Environment Canada Environnement Canada

Air Pollutant Emission Inventory Report

1990–2013

Canada

En81-6/2014E-PDF
ISSN: 1719-0487

Environment Canada
Inquiry Centre
10 Wellington Street, 23rd Floor
Gatineau QC K1A 0H3
Telephone: 819-997-2800
Toll Free: 1-800-668-6767 (in Canada only)
Fax: 819-994-1412
TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

Acknowledgements

The Pollutant Inventories and Reporting Division (PIRD) of Environment Canada (EC) wishes to acknowledge the individuals and organizations that contributed to the *Air Pollutant Emission Inventory Report: 1990-2013* and emission summary tables for submission to the United Nations Economic Commission for Europe (UNECE) under the Convention on Long-range Transboundary Pollution (CLRTAP). The Division would like to highlight the contributions of the following inventory compilers, authors and reviewers, whose work helped to improve this year's inventory report and estimates:

Luc Allard, John Ayres, Susan Charles, Angie Giammario, Jason Hawirko, Richard Joannette, Chelsea Kealey, Francois Lavallée, Chang Liang, Douglas MacDonald, John Moritz, David Niemi, Henry Quon, Steve Smyth, Brett Taylor, Emily West and Nick Zhao.

Special thanks to the National Pollutant Release Inventory (NPRI) Data Collection Section of the Programs Integration Division of Environment Canada for providing database extracts from the 2013 NPRI.

We are also indebted to Environment Canada colleagues; Pascal Bellavance, Tonya Bender, André Blais, Emile Boudreau, Alain Gingras, Maxime Grenier, Jason Hickey, Richard Holt, Megan Lewis, Lynn Lyons, Scott McKibbon, Craig Palmer, Mourad Sassi and Kristine Tracey, for their assistance.

The compilation and coordination of the emission summary tables for the UNECE submission under the CLRTAP was managed by John Moritz. The APEI database was managed by Richard Joannette.

Overall coordination of the *Air Pollutant Emission Inventory Report* was managed by Susan Charles, Mona Jennings and Emily West. Compilation and layout of the report was carried out by Mona Jennings. Editing was provided by Len Goldberg and the translation services were provided by the Translation Bureau of Public Works Canada. Special thanks to Ian Hickey for providing comments on the report and David Maher for the webpage updates.

Of the numerous people and organizations that provided support and information, we are especially indebted to the many individuals in various federal departments, provincial ministries, industries and industry associations, consulting firms, and universities who provided technical and scientific support.

Readers' Comments

Comments regarding the contents of this report should be addressed to Canada's Air Pollutant Emission Inventory Focal Point:

Director, Pollutant Inventories and Reporting Division
Science and Risk Assessment
Science and Technology Branch
Environment Canada
200 Sacré-Coeur Boulevard, 10th Floor
Gatineau QC K1A 0H3

Email: apei-iepa@ec.gc.ca

List of Acronyms, Abbreviations and Units

APEI	Air Pollutant Emission Inventory
CAC	Criteria air contaminant
Cd	Cadmium
CEIP	Centre on Emission Inventories and Projections
CEPA 1999	*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
D/F	Dioxins and furans
DRI	Direct reduced iron
EEA	European Environment Agency
EF	Emission factor
EMEP	European Monitoring and Evaluation Programme
g	Grams
gTEQ	Grams of toxic equivalent
HC	Hydrocarbon
HCB	Hexachlorobenzene
Hg	Mercury
ICI	Industrial-commercial-institutional
IE	Included Elsewhere
kg	Kilograms
kt	Kilotonnes
LFPS	Livestock Farm Practices Survey
LPG	Liquefied petroleum gas
MDF	Medium-density fiberboard
MEIT	Marine Emissions Inventory Tool
MOU	Memorandum of Understanding

Mt	Megatonnes
NAESI	National Agri-Environmental Standards Initiative
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
OSB	Oriented strand board
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
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
POPs	Persistent organic pollutants
PS	Point sources
RAC	Rail Association of Canada
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
VKT	Vehicle kilometres travelled
VOCs	Volatile organic compounds

Table of Contents

List of Tables

List of Figures

ES

Executive Summary

The 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) endeavours to limit and, as far as possible, gradually reduce and prevent air pollution. Since 1979, 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 measures-specific protocols, for the reduction of emissions of sulphur, nitrogen oxides, cadmium, lead, mercury, dioxins and furans, and other persistent organic pollutants (POPs). Parties to the CLRTAP protocols are required to report emissions of these atmospheric pollutants annually to the United Nations Economic Commission for Europe by February 15.

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 sulphur, nitrogen oxides and volatile organic compounds (VOCs) other than methane. In addition, Canada collects and publishes data on emissions of ammonia, carbon monoxide and three categories of particulate matter.

Canada's Air Pollutant Emission Inventory (APEI) has been prepared and published by Environment Canada since 1973. The APEI is a comprehensive inventory of emissions of 17 air pollutants at the national, provincial and territorial levels. This inventory fulfills Canada's international reporting obligations, supports 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.

This edition of the APEI reports the most recent estimates of air pollutant emissions for 1990–2013 as of February 2015. The inventory indicates that 12 of the 17 reported air pollutants show reductions compared to historical levels. Specifically:

- Emissions of sulphur (as sulphur oxides) were 1200 thousand tonnes in 2013, 62% below the emission ceiling of 3300 thousand tonnes established under the Helsinki Protocol.
- Emissions of nitrogen oxides were 2100 thousand tonnes in 2013, 26% below the emission ceiling of 2800 thousand tonnes established under the Sofia Protocol.
- In 2013, emissions of cadmium, lead and mercury were 81% (for both cadmium and lead) and 77% (for mercury) below the ceilings established under the Aarhus Protocol on Heavy Metals.
- The Aarhus Protocol also includes emission reduction commitments for POPs. In 2013, emissions of all POPs were largely below their ceilings, including the four species of polycyclic aromatic hydrocarbons (PAHs) (58% below their ceiling), hexachlorobenzene (HCB) (90% below its ceiling), and dioxins and furans (84% below their ceiling).

Emissions of non-methane VOCs and of carbon monoxide decreased by 51% and 63%, respectively, since 1990, even though Canada has no specific emission reduction targets for these substances.

Exceptions to the general downward trends described above are observed in emissions of ammonia (22% above 1990 levels in 2013), and particulate matter (52% above 1990 levels in 2013).

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 1999) include, but are not limited to, the following:

- *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)
- *Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations* (2013)
- *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations* (amended 2011)
- *Off-Road Compression-Ignition Engine Emission Regulations* (amended 2012)
- *Off-Road Small Spark-Ignition Engine Emission Regulations* (amended 2012)
- *On-Road Vehicle and Engine Emission Regulations* (amended 2014)
- *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* (amended 2014)
- *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 2009)
- *Products Containing Mercury Regulations* (2014)
- *Secondary Lead Smelter Release Regulations* (1991)
- *Export of Substances on the Export Control List Regulations* (2013)
- *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* (1992)

All regulations administered under CEPA 1999 are available in the registry: www.ec.gc.ca/lcpe-cepa/eng/regulations/?n=54FE5535-1.

1

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, provincial and territorial levels, prepared and published by Environment Canada since 1973. The APEI serves many purposes, including the following:

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

The APEI compiles emissions of 17 air pollutants contributing to smog, acid rain and poor air quality:

- Smog precursors: total particulate matter (TPM), 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)
- Persistent organic pollutants (POPs): dioxins and furans, 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)

Emissions at the national level are grouped into six main sources:

- Industrial
- Non-industrial (electricity and energy generation)
- Mobile
- Incineration
- Miscellaneous
- Open

Industrial sources include emissions from heavy industry and the manufacturing sector, whereas non-industrial sources include emissions from fuel combustion in residential, commercial and institutional settings and electricity generation. Mobile sources consist of emissions from vehicles, air, rail and other transportation-related devices; incineration sources include emissions from the burning of material in dedicated facilities; miscellaneous sources consist of emissions from sectors that cannot be included elsewhere; and open sources are stationary diffuse sources that emit air pollutants over large geographical areas. The six main sources are broken down further into 62 sectors and 193 associated subsectors (Table 1–1).

Environment Canada compiles and publishes the APEI on an annual basis. A time series of annual emissions is regularly updated from 1990 to the current inventory year in order to indicate the trend in emissions.

In recent years, information on emissions from facilities has originated primarily from the National Pollutant Release Inventory (NPRI), 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 in the post-2000 years, and Alberta and Newfoundland provide supplementary information for selected sources that are not reported to the NPRI. The APEI also incorporates emissions estimated by Environment Canada for sources not reported to the NPRI.

1.2. Reporting Requirements

The first national inventory of Canadian air pollutant emissions was compiled in 1973, with national and provincial /territorial estimates for 1970. Emissions of CO, SO_x, NO_x, hydrocarbons (HCs) and PM were included. Air emission estimates for Canada have continued to be published since 1973. The 1979 Convention on Long-range Transboundary Air Pollution (CLRTAP) endeavours to limit and, as far as possible, gradually reduce and prevent air pollution. Since 1979, 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 measures-specific protocols, for the reduction of emissions of sulphur, NO_x, Cd, Pb, Hg, dioxins and furans, and other persistent organic pollutants (POPs). Each protocol includes specific emission targets to be achieved. Parties are required to report emissions to the United Nations Economic Commission for Europe (UNECE) by February 15 each year. The five protocols ratified by Canada are:

- the 1985 Helsinki Protocol on the Reduction of Sulphur Emissions (NO_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),
- the 1998 Aarhus Protocol on Persistent Organic Pollutants (dioxins/furans, four species of PAHs, and HCB), and
- 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 (EMEP).

Table 1–1 APEI Sector Descriptions

APEI Source/Sector	Sector Descriptions
Industrial Sources	
Aluminium Industry	Emissions resulting from: - Alumina production through bauxite refining - Primary aluminium production through smelting and refining - Secondary aluminium production in which aluminium is recovered from aluminium-containing scrap
Asphalt Paving Industry	Emissions released during asphalt concrete (or hot-mix asphalt) manufacturing. Emissions are from permanent and portable hot-mix asphalt installations.
Cement and Concrete Industry	Emissions resulting from: - The entire process of cement production in rotary kilns - The preparation of concrete and ready-mix concrete - Lime manufacture - Concrete batching and products
Chemicals Industry	Emissions resulting from a 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.
Mineral Products Industry	Emissions resulting from the manufacture of brick and related clay products such as pipes, liner and tiles.
Foundries	Emissions from 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 included are: open ferrous, electric arc and induction foundries.
Grain Industries	Emissions produced by: primary, process, terminal and transfer elevators, as well as manufacturing or processing grain for use in other products.
Iron and Steel Industries	Emissions from 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 Mining Industry	Emissions resulting from iron ore mining, beneficiation by concentration and sintering into pellets are included.
Mining and Rock Quarrying	Emissions from 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 Smelting and Refining Industry	Emissions resulting from: - Primary copper and nickel production using pyrometallurgical operations - Lead ore crushing, concentrating and metallurgic processing - Zinc metal production through electrolytic processes
Pulp and Paper Industry	Emissions from 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 r efining, screening and drying, and various steps in chemical recovery systems.
Wood Industry	Emissions from: - Sawmills - Panel board mills (including veneer, plywood, waferboard, particle board and medium-density fiberboard mills) - Other wood products (including furniture and cabinet makers, wood treating plants, wood pellet mills and Masonite manufacturers)
Upstream Petroleum Industry	Emissions from drilling, testing and servicing of wells, conventional oil and gas production, in situ oil sands production, natural gas processing and transmission, oil transmission.
Downstream Petroleum Industry	Emissions from the refining and processing of crude oil to make fuels or other products such as solvents or asphalt.
Petroleum Product Transportation and Distribution	Emissions from the distribution of fuels from refineries. Includes pipelines, terminals (large distribution facilities), bulk plants (smaller distribution facilities).
Other Industries	Emissions resulting from manufacturing, food production or processing industries that are not included under a specific industrial sector.
Biofuel Production	Emissions from the production of ethanol for fuel or oils for biodiesel.
Non-Industrial Sources	
Commercial Fuel Combustion	Emissions resulting primarily from external combustion sources used for space/water heating in commercial establishments, health and educational institutions and government/public administration facilities.
Electric Power Generation (Utilities)	Electric power generation includes electrical power produced by utilities and by industry for commercial sale and/or private use.
Residential Fuel Combustion	Emissions resulting primarily from combustion of fossil fuels used for space/water heating in residences.
Residential Fuel Wood Combustion	Emissions from burning of fuel wood and pellets for space heating and hot water. Includes emissions from fireplaces, wood stoves and wood-fired boilers.
Mobile Sources	
Air Transportation	Emissions from 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	Emissions from diesel vehicles over 3856 kilograms.
Heavy-duty Gasoline Trucks	Emissions from gasoline trucks over 3856 kilograms.
Light-duty Diesel Trucks	Emissions from diesel trucks under 3856 kilograms.
Light-duty Diesel Vehicles	Emissions from diesel vehicles under 3856 kilograms.
Light-duty Gasoline Trucks	Emissions from gasoline trucks under 3856 kilograms.
Light-duty Gasoline Vehicles	Emissions from gasoline vehicles under 3856 kilograms.
Marine Transportation	Emissions from marine craft in anchored, berth and underway phases.
Motorcycles	Emissions from motorcycles.
Off-road Use of Diesel	Emissions from off-road vehicles using diesel fuel in mining, construction, agriculture, commercial purposes, logging, railway maintenance, airport ground support, and lawn and garden equipment, along with recreational vehicles.

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

APEI Source/Sector	Sector Descriptions
Mobile Sources (cont'd)	
Off-road Use of Gasoline/LPG/CNG	Emissions from off-road vehicles using gasoline, liquid petroleum gas, and compressed natural gas in mining, construction, agriculture, commercial purposes, logging, railway maintenance, airport ground support, and lawn and garden equipment, along with recreational vehicles.
Rail Transportation	Emissions from freight and passenger trains, including yard switching activities.
Tire Wear and Brake Lining	Emissions released from tire and brake lining wear from all categories of road transportation.
Incineration Sources	
Crematorium	Emissions resulting from the combustion of caskets and bodies.
Industrial & Commercial Incineration	Emissions resulting from the 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	Emissions released from incinerators used to combust municipal solid waste and recover energy.
Other Incineration & Utilities	Emissions from sewage sludge incineration and other small incinerators.
Miscellaneous Sources	
Cigarette Smoking	Emissions resulting from: - Mainstream cigarette smoke, which is directly exhaled by the smoker - Sidestream smoke, which is directly released from burning cigarettes
Dry Cleaning	Emissions from companies that provide dry cleaning of fabric and leather items.
General Solvent Use	Emissions resulting 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 are also included.
Marine Cargo Handling Industry	Fugitive emissions produced by the handling, loading and unloading of materials, goods and merchandise from ships to docks.
Meat Cooking	Emissions resulting from the frying and charbroiling of meat, fish and poultry in commercial and residential locations.
Refined Petroleum Products Retail	Fugitive VOC emissions resulting from fuel transfers and storage at service stations.
Printing	Emissions from the manufacturing or use of printing inks, which includes: flexographic, gravure, letterpress, lithographic and other printing.
Structural Fires	Emissions from vehicle fires and fires that burn buildings.
Surface Coatings	Emissions from a broad range of applications and industries, including individuals and companies engaged in the manufacturing or use of paints and coatings.
Human	Emissions from human respiration and perspiration.
Other Miscellaneous Sources	Emissions resulting from infant-diapered waste and non-agricultural fertilizer application.
Open Sources	
Agriculture	Emissions from agricultural operations and facilities, including: - The volatilization of ammonia from nitrogen in manure, including: animal housing, transport to long-term storage, storage, and application of manure to the field - Wind erosion and mechanical disturbances, such as seeding and tilling operations - The application of synthetic nitrogen fertilizers for annual and perennial crop production - Primarily external combustion sources used for space/water heating in agricultural facilities and for crop drying
Construction Operations	Emissions resulting from soil disturbance on construction sites (residential, industrial-commercial-institutional (ICI), engineering).
Dust from Paved Roads	Emissions resulting from the re-suspension of particulate matter by vehicles travelling on paved roads.
Dust from Unpaved Roads	Emissions resulting from the re-suspension of particulate matter by vehicles travelling on unpaved roads.
Dust from Coal Mining	Emissions resulting from the transportation of coal by train, lake vessels or truck.
Waste	Emissions from 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. Also includes emissions from on-site burning of residential waste materials in backyard barrel or open-pit burning.
Mine Tailings	Emissions resulting primarily from wind erosion at mine tailings ponds located on active and inactive mine sites.
Prescribed Burning	Emissions from controlled fires used for land management treatments such as: - Reducing logging residues - Managing forest production - Controlling insects - Minimizing the potential for destructive wildfires Excludes the burning of agricultural residues.

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 sulphur, NO_x, and VOCs other than methane. In addition, Canada collects and publishes data on emissions of NH_3, CO, VOCs and three categories of PM (TPM, PM_{10} and $PM_{2.5}$). Canada voluntarily reports the emissions from these six substances, along with the eleven substances for which there are protocols, to the UNECE by February 15 annually.

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 1999) include, but are not limited to, the following:*

- *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)
- *Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations* (2013)
- *Marine Spark-Ignition Engine, Vessel and Off-Road Recreational Vehicle Emission Regulations* (amended 2011)
- *Off-Road Compression-Ignition Engine Emission Regulations* (amended 2012)
- *Off-Road Small Spark-Ignition Engine Emission Regulations* (amended 2012)
- *On-Road Vehicle and Engine Emission Regulations* (amended 2014)
- *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* (amended 2014)
- *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 2009)
- *Products Containing Mercury Regulations* (2014)
- *Secondary Lead Smelter Release Regulations* (1991)
- *Export of Substances on the Export Control List Regulations* (2013)
- *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations* (1992)

All regulations administered under CEPA 1999 are available in the registry: http://www.ec.gc.ca/lcpe-cepa/eng/regulations/?n=54FE5535-1.

2

2013 Emissions and Trends

This chapter describes, for each pollutant, the main sources and sectors contributing to the 2013 emissions and to the historical trends.

The 2013 emissions by sources are presented in Table 2–1. Emissions of criteria air contaminants, i.e., total particulate matter (TPM), particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), sulphur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO) and ammonia (NH_3) are in kilotonnes (kt); emissions of the heavy metals mercury (Hg), cadmium (Cd) and lead (Pb), and of polycyclic aromatic hydrocarbons (PAHs), are in kilograms (kg); emissions of dioxins and furans (D/F) and hexachlorobenzene (HCB) are in grams of toxicity equivalent (gTEQ)[1] and grams (g), respectively.

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. Although the rounding protocol was applied to all data in tables and charts in this report, all subtotals and totals were calculated prior to application of the protocol.

1 A mass or concentration that is a sum of the masses or concentrations of individual congeners of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans multiplied by weighting factors.

While all source categories emit pollutants to some extent, the contribution of each source category to total emissions of air pollutants varies with substances (Table 2–1). Open sources are particularly important sources of PM emissions, accounting for 79% of total $PM_{2.5}$ emissions. Open sources also account for most NH_3 emissions (94%) and a significant proportion of HCB (54%) and D/F (28%) emissions. Industrial sources account for the largest proportion of SO_x (69%), VOCs (37%), Pb (70%), Cd (78%) and Hg (41%) emissions. Mobile sources are the most important emitters of NO_x (55%) and CO (59%). Non-industrial sources are particularly significant sources of PAHs (75%).

Source categories are broken down into sectors (e.g. the aluminium industry is a sector within industrial sources) and subsectors (e.g. primary aluminium smelting and refining is a subsector in the aluminium industry). The different components of each source category contribute varying proportions of emissions of each pollutant (Table 2-2). For example, within the open sources, dust and construction operations are by far the largest causes of total PM emissions. The upstream petroleum industry is the largest emitter of VOCs and CO among industrial sources. In mobile sources, all diesel engines are important emitters of NO_x.

The subsequent sections of this chapter identify the important sources of emissions for each substance in 2013 and their varying contribution to total emissions over time.

National, provincial and territorial data for pollutant emissions from 1990-2013 are available through the Air Pollutant Emission Inventory Online Data Query Tool, at http://ec.gc.ca/inrp-npri/donnees-data/ap/index.cfm?lang=En.

Table 2–1 2013 Total Air Pollutant Emissions for Canada by Source

	Sources						
Pollutants	**Industrial**	**Non-Industrial**	**Mobile**	**Incineration**	**Miscellaneous**	**Open**	**Total**
TPM (kt)	400	200	66	0.19	11	23 000	24 000
PM_{10} (kt)	140	180	65	0.11	10	7 100	7 500
$PM_{2.5}$ (kt)	66	170	57	0.08	9.8	1 200	1 500
SO_x (kt)	850	300	75	2.4	0.14	10	1 200
NO_x (kt)	670	240	1 100	2.4	0.053	9.5	2 100
VOC (kt)	780	240	430	0.82	420	270	2 100
CO (kt)	1 300	1 300	3 700	4.1	3.9	39	6 300
NH_3 (kt)	14	3.2	8.5	0.39	1.8	460	490
Pb (kg)	92 000	4 800	36 000	360	70	100	130 000
Cd (kg)	6 900	1 500	310	9.4	5.9	110	8 800
Hg (kg)	1 600	1 100	89	330	330	530	4 000
D/F (gTEQ)	7.8	9.4	30	3.8	0.011	20	71
PAH (kg)	32 000	100 000	1 100	0.13	3.3	1 400	140 000
HCB (g)	2 600	710		580		4 700	8 600

Note: Totals may not add up due to rounding.

Table 2–2 2013 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)
Industrial sources	**400 000**	**140 000**	**66 000**	**850 000**	**670 000**	**780 000**	**1 300 000**	**14 000**	**92 000**	**6 900**	**1 600**	**8**	**32 000**	**2 600**
Aluminium Industry	8 800	5 500	4 400	65 000	1 500	1 400	410 000				21		31 000	
Alumina (Bauxite Refining)	150	58	51	210	450	27	4 000							
Primary Aluminium Smelting & Refining	8 700	5 400	4 300	64 000	1 100	1 400	410 000				21		31 000	
Asphalt Paving Industry	20 000	4 100	1 000	610	1 200	5 800	4 500		990	23	22	0.0049	15	
Cement and Concrete Industry	42 000	14 000	6 600	23 000	31 000	430	13 000	430	530	16	310	0.54	1.7	420
Cement Manufacture	2 800	1 700	840	20 000	26 000	320	9 400	400	410	11	310	0.54	1.7	420
Lime Manufacture	1 800	1 000	470	2 800	4 100	49	3 100	29	13	4.1	1.4			
Concrete Batching & Products	37 000	11 000	5 300	88	110	66	410		100	0.97	0.046			
Chemicals Industry	3 600	2 800	1 300	15 000	22 000	14 000	14 000	7 100	64	6.4	17	0.13	25	
Chemical Manufacture	1 400	920	670	13 000	9 100	4 700	7 200	100	52	0.0017	16	0.13	25	
Paint & Varnish Manufacturing	15	13	9.4	0.0014	3.2	1 400	2.7	1.6	1.8					
Petrochemical Industry	940	910	130	67	4 000	2 600	1 900	0.017	9	3.5	0.43		0.015	
Plastics & Synthetic Resins Fabrication	280	270	240	15	280	2 600	230	36			0.016	0.0001		
Fertilizer Production	880	630	260	1 600	6 500	330	3 600	5 400	1.3	2.9				
Other (Chemical Industries)	94	40	37	1.7	2 100	1 900	1 100	1 600						
Mineral Products Industry	640	560	450	1 800	520	99	720	420			0.0005			
Clay Products	61	46	9.8	350	29		84							
Other Mineral Products	580	520	440	1 400	490	99	630	420			0.0005			
Foundries	6 100	5 700	5 200	48	140	370	49 000		91	1.7		0.0001		
Ferrous Foundries	6 100	5 700	5 200	48	140	370	49 000		64	1.6		0.0001		
Non-ferrous Foundries	0.86	0.64	0.62						28	0.13				
Die Casting	7.6	5.6	4.3											
Grain Industries	53 000	14 000	2 300	630	970	2 600	390	7.5						
Iron and Steel Industries	6 300	3 600	2 100	24 000	11 000	920	23 000	78	5 100	230	590	2.8	550	1 100
Primary (Blast Furnace and DRI)	5 900	3 400	2 000	23 000	9 700	570	19 000	71	3 800	200	230	1.2	540	150
Secondary (Electric Arc Furnaces)	400	220	160	720	1 300	350	3 200	7.3	1 300	35	360	1.6	0.78	970
Steel Recycling											9.5			
Iron Ore Mining Industry	13 000	3 100	1 100	11 000	13 000	290	20 000		2 100	69	100		18	
Iron Ore Mining Industry	2 500	880	330	460	1 500		3 400		77	8.3				
Pelletizing	11 000	2 200	740	11 000	11 000	290	17 000		2 000	61	100		18	
Mining and Rock Quarrying	180 000	43 000	10 000	2 300	22 000	1 800	14 000	93	3 100	300	7.9	0.56	130	13
Rock, Sand and Gravel	110 000	14 000	2 800	0.27	170	0.25	72							
Metal Mining	19 000	8 800	3 600	570	7 800	270	7 900	32	2 900	300	4.4	0.031		5.8
Coal Mining Industry	38 000	14 000	1 400	1 000	2 600	330	1 800		11	1.6	1.1		130	
Potash	5 900	3 200	1 700	1.5	2 200	560	1 100							
Silica Production	1 400	140	41											
Other Minerals	4 100	2 000	900	670	9 200	620	3 000	61	160	3.1	2.4	0.53		7.1
Non-Ferrous Smelting and Refining Industry	4 600	2 600	1 800	370 000	1 600	70	11 000	350	75 000	5 300	360	0.37	0.31	730
Primary Ni, Cu, Zn, Pb	4 500	2 600	1 800	370 000	1 500	40	11 000	310	75 000	5 300	360	0.37		730
Secondary Pb, Cu	10	8.4	7.5	1 300		30			210			0.0012	0.31	
Other Metals	6.7	5.4	5.3		100			38						0.09
Pulp and Paper Industry	18 000	13 000	9 200	28 000	31 000	16 000	58 000	1 700	1 400	230	50	1.8	160	94
Wood Industry	18 000	10 000	5 800	790	9 200	32 000	94 000	640	820	79	29	0.53	10	1.9
Sawmills	11 000	5 700	2 700	82	2 900	12 000	76 000		590	25		0.0059		1.7
Panel Board Mills	6 200	3 900	2 600	190	3 900	6 400	13 000	14	180	6.6	0.17	0.0027		
Other Wood Products	840	570	460	520	2 500	14 000	6 000	630	40	47	29	0.52	10	0.28
Upstream Petroleum Industry	15 000	12 000	11 000	250 000	480 000	620 000	530 000	2 500	700	130	67		9	
Crude Oil and Natural Gas Production and Processing	8 400	8 400	8 300	150 000	430 000	590 000	490 000	880						
Petroleum Liquids Storage	7.4	7.4	7.4		40	3 700								
Oil Sands In-Situ Extraction and Processing	880	850	850	10 000	18 000	3 500	16 000			14	7.4			
Oil Sands Mining Extraction and Processing	570	320	180	4 400	4 200	9 600	3 000	170	9.6	21				
Bitumen and Heavy Oil Upgrading	4 700	2 900	1 300	85 000	25 000	16 000	17 000	1 400	690	92	60		9	
Other Upstream Petroleum Industry														
Downstream Petroleum Industry	3 900	2 700	1 800	55 000	18 000	34 000	41 000	170	380	100	48		18	
Petroleum Refining	3 900	2 700	1 700	54 000	17 000	10 000	41 000	170	380	100	48		18	
Refined Petroleum Products Bulk Storage and Distribution	15	11	9.6			23 000					0.005		0.005	
Other Downstream Petroleum Industry	46	25	15	1 300	820	470	110							
Petroleum Product Transportation and Distribution	66	64	64	62	20 000	410	9 700							
Natural Gas Transmission	45	44	44		14 000	67	4 100							
Natural Gas Distribution	18	17	17	62	6 100	240	5 600							
Petroleum Product Pipelines	3	2.9	2.9		85	110								
Other Industries	6 200	3 900	2 300	2 900	4 100	50 000	5 300	320	2 300	340	13	1.1	4.1	230
Abrasives Manufacture	10	8.6	2.5			94								
Bakeries	0.9	0.9	0.9	0.0064	1.1	7 400	0.35							
Metal Fabrication	1 500	1 000	740	830	260	4 800	2 800	6.2	2 100	330	7.5	1.1	4.1	230
Glass Manufacture	200	180	150	660	530	200	200		0.37	0.56	0.13		0.0033	
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	320	270	170	150	560	7 500	580	0.77	65				0.024	
Electronics						36		17	53		3.1			
Plastics Manufacture	160	120	100	450	220	12 000	18		0.034	0.18				
Food Preparation	3 200	1 800	840	740	1 700	14 000	1 000	270						
Paint and Varnish Formulation														
Textiles	4.9	4	2.9	31	33	490	0.057							
Other (Other Industries)	820	560	240	49	820	2 800	740	21	77	6.1	2.1			
Biofuel Production	15	8.9	3.9		18	100								

Table 2-2 2013 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)
Non-industrial sources	**200 000**	**180 000**	**170 000**	**300 000**	**240 000**	**240 000**	**1 300 000**	**3 200**	**4 800**	**1 500**	**1 100**	**9.4**	**100 000**	**710**
Commercial Fuel Combustion	2 800	2 500	2 200	9 700	25 000	1 200	17 000	190	510	480	53	0.24	2.1	
Electric Power Generation (Utilities)	16 000	6 400	3 200	280 000	160 000	1 300	34 000	780	1 400	360	900	1.7	63	710
Coal	14 000	5 100	2 200	270 000	120 000	390	13 000	580	860	300	850	1.5		550
Natural Gas	800	670	470	1 300	21 000	550	15 000	110	85	47	23	0.02	0.032	140
Other (EPG)	1 100	620	500	4 900	16 000	340	5 600	82	430	20	23	0.17	63	25
Residential Fuel Combustion	2 700	2 400	2 300	6 300	31 000	1 600	12 000	410	300	480	69	0.38	3.5	
Residential Fuel Wood Combustion	170 000	160 000	160 000	2 800	20 000	230 000	1 200 000	1 800	2 700	160	41	7.1	100 000	
Mobile Sources	**66 000**	**65 000**	**57 000**	**75 000**	**1 100 000**	**430 000**	**3 700 000**	**8 500**	**36 000**	**310**	**89**	**30**	**1 100**	
Air Transportation	990	990	900	6 300	74 000	6 500	53 000	39	36 000				8.9	
Heavy-duty diesel vehicles	11 000	11 000	11 000	130	240 000	22 000	86 000	840				8.6	250	
Heavy-duty gasoline trucks	500	500	460	73	16 000	13 000	180 000	350				0.021	190	
Light-duty diesel trucks	210	210	200	2.3	3 400	540	2 100	28				1.2	17	
Light-duty diesel vehicles	150	150	150	3.5	2 600	410	1 800	17				0.7	25	
Light-duty gasoline trucks	2 800	2 800	2 600	680	92 000	74 000	980 000	3 000				0.079	190	
Light-duty gasoline vehicles	2 500	2 500	2 300	600	64 000	67 000	770 000	3 500				0.091	200	
Marine Transportation	12 000	11 000	10 000	67 000	270 000	20 000	25 000	340	540	220	5	18	110	
Motorcycles	44	44	40	4.3	620	2 100	15 000	33				0.0078	8.3	
Off-road use of diesel	19 000	19 000	19 000	180	220 000	24 000	120 000	230					0.047	
Off-road use of gasoline/LPG/CNG	5 800	5 500	5 200	91	30 000	190 000	1 400 000	100					0.42	
Rail Transportation	3 000	3 000	2 900	450	130 000	6 200	18 000	57	250	84	84	1.4	51	
Tire Wear & Brake Lining	7 300	7 300	1 800											
Incineration Sources	**190**	**110**	**80**	**2 400**	**2 400**	**820**	**4 100**	**390**	**360**	**9.4**	**330**	**3.8**	**0.13**	**580**
Crematorium	6.3	6.3	6.3	12	20	2.1	17		4.9	0.82	240	2.8		
Industrial & Commercial Incineration	47	36	18	490	660	650	1 900	72	320	1.7	6	0.006		410
Municipal Incineration	72	59	54	360	1 500	35	400	290	28	4.2	77	1	0.13	170
Other Incineration & Utilities	67	6.7	1.9	1 500	220	130	1 800	27	6.1	2.7				
Miscellaneous Sources	**11 000**	**10 000**	**9 800**	**140**	**53**	**420 000**	**3 900**	**1 800**	**70**	**5.9**	**330**	**0.011**	**3.3**	
Cigarette Smoking	470	470	470			7,9	2 200	82	1,3	3,5	0,12	0,011	0,62	
Dry Cleaning	13	13	9.1			300								
Commercial Services	13	13	9.1			300								
General Solvent Use						230 000								
Marine Cargo Handling Industry	1 200	790	480	140	29				59	2.3				
Meat Cooking	8 500	8 500	8 500										2.7	
Residential	5 100	5 100	5 100										1.6	
Commercial	3 400	3 400	3 400										1.1	
Refined Petroleum Products Retail						54 000								
Printing	26	24	21	0.0045	23	40 000	0.5		0.5					
Primary Industry	26	24	21		23	700			0.5					
Manufacturing & Assembly	0.046	0.045	0.042	0.0045	0.64	39 000	0.5							
Commercial Services						41								
Structural Fires	300	300	280			310	1 700	18						
Surface Coatings						93 000			0.06	0.12				
Human								590			16			
Other Miscellaneous Sources	0.28	13	1.3					1 100	9.7		310			
Open Sources	**23 000 000**	**7 100 000**	**1 200 000**	**10 000**	**9 500**	**270 000**	**39 000**	**460 000**	**100**	**110**	**530**	**20**	**1 400**	**4 700**
Agriculture	1 600 000	820 000	44 000	8 300	3 900	250 000	910	460 000	59	85	7.5	0.067	0.34	
Agriculture (Animals)	260 000	170 000	26 000			250 000		300 000						
Agriculture Tilling and Wind Erosion	1 300 000	640 000	16 000											
Fertilizer Application	13 000	6 200	1 800					160 000						
Agriculture - Fuel Combustion	720	500	280	8 300	3 900	150	910	47	59	85	7.5	0.067	0.34	
Construction Operations	8 400 000	2 500 000	500 000	1 500	1 900	21	320	35	13	10	2.5	0.023	0.46	0.025
Dust from Paved Roads	3 600 000	690 000	170 000											
Dust from Unpaved Roads	9 700 000	3 100 000	460 000											
Dust from Coal Mining	1 100	570	45											
Waste	6 900	2 900	2 500	640	3 300	17 000	15 000	4 200	28	18	520	20	680	4 700
Landfills	4 700	660	280	180	910	12 000	2 300	140	22	1.7	250	0.0049		4
Water and Sewage Treatment	55	42	39	250	1 100	530	490	4 000	6.2	16	190	0.0009	0.0003	3
Energy from Waste	15	11	9.9	47	420	290	710		0.27	0.27	0.61	0.0031		40
Open Burning	2 200	2 200	2 200	130	810	4 000	11 000	86			79	20	680	4 600
Waste Treatment and Disposal	0.44	0.34	0.33	27	40	27	0.001	0.67	0.025	0.02				
Mine Tailings	33 000	2 600	660											
Prescribed Burning	3 600	3 100	2 200	9.6	470	1 300	23 000	39				0.52	670	
GRAND TOTAL	**24 000 000**	**7 500 000**	**1 500 000**	**1 200 000**	**2 100 000**	**2 100 000**	**6 300 000**	**490 000**	**130 000**	**8 800**	**4 000**	**71**	**140 000**	**8 600**

Note:
1. Totals may not add up due to rounding.
2. PAH includes B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p.

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

In 2013, approximately 1.5 million tonnes (Mt) of PM less than or equal to 2.5 microns in diameter ($PM_{2.5}$) were emitted in Canada (Table 2-3). Open sources accounted for 79% (1.2 Mt) of total emissions, with the most important open sources being construction operations and dust from unpaved and paved roads, which together accounted for 76% (1.1 Mt) of total $PM_{2.5}$ emissions. In these sectors, PM is largely emitted by non-combustion sources. The second most important contributors to $PM_{2.5}$ emissions are non-industrial sources, primarily residential wood combustion, which alone accounted for 11% (160 kilotonnes [kt]) of total $PM_{2.5}$ emissions in 2013. Industrial sources (4%) and mobile sources (4%) were relatively minor contributors to total $PM_{2.5}$ emissions.

Between 1990 and 2013, emissions of $PM_{2.5}$ increased by 5% (65 kt) (Figure 2–1). Open sources alone have increased by 56% (450 kt), due to emissions from construction operations and dust from unpaved roads increasing by 112% (260 kt) and 61% (180 kt), respectively. Construction operation emissions have risen due to an increase in the upstream petroleum industry's construction activities in Alberta and Saskatchewan; dust emissions from unpaved roads have increased due to a larger number of vehicle kilometres travelled on unpaved roads. Emissions from non-industrial sources have decreased by 45% (140 kt), mainly due to a 37% (100 kt) reduction in emissions from residential fuel wood combustion, a result of new fireplace inserts, furnaces and stoves with improved controls of $PM_{2.5}$ emissions. Emissions from industrial and mobile sources have decreased by 68% (140 kt) and 45% (83 kt), respectively. In short, the trend of increasing $PM_{2.5}$ emissions from open sources is largely offset by declining emissions from almost all other sources.

Figure 2–1 National $PM_{2.5}$ Trends and Contributing Sectors

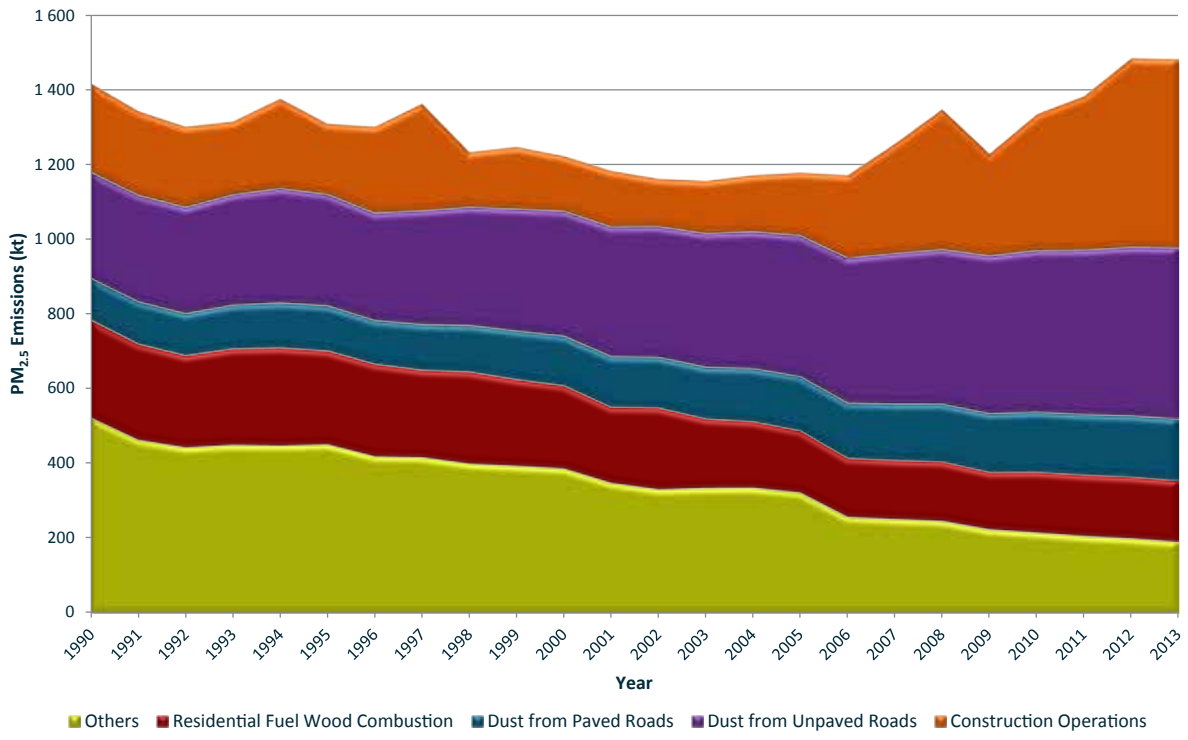


Table 2–3 National Summary of $PM_{2.5}$ Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
	(tonnes)								
Industrial Sources	**210 000**	**200 000**	**170 000**	**140 000**	**69 000**	**68 000**	**68 000**	**67 000**	**66 000**
Aluminium Industry	5 500	5 700	4 700	4 500	5 000	4 700	4 600	4 700	4 400
Asphalt Paving Industry	810	1 500	1 500	1 200	960	1 100	1 300	1 000	1 000
Cement and Concrete Industry	9 300	7 300	8 300	12 000	7 900	6 400	6 500	7 200	6 600
Chemicals Industry	5 300	5 000	5 200	4 500	1 300	1 200	1 300	1 300	1 300
Mineral Products Industry	1 300	980	1 200	1 300	800	460	420	350	450
Foundries	5 600	4 400	4 500	5 300	5 400	5 300	5 200	5 200	5 200
Grain Industries	3 200	3 500	3 200	2 300	2 200	2 500	2 600	2 500	2 300
Iron and Steel Industries	11 000	10 000	9 400	6 100	1 600	2 200	2 200	2 600	2 100
Iron Ore Mining Industry	1 600	4 000	4 500	1 900	1 300	1 300	1 100	1 100	1 100
Mining and Rock Quarrying	12 000	12 000	13 000	9 700	10 000	13 000	11 000	10 000	10 000
Non-Ferrous Smelting and Refining Industry	8 800	6 600	6 100	5 500	1 800	1 700	1 900	2 000	1 800
Pulp and Paper Industry	61 000	39 000	25 000	18 000	9 100	8 200	9 200	8 300	9 200
Wood Industry	55 000	64 000	54 000	48 000	6 200	5 100	5 400	5 700	5 800
Upstream Petroleum Industry	7 600	11 000	10 000	10 000	9 600	9 900	11 000	10 000	11 000
Downstream Petroleum Industry	5 100	5 000	4 900	5 100	2 200	2 000	1 900	1 800	1 800
Petroleum Product Transportation and Distribution	600	630	540	430	140	97	91	78	64
Other Industries	13 000	14 000	16 000	8 100	2 900	2 600	2 900	2 300	2 300
Biofuel Production						6.3	4.2	4.4	3.9
Non-Industrial Sources	**310 000**	**280 000**	**250 000**	**180 000**	**170 000**	**170 000**	**170 000**	**170 000**	**170 000**
Commercial Fuel Combustion	52	2 200	2 600	2 600	2 400	2 200	2 400	2 200	2 200
Electric Power Generation (Utilities)	49 000	21 000	23 000	9 100	6 200	5 800	4 200	3 200	3 200
Residential Fuel Combustion		2 400	2 500	2 400	2 400	2 300	2 500	2 300	2 300
Residential Fuel Wood Combustion	260 000	250 000	220 000	170 000	150 000	160 000	160 000	170 000	160 000
Mobile Sources	**140 000**	**130 000**	**110 000**	**91 000**	**76 000**	**78 000**	**70 000**	**62 000**	**57 000**
Air Transportation	640	640	840	830	730	750	760	900	900
Heavy-duty diesel vehicles	30 000	25 000	17 000	18 000	14 000	14 000	14 000	12 000	11 000
Heavy-duty gasoline trucks	3 400	1 600	1 000	980	780	730	440	430	460
Light-duty diesel trucks	520	610	480	490	290	280	270	250	200
Light-duty diesel vehicles	720	430	280	360	200	200	200	180	150
Light-duty gasoline trucks	4 200	3 900	3 700	3 200	2 800	2 800	2 500	2 600	2 600
Light-duty gasoline vehicles	8 800	7 300	5 300	3 900	3 000	2 900	2 500	2 400	2 300
Motorcycles	16	13	19	29	37	40	37	39	40
Marine Transportation	9 700	11 000	13 000	15 000	13 000	13 000	14 000	12 000	10 000
Off-road use of diesel	45 000	48 000	45 000	35 000	29 000	31 000	25 000	21 000	19 000
Off-road use of gasoline/LPG/CNG	28 000	23 000	16 000	8 800	8 000	7 900	6 100	5 500	5 200
Rail Transportation	3 600	3 200	3 400	3 300	2 200	2 600	2 900	2 900	2 900
Tire Wear & Brake Lining	1 100	1 200	1 400	1 500	1 600	1 700	1 700	1 800	1 800
Incineration Sources	**1 700**	**1 900**	**1 800**	**940**	**520**	**400**	**270**	**130**	**80**
Crematorium	4.6	5.8	6.6	5.5	6.5	6.5	6.7	6.1	6.3
Industrial & Commercial Incineration	20	20	72	53	32	26	26	18	18
Municipal Incineration	1700	1900	1700	880	480	360	230	100	54
Other Incineration & Utilities	2.1	2.1	2.1	1.5	1.9	1.9	1.9	1.9	1.9
Miscellaneous Sources	**7 800**	**8 300**	**8 900**	**8 800**	**9 200**	**9 000**	**8 900**	**9 400**	**9 800**
Cigarette Smoking	780	880	690	520	480	480	480	470	470
Dry Cleaning	0.32	0.32	0.32	0.62	1.6	1.2	17	9.4	9.1
General Solvent Use									
Marine Cargo Handling Industry	180	150	140	100	30	39	46	41	480
Meat Cooking	6 300	6 800	7 600	7 800	8 500	8 200	8 100	8 500	8 500
Refined Petroleum Products Retail									
Printing	3.7	13	7.1	24	14	11	5.8	24	21
Structural Fires	350	330	290	250	240	240	280	280	280
Surface Coatings									
Human									
Other Miscellaneous Sources	160	160	160	160			0.12	0.11	1.3
Open Sources	**750 000**	**700 000**	**680 000**	**750 000**	**910 000**	**1 000 000**	**1 100 000**	**1 200 000**	**1 200 000**
Agriculture	46 000	53 000	52 000	58 000	48 000	44 000	44 000	44 000	44 000
Construction Operations	240 000	190 000	150 000	170 000	270 000	360 000	410 000	500 000	500 000
Dust from Paved Roads	110 000	120 000	130 000	150 000	160 000	160 000	160 000	160 000	170 000
Dust from Unpaved Roads	280 000	300 000	330 000	380 000	420 000	430 000	440 000	450 000	460 000
Dust from Coal Mining								41	45
Waste	2 500	2 700	1 900	1 900	2 400	2 500	2 500	2 500	2 500
Mine Tailings	1 200	690	1 200	580	660	660	660	660	660
Prescribed Burning	71 000	38 000	13 000	2 100	7 100	2 400	3 300	6 200	2 200
Grand Total	**1 400 000**	**1 300 000**	**1 200 000**	**1 200 000**	**1 200 000**	**1 300 000**	**1 400 000**	**1 500 000**	**1 500 000**

Note: Totals may not add up due to rounding.

2.2. Sulphur Oxides (SO_x)

In 2013, just over 1.2 Mt of SO_x were emitted in Canada (Table 2–4). Industrial sources accounted for 69% (850 kt) of the national emissions, approximately 50% (620 kt) of national emissions are attributed to the non-ferrous smelting and refining industry and the upstream petroleum industry. The second-largest source of SO_x is non-industrial sources, specifically electric power generation (utilities) with 23% (280 kt) of the total SO_x emissions. Minor contributors were mobile, incineration, miscellaneous and open sources, collectively accounting for 7% of the total national SO_x emissions.

SO_x emissions have decreased by 60% (1.9 Mt) between 1990 and 2013 (Figure 2–2). Emissions from industrial sources, as a whole, have decreased by 62% (1.4 Mt) in this time frame, which is attributed to emission reductions within the non-ferrous smelting and refining industry and the upstream petroleum industry. Combined, emissions from these sectors have reduced by 63% (1.0 Mt). The decrease in SO_x emissions from non-ferrous smelting is attributed to installation of new technology or processes at the facilities and the closing of some smelters, while the decrease in emissions from the upstream petroleum industry is a result of a decline in sour gas processing. Furthermore, a 53% (330 kt) reduction of SO_x emissions occurred in non-industrial sources, largely as a result of a 55% (340 kt) reduction of emissions from electric power generation (utilities) due to desulphurization technologies and the phase-out of coal electricity generation in Ontario. Emissions from mobile sources have decreased by 60% (115 kt) due to emission reductions in the following sectors: more than a 99% (46 kt) reduction in emissions from heavy-duty diesel vehicles (e.g. diesel vehicles over 3856 kg), and a 99% reduction in emissions from off-road use of diesel (e.g. off-road vehicles using diesel fuel in mining, construction, recreational vehicles, etc.). Both of these decreasing emissions trends are a result of changes to the sulphur level in diesel fuel.

Figure 2–2 National SO_X Trends and Contributing Sectors

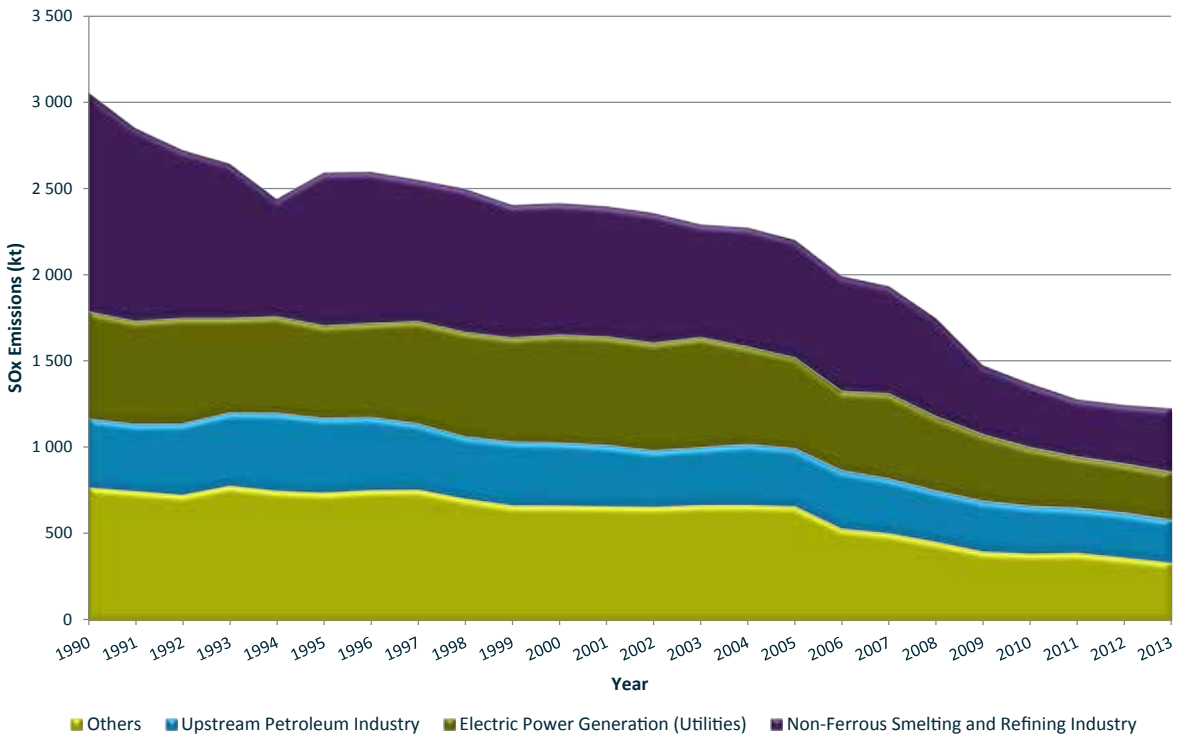


Table 2–4 National Summary of SO_X Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
	(tonnes)								
Industrial Sources	**2 200 000**	**1 900 000**	**1 600 000**	**1 500 000**	**950 000**	**900 000**	**840 000**	**840 000**	**850 000**
Aluminium Industry	33 000	47 000	52 000	74 000	64 000	65 000	70 000	67 000	65 000
Asphalt Paving Industry	190	1 100	650	720	820	990	950	660	610
Cement and Concrete Industry	48 000	39 000	44 000	60 000	25 000	23 000	22 000	25 000	23 000
Chemicals Industry	35 000	28 000	27 000	30 000	14 000	15 000	16 000	15 000	15 000
Mineral Products Industry	1 600	1 800	1 000	1 200	1 500	1 200	1 400	1 500	1 800
Foundries	1 300	1 200	920	730	50	49	48	48	48
Grain Industries	230	220	210	390	580	660	700	660	630
Iron and Steel Industries	36 000	38 000	29 000	31 000	22 000	27 000	29 000	30 000	24 000
Iron Ore Mining Industry	59 000	65 000	17 000	19 000	11 000	15 000	12 000	13 000	11 000
Mining and Rock Quarrying	33 000	29 000	11 000	10 000	4 700	5 300	6 000	2 700	2 300
Non-Ferrous Smelting and Refining Industry	1 300 000	890 000	760 000	680 000	400 000	370 000	330 000	340 000	370 000
Pulp and Paper Industry	140 000	73 000	78 000	70 000	29 000	27 000	27 000	26 000	28 000
Wood Industry	4 000	4 500	4 700	3 600	1 200	880	760	790	790
Upstream Petroleum Industry	400 000	430 000	370 000	340 000	290 000	280 000	260 000	260 000	250 000
Downstream Petroleum Industry	130 000	150 000	140 000	110 000	76 000	61 000	57 000	54 000	55 000
Petroleum Product Transportation and Distribution	3 200	2 900	6 100	5 900	1 300	890	570	100	62
Other Industries	48 000	44 000	43 000	42 000	5 400	4 800	4 200	3 200	2 900
Biofuel Production									
Non-Industrial Sources	**630 000**	**570 000**	**660 000**	**560 000**	**400 000**	**350 000**	**320 000**	**300 000**	**300 000**
Commercial Fuel Combustion	240	12 000	19 000	21 000	8 500	6 700	9 200	9 700	9 700
Electric Power Generation (Utilities)	620 000	540 000	630 000	530 000	380 000	340 000	300 000	280 000	280 000
Residential Fuel Combustion		12 000	12 000	11 000	6 500	6 800	6 800	6 300	6 300
Residential Fuel Wood Combustion	3 600	3 500	3 300	2 700	2 600	2 800	2 800	2 900	2 800
Mobile Sources	**190 000**	**170 000**	**170 000**	**160 000**	**120 000**	**110 000**	**110 000**	**94 000**	**75 000**
Air Transportation	5 300	5 200	6 600	7 400	4 400	4 800	5 100	6 300	6 300
Heavy-duty diesel vehicles	46 000	31 000	13 000	6 800	120	130	140	140	130
Heavy-duty gasoline trucks	1 700	1 400	950	64	55	58	64	70	73
Light-duty diesel trucks	530	400	220	130	1.8	1.9	2.3	2.3	2.3
Light-duty diesel vehicles	780	370	130	160	2.8	3.1	3.7	3.6	3.5
Light-duty gasoline trucks	3 900	6 000	6 800	560	500	540	610	670	680
Light-duty gasoline vehicles	11 000	12 000	9 200	660	510	520	570	610	600
Motorcycles	26	24	33	3.2	3.1	3.4	3.7	4.1	4.3
Marine Transportation	80 000	95 000	110 000	130 000	110 000	110 000	100 000	85 000	67 000
Off-road use of diesel	28 000	15 000	17 000	7 700	440	370	300	180	180
Off-road use of gasoline/LPG/CNG	3 000	3 400	2 200	110	99	100	92	89	91
Rail Transportation	5 700	5 200	5 400	5 000	310	470	450	450	450
Tire Wear & Brake Lining									
Incineration Sources	**2 400**	**2 200**	**2 200**	**2 300**	**2 400**	**2 400**	**2 400**	**2 600**	**2 400**
Crematorium	3.7	4.3	5.1	7.1	12	13	13	12	12
Industrial & Commercial Incineration	65	63	52	51	520	520	540	490	490
Municipal Incineration	1 300	1 100	1 100	800	300	330	350	550	360
Other Incineration & Utilities	1 000	1 000	1 000	1 400	1 600	1 500	1 500	1 500	1 500
Miscellaneous Sources	**290**	**260**	**200**	**190**	**0.034**	**0.014**	**0.0038**	**0.003**	**140**
Cigarette Smoking									
Dry Cleaning	0.0068	0.0067	0.0086						
General Solvent Use									
Marine Cargo Handling Industry	0.005	0.005	0.001						140
Meat Cooking									
Refined Petroleum Products Retail									
Printing	2.1	1.4	3.4	1.3	0.034	0.014	0.0038	0.003	0.0045
Structural Fires									
Surface Coatings									
Human									
Other Miscellaneous Sources	290	260	190	190					
Open Sources	**4 100**	**4 800**	**3 200**	**4 700**	**8 200**	**9 700**	**12 000**	**10 000**	**10 000**
Agriculture	0.0036	1 600	1 500	2 900	6 100	7 500	10 000	8 300	8 300
Construction Operations		730	610	1 400	1 400	1 700	690	1 500	1 500
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	630	710	570	440	650	470	750	500	640
Mine Tailings									
Prescribed Burning	3500	1700	500	12	31	9.6	14	30	9.6
Grand Total	**3 100 000**	**2 600 000**	**2 400 000**	**2 200 000**	**1 500 000**	**1 400 000**	**1 300 000**	**1 300 000**	**1 200 000**

Note: Totals may not add up due to rounding.

2.3. Nitrogen Oxides (NO_x)

Approximately 2.1 Mt of NO_x were released in Canada in 2013 (Table 2–5). Mobile sources were the largest contributor, accounting for 55% (1.1 Mt) of total NO_x emissions. Within mobile sources, heavy-duty diesel vehicles, marine transportation and off-road use of diesel sectors were the largest contributors, collectively emitting 36% (730 kt) of total NO_x emissions. Industrial sources accounted for 32% (670 kt) of NO_x emissions in 2013, including upstream petroleum which accounted for 23% (480 kt) of the national total. The non-industrial sources contributed 12% (240 kt) of NO_x emissions, including electric power generation (utilities) which contributed 8% (160 kt) of the national emissions. Incineration sources (< 1%), miscellaneous sources (< 1%) and open sources (< 1%) were minor contributors to national NO_x emissions.

From 1990–2013, national NO_x emissions decreased by 28% (800 kt) (Figure 2–3). Collectively, mobile sources reduced their emissions by 38% (710 kt) from 1.9 to 1.1 Mt, a decline mainly attributed to emission reductions in light-duty gasoline trucks and vehicles, where emissions have decreased by 78% (550 kt) due to increasingly stringent vehicle regulations. In general, industrial and non-industrial sources have also seen reductions in NO_x emissions. One exception to this downward trend occurs in the upstream petroleum industry within industrial sources, where emissions have increased approximately 50% (160 kt) since 1990 from 320–480 kt. This increase is attributed to expansion and growth in the petroleum industry.

Figure 2–3 National NO_X Trends and Contributing Sectors

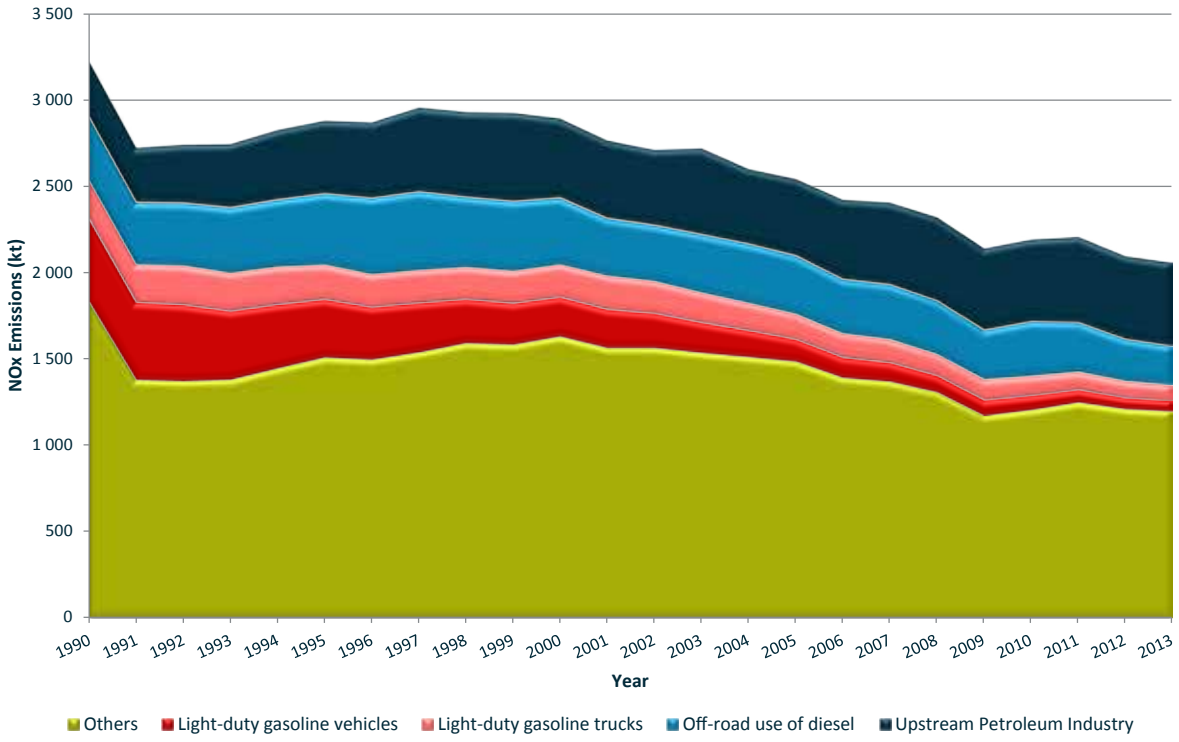


Table 2–5 National Summary of NO_X Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
	(tonnes)								
Industrial Sources	**690 000**	**780 000**	**820 000**	**760 000**	**660 000**	**670 000**	**690 000**	**670 000**	**670 000**
Aluminium Industry	2 000	1 600	1 500	2 400	1 500	1 300	1 200	1 600	1 500
Asphalt Paving Industry	270	1 500	1 100	1 200	1 200	1 500	1 500	1 200	1 200
Cement and Concrete Industry	42 000	48 000	45 000	53 000	31 000	33 000	32 000	35 000	31 000
Chemicals Industry	43 000	42 000	47 000	34 000	23 000	23 000	23 000	23 000	22 000
Mineral Products Industry	1 500	1 100	780	1 100	460	400	370	450	520
Foundries	590	660	690	550	150	150	140	140	140
Grain Industries	1 400	1 300	1 300	1 600	1 000	870	880	980	970
Iron and Steel Industries	20 000	19 000	16 000	13 000	8 600	11 000	11 000	12 000	11 000
Iron Ore Mining Industry	10 000	10 000	10 000	13 000	10 000	14 000	13 000	13 000	13 000
Mining and Rock Quarrying	24 000	26 000	21 000	23 000	18 000	22 000	25 000	24 000	22 000
Non-Ferrous Smelting and Refining Industry	5 100	4 200	4 400	1 600	2 400	1 600	1 600	1 500	1 600
Pulp and Paper Industry	73 000	54 000	52 000	41 000	30 000	30 000	31 000	29 000	31 000
Wood Industry	21 000	24 000	24 000	19 000	7 500	7 100	7 600	8 400	9 200
Upstream Petroleum Industry	320 000	420 000	460 000	440 000	470 000	470 000	490 000	480 000	480 000
Downstream Petroleum Industry	34 000	29 000	29 000	30 000	24 000	20 000	19 000	19 000	18 000
Petroleum Product Transportation and Distribution	29 000	33 000	41 000	43 000	27 000	23 000	21 000	12 000	20 000
Other Industries	59 000	67 000	68 000	46 000	5 400	5 300	5 300	4 500	4 100
Biofuel Production						22	19	18	18
Non-Industrial Sources	**290 000**	**340 000**	**420 000**	**340 000**	**280 000**	**290 000**	**270 000**	**240 000**	**240 000**
Commercial Fuel Combustion	620	26 000	30 000	29 000	26 000	25 000	27 000	25 000	25 000
Electric Power Generation (Utilities)	260 000	250 000	330 000	250 000	210 000	210 000	190 000	160 000	160 000
Residential Fuel Combustion		35 000	35 000	34 000	34 000	32 000	34 000	31 000	31 000
Residential Fuel Wood Combustion	25 000	24 000	23 000	19 000	18 000	20 000	20 000	20 000	20 000
Mobile Sources	**1 900 000**	**1 700 000**	**1 600 000**	**1 400 000**	**1 200 000**	**1 200 000**	**1 200 000**	**1 200 000**	**1 100 000**
Air Transportation	52 000	52 000	64 000	67 000	58 000	60 000	60 000	73 000	74 000
Heavy-duty diesel vehicles	260 000	320 000	350 000	350 000	280 000	290 000	280 000	260 000	240 000
Heavy-duty gasoline trucks	94 000	53 000	36 000	25 000	20 000	19 000	17 000	16 000	16 000
Light-duty diesel trucks	2 800	3 900	4 500	5 900	3 900	3 900	4 000	3 700	3 400
Light-duty diesel vehicles	980	820	760	2 800	2 500	2 700	2 900	2 700	2 600
Light-duty gasoline trucks	220 000	200 000	190 000	150 000	120 000	110 000	100 000	97 000	92 000
Light-duty gasoline vehicles	480 000	340 000	230 000	130 000	95 000	88 000	78 000	70 000	64 000
Motorcycles	430	330	510	540	600	610	590	610	620
Marine Transportation	140 000	160 000	190 000	210 000	200 000	200 000	250 000	260 000	270 000
Off-road use of diesel	370 000	410 000	390 000	340 000	280 000	310 000	280 000	240 000	220 000
Off-road use of gasoline/LPG/CNG	67 000	54 000	38 000	26 000	30 000	32 000	29 000	29 000	30 000
Rail Transportation	160 000	150 000	150 000	130 000	88 000	110 000	120 000	120 000	130 000
Tire Wear & Brake Lining									
Incineration Sources	**1 500**	**1 500**	**1 700**	**1 600**	**2 400**	**2 400**	**2 300**	**2 200**	**2 400**
Crematorium	21	25	30	40	20	21	21	19	20
Industrial & Commercial Incineration	120	120	210	180	650	680	700	650	660
Municipal Incineration	1 100	1 200	1 200	1 300	1 500	1 400	1 400	1 300	1 500
Other Incineration & Utilities	250	250	250	73	260	270	220	220	220
Miscellaneous Sources	**4 100**	**4 100**	**4 200**	**3 600**	**33**	**29**	**23**	**23**	**53**
Cigarette Smoking									
Dry Cleaning	1.1	1.1	1.6						
General Solvent Use									
Marine Cargo Handling Industry	0.2	0.2	0.059						29
Meat Cooking									
Refined Petroleum Products Retail									
Printing	120	120	150	140	33	29	23	23	23
Structural Fires									
Surface Coatings									
Human									
Other Miscellaneous Sources	4 000	4 000	4 000	3 500					
Open Sources	**18 000**	**15 000**	**10 000**	**8 500**	**9 300**	**9 000**	**9 600**	**10 000**	**9 500**
Agriculture	0.66	2 500	2 200	2 000	2 800	3 300	4 200	3 900	3 900
Construction Operations		1 700	1 700	2 300	1 900	2 000	1 700	1 900	1 900
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	3 100	3 300	3 300	3 700	3 100	3 300	3 000	2 900	3 300
Mine Tailings									
Prescribed Burning	15 000	7 100	2 800	460	1 500	460	700	1 300	470
Grand Total	**2 900 000**	**2 900 000**	**2 900 000**	**2 500 000**	**2 100 000**	**2 200 000**	**2 200 000**	**2 100 000**	**2 100 000**

Note: Totals may not add up due to rounding.

2.4. Volatile Organic Compounds (VOCs)

In 2013, approximately 2.1 Mt of VOCs were released in Canada (Table 2–6). Industrial sources were the largest contributors with 37% (780 kt) of total emissions, with the upstream petroleum industry the largest emitter at 29% (620 kt) of total VOCs. Mobile sources were the next-largest contributor, accounting for 20% (430 kt) of emissions, with off-road use of gasoline / liquefied petroleum gas (LPG) / compressed natural gas (CNG) accounting for 9% (190 kt) of the national total. Miscellaneous sources accounted for 20% (420 kt) of emissions, with general solvent use as its largest contributor at 11% (230 kt) of the national total. Open sources were the next-largest contributors, representing 13% (270 kt) of VOC emissions, mainly attributed to agriculture (12% of the total [250 kt]). The other major contributors are non-industrial sources with 11% (240 kt) of the total, including residential fuel wood combustion as the main contributor at 11% (230 kt) of total VOC emissions.

Between 1990 and 2013, VOC emissions have decreased by 51% (2.2 Mt) (Figure 2–4). VOC emissions from mobile sources alone have decreased by 82% (2.0 Mt), which is specifically attributed to emission reductions in off-road use of gasoline/LPG/CNG by 88% (1.4 Mt) due to increasingly stringent regulations on spark-ignition engines. Emissions by industrial sources have experienced a modest decrease of 6% (52 kt) as a result of emission reductions in most sectors, with the exception of the upstream petroleum industry where emissions have increased by 33% (150 kt) since 1990 due to expansion and growth in this industry.

Figure 2–4 National VOC Trends and Contributing Sectors

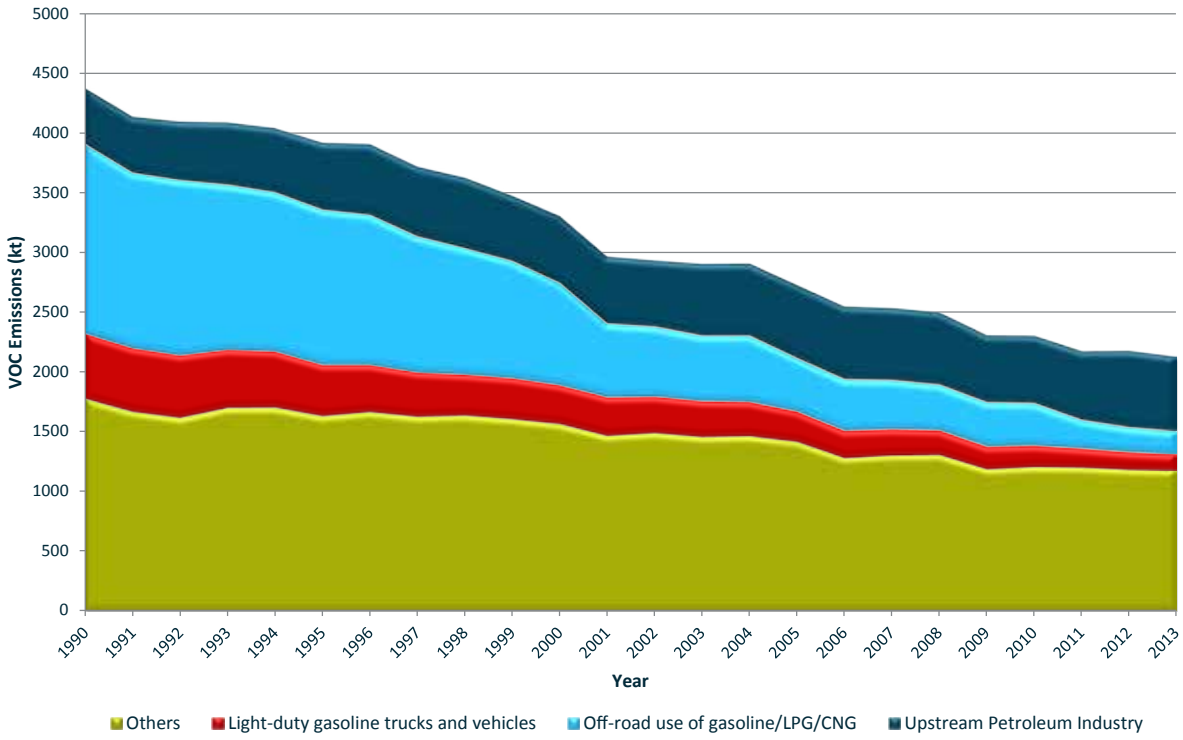


Table 2–6 National Summary of VOC Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(tonnes)				
Industrial Sources	**830 000**	**890 000**	**890 000**	**880 000**	**730 000**	**730 000**	**750 000**	**800 000**	**780 000**
Aluminium Industry	710	970	1 100	1 600	1 500	1 400	1 500	1 300	1 400
Asphalt Paving Industry	150	5 200	9 900	6 300	4 900	6 400	6 800	5 800	5 800
Cement and Concrete Industry	1 200	1 400	1 700	1 300	260	330	370	420	430
Chemicals Industry	47 000	39 000	36 000	25 000	12 000	12 000	12 000	10 000	14 000
Mineral Products Industry	220	230	330	220	190	110	95	72	99
Foundries	1 800	1 700	1 200	790	400	400	430	370	370
Grain Industries	2 200	2 300	2 300	2 200	2 800	2 900	2 700	2 300	2 600
Iron and Steel Industries	5 700	5 300	4 200	2 200	640	1 100	1 400	1 300	920
Iron Ore Mining Industry	570	850	3 200	1 600	40	49	38	170	290
Mining and Rock Quarrying	3 100	3 400	2 800	4 300	2 400	2 400	2 600	1 800	1 800
Non-Ferrous Smelting and Refining Industry	330	69	37	51	68	73	73	65	70
Pulp and Paper Industry	23 000	25 000	24 000	18 000	16 000	17 000	18 000	17 000	16 000
Wood Industry	76 000	67 000	61 000	76 000	29 000	28 000	27 000	31 000	32 000
Upstream Petroleum Industry	470 000	560 000	560 000	610 000	560 000	570 000	580 000	640 000	620 000
Downstream Petroleum Industry	120 000	90 000	76 000	54 000	42 000	41 000	42 000	32 000	34 000
Petroleum Product Transportation and Distribution	1 400	1 500	2 600	1 500	180	170	650	310	410
Other Industries	81 000	88 000	98 000	75 000	51 000	55 000	56 000	54 000	50 000
Biofuel Production						70	97	100	100
Non-Industrial Sources	**360 000**	**350 000**	**320 000**	**250 000**	**230 000**	**240 000**	**240 000**	**240 000**	**240 000**
Commercial Fuel Combustion	290	1 200	1 400	1 400	1 300	1 200	1 300	1 200	1 200
Electric Power Generation (Utilities)	2 500	3 600	3 600	3 300	1 900	1 800	1 700	1 200	1 300
Residential Fuel Combustion		1 600	1 700	1 700	1 700	1 600	1 700	1 600	1 600
Residential Fuel Wood Combustion	360 000	340 000	310 000	250 000	220 000	240 000	240 000	230 000	230 000
Mobile Sources	**2 400 000**	**1 900 000**	**1 300 000**	**830 000**	**670 000**	**650 000**	**500 000**	**460 000**	**430 000**
Air Transportation	5 200	4 800	6 000	5 400	5 700	5 900	5 800	6 500	6 500
Heavy-duty diesel vehicles	30 000	23 000	19 000	26 000	24 000	26 000	25 000	24 000	22 000
Heavy-duty gasoline trucks	140 000	50 000	28 000	22 000	17 000	16 000	14 000	13 000	13 000
Light-duty diesel trucks	450	690	760	910	650	650	650	600	540
Light-duty diesel vehicles	300	260	220	460	390	410	450	440	410
Light-duty gasoline trucks	150 000	140 000	130 000	120 000	97 000	93 000	83 000	78 000	74 000
Light-duty gasoline vehicles	400 000	290 000	200 000	140 000	98 000	91 000	80 000	73 000	67 000
Motorcycles	1 700	1 500	2 500	2 000	2 200	2 200	2 200	2 100	2 100
Marine Transportation	12 000	11 000	14 000	19 000	18 000	17 000	19 000	20 000	20 000
Off-road use of diesel	58 000	63 000	56 000	44 000	35 000	38 000	31 000	26 000	24 000
Off-road use of gasoline/LPG/CNG	1 600 000	1 300 000	850 000	440 000	370 000	350 000	240 000	210 000	190 000
Rail Transportation	6 800	6 100	6 300	6 200	4 600	5 700	6 200	6 200	6 200
Tire Wear & Brake Lining									
Incineration Sources	**4 200**	**4 200**	**4 200**	**4 100**	**1 400**	**1 300**	**1 200**	**1 000**	**820**
Crematorium	0.94	1.1	1.3	1.8	2.2	2.2	2.2	2	2.1
Industrial & Commercial Incineration	22	22	17	20	640	710	650	650	650
Municipal Incineration	4 100	4 100	4 100	4 000	630	470	390	240	35
Other Incineration & Utilities	90	90	90	27	120	130	130	130	130
Miscellaneous Sources	**480 000**	**480 000**	**490 000**	**450 000**	**410 000**	**420 000**	**420 000**	**420 000**	**420 000**
Cigarette Smoking	290	220	120	17	8	8.1	8	7.9	7.9
Dry Cleaning	740	730	790	210	340	550	280	280	300
General Solvent Use	190 000	230 000	260 000	240 000	220 000	230 000	230 000	230 000	230 000
Marine Cargo Handling Industry	0.34	0.75	0.92	1.9	16	19	17	10	
Meat Cooking									
Refined Petroleum Products Retail	120 000	96 000	92 000	82 000	51 000	51 000	54 000	54 000	54 000
Printing	38 000	40 000	50 000	47 000	43 000	41 000	41 000	40 000	40 000
Structural Fires	670	650	700	650	270	270	310	310	310
Surface Coatings	130 000	110 000	89 000	77 000	92 000	93 000	93 000	93 000	93 000
Human	3 800	3 500	2 400	2 800					
Other Miscellaneous Sources	320	320	330	330					
Open Sources	**320 000**	**310 000**	**290 000**	**320 000**	**280 000**	**270 000**	**270 000**	**270 000**	**270 000**
Agriculture	220 000	260 000	270 000	300 000	260 000	250 000	250 000	250 000	250 000
Construction Operations		25	23	30	26	22	20	21	21
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	14 000	14 000	13 000	13 000	18 000	19 000	15 000	15 000	17 000
Mine Tailings									
Prescribed Burning	85 000	39 000	14 000	1 300	4 300	1 300	2 000	6 300	1 300
Grand Total	**4 400 000**	**3 900 000**	**3 300 000**	**2 700 000**	**2 300 000**	**2 300 000**	**2 200 000**	**2 200 000**	**2 100 000**

Note: Totals may not add up due to rounding.

2.5. Carbon Monoxide (CO)

In 2013, approximately 6.3 Mt of CO were released in Canada (Table 2–7). Mobile sources accounted for 59% (3.7 Mt) of total emissions, including light-duty gasoline vehicles/trucks at 28% (1.7 Mt) and off-road use of gasoline/LPG/CNG at 23% (1.4 Mt) of total CO emissions. The next-largest contributors are industrial sources, which in 2013 accounted for 21% (1.3 Mt) of emissions. The upstream petroleum industry and aluminium industry were the largest-emitting industrial sectors, accounting for 8% (530 kt) and 7% (410 kt) of CO, respectively. Non-industrial sources represented 20% (1.3 Mt) of CO emissions, with residential fuel wood combustion as its largest emitter at 19% (1.2 Mt) of total CO emissions.

Between 1990 and 2013, CO emissions decreased by 63% (10 Mt) (Figure 2–5). Mobile source emissions alone have decreased by 70% (8.8Mt) over this time period, a result of emissions from the off-road use of gasoline/LPG/CNG decreasing by 69% (3.3 Mt) and emissions from light-duty gasoline trucks/vehicles decreasing by 68% (3.7 Mt), due to increasingly stringent vehicle regulations. CO emissions from non-industrial sources have also decreased by 26% (440 kt), mainly as a result of emission reductions in the residential fuel wood combustion sector of 27% (450 kt) due to a decline in the consumption of wood for fuel.

Figure 2–5 National CO Trends and Contributing Sectors

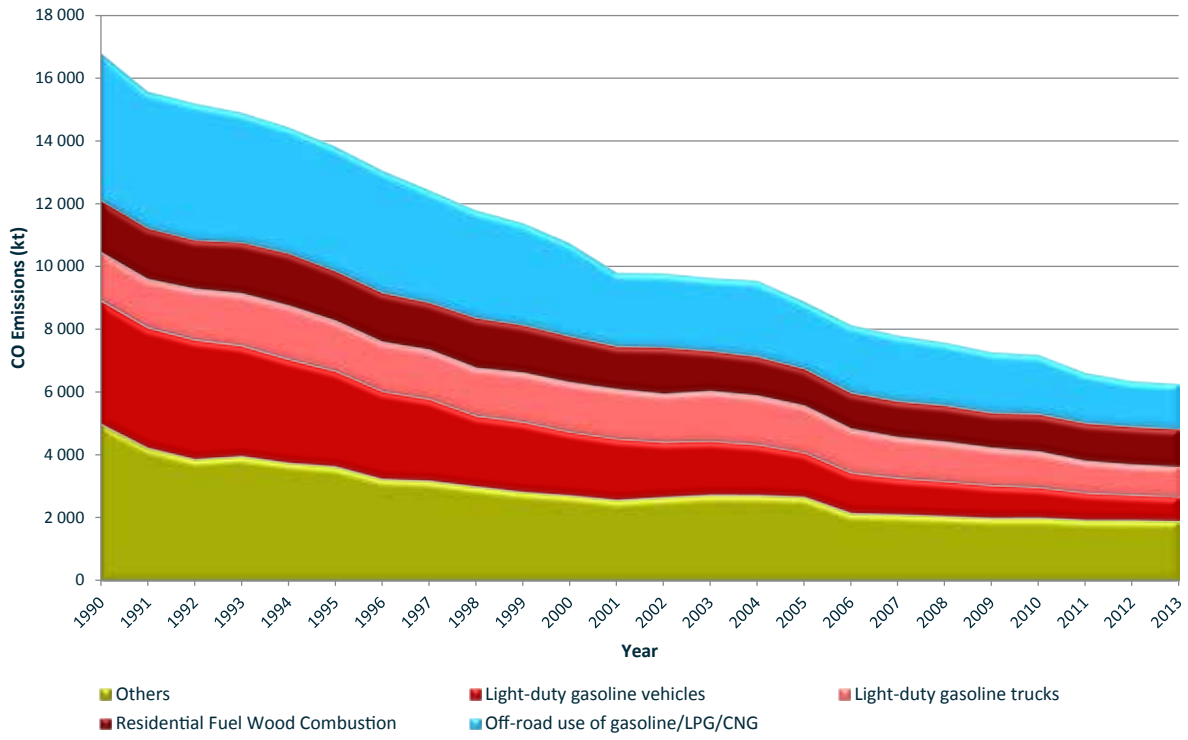


Table 2–7 National Summary of CO Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
	(tonnes)								
Industrial Sources	**1 700 000**	**1 900 000**	**1 700 000**	**1 800 000**	**1 200 000**	**1 300 000**	**1 300 000**	**1 300 000**	**1 300 000**
Aluminium Industry	240 000	300 000	250 000	380 000	390 000	390 000	400 000	400 000	410 000
Asphalt Paving Industry	1 500	3 900	4 200	4 500	4 500	5 500	5 600	4 600	4 500
Cement and Concrete Industry	16 000	17 000	23 000	28 000	12 000	15 000	16 000	18 000	13 000
Chemicals Industry	28 000	34 000	31 000	18 000	14 000	13 000	13 000	13 000	14 000
Mineral Products Industry	4 000	3 400	3 500	2 900	3 400	710	630	630	720
Foundries	51 000	44 000	40 000	49 000	51 000	50 000	49 000	49 000	49 000
Grain Industries	1 900	2 200	2 700	590	490	540	460	340	390
Iron and Steel Industries	43 000	49 000	47 000	89 000	19 000	20 000	21 000	28 000	23 000
Iron Ore Mining Industry	18 000	25 000	9 600	23 000	18 000	24 000	22 000	20 000	20 000
Mining and Rock Quarrying	14 000	14 000	14 000	10 000	9 300	11 000	15 000	19 000	14 000
Non-Ferrous Smelting and Refining Industry	280	280	360	13 000	9 200	22 000	11 000	13 000	11 000
Pulp and Paper Industry	180 000	180 000	150 000	110 000	53 000	73 000	77 000	48 000	58 000
Wood Industry	740 000	750 000	570 000	510 000	100 000	99 000	58 000	94 000	94 000
Upstream Petroleum Industry	300 000	390 000	430 000	520 000	520 000	510 000	530 000	520 000	530 000
Downstream Petroleum Industry	21 000	23 000	23 000	22 000	21 000	24 000	18 000	16 000	41 000
Petroleum Product Transportation and Distribution	33 000	14 000	14 000	18 000	15 000	12 000	10 000	4 200	9 700
Other Industries	47 000	62 000	77 000	25 000	8 000	7 000	7 100	6 600	5 300
Biofuel Production						20			
Non-Industrial Sources	**1 700 000**	**1 700 000**	**1 500 000**	**1 300 000**	**1 200 000**	**1 300 000**	**1 300 000**	**1 300 000**	**1 300 000**
Commercial Fuel Combustion	790	16 000	19 000	19 000	19 000	17 000	18 000	17 000	17 000
Electric Power Generation (Utilities)	51 000	34 000	44 000	51 000	41 000	44 000	44 000	32 000	34 000
Residential Fuel Combustion		13 000	13 000	13 000	13 000	12 000	13 000	12 000	12 000
Residential Fuel Wood Combustion	1 700 000	1 600 000	1 500 000	1 200 000	1 100 000	1 200 000	1 200 000	1 200 000	1 200 000
Mobile Sources	**12 000 000**	**9 800 000**	**7 400 000**	**5 800 000**	**4 800 000**	**4 600 000**	**4 100 000**	**3 800 000**	**3 700 000**
Air Transportation	60 000	51 000	47 000	43 000	46 000	46 000	41 000	51 000	53 000
Heavy-duty diesel vehicles	98 000	90 000	76 000	100 000	93 000	98 000	98 000	91 000	86 000
Heavy-duty gasoline trucks	1 800 000	690 000	350 000	300 000	220 000	210 000	180 000	170 000	180 000
Light-duty diesel trucks	1 600	2 500	2 700	3 200	2 300	2 300	2 400	2 200	2 100
Light-duty diesel vehicles	820	730	700	1 100	900	1 100	1 400	1 600	1 800
Light-duty gasoline trucks	1 600 000	1 600 000	1 600 000	1 500 000	1 200 000	1 200 000	1 000 000	990 000	980 000
Light-duty gasoline vehicles	3 900 000	3 000 000	2 000 000	1 400 000	1 000 000	970 000	860 000	800 000	770 000
Motorcycles	12 000	9 600	15 000	18 000	18 000	17 000	16 000	15 000	15 000
Marine Transportation	13 000	14 000	17 000	19 000	18 000	18 000	23 000	24 000	25 000
Off-road use of diesel	240 000	280 000	250 000	200 000	170 000	190 000	160 000	140 000	120 000
Off-road use of gasoline/LPG/CNG	4 700 000	4 000 000	3 000 000	2 100 000	1 900 000	1 900 000	1 600 000	1 500 000	1 400 000
Rail Transportation	16 000	15 000	15 000	15 000	12 000	16 000	18 000	18 000	18 000
Tire Wear & Brake Lining									
Incineration Sources	**11 000**	**9 600**	**11 000**	**10 000**	**5 200**	**4 700**	**4 400**	**4 100**	**4 100**
Crematorium	10	12	14	19	17	17	17	16	17
Industrial & Commercial Incineration	31	19	110	19	1 900	1 900	1 900	1 900	1 900
Municipal Incineration	9 800	8 300	9 400	8 400	1 600	1 100	760	460	400
Other Incineration & Utilities	1 200	1 200	1 200	1 500	1 700	1 800	1 800	1 800	1 800
Miscellaneous Sources	**6 400**	**6 700**	**5 800**	**4 600**	**3 700**	**3 700**	**3 900**	**3 900**	**3 900**
Cigarette Smoking	3 700	4 100	3 300	2 500	2 300	2 300	2 300	2 200	2 200
Dry Cleaning	0.95	0.94	0.81						
General Solvent Use									
Marine Cargo Handling Industry	0.16	0.16	0.05						
Meat Cooking									
Refined Petroleum Products Retail									
Printing	25	24	84	32	5.6	1.9	0.48	0.38	0.5
Structural Fires	2 100	2 000	1 700	1 500	1 500	1 500	1 700	1 700	1 700
Surface Coatings									
Human									
Other Miscellaneous Sources	570	560	690	590					
Open Sources	**890 000**	**490 000**	**170 000**	**36 000**	**91 000**	**47 000**	**52 000**	**91 000**	**39 000**
Agriculture	0.56	710	690	510	620	700	890	910	910
Construction Operations		310	300	390	330	340	300	320	320
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	31 000	23 000	14 000	12 000	14 000	15 000	15 000	14 000	15 000
Mine Tailings									
Prescribed Burning	860 000	460 000	150 000	23 000	77 000	32 000	36 000	76 000	23 000
Grand Total	**17 000 000**	**14 000 000**	**11 000 000**	**8 900 000**	**7 300 000**	**7 200 000**	**6 700 000**	**6 400 000**	**6 300 000**

Note: Totals may not add up due to rounding.

2.6. Ammonia (NH_3)

In 2013, approximately 490 kt of NH_3 were released in Canada (Table 2–8). NH_3 emissions originate primarily from open sources, specifically from agriculture, accounting for 94% (460 kt) of total emissions. All other sectors combined accounted for 6% (28 kt) of emissions.

From 1990–2013, Canada's NH_3 emissions increased by 22% (90 kt) (Figure 2–6), entirely driven by emissions from open sources, which have increased by 27% (97 kt) as a result of a 28% (99 kt) increase in NH_3 emissions from agriculture. This trend is a result of expansions in the livestock industry and an increase in consumption of synthetic nitrogen fertilizer.

Figure 2–6 National NH_3 Trends and Contributing Sectors

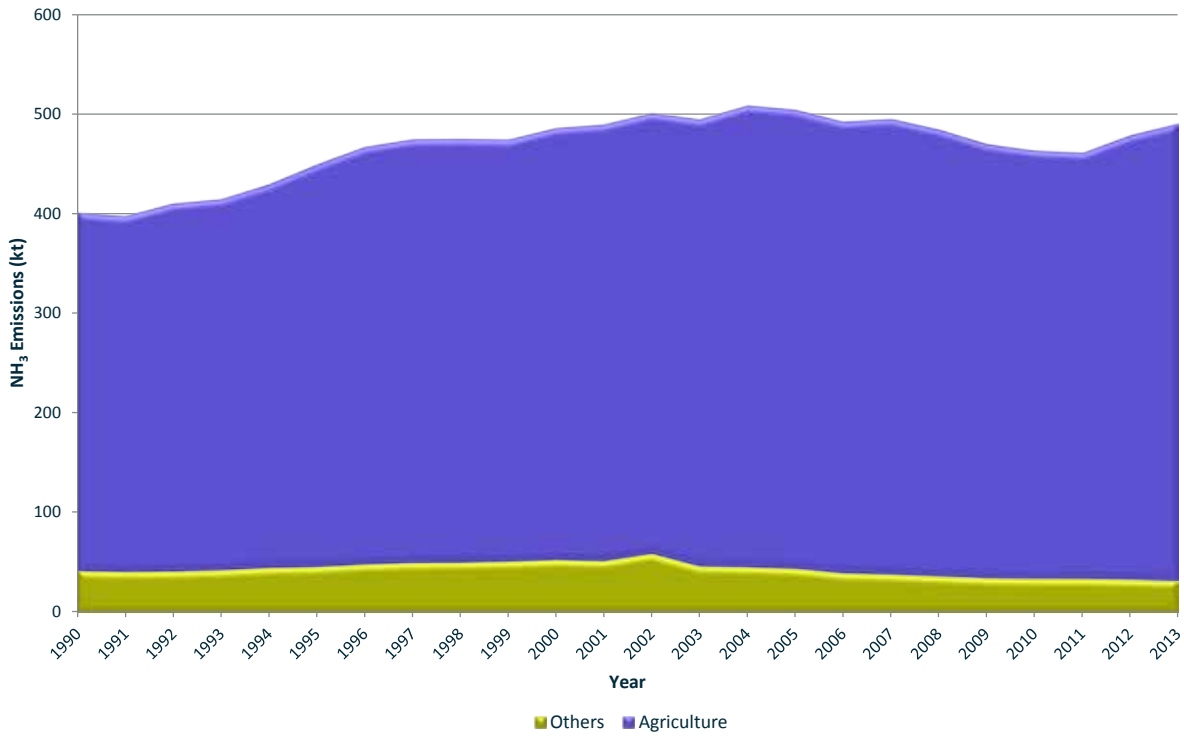


Table 2–8 National Summary of NH_3 Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
	(tonnes)								
Industrial Sources	**23 000**	**24 000**	**29 000**	**23 000**	**16 000**	**15 000**	**15 000**	**15 000**	**14 000**
Aluminium Industry	250	250	260	270					
Asphalt Paving Industry	0.6	0.6	1.3	1.2					
Cement and Concrete Industry	590	610	620	420	240	380	320	330	430
Chemicals Industry	9 900	10 000	14 000	11 000	10 000	8 900	9 100	9 100	7 100
Mineral Products Industry	85	93	110	97	200	200	290	230	420
Foundries	12	13	13	8.5					
Grain Industries	6.2	6.4	6.7	1.5	4.3	0.38	11	15	7.5
Iron and Steel Industries	200	240	260	97	85	88	99	91	78
Iron Ore Mining Industry	160	160	160	210					
Mining and Rock Quarrying	620	670	640	86	1 200	1 100	410	67	93
Non-Ferrous Smelting and Refining Industry	230	250	460	380	360	390	460	420	350
Pulp and Paper Industry	4 500	3 700	3 500	2 500	1 500	1 600	1 700	1 700	1 700
Wood Industry	5 100	5 200	5 200	4 000	650	540	610	630	640
Upstream Petroleum Industry	290	1 200	1 500	2 900	1 300	1 800	1 900	2 200	2 500
Downstream Petroleum Industry	360	290	250	150	75	84	73	75	170
Petroleum Product Transportation and Distribution	180	210	250	1.9					
Other Industries	1 000	1 100	1 300	740	280	330	300	320	320
Biofuel Production									
Non-Industrial Sources	**3 000**	**4 100**	**4 500**	**3 600**	**2 800**	**2 900**	**3 100**	**2 700**	**3 200**
Commercial Fuel Combustion	1.1	300	340	310	200	190	210	190	190
Electric Power Generation (Utilities)	740	1 000	1 500	1 000	460	470	630	340	780
Residential Fuel Combustion		560	560	530	490	460	460	410	410
Residential Fuel Wood Combustion	2 300	2 200	2 100	1 700	1 600	1 800	1 800	1 800	1 800
Mobile Sources	**7 600**	**11 000**	**13 000**	**11 000**	**9 700**	**9 500**	**9 200**	**8 800**	**8 500**
Air Transportation	29	28	35	36	31	32	32	39	39
Heavy-duty diesel vehicles	240	340	420	610	700	780	830	850	840
Heavy-duty gasoline trucks	840	590	500	420	370	360	350	350	350
Light-duty diesel trucks	8.8	14	19	27	22	23	27	27	28
Light-duty diesel vehicles	5.6	5.1	5.4	13	12	14	16	16	17
Light-duty gasoline trucks	1 400	2 500	3 900	3 700	3 300	3 300	3 200	3 100	3 000
Light-duty gasoline vehicles	4 400	6 400	7 200	6 000	4 600	4 400	4 000	3 700	3 500
Motorcycles	7.4	5.8	9.6	13	23	26	27	30	33
Marine Transportation	160	190	220	250	240	240	310	330	340
Off-road use of diesel	190	220	230	230	220	250	260	230	230
Off-road use of gasoline/LPG/CNG	370	300	200	120	120	120	110	100	100
Rail Transportation	51	46	48	48	37	49	56	57	57
Tire Wear & Brake Lining									
Incineration Sources	**500**	**500**	**500**	**220**	**140**	**140**	**400**	**370**	**390**
Crematorium									
Industrial & Commercial Incineration	15	15	15	15	72	72	72	72	72
Municipal Incineration	460	460	460	200	23	23	300	270	290
Other Incineration & Utilities	29	29	29	0.0036	43	43	27	27	27
Miscellaneous Sources	**620**	**650**	**660**	**640**	**1 700**	**1 700**	**1 800**	**1 800**	**1 800**
Cigarette Smoking	110	120	110	86	86	84	87	82	82
Dry Cleaning	0.046	0.046	0.046						
General Solvent Use									
Marine Cargo Handling Industry	0.001	0.001							
Meat Cooking									
Refined Petroleum Products Retail									
Printing	15	15	15	1.4	0.055	0.056			
Structural Fires	22	21	18	16	15	15	18	18	18
Surface Coatings									
Human	470	490	520	530	570	570	580	590	590
Other Miscellaneous Sources	3.9	4.7	4.9	3.9	1 000	1 100	1 100	1 100	1 100
Open Sources	**370 000**	**410 000**	**440 000**	**470 000**	**440 000**	**430 000**	**430 000**	**450 000**	**460 000**
Agriculture	360 000	400 000	430 000	460 000	440 000	430 000	430 000	450 000	460 000
Construction Operations		35	32	44	37	39	33	35	35
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	5 300	5 300	5 300	4 900	4 100	4 300	4 100	4 000	4 200
Mine Tailings									
Prescribed Burning	1 100	550	220	39	130	39	59	170	39
Grand Total	**400 000**	**450 000**	**490 000**	**510 000**	**470 000**	**460 000**	**460 000**	**480 000**	**490 000**

Note: Totals may not add up due to rounding.

2.7. Lead (Pb)

In 2013, approximately 130 tonnes (t) of Pb were emitted in Canada (Table 2–9). Industrial sources are the largest contributors at 70% (92 t) of emissions, with the non-ferrous smelting and refining industry as the largest contributor at 56% (75 t) of total Pb emissions. Mobile sources are the second-largest contributors at 27% (36 t) of total emissions, including air transportation at 27% (36 t) of national emissions.

Pb emissions have decreased by 90% (1.2 kt) from 1990–2013 (Figure 2–7). This trend is mainly attributed to a 92% (1.1 kt) reduction of emissions in industrial sources, specifically in the non-ferrous smelting and refining industry with an emissions reduction of 92% (810 t) and mining and rock quarrying with an emissions reduction of 98% (200 t). The decreasing trend in Pb emissions from these industries is due to changes in production processes, more effective PM controls, and the closure of smelters.

Figure 2–7 National Pb Trends and Contributing Sectors

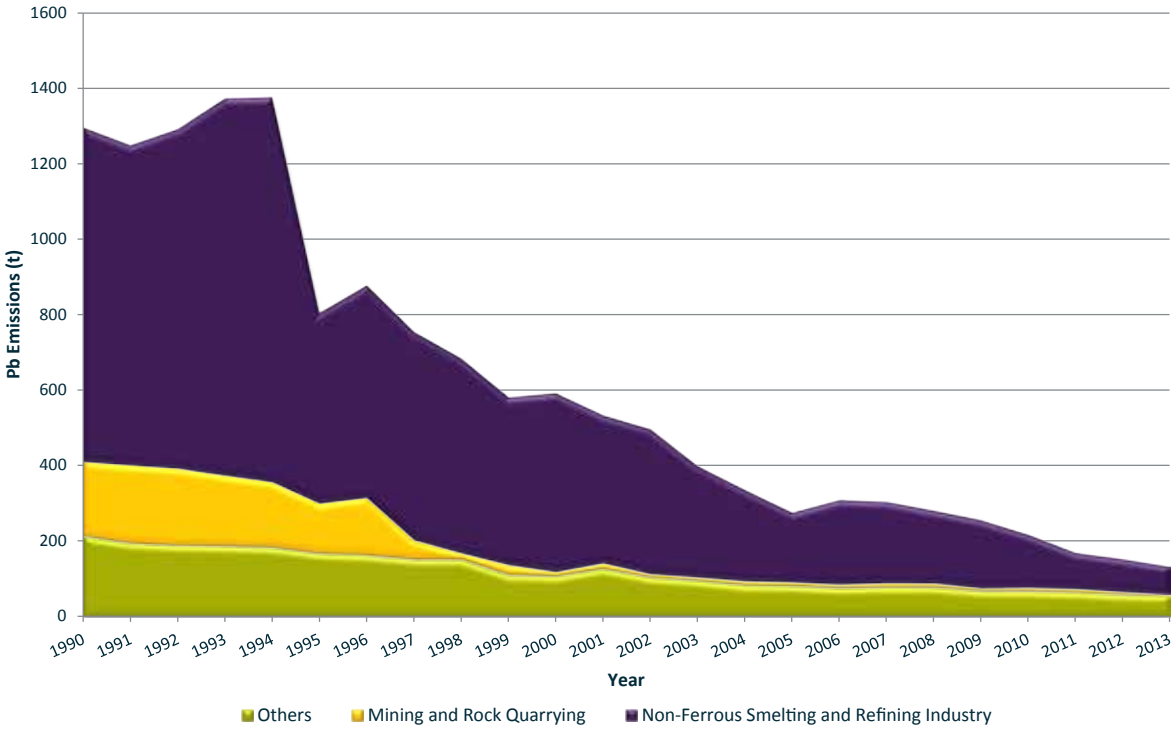


Table 2–9 National Summary of Pb Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(kg)				
Industrial Sources	**1 200 000**	**730 000**	**520 000**	**220 000**	**210 000**	**170 000**	**130 000**	**110 000**	**92 000**
Aluminium Industry	84	84	84						
Asphalt Paving Industry	960	1 200	1 200	1 200	1 200	1 300	1 400	990	990
Cement and Concrete Industry	550	500	610	980	570	620	560	630	530
Chemicals Industry	12 000	110	290	1 900	1 600	530	74	72	64
Mineral Products Industry									
Foundries	12 000	16 000	18 000	1 500	570	550	380	360	91
Grain Industries									
Iron and Steel Industries	54 000	49 000	3 500	5 600	4 300	6 300	6 000	6 600	5 100
Iron Ore Mining Industry					1 200	2 000	1 800	1 900	2 100
Mining and Rock Quarrying	200 000	130 000	13 000	11 000	7 800	9 700	9 700	7 000	3 100
Non-Ferrous Smelting and Refining Industry	890 000	510 000	470 000	190 000	180 000	140 000	96 000	88 000	75 000
Pulp and Paper Industry	2 100	1 300	710	2 400	1 800	1 400	1 500	1 300	1 400
Wood Industry	220	240	260	560	370	730	470	840	820
Upstream Petroleum Industry	140	180	220	260	780	850	610	660	700
Downstream Petroleum Industry	200	200	81	450	500	440	330	320	380
Petroleum Product Transportation and Distribution									
Other Industries	32 000	21 000	11 000	11 000	8 000	8 900	14 000	2 200	2 300
Biofuel Production									
Non-Industrial Sources	**17 000**	**16 000**	**18 000**	**5 200**	**5 800**	**6 300**	**6 800**	**6 500**	**4 800**
Commercial Fuel Combustion	330	230	290	480	320	1 100	910	1 000	510
Electric Power Generation (Utilities)	11 000	12 000	14 000	1 800	2 700	2 200	2 900	2 500	1 400
Residential Fuel Combustion	1 400	400	400	380	350	330	340	300	300
Residential Fuel Wood Combustion	3 500	3 400	3 200	2 600	2 500	2 600	2 700	2 700	2 700
Mobile Sources	**79 000**	**60 000**	**52 000**	**48 000**	**41 000**	**37 000**	**31 000**	**36 000**	**36 000**
Air Transportation	78 000	59 000	51 000	47 000	41 000	37 000	30 000	36 000	36 000
Heavy-duty diesel vehicles									
Heavy-duty gasoline trucks	0.017								
Light-duty diesel trucks									
Light-duty diesel vehicles									
Light-duty gasoline trucks									
Light-duty gasoline vehicles									
Motorcycles									
Marine Transportation	600	660	740	830	650	600	670	610	540
Off-road use of diesel									
Off-road use of gasoline/LPG/CNG									
Rail Transportation	310	280	290	290	190	230	250	250	250
Tire Wear & Brake Lining									
Incineration Sources	**200**	**150**	**110**	**680**	**510**	**540**	**510**	**360**	**360**
Crematorium	2	2.4	2.9	3.9	5	5.1	5.2	4.7	4.9
Industrial & Commercial Incineration				420	370	380	360	310	320
Municipal Incineration	74	5.9	29	260	130	150	140	36	28
Other Incineration & Utilities	130	150	77	4.6	6.1	6.1	6.1	6.1	6.1
Miscellaneous Sources	**2 000**	**2 100**	**980**	**1 200**	**31**	**4.9**	**11**	**4.6**	**70**
Cigarette Smoking				1.5	1.3	1.4	1.3	1.3	1.3
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry	2 000	2 100	970	1 200	29	3	9.1	2.9	59
Meat Cooking									
Refined Petroleum Products Retail									
Printing	4.3	5.1	6.3	1	0.84	0.52	0.65	0.4	0.5
Structural Fires									
Surface Coatings									0.06
Human									
Other Miscellaneous Sources									9.7
Open Sources	**34**	**42**	**34**	**110**	**160**	**460**	**100**	**280**	**100**
Agriculture		36	30	26	44	53	71	59	59
Construction Operations	34	5.5	4.9	11	12	13	7.6	13	13
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste				77	110	400	24	210	28
Mine Tailings									
Prescribed Burning									
Grand Total	**1 300 000**	**810 000**	**590 000**	**280 000**	**260 000**	**220 000**	**170 000**	**150 000**	**130 000**

Note: Totals may not add up due to rounding.

2.8. Cadmium (Cd)

Approximately 8.8 t of Cd were released in Canada in 2013 (Table 2–10). Industrial sources accounted for 78% (6.9 t) of national emissions, including the non-ferrous smelting and refining industry at 61% (5.3 t) of emissions. Non-industrial sources contributed 17% (1.5 t) of Cd emissions, including commercial fuel combustion, electric power generation (utilities) and residential fuel combustion, which collectively accounted for 15% (1.3 t) of the national total.

From 1990–2013, national Cd emissions decreased by 90% (83 t) (Figure 2–8), a decline mainly attributed to a reduction in emissions from industrial sources of 92% (76 t), specifically a reduction in emissions from the non-ferrous smelting and refining industry of 93% (73 t). As with Pb emissions, reductions in Cd emissions in the non-ferrous smelting and refining industry are due to changes in production processes, better control of PM emissions, and the closure of smelters.

Figure 2–8 National Cd Trends and Contributing Sectors

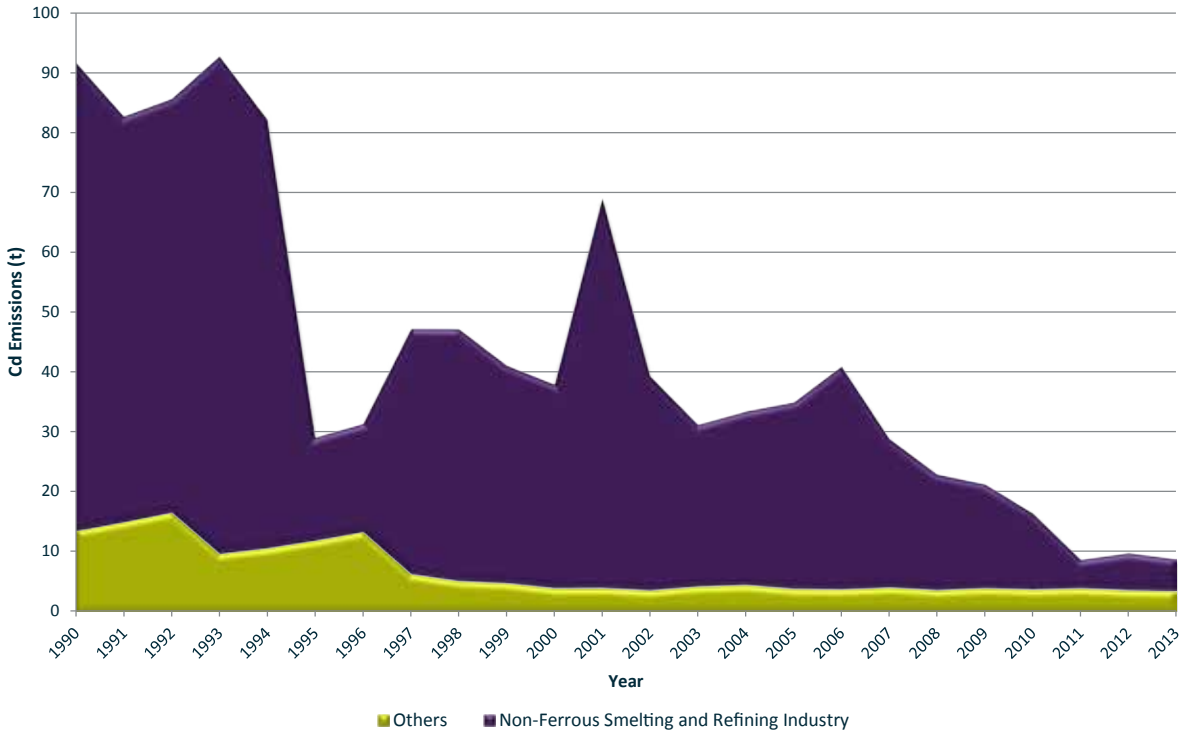


Table 2–10 National Summary of Cd Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(kg)				
Industrial Sources	**82 000**	**24 000**	**36 000**	**33 000**	**19 000**	**15 000**	**6 400**	**7 800**	**6 900**
Aluminium Industry	0.67	0.81	0.98						
Asphalt Paving Industry	33	22	24	25	25	29	30	23	23
Cement and Concrete Industry	47	42	47	43	19	29	20	28	16
Chemicals Industry	140	160	130	71	3.3	7.6	6.4	6.6	6.4
Mineral Products Industry									
Foundries	500	470	350	26	0.06	0.0068	1.8	1.8	1.7
Grain Industries									
Iron and Steel Industries	150	220	160	300	230	270	240	250	230
Iron Ore Mining Industry					19	52	50	58	69
Mining and Rock Quarrying	2 200	4 400	280	360	280	280	290	300	300
Non-Ferrous Smelting and Refining Industry	78 000	17 000	34 000	31 000	17 000	13 000	4 800	6 200	5 300
Pulp and Paper Industry	370	340	150	330	610	220	220	210	230
Wood Industry	21	26	28	53	32	43	55	76	79
Upstream Petroleum Industry	25	33	38	60	290	430	140	130	130
Downstream Petroleum Industry	110	130	150	130	130	120	120	120	100
Petroleum Product Transportation and Distribution									
Other Industries	550	620	600	450	340	400	400	380	340
Biofuel Production									
Non-Industrial Sources	**1 800**	**1 300**	**1 300**	**1 400**	**1 500**	**1 300**	**1 800**	**1 500**	**1 500**
Commercial Fuel Combustion	420	500	510	450	430	430	470	480	480
Electric Power Generation (Utilities)	130	140	130	280	410	270	700	430	360
Residential Fuel Combustion	1 100	510	500	490	490	470	510	480	480
Residential Fuel Wood Combustion	200	190	180	150	140	150	160	160	160
Mobile Sources	**300**	**330**	**370**	**410**	**350**	**360**	**380**	**340**	**310**
Air Transportation									
Heavy-duty diesel vehicles									
Heavy-duty gasoline trucks									
Light-duty diesel trucks									
Light-duty diesel vehicles									
Light-duty gasoline trucks									
Light-duty gasoline vehicles									
Motorcycles									
Marine Transportation	190	230	280	320	290	280	300	260	220
Off-road use of diesel									
Off-road use of gasoline/LPG/CNG									
Rail Transportation	100	94	98	95	63	76	83	84	84
Tire Wear & Brake Lining									
Incineration Sources	**7 000**	**3 600**	**200**	**55**	**35**	**37**	**37**	**9.6**	**9.4**
Crematorium	0.34	0.4	0.46	0.65	0.85	0.86	0.87	0.79	0.82
Industrial & Commercial Incineration	200	99	2	7.4	2	5.4	4.9	2.3	1.7
Municipal Incineration	380	250	130	44	30	28	28	3.9	4.2
Other Incineration & Utilities	6 400	3 300	70	2.1	2.7	2.7	2.7	2.7	2.7
Miscellaneous Sources	**1**	**1**	**1**	**51**	**4.8**	**3.7**	**4**	**3.6**	**5.9**
Cigarette Smoking				3.8	3.5	3.6	3.5	3.5	3.5
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry				47	1.3	0.16	0.41	0.077	2.3
Meat Cooking									
Refined Petroleum Products Retail									
Printing	1	1	1		0.046	0.013	0.01		
Structural Fires									
Surface Coatings									0.12
Human									
Other Miscellaneous Sources									
Open Sources	**140**	**75**	**61**	**77**	**85**	**96**	**100**	**120**	**110**
Agriculture		68	54	57	62	69	81	85	85
Construction Operations	140	6.5	7	10	8.9	10	8.4	10	10
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste				10	14	17	13	23	18
Mine Tailings									
Prescribed Burning									
Grand Total	**92 000**	**29 000**	**38 000**	**35 000**	**21 000**	**16 000**	**8 700**	**9 800**	**8 800**

Note: Totals may not add up due to rounding.

2.9. Mercury (Hg)

Approximately 4.0 t of Hg were emitted in Canada in 2013 (Table 2–11). Industrial sources were the largest contributors and accounted for 41% (1.6 t) of the national total, with the cement and concrete, iron and steel, and non-ferrous smelting and refining industries collectively contributing 32% (1.3 t) of total Hg emissions. As the second-largest contributor, non-industrial sources accounted for 27% (1.1 t) of emissions, with electric power generation (utilities) accounting for 23% (900 kg) of the total. Open sources contributed 13% (530 kg) of Hg emissions, largely due to emissions from waste, which accounted for 13% (520 kg) of the national total.

Between 1990 and 2013, Hg emissions decreased by 88% (30 t) (Figure 2–9). Emission reductions in industrial sources are the main reason for this decline, as they have decreased by 94% (26 t). Specifically, emissions from the non-ferrous smelting and refining industry have decreased by 99% (25 t) due to better controls on PM emissions, smelter closures, and the separation of production materials with high Hg content.

Figure 2–9 National Hg Trends and Contributing Sectors

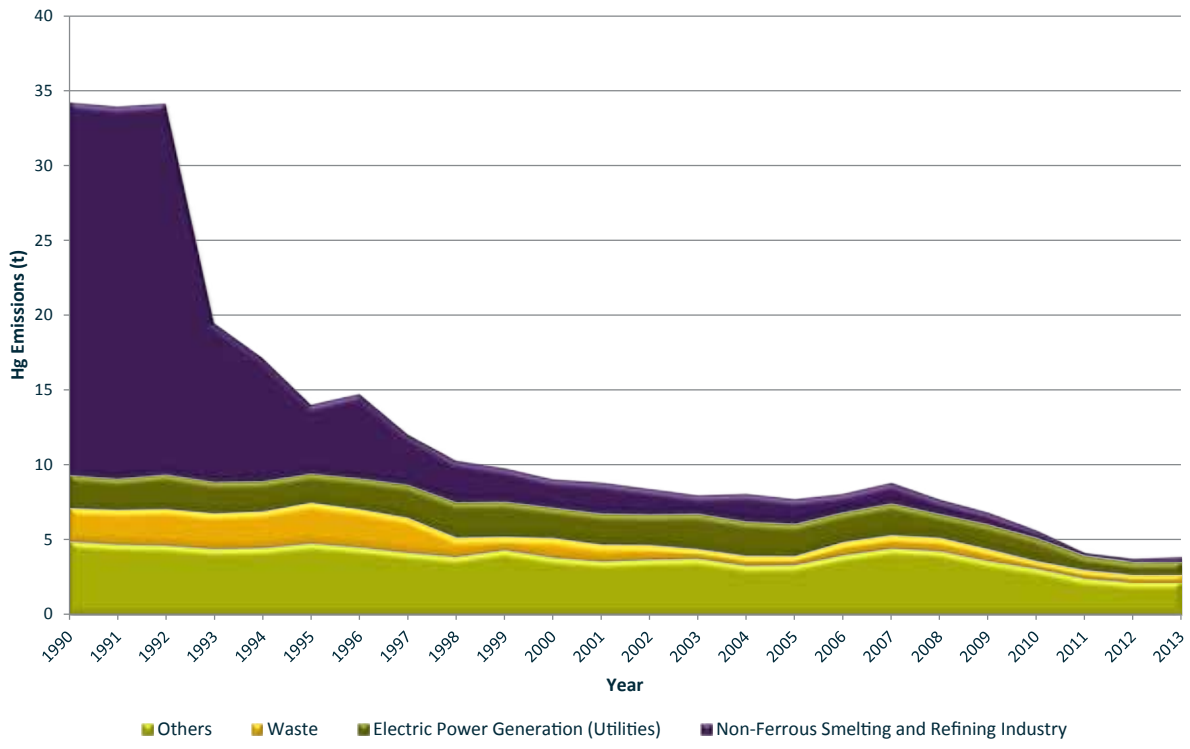


Table 2–11 National Summary of Hg Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(kg)				
Industrial Sources	**27 000**	**6 900**	**4 400**	**3 300**	**2 600**	**2 000**	**1 400**	**1 500**	**1 600**
Aluminium Industry	18	23	31	43	24	22	19	20	21
Asphalt Paving Industry		21	22	22	23	28	29	22	22
Cement and Concrete Industry	460	410	390	210	300	320	300	300	310
Chemicals Industry	170	120	82	58	15	17	16	15	17
Mineral Products Industry				0.036				0.0003	0.0005
Foundries	210	180	120	4.2					
Grain Industries									
Iron and Steel Industries	710	550	940	660	710	420	460	550	590
Iron Ore Mining Industry	60	60	60	60	70	85	100	98	100
Mining and Rock Quarrying	12	12	12	28	7.9	7.4	4.9	5	7.9
Non-Ferrous Smelting and Refining Industry	25 000	4 600	1 900	1 700	840	540	210	250	360
Pulp and Paper Industry	98	130	130	59	50	67	63	53	50
Wood Industry	2	2	2	9.8	33	24	20	29	29
Upstream Petroleum Industry	3	27	36	38	78	140	59	59	67
Downstream Petroleum Industry	110	120	26	46	56	55	47	46	48
Petroleum Product Transportation and Distribution									
Other Industries	570	590	600	300	350	250	19	17	13
Biofuel Production									
Non-Industrial Sources	**2 300**	**2 200**	**2 200**	**2 300**	**1 800**	**1 700**	**1 200**	**1 000**	**1 100**
Commercial Fuel Combustion	1.3	50	61	63	59	54	58	53	53
Electric Power Generation (Utilities)	2 200	2 000	2 000	2 200	1 700	1 600	990	860	900
Residential Fuel Combustion		71	72	72	73	68	75	69	69
Residential Fuel Wood Combustion	54	51	48	40	38	40	41	41	41
Mobile Sources	**110**	**99**	**100**	**100**	**69**	**83**	**90**	**90**	**89**
Air Transportation									
Heavy-duty diesel vehicles									
Heavy-duty gasoline trucks									
Light-duty diesel trucks									
Light-duty diesel vehicles									
Light-duty gasoline trucks									
Light-duty gasoline vehicles									
Motorcycles									
Marine Transportation	4.3	5.2	6.2	7.2	6.6	6.4	6.7	5.9	5
Off-road use of diesel									
Off-road use of gasoline/LPG/CNG									
Rail Transportation	100	94	98	95	63	76	83	84	84
Tire Wear & Brake Lining									
Incineration Sources	**1 300**	**1 300**	**680**	**1 100**	**1 300**	**1 000**	**680**	**380**	**330**
Crematorium	100	120	140	190	250	260	260	230	240
Industrial & Commercial Incineration	120	140	21	130	160	120	160	44	6
Municipal Incineration	700	750	420	650	540	370	260	100	77
Other Incineration & Utilities	380	310	110	160	310	290			
Miscellaneous Sources	**980**	**920**	**410**	**380**	**380**	**370**	**350**	**340**	**330**
Cigarette Smoking				0.14	0.13	0.13	0.13	0.12	0.12
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry				2.8	0.039	0.0048			
Meat Cooking									
Refined Petroleum Products Retail									
Printing									
Structural Fires									
Surface Coatings									
Human	110	110	20	15	32	33	16	16	16
Other Miscellaneous Sources	870	810	390	360	350	340	340	320	310
Open Sources	**2 300**	**2 700**	**1 300**	**630**	**830**	**540**	**600**	**550**	**530**
Agriculture		2.8	3.4	3.2	5.1	6	7.9	7.5	7.5
Construction Operations		1.6	1.7	2.6	2.2	2.6	2	2.5	2.5
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	2 300	2 700	1 300	630	820	540	590	540	520
Mine Tailings									
Prescribed Burning									
Grand Total	**34 000**	**14 000**	**9 200**	**7 800**	**6 900**	**5 700**	**4 200**	**3 800**	**4 000**

Note: Totals may not add up due to rounding.

2.10. Dioxins and Furans (D/F)

In 2013, D/F emissions in Canada were approximately 71 grams of toxicity equivalent (gTEQ) (Table 2–12). Mobile sources accounted for the largest portion of these emissions at 42% (30 gTEQ), with the most significant mobile sources being marine transport and heavy-duty diesel vehicles, which accounted for 25% (18 gTEQ) and 12% (8.6 gTEQ) of total emissions, respectively. Open sources were the second-largest contributors with 28% (20 gTEQ) of D/F emissions, mainly due to waste and specifically open burning (Table 2–2), which accounted for 27% (20 gTEQ) of total D/F. Other significant contributors are non-industrial sources with 13% (9.4 gTEQ) and industrial sources with 11% (7.8 gTEQ) of total emissions.

Between 1990 and 2013, D/F emissions decreased by 84% (380 gTEQ) (Figure 2–10), primarily due to a reduction in emissions from incineration sources of 99% (320 gTEQ). Specifically, municipal incineration and other incineration & utilities emissions have decreased by 99% (190 gTEQ) and 100% (130 gTEQ), respectively, as a result of a decline in the number of municipal incinerator facilities in Newfoundland and Labrador.

Figure 2–10 National D/F Trends and Contributing Sectors

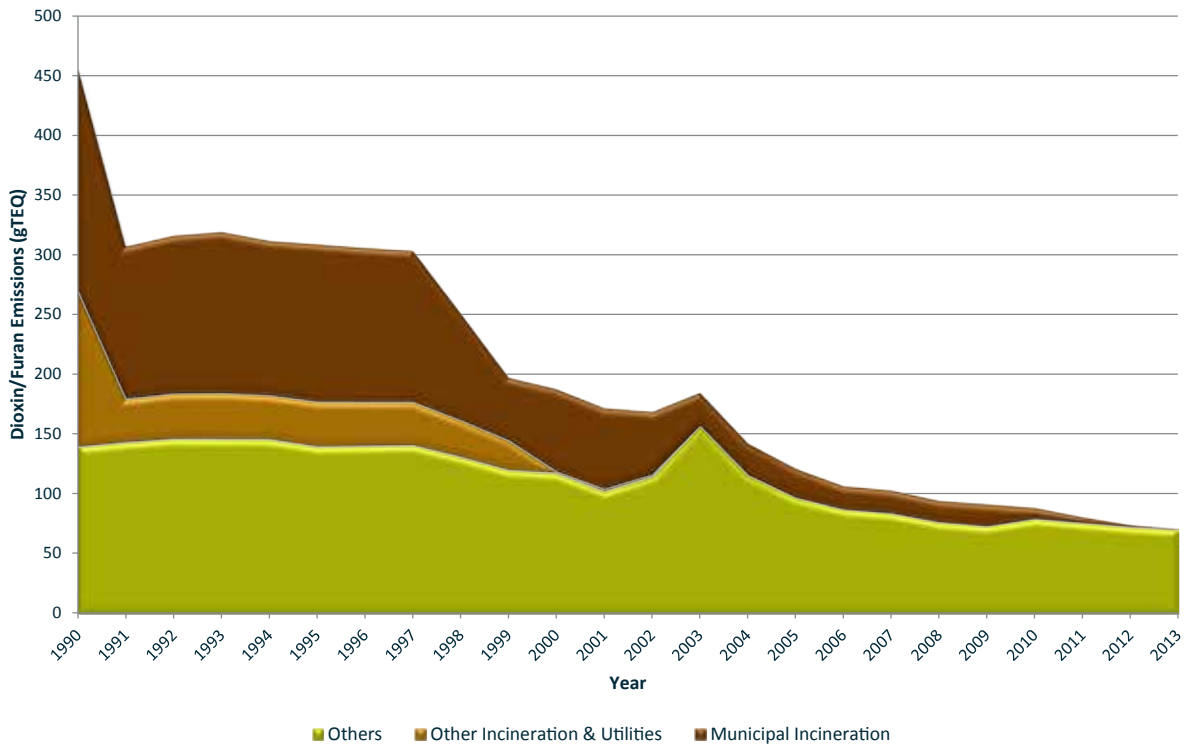


Table 2–12 National Summary of D/F Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(gTEQ)				
Industrial Sources	**66**	**67**	**48**	**15**	**7.3**	**13**	**7.6**	**7.3**	**7.8**
Aluminium Industry	2.8	3.3	4.1		1	1.3	0.4		
Asphalt Paving Industry	0.51	0.015	0.021	0.013	0.0057	0.0063	0.0066	0.0049	0.0049
Cement and Concrete Industry	3	2.7	1.8	1.6	0.76	0.76	0.4	0.63	0.54
Chemicals Industry	2.2	1.7	0.12	0.02	0.24	0.32	0.35	0.27	0.13
Mineral Products Industry	0.81	0.96	1.2	0.81					
Foundries	0.94	1	0.12	0.003	0.00014	0.0001	0.01	0.01	0.0001
Grain Industries									
Iron and Steel Industries	35	36	16	3	1.7	2.7	2.3	2.9	2.8
Iron Ore Mining Industry									
Mining and Rock Quarrying			0.14	0.58	0.039	0.12	0.056	0.044	0.56
Non-Ferrous Smelting and Refining Industry	3.4	3.4	3.5	1.3	0.46	0.73	0.47	0.48	0.37
Pulp and Paper Industry	11	11	14	3.1	1.9	2.1	1.2	1	1.8
Wood Industry	1.8	2	1.1	0.046	0.61	4	0.84	0.52	0.53
Upstream Petroleum Industry									
Downstream Petroleum Industry									
Petroleum Product Transportation and Distribution									
Other Industries	4.4	5.3	5.6	4.1	0.62	1.5	1.5	1.4	1.1
Biofuel Production									
Non-Industrial Sources	**19**	**15**	**14**	**11**	**10**	**10**	**9.7**	**9.4**	**9.4**
Commercial Fuel Combustion	0.31	0.33	0.35	0.31	0.17	0.17	0.47	0.24	0.24
Electric Power Generation (Utilities)	3	5.2	5.2	3	2.9	2.5	1.7	1.6	1.7
Residential Fuel Combustion	7	0.56	0.55	0.51	0.46	0.44	0.42	0.38	0.38
Residential Fuel Wood Combustion	9	8.7	8.2	6.7	6.5	7	7.1	7.2	7.1
Mobile Sources	**25**	**28**	**32**	**37**	**31**	**31**	**34**	**32**	**30**
Air Transportation									
Heavy-duty diesel vehicles	2.5	3.5	4.3	6.3	7.2	7.9	8.5	8.7	8.6
Heavy-duty gasoline trucks	0.049	0.035	0.03	0.025	0.022	0.021	0.021	0.021	0.021
Light-duty diesel trucks	0.36	0.56	0.76	1.1	0.88	0.94	1.1	1.1	1.2
Light-duty diesel vehicles	0.23	0.21	0.22	0.52	0.5	0.57	0.66	0.67	0.7
Light-duty gasoline trucks	0.067	0.086	0.11	0.099	0.088	0.087	0.083	0.081	0.079
Light-duty gasoline vehicles	0.22	0.21	0.2	0.16	0.12	0.11	0.11	0.097	0.091
Motorcycles	0.0017	0.0014	0.0023	0.003	0.0055	0.0062	0.0065	0.0071	0.0078
Marine Transportation	20	22	25	28	22	20	22	20	18
Off-road use of diesel									
Off-road use of gasoline/LPG/CNG									
Rail Transportation	1.2	1.1	1.2	1.2	0.92	1.2	1.4	1.4	1.4
Tire Wear & Brake Lining									
Incineration Sources	**330**	**180**	**74**	**27**	**22**	**13**	**8.9**	**5**	**3.8**
Crematorium	1.6	1.6	1.6	2.2	2.9	2.9	2.9	2.7	2.8
Industrial & Commercial Incineration	9	8.3	1.7	0.19	0.35	0.48	0.46	0.11	0.006
Municipal Incineration	190	130	69	25	19	9.7	5.5	2.2	1
Other Incineration & Utilities	130	38	1.5	0.007	9.2E-07	9.2E-07	0.01		
Miscellaneous Sources	**2**	**2**	**2**	**2**	**0.011**	**0.011**	**0.011**	**0.011**	**0.011**
Cigarette Smoking	0.016	0.016	0.016	0.012	0.011	0.011	0.011	0.011	0.011
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry									
Meat Cooking									
Refined Petroleum Products Retail									
Printing									
Structural Fires									
Surface Coatings									
Human									
Other Miscellaneous Sources	2	2	2	2					
Open Sources	**17**	**18**	**18**	**30**	**21**	**21**	**21**	**21**	**20**
Agriculture		0.076	0.054	0.042	0.052	0.061	0.078	0.067	0.067
Construction Operations	0.015	0.028	0.021	0.029	0.028	0.027	0.019	0.023	0.023
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	17	18	18	30	19	21	20	19	20
Mine Tailings									
Prescribed Burning				0.49	1.7	0.52	0.78	1.3	0.52
Grand Total	**460**	**310**	**190**	**120**	**92**	**89**	**81**	**75**	**71**

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). For the analysis presented here, the aggregate total of all four substances is used. In 2013, 140 t of PAHs were emitted in Canada (Table 2–13), the majority attributed to non-industrial sources with just over 75% (100 t) of total emissions, largely due to residential fuel wood combustion. Industrial sources are the second-largest contributors with 23% (32 t) of total emissions, including the aluminium industry with 22% (31 t) of PAH emissions in 2013.

From 1990–2013, emissions of PAHs decreased by 58% (190 t) (Figure 2–11), a decline largely attributed to an 85% (160 t) reduction in emissions from industrial sources, specifically the iron and steel industry and aluminium industry, which have reduced emissions by 98% (79 t) and 72% (78 t), respectively. The decrease in emissions from the iron and steel industry is a result of effective emission controls on coke ovens and electric arc furnaces, while aluminium emissions have decreased due to implementation of new production technologies. Furthermore, emissions from non-industrial sources have declined by 25% (34 t), mainly due to a decrease in residential fuel wood combustion emissions of 25% (33 t) from 1990–2013, as a result of less wood being consumed for fuel.

Figure 2–11 National PAH Trends and Contributing Sectors

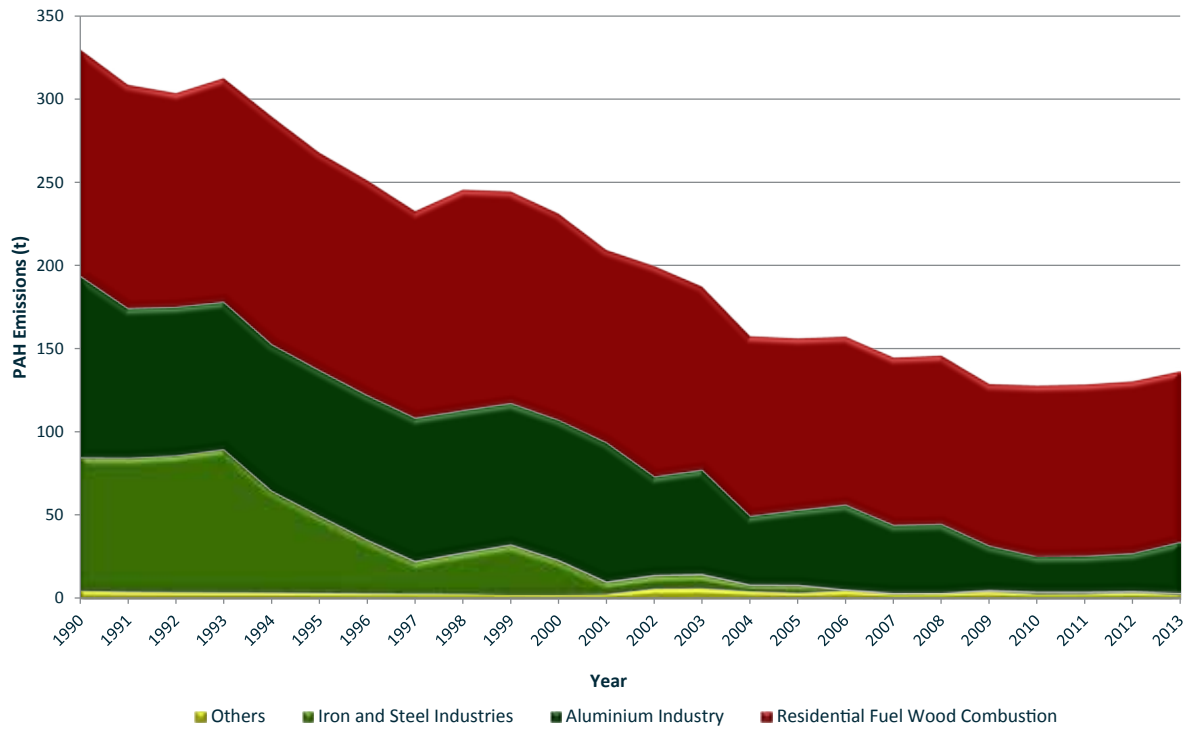


Table 2–13 National Summary of PAH Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(kg)				
Industrial Sources	**190 000**	**130 000**	**100 000**	**50 000**	**28 000**	**23 000**	**23 000**	**24 000**	**32 000**
Aluminium Industry	110 000	87 000	84 000	45 000	27 000	21 000	22 000	23 000	31 000
Asphalt Paving Industry	8.8	12	14	15	15	18	18	15	15
Cement and Concrete Industry	17	17	13	16	0.28	0.61	0.77	12	1.7
Chemicals Industry	0.53	15	15	27	28	27	28	28	25
Mineral Products Industry									
Foundries									
Grain Industries									
Iron and Steel Industries	80 000	46 000	20 000	4 500	580	1 100	1 000	740	550
Iron Ore Mining Industry					7.9	21	18	19	18
Mining and Rock Quarrying	0.32	0.38	0.49				0.3	0.25	130
Non-Ferrous Smelting and Refining Industry	2.1	2.5	3.1	0.36	0.3	0.35	0.33	0.27	0.31
Pulp and Paper Industry	110	120	120	190	130	56	59	120	160
Wood Industry	4	4.3	4.1	43	24	17	13	11	10
Upstream Petroleum Industry	2.2	2.9	3.3	3	5.4	7.7	8.4	8.2	9
Downstream Petroleum Industry	150	160	100	42	35	37	16	19	18
Petroleum Product Transportation and Distribution			0.24						
Other Industries	1.1	1.2	1.2	10	2.2	7.1		4.1	4.1
Biofuel Production									
Non-Industrial Sources	**140 000**	**130 000**	**120 000**	**100 000**	**97 000**	**100 000**	**100 000**	**100 000**	**100 000**
Commercial Fuel Combustion	2.4	2.7	3.1	2.9	2.1	2	2.3	2.1	2.1
Electric Power Generation (Utilities)	370	360	340	250	5.1	73	23	7.8	63
Residential Fuel Combustion	3.9	4.5	4.5	4.3	4.1	3.8	3.9	3.5	3.5
Residential Fuel Wood Combustion	140 000	130 000	120 000	100 000	97 000	100 000	100 000	100 000	100 000
Mobile Sources	**4 200**	**2 900**	**2 000**	**1 800**	**1 400**	**1 300**	**1 200**	**1 100**	**1 100**
Air Transportation	13	9.6	11	7.6	6.6	6.9	6.6	8.7	8.9
Heavy-duty diesel vehicles	830	710	470	580	390	390	350	290	250
Heavy-duty gasoline trucks	1 800	840	460	380	300	270	210	190	190
Light-duty diesel trucks	56	65	52	50	26	25	23	20	17
Light-duty diesel vehicles	45	26	17	36	24	25	27	26	25
Light-duty gasoline trucks	600	500	410	260	230	220	200	180	190
Light-duty gasoline vehicles	600	510	370	220	200	210	200	200	200
Motorcycles	4.6	3.7	6.1	5.2	6.7	7.2	7.5	7.5	8.3
Marine Transportation	120	130	150	170	130	120	130	120	110
Off-road use of diesel	0.11	0.12	0.11	0.084	0.067	0.073	0.061	0.051	0.047
Off-road use of gasoline/LPG/CNG	3.5	2.9	1.9	0.98	0.81	0.78	0.52	0.45	0.42
Rail Transportation	63	57	59	58	38	46	50	51	51
Tire Wear & Brake Lining									
Incineration Sources	**1.4**	**1.6**	**1.7**	**3**	**0.0057**	**0.0058**	**0.054**	**0.055**	**0.13**
Crematorium				0.0038	0.0057	0.0058	0.0058	0.0053	
Industrial & Commercial Incineration									
Municipal Incineration				3			0.048	0.05	0.13
Other Incineration & Utilities	1.4	1.6	1.7						
Miscellaneous Sources	**0.39**	**0.39**	**0.39**	**0.67**	**3.3**	**3.3**	**3.3**	**3.3**	**3.3**
Cigarette Smoking	0.39	0.39	0.39	0.67	0.62	0.63	0.62	0.62	0.62
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry									
Meat Cooking					2.7	2.7	2.7	2.7	2.7
Refined Petroleum Products Retail									
Printing									
Structural Fires									
Surface Coatings									
Human									
Other Miscellaneous Sources									
Open Sources		**0.63**	**0.48**	**1 300**	**2 800**	**1 400**	**1 700**	**2 400**	**1 400**
Agriculture		0.4	0.31	0.21	0.25	0.29	0.38	0.34	0.34
Construction Operations		0.23	0.17	0.39	0.45	0.49	0.27	0.46	0.46
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste				690	670	730	690	680	680
Mine Tailings									
Prescribed Burning				630	2 200	670	1 000	1 700	670
Grand Total	**330 000**	**270 000**	**230 000**	**160 000**	**130 000**	**130 000**	**130 000**	**130 000**	**140 000**

Note: Totals may not add up due to rounding. PAHs include B(a)p, B(b)f, B(k)f, I(1,2,3-cd)p.

2.12. Hexachlorobenzene (HCB)

In 2013, approximately 8.6 kg of HCB were emitted in Canada (Table 2–14). Open sources were the largest contributor, entirely due to emissions from waste at 54% (4.7 kg) of HCB emissions. The second-largest contributors were industrial sources with 30% (2.6 kg) of total emissions, largely due to iron and steel industries, which represented 13% (1.1 kg) of the national total.

Overall, a 90% (80 kg) decrease in HCB emissions occurred between 1990 and 2013 (Figure 2–12), largely attributed to a reduction in emissions from incineration sources of 99% (67 kg), specifically reductions in municipal incineration. Emissions in this sector have rapidly decreased by almost 100% (68 kg) to account for less than 2% (0.2 kg) of emissions in 2013, a result of steady decline in the number of municipal incinerators operating in Newfoundland and Labrador. HCB emissions from waste increased in 2005 due to contributions from the open burning subsector (Table 2–2), and remained relatively constant over the 2005–2013 time frame. Pre-2005 estimates for open burning are not currently available. Emissions from non-industrial sources have decreased by 94% (10 kg), entirely attributed to emission reductions in electric power generation (utilities) over the 1990–2013 time period. Emissions from electric power generation (utilities) have decreased due to more effective PM controls and the phasing out of coal electricity generation in Ontario.

Figure 2–12 National HCB Trends and Contributing Sectors

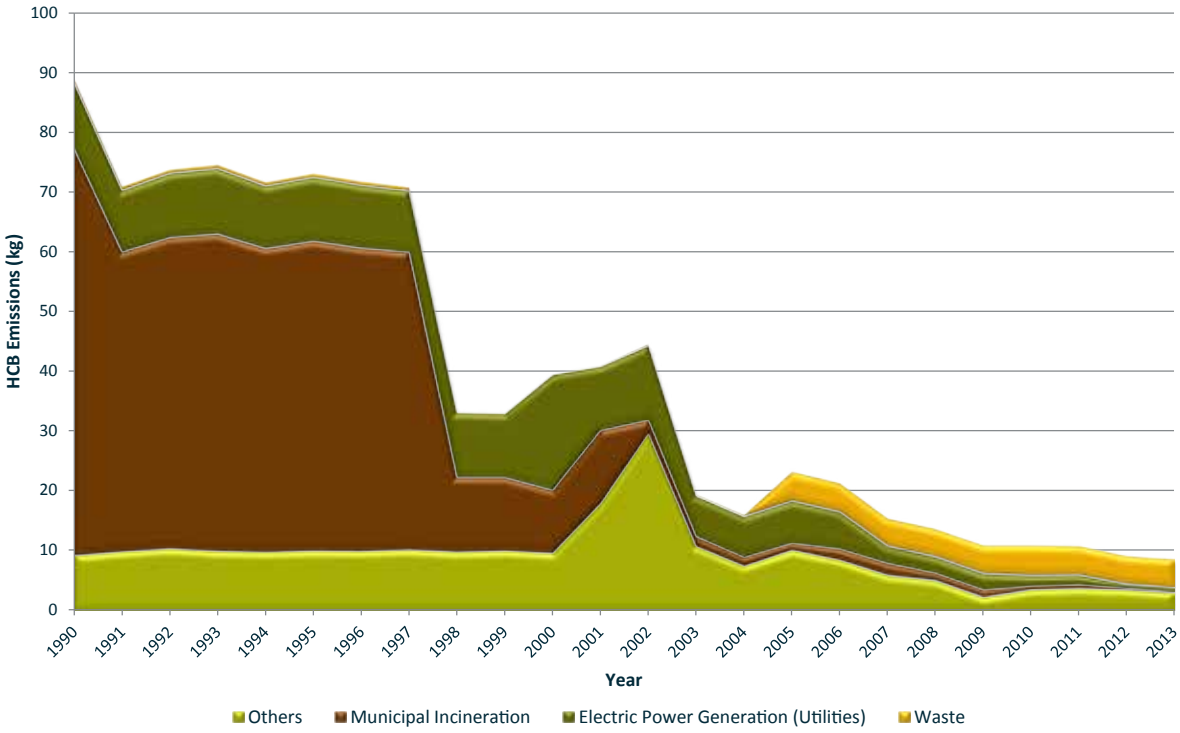


Table 2–14 National Summary of HCB Emissions for Sources and Sectors by Year

	1990	1995	2000	2005	2009	2010	2011	2012	2013
					(g)				
Industrial Sources	**9 200**	**10 000**	**9 500**	**8 200**	**2 200**	**3 400**	**3 300**	**3 000**	**2 600**
Aluminium Industry						49	48		
Asphalt Paving Industry									
Cement and Concrete Industry	1 600	1 900	2 100	880	470	660	560	420	420
Chemicals Industry	680	720	330	390	0.17				
Mineral Products Industry									
Foundries	2 100	2 300	2 300				0.01	0.01	
Grain Industries									
Iron and Steel Industries	1 100	1 200	920	1 500	840	1 500	1 500	1 400	1 100
Iron Ore Mining Industry									
Mining and Rock Quarrying	13	13	13	32	11	12	14	18	13
Non-Ferrous Smelting and Refining Industry	2 700	2 700	2 600	4 400	720	950	930	650	730
Pulp and Paper Industry	140	140	180	310	140	170	120	120	94
Wood Industry	340	410	390	620	6.6	6.8	3.4	0.091	1.9
Upstream Petroleum Industry	1.3	1.3	1.6						
Downstream Petroleum Industry									
Petroleum Product Transportation and Distribution									
Other Industries	470	560	590	55		130	120	350	230
Biofuel Production									
Non-Industrial Sources	**11 000**	**11 000**	**19 000**	**7 000**	**2 700**	**1 800**	**1 600**	**660**	**710**
Commercial Fuel Combustion									
Electric Power Generation (Utilities)	11 000	11 000	19 000	7 000	2 700	1 800	1 600	660	710
Residential Fuel Combustion									
Residential Fuel Wood Combustion									
Mobile Sources									
Air Transportation									
Heavy-duty diesel vehicles									
Heavy-duty gasoline trucks									
Light-duty diesel trucks									
Light-duty diesel vehicles									
Light-duty gasoline trucks									
Light-duty gasoline vehicles									
Motorcycles									
Marine Transportation									
Off-road use of diesel									
Off-road use of gasoline/LPG/CNG									
Rail Transportation									
Tire Wear & Brake Lining									
Incineration Sources	**68 000**	**52 000**	**11 000**	**3 100**	**1 300**	**710**	**1 100**	**830**	**580**
Crematorium									
Industrial & Commercial Incineration	21	21	81	1 900	53	79	510	540	410
Municipal Incineration	68 000	52 000	11 000	1 200	1 300	630	610	290	170
Other Incineration & Utilities									
Miscellaneous Sources									
Cigarette Smoking									
Dry Cleaning									
General Solvent Use									
Marine Cargo Handling Industry									
Meat Cooking									
Refined Petroleum Products Retail									
Printing									
Structural Fires									
Surface Coatings									
Human									
Other Miscellaneous Sources									
Open Sources	**660**	**640**	**68**	**4 800**	**4 600**	**5 000**	**4 800**	**4 600**	**4 700**
Agriculture									
Construction Operations									
Dust from Paved Roads									
Dust from Unpaved Roads									
Dust from Coal Mining									
Waste	660	640	68	4 800	4 600	5 000	4 800	4 600	4 700
Mine Tailings									
Prescribed Burning									
Grand Total	**89 000**	**73 000**	**40 000**	**23 000**	**11 000**	**11 000**	**11 000**	**9 100**	**8 600**

Note: Totals may not add up due to rounding.

3

Overview, APEI Compilation Process

Compilation of the Air Pollutant Emission Inventory (APEI) draws from many sources of information, procedures and emission estimation models. 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. Emission Data

The APEI is compiled using two broad estimate categories:

- Point sources, consisting of emissions from large and medium-sized industrial and commercial facilities
- Area sources, including emissions from small industrial facilities 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

3.2. Point Sources

Point sources generally refer to any stationary source that emits pollutants through stacks and other equipment. These include facilities or operations at specific geographical locations that can be inventoried through national or provincial programs.

The National Pollutant Release Inventory (NPRI) is Environment Canada's Pollutant Release and Transfer Register program. 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 (POPs) since 1994. Prior to 2002, facility-level emissions for the criteria air contaminants (CACs) were collected and compiled by provincial, territorial and regional environmental authorities across Canada; that information was provided to Environment Canada for compilation of the APEI for the 1990–2001 time period.

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 the Environment Canada website at http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=4A577BB9-1. Point source emission estimates reported to the NPRI are used in the APEI without modifications, except when data quality issues are detected.

A distinction is made between reporting facilities and non-reporting facilities. Reporting facilities meet the threshold required by Environment Canada to report to the NPRI, and are therefore included in the point sources; non-reporting facilities do not meet these thresholds due to their size or emissions, and therefore are not required to report to the NPRI. Some facilities may be required to report emissions solely of certain pollutants. Emissions of non-reporting facilities or non-reported pollutants must be estimated by Environment Canada as an area source emission estimate.

3.3. Area Sources

The APEI also includes emissions for non-industrial, residential, commercial, transportation and some miscellaneous sources (such as open burning, agricultural activities and construction operations). Area source emissions are those from small industrial and commercial facilities and various other sources that are too numerous to be accounted for individually; area sources are typically inventoried as a group. Environment Canada lists the following as area sources:

- Any small residential, governmental, institutional, commercial or industrial fuel combustion operations
- On-site solid waste disposal facilities
- Motor vehicles, aircraft, vessels or other transportation facilities
- Other miscellaneous 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., and is applied to peer-reviewed and accepted emission factors to produce a provincial/territorial-level emission estimate for the APEI.

The area source estimation methodologies and emission models used in Canada are generally based upon those developed by the United States Environmental Protection Agency (U.S. EPA), and 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).

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)."

The APEI reports air pollutant emissions from mobile sources such as road vehicles, off-road vehicles and engines. The emissions for road vehicles (such as cars, light- and heavy-duty vehicles and motorcycles) are estimated using an area source estimation approach. For the current edition of the APEI, a Canadian version of an emissions estimation model developed by the U.S. EPA (MOVES) was used (see "on-road vehicles" in Table A2-4 of Annex 2). The emissions for the 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 A2-4 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.

3.4. Recalculations

Emission recalculation is an essential practice in the maintenance of an up-to-date air pollutant emission inventory. The APEI time series, which begins with the year 1990, is continuously updated with improved estimation methodologies, statistics and more recent and appropriate emission rates. Environment Canada updates/recalculates the historical time series when appropriate to ensure their consistency and comparability with the latest emission estimates. Recalculations of previously reported emission estimates are common in area sources; recalculated point source estimates are occasionally provided by facilities. More information on recalculations is provided in Annex 2.

3.5. Reconciliation

In several sectors, such as the upstream petroleum industry, estimating total emissions involves combining emissions from point and area sources. To ensure that there is no double-counting of emissions in these sectors 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. 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: Point Sources

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; the process 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 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 skew the trend analysis of 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 2013 data was the result of unit errors such as reporting in kilograms instead of tonnes. Such reporting errors were identified and corrected for the 2013 data year.

Potential outliers are defined as any data submission that:

- has a large year-over-year change, and/or
- contributes a significant and often overwhelming 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;
- the identification of substance reports with a large change in contribution/impact on the reported total; and
- the identification of substance reports with significant time-based variation over a five-year period.

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 resulted in the elimination of this type of error.

Quality control checks are also performed at the inventory level. These checks include verification of reported business numbers, North American Industry Classification System (NAICS) codes, and all geographical information (i.e. city, province, address and latitude/longitude) provided by first-year reporting facilities.

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: Area Sources

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

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

Phase 2 of the quality control is carried out through the following:

- Manual verification of the updated area source data as it is 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

Any significant changes (+/- 15%) 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.

4.3. General Assessment of Completeness

The completeness of the APEI is assessed by the level of inclusion of all measurable sources of pollutant emissions in the provincial/territorial and national totals. Sources include those attributed to

anthropogenic activities. Where the reporting of the NPRI point source data is incomplete, sector coverage is completed by the estimation of area source emissions. An overall estimation of completeness in this case is related to the availability and reliability of area source activity data and compilation methodologies.

4.4. Sector Coverage

The reporting of NPRI substances to Environment Canada 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.

Area source estimates are not required in sectors where NPRI facility data provide complete coverage of air pollutant emissions (e.g. pulp and paper). Area source estimates are necessary to complement NPRI data for those sectors characterized by a large number of smaller facilities falling below the reporting threshold (e.g. upstream petroleum industry, wood industry facilities, foundries), in order to produce a complete inventory of emissions.

Other sectors, such as residential fuel combustion, mobile sources and construction operations, are not represented by the NPRI, and coverage is assured solely through the calculation of area source emissions.

4.5. Sources Not Estimated

Although most 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. The residential fuel wood 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 because of the lack of publicly available information. In the future, these sectors may be included in the inventory, pending the availability of activity data.

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 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 solvents usage. Some VOCs, such as formaldehyde and benzene, are carcinogenic.

Carbon Monoxide (CO)

CO is an odourless gas that, when inhaled, reduces the body's ability to use oxygen. It also participates to a lesser degree in the formation of ground-level ozone. The principal human source of CO is combustion, primarily mobile sources (on-road vehicles). CO ambient 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)

Pb occurs naturally in the Earth's crust. It is declared as a toxic substance under the *Canadian Environmental Protection Act, 1999* (CEPA 1999), and is used extensively in industry to manufacture products such as lead-acid batteries and radiation shields. Metals

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

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

3 Environment Canada's definition of VOCs can be found in the *Canada Gazette*, Part II. Statutory instruments. Vol. 137, no. 14. Available from: http://publications.gc.ca/site/eng/248253/publication.html.

processing is the major source of Pb emissions to air, with the highest levels of Pb air emissions originating from the non-ferrous smelting and refining industry.

Cadmium (Cd)

Cd, declared as toxic under CEPA 1999, is present in the air as a result of human activities (i.e. anthropogenic) and natural processes. Anthropogenic sources include metal production (particularly base-metal smelting and refining) and stationary fuel combustion (e.g. power generation and heating); natural sources include weathering of soil and bedrock (Cd is a naturally occurring metal element in the environment).

Mercury (Hg)

Hg is declared as toxic under CEPA 1999. It is estimated that 7500 tonnes of Hg are released globally into the atmosphere every year. Direct anthropogenic emissions account for 30% of Hg in the air, while purely natural sources account for approximately 10%, leaving 60% from revolatilization of Hg from land and oceans (Pirrone et al. 2010; UNEP 2013). This means that, of the new Hg being emitted via revolatilization, anthropogenic sources account for approximately three quarters of emissions. In total, then, anthropogenic activities overall could account for up to approximately 75% of Hg in the air.

Hg's unique properties are utilized to produce various consumer products, including fluorescent lights and dental amalgam. When Hg is released to the atmosphere, it can be transported around the globe on wind currents, and be deposited onto land and re-emitted into the atmosphere several times along the way.

A1.3. Persistent Organic Compounds

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 mobile, home heating and electric power generation.

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.

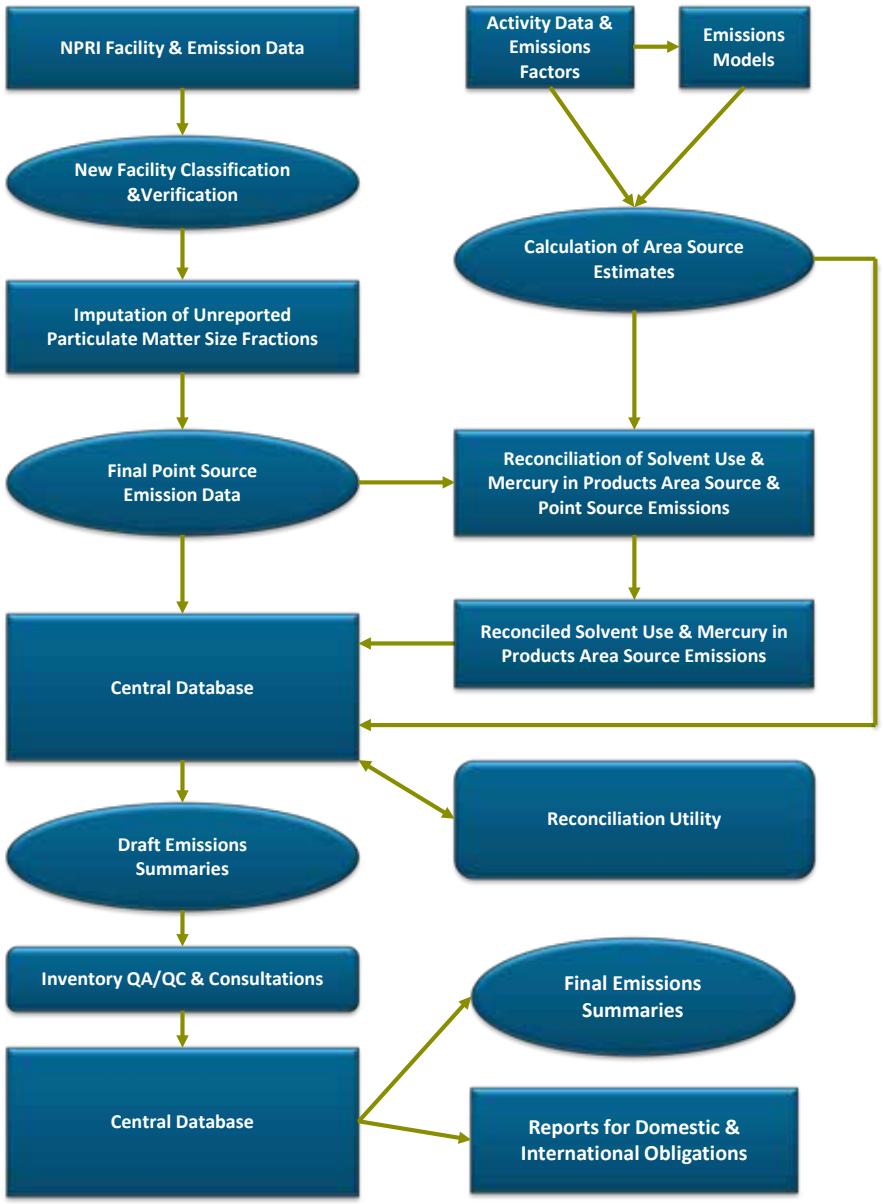
A2

Inventory Development

A2.1. Overview of the Compilation Processs

The process of compiling emission estimates consists of ensuring that point source estimates and area source estimates are finalized to allow for reconciliation where required (Figure A2–1). First, point source emission are compiled with the extraction of the National Pollutant Release Inventory (NPRI) facility and emissions data from the verified NPRI database. New facilities are identified in the extracted data and classified among the 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 inclusion of the data in the APEI. A summary of this

Figure A2–1 Overview of the Annual APEI Compilation Process



quality control process is presented in Chapter 4. A list of the final point source emission data is then produced, and transferred to a central database.

While the point source data are compiled, the area source emissions are estimated. Area source estimation involves a review of the area source sectors' estimation methodologies, followed by a literature search and collection and analysis of the latest emission factors and activity data. A decision is then made on whether to update the emission factors and estimation methodologies and whether to recalculate the estimates for the time series. Updated area source emission estimates are calculated using new and/or updated activity data. Calculations are typically performed in spreadsheets or database-driven emissions 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, which is performed by an automated database utility following transfer of the area source and point source emissions to the central database. Reconciliation of solvent use and mercury emissions from various sectors is carried out separately.

The final steps in the compilation process involve aggregation of the final point source and reconciled area source emission data in the central database to produce draft emissions summaries for quality assurance/control and consultation purposes. Any identified issues are addressed and the database is updated. Final emissions summaries are produced by December 1 of each year. The final emission database is also used to fulfill Canada's international and domestic reporting obligations.

Reconciliation of the area source estimates with the point source emissions is not required for every sector or subsector in the APEI, because point source data is not available for each one. Within the Industrial Sources category, only nine sectors/subsectors require reconciliation. In addition, the majority of sectors/subsectors in the following source categories **do not** require reconciliation (exceptions noted):

- Non-Industrial Sources – exception Commercial Fuel Combustion
- Mobile Sources
- Incineration Sources – exception Industrial & Commercial Incineration
- Miscellaneous Sources – exception Solvent Use sectors (Dry Cleaning, General Solvent Use, Printing and Surface Coatings)
- Open Sources – exception Landfills

A2.2. Estimation of the Area Source Emissions

The compilation of area source emissions relies on the availability of information such as production data / activity levels for each sector. Given that the required information is not always available in time for inventory compilation, calculations of area source emissions for some sectors are based on the latest data available at the time of compilation; if required, the data are updated the following year.

Updating all area source estimates of the APEI on an annual basis is resource-intensive and not always possible. This challenge was addressed by careful assessment of the required frequency of updates. An analysis of historical emissions inventories was undertaken in 2009, with the goal of determining the frequency of emission updates for each area source. The criteria used in this assessment included: the quantity of the area source emission estimates, availability of activity data, and the change in emissions from year to year. The results showed that not all area source sectors require annual estimation; as a result, each sector was assigned a target frequency for updates, generally ranging from annually to every three years.

Table A2–1 lists the area source sectors and subsectors of the APEI, and provides the activity data year upon which the 2013 area source estimate is based. It also indicates which sectors' emissions are no longer calculated using an area source estimate due to adequate coverage of emissions by the point source component.

The area source estimation methodologies and emission models used in Canada are generally based upon those developed by the United States Environmental Protection Agency (U.S. EPA), and adapted to reflect 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).

Table A2–2 to Table A2–8 summarize, for each source category, the estimation methodologies used to estimate the area source emissions for 2013. For each area source sector or subsector, 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 emissions model used.

Table A2–1 2013 Air Pollutant Emission Inventory (APEI)

APEI Sectors	Point Source (NPRI)[a]	Area Source (Estimated by EC)	Activity Data Used for Estimation	Area Source (No Longer Required)	Year Area Source was Last Estimated
Industrial Sources					
Aluminium Industry					
Alumina (Bauxite Refining)	✓				
Primary Aluminium Smelting & Refining	✓				
Secondary Aluminium (includes Recycling)	✓				
Asphalt Paving Industry	✓	✓	2012		
Cement and Concrete Industry					
Cement Manufacture	✓			☒	2006
Lime Manufacture	✓			☒	2006
Concrete Batching & Products	✓	✓	2013		
Chemicals Industry					
Chemical Manufacture	✓				
Paint & Varnish Manufacturing	✓				
Petrochemical Industry	✓				
Plastics & Synthetic Resins Fabrication	✓				
Fertilizer Production	✓				
Other (Chemical Industries)	✓			☒	2006
Mineral Products Industry					
Clay Products	✓				
Brick Products	✓				
Other Mineral Products	✓				
Foundries					
Ferrous Foundries	✓	✓	2011		
Non-ferrous Foundries	✓				
Die Casting	✓				
Grain Industries	✓	✓	2013		
Iron and Steel Industries					
Primary (Blast furnace and DRI)	✓				
Secondary (Electric Arc Furnaces)	✓			☒	2012
Steel Recycling	✓			☒	2012
Other (Iron and Steel Industries)	✓			☒	2006
Iron Ore Mining Industry					
Iron Ore Mining Industry	✓				
Pelletizing	✓				
Mining and Rock Quarrying					
Rock, Sand and Gravel	✓	✓	2012 and 2013		
Metal Mining	✓			☒	2011
Coal Mining Industry	✓			☒	2011
Potash	✓				
Silica Production		✓	2013		
Other Minerals	✓			☒	2011
Non-Ferrous Smelting and Refining Industry					
Primary Ni, Cu, Zn, Pb	✓				
Secondary Pb, Cu	✓				
Other Metals	✓			☒	2006
Pulp and Paper Industry	✓			☒	2006
Wood Industry[b]					
Sawmills	✓	✓	2013		
Panel Board Mills	✓	✓	2013		
Other Wood Products	✓	✓	2013		
Upstream Petroleum Industry					
Crude Oil and Natural Gas Production and Processing	✓	✓	2012		
Petroleum Liquids Storage	✓				
Oil Sands In-Situ Extraction and Processing	✓				
Oil Sands Mining Extraction and Processing	✓				
Bitumen and Heavy Oil Upgrading	✓				
Other Upstream Petroleum Industry	✓			☒	2009
Downstream Petroleum Industry					
Petroleum Refining	✓			☒	2006
Refined Petroleum Products Bulk Storage and Distribution	✓	✓	2011		
Other Downstream Petroleum Industry	✓				
Petroleum Product Transportation and Distribution					
Natural Gas Transmission	✓				
Natural Gas Distribution	✓				
Petroleum Product Pipelines	✓				
Other Industries					
Abrasives Manufacture	✓				
Bakeries	✓	✓	2013		
Metal Fabrication	✓				
Glass Manufacture	✓			☒	2010
Vehicle Manufacture (Engines, Parts, Assembly, Painting)	✓				
Electronics	✓			☒	2012
Plastics Manufacture	✓				
Food Preparation	✓				
Paint and Varnish Formulation	✓				
Textiles	✓				
Other (Other Industries)	✓			☒	2007
Biofuel Production	✓				

Table A2-1 2013 Air Pollutant Emission Inventory (APEI) (cont'd)

APEI Sectors	Point Source (NPRI)[a]	Area Source (Estimated by EC)	Activity Data Used for Estimation	Area Source (No Longer Required)	Year Area Source was Last Estimated
Non-industrial Sources					
Commercial Fuel Combustion	✓	✓	2012		
Electric Power Generation (Utilities)					
Coal	✓			☒	2011
Natural Gas	✓			☒	2011
Other (EPG)	✓			☒	2011
Residential Fuel Combustion		✓	2012		
Residential Fuel Wood Combustion		✓	2013		
Mobile Sources					
Air Transportation		✓	2013		
Heavy-duty Diesel Vehicles		✓	2013		
Heavy-duty Gasoline Trucks		✓	2013		
Light-duty Diesel Trucks		✓	2013		
Light-duty Diesel Vehicles		✓	2013		
Light-duty Gasoline Trucks		✓	2013		
Light-duty Gasoline Vehicles		✓	2013		
Marine Transportation		✓	2013		
Motorcycles		✓	2013		
Off-road use of Diesel		✓	2013		
Off-road use of Gasoline/LPG/CNG		✓	2013		
Rail Transportation		✓	2013		
Tire Wear & Brake Lining		✓	2013		
Incineration Sources					
Crematorium		✓	2013		
Industrial & Commercial Incineration	✓	✓	2011		
Municipal Incineration	✓			☒	2011
Other Incineration & Utilities		✓	2011		
Miscellaneous Sources					
Cigarette Smoking		✓	2012		
Dry Cleaning	✓	✓	2010		
General Solvent Use	✓	✓	2010		
Marine Cargo Handling Industry	✓				
Meat Cooking		✓	2013		
Refined Petroleum Products Retail		✓	2011		
Printing	✓	✓	2010		
Structural Fires		✓	2002 to 2010		
Surface Coatings	✓	✓	2010		
Human		✓	2013		
Other Miscellaneous Sources		✓	2013		
Open Sources					
Agriculture					
Agriculture (Animals)		✓	2010 and 2013[c]		
Agriculture Tilling and Wind Erosion		✓	2010		
Fertilizer Application		✓	2010 and 2013[d]		
Agriculture - Fuel Combustion		✓	2011		
Construction Operations		✓	2012		
Dust from Paved Roads		✓	2013		
Dust from Unpaved Roads	✓	✓	2013		
Dust from Coal Mining		✓	2013		
Waste					
Landfills	✓	✓	2012		
Water and Sewage Treatment	✓			☒	2012
Energy from Waste	✓				
Open Burning		✓	2013		
Waste Treatment and Disposal	✓				
Mine Tailings		✓	2005		
Prescribed Burning		✓	2013		
Mercury in Products[e]	✓	✓	2013		

Note:
✓ denotes yes
☒ denotes no longer required

a. All point source data were obtained from the 2013 NPRI.
b. Area source PM emissions for the Wood Industry were estimated by the Forestry Products group of the Environmental Stewardship Branch at EC. All other area source pollutants were estimated by PIRD.
c. Emissions of NH_3 are based upon 2013 activity data. Emissions of TPM, PM_{10}, $PM_{2.5}$ and VOCs are based on 2010 activity data.
d. Emissions of NH_3 are based upon 2013 activity data. Emissions of TPM, PM_{10} and $PM_{2.5}$ are based on 2010 activity data.
e. Emissions from Hg-containing products were calculated as a separate inventory. Emissions are reported under many sectors, such as: Iron and Steel Industries, Other Industries, Incineration, Human, Other Miscellaneous Sources, Landfills, and Water and Sewage Treatment. All area source Hg in product emissions continue to be estimated and reported under these sectors.

Table A2–2 Summary of Area Source Estimation Methodologies for Industrial Sources

Sector or Subsector	
Asphalt Paving Industry	
Sector Description	The *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 was 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 (2014d)
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 (Subsector of *Cement and Concrete Industry*)	
Sector Description	The *Concrete Batching & Products* subsector includes 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 job 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), was multiplied by pollutant-specific emission factors.
Activity Data	Cement consumption distribution for the provinces: CANMET (1993) Cement production data: NRCan (2013) Population data for the provinces: Statistics Canada (2013a)
Emission Factors (EF)	TPM, PM_{10}, $PM_{2.5}$, Pb, Cd: U.S. EPA (1998); U.S. EPA (2010a) Updates to the TPM and PM_{10} EFs for a loading mixer and a loading truck were incorporated (U.S. EPA 2006). PM_{10} and $PM_{2.5}$ emission factors for sand and aggregate transfer were 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 (Subsector of *Foundries*)	
Sector Description	The *Ferrous Foundries* sector includes 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 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Grain Industry	
Sector Description	The *Grain Industry* applies to 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, 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 output of grain by province/territory was multiplied by pollutant-specific emission factors.
Activity Data	Crop year production data for regions: CGC (2013) Distribution of elevator throughputs: EC (1983) Grain throughputs data: Statistics Canada (2012a)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$:* Pinchin Environmental (2007)

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

Sector or Subsector	
Rock, Sand and Gravel (Subsectors of *Mining and Rock Quarrying*)	
Sector Description	The *Rock, Sand and Gravel* subsector 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]
Emission Factors (EF)	Rock Quarrying: *TPM, PM_{10}, $PM_{2.5}$*: U.S. EPA (1995a) Stone Processing: *TPM*: U.S. EPA (1988); U.S. EPA (1995a) *PM_{10}, $PM_{2.5}$*: U.S. EPA (2010a) Sand and Gravel: *TPM*: Vandergrift et al. (1971) *PM_{10}, $PM_{2.5}$*: U.S. EPA (2010a)
Silica Production (Sub-sector of *Mining and Rock Quarrying*)	
Sector Description	The *Silica Production* subsector applies to silica sand quarrying and processing for (mainly) 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 practised 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}, $PM_{2.5}$ Silica production data were applied to coarse vs. fine distribution data for each province/territory. The resulting activity data were multiplied by the applicable PM emission factor.
Activity Data	National and provincial silica production: NRCan (2014) Confidential provincial production values were estimated with population distributions: Statistics Canada (2013a) Silica production data were applied to coarse vs. fine distribution data (NRCan 1993) for each province/territory: - Newfoundland and Labrador: 100% coarse - Prince Edward Island: 100% coarse - New Brunswick: 100% fine - Nova Scotia: 100% fine - Quebec: 41% fine, 59% coarse - Ontario: 35% fine, 65% coarse - Manitoba: 100% coarse - Saskatchewan: 100% coarse - Alberta: 100% fine - British Columbia: 100% coarse - Yukon: 100% coarse - Northwest Territories: 100% coarse - Nunavut: 100% coarse
Emission Factors (EF)	Coarse/fine production: *TPM*: U.S. EPA (1995a) *PM_{10}, $PM_{2.5}$*: U.S. EPA (2010a)
Sawmills, Panel Board Mills & Other Wood Products (Subsectors of *Wood Industry*)	
Sector Description	The *Sawmills* subsector covers 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. The *Panel Board Mills* subsector includes emissions from several types of mills, all producing hardwood and softwood-based materials. These include: • Veneer and plywood mills • Waferboard mills, composed primarily of oriented strand board (OSB) mills • Particle board and medium-density fiberboard (MDF) mills The *Other Wood Products* subsector encompasses 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.

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

Sector or Subsector	Se
Sawmills, Panel Board Mills & Other Wood Products (Subsectors of *Wood Industry*) (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 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, RISI publications, Madison publications and occasional discussion with industry representatives); • *All other pollutants*: Production rate estimates, hog fuel combustion data, and other fuel use data were used to estimate the area source emissions of the remaining pollutants (Meil et al. 2009; U.S. EPA 2014a).
Activity Data	NPRI 2013 data (EC 2014a) 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) - Corporate website information (not listed) - *RISI North American Wood Panels and Engineered Wood Products Capacity Report* (RISI 2013) - *Madison's 2013 Online Lumber Directory* (Maddison 2013) - 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); U.S. EPA (1995b); U.S. EPA (2014a)
Crude Oil and Natural Gas Production and Processing (Subsector of *Upstream Petroleum Industry*)	
Sector Description	This subsector includes emissions from all infrastructure used to locate, extract, produce, process/treat and transport natural gas, 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, in situ oil sands production, natural gas processing and oil transmission. Emissions from related construction activities, ancillary structures and operations (buildings, offices, etc.) and mobile sources are excluded. Emissions for these sources are included under the Construction, Commercial Fuel Combustion and Mobile sectors (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 were generated with a comprehensive inventory for 2011 and extrapolated based on production data (Clearstone 2014).
Activity Data	Clearstone Engineering (2014)
Emission Factors (EF)	Clearstone Engineering (2014)
Refined Petroleum Products Bulk Storage and Distribution (Subsector of *Downstream Petroleum Industry*)	
Sector Description	The *Refined Petroleum Products Bulk Storage and Distribution* subsector 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.
General Inventory Method	*Pollutant(s) Estimated:* VOCs Methodology under review. The area source emissions were last estimated for 2011 and have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Bakeries (Subsector of *Other Industries Sector*)	
Sector Description	The *Bakeries* sector applies to VOCs released 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 was multiplied by an emission factor for VOCs.
Activity Data	Bread production values were estimated using: - National bread/bakery product shipment values: Statistics Canada (2014a) - Provincial bread/bakery product shipment values: Statistics Canada (2014b) - *Monthly Consumer Price Index (CPI) for Bread/Rolls and Flatbreads*: Statistics Canada (2014c)
Emission Factors (EF)	Cheminfo (2005) EF_{VOC} = 2.35 kg per tonne of baked goods

Notes:
1. Menezes F. 2014. Personal communication (email, dated Aug. 15, 2014), Natural Resources Canada.

Table A2–3 Summary of Area Source Estimation Methodologies for Non-Industrial Sources

Sector or Subsector	
Commercial Fuel Combustion, Residential Fuel Combustion & Agriculture - Fuel Combustion (subsector of *Agriculture* in the *Open Sources* category)	
Sector Description	The *Commercial* and *Residential Fuel Combustion* sectors and the *Agriculture - Fuel Combustion* subsector include emissions resulting primarily from external combustion sources used for space/water heating and in the agricultural sector, for crop drying. Commercial establishments, health and educational institutions, government/public administration facilities as well as residences and agricultural operations all fall under these sectors/subsector.
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 were calculated for ten types of fuels: 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 was multiplied by pollutant-specific emission factors.
Activity Data	Statistics Canada (2012b)
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, SO_X, NO_X, VOCs, CO: U.S.* EPA (1998) (Emission factors were 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 (2004) *Sulphur contents of liquid fuels*: EC (2010a) *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); U.S. EPA (2003a); U.S. EPA (2004) (Emission factors were chosen to represent the typical type of combustion equipment for each fuel type.)
Residential Fuel Wood Combustion	
Sector Description	*The Residential Fuel Wood Combustion* sector encompasses emissions from wood burned in urban and rural homes, for primary and supplementary heating as well as aesthetics and hot water, in both main and secondary residences. This covers household wood-burning devices from 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 were multiplied by pollutant-specific emission factors by device type.
Activity Data	Activity data from Canadian Facts (1997, 2006) and TNS Canada (2012) were converted from volume to mass utilizing the reported wood species burnt. The mass of wood was then interpolated and extrapolated from the three points (1996, 2006 and 2012) to the time series utilizing 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 (2000a)

Table A2–4 Summary of Area Source Estimation Methodologies for Mobile Sources

Sector or Subsector	
Air Transportation	
Sector Description	The *Air Transportation* sector 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 was multiplied by pollutant-specific emission factors.
Activity Data	The emission estimates from Air Transportation were calculated using Aircraft Movement Statistics (Statistics Canada 2013b), 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 were 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 in-flight. Emission factors are mapped to representative aircraft, based on specific engines. SO_2 was estimated as a sulphur balance, using data from the *Sulphur In Liquid Fuels* reports (EC 2013). NH_3 was taken from Coe et al. (1996). For PM for LTO, a paper by Wayson et al. (2009) was used, which relates the Smoke Number from the ICAO databank to an emission factor in g/kg fuel. For aircraft using aviation gasoline, VOC, CO, PM_{10} and NO_X emission factors were taken from the Federal Office of Civil Aviation (FOCA 2007). No quantification of these emissions has been performed at the cruise stage, due to a lack of emission factors. SO_2 was estimated as a sulphur balance, using data from the *Sulphur In Liquid Fuels* reports (EC 2013). The NH_3 emission factor was taken from Coe et al. (1996). $PM_{2.5}$ was calculated as 69% of PM_{10} as per U.S. EPA (2005a). Lead was estimated as a lead balance, using the U.S. EPA's 5% retention (U.S. EPA 2013). TPM was equal to PM_{10} (U.S. EPA 2005a). Emissions of non-standard CACs were estimated as a ratio to PM_{10} or HC/VOCs, based on speciation profiles from the U.S. EPA (U.S. EPA 2005a).
On-road Vehicles (group of sectors)	
Sector Description	On-road vehicles include the following sectors: Heavy-duty diesel vehicles, *Heavy-duty gasoline trucks, Light-duty diesel trucks, Light-duty diesel vehicles, Light-duty gasoline trucks, Light-duty gasoline 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) was multiplied by pollutant-specific emission factors in the MOVES model.
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. (IHS 2013), for light- and heavy-duty vehicles, respectively. Motorcycle populations originate from the publication *Road Motor Vehicle, Trailer and Snowmobile Registration (registrations)* (Statistics Canada 2013c). The *Annual Industry Statistics* report (MMIC 2013) was used to estimate the model years of the motorcycles within Statistics Canada's registrations. 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: http://www.epa.gov/otaq/models/moves/ as well as the user guides U.S. EPA (2012b, 2014b) and the technical guidance document U.S. EPA (2010b).
Marine Transportation	
Sector Description	The *Marine Transportation* sector 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) was multiplied by pollutant-specific emission factors.
Activity Data	Vessel-specific movements: SNC-Lavalin Environment (2012)
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* (MEITv4.1) 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 was taken from U.S. EPA (2010c). Emissions of non-standard CACs were estimated as a ratio to PM_{10} or HC/VOC, based on speciation profiles from the U.S. EPA (2005a).
Off-road Applications (group of sectors)	
Sector Description	Off-road applications consist of the sectors: *Off-road use of diesel* and *Off-road use of gasoline/LPG/CNG*.
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) was 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 Environ (EC) Canada (2011).
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 NONROAD2008, and modified by Environment Canada to exploit detailed activity data. Model operation was conducted following the user guide for NONROAD2005/2008 (U.S. EPA 2005b), given that the functionality of the models is the same. Emissions of non-standard CACs were estimated as a ratio to PM_{10} or HC/VOC, based on speciation profiles in the SPECIATE4.2 database (U.S. EPA 2008). More information on the NONROAD model is available online at http://www.epa.gov/otaq/nonrdmdl.htm.

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

Sector or Subsector	
Rail Transportation	
Sector Description	The *Rail Transportation* sector covers emissions from railways.
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) was multiplied by pollutant-specific emission factors.
Activity Data	Fuel consumption data: Statistics Canada (2014d)
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. Hydrocarbon (HC), CO, SO_2, PM_{10} and NO_X emission factors were taken from RAC (2011). HC was converted to VOCs using U.S. EPA (2011). Ratios of PM_{10} to $PM_{2.5}$ and TPM were taken from the U.S. EPA (U.S. EPA 2005a). The emission factor for NH_3 was taken from Coe et al. (1996). With the exception of dioxins/furans, emissions of non-standard CACs were estimated as a ratio to PM_{10} or HC/VOCs, based on speciation profiles from U.S. EPA (2011). The dioxins/furans emission factor (0.54 ng/L) was taken from U.S. EPA (2006).

Table A2–5 Summary of Area Source Estimation Methodologies for Incineration Sources

Sector or Subsector	
Crematorium	
Sector Description	The *Crematorium* sector includes emissions from the combustion of caskets and 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 Number of cremations per year by province/territory were multiplied by pollutant-specific emission factors.
Activity Data	Number of annual cremations obtained from the following contacts: SB. Cable, CANA[a]; R. Breau, Service New Brunswick[b]; K. Douglas, Ontario Funeral Service Association[c]; K. Bartmanovich, Vital Statistics Agency[d]; K. Mullaly, Service Newfoundland and Labrador[e]; I. Pelletier, Corporation des thanatologues du Québec[f]
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$*: U.S. EPA (2014a) *VOCs*: EMEP/EEA (2013) *SO_x, NO_x, CO*: EMEP/EEA (2009) *Hg, Cd, Pb*: U.S. EPA (2014a) *Dioxins/Furans*: U.S. EPA (2003b) *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. was assumed.
Industrial & Commercial Incineration	
Sector Description	The *Industrial & Commercial Incineration* sector involves the incineration of waste from industrial, commercial and institutional facilities. The incineration of wood waste is included in other sectors such as the pulp and paper, wood industry and power generation sectors where it is burned.
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 have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Other Incineration & Utilities	
Sector Description	The *Other Incineration and Utilities* sector 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 have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.

Notes:
a. Cable SB. 2014. Personal communication (email from Cable SB to Inventories Engineer dated April 6, 2014). (CANA) Cremation Association of North America.
b. Breau R. 2014. Personal communication (email from Breau R to Inventories Engineer dated August 20, 2014). Vital Statistics Branch, Service New Brunswick.
c. Douglas K. 2014. Personal communication (email from Douglas K to Inventories Engineer dated August 18, 2014). Ontario Funeral Service Association, Burlington, ON.
d. Bartmanovich K. 2014. Personal communication (email from Bartmanovich K to Inventories Engineer dated August 18, 2014). Vital Statistics Agency, Winnipeg, MB.
e. Mullaly K. 2014. Personal communication (email from Mullaly K to Inventories Engineer dated August 18, 2014). Vital Statistics Division, Service Newfoundland and Labrador.
f. Pelletier I. 2014. Personal communication (email from Pelletier I to Inventories Engineer dated August 18, 2014). Corporation des thanatologues du Québec.

Table A2–6 Summary of Area Source Estimation Methodologies for Miscellaneous Sources

Sector or Subsector	
Cigarette Smoking	
Sector Description	Two sources of emissions are included under the *Cigarette Smoking* sector: 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 was calculated and then multiplied by pollutant-specific emission factors.
Activity Data	Health Canada (2013)
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 (2003c) *B(a)p, B(b)f, B(b)k*: Ding et al. (2005)
Dry Cleaning, General Solvent Use, Printing & Surface Coatings	
Sector Description	The *Dry Cleaning* sector includes emissions from companies that provide dry cleaning of fabric and leather items. The *General Solvent Use* sector consists of emissions from a broad range of applications occurring in residential, commercial, industrial and institutional locations. Industrial applications includes 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. The *Printing* sector covers emissions from the manufacturing or use of printing inks. The sector consists of flexographic, gravure, letterpress, lithographic and other printing. The *Surface Coatings* sector 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 was a "top-down" approach that involved gathering statistical activity data on the production, distribution, end-use patterns and disposal of VOC-containing products, and then building relationships between stages.
Activity Data	Solvent use quantities (1985 to 2005): Cheminfo (2007a) Solvent use quantities (2006 to 2010): CRA (2012) Twenty-nine commercially sold solvents, defined as VOCs under CEPA 1999, were inventoried.[a] Domestic consumption was determined using a mass-balance approach: *Consumption = Production + Imports - Exports ± Inventory Change* "Inventory change" is a volume buffer between total supply (production and imports) and total demand (domestic consumption and exports) (Cheminfo 2007a). For most solvents, the value was zero because of lack of information (Cheminfo 2007a). Estimates were based on production, import and export data from Statistics Canada and the Canada Border Services Agency, and information gathered in supplier interviews (CRA 2012). Previous emissions inventory analyses, sector studies and technical studies were then used to allocate the total demand for each solvent into application categories and sub-categories.
Emission Factors (EF)	Emission factors (1985 to 2005): Cheminfo (2007a) Emission factors (2006 to 2010): CRA (2012) If control technologies were not estimated to be used for an application, 100% of the solvent VOCs was assumed to evaporate. Only a small portion of the estimated VOC emissions were reduced by the application of control technologies. Control efficiencies were applied (as percentages) in only a few selected applications: flexographic, rotogravure, lithographic and other printing, automotive Original Equipment Manufacture (OEM) coatings, metal can manufacturing, metal coil coating, and metal furniture manufacturing (Cheminfo 2007a; CRA 2012).
Meat Cooking	
Sector Description	The *Meat Cooking* sector includes emissions from the frying and charbroiling of meat, fish and poultry in commercial and residential locations.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, B(a)p Weights of cooked meat, fish and poultry, by grade, cooking method and province/territory, in a commercial or residential location, were estimated and then multiplied by pollutant-specific emission factors.
Activity Data	Activity data estimated using: • The weights of boneless meat and poultry and the edible weight of fish, available per person, per year, for Canada (Statistics Canada 2014e). • Population data by province/territory (Statistics Canada 2013a). • The Canadian consumption rate of ground meat provided by the Beef Information Centre and determined using the 1996 National Purchase Diary, which surveyed food consumption for that year (Beef Information Centre 1997). • An assumption on the distribution of meat cooked by location (commercial vs. residential) (Rogge et al. 1991). • The distribution of boneless red meat types and relative consumption, calculated from Statistics Canada shipment data and estimates of red meat consumption in Canada for 1995 (Statistics Canada 1997). • An assumption of the distribution of cooking methods (Rogge et al. 1991).

Table A2-6 Summary of Area Source Estimation Methodologies for Miscellaneous Sources (cont'd)

Sector or Subsector	
Meat Cooking *(cont'd)*	
Emission Factors (EF)	Rogge et al. (1991)
Refined Petroleum Products Retail	
Sector Description	The *Refined Petroleum Products Retail* sector covers fugitive VOC emissions from fuel transfers and storage at service stations.
General Inventory Method	*Pollutant(s) Estimated*: VOCs Methodology under review. The area source emissions were last estimated for 2011 and have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Structural Fires	
Sector Description	The *Structural Fires* sector covers emissions from vehicle fires and fires that burn buildings. Structural fires emit large quantities of pollutants due to rapid, incomplete combustion.
General Inventory Method	*Pollutant(s) Estimated:* TPM, PM_{10}, $PM_{2.5}$, VOCs, CO, NH_3 Tonnes of structures burned per year, by province/territory, was multiplied by pollutant-specific emission factors.
Activity Data	Numbers of annual structural fires were obtained from the Offices of the Fire Marshals/Fire Commissioners in the provinces/territories. A 10-year average was used when the number of structural fires was not available (CCFM/FC 2002). Number of structure fires in each province/territory was multiplied by a loading factor to convert the number of fires into tonnes of structure burned (EIIP 2001). Loading factor = 1.04 t of structure burned/fire
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, VOCs, CO*: GVRD and FVRD (2003) *NH_3*: Battye et al. (1994)
Human	
Sector 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 were multiplied by an NH_3 emission factor.
Activity Data	Statistics Canada (2013a)
Emission Factors (EF)	Roe et al. (2004) EF_{NH3} = 0.0168 kg per person-yr
Other Miscellaneous Sources	
Sector Description	Emissions included under *Other Miscellaneous Sources* are from infant-diapered waste and non-agricultural fertilizer application.
General Inventory Method	*Pollutant(s) Estimated*: NH_3 *Infant-diapered waste*: An annual estimate of the population aged 0-3 years by province/territory was multiplied by an NH_3 emission factor. *Non-agricultural fertilizer application*: Annual population data by province/territory was multiplied by an NH_3 emission factor.
Activity Data	Number of children aged 0-3 years by province/territory: 2011 Census of Canada (Statistics Canada 2012c) Population of each province/territory: Statistics Canada (2013a)
Emission Factors (EF)	Roe et al. (2004) *Infant-diapered waste*: EF_{NH3} = 0.0136 kg of NH_3/person-yr *Non-agricultural fertilizer application*: EF_{NH3} = 0.0304 kg of NH_3/person-yr

Notes:

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

Table A2–7 Summary of Area Source Estimation Methodologies for Open Sources

Sector or Subsector	
Agriculture (Animals) (Sub-sector of *Agriculture*)	
Sector Description	The *Agriculture (Animals)* subsector applies to the volatilization of NH_3 from nitrogen in manure. Ammonia volatilization is a chemical process that occurs when manure is excreted or stored without a cover. Once manure is excreted from the animal, it 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.
General Inventory Method	*Pollutant(s) Estimated:* NH_3 The general methodology was developed by Environment Canada in collaboration with Agriculture and Agri-Food Canada through a national research project: the National Agri-Environmental Standards Initiative (NAESI). Methodologies have been 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); Sheppard et al. (2007a, 2007b, 2009a, 2009b, 2010a, 2011a, 2011b).
Activity Data	Annual animal populations of cattle, sheep and swine originated from semi-annual or quarterly surveys, CANSIM (database) (Statistics Canada 2013d, 2013e). The populations of horses, goats, bison, llamas, alpacas, fur-bearing animals (mink, fox), wild boars, deer, elk, rabbit and poultry were taken from the Census of Agriculture and interpolated between census years (Statistics Canada 2008, 2011).
Emission Factors (EF)	Emission factors were a weighted average of a variety of different emission fractions that occur during the stages of the manure cycle. The input to the emission factor equation originated from a combination of the Livestock Farm Practices Survey (LFPS), which defined what animals consumed and how the animals received their feed throughout the year, and generic parameters that were derived from scientific literature or expert opinion. This information was distributed spatially by ecoregion. A matrix of animal housing and manure management systems was created from the LFPS, and animal populations were assigned to this matrix based on their relative proportion in the overall farm population. The fractions of NH_3 emitted at each step in the manure cycle were taken in part from the European Monitoring and Evaluation Program (EMEP)/Core Inventory of Air Emissions in Europe (CORINAIR) guidebook (EMEP/CORINAIR 2002), and in part from Canadian studies. The resulting weighted emission factors were applied to populations of animal subcategories taken from census data at the ecoregion spatial scale.
Agriculture Tilling and Wind Erosion (Subsector of *Agriculture*)	
Sector Description	The *Agriculture Tilling and Wind Erosion* subsector covers PM emissions from wind erosion as well as from mechanical disturbances such as seeding and tilling operations.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ Methodology under review. The area source emissions were last estimated for 2010 and have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Fertilizer Application (Subsector of *Agriculture*)	
Sector Description	The *Fertilizer Application* subsector includes emissions emitted when synthetic nitrogen fertilizers are applied for annual and perennial crop production.
General Inventory Method	*Pollutant(s) Estimated*: NH_3 The general methodology was developed as a part of the NAESI project. The current 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 fertilizer application, based on a meta-analysis of scientific literature.
Activity Data	Data on the types of nitrogen fertilizer used on farms were published by Statistics Canada (2013f). *Areas of seeded annual and perennial crops*: Statistics Canada (2013g) - CANSIM Table 001-0010 - Estimated areas, yield, production and average farm price of principal field crops, in metric units, annual, 1990 to 2013. Soil properties, including pH and cation exchange capacity, were 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 http://sis.agr.gc.ca/cansis/nsdb/slc/v1/intro.html).
Emission Factors (EF)	Ammonia emission factors were calculated using the multiple linear regression equation from Bouwman et al. (2002). The paper presents 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 was derived. The average provincial and national emission factors were weighted averages of the relative proportion of each combination of fertilizer types and fertilizer application practice on different soil types in different ecodistricts across the country.

Table A2-7 Summary of Area Source Estimation Methodologies for Open Sources (cont'd)

Sector or Subsector	
Construction Operations	
Sector Description	The *Construction Operations* sector includes 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}, $PM_{2.5}$ The inventory method consisted of calculating the surface area disturbed by the construction project, the moisture and silt levels in the soil that influence fugitive emissions of PM, and the duration of the construction project. The derivation of separate emission factors was based on the type of project and regional conditions.
Activity Data	The following activity data sources were used to calculate the construction sector area sources estimates: • Capital costs of institutional, commercial and industrial construction (Statistics Canada 2014f) • Housing starts (residential detached / semi-detached, apartment and row (Statistics Canada 2014g) • Cost indices (Statistics Canada 2014h)
Emission Factors (EF)	SNC-Lavalin Environment (2005)
Dust from Paved Roads & Dust from Unpaved Roads	
Sector Description	Emissions from the *Paved and Unpaved Road Dust* sectors originate from re-suspended PM emissions
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$ An empirical equation, taken from the U.S. EPA (1995a), was used to generate estimates of PM emission factors, E (kg/vehicle kilometres travelled).
Activity Data	In order to use the U.S. EPA's (1995a) equation, information regarding the average vehicle weight, road type, silt loadings, precipitation, and distance travelled by vehicles (VKT) on the road was required. To arrive at estimates of VKT, vehicle counts from DesRosiers Automotive Consultants (DAC 2014) and R. L. Polk & Co. (IHS 2013) were multiplied by mileage accumulation rates from Stewart-Brown Associates (2012). The road networks in Canada were assumed to be the same as those used for the 1995 inventory. Information on roads in 1995 in Canada was taken from a Natural Resources Canada Road Network Information database (GeoCom 1997). Road classes were divided into five categories: highway, primary road, secondary road, street (residential) and limited-access road. Silt loadings by road type were extracted from road dust reports (AGRA 1997; Golder 1997; Innovacorp 1997; John D. Paterson 1997; NEIPTG 1997) and extrapolated to missing road types and provinces/territories not covered in the reports. Vehicle class mixes and the percentage of total kilometres driven were assumed for each of the five road classes. Precipitation (both rain and snow) data in Canada were available through an Atmospheric Environment Service database (EC 2000b).
Emission Factors (EF)	An empirical equation, taken from the U.S. EPA's AP-42, Section 13.2.1 (1995a), was used to generate estimates of PM factors, E (kg/VKT). The equation includes the base emission factor for the particle size range (g/VKT), the road silt loading (g/m2), the average weight of the vehicles travelling the road, and the number of days per year on which snow covers the road. Particle size multipliers for paved roads (U.S. EPA 1995a) are 24 g/VKT for TPM, 4.6 g/VKT for PM_{10}, and 1.1 g/VKT for $PM_{2.5}$. It was assumed that no particulate emissions occur on days when the road surface is covered with either fresh or packed snow.
Dust from Coal Mining	
Sector Description	The *Dust from Coal Mining* sector 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 via 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 were 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 were multiplied by annual coal production by province/territory.
Activity Data	National and provincial coal production: NRCan (2014) Monthly climate summaries: EC (2014b)
Emission Factors (EF)	CCME (2001)
Landfills	
Sector Description	The *Landfills* sector includes emissions from 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. Disposal sites may be designated to receive only one of these waste materials. Materials deposited into landfills are progressively covered with soil to prevent scattering of litter by wind, scavenging by animals, and odours. As a result, PM emissions due to wind erosion and the movement of heavy vehicles are common. The other main emissions from landfills include CH_4 and associated VOCs found in small concentrations in landfill gas escaping from the sites.
General Inventory Method	*Pollutant(s) Estimated*: TPM, PM_{10}, $PM_{2.5}$, VOCs The quantity of waste landfilled for each province/territory was applied to PM emission factors. Emission factors for VOCs were calculated as the ratio of VOC emissions, derived from CH_4 emissions, to the amount of waste landfilled. Emissions reported to the NPRI were related to air emissions from flares and co-generation facilities. The emissions calculated for this sector were related to the air emissions from the activity of landfilling itself.

Table A2-7 Summary of Area Source Estimation Methodologies for Open Sources (cont'd)

Sector or Subsector	
Landfills *(cont'd)*	
Activity Data	Provincial quantities of waste sent to landfills were derived based on the per capita landfill rate for 2012[a] and the population for the inventory year (Statistics Canada 2013a).
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$*: BCMELP (1997) for all provinces/territories except British Columbia. The EF_{PM10} was calculated using a speciation profile of 8% of the EF_{TPM}. The $EF_{PM2.5}$ was calculated using a speciation profile of 2% of the EF_{TPM}. *TPM, PM_{10}, $PM_{2.5}$*: GVRD and FVRD (2003) for British Columbia only. *VOCs*: U.S. EPA (1995a) Emission factors for VOCs were calculated as the ratio of VOC emissions, derived from CH_4 emissions, to the amount of waste landfilled. Emissions of CH_4 were estimated using the Scholl Canyon Model (U.S. EPA 1990) and the conversion of CH_4 to VOCs was completed by using an equation supplied by the U.S. EPA (1995a) and Robertson et al. (2005).
Open Burning	
Sector Description	Emissions from the *Open Burning* sector are related to on-site burning of residential waste materials in backyard barrel or 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 The quantity of backyard and open pit waste burned was estimated by taking the current rural population by province/territory and multiplying it by the waste burned per capita (based on 2002 levels) by province/territory. The tonnage of waste burned was then multiplied by pollutant-specific emission factors.
Activity Data	Activity data were estimated using: • The percentage of the 2002 population that was considered rural by province/territory (Statistics Canada 2003) • Amount of residential waste generated per capita per year by province/territory (Statistics Canada 2004) • The percentage of rural population by province/territory that performed the activity of open burning (Environics 2001) • The percentage of the rural population that used a particular type of burning method (Environics 2001) Backyard burning = 36% Open-pit burning = 38% • The percentage of waste burned when conducting open burning. The same value is used for all provinces and equipment types (Gartner Lee 2003). • Population by province/territory (Statistics Canada 2013a)
Emission Factors (EF)	*Backyard Barrel and Open Pit Burning*: *TPM, PM_{10}, $PM_{2.5}$, SO_X, NO_X, VOCs, CO*: U.S. EPA (1995a) *NH_3*: GVRD and FVRD (2003) *Dioxins/Furans*: Gartner Lee (2003) *Backyard Barrel Burning*: *B(a)p, B(b)f, B(k)f, I(cd)p, HCB*: U.S. EPA (1997)
Mine Tailings	
Sector Description	The *Mine Tailings* sector 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 for some reason 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 have been carried forward to 2013.
Activity Data	Methodology under review.
Emission Factors (EF)	Methodology under review.
Prescribed Burning	
Sector Description	The *Prescribed Burning* sector 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 wood waste burned by fire and by province/territory was multiplied by pollutant-specific emission factors. Reconciliation of the emissions was not required.
Activity Data	The total number of hectares burned in each province/territory per year (CIFFC 2013) was multiplied by a conversion factor for each province/territory (EC 1992) to convert the area burned into the mass of wood waste burned. The mass of wood waste burned was applied to pollutant-specific emission factors.
Emission Factors (EF)	*TPM, PM_{10}, $PM_{2.5}$, SO_X, NO_X, VOCs, CO, NH_3*: U.S. EPA (1995a) (Emission factors for the above pollutants were taken from GVRD and FVRD (2003) for British Columbia.) *Dioxins/Furans, B(b)f, B(k)f*: Lemieux et al. (2004) *B(a)p, I(cd)p*: Ortech (1992)

Notes:
a. Palmer C. 2014. Personal communication (email from Palmer C dated September 29, 2014). Pollutant Inventories and Reporting Division, Environment Canada.

Table A2–8 Summary of Area Source Estimation Methodology for Mercury in Products

Sector or Subsector	
Mercury in Products	
Sector Description	The *Mercury in Products* sector 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 • Other Industries – Electronics (i.e. Lamp Manufacturing) • Other Industries – Other (Other Industries) • Municipal Incineration • Other Incineration & Utilities (i.e. Sewage Sludge Incineration) • Human • Other Miscellaneous Sources • Waste - Landfills • Waste - Water and Sewage Treatment
General Inventory Method	*Pollutant(s) Estimated*: Hg Mercury emissions were estimated based on the model *Substance Flow Analysis of Mercury in Products* originally developed by the Minnesota Pollution Control Agency (Barr 2001) and modified by ToxEcology Environmental (ToxEcology 2007a, 2007b, 2009b). This lifecycle model considers releases from manufacture, sales, in-service, breakage, disposal, recycling, transportation of items to disposal, disposal point, and the ultimate fate of the contained Hg. Note that while the model apportions releases to air, water and land, only the air portion was used.
Activity Data	ToxEcology (2007b) The vehicle population data used were extracted from the population data used for the on-road vehicle emission estimates (DesRosier 2014; Polk 2014). Provincial and territorial population data: Statistics Canada (2013a)
Emission Factors (EF)	The model used is entitled the *Substance Flow Analysis of Mercury in Product*s by Barr (2001), which was modified (ToxEcology 2007a, 2007b, 2009b). The model includes partitioning factors to the various streams, from manufacture through final disposal, including emission factors at every point along the way. The model produced emissions at the national level. To obtain provincial-level estimates, emissions by source (e.g. electric arc furnaces, sewage, landfill, etc.) were distributed based on population or surrogates developed from reported point sources (electric arc furnaces, incinerators, lamp manufacturers).

A2.3. Recalculations

Emission recalculation is an essential practice in the maintenance of up-to-date and internally consistent trends in air pollutant emissions. The EMEP/EEA guidebook (EMEP/EEA 2009) lists the circumstances that warrant a change or refinement of data and/or methods:

- Available data have changed.
- The previously used method is not consistent with good practice for a certain category.
- An emissions source category has become a key category.
- The previously used method is inadequate to reflect mitigation activities in a transparent manner.
- The capacity (resources) for inventory preparation has increased.
- New inventory methods become available.
- The correction of errors is necessary.

Some facilities recalculate their point source emission estimates as new emission factors become available, and resubmit their 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 addition, new activity data are incorporated into the area source estimates as they become available, and methodological changes 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.

The Asphalt Paving Industry, Commercial Fuel Combustion and Residential Fuel Combustion sectors rely on fuel use quantities from the Statistics Canada publication *Report on Energy Supply-Demand Canada (RESD)*, which is not available until December annually (Statistics Canada 2014d). As a result, the emission estimates for these sectors were based on the 2012 activity data and were carried over to the 2013 inventory year pending the availability of activity data for 2013. Once Statistics Canada RESD data are available, the area source estimates for these sectors will be updated.

The following area source sectors/subsectors were recalculated for the 2015 APEI. Brief descriptions of the recalculations, justifications for the changes, and the impacts on emission levels are provided in Table A2–9 to Table A2–13.

- Asphalt Paving Industry (1985–2012)
- Wood Industry (2006–2013)
- Crude Oil and Natural Gas Production and Processing (2000–2012)
- Commercial Fuel Combustion (1995–2012)
- Residential Fuel Combustion (1995–2012)
- Residential Fuel Wood Combustion (1985–2013)
- All Mobile Source sectors (1985–2013)
- Agriculture (Animals) (1990–2013)
- Fertilizer Application (1990–2013)
- Agriculture Fuel Combustion – other (2012)
- Construction Operations (1985–2012)
- Mercury in Products (2011–2013)

Table A2–9 Summary of Recalculations Due to Methodological Change or Refinement for Industrial Sources

Sector/Subsector	Pollutants	Description	Justification	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	Updated historical VOC emission data from 1985 to 2012 were incorporated for the paving process. A 2008 cutback/emulsion asphalt ratio was used to calculate VOC emissions from 2009 to 2012.	Incorporation of the new data and estimation methodology improved data quality.	Total VOC emissions increased by 12.5% in 2012.
Wood Industry				
	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	Recalculation of emission estimates for 2006 to 2012 was carried out due to methodology changes. Improved fuel use data as well as adjustments to certain calculations and emission factors were part of a larger list of modifications implemented. For example, the emission factors for waste wood incineration were converted to a dry fuel basis. Certain calculations (e.g. dioxins/furans emissions) were corrected to account for units. Emissions of Pb, Cd, Hg, dioxins/furans, B(a)p, B(b)f, B(k)f and I(cd)p are now estimated for waste wood and hog fuel incineration and combustion.	Updated area source PM estimates and modifications, shown to be more representative of industry conditions, improved the accuracy of the emission estimates.	Emissions of most pollutants have decreased. In particular, emissions of CO greatly decreased and were more in line with NPRI emissions. Emissions of dioxins/furans, B(a)p, B(b)f, B(k)f, I(cd)p, Pb, Cd and Hg increased, as they are now calculated for biomass emissions, unlike in previous estimates.
Crude Oil and Natural Gas Production and Processing (Subsector of *Upstream Petroleum Industry*)				
	TPM, PM_{10}, $PM_{2.5}$, SO_X, NO_X, VOCs, CO, NH_3	New comprehensive estimates for 2005 and 2011 were generated from in-depth study commissioned by Environment Canada on fuel use in the Upstream Petroleum Industry.	Updates to the conventional oil and gas model with the latest knowledge and information for the industry improved the accuracy of the estimates.	Recalculations generally increased the estimated emissions. The new 2012 estimates for PM, NO_X, VOCs and CO all increased by approximately 18%, 15%, 15%, and 27%, respectively, whereas the new estimates for SO_X decreased by approximately 5%. Lastly, NH_3 estimates were historically incomplete, and this has been rectified with the new estimates.

Table A2–10 Summary of Recalculations Due to Methodological Change or Refinement for Non-Industrial Fuel Combustion

Sector/Subsector	Pollutants	Fuel Type	Description	Justification	Impact on Emissions
Commercial 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	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, Imported Coal	Liquid fuel sulphur content data was updated for 1995 to 2008. Updated fuel consumption data were incorporated for 2012.	Changes were made to maintain consistency and to increase the accuracy of the emission estimates.	Emissions of SO_X decreased by 11.8% and TPM emissions decreased by 2.2% in 2012. There was no impact on the other pollutants. Some changes in the emission levels of selected years were due to the use of consistent activity data and emission factors for the time series.
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	Natural Gas, Natural Gas Liquids, Kerosene and Stove Oils, Light Fuel Oil, Heavy Fuel Oil	Liquid fuel sulphur content data were updated for 1995 to 2008. Updated fuel consumption data were incorporated for 2012.	Changes were made to maintain consistency and to increase the accuracy of the emission estimates.	Emissions of SO_X decreased by 19.9% and TPM emissions decreased by 0.7% in 2012. There was no impact on the other pollutants. Some changes in the emission levels of selected years were due to the use of consistent activity data and emission factors for the time series.
Residential Fuel Wood 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	Wood	The entire time series of the wood quantity burned was recalculated to include new surveys, additional statistical information for surrogates to interpolate and extrapolate data and reported wood species consumed. Additional information on respondents' answers regarding wood quantification and void spaces is still under review.	Changes were required to: 1) improve the consistency of the data following incorporation of the 2006 survey; 2) include new 2012 survey data; and 3) update the trends based on statistical information on wood-burning devices from households.	Generally, all emissions increased by varying amounts through time. For the early years, the increase in emissions is higher, as some additional work on reporter wood quantification is presently being reviewed for this time period and has not yet been included. In 2012, emissions increased by 62% to 102%.
Agriculture - Fuel Combustion (Subsector of *Agriculture*)					
	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	Natural Gas, Natural Gas Liquids, Kerosene and Stove Oils, Light Fuel Oil, Heavy Fuel Oil	Liquid fuel sulphur content data were updated for 1995 to 2008. Updated fuel consumption data were incorporated for 2012.	Changes were made to maintain consistency and to increase the accuracy of the emission estimates.	Emissions of SO_X increased by 3% and TPM emissions increased by 2.2% in 2012. There was no impact on other pollutants. There were some changes in the emission levels of selected years, due to the use of consistent activity data and emission factors for the time series.
Construction Fuel Combustion (Subsector of *Construction Operations*)					
	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	Natural Gas, Natural Gas Liquids, Kerosene and Stove Oils, Light Fuel Oil, Heavy Fuel Oil	Emissions from *Construction Fuel Combustion* were calculated for the first time in the APEI. Estimates were calculated for the years 1995 to 2012.	This emission source was added to increase the comprehensiveness of the inventory and the accuracy of stationary fuel combustion emissions.	Fuel combustion emissions have been included for the first time.

Table A2–11 Summary of Recalculations Due to Methodological Change or Refinement for Mobile Sources

Sector/ Subsector	Pollutant	Fuel Type	Description	Justification	Impact on Emissions
Air Transportation					
	TPM, PM_{10}, $PM_{2.5}$	Aviation Gasoline, Aviation Turbo Fuel	New particle matter emission factors were adopted and new activity data (actual landing/take-off counts) replaced forecasted data for years 2006 through 2013.	More current emission factors from a recent study by Wayson et al. (2009) and actual activity data increased the accuracy of the estimates.	Particle matter emissions decreased by roughly 20% through the time series, as a result of the combined changes to emission factors and activity data.
	SO_X	Aviation Gasoline, Aviation Turbo Fuel	Actual sulphur levels in fuels were used to estimate SO_2 through a sulphur balance.	Actual sulphur levels in fuels replaced antiquated general emission factors from the U.S. EPA.	SO_2 emissions generally decreased between 10 and 50% over the time series, but vary year by year.
	NO_X, VOCs, B(a)p, B(b)f, B(k)f, I(cd)p	Aviation Gasoline, Aviation Turbo Fuel	Allocations of emissions factors to individual aircraft types was implemented and new activity data (actual landing/take-off counts) replaced forecasted data for years 2006 through 2013.	Better spatial and temporal resolution and actual activity data increased the accuracy of the estimates.	Generally NO_X emissions were similar over the time series, with the exception of the onset of the 2008 economic downturn, not captured in the previous set of estimates. VOC emissions decreased by roughly 50% over the time series, with estimates diverging over the last ten years.
	CO	Aviation Gasoline, Aviation Turbo Fuel	New emission factors for CO were adopted and new activity data (actual landing/take-off counts) replaced forecasted data for years 2006 through 2013.	More defensible emission factors (from a recent study by Hagstrom (2010)) and actual activity data increased the accuracy of the estimates.	CO estimates decreased by roughly 25% as a result of the combined changes to emission factors and activity data.
	NH_3	Aviation Gasoline, Aviation Turbo Fuel	New activity data (actual landing/take-off counts) replaced forecasted data for years 2006 through 2013.	Actual activity data increased the accuracy of the estimates.	Generally NH_3 emissions were similar over the time series, with the exception of the onset of the 2008 economic downturn, not captured in the previous set of estimates.
	Pb	Aviation Gasoline	For the first time, a lead balance was used (with the U.S. EPA–recommended retention rates) on a by-aircraft basis.	Better spatial and temporal resolution and actual activity data increased the accuracy of the estimates.	Generally lead levels were unchanged, but spatial/temporal resolution is considerably improved.
On-road Vehicles (Includes the following sectors: *Heavy-duty diesel vehicles, Heavy-duty gasoline trucks, Light-duty diesel trucks, Light-duty diesel vehicles, Light-duty gasoline trucks, Light-duty gasoline vehicles, Motorcycles, Tire Wear & Brake Lining*)					
	TPM, PM_{10}, $PM_{2.5}$, NO_X, VOCs, CO, NH_3, Pb, Cd, Hg, Dioxins/Furans, B(a)p, B(b)f, B(k)f, I(cd)p	Gasoline, Diesel	Migration to the MOVES model, and new activity data (VKT), replaced forecasted data for years 2008 through 2013.	Harmonization with the U.S. EPA's emission modelling techniques, given that our emission standards (for Mobile Sources) are harmonized.	Particle matter emissions more than doubled as a result of the combined changes to activity data and the implementation of MOVES. NO_X estimates increased by between 20 and 45% over the time series as a result of the combined changes to activity data and the implementation of MOVES. Generally, VOC emissions were similar over the time series, showing a tendency for a roughly 10% increase in the most recent years. CO emissions decreased by between 30 and 35% over the time series as a result of the combined changes to activity data and the implementation of MOVES. NH_3 emissions diverged considerably, with the trends being directionally different by year 2000, as a result of increased fuel economy (through regulation) that was not considered in the previous estimates.
	SO_X	Gasoline, Diesel	Actual sulphur levels (refiner-reported) in fuels were used as input to MOVES.	Harmonization with the U.S. EPA's emission modelling techniques, given that our emission standards (for Mobile Sources) are harmonized. Using refiner-reported data to Environment Canada was the best possible data available (replacing assumptions based on regulated maximums).	SO_2 emissions generally decreased over the time-series, but vary year by year with the estimates generally converging over the last 10 years.
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	Migration to the most recent version of the Marine Emission Inventory Tool (MEITv4.5), and new activity data (ship movements) replaced forecasted data for years 2010 through 2013.	Better spatial and temporal resolution and actual activity data increased the accuracy of the estimates.	Particle matter estimates were sometimes higher (considerably so) and sometimes lower in the new estimates relative to the older ones, but converged most recently as the new results reflected a reduction in sulphur in fuel not assumed in the original estimates (impacted the sulphate portion of particle matter).

Table A2-11 Summary of Recalculations Due to Methodological Change or Refinement for Mobile Sources (cont'd)

Sector	Pollutant	Fuel Type	Description	Justification	Impact on Emissions
Marine Transportation *(cont'd)*					
					CO, NO_X and NH_3 emissions more than doubled from the previous estimate. SO_2 emissions were sometimes higher (considerably so) and sometimes lower in the new estimates relative to the older ones, but converged most recently as the new results realized a reduction in sulphur in fuel not assumed in the original estimates. VOC emissions more than quadrupled as a result of the combined changes to activity data and the implementation of MEITv4.5.
Off-road Applications (Includes the following sectors: *Off-road use of diesel, Off-road use of gasoline/LPG/CNG*)					
	TPM, PM_{10}, $PM_{2.5}$, NO_X, VOCs, CO, NH_3, Pb, Cd, Hg, Dioxins/Furans, B(a)p, B(b)f, B(k)f, I(cd)p	Gasoline, Diesel, Natural Gas, LPG	Migration to the most recent version of the NONROAD model, and new activity data (engine populations, hours-of-use and load factors) replaced forecasted data for all years.	Harmonization with the U.S. EPA's emission modelling techniques, given that our emission standards (for Mobile Sources) are harmonized.	Particle matter estimates converged over the last ten years with the exception of the onset of the 2008 economic downturn, not captured in the previous set of estimates. NO_X emissions generally decreased over the time-series, but vary year by year with the newer estimates being roughly 30% lower in the most recent years. VOC estimates were considerably different for the historic years, but converged such that the most recent estimates were roughly 8% lower than previous estimates. Trends in CO emissions were inconsistent between the two sets of estimates (previous estimates showed a general increasing trend while the current estimates show a decreasing trend), such that CO decreased by roughly 41% in the most recent years. Trends in NH_3 estimates were inconsistent between the two sets of estimates (previous estimates showed a sharp increase after year 2002 while the current estimates show a gradual but decreasing trend), such that NH_3 estimates were revised downward by roughly 65% in the most recent years as a result of increased fuel economy (through regulation) that was not considered in the previous estimates.
	SO_X	Gasoline, Diesel, Natural Gas, LPG	Actual sulphur levels (refiner-reported) in fuels were used as input to NONROAD.	Harmonization with the U.S. EPA's emission modelling techniques, given that our emission standards (for Mobile Sources) are harmonized. Using refiner-reported data to Environment Canada was the best possible data available (replacing assumptions based on regulated maximums.	SO_2 emissions generally decreased over the time-series, but varied year by year with the estimates dramatically converging over the last 5 years.
Rail 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	Diesel	Migration to RESD fuel use (from LEM-reported fuel use) and the addition of some new emission factors.	Method and data harmonization for the Rail Transportation estimates and the use of the most recent activity data and emission factors (especially for particle matter, where a step-function change in emission factor is now remedied).	Particle matter estimates, as a result of the step-function change in the particle matter emission factor from RAC, were lower for historical years and higher for more current years in the previous estimate. SO_2 emissions were generally unchanged. NO_X emissions generally increased by 35% over the time-series, but do vary year by year. VOC emissions more than doubled. CO estimates were higher for historic years in the previous set of estimates, but converged after year 2004 and were roughly similar after that. NH_3 estimates roughly halved in the current set of estimates, relative to the previous set of estimates, as a result of the change to RESD fuel use.

Table A2–12 Summary of Recalculations Due to Methodological Change or Refinement for Open Sources

Sector	Pollutants	Description	Justification	Impact on Emissions
Agriculture (Animals) (Subsector of *Agriculture*)				
	NH_3	Small changes in minor livestock populations were made due to updates since 1997. As well, changes in major livestock populations from 2006 to present were implemented due to updates to survey numbers in the 2011 Census of Agriculture.	Changes were made to maintain consistency between Statistics Canada's reported livestock statistics and emission models.	Ammonia emission estimates from animals increased relative to the 2012 submission: 8.3 tonnes or 0.0025% for 1997 and 3 kt or 1% for 2012.
Fertilizer Application (Subsector of Agriculture)				
	NH_3	Efforts were made to harmonize and use common databases for activity data for various greenhouse gas and air pollutant emission estimates. These were done separately before the compilation of the 2013 APEI, creating inconsistencies in activity data due to reconfiguration among various census years. The integration of the 2011 Census of Agriculture also resulted in small differences in perennial crop areas annually since 2006. As a result, the distribution of N fertilizers between annual crops and perennial crops changed slightly. There was also a transcription error in converting "other type of fertilizers" into N for Quebec in 2005 and 2006 in the Excel spreadsheets. There was no change in the method used for estimating NH_3 emissions, however, the database changed from Excel spreadsheets at the provincial level to ACCESS at the ecodistrict level. As a result, the distribution of soil characteristics (pH and cation exchange capacity) changed slightly.	Changes were a result of quality control checks during the conversion of calculations from Excel spreadsheets at the provincial level, to ACCESS databases calculated at the ecodistrict scale, and alignment with the greenhouse gas database.	Ammonia emission estimates from fertilizers were recalculated for all submission years from 1990-2012. Emissions for 1990 decreased from 78.8 kt to 77.9 kt (or by -1.2%); and for 2012, emissions increased from 140.9 kt to 143.4 kt (or by 1.7%). The correction to the transcription error in the Excel spreadsheets resulted in a decrease in emissions of about 5 kt NH_3 for 2005 and 2006.
Construction Operations				
	TPM, PM_{10}, $PM_{2.5}$	A change was made to the base year of the cost factor, which is meant to adjust construction capital costs for inflation. The base year changed from 2005 to 1995.	Baseline factors relating capital construction costs of construction projects to the surface area disturbed by these projects were based on 1995 costs. Emissions from 1985 to 2012 were recalculated to address this issue as well as a change in methodology.	There was an overall decrease in estimated construction emissions. The changes in methodology resulted in emissions for 2006 that were 6% lower than those previously calculated. For 2012, although emissions increased from those in 2011 due to an increase in construction expenditures, the cost factor adjustment resulted in a 3.3% reduction in emissions compared with the previous method.

Table A2–13 Summary of Recalculations Due to Methodological Change or Refinement for Mercury in Products Sources

Sector	Pollutants	Subsector	Description	Justification	Impact on Emissions
Mercury in Products					
	Hg	Other Incineration & Utilities	Reconciliation of the sewage sludge emissions was updated for 2011-2013 to remove products emissions, as this was adequately covered by the point source reporting to the NPRI.	Re-examination of the waste incineration sectors showed that these sources were adequately covered.	These changes resulted in decreased Hg emissions of about 140 kg per year, which was approximately 35% in 2012.

A2.4. Point Source Emissions

This section presents the procedures used to incorporate point sources into the APEI, by describing the data sources and how they were integrated into the inventory.

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 emission data reported to the NPRI as the major source of industrial emissions. Point source information from the NPRI as well as data provided by the provinces were used for the 2002, 2004 and 2005 inventories, and interpolation was used for 2001 and 2003.

In recent years, information on emissions from point sources has originated mainly from the NPRI, with limited data provided by provincial governments (Alberta, Manitoba, New Brunswick, Newfoundland, Ontario and Quebec). For example, Alberta

provides additional data for the Upstream Petroleum sector for the post-2000 years, and Alberta and Newfoundland provide supplementary information for selected sources that are not reported to the NPRI.

The NPRI groups the substances into the five parts listed below. Each part has reporting thresholds or triggers that must be satisfied before the facility is required to report.

- 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)

For the purposes of the APEI, Table A2–14 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), 2012 and 2013 (EC 2012)*.

In total in 2013, 6477 facilities reported releases of one or more APEI pollutants to the NPRI.

Using the 2013 NPRI database (the version dated September 3, 2013), facility information and emission data for the pollutants in Table A2–14 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 a classification for the APEI.

For new NPRI reporting facilities, the North American Industry Classification System (NAICS) codes (Statistics Canada 2012d), 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 was developed to estimate a complete set of PM emissions for facilities. Sector-specific PM distribution profiles were developed based on PM emissions from point sources for the inventory year 2000. The ratios were calculated for each facility in the 2000 inventory and then averaged by sector. The resulting distributions are presented in Table A2–15.

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

Table A2–14 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%
Cadmium	1B	5 kg MPO	MPO by weight of ≥ 0.1%
Lead	1B	50 kg MPO	MPO by weight of ≥ 0.1%
Mercury	1B	5 kg MPO	N/A
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
Indeno(1,2,3-c,d)pyrene	2	50 kg total PAHs	N/A
Dioxins and Furans	3	Activity-based	N/A
Hexachlorobenzene	3	Activity-based	N/A
Carbon monoxide	4	20 tonnes air release	N/A
Nitrogen oxides	4	20 tonnes air release	N/A
Sulphur dioxide	4	20 tonnes air release	N/A
Volatile organic compounds	4	10 tonnes air release	N/A
Total particulate matter	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

MPO – Manufactured, processed or otherwise used

Table A2–15 Particulate Matter (PM) Distribution Ratios[a]

Sector	PM_{10} Ratio	$PM_{2.5}$ Ratio	$PM_{2.5}/PM_{10}$ Ratio
Abrasives Manufacture	0.842	0.773	0.843
Aluminium Industry			
Secondary Aluminium (Includes Recycling)	0.705	0.46	0.635
Asphalt Paving Industry	0.466	0.212	0.382
Bakeries	1	1	1
Cement and Concrete Industry	0.531	0.185	0.344
Chemicals Industry	0.866	0.762	0.833
Paint and Varnish Manufacturing	0.891	0.729	0.775
Petrochemical Industry	0.928	0.854	0.904
Plastics and Synthetic Resins Fabrication	0.897	0.778	0.84
Mineral Products Industry	0.675	0.516	0.626
Foundries	0.74	0.618	0.827
Grain Industries	0.297	0.044	0.137
Iron and Steel Industries			
Secondary (Electric Arc Furnaces)	0.605	0.457	0.755
Iron Ore Mining Industry[b]	0.443	0.142	0.311
Mining and Rock Quarrying	0.524	0.276	0.458
Non-Ferrous Mining and Smelting Industry	0.801	0.604	0.729
Pulp and Paper Industry	0.75	0.597	0.769
Wood Industry	0.56	0.377	0.638
Upstream Petroleum Industry	0.975	0.971	0.995
Oil Sands In-Situ Extraction and Processing	0.798	0.601	0.669
Oil Sands Mining Extraction and Processing	0.798	0.601	0.669
Downstream Petroleum Industry			
Refined Petroleum Products Bulk Storage and Distribution	0.72	0.447	0.519
Other Downstream Petroleum Industry	0.833	0.632	0.736
Other Industries	0.808	0.684	0.78
Petroleum Product Transportation and Distribution	0.975	0.971	0.995
Commercial Fuel Combustion	0.823	0.711	0.833
Electric Power Generation (Utilities)	0.743	0.6	0.761
Crematorium[c]	1	1	1
Industrial & Commercial Incineration	0.8	0.477	0.596
Municipal Incineration	0.64	0.55	0.832
Other Incineration and Utilities[d]	0.1	0.028	0.28
Dry Cleaning	1	1	1
Marine Cargo Handling Industry	0.512	0.156	0.303
Printing	0.932	0.904	0.964
Agriculture			
Agriculture - Fuel Combustion[b]	0.646	0.503	0.749
Dust from Unpaved Roads[e]	0.265	0.027	0.1
Waste	0.76	0.617	0.763

Notes:

a. Based on the year 2000 point source emissions except where indicated otherwise.
b. Ratios derived from complete sets of particulate emission data (TPM, PM_{10} and PM_{2}.5), from facilities in the same sector, in the 2011 and 2012 NPRI.
c. Ratios based on the 2011 area source estimates of TPM, PM_{10} and PM_{2}.5 for cremation, at the national level.
d. PM ratios for this sector were derived from the 2008 area source emissions for sewage sludge incineration.
e. Ratios derived from particulate matter ratios provided in the NPRI Toolbox guidance document entitled *Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces* (http://www.ec.gc.ca/inrp-npri).

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

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

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

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

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

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 Canada estimate.

A2.5. Reconciliation of Point and Area Source Emissions

A process of reconciliation, to prevent the double-counting of emissions, is required prior to combining the area source data with the point source data in order to form the final APEI. Reconciliation is performed at the subsector level. Table A2–1 in Section A2.2 provides a complete list of the sectors that required reconciliation.

The general approach for reconciling point source and area source emissions from a province, sector (and subsector/category) 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 a significant portion (if not all) of 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.

General reconciliation procedures are performed for the following sectors:

- Bakeries
- Concrete Batching & Products
- Ferrous Foundries
- Grain Industries
- Rock, Sand and Gravel (Sand & Gravel Production)
- Wood Industry (pollutants other than PM)
- Refined Petroleum Products Bulk Storage and Distribution
- Industrial and Commercial Incineration

Two sectors that are not included in this list also undergo general reconciliation procedures: the Asphalt Paving Industry and Commercial Fuel Combustion. Area source emissions for these sectors were carried over from the 2012 inventory to 2013 due to the unavailability of activity data; however, reconciliation for these sectors was performed using the 2013 point source emissions.

A2.6. Solvent Use Sectors

The Solvent Use sectors in the APEI comprise Dry Cleaning, General Solvent Use, Printing, and Surface Coatings. The area source emissions in these sectors include 92 subcategories representing combinations 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 NAICS. Due to this sector's complexity, reconciliation of area source emissions with the point source emissions from the NPRI requires several steps (Cheminfo Services 2007b):

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

The same allocation percentages developed for the 2005 reconciliation (Cheminfo 2007b) are used to reconcile solvent emissions for other years. 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 are performed, and the estimates are adjusted accordingly.

A2.7. Mercury in Products

Reconciliation of Mercury in Products estimates with the NPRI point source emissions was performed in a more specific manner for the entire time series, primarily for the Waste sectors. Given that only a few sewage sludge and municipal waste incinerators exist in Canada and all reported to the NPRI, the facility-reported mercury (Hg) emissions were used rather than area source estimates calculated by Environment Canada. For the Landfills and Water and Sewage Treatment sectors, a review and characterization of the sources included in estimates by the NPRI reporting facilities confirmed that these facilities did not duplicate the Hg emissions estimated by the area source. In addition, the estimated Hg emissions from landfills do not duplicate the NPRI reported emissions. The end result of these changes to the reconciliation of the Mercury in Products emissions is a small increase in the Mercury in Products–based estimates, resulting in a similar increase in total Hg emissions from these sectors.

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) by virtue of 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 and the 1998 Aarhus Protocol on Heavy Metals and 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 12 of the 17 reported air pollutants show reductions compared to historical levels:

- Emissions of sulphur (as sulphur oxides [SO_x]) were 1200 thousand tonnes in 2013, 62% below the emission ceiling of 3300 thousand tonnes established under the Helsinki Protocol.
- Emissions of nitrogen oxides (NO_x) were 2100 thousand tonnes in 2013, 28% below the emission ceiling of 2800 thousand tonnes established under the Sofia Protocol.
- In 2013, emissions of cadmium (Cd), lead (Pb) and mercury (Hg) were 81% (for both Cd and Pb) and 77% (for Hg) below the ceilings established under the Aarhus Protocol on Heavy Metals.
- The Aarhus Protocol also includes emission reduction commitments for POPs. In 2013, emissions of all POPs were largely below their ceilings, including the four species of polycyclic aromatic hydrocarbons (PAHs) (58% below their ceiling), hexachlorobenzene (HCB) (90% below its ceiling), and dioxins and furans (84% below their ceiling).

Emissions of non-methane volatile organic compounds (VOCs) and carbon monoxide (CO) decreased by 52% and 63%, respectively, since 1985, 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 2013), and total particulate matter (TPM) (56% above 1985 levels in 2013).

In 2015, Canada's Air Pollutant Emission Inventory (APEI) will accompany the UNECE report on 2013 emissions.

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 NOX 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(1,2,3-cd)p	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level
HCB	1998 Aarhus Protocol on POPs	Stabilize (not exceed) 1990 level

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 sectorial emissions to NFR codes.

Whereas the APEI report groups emissions by sectors (e.g. pulp & paper industry), the emissions in the UNECE are grouped by *process and combustion* categories. For example, the combustion emissions from the chemicals and printing industries of the APEI are mapped to the NFR category *1A2c: Stationary combustion in manufacturing industries and construction*. The process emissions from these APEI sectors are reported in the *2B10a Chemical industry: Other* and *2D3h Printing* NFR categories in the UNECE template.

The UNECE template was modified to support the new NFR-14 coding system, which replaces the older NFR-09 system. Table A3–2 illustrates the UNECE report template's structure, 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 sectorial emissions into their combustion and process components. Whereas certain sectors such as road dust contribute solely a process component, or solely a

Table A3–2 Excerpt from UNECE NFR 14 Reporting Template for 2015

Annex 1: National sector emissions: Main pollutants, particulate matter, heavy metals and persistent organic pollutants *(NFR 2014-1)*

	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)											

Table A3–3 APEI Subsector 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	$2C_3$: Aluminium production	TPM	0.229	0.771
				PM_{10}	0.290	0.710
				$PM_{2.5}$	0.352	0.648
				SO_x	1.000	0.000
				NO_x	0.746	0.254
				CO	1.000	0.000
				VOCs	1.000	0.000
				Hg	1.000	0.000

combustion component in the case of mobile sources, the majority of sectorial 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 subclass code 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 result from 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.

References

Chapter 3

[EMEP/EEA] European Monitoring and Evaluation Programme / European Environment Agency. 2013. *EMEP/EEA air pollutant emission inventory guidebook 2013: Technical guidance to prepare national emission inventories. Luxembourg (DNK): Publications Office of the European Union. Report No.: 12/2013. Available from:* www.eea.europa.eu/publications/emep-eea-guidebook-2013/download-complete-guidebook-2013.zip

Annex 1

Pirrone N, Cinnirella S, Feng X, Finkelman RB, Friedli HR, Leaner J, Mason R, Mukherjee AB, Stracher GB, Street DG et al. 2010. *Global mercury emissions to the atmosphere from anthropogenic and natural sources*. Atmos Chem Phys 10:5951-5964.

[UNEP] United Nations Environment Programme. 2013. *Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport*. Geneva (CH): UNEP Chemicals Branch.

Annex 2

AGRA Earth & Environmental Ltd. 1997. *Dust Loading Sampling in Winnipeg Region*. WX-06022. Winnipeg (MB).

Barr Engineering. 2001. *Substance Flow Analysis of Mercury in Products*. Minneapolis (MN): Barr Engineering. Prepared for the Minnesota Pollution Control Agency. Available from: www.pca.state.mn.us/index.php/view-document.html?gid=315.

Battye R, Battye W, Overcash C, Fudge S. 1994. *Development and Selection of Ammonia Emission Factors. Final Report*. Durham (NC): Contract No. 68-D3-0034. Available from: U.S. EPA, Washington (DC).

[BCMELP] British Columbia Ministry of Environment, Lands and Parks. 1997. *British Columbia Inventory of Common Air Contaminants Emitted in 1995 from Miscellaneous Area Sources Outside of the Lower Fraser Valley*. Victoria (BC): BCMELP. Available from: http://www.env.gov.bc.ca/eirs/epd/environmental_protection_publications_index/epdStaticPageB.htm.

Beef Information Centre. 1997. *Survey of Food Consumption for 4300 Households across Canada*. 1996 National Purchase Diary.

Bouwman AF, Boumans LJM, Batjes NH. 2002. *Estimation of global NH_3 volatilization loss from synthetic fertilizers and animal manure applied to arable lands and grassland*. Global Biogeochem Cy 16:8.1-8.15.

Canada, Department of Environment. 2012. *Canadian Environmental Protection Act, 1999:* Notice with respect to substances in the National Pollutant Release Inventory for 2012 and 2013. Part I, vol. 146, no.52, pp. 3642-3671. Ottawa (ON): Queen's Printer. Available from: www.gazette.gc.ca/rp-pr/p1/2012/2012-12-29/pdf/g1-14652.pdf.

Canadian Facts. 1997. *Residential Fuelwood Combustion in Canada. Volumes I, II and III*. Unpublished report. Hull (QC): Canadian Facts. Prepared for Environment Canada.

Canadian Facts. 2006. *Residential Fuelwood Combustion in Canada. Volume I.* Unpublished report. Hull (QC): Canadian Facts. Prepared for Environment Canada.

Canadian Facts. 2012. R*esidential Fuelwood Combustion in Canada. Volume I*. Unpublished report. Ottawa (ON): Canadian Facts. Prepared for Natural Resources Canada.

[CANMET] Canada Centre for Mineral and Energy Technology. 1993. P*resent and Future Uses of Energy in the Cement and Concrete Industries in Canada*. Unpublished report. Mississauga (ON): Holderbank Consulting. Prepared for Energy, Mines and Resources Canada.

[CARB] California Air Resources Board. 2005. *California Air Toxic Emission Factor database* [database on the Internet]. Available from: www.arb.ca.gov/ei/catef/catef.htm.

[CCFM/FC] Council of Canadian Fire Marshals and Fire Commissioners. 2002. *Annual Report 2002: Fire Losses in Canada*. Unpublished report. Human Resources and Social Development Canada, Fire Protection Services.

[CCME] Canadian Council of Ministers of the Environment. 2001. *A Study of Fugitive Coal Dust Emissions in Canada*. Unpublished report. Prepared for the CCME.

[CEA] Canadian Electricity Association. 2002. *Perspectives: Understanding Mercury. Volume 1, Issue 1, May 2002*. Available from: www.electricity.ca/media/pdfs/AirQuality/Perspectives_mercury.pdf.

[CGC] Canadian Grain Commission. 2013. *Grain Statistics Weekly 2012-2014*. Available from: http://www.grainscanada.gc.ca/statistics-statistiques/gsw-shg/gswm-mshg-eng.htm.

Cheminfo Services. 2005. *Survey of Small and Medium Commercial Baking Establishments to Estimate Average VOC Emission Factors*. Unpublished report. Markham (ON): Cheminfo. Prepared for Environment Canada.

Cheminfo Services. 2007a. *Volatile Organic Compound (VOC) Emissions from the Use of Solvents in Canada – Inventory Improvement and Trends Compilation - Task #2: VOC Emission Trends Compilation 1985-2005*. Unpublished report. Markham (ON): Cheminfo. Prepared for Environment Canada.

Cheminfo Services. 2007b. *Volatile Organic Compound (VOC) Emissions from the Use of Solvents in Canada – Inventory Improvement and Trends Compilation - Task #3: Mapping of Solvent Application Sub-Categories to NAICS Codes*. Unpublished report. Markham (ON): Cheminfo. Prepared for Environment Canada.

[CIFFC] Canadian Interagency Forest Fires Centre. 2013. *Canada Report 2013*. Available from: http://www.ciffc.ca/index.php?option=com_content&task=view&id=39&Itemid=100.

Clearstone Engineering. 2014. *Upstream Oil and Gas Emissions Inventory. Vols. 1, 2, 3 and 4. Unpublished report*. Calgary (AB): Clearstone Engineering. Prepared for Environment Canada.

Coe DL, Main HH, Chinkin LL, Loomis C, Wilkinson J. 1996. *Review of Current Methodologies for Estimating Ammonia Emissions, Draft Final Report*. Santa Rosa (CA): Sonoma Technology. Prepared for the California Air Resources Board. Report No.: STI-95310-1580-DFR.

[CRA] Conestoga-Rovers & Associates. 2012. *Inventory Improvement and Compilation of Volatile Organic Compound (VOC) Emissions from the Use of Solvents in Canada*. Unpublished report. Conestoga-Rovers. Prepared for Environment Canada.

[DAC] DesRosiers Automotive Consultants. 2014. *Census of Vehicles in Operation in Canada* [Excel spreadsheet]. Richmond Hill (ON): DesRosiers Automotive. Prepared for Environment Canada.

Ding YS, Trommel JS, Yan Xj, Ashley D, Watson CH. 2005. *Determination of 14 polycyclic aromatic hydrocarbons in mainstream smoke from domestic*

cigarettes. Environ Sci Technol 39:471-478.

[EC] Environment Canada. 1983. *A Nationwide Inventory of Emissions of Air Contaminants (1978)*. Ottawa (ON): Environment Canada, Environmental Protection Programs Directorate. Report EPS 3-EP-83-10.

[EC] Environment Canada. 1992. *Canada's Greenhouse Gas Emissions: Estimates for 1990*. Ottawa (ON): Environment Canada. Report EPS 5/AP/4.

[EC] Environment Canada. 2000a. *Characterization of Organic Compounds from Selected Residential Wood Stoves and Fuels*. Ottawa (ON): Environment Canada, Environmental Technology Centre. Report No. ERMD 2000-01.

[EC] Environment Canada. 2000b. *Daily Climate Data*. Downsview (ON): Meteorological Service of Canada, National Archives and Data Management Branch.

[EC] Environment Canada. 2010. *Sulphur in Liquid Fuels*. Gatineau (QC): Environment Canada, Oil, Gas and Alternative Energy Division. Available from: http://publications.gc.ca/collections/collection_2012/ec/En11-6-2008-eng.pdf.

[EC] Environment Canada. 2012. *Guide for Reporting to the National Pollutant Release Inventory (NPRI), 2012 and 2013*. Gatineau (QC): Environment Canada. Catalogue Number: En81-1/2013E-PDF. Available from: www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=AFC98B81-1.

[EC] Environment Canada. 2013. *Sulphur in Liquid Fuels [confidential* database]. Gatineau (QC): Environment Canada, Oil, Gas and Alternative Energy Division.

[EC] Environment Canada. 2014a. *National Pollutant Release Inventory (NPRI), 2013* [database on the Internet]. Gatineau (QC): Environment Canada, National Pollutant Release Inventory. Available from: www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=0EC58C98-

[EC] Environment Canada. 2014b. *Monthly Climate Summaries* [database on the Internet]. Fredericton (NB): Environment Canada , National Inquiry Response Team [modified 2014 April 10; cited 2014 August 14]. Available from: http://climate.weather.gc.ca/prods_servs/cdn_climate_summary_e.html.

[EIIP] Emission Inventory Improvement Program. 2001. *EIIP Technical Report Series Volume 3: Area Sources*. Revised Final [cited 2014 October 22]. Report No.: EPA 454/R-97-004. Available from: www.epa.gov/ttnchie1/eiip/techreport/volume03/.

[EMEP/CORINAIR] European Monitoring and Evaluation Programme/ Core Inventory of Air Emissions. 2002. *Emission Inventory Guidebook. 3rd Edition*. Copenhagen (DK): European Environment Agency, UNECE/EMEP Task Force on Emissions Inventories and Projections. Report No.: 30.

[EMEP/CORINAIR] European Monitoring and Evaluation Programme/Core Inventory of Air Emissions. 2006. *Emission Inventory Guidebook. Version 2.3*. Copenhagen (DK): European Environment Agency. Available from: www.eea.europa.eu/publications/EMEPCORINAIR4/page017.html.

[EMEP/EEA] European Monitoring and Evaluation Programme/European Environment Agency. 2009. *EMEP/EEA Air Pollutant Emission Inventory Guidebook: Technical Guidance to Prepare National Emission Inventories. Part B: Technical Chapters*. Luxembourg (BE): Office for Official Publications of the European Communities. Report No.: 9/2009.

[EMEP/EEA] European Monitoring and Evaluation Programme/European Environment Agency. 2013. *EMEP/EEA Air Pollutant Emission Inventory Guidebook 2013: Technical Guidance to Prepare National Emission Inventories*. Luxembourg (BE): Publications Office of the European Union. Report No.: 12/2013. Available from: www.eea.europa.eu/publications/emep-eea-guidebook-2013/download-complete-guidebook-2013.zip.

Environ (EC) Canada Inc. 2011. *Canadian Off-road Equipment Population. Unpublished report*. Mississauga (ON): Environ (EC) Canada. Prepared for Environment Canada. Contract No.: CA12-00333A.

Environics Research Group. 2001. *Household Garbage Disposal and Burning*. Unpublished report. Environics. Prepared for Environment Canada. Report No.: PN4855.

[FOCA] Federal Office of Civil Aviation. 2007. *Aircraft Piston Engine Emissions Summary Report*. Swiss Confederation. 0/3/33/33-05-003.022.

Gartner Lee Limited. 2003. *Dioxin/Furan Emissions from On-site Residential Waste Combustion in Canada*. Prepared for the Canadian Council of Ministers of the Environment. Reference No.: GLL 22-275.

GeoCom Inc. 1997. National Road Network from Natural Resources Canada.

Golder Associates. 1997. *Road Dust Emission Characterization of the Paved and Unpaved Roads in the City of Calgary*. Calgary (AB). Project No.: 972-2006.

Gray N, Boyle P. 2002. *Heavy metals range of emissions from 26 selected brands*. Ann Oncol 13:19-21.

Gulland J. 2000. *Non-Industrial Fuel Combustion Sector: Residential Fuel Wood Combustion*. Unpublished report. Gatineau (QC). Prepared for Environment Canada.

[GVRD] Greater Vancouver Regional District, [FVRD] Fraser Valley Regional District. 2003. *2000 Emission Inventory for the Canadian Portion of the Lower Fraser Valley Airshed – Detailed Listing of Results and Methodology*. Unpublished report. Burnaby (BC): GVRD.

Hagstrom M. 2010. *TPengs FOI orig comp data 031105 corr 071129 Jason Hickey 13 June 2010* [Excel spreadsheet]. Stockholm (SE): Swedish Defence Research Agency, Department of Systems Technology.

Health Canada. 2013. *Canadian Tobacco Use Monitoring Survey (CTUMS) Supplementary Tables - Annual (February to December 2012)* [tables on the Internet]. Ottawa (ON): Health Canada [revised 2013 October 1]. Available from: www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/index-eng.php.

[ICAO] International Civil Aviation Organization. 2009. *ICAO Engine Emissions Databank. Version 16A*. Civil Aviation Authority. Available from: http://www.caa.co.uk/default.aspx?catid=1437&pagetype=90&pageid=13449.

IHS. 2013. *Vehicles in Operation* [Excel spreadsheet]. Southfield (MI): IHS. Prepared for Environment Canada.

Innovacorp. 1997. *Road Dust Report for Nova Scotia*. 97-0682.

John D. Paterson & Associates Ltd. 1997. *Road Dust Emissions Inventory*. Ottawa (ON).

Lemieux PM, Lutes CC, Santoianni DA. 2004. *Emissions of organic air toxics from open burning: a comprehensive review*. Science 30:1-32.

Madison. 2013. *Madison's 2013 Online Lumber Directory*. Available from: www.madisonsreport.com/products/madisons-directory/.

Meil J, Bushi L, Garrahan P, Aston R, Gingras A, Elustondo D. 2009. *Status of Energy Use in the Canadian Wood Products Sector*. Ottawa (ON): Natural Resources Canada, Canadian Industry Program for Energy Conservation. 68 pp. Catalogue No. M144-214/2009. Available from: http://publications.gc.ca/site/eng/359584/publication.html.

[MMIC] Motorcycle & Moped Industry Council. 2013. *Motorcycle, Scooter & All-Terrain Vehicle Annual Industry Statistics Report, 2013*. Markham (ON): MMIC.

[NEIPTG] National Emissions Inventory and Projections Task Group. 1997. *Road Dust Monitoring Study*. Vancouver (BC): SEACOR Environmental Engineering. Project No.: C0485-003.

[NRCan] Natural Resources Canada. 1993. *Canadian Mineral Yearbook* (CMY).

[NRCan] Natural Resources Canada. 2013. *Minerals and Mining Statistics On-Line – Mineral Production of Canada, by Province and Territory*. Ottawa (ON): NRCan. Available from: http://sead.nrcan.gc.ca/prod-prod/ann-ann-eng.aspx.

[NRCan] Natural Resources Canada. 2014. *Annual Statistics, Mineral Production of Canada, by Province and Territory* [Internet]. Ottawa (ON): NRCan [cited 2014 August 21]. Available from: http://sead.nrcan.gc.ca/prod-prod/ann-ann-eng.aspx.

Ortech International. 1992. *MOE Toxic Chemical Emission Inventory for Ontario and Eastern North America*. Mississauga (ON): Ortech International. Report No. P.92-T61-5429/OG. Available from: https://archive.org/download/moetoxicchemical00ontauoft/moetoxicchemical00ontauoft.pdf.

Ott WR, Langan L, Switzer P. 1992. *A time series model for cigarette smoking activity patterns: Model validation for carbon monoxide and respirable particles in a chamber and an automobile*. J Exp Anal Env Epid 2:175–200.

Ott WR, Switzer P, Robinson J. 1996. *Particle concentrations inside a tavern before and after prohibition of smoking: Evaluating the performance of an indoor air quality model*. JAPCA J Air Waste Ma 46:1120–1134.

Pinchin Environmental Ltd. 2007. *CAC Emissions from the Canadian Grain Handling Industry – 1985-2007*. Unpublished report. Mississauga (ON): Pinchin Environmental. Prepared for Environment Canada.

Polk & Co. 2014. *Trucking Industry Profile Database* [unpublished database]. Polk & Co. Prepared for Environment Canada.

[RAC] Rail Association of Canada. 2013. *Locomotive Emissions Monitoring Program 2011*. ISBN 978-1-927520-02-4.

[RISI] Resource Information Systems Inc. 2013. *North American Wood Panels and Engineered Wood Products Capacity Report, 2013*. Available from: www.risiinfo.com/.

Robertson T, Dunbar J. 2005. *Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities*. Washington (DC): U.S. EPA, Office of Research and Development. Report No. EPA-600/R-05/123a. Available from: http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1000BRN.txt.

Roe SM, Spivey MD, Lindquist HC, Thesing KB, Strait RP, EH Pechan & Associates Inc. 2004. *Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources-Draft Final Report*. Unpublished report. U.S. EPA, Emission Inventory Improvement Program.

Rogge WF, Hildemmann LM, Mazurek MA, Cass GR, Simonelt BRT. 1991. *Sources of fine organic aerosol. 1. Charbroilers and meat cooking operations*. Enviro Sci Technol 25:1112-1125.

Senes Consultants. 2008. *Update of Process Emission Profiles for Hot Mix Asphalt (HMA) Manufacturing Establishments across Canada*. Unpublished report. Richmond Hill (ON): Senes Consultants. Prepared for Environment Canada.

Sheppard SC, Bittman S. 2010. F*arm survey used to guide estimates of N intake and NH_3 emissions from cattle, including early season grazing and piosphere effects*. Anim Feed Sci Tech 167:689-698.

Sheppard SC, Bittman S. 2012. *Farm practices as they affect NH_3 emissions from beef cattle*. Can J Anim Sci 92:525-543.

Sheppard SC, Bittman S, Tait J, Sommer SG, Webb J. 2007a. *Sensitivity analysis of alternative model structures for an indicator of ammonia emissions from agriculture*. Can J Soil Sci 87:129-139.

Sheppard SC, De Jong R, Sheppard MI, Bittman S, Beaulieu MS. 2007b. *Estimation of ammonia emission episodes for a national inventory using a farmer survey and probable number of field working days*. Can J Soil Sci 87:301-313.

Sheppard SC, Bittman S, Beaulieu M, Sheppard MI. 2009a. *Ecoregion and farm-size differences in feed and manure nitrogen management: 1. Survey methods and results for poultry*. Can J Anim Sci 89:1-19.

Sheppard SC, Bittman S, Tait J. 2009b. *Monthly NH_3 emissions from poultry in 12 Ecoregions of Canada*. Can J Anim Sci 89: 21-35.

Sheppard SC, Bittman S, Swift ML, Tait J. 2010a. *Farm practices survey and modelling to estimate monthly NH_3 emissions from swine production in 12 Ecoregions of Canada*. Can J Anim Sci 90: 145-158.

Sheppard SC, Bittman S, Bruulsema T. 2010b. *Monthly ammonia emissions from fertilizers in 12 Canadian ecoregions*. Can J Soil Sci 90:113-127.

Sheppard SC, Bittman S, Swift ML, Beaulieu M, Sheppard MI. 2011a. *Ecoregion and farm size differences in dairy feed and manure nitrogen management: A survey*. Can J Animal Sci 91:459-473.

Sheppard SC, Bittman S, Swift ML, Tait J. 2011b. *Modelling monthly NH_3 emissions from dairy in 12 Ecoregions of Canada. Can J Animal Sci 91:649-661*.

SNC/GECO Canada Inc., Ontario Research Foundation. 1981. A Nationwide Inventory of Anthropogenic Sources and Emissions of Primary Fine Particulate Matter. Unpublished report. Montreal (QC): SNC/GECO Canada. Prepared for Environment Canada.

SNC-Lavalin Environment. 2005. *CAC fugitive emissions from the Canadian construction and demolition sector, Final report*. Unpublished report. SNC-Lavalin. Prepared for the CCME.

SNC-Lavalin Environment. 2012. *National Marine Emissions Inventory for Canada, 2010. Unpublished report*. Burnaby (BC): SNC-Lavalin. Prepared for Environment Canada.

Statistics Canada. 1997. *Products Shipped by Canadian Manufacturers, 1995*. Ottawa (ON): Statistics Canada. Catalogue. No.: 31-211-XPB.

Statistics Canada. 2003. *Annual Demographics Statistics 2002. Ottawa (ON): Statistics Canada*. Catalogue No.: 91-213-XIB. Available from: http://publications.gc.ca/Collection-R/Statcan/91-213-XIB/0000291-213-XIB.pdf.

Statistics Canada. 2004. *Waste Management Industry Survey: Business and Government Sectors 2002*. Ottawa (ON): Statistics Canada. Catalogue No.: 16F0023-XIE. Available from: www.statcan.gc.ca/pub/16f0023x/16f0023x2002001-eng.pdf.

Statistics Canada. 2007. *Annual Demographics Estimates: Census Metropolitan Areas, Economic Regions and Census Divisions, Age and Sex 2001 to 2006*. Ottawa (ON): Statistics Canada. Catalogue No.: 91-214-XIE. Available online at: http://publications.gc.ca/Collection/Statcan/91-214-X/91-214-XIE2006000.pdf.

Statistics Canada. 2008. *Alternative Livestock on Canadian Farms: Census years 1981, 1986, 1991, 1996, 2001, and 2006*. Ottawa (ON): Catalogue No.: 23-502-X.

Statistics Canada. 2010. S*pending Patterns in Canada 2009*. Ottawa (ON): Catalogue No. 62-202-X.

Statistics Canada. 2011. *CANSIM Table 003-0004: Number of hogs on farms at end of quarter, quarterly (head x 1000)* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26;jsessionid=59B3777642DC730198B7D13BA6029B86?-lang=eng&retrLang=eng&id=0030004&tabMode=dataTable&srchLan=-1&p1=-1&p2=35.

Statistics Canada. 2012a. *Cereals and Oilseeds Review*. Ottawa (ON): Statistics Canada. Catalogue No.: 22-007-XI. Available from: www.statcan.gc.ca/pub/22-007-x/22-007-x2012006-eng.htm.

Statistics Canada. 2012b. *Report on Energy Supply-Demand in Canada*. Catalogue No.: 57-003-XIB.

Statistics Canada. 2012c. *2011 Census of Canada: Topic-based tabulations* [database on the Internet] [cited 2012 May 30]. Available from: http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/tbt-tt/Rp-eng.cfm?LANG=E&APATH=3&DETAIL=1&DIM=0&FL=A&FREE=0&GC=0&GID=0&GK=0&GRP=1&PID=101998&PRID=0&PTYPE=101955&S=0&SHOWALL=0&SUB=0&Temporal=2011&THEME=88&VID=0&VNAMEE=&VNAMEF.

Statistics Canada. 2012d. *North American Industry Classification System (NAICS) – Canada 2012*. Ottawa (ON): Statistics Canada. Catalogue No.: 12-501-X. Available from: www.statcan.gc.ca/subjects-sujets/standard-norme/naics-scian/2012/index-indexe-eng.htm.

Statistics Canada. 2013a. CANSIM Table 051-0001: *Population by year, by province and territory* [database on the Internet]. Ottawa (ON): Statistics Canada [revised 2014 September 26]. Available from: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo02a-eng.htm.

Statistics Canada. 2013b. *Aircraft Movement Statistics* [database]. Ottawa (ON): Statistics Canada [database extracts from Rose Krakower from Statistics Canada for years Nov. 1, 1996 to 2012; Transport Canada personnel for years 1990 to Oct. 31, 1996].

Statistics Canada. 2013c. *CANSIM Table 405-0001 and Table 405-0004: Road Motor Vehicle, Trailer and Snowmobile Registration (registrations)* [database on the Internet]. Ottawa (ON): Statistics Canada.

Statistics Canada. 2013d. *CANSIM Table 003-0031: Number of sheep and lambs on farms, annual (head)* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030031&pattern=Livestock&tabMode=dataTable&srchLan=-1&p1=1&p2=1.

Statistics Canada. 2013e. *CANSIM Table 003-0032: Number of cattle, by class and farm type, annual (head)* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0030032&pattern=Livestock&tabMode=dataTable&srchLan=-1&p1=1&p2=1.

Statistics Canada. 2013f. *Fertilizer shipments survey*. Catalogue No.: 21-022.

Statistics Canada. 2013g. *CANSIM Table 001-0010: Estimated areas, yield, production and average farm price of principal field crops, in metric units, annual, 1908 to 2013* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0010010&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=.

Statistics Canada. 2014a. *CANSIM Table 304-0014: Manufacturers' sales, inventories, orders and inventory to sales ratios, by North American Industry Classification System (NAICS), Canada, monthly (dollars unless otherwise noted)* [database on the Internet]. Ottawa (ON): Statistics Canada [revised 2014 October 15; cited 2014 September 26]. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3040014&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=.

Statistics Canada. 2014b. *CANSIM Table 304-0015: Manufacturing sales, by North American Industry Classification System (NAICS) and province, monthly (dollars)* [database on the Internet]. Ottawa (ON): Statistics Canada [revised 2014 October 15; cited 2014 September 26]. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3040015&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid=.

Statistics Canada. 2014c. *CANSIM Table 329-0075: Industrial product price index, by North American Product Classification System (NAPCS), monthly (index, 2010=100)* [database on the Internet]. Ottawa (ON): Statistics Canada [revised 2014 September 29; cited 2014 September 26]. Available from: http://www5.statcan.gc.ca/cansim/a26?id=3290075&retrLang=eng&lang=eng.

Statistics Canada. 2014d. *Report on Energy Supply and Demand in Canada, 2012 Preliminary*. Statistics Canada. Catalogue No.: 57-003-X. Available from: www.statcan.gc.ca/pub/57-003-x/57-003-x2014002-eng.pdf.

Statistics Canada. 2014e. *Food availability data series [database on the Internet]. 1960 - . Ottawa (ON)*: Statistics Canada [revised 2014 May 29; cited 2014 June 9]. Available from: http://www.statcan.gc.ca/daily-quotidien/140529/dq140529e-eng.htm.

Statistics Canada. 2014f. *CANSIM Table 29-0040: Capital Expenditures on Construction by Type of Asset, by Province* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0290040&tabMode=dataTable&srchLan=-1&p1=-1&p2=9.

Statistics Canada. 2014g. *CANSIM Table 027-0009: Canada Mortgage and Housing Corporation, housing starts, under construction and completions, all areas, annual (units)* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0270009&tabMode=dataTable&srchLan=-1&p1=-1&p2=9.

Statistics Canada. 2014h. *CANSIM Table 326-0020: Consumer price index (CPI),2001 basket* [database on the Internet]. Ottawa (ON): Statistics Canada. Available from: http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=3260020&pattern=consumer+price+index&tabMode=dataTable&srchLan=-1&p1=1&p2=1.

Stewart-Brown Associates. 2012. *Kilometre Accumulation Rates in British Columbia and Ontario*. Abbotsford (BC): PO No.: K2A12-13-0508/0. Prepared for Environment Canada.

TNS Canada. 2012. *Residential Fuelwood Combustion in Canada. Volume I*. Unpublished report. Ottawa (ON): TNS Canada. Prepared for Natural Resources Canada.

ToxEcology. 2007a. *Mass Balance Study for Mercury-Containing Products Report*. Unpublished report. Vancouver (BC): ToxEcology. Prepared for Environment Canada.

ToxEcology. 2007b. *Mass Balance Study for Mercury-Containing Products Model*. Unpublished report. Vancouver (BC): ToxEcology. Prepared for Environment Canada.

ToxEcology. 2009a. *Mercury Update 2009 Nov 23_Summary.xls* [Excel spreadsheet]. Unpublished report. Vancouver (BC): ToxEcology. Prepared for Environment Canada.

ToxEcology 2009b. *Mercury Mass Balance Model_2008.xls* [Excel spreadsheet]. Unpublished report. Vancouver (BC): ToxEcology. Prepared for Environment Canada.

Tracey K. 2014. *Residential Fuelwood Combustion in Canada*. Unpublished report. Gatineau (QC): Environment Canada, Pollutant Inventories and Reporting Division.

[U.S. EPA] United States Environmental Protection Agency. 1985. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 5th Edition*. Research Triangle (NC): Office of Air Quality Planning and Standards [cited 2014 August 27]. Available from: www.epa.gov/ttn/chief/ap42/oldeditions.html.

[U.S. EPA] United States Environmental Protection Agency. 1988. C*ompilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 5th Edition*. Research Triangle Park (NC): Office of Air Quality Planning and Standards [cited 2008 April]. Available from: www.epa.gov/ttn/chief/ap42/oldeditions.html.

[U.S. EPA] United States Environmental Protection Agency. 1990. *Landfill Air Emissions Estimation Model User's Manual*. Washington (DC): Office of Research and Development. EPA-600/8-90-085a.

[U.S. EPA] United States Environmental Protection Agency. 1992. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 4th Edition*. Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/ap42/oldeditions.html.

[U.S. EPA] United States Environmental Protection Agency. 1995a. *Compilation of Air Pollutant Emission Factors. Volume I. Stationary Point and Area Sources. 5th Edition*. Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/ap42/ch02/.

[U.S. EPA] United States Environmental Protection Agency. 1995b. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 5th Edition* [updates for 2002]. Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/ap42/suppchg-updates.html.

[U.S. EPA] United States Environmental Protection Agency. 1997. *Evaluation of emissions from the open burning of household waste in barrels Volume 1*. Technical Report. Washington (DC): Office of Research and Development. EPA-600/R-97-134a. Available from: www.epa.gov/ttncatc1/products.html.

[U.S. EPA] United States Environmental Protection Agency. 1998. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 5th Edition*. Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/ap42/oldeditions.html.

[U.S. EPA] United States Environmental Protection Agency. 2002. *Technical Description of the Toxics Module for MOBILE6.2 and Guidance on Its Use for Emission Inventory Preparation*. Washington (DC): Office of Transportation and Air Quality. Report No.: EPA420-R-02-029.

[U.S. EPA] United States Environmental Protection Agency. 2003a. *Draft Dioxin Reassessment*. Available from: http://cfpub.epa.gov/ncea/cfm/part1and2.cfm?ActType=default.

[U.S. EPA] United States Environmental Protection Agency. 2003b. *Combustion Sources of CDD/CDF: Waste Incineration*. Washington (DC): EPA/600/P-00/001Cb. Available from: www.epa.gov/ncea/pdfs/dioxin/nas-review/pdfs/part1_vol1/dioxin_pt1_vol1_ch03_dec2003.pdf.

[U.S. EPA] United States Environmental Protection Agency. 2003c. E*xposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-P-Dioxin (TCDD) and Related Compounds*. Washington (DC): National Academy of Sciences (External Review Draft). EPA/600/P-00/001Cb. Available from: http://cfpub.epa.gov/ncea/cfm/part1and2.cfm?ActType=default.

[U.S. EPA] United States Environmental Protection Agency. 2004. *FIRE 6.25. Factor Information Retrieval (FIRE) Data System* [database]. Clearinghouse for Inventories & Emissions Factors.

[U.S. EPA] United States Environmental Protection Agency. 2005a. *Documentation for Aircraft CMV Locomotive of the NEI - Vol 1 methods.* Research Triangle Park (NC): U.S. EPA, Emission Factor and Inventory Group. Contract No.: 68-D-02-063.

[U.S. EPA] United States Environmental Protection Agency. 2005b. *User's Guide for the Final NONROAD2005 Model*. Washington (DC): Office of Transportation and Air Quality. Report No.: EPA420-R-05-013.

[U.S. EPA] United States Environmental Protection Agency. 2006. *Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources. 5th Edition.* Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/ap42/oldeditions.html.

[U.S. EPA] United States Environmental Protection Agency. 2008. *SPECIATE 4.2-Speciation Database Development Documentation.* Research Triangle Park (NC): Office of Research and Development. Report No.: EPA/600-R-09/038. Available from: www.epa.gov/ttn/chief/software/speciate/index.html.

[U.S. EPA] United States Environmental Protection Agency. 2010a. *PM Calculator* [database on the Internet]. Research Triangle Park (NC): Office of Air Quality Planning and Standards. Available from: www.epa.gov/ttn/chief/eiinformation.html.

[U.S. EPA] United States Environmental Protection Agency. 2010b. *Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity*. Washington (DC): Office of Transportation and Air Quality. Report No.: EPA-420-B-10-023.

[U.S. EPA] United States Environmental Protection Agency. 2010c. *Documentation for the Commercial Marine Vessel Component of the National Emissions Inventory*. Morrisville (NC): Eastern Research Group. Prepared for the U.S. EPA. Contract No.: EP-D-07-097.

[U.S. EPA] United States Environmental Protection Agency. 2011. *Documentation for Locomotive Component of the National Emissions Inventory Methodology*. Morrisville (NC): Eastern Research Group for Emissions. Prepared for the U.S. EPA. Contract No.: EP-D-07-097.

[U.S. EPA] United States Environmental Protection Agency. 2012a. *EPA memorandum - EPA Region 10 HAP and VOC Emission Factors for Lumber Drying, December 2012*. Available from: www.epa.gov/region10/pdf/air/technical/ldkhapvocpteef_memo.pdf.

[U.S. EPA] United States Environmental Protection Agency. 2012b. U*ser Guide for MOVES2010b*. Washington (DC): Office of Transportation and Air Quality. Report No.: EPA-420-B-12-001b.

[U.S. EPA] United States Environmental Protection Agency. 2013. *Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2011 National Emissions Inventory*. Office of Transportation and Air Quality. Report No.: EPA-420-B-13-040.

[U.S. EPA] United States Environmental Protection Agency. 2014a. *WebFIRE* [database on the Internet]. Durham (NC): Technology Transfer Network Clearinghouse for Inventories & Emissions Factors. Available from: http://cfpub.epa.gov/webfire/.

[U.S. EPA] United States Environmental Protection Agency. 2014b. *User Guide for MOVES2014*. Washington (DC): Office of Transportation and Air Quality. Report No.: EPA-420-B-14-055.

Vandergrift A, Shannon L, Gorman P, Lawless E, Sallee E, Reichel M. 1971. *Particulate Pollutant Systems Study, Volume III: Handbook of Emission Properties.* Durham (NC): U.S. Environmental Protection Agency. Contract CPA-22-69-I04.

Wallace L, Pellizzari E, Hartwell T, Perrit R, Ziegenfus R. 1987. *Exposures to benzene and other volatile compounds from active and passive smoking*. Arch Environ Health 42(5):272–279.

Wayson R, Flemming G, Iovinelli R. 2009. *Methodology to estimate particulate matter emissions from certified commercial aircraft engines*. JAPCA J Air Waste Ma 59(1): 91-10

Annex 3

[CEIP] Centre on Emission Inventories and Projections. Available from: www.ceip.at/.

[EMEP/EEA] European Monitoring Evaluation Programme/European Environment Agency. 2013. *EMEP/EEA air pollutant emission inventory guidebook 2013, Technical guidance to prepare national emissions inventories*. Luxembourg (BE): European Environment Agency. EEA Technical report No. 12/2013. Available from: www.eea.europa.eu/publications/emep-eea-guidebook-2013.

[UNECE] United Nations Economic Commission for Europe. 2014. *Guidelines for Reporting Emissions and Projections Data under the Convention on Long-range Transboundary Air Pollution. Advance Version. ECE*. ECE/EB.AIR/125. Available from: http://ceip.at/fileadmin/inhalte/emep/2014_Guidelines/ece.eb.air.125_ADVANCE_VERSION_reporting_guidelines_2013.pdf.