estimated:* VOCs Total quantity of bread produced by province/territory is multiplied by an emission factor for VOCs.
Activity Data	Bread production values are estimated using: • National bread/bakery product shipment values: Statistics Canada (2016a) • Provincial bread/bakery product shipment values: Statistics Canada (2016c) • *Monthly Consumer Price Index (CPI) for Bread/Rolls and Flatbreads*: Statistics Canada (2016c)
Emission Factors (EF)	Cheminfo (2005) EF_{VOC} = 2.35 kg per tonne of baked goods
Grain Processing	
Description	*Grain* Processing covers emissions from grain elevators. Grain elevators are divided into four groups in the APEI: **Primary elevators** receive grain by truck from producers for either storage or forwarding. These elevators sometimes clean or dry grain before it is transported to terminal or process elevators (U.S. EPA 1985). **Process elevators** are grain processing plants or mills. While the elevator operations of unloading, conveying and storing are performed at these locations, direct manufacturing or processing of grain for use in other products are also carried out (U.S. EPA 1985). **Terminal elevators** dry, clean, blend and store grain for shipment to transfer elevators, other terminals (for export) or process elevators. **Transfer elevators** generally perform the same function as terminal elevators.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Total grain production by province/territory is multiplied by pollutant-specific emission factors through primary elevators, process elevators, transfer elevators and terminal elevators.
Activity Data	Annual grain production data by regions: CGC (2015) Distribution of elevator throughputs: EC (1983) Grain data: annual field crop production data by province (Statistics Canada 2015b, CANSIM, Table 001-0010).
Emission Factors (EF)	TPM, PM_{10}, $PM_{2.5}$: Pinchin Environmental Ltd (2007)
Sawmills, Panel Board Mills and Other Wood Products (under *Wood Products*)	
Description	*Sawmills* cover emissions from facilities that typically produce hardwood and softwood lumber from logs. The process of converting wet logs into dry lumber includes debarking, sawing, drying and planing steps, which all release air emissions. *Panel Board Mills* include emissions from several types of mills, all producing hardwood and softwood-based materials. These include: • National bread/bakery product shipment values: Statistics Canada (2016a) • Veneer and plywood mills • Waferboard mills, consisting primarily of oriented strand board (OSB) mills • Particle board and medium-density fiberboard (MDF) mills *Other Wood Products* encompass emissions from furniture and cabinet manufacturers, wood treating plants, wood pellet mills and Masonite manufacturers. The combustion of various fuels for energy production or waste disposal, notably wood residues, natural gas, liquefied petroleum gas (LPG) and fuel oil, is a common practice at wood products facilities. Significant amounts of air pollutant emissions result from combustion in this sector.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Sawmills and Panel Board Mills: • *TPM, PM_{10} and $PM_{2.5}$*: Estimation methodology makes use of the NPRI point source data in addition to a number of production indicators to estimate the PM of the facilities not reporting to the NPRI (Natural Resources Canada, Forest Products Association of Canada and the Composite Panel Association, corporate website information, annual reports, Resource Information Systems Inc. publications, Madison publications and occasional discussion with industry representatives); • *All other pollutants*: Production rate estimates, hog fuel combustion data, and other fuel use data are used to estimate the area source emissions of the remaining pollutants (Meil et al. 2009; U.S. EPA 2014a).

Table A2-4 Summary of Area Source Estimation Methodologies for Mobile Sources (cont'd)

Sector/Subsector	
Sawmills, Panel Board Mills and Other Wood Products (con'd)	
General Inventory Method (cont'd)	The area source emissions were last estimated for 2014 and have been carried forward to 2015. Other Wood Products: *All pollutants*: Area source emissions are not calculated for this subsector. Rather, emissions are represented by point source data reported to the NPRI by the facilities themselves. The area source emissions were last estimated for 2014 and have been carried forward to 2015.
Activity Data	NPRI 2015 data (EC 2015a) and data sources for facilities not reporting to the NPRI, including: • Natural Resources Canada: *Status of Energy Use in the Canadian Wood Products Sector* (Meil et al. 2009) • Forest Products Association of Canada annual reports (proprietary reports) • Environment and Climate Change Canada's Forestry Products Group • *RISI North American Wood Panels and Engineered Wood Products Capacity Report* (RISI 2013) • *Madison's 2014 Online Lumber Directory* (Madison 2014) • Verbal communications with industry representatives (unpublished)
Emission Factors (EF)	Sawmills: U.S. EPA (2012a) Plywood manufacturing, particle board, oriented strand board: U.S. EPA (1995b) Fuel combustion: Meil et al. (2009); U.S. EPA (1992, 1995b, 2014a)

Table A2–5 Estimation Methodologies for Transportation and Mobile Equipment

Sector/Subsector	
Air Transportation	
Description	*Air Transportation* covers emissions from aircraft but not airport support equipment (captured as off-road applications).
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, B(a)p, B(b)f, B(k)f, I(cd)p Aircraft-specific activity (landing/take-offs) by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	The emission estimates from Air Transportation are calculated using Aircraft Movement Statistics (Statistics Canada 2015d), a database developed by Statistics Canada based on flight-by-flight data, recorded at airport towers operated by NAV Canada post-1996 and Transport Canada pre-1996. The data are of the highest resolution available and are the only known such aircraft movement data within Canada.
Emission Factors (EF)	For aircraft using turbo aviation fuel, hydrocarbon (HC), CO and NO_x emission factors are taken from the International Civil Aviation Organization (ICAO) databank (2009) or Hagstrom (2010) databank for landing/take-offs (LTO), and from EMEP/CORINAIR (2006) for the cruise stage. Emission factors are mapped to representative aircraft, based on engine characteristics. SO_2 is estimated as a sulphur balance, using data from the *Sulphur In Liquid Fuels* reports (EC 2013). The NH_3 emission factor is taken from Coe et al. (1996). Emissions of PM during LTO are based on a paper by Wayson et al. (2009), which relates the smoke number from the ICAO databank to an emission factor in g/kg fuel consumed. For aircraft using aviation gasoline, VOC, CO, PM_{10} and NO_x emission factors are taken from the Federal Office of Civil Aviation (FOCA 2007). No quantification of these emissions is performed at the cruise stage, due to a lack of emission factors. SO_2 is estimated as a sulphur balance, using data from the *Sulphur In Liquid Fuels* reports (EC 2013). The NH_3 emission factor is taken from Coe et al. (1996). $PM_{2.5}$ is calculated as 69% of PM_{10} as per U.S. EPA (2005a). Lead is estimated as a lead balance, using the U.S. EPA's 5% retention (U.S. EPA 2013). TPM is equal to PM_{10} (U.S. EPA 2005a). Emissions of non-standard CACs are estimated as a ratio to PM_{10} or HC/VOCs based on speciation profiles from the U.S. EPA (U.S. EPA 2005a).
Marine Transportation	
Description	*Marine Transportation* covers emissions from commercial marine vessels, but not recreational marine engines (captured as off-road applications).
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Vessel-specific activity (movements) is multiplied by pollutant-specific emission factors.
Activity Data	Vessel-specific movements: SNC-Lavalin Environment (2012) Due to the unavailability of activity data, emission estimates are calculated using interpolations for the years 2011 through 2014.
Emission Factors (EF)	Emission factors originate from a variety of sources and are distinct per vessel type and dead weight tonnage, engine size and type, fuel type, and movement component (underway, anchor or berth). For this iteration of the APEI, the *Marine Emission Inventory Tool* (MEITv4.3.1) was used. Emission factor sources, application and summaries are provided in section 3.3 of SNC-Lavalin Environment (2012). MEIT natively outputs hydrocarbon (HC), but not VOCs. An HC-to-VOC conversion rate is taken from U.S. EPA (2010c). Emissions of non-standard CACs are estimated as a ratio to PM_{10} or HC/VOC, based on speciation profiles from the U.S. EPA (2005a).
On-road Vehicles	
Description	*On-road Vehicles* include: *Heavy-duty diesel vehicles, Heavy-duty gasoline trucks, Light-duty diesel trucks, Light-duty diesel vehicles, Light-duty gasoline trucks, Light-duty gasoline vehicles, Propane and natural gas vehicles, Motorcycles,* and *Tire Wear & Brake Lining.*
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Vehicle-specific activity (vehicle kilometres travelled) is multiplied by pollutant-specific emission factors in the MOVES model (version $MOVES_{2014}$ was used for this submission). Refuelling VOC emissions are included in under Service Stations.
Activity Data	Data on the vehicle fleet (counts), defined by fuel type, model-year and gross vehicle weight rating, originate from DesRosiers Automotive Consultants (DAC 2014) and R. L. Polk & Co. (Polk & Co. 2013) for light- and heavy-duty vehicles, respectively. Motorcycle populations originate from the publication *Road Motor Vehicle, Trailer and Snowmobile Registration (registrations)* (Statistics Canada 2013). The *Annual Industry Statistics* report (MMIC 2013) is used to estimate the age distribution of motorcycles by model year which is applied to motorcycle populations obtained from Statistics Canada. The actual activity level is vehicle kilometres travelled (VKT). To arrive at estimates of VKT, vehicle counts are multiplied by mileage accumulation rates from Stewart-Brown Associates (Stewart-Brown 2012).
Emission Factors (EF)	Emission factors for on-road vehicles are embedded in the MOVES model. More information on MOVES is available online at www.epa.gov/otaq/models/moves/, in the U.S. EPA user guides (U.S. EPA 2012b, 2014b) and in U.S. EPA technical guidance document (U.S. EPA 2010b).

Table A2-5 Estimation Methodologies for Transportation and Mobile Equipment (cont'd)

Sector/Subsector	
Off-road Vehicles and Equipment	
Description	*Off-road Vehicles and Equipment consists of Off-road diesel vehicles* and *equipment and Off-road gasoline/LPG/CNG vehicles* and *equipment*
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, B(a)p, B(b)f, B(k)f, I(cd)p Application-specific activity (hours-of-use, load factor) is multiplied by pollutant-specific emission factors in the NONROAD model.
Activity Data	Data on the applications (vehicle/engine counts, load factor, hours-of-use), defined by fuel type, model year and source classification code, originate from EC (2011). Off-road gasoline usage data: (ECCC 2016)
Emission Factors (EF)	Emission factors for off-road applications are embedded in the NONROAD model. For this iteration of the APEI, NONROAD version 2012C was used. This version is based on the U.S. EPA's $NONROAD_{2008}$, and modified by Environment and Climate Change Canada to exploit detailed activity data. Model operation is conducted following the user guide for $NONROAD_{2005}$/2008 (U.S. EPA 2005b), given that the functionality of the models is the same. Emissions of non-standard CACs are estimated as a ratio to PM_{10} or HC/VOC, based on speciation profiles in the $SPECIATE_4$.2 database (U.S. EPA 2008). More information on the NONROAD model is available online at www.epa.gov/otaq/nonrdmdl.htm.
Rail Transportation	
Description	*Rail Transportation covers emissions from the fuel consumed by locomotive engines.*
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Railway activity (fuel consumption) is multiplied by pollutant-specific emission factors.
Activity Data	Fuel consumption data: Statistics Canada (2015c)
Emission Factors (EF)	In 2013, the Rail Association of Canada (RAC) signed a Memorandum of Understanding (MOU) on locomotive emissions with Transport Canada for the period 2011–2015. Under the terms of the MOU, the RAC provides multiple datasets on the industry, including emission factors. HC, CO, SO_2, PM_{10} and NO_x emission factors are taken from RAC (2013). HC emissions are converted to VOCs using the method in U.S. EPA (2011). Ratios of PM_{10} to $PM_{2.5}$ and TPM are taken from the U.S. EPA (U.S. EPA 2005a). The emission factor for NH_3 is taken from Coe et al. (1996). With the exception of dioxins/furans, emissions of non-standard CACs are estimated as a ratio to PM_{10} or HC/VOCs, based on speciation profiles from U.S. EPA (2011). The dioxin/furan emission factor (0.54 ng/L) is taken from U.S. EPA (2006).

Table A2–6 Estimation Methodologies for Agriculture

Sector/Subsector	
Animal Production	
Description	*Animal Production* reports emissions from the volatilization of NH_3 from nitrogen in manure, particulate matter that is released from feeding and housing, and non-methane volatile organic compounds (NMVOCs) that are released during livestock feeding, housing and manure management. Ammonia volatilization is a chemical process that occurs when manure is excreted or stored without a cover. Once excreted, manure moves through a number of stages until it is eventually cycled back to farm fields. Ammonia volatilization occurs at each stage of this cycle, including animal housing, transport to long-term storage, storage, and application of manure to the field. Livestock production results in primary PM emissions as a result of the aerial transport of feed particles, feather fragments, fecal material, skin debris or dander, animal wastes, mould spores, bacteria, fungus, litter fragments, etc. Ventilation systems in livestock buildings are required for air exchange and, as a result, a portion of the PM in confined livestock buildings will be emitted into the atmosphere via the ventilation system. NMVOC emissions from livestock production are the result of biological processes that partially break down feed during storage and digestion. Emissions from excreted manure occur during all stages of the manure management cycle. Sites of emission therefore include silage stores, livestock housing, manure stores, and agricultural fields on which manure is applied or that are used for grazing.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, NH_3, NMVOCs The methodologies for ammonia emissions are developed by Environment and Climate Change Canada in collaboration with Agriculture and Agri-Food Canada (AAFC) through a national research project: the National Agri-Environmental Standards Initiative (NAESI). Methods describing the estimates of NH_3 emissions from Canadian livestock are published for all major livestock categories (dairy, non-dairy, swine and poultry). Details on parameters used and animal category-specific methodologies are available from the following publications: Sheppard and Bittman (2010, 2012); and Sheppard et al. (2007a, 2007b, 2009a, 2009b, 2010a, 2011a; 2011b). Methodologies for minor animals, such as horses, goats, fur-bearing animals (mink, fox), wild boars, deer, elk, rabbit and poultry, were taken from Battye et al. (1994). The methodologies for emissions of particulate matter from livestock production are developed by AAFC for publication in the National Agri-Environmental Health Analysis and Reporting Program (NAHARP), published every five years with the Agricultural Census. The method is consistent with the European Monitoring and Evaluation Programme (EMEP)/Core Inventory of Air Emissions in Europe (CORINAIR) Guidebook (EMEP/CORINAIR 2002), but uses country-specific emission factors. Methodologies are published in Pattey and Qiu (2012) and Pattey et al. (2015). The methodology for estimating NMVOC emissions of was based on tier 1 methodology outlined in the 2013 European Monitoring and Evaluation Programme/European Environment Agency Air Pollutant Emission Inventory Guidebook *(EMEP/EEA, 2013)*.
Activity Data	Annual cattle, sheep and swine populations are calculated as the simple mean of semi-annual or quarterly surveys (Statistics Canada 2016f, 2016g). These smaller surveys are corrected to the Census of Agriculture (COA) population estimates that are collected every 5 years to ensure the accuracy of the estimates. The populations of other livestock, such as horses, goats, bison, llamas and alpacas, deer and elk, wild boars, rabbits, and poultry, are taken from the COA exclusively, and annual populations are developed by linear interpolation in order to avoid large changes in census years. Where populations for certain alternative livestock animal categories were not available in the COA, values were held constant, or extrapolated back to zero. The breeding mink and fox population estimates were taken from an annual Statistics Canada survey titled Supply and Disposition of Mink and Fox on Fur Farms (Statistics Canada 2016h),. Rabbit populations were taken from responses to the COA as provided on the AAFC Red Meat Market website (AAFC 2016).
Emission Factors (EF)	*Ammonia:* Ammonia emission factors are a weighted average of a variety of different emission fractions that occur during the stages of the manure and animal production cycle. The input to the emission factor equation originates from a combination of the Livestock Farm Practices Survey (LFPS), which defines feed distribution to and consumption by animals throughout the year, and generic parameters derived from scientific literature or expert opinion. This information is distributed spatially across Canada by ecoregion.

Table A2-6 Estimation Methodologies for Agriculture (cont'd)

Sector/Subsector	
Animal Production (cont'd)	
Emission Factors (EF)	Animal populations are reassigned to a matrix of animal housing and manure management systems based on their relative proportion in the overall farm population. The fractions of NH_3 emitted at each step in the manure cycle are taken in part from the European Monitoring and Evaluation Programme (EMEP)/Core Inventory of Air Emissions in Europe (CORINAIR) Guidebook (EMEP/CORINAIR 2002) and in part from Canadian studies. The resulting weighted emission factors are applied to populations of animal subcategories taken from census data at the ecoregion spatial scale. Model to calculate NH_3 emissions: Sheppard et al. (2010a) *Particulate Matter:* Total particulate matter (TPM) emission factors for poultry are taken from Van Heyst (2005) and Van Heyst and Roumeliotis (2007). Emission factors for cattle and swine are average values from Takai et al. (1998) and Seedorf (2004). In the case of PM_{10} and $PM_{2.5}$, emissions are estimated from TPM emission factors multiplied by 0.45 and 0.1 to produce PM_{10} and $PM_{2.5}$ emission factors, respectively. Average animal weights are used to convert emission factors in the form of g d^{-1} AU^{-1} to units of kg $head^{-1}$ $year^{-1}$ The emission factors for cattle are also assigned to the other animal types by assuming that the emission factors per animal unit for sheep, goats, bison, llamas, alpacas and horses are the same as those for cattle. Average body weight of cattle are consistent with information provided by Boadi et al. (2004) and with weight corrections for cattle according to the methodology outlined in the *National Inventory Report: 1990–2013, Greenhouse Gas Sources and Sinks in Canada* (EC 2015b). All other animal weights were consistent with values used to estimate nitrogen excretion in EC (2015b). Currently no emissions are estimated for mink, fox, wild boars, deer, elk or rabbit. *Non-methane volatile organic compounds*: The emission factors for all animals were taken from Table 3-3 of EMEP/EEA (2013). For livestock categories where a choice of emissions factors was provided, the non-silage emission factor was selected, except for dairy cows and beef cattle in feedlots where the silage emission factor was used. A weighted emission factor for beef cattle was calculated using the fraction of time spent during each stage of production according to Boadi et al. (2004).
Fertilizer Application (Under of *Crop Production*)	
Description	*Fertilizer Application* includes emissions emitted when synthetic nitrogen fertilizers are applied for annual and perennial crop production.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, NH_3 *Ammonia*: The method is a simplified version of the approach adopted by Sheppard et al. (2010b) for application on an annual time step. The methodology uses a regression model developed by Bouwman et al. (2002) and derived NH_3 emission factors, taking into account the most important parameters influencing emissions from synthetic nitrogen fertilizer application, based on a meta-analysis of scientific literature. *Particulates*: Methodology is under review.
Activity Data	Data on the types of nitrogen fertilizer used on farms are published by Statistics Canada (2015e). *Areas of seeded annual and perennial crops*: Statistics Canada (2015d– - CANSIM Table 001-0010 Estimated areas, yield, production and average farm price of principal field crops, in metric units, annual, 1990 to 2015. Soil properties, including pH and cation exchange capacity, are included in calculations by using soil polygon information from a national-scale spatial database describing the types of soils associated with landforms (available online at www.sis.agr.gc.ca/cansis/nsdb/slc/index.html).
Emission Factors (EF)	Ammonia emission factors are calculated using the multiple linear regression equation from Bouwman et al. (2002). The approach uses different regression parameters for synthetic nitrogen fertilizer types, method of nitrogen application, crop type, and soil pH and cation exchange capacity. A matrix of emission factors for each combination of these conditions occurring across Canada is derived. The average provincial and national emission factors are weighted averages of the relative proportion of each combination of fertilizer type and fertilizer application practice on different soil types in different ecodistricts across the country. TPM, PM_{10} and $PM_{2.5}$ methodology is under review.
Harvesting (under *Crop Production*)	
Description	Agricultural harvest activities entrain particulate matter into the air. Particulate matter generated from agricultural harvesting, also known as grain dust, includes grain and dry plant particles, moulds, pollen and spores, silica, bacteria, fungi, insects and possibly pesticide residues. These emissions are generated by vehicles traveling over the soil or by the processing of plant materials by agricultural equipment.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$ Particulate matter emissions from agricultural harvest operations are computed by multiplying an emission factor and an activity factor relating emissions to the area harvested.
Activity Data	Activity data for PM emission estimates from crop harvesting rely on a combination of data from the Census of Agriculture and area estimates based on Earth Observation data. Activity data on areas of major field crops at an ecodistrict level from 1990 to 2015 are consistent with the data reported in the *Agriculture* and the *Cropland remaining Cropland category of the Land Use, Land-use Change and Forestry sector* for the *National Inventory Report: 1990–2015, Greenhouse Gas Sources and Sinks in Canada* (EC 2015).
Emission Factors (EF)	There are no emission factors for agricultural harvest in Canada. The PM_{10} emission factors proposed by CARB (2003) are used to calculate PM emissions from crop harvest. Where the specific emission factors for some crops are not available from CARB (2003), the emission factors for these crops are based on an approximation from the closest representation (Pattey and Qiu 2012).
Tillage Practices (under *Crop Production*)	
Description	Tillage practices produce PM emissions from mechanical disturbances such as seeding, seed bed preparation and cultivation.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Agricultural tillage is the common method used by farmers to prepare land for seeding and weed control. Particulate matter emissions are generated from airborne soil particles during tillage operations due to the mechanical disturbance of the soil surface. Particulate matter emissions from agricultural tillage operations are proportional to the area tilled. They are also dependent on the type of tillage practice as well as the number of tillage events per year. The calculations are described in more detail in Pattey and Qiu (2012). The number of tillage events per year is dependent on tillage practices. There are fewer tillage events per year for conservation tillage compared to conventional tillage. Therefore, a reduction in particulate matter emissions from reduced tillage and no-till is observed.

Table A2-6 Estimation Methodologies for Agriculture (cont'd)

Sector/Subsector	
Tillage Practices (cont'd)	
Activity Data	Activity data for PM emission estimates from tillage practices rely mainly on a combination of data from the Census of Agriculture and area estimates based on Earth Observation analyses. Activity data on areas of major field crops, including summerfallow, and on tillage practices at an ecodistrict level from 1990 to 2015 are consistent with the data reported in the Cropland remaining *Cropland* category of the *Land Use, Land-use Change and Forestry* sector for the *National Inventory Report: 1990–2015, Greenhouse Gas Sources and Sinks in Canada* (EC 2015). Information on the number of tillage events per year for crop type and tillage practices is taken from soil cover indicators (Huffman et al. 2012).
Emission Factors (EF)	Emission factors for tillage practices are calculated using the method in described in U.S. EPA (1985).
Wind Erosion (Under of *Crop Production*)	
Description	*Wind erosion occurs when wind blows across exposed agricultural land resulting in PM emissions from the entrained particles.*
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Wind erosion emissions from agricultural lands are calculated by multiplying the cultivated cropland area by an emission factor.
Activity Data	Activity data for PM emission estimates from wind erosion rely mainly on a combination of data from the Census of Agriculture and area estimates based on Earth Observation data. Activity data on areas of major field crops, including summerfallow, and on tillage practices at an ecodistrict level from 1990 to 2015 are consistent with the data reported in the *Cropland remaining Cropland* category of the *Land Use, Land-use Change and Forestry* sector for the *National Inventory Report: 1990–2015, Greenhouse Gas Sources and Sinks in Canada* (EC 2015).
Emission Factors (EF)	The PM emission factor for wind erosion is calculated using the wind erosion equation (Woodruff and Siddoway 1965), but considers the impact of soil and crop cover on PM emissions (Huffman et al. 2012). The emission factor for windblown PM emissions from agricultural lands is calculated using the methodology described in Pattey and Qiu (2012).
Fuel Use	
Description	Agriculture – Fuel Use includes emissions resulting primarily from external combustion sources used for space/water heating and crop drying.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Emissions are calculated for 10 types of fuel: natural gas, natural gas liquids, kerosene and stove oils, light fuel oil, heavy fuel oil, Canadian bituminous coal, sub-bituminous coal, lignite coal, anthracite coal and imported coal. Total usage by fuel type and province/territory is multiplied by pollutant-specific emission factors.
Activity Data	Statistics Canada (2015c)
Emission Factors (EF)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO: U.S. EPA (1998) (Emission factors are chosen to represent the typical type of combustion equipment for each fuel type.) TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO for natural gas fuel: U.S. EPA (2004a) Sulphur contents of liquid fuels: EC (2010) Sulphur contents of coal: CEA (2002) NH_3: Battye et al. (1994); Coe et al. (1996) Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f: CARB (2005); U.S. EPA (1998, 2003, 2004a) (Emission factors are selected to represent the typical type of combustion equipment for each fuel type.)

Table A2–7 Estimation Methodologies for Commercial/Residential/Institutional

Sector/Subsector	
Cigarette Smoking	
Description	Two sources of emissions are included under *Cigarette Smoking*: 1. Mainstream cigarette smoke, which is directly exhaled by the smoker 2. Sidestream smoke, which is directly released from burning cigarettes
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f The average number of cigarettes smoked per year by the smoking population by province/territory is calculated and then multiplied by pollutant-specific emission factors.
Activity Data	Health Canada (2015); Statistics Canada (2014c) Due to the unavailability of activity data, emission estimates for 2014 were carried over for 2015 and estimates for 1998 were calculated using linear interpolation
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$*: Ott et al. (1996) *VOCs*: Wallace et al. (1987) *CO*: Ott et al. (1992) *NH_3*: Roe et al. (2004) *Hg, Cd, Pb:* Gray and Boyle (2002) *Dioxins/furans*: U.S. EPA (2004b) *B(a)p, B(b)f, B(b)k*: Ding et al. (2005)
Commercial and Institutional Fuel Combustion, Construction Fuel Combustion and Residential Fuel Combustion	
Description	*Commercial and Institutional Fuel Combustion, Construction Fuel Combustion and Residential Fuel Combustion* include emissions resulting primarily from external combustion sources used for space/water heating and material heating. Commercial establishments, health and educational institutions, government/public administration facilities, and residences all fall under these categories, in addition to construction sites.

Table A2-7 Estimation Methodologies for Commercial/Residential/Institutional (cont'd)

Sector/Subsector	
Commercial and Institutional Fuel Combustion, Construction Fuel Combustion and Residential Fuel Combustion (cont'd)	
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Emissions are calculated for 10 types of fuel: natural gas, natural gas liquids, kerosene and stove oils, light fuel oil, heavy fuel oil, Canadian bituminous coal, sub-bituminous coal, lignite coal, anthracite coal and imported coal. Total usage by fuel type and province/territory is multiplied by pollutant-specific emission factors.
Activity Data	Statistics Canada (2015c)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO:* U.S. EPA (1998) (Emission factors are chosen to represent the typical type of combustion equipment for each fuel type.) *TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO* for natural gas fuel: U.S. EPA (2004a) *Sulphur contents of liquid fuels*: EC (2010) *Sulphur contents of coal*: CEA (2002) *NH_3*: Battye et al. (1994) ; Coe et al. (1996) *Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f*: CARB (2005); U.S. EPA (1998, 2003, 2004a) (Emission factors are selected to represent the typical type of combustion equipment for each fuel type.)
Commercial Cooking	
Description	*Commercial Cooking* includes emissions from cooking meat and French fries in commercial operations that are classified under five foodservice types: ethnic, fast food, family, seafood, and steak & BBQ. The types of meat considered include beef steak, hamburger, poultry with skin, poultry without skin, pork, seafood and other. Five types of commercial cooking equipment are taken into account including: chain driven charbroilers, underfired charbroilers, deep-fat fryers, flat griddles and clamshell griddles. The commercial operations inventoried are defined as all commercial foodservice points of distribution that are open to the public, offer prepared meals and snacks for consumption on/off-premises, and operate in a fixed location.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, VOCs, CO, B(a)p Commercial Meat Cooking (1999 to 2014): 1. Determined the number of restaurants in each province/territory that were classified as ethnic, fast food, family, seafood, steak & BBQ. 2. Determined the fraction of restaurants with commercial cooking equipment (i.e. chain driven charbroilers, underfired charbroilers, deep-fat fryers, flat griddles and clamshell griddles), the average number of units of each type of equipment per restaurant, and the average amount of food cooked (i.e. steak, hamburger, poultry with skin, poultry without skin, pork, seafood and other) on each type of equipment. 3. Applied pollutant-specific emission factors to each type of food for each type of commercial cooking equipment to get the final emission estimates. Commercial Meat Cooking (1990 to 1998): Emission estimates for 1999 were back-casted to 1990 using the gross domestic product (GDP) for NAICS [72]: Accommodation and Food Services (Statistics Canada 2007). Commercial Cooking of French Fries (1990 to 2014): The annual national consumption rate of frozen fries was multiplied by the annual provincial/territorial population and by a VOC-specific emission factor. All Commercial Cooking (2015): Emission estimates for 2014 were carried forward to 2015 since 2015 activity data were not available.
Activity Data	Commercial Meat Cooking (1999 to 2014): Activity data were estimated using: • Annual restaurant census for Canada: ReCount Database (The NPD Group 2016) • Statistics on the prevalence of commercial cooking equipment, for the five restaurant types (E.H. Pechan & Associates 2003) • Statistics on the average number of pounds of meat cooked on each type of equipment per week for the seven types of meat (E.H. Pechan & Associates 2003) Commercial Cooking of French Fries (1990 to 2014): Activity data were estimated using: • Provincial/territorial population data (Statistics Canada 2016b) • Annual Canadian consumption rates of frozen fries (USDA Foreign Agricultural Service 2015) • Assumed 80% of French fries were purchased in restaurants (E.H. Pechan & Associates 2003)
Emission Factors (EF)	*Commercial Meat Cooking:* *TPM, PM_{10}, $PM_{2.5}$, VOCs, CO, B(a)p*: E.H. Pechan & Associates (2003) *Commercial Cooking of French Fries:* *VOCs*: EF = 0.21 g/kg (E.H. Pechan & Associates 2003)
Home Firewood Burning	
Description	*Home Firewood Burning* encompasses emissions from wood burned in urban and rural homes for primary and supplementary heating, as well as for aesthetics and hot water, in both main and secondary residences. This covers household wood-burning devices such as wood-burning fireplaces, wood stoves, pellet stoves, outdoor boilers and a variety of other devices used in limited quantities, such as wood-fired cooking stoves.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p The quantity of wood burned by device type and province is multiplied by pollutant-specific emission factors by device type.
Activity Data	Activity data from Canadian Facts (1997, 2006) and TNS Canada (2012) are converted from volume to mass utilizing the reported wood species burnt. Wood consumption is interpolated and extrapolated from the three points (1996, 2006 and 2012) to the time series using statistical information on household wood-burning devices from Statistics Canada (1997, 2010) and Tracey (2014).
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3*: Gulland (2000) *Pb, Cd, Hg, B(a)p, B(b)f, B(k)f*: U.S. EPA (1995b) *Dioxins/furans*: EC (2000)
Human	
Description	Sources of emissions in the *Human* sector include respiration and perspiration.
General Inventory Method	*Pollutant(s) Estimated*: NH_3 Annual population data by province/territory are multiplied by an NH_3 emission factor.

Table A2-7 Estimation Methodologies for Commercial/ Residential/ Institutional (cont'd)

Sector/Subsector	
Human (cont'd)	
Activity Data	Statistics Canada (2015b)
Emission Factors (EF)	Roe et al. (2004) $EFNH_3$ = 0.0168 kg per person-year
Service Stations	
Description	*Service Station* estimates covers fugitive VOC emissions from fuel transfers and storage from refined petroleum products retail, as well as fugitive emissions from the refuelling of on- and off-road vehicles. Off-road refuelling emissions include all non-vehicle gasoline usage (lawn mowers, snow blowers, etc.).
General Inventory Method	*Pollutant(s) Estimated:* VOCs *Refined petroleum products retail* Emissions are calculated using gasoline usage data multiplied by emission factors for underground tank filling and breathing. For British Columbia and Ontario, emissions from service stations are broken down into regulated versus unregulated areas. An emission control efficiency of 50% is applied to the filling of underground storage tanks in regulated areas in British Columbia and Ontario. The rest of the country is assumed to have no control efficiency. *Off-road refuelling* Off-road refuelling emissions are calculated using off-road gasoline usage data multiplied by an emission factor for uncontrolled vehicle refuelling. *On-road refuelling* On-road refuelling estimates are produced using the MOVES model. This year's estimates were made using $MOVES_{2014}$. Vehicle-specific activity (vehicle kilometres travelled) is multiplied by pollutant-specific emission factors.
Activity Data	*Refined petroleum products retail*: Gross sales of gasoline for motor vehicles: (Statistics Canada 2015b) *Off-road refuelling*: Off-road gasoline usage data (ECCC 2016) *On-road refuelling*: Data on the vehicle fleet (counts), defined by fuel type, model-year and gross vehicle weight rating, originate from DesRosiers Automotive Consultants (DAC 2014) and R. L. Polk & Co. (Polk & Co. 2013) for light- and heavy-duty vehicles, respectively. Motorcycle populations originate from the *Road Motor Vehicle, Trailer and Snowmobile Registration* database (Statistics Canada 2013).. The Annual Industry Statistics report (MMIC 2013) is used to estimate the age distribution of motorcycles by model year which is applied to motorcycle populations obtained from Statistics Canada. The actual activity level is vehicle kilometres travelled (VKT). To arrive at estimates of VKT, vehicle counts are multiplied by mileage accumulation rates from Stewart-Brown Associates (Stewart-Brown 2012).
Emission Factors (EF)	*Refined petroleum products retail and off-road refuelling*: Evaporative emissions from gasoline service station operations (U.S. EPA 2008) *On-road refuelling*: Emission factors for on-road vehicles are embedded in the MOVES model. More information on MOVES is available online at www.epa.gov/otaq/models/moves/, in the U.S. EPA user guides (U.S. EPA 2012b, 2014b) and in the U.S. EPA technical guidance document (U.S. EPA 2010b).
Other Miscellaneous Sources	
Description	Emissions included under *Other Miscellaneous Sources* are from infant-diapered waste.
General Inventory Method	*Pollutant(s) Estimated:* NH_3 An annual estimate of the population aged 0-3 years by province/territory is multiplied by an NH_3 emission factor.
Activity Data	Number of children aged 0-3 years by province/territory: Statistics Canada (2015a).
Emission Factors (EF)	Roe et al. (2004) EF_{NH3} = 0.0136 kg of NH_3/person-year

Table A2–8 Estimation Methodologies for Incineration and Waste

Sector/Subsector	
Crematoriums	
Description	*Crematoriums* cover emissions from the combustion of caskets and human bodies. The combustion of fuel associated with the operation of a crematorium furnace or crematory fire is excluded from the sector. Fuel combustion emissions from cremations are captured under the Commercial Fuel Combustion sector.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB Number of human cremations per year by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	Area source activity data is obtained from an annual report produced by the Cremation Association of North America (CANA): the Annual CANA Statistics Report 2012: Executive Summary (CANA 2013) and the draft Annual CANA Statistics Report (CANA 2016). Due to the unavailability of data, emission estimates are calculated using linear interpolation for all provinces/territories for the year 2001, and as well as Quebec for the years 2002–2007.
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$*: U.S. EPA (2014a) *VOCs, HCB*: EMEP/EEA (2013) *SO_x, NO_x*, CO: EMEP/EEA (2009) *Hg, Cd, Pb*: U.S. EPA (2014a) *Dioxins/furans*: U.S. EPA (2014a) *B(a)p, B(b)f, B(b)k, I(cd)p*: U.S. EPA (2014a) An average weight per body and casing of approximately 150 lbs. is assumed.
Industrial and Commercial Incineration	
Description	*Industrial and Commercial Incineration* involves the incineration of waste from industrial, commercial and institutional facilities. Emissions from the combustion of wood waste are included in Pulp and Paper Industry, Wood Products or Electric Power Generation.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, dioxins/furans Methodology under review. The area source emissions were last estimated for 2011 and were carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Municipal Incineration	
Description	The *Municipal Incineration* sector involves the incineration of domestic waste, as well as non-hazardous and industrial waste.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, dioxins/furans Methodology under review. The area source emissions were last estimated for 2011 and were carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Landfills (under *Waste*)	
Description	*Landfills* include emissions from disposal sites used for a variety of wastes, such as domestic, commercial, liquid and non-hazardous solid industrial wastes as well as sewage sludge. Disposal sites may be designated to receive only one or many of these waste materials. Materials deposited into landfills are covered daily with soil to prevent scattering of litter by wind, scavenging by animals, and odours. As a result, PM emissions are due to wind erosion, the movement of heavy vehicles and the dumping of waste. The other main emissions from landfills include CH_4 and CO_2, with associated VOCs found in small concentrations in the fugitive landfill gas.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, VOCs The quantity of waste landfilled for each province/territory is applied to PM emission factors. VOC emissions are calculated as a concentration of the total fugitive landfill gas released, derived from CH_4 emissions.
Activity Data	Data for both provincial quantities of waste sent to landfills and CH_4 emissions from landfills were obtained from the Waste and Open Sources Section of the Pollutant Inventories and Reporting Division of Environment and Climate Change Canada.[1] CH_4 emissions were estimated using the Landfill Air Emissions Estimation model, which is based on the Scholl Canyon model (U.S. EPA 1990)
Emission Factors (EF)	*TPM*: BCMELP (1997) *PM_{10}, $PM_{2.5}$*: GVRD and FVRD (2003). The $EFPM_{10}$ is calculated using a distribution percentage of 8% of the EFTPM. The $EFPM_{2.5}$ is calculated using a distribution percentage of 2% of the EFTPM. *VOCs*: U.S. EPA (1995a). The default concentration of VOC in landfill gas is 835 ppmv.
Residential Waste Burning (under *Waste*)	
Description	Emissions from *Residential Waste Burning* are related to on-site burning of residential waste materials in backyard barrels or to open-pit burning in rural areas.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB Methodology under review. The area source emissions were last estimated for 2014 and were carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.

Table A2-8 Estimation Methodologies for Incineration and Waste (cont'd)

Sector/Subsector	
Other Incineration and Utilities	
Description	*Other Incineration and Utilities* applies to emissions from sewage sludge incineration and other small incinerators.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans Methodology under review. The area source emissions were last estimated for 2011 and were carried forward to 2015
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.

Notes:
1. Palmer C. 2015. Personal communication (email from Palmer C dated July 21, 2016). Pollutant Inventories and Reporting Division, Environment and Climate Change Canada.

Table A2–9 Estimation Methodologies for Paints and Solvents

Sector/Subsector	
Dry Cleaning, General Solvent Use, Printing and Surface Coatings	
Description	*Dry Cleaning* includes emissions from companies that provide dry cleaning of fabric and leather items. *General Solvent Use* consists of emissions from a broad range of applications occurring in residential, commercial, industrial and institutional locations. Industrial applications include uses such as degreasing, adhesives and sealants, aerosols, blowing agents and resin manufacturing. The use of consumer and commercial products, pesticides and personal care products is also included under General Solvent Use. *Printing* covers emissions from the manufacturing or use of printing inks. The sector consists of flexographic, gravure, letterpress, lithographic and other printing. *Surface Coatings* encompasses emissions from a broad range of applications and industries, including individuals and companies engaged in the manufacturing or use of paints and coatings.
General Inventory Method	*Pollutant(s) Estimated:* VOCs The analysis methodology used is largely a "top-down" national mass balance approach that involves gathering statistical activity data on the production, distribution, end-use patterns and disposal of VOC-containing products, and then building relationships between stages. However, more detailed data on solvent quantities and practices are collected from a subset of solvent and formulated product users, producers and distributors in Canada.
Activity Data	Solvent use quantities (1990 to 2004): Cheminfo (2007) Solvent use quantities (2005 to 2014): Cheminfo (2016a) Twenty-nine commercially sold solvents, defined as VOCs under CEPA 1999, are inventoried.[1] Domestic consumption is determined using a national mass balance approach: *Consumption = Production + Imports - Exports ± Inventory Changes* "Inventory changes" are a volume buffer between total supply (production and imports) and total demand (domestic consumption and exports) (Cheminfo 2016a). For most solvents, the value is zero because of a lack of detailed data on inventory changes (Cheminfo 2016a). Information on production, trade and inventory changes is obtained from various literature sources, Statistics Canada and interviews with a subset of solvent producers and distributors. Domestic consumption estimates are allocated to many reactive and emissive application areas. The default allocation basis in many cases is the historical distribution of solvent use from previous studies (Cheminfo 2016a). Survey questionnaire results, input from telephone consultations and literature sources are used to develop solvent use and VOC estimates for each solvent and application (Cheminfo 2016a). Allocation to the provinces and territories is based on macroeconomic indicators, such as population, households and the gross domestic product (GDP) of commercial services and manufacturing (Cheminfo 2016a). For some industrial applications, specific allocations are derived from previous sector-specific studies (Cheminfo 2016a). Projected estimates of national total solvent use for the year 2015 were developed based on historical base year national total solvent use and macroeconomic growth and solvent growth ratios (Cheminfo 2016b).
Emission Factors (EF)	The estimated use of emission control technologies is applied in each solvent application area. More specifically, emissions are calculated by taking the estimated quantity of solvent used in an application area and multiplying it by the estimated percentage of uncontrolled VOCs or: $E_{VOCs} = Quantity_{solventused} \times (100\% - \%\ Controlled_{VOCs})$ where EVOCs is the emission estimate of VOCs. Emission controls (1990 to 2004): Cheminfo (2007) Emission controls (2005 to 2014): Cheminfo (2016a) If there is no estimated use of control technologies, then 100% of the solvent VOCs is are assumed to evaporate. Only a small portion of the estimated VOC emissions is reduced by the application of control technologies. Control efficiencies are applied (as percentages) in the following applications: flexographic, rotogravure and lithographic printing, aircraft coatings, automotive original equipment manufacture (OEM) coatings, metal can manufacturing, metal coil coating, metal furniture manufacturing, adhesives and sealants, and resin manufacturing (Cheminfo 2016a).

Notes:
1. VOCs that participate in photochemical atmospheric reactions are included under the list of toxic substances managed under the *Canadian Environmental Protection Act, 1999* (CEPA 1999) Schedule 1. Additional information on CEPA 1999 is available online at www.ec.gc.ca/toxiques-toxics/default.asp?lang=En&n=98E80CC6-1.

Table A2–10 Estimation Methodologies for Dust

Sector/Subsector	
Coal Transportation	
Description	*Coal Transportation* includes PM emissions resulting from the transportation of coal. Most of the coal mined in Canada is carried to trans-shipment or export terminals by unit trains. Coal imported into Canada is shipped in lake vessels. Some minor amounts of coal are shipped by truck (CCME 2001). Load-in and load-out losses are estimated and reported by mine facilities to the NPRI as part of fugitive emissions. Emissions from fuel combustion during coal transport (diesel, gasoline or oil) are inventoried separately as part of the Mobile Sources category.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Average emission factors are derived from the quantities of coal transported, the distance travelled and the type of containment of the coal (control, closed environment, covered wagon, etc.) (CCME 2001). Resulting emission factors are multiplied by annual coal production by province/territory.
Activity Data	National and provincial coal production: NRCan (2015) Monthly climate summaries: EC (2015c) Monthly climate summaries: EC (2015c)
Emission Factors (EF)	CCME (2001)
Construction Operations	
Description	*Construction Operations* include PM emissions primarily resulting from soil disturbance on construction sites. The amount of soil disturbance is related to the surface area and duration of a construction project. The geographic region, type of construction (residential, industrial-commercial-institutional [ICI], engineering) and soil characteristics are all considered.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Methodology under review. The area source emissions were last estimated for 2012 and are carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Mine Tailings	
Description	*Mine Tailings* covers emissions of particulates resulting primarily from wind erosion at mine tailings ponds located on active and inactive mine sites. Concentrators used for mining produce both a finely-milled concentrate rich in the desired metal(s) and a solids-laden mine tailings stream. This slurry is sent to a tailings pond where the solids settle out of suspension and the supernatant solution is either recycled back in the process or discharged as effluent. It is common practice to keep the solids in the tailings pond submerged, even when the mine is inactive or closed. If the solids in the pond are no longer submerged, fugitive particulate emissions occur through wind dispersion.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Methodology under review. The area source emissions were last estimated for 2005 and are carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	*Methodology under review.*
Paved Roads	
Description	Emissions from the *Paved Road Dust* sector originate from primary and secondary (re-suspended) PM emissions.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ **Primary** emissions are produced by multiplying the total vehicle kilometers travelled for each province/territory by pollutant-specific emissions factors. The methodology for **secondary (re-suspended)** emissions is currently under review. The emissions were last estimated for 2002 and have been carried forward to 2015.
Activity Data	**Primary** - Vehicle kilometres travelled (VKT) are estimated by multiplying vehicle counts by mileage accumulation rates from Stewart-Brown Associates (Stewart-Brown 2012).
Emission Factors (EF)	**Primary** - EMEP/EEA (2013) **Secondary** - Methodology under review.
Unpaved Roads	
Description	Emissions from the *Unpaved Road Dust* sector originate from re-suspended PM emissions.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Methodology under review. The area source emissions were last estimated for 2002 and have been carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.

Table A2–11 Estimation Methodologies for Fires

Sector/Subsector	
Prescribed Forest Burning	
Description	*Prescribed Forest Burning* includes emissions from controlled fires used for land management treatments. Prescribed burning is used to reduce logging residues, manage forest production, control insects and minimize potential for destructive wildfires. The practice of prescribed burning is carried out by the logging industry and forestry officials to manage Crown lands. This sector excludes the burning of agricultural residues.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p Total annual mass of forest debris burned by fire and by province/territory is multiplied by pollutant-specific emission factors.
Activity Data	The total number of hectares burned in each province/territory per year (CIFFC 2016; PCA 2016; NFD 2016) is multiplied by a conversion factor for each province/territory (EC 1992) to convert the area burned into the mass of forest debris burned. Pollutant and province-specific emission factors are then applied to the mass of forest debris to determine the release of pollutants from the burn.
Emission Factors (EF)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3: All provinces/territories (except British Columbia): U.S. EPA (1995a) British Columbia: GVRD and FVRD (2003), BCMWLAP (2004). Dioxins/furans, B(b)f, B(k)f: Lemieux et al. (2004) B(a)p, I(cd)p: Johnson et al. (1992)
Structural Fires	
Description	*Structural Fires* cover emissions from vehicle fires (such as fires from cars, trains and airplanes) and fires that burn buildings. Structural fires emit large quantities of pollutants due to rapid but incomplete combustion.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, NO_x, VOCs, CO, NH_3 Tonnes of structures burned per year, by province/territory, are multiplied by pollutant-specific emission factors
Activity Data	The Secretary/Treasurer of the Council of Canadian Fire Marshals and Fire Commissioners[1] (CCMFC) and the following members of the CCMFC are contacted to obtain the number of annual structural fires in their jurisdictions: • Government of Nunavut[2] • Fire and Emergency Services, Newfoundland and Labrador[3] • Office of the Fire Marshal and Emergency Management (Ontario)[4] • Office of the Fire Commissioner (Manitoba)[5] • Emergency Management and Fire Safety Branch (Saskatchewan)[6] • Canadian Forces Fire Marshal[7] • Office of Public Safety (Prince Edward Island)[8] • Yukon Government[9] • Department of Labour and Advanced Education (Nova Scotia)[10] • Department of Municipal and Community Affairs (Government of the Northwest Territories)[11] • Department of Public Safety (New Brunswick)[12] • Office of the Fire Commissioner (Alberta)[13] • Emergency Management British Columbia[14] • Ministère de la Sécurité publique[15]
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, NO_x, VOCs, CO*: GVRD and FVRD (2003) *NH_3*: Battye et al. (1994)

Notes:
1. Gourley P. 2015. Personal communication (email from Gourley P to Inventories Engineer dated May 25, 2015). Council of Canadian Fire Marshals and Fire Commissioner.
2. Prima R. 2015. Personal communication (email from Prima R to Inventories Engineer dated June 22, 2015). Government of Nunavut.
3. King A. 2015. Personal communication (email from King A to Inventories Engineer dated June 19, 2015). Fire and Emergency Services, Newfoundland and Labrador.
4. Robinson B. 2015. Personal communication (email from Robinson B to Inventories Engineer dated June 18, 2015). Office of the Fire Marshal and Emergency Management (Ontario).
5. Dimayuga P. 2015. Personal communication (email from Dimayuga P to Inventories Engineer dated June 17, 2015). Office of the Fire Commissioner (Manitoba).
6. Catley K. 2015. Personal communication (email from Catley K to Inventories Engineer dated June 16, 2015). Emergency Management and Fire Safety Branch (Saskatchewan).
7. Page L. 2015. Personal communication (email from Page L to Inventories Engineer dated June 11, 2015). Canadian Forces Fire Marshal (Canadian Forces).
8. Rossiter D. 2015 Personal communication (email from Rossiter D to Inventories Engineer dated June 10, 2015). Office of Public Safety (Prince Edward Island).
9. Marcuson M. 2015 Personal communication (email from Marcuson M to Inventories Engineer dated June 10, 2015). Yukon Government.
10. Pothier H. 2015 Personal communication (email from Pothier H to Inventories Engineer dated June 10, 2015). Department of Labour and Advanced Education (Nova Scotia).
11. Dewar C. 2015 Personal communication (email from Dewar C to Inventories Engineer dated June 5, 2015). Department of Municipal and Community Affairs (Government of the Northwest Territories).
12. Nowlan M. 2015 Personal communication (email from Nowlan M to Inventories Engineer dated June 5, 2015). Department of Public Safety (New Brunswick).
13. Jurisic M. 2015 Personal communication (email from Jurisic M to Inventories Engineer dated June 3, 2015). Office of the Fire Commissioner (Alberta).
14. Simpson F. 2015 Personal communication (email from Simpson F to Inventories Engineer dated June 2, 2015). Emergency Management British Columbia.
15. Mathurin S. 2015 Personal communication (email from Mathurin S to Inventories Engineer dated June 1, 2015). Ministère de la Sécurité publique.

Table A2–12 Estimation Methodology for Mercury in Products

Sector/Subsector	
Mercury in Products	
Description	*Mercury in Products* covers emissions from Hg contained in products throughout their life cycle from manufacture to final disposition. The following products are included: • Automotive switches • Switches and relays • Batteries • Dental amalgams • Fluorescent tubes • Non-fluorescent lamps • Measurement and control devices • Thermometers • Thermostats • Tire balancers Emissions from the above devices impact the following sectors/subsectors: • Iron and Steel Industries – (Secondary) Electric Arc Furnaces • Iron and Steel Industries – Steel Recycling • Electronics • Other Manufacturing • Municipal Incineration • Other Incineration • Human • Other Miscellaneous Sources • Landfills • Water and Sewage Treatment • Residential Waste Burning
General Inventory Method	*Pollutant(s) Estimated*: Hg Methodology under review. The area source emissions were last estimated for 2008 and have been carried forward to 2015.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.

A2.3. Recalculations

Emission recalculation is an essential practice in the maintenance of up-to-date and internally consistent trends in air pollutant emissions. Circumstances that warrant a change or refinement of data and/or methods include:

- Available data have changed.
- New inventory methods have become available.
- The previously used method is inconsistent with good practice.
- An emissions source category has become a key category.
- The previously used method is not representative of practices or technologies.
- Previously undetected errors are corrected.

Recalculations of point source emission data previously reported from the NPRI are not conducted systematically. Rather, some facilities recalculate their point source emission estimates as new emission factors become available and resubmit a previous emissions report to the NPRI as an update. Generally, these recalculations by facilities are completed for only a few years in their historical emissions.

In contrast, new activity data are incorporated into the area source estimates as they become available, and these updates are reflected in the trends on an ongoing basis. Updated trends, based on updated point source and area source data, are published on a yearly basis. For example, the calculation of emissions from the asphalt paving industry, commercial fuel combustion, residential fuel combustion, agricultural fuel use and construction fuel combustion sectors rely on fuel use quantities from the Statistics Canada publication *Report on Energy Supply and Demand in Canada* (RESD), which is not available until December of each year (Statistics Canada 2015c). As a result, the emission estimates for these sectors are based on the 2014 activity data and are carried over to the 2015 inventory year pending the availability of activity data for 2015. Once Statistics Canada RESD data are available, the

area source estimates for these sectors will be updated.

Emissions in the following area sources were recalculated for the 2017 edition of the APEI. Brief descriptions of the recalculations and the impacts on emission levels are provided in Table A2–13 to Table A2–23.

- Ore and mineral industries: asphalt paving; cement and concrete; rock, sand and gravel; and silica production;
- Oil and gas industry: refined petroleum products bulk storage and distribution; natural gas distribution; natural gas transmission and upstream petroleum industry;
- Manufacturing: panel board mills and sawmills;
- Transportation and mobile equipment: marine transportation; on-road vehicles; and off-road vehicles and equipment;
- Agriculture: animal production; fertilizer application; harvesting; tillage practices; wind erosion and fuel use;
- Commercial/Residential/Institutional: commercial and institutional fuel combustion; construction fuel combustion; commercial cooking; human; residential fuel combustion; service stations and other miscellaneous sources;
- Incineration and waste sources: crematoriums; industrial and commercial incineration; municipal incineration; landfills; other incineration and utilities; and residential waste burning;
- Paints and solvents: dry cleaning; general solvent use; printing and surface coatings;
- Dust: paved roads and unpaved roads;
- Fires: prescribed forest burning;
- Mercury in products: ore and mineral industries; manufacturing; commercial / residential / institutional; and incineration and waste.

For the purpose of Table A2–13 to Table A2–23, the term "significant" refers to changes greater than ±10% in emission levels.

Table A2–13 Recalculations for Ore and Mineral Industries

Sector/Subsector	Pollutants	Description	Impact on Emissions
Asphalt Paving	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The activity data have been updated from a more recent RESD edition.	The recalculations resulted in no significant changes in emission levels (± >10%) for 1990. The recalculations resulted in the following changes in 2014 at the national level: +18% (+6 kt) for TPM, +18% (+1.3 kt) for PM_{10}, +18% (0.28 kt) for $PM_{2.5}$, +16% (88 t) for SO_x, +21% (+200 t) for NO_x, +50% (+2.8 kt) for VOCs, +20% (0.66 kt) for CO, +14% (+2.6 kg) for Cd, +16% (+3.0 kg) for Hg and +17% (+1.9 kg) for PAHs.
Cement and Concrete	TPM, PM_{10}, $PM_{2.5}$, Pb and Cd.	The recalculations were done using updated activity data.	No significant changes in emission levels (greater than ±10%) resulted for 1990. For 2014, estimates for all pollutants increased by 10% (TPM +4.0 kt, PM_{10} +1.2 kt, $PM_{2.5}$ +0.6 kt, Pb +10 kg, Cd +0.10 kg).
Rock, Sand and Gravel (under *Mining and Rock Quarrying*)	TPM, PM_{10}, $PM_{2.5}$,	Recalculations of emission estimates for 1990–2015 were due to changes in emission factors. Emission factors are now taken from the EMEP/EEA 2013 Guidebook's Tier 1 emission factors for Quarrying and mining of minerals other than coal. Activity level data for the complete time series was updated to reflect the most recent information from NRCan.	The methodology and activity level data updates resulted in both increases and decreases to the particulate matter area source estimates. In 1990, the significant changes at the national level were +59% for TPM (+30 kt) and -51% for PM_{10} (-13 kt). In 2014, the significant changes at the national level were +72% for TPM
Silica Production (under *Mining and Rock Quarrying*)	TPM, PM_{10}, $PM_{2.5}$	Recalculations of emission estimates for 1990–2015 were due to changes in emission factors. Silica production estimates are no longer distributed into fine and coarse silica production, and are now multiplied by the EMEP/EEA 2013 Guidebook's Tier 1 emission factors for Quarrying and mining of minerals other than coal. Activity level data for the complete time series was updated to reflect the most recent information from NRCan.	Emissions are reduced over the complete time series for all pollutants. In 1990, changes at the national level were -89% for TPM (-1.6 kt), -43% for PM_{10} (-0.076 kt), and -81% for $PM_{2.5}$ (-0.042 kt). In 2014, changes at the national level were 84% for TPM (1.1 kt), 21% for PM_{10} (0.027 kt), and -73% for $PM_{2.5}$ (0.028 kt).

Table A2–14 Recalculations for Oil and Gas Industry

Sector/Subsector	Pollutants	Description	Impact on Emissions
Refined Petroleum Products Bulk Storage and Distribution (under *Downstream Petroleum Industry*)	VOCs	Recalculations occurred for the entire time series as a result of updated activity level data being made available.	The recalculations did not result in changes in emission levels of greater than ±10% for VOCs in 1990 or 2014.
Natural Gas Distribution (under *Petroleum Product Transportation and Distribution*)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO	Recalculations occurred for recent years (2011 through current) as a result of updated activity data being made available.	For 2014, on a national level, the updated activity level data resulted in significant changes to VOC emissions only; VOC estimates changed by -12% (-0.024 kt). The recalculations resulted in changes in emission levels of less than ±10% in 2014 for the rest of the pollutants.
Natural Gas Transmission (under *Petroleum Product Transportation and Distribution*)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3	Recalculations occurred for recent years (2011 through current) as a result of updated activity data being made available.	For 2014, on a national level, the updated activity level data resulted in significant changes to NH_3 emissions only; NH_3 estimates changed by -22% (-0.00041 kt). The recalculations resulted in changes in emission levels of less than ±10% in 2014 for the rest of the pollutants.
Upstream Petroleum Industry	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3	Recalculations occurred for recent years (2011 through current) as a result of updated activity data being made available.	The recalculations did not result in changes greater than ±10% for any of the pollutants in 2014.

Table A2–15 Recalculations for Manufacturing

Sector/Subsector	Pollutant	Description	Impact on Emissions
Panel Board Mills (under *Wood Products*)	TPM, PM_{10}, $PM_{2.5}$	Data omission corrections for the pollutants TPM, PM_{10} and $PM_{2.5}$ for the years 1990 to 2014.	There were no changes in the emission levels of any of the pollutants for 1990 with the exception of TPM, PM_{10} and $PM_{2.5}$. Emissions changed by +100% for all three pollutants, amounting to +4043 t, +2348 t and +769 t, respectively. For the year 2014, there were no changes in the emission levels of any of the pollutants.
Sawmills (under *Wood Products*)	TPM, PM_{10}, $PM_{2.5}$	Data omission corrections for the pollutants TPM, PM_{10} and $PM_{2.5}$ for the years 1990 to2014.	There were no changes in the emission levels of any of the pollutants for 1990, with the exception of TPM, PM_{10} and $PM_{2.5}$. Emissions changed by +100% for all three pollutants, amounting to +6275 t, +2241 t and +829 t, respectively. For the year 2014, there were no changes in the emission levels of any of the pollutants.

Table A2–16 Recalculations for Transportation and Mobile Equipment

Sector	Pollutant	Fuel	Description	Impact on Emissions
Marine Transportation	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p	Heavy Fuel Oil, Marine Diesel Oil, Marine Gasoline Oil	Model updates from Marine Emissions Inventory Tool v.4.0 to v.4.3.1, new interpolation for the years between 2010 and 2015, and removal of evaporative emissions from transported fuel.	The recalculations for 1990 resulted in significant changes in VOC emissions (-53% or -6.5 kt). The recalculations did not result in changes in emission levels of greater than 10% for any of the other pollutants in 1990. The recalculations for 2014 resulted in significant changes in the emissions of TPM (+120% or +8.2 kt), PM_{10} (+120% or +7.9 kt), $PM_{2.5}$ (+120% or +7.3 kt), SO_x (+284% or +80 kt) and VOCs (-48% or -8.9 kt). The recalculations did not result in changes in emission levels of greater than 10% for any of the other pollutants in 2014.
On-road Vehicles (Includes the following sectors: *Heavy-duty diesel vehicles, Heavy-duty gasoline trucks, Heavy-duty LPG/NG vehicles, Light-duty diesel trucks, Light-duty diesel vehicles, Light-duty gasoline trucks, Light-duty gasoline vehicles, Light-duty LPG/CNG vehicles, Light-duty LPG/CNG trucks, Motorcycles, Tire Wear & Brake Lining*)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p	All transport fuels	Update of MOVES version (2010 to 2014). In addition to broadly updating all pollutant emissions rates, PM_{10} is now directly estimated with MOVES rather than using a ratio to $PM_{2.5}$. Environment and Climate Change Canada (ECCC) aligns estimates of on- and off-road fuel use with fuel data in the RESD. This is now done on a provincial, rather than a national basis. The activity data have been updated to a more recent edition of the RESD.	The recalculations for 1990 resulted in significant changes in the emissions of TPM (-34% or -19 kt), PM_{10} (-34% or -19 kt), $PM_{2.5}$ (43% or -21 kt), SO_x (-55% or -35 kt), VOCs (-47% or 333 kt), CO (-25% or 1878 kt), NO_x (-34% or 367 kt), NH_3 (-25% or 1.7 kt), dioxins/furans (100% or -3.4 g-TEQ), B(a)p (-99% or -1.0 t), B(b)f (-100% or -1.2 t), B(k)f (100% or -1.2 t) and I(cd)p (-99% or -0.6 t). The recalculations for 2014 resulted in significant changes in the emissions of $PM_{2.5}$ (-19% or -3.4 kt), VOCs (-23% or -39 kt), CO (-19% or -374 kt), NH_3 (11% or -0.8 kt), dioxins/furans (-100% or 11 g-TEQ), B(a)p (-99% or -0.2 t), B(b)f (-99% or 0.2 t), B(k)f (-99% or 0.2 t) and I(cd)p (-98% or -0.1 t). The recalculations did not result in changes in emission levels of greater than 10% for any of the other pollutants in 2014. Hg emissions were not estimated using the previous methodology, so there are no values to compare against for 1990 or 2014. Pb emissions were not estimated using the current methodology, so there are no values to compare against for 1990 or 2014.

Table A2-16 Recalculations for Transportation and Mobile Equipment (cont'd)

Sector	Pollutant	Fuel	Description	Impact on Emissions
Off-road Vehicles and Equipment	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3	All transport fuels	ECCC aligns estimates of on- and off-road fuel use with fuel data in the RESD. This is now done on a provincial, rather than a national basis. The activity data have been updated to a more recent edition of the RESD.	The recalculations for 1990 resulted in significant changes in the emissions of TPM (-32% or -25 kt), PM_{10} (-31% or -24 kt), $PM_{2.5}$ (31% or -23 kt), SO_x (-14% or -4.5 kt), VOCs (-61% or 1013 kt), CO (-59% or 2899 kt), NO_x (-17% or 75 kt) and NH_3 (45% or 0.25 kt). The recalculations for 2014 resulted in significant changes in the emissions of TPM (-18% or -4.2 kt), PM_{10} (-18% or -4.2 kt), $PM_{2.5}$ (18% or -4.0 kt), SO_x (-17% or -0.05 kt), VOCs (-23% or -51 kt), CO (-18% or 299 kt), NO_x (17% or 41 kt) and NH_3 (-18% or -0.06 kt). B(a)p, B(b)f, B(k)f and I(cd)p emissions were not estimated using the current methodology, so there are no values to compare against for 1990 or 2014.

Notes:
1. MOVES2014 is a forward-looking model and does not have the capability to model the years 1991-1998. For this inventory, emission estimates were revised for these years to maintain time series consistency using previous inventories as a proxy for rates of change.

Table A2–17 Recalculations for Agriculture

Sector	Pollutants	Description	Impact on Emissions
Animal Production	NH_3	A new animal category, mules and asses, was added, and corrections were made to populations of fox, mink and rabbit. The corrections predominantly impacted populations prior to the 2011 census. Modifications to cropland areas occurred this year to reduce differences between earth observation and census estimates of provincial cropland. The modifications to areas also caused a minor redistribution of livestock within provinces, and since NH_3 emission factors are ecoregion-based, resulted in small changes to emissions.	The recalculations did not result in changes in emission levels of greater than 10% for NH_3 in 1990 or 2014.
	VOCs	A new tier 1 methodology for estimating non-methane VOCs was implemented based on EMEP guidelines (see methodological description).	The recalculated emissions decreased by 128 kt or 57% in 1990, and by 153 kt or 61% in 2014.
Fertilizer Application (under *Crop Production*)	NH_3	Modifications to cropland areas were carried out this year in order to reduce differences between earth observation and census estimates of provincial cropland areas. Earth observation-based cropland categories were reconciled using provincial scaling factors. This resulted in changes in areas of annual and perennial crops, and thus the distribution of synthetic N between annual and perennial crop also changed.	The recalculations did not result in changes of greater than 10% in emission levels for NH_3 in 1990 or 2014.
Harvesting (under *Crop Production*)	TPM, PM_{10}, $PM_{2.5}$	The update to activity data on areas of annual crops as a result of reconciliation between earth observation and census estimates of annual provincial crop areas, noted in the ammonia recalculation section, resulted in an increase of 2 Mha in the area of annual cropland in 1990, and a decrease of 2.2 Mha in 2014 compared with the 2016 APEIR.	As a result of these changes, emissions of TPM, PM_{10} and $PM_{2.5}$ increased by 20.1 kt, 9.2 kt, and 1.8 kt or 6.7% in 1990, and decreased by 14.7 kt, 6.7 kt, and 1.3 kt or 5.8% in 2014, respectively.
Tillage Practices (under *Crop Production*)	TPM, PM_{10}, $PM_{2.5}$	In addition to the changes in areas of annual and perennial crops as a result of reconciliation between earth observation and census estimates of annual provincial crop areas, compared with the 2016 APEIR, the areas of conventional tillage, reduced tillage and no-till increased by 1.3 Mha, 0.6 Mha, and 0.1 Mha, respectively, in 1990 and decreased by 0.3 Mha, 0.5 Mha, and 1.4 Mha in 2014, respectively.	Emissions of TPM, PM_{10} and $PM_{2.5}$ increased by 195 kt, 40.9 kt and 19.5 kt or 6.0% in 1990, and decreased by 84.5 kt, 17.8 kt, and 8.5 kt or 8.2% in 2014, respectively.
Wind Erosion (under *Crop Production*)	TPM, PM_{10}, $PM_{2.5}$	The update on activity data noted under Tillage Practices further impacted Wind Erosion estimates.	Emissions of TPM, PM_{10} and $PM_{2.5}$ increased by 25.1 kt, 12.5 kt, and 2.5 kt or 0.8% in 1990, and decreased by 195 kt, 97.5 kt, and 19.5 kt or 8.6% in 2014, respectively.
Fuel Use	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/ furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The activity data have been updated to a more recent edition of the RESD.	Comparing with the year 1990, the recalculations resulted in the following changes: +20% (+32 t) for TPM; +16% (+20 t) for PM_{10}. There were no significant changes in emission levels (greater than ±10%) for any of the other pollutants in 1990. For the year 2014, recalculation resulted in the following changes: +407% (+624 t) for TPM, +265% (+390 t) for PM_{10}, +97% (+140 t) for $PM_{2.5}$ and -29% (0.01 kg) for B(a)p, The rest of the pollutant emissions changed by less than ±10% in 2014.

Table A2–18 Recalculations Commercial/Residential/Institutional

Sector	Pollutant	Description	Impact on Emissions
Commercial and Institutionnel Fuel Combustion	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The activity data have been updated to a more recent edition of the RESD.	Comparing with the year 1990, the recalculations resulted in the following changes: +32% (+679 t) for TPM, +22% (+421 kt) for PM_{10}. For all other pollutants, there were no significant changes in emission levels (changes were less than ±10%). For the year 2014, TPM changed by +17% (+380 t), PM_{10} by +13% (290 t), SO_x by -29% (-1300 t), NH_3 by +18% (34 t), Pb by +16% (26 kg), PAHs by +15% (0.31 kg) and D/F by +23% (0.04 g-TEQ). The rest of the pollutant emissions changed by less than ±10% in 2014.
Construction Fuel Combustion	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The activity data have been updated to a more recent edition of the RESD.	Comparing with the year 1990, the recalculations resulted in the following changes: +41% (+78 t) for TPM, +27% (+48 t) for PM_{10}, and +11% (+18 t) for $PM_{2.5}$. For all other pollutants, there were no significant changes in emission levels (changes were less than ±10%. For the year 2014, TPM changed by -37% (-77 t), PM_{10} by -28% (-47 t), $PM_{2.5}$ by -13% (-15 t), NO_x by -12% (-232 t), NH_3 by -12% (4.3 t), Pb by 51% (6.5 kg), Cd emissions by -14% (-1.4 kg), Hg by -17% (0.4 kg), D/F by 39% (0.01 g-TEQ) and PAHs by -58% (-0.27 kg). The rest of the pollutant emissions changed by less than ±10% in 2014.
Commercial Cooking	TPM, PM_{10}, $PM_{2.5}$, VOCs, CO, B(a)p	A new estimation methodology was implemented for the time series (Pechan & Associates 2003). As a result, two new pollutants were estimated (VOCs and CO).	The recalculations resulted in significant increases in emission levels of all pollutants for all years. For 1990, TPM and PM_{10} changed by +449% (+12 241 t), $PM_{2.5}$ by +409% (+11 129 t) and B(a)p by +9464% (+100 kg). For the year 2014, TPM and PM_{10} changed by +408% (+13 934 t), $PM_{2.5}$ by +370% (+12 648 t), and B(a)p by +10930% (+116 kg).
Human	NH_3, Hg	Updated population data by province and territory were incorporated into the time series. The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions from 2009 to 2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations resulted in changes in NH_3 and Hg emission levels of less than ±10% in 1990 and 2014.
Residential Fuel Combustion	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The activity data have been updated to a more recent edition of the RESD.	The recalculations did not result in changes in emission levels of greater than 10% for any of the pollutants in 1990. In 2014, the recalculations resulted in a+14% change in Hg (+9.7 kg) and a -96% (-4200 t) change in SO_x The rest of the pollutant emissions changed by less than ±10% in 2014.
Service Stations	VOCs	Refined petroleum products retail: The estimation methodology for service stations has been changed from a growth factor approach to use of emission factors from U.S. EPA AP-42. The emissions from refuelling on-road vehicles have been removed as they are already included in on-road estimates for recalculation purposes. *Off-road refuelling*: The activity data have been updated to a more recent edition of the RESD. *On-road refuelling*: Quantification of the impact of the new methodology for estimates of emissions from refuelling of on-road vehicles cannot be calculated because emissions from this source were not calculated separately in the previous estimation methods. The recalculations of VOC emissions related to refuelling of on-road vehicles estimates are included in Table A_2-16 for on-road vehicles.	Refined petroleum products retail: The recalculations did not result in changes greater than ±10% for any of the pollutants in 1990 and 2014. Off-road refuelling: The recalculations resulted in a -63% (9900 t) decrease in VOC estimates for 1990, and a -25% (990 t) change in VOC estimates for 2014.
Other Miscellaneous Sources	NH_3, Hg	Updated population data by province and territory were incorporated into the time series. The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations resulted in changes in NH_3 and Hg emission levels of less than ±10% in 1990 and 2014.

Table A2–19 Recalculations for Incineration and Waste Sources

Sector	Pollutant	Description	Impact on Emissions
Crematoriums	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	Activity data for the years 2008–2014 were updated to correspond with the most recent report by the Cremation Association of North America (CANA,2016). This report includes a new data source for cremation data from Quebec. Data for the years 2002–2007 were updated to correspond with CANA's 2013 report. Interpolation was required to fill a data gap for 2001 for all provinces. Inconsistencies in data sources for Quebec required the interpolation of Quebec activity data for the years 2002–2007.	The update in activity data did not result in changes in emission levels of greater than ±10% for any of the pollutants for 1990 or 2014.
Industrial and Commercial Incineration	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, HCB	QC was performed to update obsolete data.	There were no changes to emissions in 1990. In 2014, TPM, PM_{10} and $PM_{2.5}$ changed by -46% (-11 t), -48% (-8 t) and -29% (-3 t), respectively. Cd changed by 77% (-2 kg), while Hg (105 kg), dioxins/furans (0.44 g-TEQ) and HCB (-41 g) all changed by -100%. Emissions of all other pollutants changed by less than ±10% in 2014.
Municipal Incineration	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans	Previously, area source emissions were not estimated after 2011. Pending a full methodology review, the 2011 reporting year data are now carried forward through 2015. The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	Hg changed by +13% (+48 kg) in 1990 and by +245% (+327 kg) in 2014. No other emissions changed in 1990. In 2014, all emissions excluding Hg changed by +100%. Emissions increased by 10 t for TPM, 2 t for PM_{10}, 1 t for $PM_{2.5}$, 129 t for SO_x, 153 t for NO_x, 38 t for VOCs, 56 t for CO, 19 t for NH_3, 146 kg for Pb, 26 kg for Cd, and 0.000004 g-TEQ for dioxins/furans.
Landfills (under *Waste*)	TPM, PM_{10}, $PM_{2.5}$, VOCs, Hg	PM_{10} and $PM_{2.5}$ distribution percentages of TPM were updated in all provinces except BC. The methodology for VOCs was updated based on the U.S. EPA AP-42 to account for current landfilling practices in Canada. New VOC concentrations in fugitive landfill gas were used. Activity data was updated across the whole time series for the amount of methane gas released and the amount of waste landfilled. The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	PM_{10} and $PM_{2.5}$ changed by +347% (+843 t) and +396% (+241 t) in 1990 and by +217% (+967 t) and +239% (+277 t) in 2014, respectively. VOCs changed by 41% (4583 t) and 8% (-635 t) in 1990 and 2014, respectively. Neither TPM nor Hg changed by more than ±10%.
Residential Waste Burning (under *Waste*)	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, HCB	The 2014 data was carried forward until a full methodology review can be completed. The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	In 2014, Hg emissions increased by 131% (+91 kg). No other emissions changed by more than ±10%.
Other Incineration and Utilities	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p	QC was performed to update obsolete data. A change in methodology was implemented for mercury in products.	The only change in 1990 was an increase of +51% (+194 kg) in Hg. In 2014, TPM (+50 t), PM_{10} (+5 t), $PM_{2.5}$ (+1 t), NO_x (+169 t), NH_3 (+20 t), Pb (+5 kg), Cd (+2 kg) all increased by 75%. CO emissions changed by +10% (+177 t), Hg by +100% (+218 kg) and dioxins/furans by +100% (+0.00 g-TEQ). SO_x and VOC emissions did not change by more than ±10%.

Table A2–20 Recalculations for Paints and Solvents

Sector	Pollutant	Description	Impact on Emissions
Dry Cleaning	VOCs	Corrections made by Cheminfo to their 2016(a) study resulted in changes in the VOC emission estimates for 2005 to 2014.	Resulted in a change in VOC emission levels of less than ±10% in 2005 and -11% or -19 t in 2014.
General Solvent Use	VOCs	Corrections made by Cheminfo to their 2016(a) study resulted in changes in the VOC emission estimates for 2005 to 2014.	Resulted in a change in VOC emission levels of less than ±10% in 2005 and 2014.
Printing	VOCs	Corrections made by Cheminfo to their 2016(a) study resulted in changes in the VOC emission estimates for 2005 to 2014.	Resulted in a change in VOC emission levels of less than ±10% in 2005 and +20% or +3139 t in 2014.
Surface Coatings	VOCs	Corrections made by Cheminfo to their 2016(a) study resulted in changes in the VOC emission estimates for 2005 to 2014.	Resulted in a change in VOC emission levels of less than ±10% in 2005 and +11% or +7361 t in 2014.

Table A2–21 Recalculations for Dust

Sector	Pollutant	Description	Impact on Emissions
Paved Roads	TPM, PM_{10}, $PM_{2.5}$	A new estimation methodology was implemented for primary emissions from paved road dust. The estimation methodology for secondary emissions from paved and unpaved road dust is under review as it has not been updated since 2002. Previously, the emissions from 2003 to 2014 were driven by vehicle kilometers travelled. In this update, values are held constant from the last time the emissions were calculated using the former methodology. An updated methodology will be implemented for the entire time series.	The recalculations did not result in changes in emission levels of greater than ±10% for any of the pollutants in 1990. The recalculation for 2014 resulted in significant changes in the emissions of TPM (-19% or -679 kt), PM_{10} (-19% or -130 kt) and $PM_{2.5}$ (-19% or -31 kt).
Unpaved Roads	TPM, PM_{10}, $PM_{2.5}$	The estimation methodology for secondary emissions from unpaved road dust is under review as it has not been updated since 2002. Previously, the emissions from 2003 to 2014 were driven by vehicle kilometers travelled. In this update, values are held constant from the last time the emissions were calculated using the former methodology. An updated methodology will be implemented for the entire time series.	The recalculations did not result in changes in emission levels of greater than ±10% for any of the pollutants in 1990. The recalculation for 2014 resulted in significant changes in emissions of TPM (-23% or -2234 kt), PM_{10} (-23% or -701 kt) and $PM_{2.5}$ (-23% or -105 kt).

Table A2–22 Recalculations for Fires

Sector	Pollutant	Description	Impact on Emissions
Prescribed Forest Burning	TPM, PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOCs, CO, NH_3, dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p	Parks Canada reassessed all prescribed burn data from 1990 to 2015 and provided an updated time series of activity data.	The updated activity data did not result in changes in emission levels of greater than ±10% for any of the pollutants in 1990 or 2014.

Table A2–23 Summary of Recalculations Due to Methodological Change or Refinement for Mercury in Products

Sector	Pollutant	Description	Impact on Emissions
Ore and Mineral Industries	Hg	The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations did not result in changes greater than ±10% for Hg in 1990. In 2014, Hg changed by -46% or -174 kg.
Manufacturing	Hg	The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations did not result in changes greater than ±10% for Hg in 1990. In 2014, Hg changed by -81% or -14 kg.
Commercial / Residential / Institutional	Hg	The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations did not result in changes greater than ±10% for Hg in 1990. In 2014, Hg changed by -81% or -14 kg.
Incineration and Waste	Hg	The estimation methodologies for mercury in products are under review. The methodology used to estimate emissions for 2009–2014 is deemed unreliable. In the current inventory, emissions are held constant (at their 2008 levels) until a revised methodology is implemented for the entire time series.	The recalculations did not result in changes greater than ±10% for Hg in 1990. In 2014, Hg changed by -17% or -172 kg.

A2.4. Point Source Emissions

This section presents the procedures used to incorporate point sources into the APEI.

Information on emissions from point sources was provided by the provinces for 1985, 1990, 1995 and 2000. In some cases, additional information was provided to fill in intervening years or to update the original submissions. Trends for the intervening years were estimated using interpolation techniques. The compilation of emissions for 2001–2005 occurred during a transition to using emissions data reported to the National Pollutant Release Inventory (NPRI) as the major source of industrial emissions. In general, point source information from the NPRI and data provided by the provinces were used for the 2002, 2004 and 2005 inventories, and interpolation was used for 2001 and 2003.

Since 2005, information on point source emissions has originated mainly from the NPRI, with limited data obtained from provincial governments

(Alberta, Manitoba, New Brunswick, Newfoundland, Ontario and Quebec) on selected sources that are not reported to the NPRI.

The NPRI groups the substances into the five parts listed below. Each part has its own reporting thresholds or triggers of mandatory reporting.

- Part 1A – Core Substances, and Part 1B – Alternate Threshold Substances
- Part 2 – Polycyclic Aromatic Hydrocarbons
- Part 3 – Dioxins, Furans and Hexachlorobenzene
- Part 4 – Criteria Air Contaminants (CACs)
- Part 5 – Speciated Volatile Organic Compounds (VOCs)

Table A2–24 shows the 17 air pollutants reported in the APEI and their NPRI reporting thresholds. Details on the NPRI reporting requirements for each substance group are available in the *Guide for Reporting to the National Pollutant Release Inventory (NPRI) 2014 and 2015)* (EC 2015d). No VOC data collected under Part 5 is used in the APEI.

In 2015, approximately 6200 facilities reported releases of one or more APEI pollutants to the NPRI.

Using the 2015 NPRI database (version dated September 7, 2016), facility information and air emissions data for the pollutants in Table A2–24 were extracted for each province and territory. The quality control process described in Section 4.1 was applied to the NPRI data to identify outliers or missing substance reports. Each extracted NPRI facility was assigned to an APEI source, sector and subsector.

For new NPRI reporting facilities, the North American Industry Classification System (NAICS) codes (Statistics Canada 2012), reported by the facilities, were used to assign the related APEI sector and subsector classifications. In some cases, additional research and verification was required to provide the correct classification for facilities with a number of activities that were different from the NAICS code reported by the facility to the NPRI.

NPRI reporting facilities may not report all three of the PM size fractions. For cases where only one or two of the three PM size fractions were reported to the NPRI, a distribution procedure is applied to estimate a complete set of PM emissions for

Table A2–24 NPRI Thresholds for the Air Pollutants

Substance	NPRI Part # (Threshold Category)	Mass Threshold	Concentration Threshold
Ammonia	1A	10 tonnes MPO	MPO by weight of ≥ 1%
Benzo(a)pyrene	2	50 kg total PAHs	N/A
Benzo(b)fluoranthene	2	50 kg total PAHs	N/A
Benzo(k)fluoranthene	2	50 kg total PAHs	N/A
Cadmium	1B	5 kg MPO	MPO by weight of ≥ 0.1%
Carbon monoxide	4	20 tonnes air release	N/A
Dioxins and furans	3	Activity-based	N/A
Hexachlorobenzene	3	Activity-based	N/A
Indeno(1,2,3-c,d)pyrene	2	50 kg total PAHs	N/A
Lead	1B	50 kg MPO	MPO by weight of ≥ 0.1%
Mercury	1B	5 kg MPO	N/A
Nitrogen oxides	4	20 tonnes air release	N/A
PM_{10} - particulate matter <= 10 microns	4	0.5 tonnes air release	N/A
$PM_{2.5}$ - particulate matter <= 2.5 microns	4	0.3 tonnes air release	N/A
Sulphur dioxide	4	20 tonnes air release	N/A
Total particulate matter	4	20 tonnes air release	N/A
Volatile organic compounds	4	10 tonnes air release	N/A

Note: MPO – Manufactured, processed or otherwise used

facilities. The procedure is based on sector-specific PM distribution profiles developed based on PM emissions reported by facilities to the NPRI for the 2006 to 2014 inventory years. The ratios were calculated for each facility and averaged by sector. The resulting distributions are presented in Table A2–25.

The PM distribution procedure described in Equation A2–1, Equation A2–2 and Equation A2–3 is applied on a case-by-case basis to fill data gaps.

Equation A2–1: PM_{10} Distribution Ratio

$$PM_{10}\ ratio = \frac{PM_{10}\ emissions}{TPM\ emissions}$$

Where		
$PM_{10}\ ratio$	=	Ratio of the sector's PM_{10} emissions to TPM emissions
$PM_{10}\ emissions$	=	PM_{10} emissions for the sector
$TPM\ emissions$	=	TPM emissions for the sector

Equation A2–2: $PM_{2.5}$ Distribution Ratio

$$PM_{2.5}\ ratio = \frac{PM_{2.5}\ emissions}{TPM\ emissions}$$

Where		
$PM_{2.5}\ ratio$	=	Ratio of the sector's $PM_{2.5}$ emissions to TPM emissions
$PM_{2.5}\ emissions$	=	$PM_{2.5}$ emissions for the sector
$TPM\ emissions$	=	TPM emissions for the sector

Equation A2–3: $PM_{2.5}/PM_{10}$ Distribution Ratio

$$PM_{2.5}/PM_{10}\ ratio = \frac{PM_{2.5}\ emissions}{PM_{10}\ emissions}$$

Where		
$(PM_{2.5}/PM_{10})ratio$	=	Ratio of the sector's $PM_{2.5}$ emissions to the PM_{10} emissions
$PM_{2.5}\ emissions$	=	$PM_{2.5}$ emissions for the sector
$PM_{10}\ emissions$	=	PM_{10} emissions for the sector

The TPM, PM_{10} and $PM_{2.5}$ emissions calculated using the distribution procedure are added to the list of point source emissions and flagged as an Environment and Climate Change Canada estimate.

Table A2–25 Particulate Matter (PM) Distribution Ratios[a]

Sector	PM_{10} Ratio	$PM_{2.5}$ Ratio	$PM_{2.5}/PM_{10}$ Ratio
Ore and Mineral Industries			
Aluminium Industry			
Primary Aluminium Smelting and Refining	0.686	0.559	0.798
Secondary Aluminium (Includes Recycling)	0.951	0.937	0.926
Asphalt Paving Industry	0.385	0.177	0.513
Cement and Concrete Industry			
Cement Manufacture	0.623	0.310	0.474
Concrete Batching and Products	0.497	0.230	0.465
Lime Manufacture	0.576	0.309	0.512
Foundries			
Die Casting	0.711	0.510	0.810
Ferrous Foundries	0.711	0.510	0.723
Non-ferrous Foundries	0.927	0.490	0.719
Iron and Steel Industries			
Primary (Blast Furnace and DRI)	0.598	0.403	0.650
Secondary (Electric Arc Furnaces)	0.616	0.474	0.802
Steel Recycling	0.711	0.510	0.287
Iron Ore Industry			
Iron Ore Mining	0.513	0.191	0.432
Pelletizing	0.480	0.212	0.410
Mineral Products Industry			
Clay Products	0.802	0.094	0.484
Other Mineral Products	0.762	0.545	0.665
Mining and Rock Quarrying			
Coal Mining Industry	0.368	0.064	0.147
Metal Mining	0.532	0.283	0.509
Rock, Sand and Gravel	0.460	0.165	0.397

Table A2-25 Particulate Matter (PM) Distribution Ratios[a] (cont'd)

Sector	PM_{10} Ratio	$PM_{2.5}$ Ratio	$PM_{2.5}/PM_{10}$ Ratio
Ore and Mineral Industries (cont`d)			
Mining and Rock Quarrying (cont'd)			
Other Minerals[b]	0.465	0.197	0.398
Non-Ferrous Mining and Smelting Industry			
Primary Ni, Cu, Zn, Pb	0.649	0.375	0.606
Secondary Pb, Cu	0.574	0.396	0.748
Other Metals	0.494	0.444	0.859
Oil and Gas Industry			
Downstream Petroleum Industry			
Refined Petroleum Products Bulk Storage and Distribution	0.100	0.100	0.750
Other Downstream Petroleum Industry	0.743	0.641	0.628
Petroleum Product Transportation and Distribution			
Natural Gas Distribution	1.000	1.000	1.000
Natural Gas Transmission	1.000	1.000	1.000
Petroleum Product Pipelines	1.000	1.000	1.000
Upstream Petroleum Industry			
Bitumen and Heavy Oil Upgrading	0.729	0.451	0.603
Light Medium Crude Oil Production	0.915	0.876	0.997
Natural Gas Production and Processing	0.915	0.876	0.997
Oil Sands In-Situ Extraction and Processing	0.995	0.994	1.000
Oil Sands Mining Extraction and Processing	0.956	0.908	0.947
Petroleum Liquids Storage	0.690	0.594	0.756
Electric Power Generation (Utilities)			
Coal	0.578	0.293	0.484
Diesel	0.735	0.608	0.924
Natural Gas	0.909	0.663	0.902
Waste Materials	0.734	0.540	0.760
Other Electric Power Generation	0.735	0.608	0.924
Manufacturing			
Abrasives Manufacture	0.842	0.773	0.371
Bakeries	0.947	0.931	0.857
Chemicals Industry			
Chemical Manufacture	0.737	0.595	0.754
Fertilizer Production	0.575	0.235	0.520
Paint and Varnish Manufacturing	0.919	0.564	0.701
Petrochemical Industry	0.894	0.424	0.587
Plastics and Synthetic Resins Fabrication	0.791	0.566	0.744
Other Chemical Industries[c]	Varies	Varies	Varies
Electronics	0.958	0.833	0.834
Food Preparation	0.651	0.409	0.634
Glass Manufacture	0.836	0.755	0.919
Grain Processing	0.387	0.140	0.338
Metal Fabrication	0.747	0.590	0.771
Plastics Manufacture	0.731	0.474	0.817
Pulp and Paper Industry	0.737	0.560	0.757
Textiles	1.000	1.000	0.759
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	0.694	0.427	0.748
Wood Products			
Panel Board Mills	0.596	0.361	0.589
Sawmills	0.423	0.197	0.451
Other Wood Products	0.688	0.549	0.732
Other Manufacturing Industries[d]	Varies	Varies	Varies
Agriculture			
Animal Production	0.280	0.058	0.208
Crop Production			
Fertilizer Application	0.490	0.140	0.286
Harvesting	0.455	0.091	0.200
Tillage Practices	0.210	0.100	0.476
Wind Erosion	0.500	0.100	0.200
Fuel Use	0.646	0.503	0.749
Commercial / Residential / Institutional			
Commercial and Institutional Fuel Combustion	0.761	0.581	0.599
Marine Cargo Handling	0.396	0.147	0.365

Table A2-25 Particulate Matter (PM) Distribution Ratios[a] (cont'd)

Sector	PM_{10} Ratio	$PM_{2.5}$ Ratio	$PM_{2.5}/PM_{10}$ Ratio
Incineration and Waste (cont'd)			
Industrial and Commercial Incineration	0.718	0.359	0.479
Municipal Incineration	0.737	0.680	0.913
Waste			
Landfills	0.778	0.603	0.743
Waste Treatment and Disposal	1.000	1.000	1.000
Water and Sewage Treatment	1.000	1.000	0.968
Remediation and Other Waste Management Services	0.778	0.603	0.743
Paints and Solvents			
Dry Cleaning	1.000	1.000	1.000
Printing[e]	Varies	Varies	Varies
Surface Coatings	0.942	0.786	0.792
Dust			
Unpaved Roads[f]	0.265	0.027	0.100

Notes:
a. Based on the point source emissions for 2006 to 2013 except where indicated otherwise.
b. For the purpose of this table, this category does not include Limestone.
c. Values for PM ratios for these categories vary by subsector: Other Chemical Industries - values range from 0.465 to 0.886.
d. Values for PM ratios for these categories vary by subsector: Other Manufacturing Industries - values range from 0.122 to 0.771.
e. Values for PM ratios for these categories vary by subsector: Printing - values range from 0.786 to 1.0.
f. Ratios derived from particulate matter ratios provided in the NPRI Toolbox guidance document entitled *Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces* (https://ec.gc.ca/inrp-npri/default.asp?lang=En&n=5DF2CF83-1).

A2.5. Reconciliation of Point and Area Source Emissions

A reconciliation protocol is in place to prevent the double-counting of emissions when combining the area source and point source data for the purpose of forming the final APEI. Reconciliation is performed separately at the subsector level for each province and territory. Table A2–1 in Section A2.2 provides a complete list of the sectors that required reconciliation.

A2.5.1. General Procedures

The approach for reconciling point source and area source emissions from a province, sector and subsector and for a specific pollutant is as follows: The general approach for reconciling point source and area source emissions from a province, sector and subsector and for a specific pollutant is as follows:

- If the total area source emission quantity is greater than or equal to the total point source emission quantity, the reconciled area source estimate is equal to the total area source estimate minus the total point source estimate, as outlined in Equation A2–4.

Equation A2–4:

$$If,\ AreaSource_{Total} \geq PointSource_{Total}$$

$$Then,\ AreaSource_{REC} = AreaSource_{Total} - PointSource_{Total}$$

- If the total area source emission quantity is less than or equal to the total point source emission quantity, the reconciled area source estimate is equal to zero, as outlined in Equation A2–5.

Equation A2–5:

$$If,\ AreaSource_{Total} \leq PointSource_{Total}$$

$$Then,\ AreaSource_{REC} = 0$$

Some points to consider:

- In general, $AreaSource_{REC}$ represents non-reporting facilities (including smaller facilities or emissions from reporting facilities that do not meet reporting requirements).
- In cases where $AreaSource_{REC} = 0$ (Equation A2–5), point source data are considered to reflect all the sector emitting sources.

For most industrial sectors, the NPRI point source data captures all facilities' emissions, resulting in area source estimates not being required (i.e. $AreaSource_{REC} = 0$). However, certain industrial sectors still have an area source component and require reconciliation.

Reconciliation procedures were performed for sector/subsectors that had both area source and point source emissions (Table A2–1). For example, for 2015, reconciliation was performed for the asphalt paving industry.

A2.5.2. Wood Products

Particulate matter emissions (TPM, PM_{10} and $PM_{2.5}$) from Sawmills and Panel Board Mills (Wood Products sector) were not reconciled using the procedure described in section A2.5.1. Rather, NPRI facility-reported data from Sawmills and Panel Board Mills were used to characterize the entire industry. These point source data, together with a number of production indicators, were used to estimate the PM emissions from facilities that are not required to report to the NPRI but that are operational. These estimates were reported as area source emissions. The sum of the resulting area source emissions and NPRI point source emissions represents the total emissions for these subsectors. All other pollutants were reconciled at the subsector and provincial level according to the standard procedure and equations outlined in section A2.5.1.

A2.6. Dry Cleaning, General Solvent Use, Printing and Surface Coatings

The area source emissions in the Dry Cleaning, General Solvent Use, Printing, and Surface Coatings sectors (Paints and Solvents source category) include a total of 92 different kinds of solvents and applications. The challenge is to reconcile the area source estimates with point source emissions reported by facilities, which include a variety of sources (solvent use as well as processes, fuel combustion, road dust, etc.) grouped under the same North American Industry Classification System. Due to this sector's complexity, reconciliation of area source emissions with the point source emissions from the NPRI requires that several steps be performed by a specially designed database application (Cheminfo 2016a):

1. Allocating the solvent use area source emissions to the 4-digit NAICS level from the NPRI;
2. Allocating the NPRI VOC inventory totals at the 4-digit NAICS level to "Process" and "Solvent" type emissions;
3. Subtracting the "Solvent" type NPRI emissions from the area source solvent emissions.

If subtraction of the point source emissions from the area source emissions for a certain solvent use yields a small negative value, the emission estimate for that area source is set to zero. However, if the reconciliation yields a large negative value, examination/verification of both the area and point source estimates and the allocation percentages for that solvent use is performed, and the estimates are adjusted accordingly.

A2.7. Mercury in Products

Mercury can be released to air throughout the life cycle of mercury-containing products, including during manufacture, distribution, use, disposal, transportation and final disposition, as well as through waste streams. Releases can also result from breakage and processing. As such, reconciliation of Hg air emissions from mercury in products with NPRI facility-reported data involves a review and characterization of the source of the Hg air emissions included in the facility-reported estimate

(primarily in the waste sector, such as the landfill) to ensure that the Hg emissions estimated through the life-cycle approach are not duplicated in the facility-reported data.

A3

PREPARATION OF APEI DATA FOR SUBMISSION TO THE UNECE PER CLRTAP OBLIGATIONS

A3.1. Introduction

Canada submits reports on atmospheric emissions of air pollutants to the European Monitoring and Evaluation Programme (EMEP) Centre on Emission Inventories and Projections (CEIP)[1] pursuant to the Convention on Long-range Transboundary Air Pollution (CLRTAP) and its associated protocols. Of these, the 1999 Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, the 1998 Aarhus Protocol on Heavy Metals and the 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs) identify the pollutants and reporting requirements under the CLRTAP. Table A3–1 lists the atmospheric pollutants for which annual emissions are reported to the United Nations Economic Commission for Europe (UNECE), along with the corresponding protocols under CLRTAP.

The present edition of the APEI indicates that 14 of the 17 reported air pollutants show reductions compared to historical levels:

- Emissions of sulphur oxides (SOx) were 1.0 million tonnes in 2015 68% below the emission ceiling of 3.3 million tonnes established under the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions or their Transboundary Fluxes.
- Emissions of nitrogen oxides (NOx) were 1.8 million tonnes in 2015, 19% below the emission ceiling of 2.3 million tonnes established under the 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes.
- In 2015, emissions of cadmium (Cd), lead (Pb) and mercury (Hg) were 83%, 76% and 75% respectfully

1 CEIP available online at: http://www.ceip.at/.

Table A3–1 Pollutant Emissions Reported to the UNECE and Related Protocols under CLTRAP

Pollutant	Relevant Protocols under the CLRTAP	Protocol Obligation
TPM	2012 Gothenburg Protocol	Voluntary, pending ratification of protocol
PM_{10}	2012 Gothenburg Protocol	Voluntary, pending ratification of protocol
$PM_{2.5}$	2012 Gothenburg Protocol	Voluntary, pending ratification of protocol
BC	2012 Gothenburg Protocol	Voluntary reporting
SO_x	2012 Gothenburg Protocol / 1985 Helsinki Protocol / 1994 Oslo Protocol	Reduction of SO_x emissions or their transboundary fluxes by at least 30 percent
NO_x	2012 Gothenburg Protocol / 1988 Sofia Protocol	Stabilize (not exceed) 1987 NO_x level
VOCs	2012 Gothenburg Protocol / 1991 Geneva Protocol	Voluntary, pending ratification of protocol
CO	—	Voluntary, pending ratification of protocol
NH_3	2012 Gothenburg Protocol	Voluntary, pending ratification of protocol
Pb	1998 Aarhus Protocol on Heavy Metals	50% reduction of 1990 level by 2011
Cd	1998 Aarhus Protocol on Heavy Metals	50% reduction of 1990 level by 2011
Hg	1998 Aarhus Protocol on Heavy Metals	50% reduction of 1990 level by 2011
D/F	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
B(a)p	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
B(b)f	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
B(k)f	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
I(cd)p	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
HCB	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level

below the ceilings established under the 1998 Aarhus Protocol on Heavy Metals.

In 2015, emissions of all Persistent Organic Pollutants (POPs) were below ceilings established in the 1998 Aarhus Protocol on Persistent Organic Pollutants including the four species of polycyclic aromatic hydrocarbons (PAHs) (67% below), hexachlorobenzene (HCB) (91 % below), and dioxins and furans (87% below). Emissions of non-methane volatile organic compounds (VOCs) and carbon monoxide (CO) decreased by 36% and 54%, respectively, since 1990, even though Canada has no specific emission reduction targets for these substances.

Exceptions to the general downward trends described above occur for emissions of ammonia (NH_3) (22% above 1990 levels in 2015), and total particulate matter (TPM) (11% above 1990 levels in 2015), although fine particulate matter emissions decreased (18%) in the same time frame.

In 2017, Canada's Air Pollutant Emission Inventory (APEI) will accompany the UNECE report on 1985–2015 emissions.

A3.2. Overview of the UNECE Reporting Template

The UNECE Nomenclature for Reporting (NFR) categories correspond to the sectors described in the European Monitoring and Evaluation Programme/European Environment Agency (EMEP/EEA) 2013 Air Pollutant Emission Inventory Guidebook (EMEP/EEA 2013). In addition to providing technical guidance for developing inventory methodologies, the 2013 EMEP/EEA guidebook includes instructions for attributing sectoral emissions to NFR codes.

Table A3–2 Excerpt from UNECE NFR 14 Reporting Template for 2017

Annex 1: National sector emissions: Main pollutants, particulate matter, heavy metals and persistent organic pollutants

	NFR sectors to be reported			Main Pollutants (from 1990)				Particulate Matter (from 2000)				Other (from 1990)	
				NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH_3	$PM_{2.5}$	PM_{10}	TSP	BC	CO	HCB
NFR Aggregation for Gridding and LPS (GNFR)	**NFR Code**	**Longname**	**Notes**	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kt*	*kg*
A_PublicPower	1 A 1 a	Public electricity and heat production											
B_Industry	1 A 1 b	Petroleum refining											
B_Industry	1 A 1 c	Manufacture of solid fuels and other energy industries											
B_Industry	1 A 2 a	Stationary combustion in manufacturing industries and construction: Iron and steel											
B_Industry	1 A 2 b	Stationary combustion in manufacturing industries and construction: Non-ferrous metals											
B_Industry	1 A 2 c	Stationary combustion in manufacturing industries and construction: Chemicals											
B_Industry	1 A 2 d	Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print											
B_Industry	1 A 2 e	Stationary combustion in manufacturing industries and construction: Food processing, beverages and tobacco											
B_Industry	1 A 2 f	Stationary combustion in manufacturing industries and construction: Non-metallic minerals											
I_Offroad	1 A 2 g vii	Mobile combustion in manufacturing industries and construction: (please specify in your IIR)											
B_Industry	1 A 2 g viii	Stationary combustion in manufacturing industries and construction: Other (please specify in your IIR)											

Whereas the APEI report groups emissions by sectors (e.g. pulp and paper industry), the emissions in the UNECE are grouped by process and combustion sources. For example, the pulp and paper industry within the APEI includes both combustion and process emissions. The combustion component is mapped to NFR sector 1A2d (Stationary combustion in manufacturing industries and construction: Pulp, Paper and Print). The process component is mapped to NFR sector $2H_1$ (Pulp and paper industry).

Table A3–2 illustrates the structure of the UNECE reporting template for the category 1A1b Petroleum Refining. The template in its entirety can be found on the CEIP website

A3.3. Mapping of APEI Emissions to UNECE NFR Categories

The mapping of emissions by APEI sectors to the UNECE NFR categories involves the division of sectoral emissions into their combustion and process components. Whereas certain sectors contribute solely a process component (in the case of road dust) or solely a combustion component (in the case of mobile sources), the majority of sectoral emissions are distributed over both components. This is accomplished using a split ratio, which, apart from a small number of exceptions, is assigned to a particular subsector and pollutant. For example, in the alumina production sector, all Hg, CO, sulphur dioxide (SO_2) and VOC emissions are attributed to combustion activities, while the remaining pollutants are attributed to both the bauxite refining process and combustion activities (Table A3–3).

The mapping of APEI sector emissions to UNECE NFR categories is achieved through the use of database queries. A manual process is in place to verify the results during the quality assurance / quality control process.

Table A3–3 APEI Sub-sector to UNECE NFR Category Mapping Example

APEI Subsector	Subclass Code	UNECE NFR Category		Pollutant	Split ratios (w/w)	
		Combustion	Process		Combustion	Process
Alumina (Bauxite Refining)	10201	1A2b: Stationary combustion in manufacturing industries and construction: Non-ferrous metals	2C3: Aluminium production	TPM	0.229	0.771
				PM_{10}	0.290	0.710
				$PM_{2.5}$	0.352	0.648
				SOx	1.000	0.000
				NOx	0.746	0.254
				CO	1.000	0.000
				VOCs	1.000	0.000
				Hg	1.000	0.000

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