Taking Stock

2005 North American

Pollutant Releases and Transfers

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- Expert/Parties review (Chapter 4): October-December 2008
- For more information, please consult the Acknowledgements.

Disclaimer

The national PRTR data sets are constantly evolving as facilities revise previous submissions to correct reporting errors or make other changes. For this reason, the three countries "lock" their data sets on a specific date and use the "locked" data for annual summary reports. Each year, the countries issue revised databases that cover all reporting years.

The Commission for Environmental Cooperation (CEC) follows a similar process. For the purposes of this report, the NPRI and TRI data sets of February 2008 and the RETC data set of May 2008 were used. The CEC is aware that changes have occurred to the data sets subsequent to the official release of the 2005 data that are not reflected in this report. Readers can visit the national PRTR websites to see if any changes to the data have occurred.

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Preface

This is the twelfth annual report in the CEC's *Taking Stock* series on releases and transfers of pollutants from industrial facilities in North America, and the second year in which the CEC is able to present publicly available, mandatory PRTR data from Mexico. Inclusion of data from Mexico's *Registro de Emisiones y Transferencia de Contaminantes* (RETC) is an important step for the CEC's PRTR project and greatly improves public understanding of releases and transfers of pollutants from industrial sources throughout North America.

Bringing the data from Canada, Mexico and the United States into one report is challenging. Differences in the industrial makeup, pollutant coverage and PRTR reporting requirements of the three countries, as well as differences in methodologies used to estimate releases and transfers and accuracy of reporting, affect what is reported and therefore what can be presented at the North American level.

In response to input from stakeholders and in accordance with our desire to continually improve the coverage and usefulness of *Taking Stock*, this year's report features a different approach than previous editions. This new approach is distinguished by a greater scope, including all data reported to the three North American PRTRs—some 5.5 billion kilograms of toxic pollutants—as compared to previous years' reports, which examined subsets of all reported data. It also disaggregates releases and transfers, with a stronger emphasis on specific release media (e.g., air, water, land) and transfer types (e.g., recycling). In addition, we have improved the report's accompanying website, *Taking Stock Online*. The new site features mapping capabilities and allows users to explore different aspects of the reported data, such as year to year changes in releases and transfers.

This new approach, and its expanded data coverage, better addresses the CEC's objectives of providing the most complete picture possible of industrial releases and transfers, giving additional context to enable readers to better interpret the information, and improving the utility of PRTR data. As in past years, this report provides information about releases of pollutants of concern (such as carcinogens and developmental or reproductive toxicants), criteria air contaminants, and greenhouse gases. It also includes a special feature chapter on releases and transfers from the petroleum industry in North America.

Taking Stock 2005 highlights important differences in PRTR reporting among the three countries, including the types and amounts of pollutants reported, the release and transfer methods used, and the sectors or facilities reporting to each program. Thus, while only about thirty substances from fifteen industrial sectors represented over 90 percent of all reported releases and transfers in North America, there are important gaps in the picture of industrial pollution, partly as a result of differences in PRTR reporting requirements from country to country. The comparison of data in the context of these differences can therefore highlight opportunities for further actions to enhance data comparability, improve our understanding of industrial pollution in North America, and foster initiatives leading to pollution reductions.

Felipe Adrían Vázquez-Gálvez
Executive Director

Acknowledgements

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The CEC wishes to thank the various groups and individuals who provided invaluable input on this project, including the PRTR program officials from Canada, the United States and Mexico, and the team of consultants from Hampshire Research Institute (United States), Environmental Economics International (Canada) and ÜV Lateinamerika S. de R.L. de C.V. (Mexico).

The CEC also gratefully acknowledges the participation of representatives from North American petroleum facilities who granted interviews and provided information for the special feature chapter, as well as members of industry, government and nongovernmental organizations who reviewed and provided comments on the chapter. Their names are provided at the end of **chapter 4**.

Finally, the CEC wishes to thank Pangaea Information Technologies, Ltd, along with the CEC's IT staff, for their innovation and efforts on the *Taking Stock Online* website <http://www.cec.org/takingstock/>. In the spirit of right-to-know, this integrated and searchable North American PRTR database provides access to valuable information that enables governments, individuals, NGOs and communities to act in an informed manner to protect our shared environment.

Acronym

CAC	criteria air contaminant
CAS	Chemical Abstracts Service
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation
CEPA	Canadian Environmental Protection Act
COA	*Cédula de Operación Anual* (Annual Certificate of Operation)
EPA	US Environmental Protection Agency
FCCU	fluidized catalytic cracking unit
GHG	greenhouse gas
HAP	hazardous air pollutant
IARC	International Agency for Research on Cancer
MACT	maximum achievable control technology
MNEI	Mexican National Emissions Inventory
NAICS	North American Industry Classification System
NEB	National Energy Board (Canada)
NEI	US National Emissions Inventory
NOM	*Norma Oficial Mexicana* (Mexican Official Standard)
NO_x	nitrogen oxides
NPRI	National Pollutant Release Inventory (PRTR for Canada)
OECD	Organisation for Economic Co-operation and Development
PAC	polycyclic aromatic compounds (in US)
PAH	polycyclic aromatic hydrocarbons (in Canada)
PBT	persistent, bioaccumulative and toxic substance
PCB	polychlorinated biphenyl
PM	particulate matter
PRTR	pollutant release and transfer register
RETC	*Registro de Emisiones y Transferencia de Contaminantes* (PRTR for Mexico)
Semarnat	*Secretaría de Medio Ambiente y Recursos Naturales* (Mexican Secretariat of the Environment and Natural Resources)
SIC	Standard Industrial Classification
SO_2	sulfur dioxide
SO_x	sulfur oxides
TEP	toxic equivalency potential
TRI	Toxics Release Inventory (PRTR for United States)
VOC	volatile organic compound

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Introduction

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Introduction

Taking Stock 2005 presents an overview of the releases and transfers of chemical contaminants from North American industrial sectors in 2005. The report is based primarily on publicly available data reported to the three national pollutant release and transfer registers (PRTRs) in North America:

- *National Pollutant Release Inventory* (NPRI) in Canada;
- *Registro de Emisiones y Transferencia de Contaminantes* (RETC) in Mexico; and
- *Toxics Release Inventory* (TRI) in the United States.

PRTRs gather detailed information on the types, locations and amounts of pollutants released or transferred by industrial facilities. By bringing together data and information from the three national PRTR programs, this publication supports a key objective of the overall goal of the Commission for Environmental Cooperation (CEC) to provide information for decision making at all levels of society. *Taking Stock* aims to:

- paint a picture of the industrial releases and transfers of pollutants in North America and serve as an information source for governments, industry and communities in analyzing such data and identifying opportunities to reduce pollution;
- promote greater comparability of PRTR data among the three countries;
- raise awareness of the important health and environmental issues associated with toxic chemicals and industry in North America;
- increase dialogue and collaboration across borders and industrial sectors; and
- support integration of PRTR data into an overarching framework for managing pollutants in North America.

This report describes and analyzes data reported by industrial facilities in 2005 in North America. And this year's special feature (**Chapter 4**) presents a more in-depth discussion of releases and transfers from the North American petroleum industry. Data for Canada, Mexico and the United States for 2004 and 2005, as well as additional data going back to 1998 for the United States and Canada, can be searched using *Taking Stock Online*.

Focus of This Year's Report

This report is the twelfth in the CEC's *Taking Stock* series on releases and transfers of pollutants from industrial sources in North America. It is the second year in which the CEC is able to present publicly available PRTR data from Mexico. Inclusion of these data has represented a major milestone for Mexico and an important step for the CEC's PRTR project, which is aimed at understanding releases and transfers of pollutants from industrial sources in North America. However, the addition of a third country's data has also created significant challenges for *Taking Stock*. Therefore, this year's report features some important changes in the presentation of PRTR data. These changes are intended to better address the following questions:

What Is a Pollutant Release and Transfer Register?

PRTRs provide annual data on the amounts of pollutants released from a facility to the air, water and land and injected underground, as well as transferred off-site for recycling, treatment or disposal. PRTRs are an innovative tool that can be used for a variety of purposes— that is, they track certain chemicals, thereby helping industry, governments and citizens identify ways to reduce the release and transfer of these substances, increase responsibility for chemical use, prevent pollution and cut back on waste generation. Corporations use the data to report on their environmental performance and to identify opportunities for reducing or preventing pollution. Governments use the data to guide program priorities and evaluate results. And communities, nongovernmental organizations and citizens use the data to gain an understanding of the sources and management of pollutants and to support dialogue with facilities and governments.

PRTRs collect data on individual pollutants rather than on the volume of waste streams containing mixtures of substances, because this approach allows the tracking of data on releases and transfers of individual substances. *Reporting by facility* is central to locating where releases occur and who or what generated them. Much of the power of a PRTR lies in *public disclosure of the data* and their dissemination to a wide range of users in both raw and summarized form. The public availability of pollutant- and facility-specific data allows interested persons and groups to identify local industrial sources of releases and support regional and other geographically based analyses.

- What portion of North America's industrial pollution is represented by *Taking Stock* data?
- Which pollutants are being released and transferred in the largest amounts, and how?
- What are the similarities and differences in how North American industrial sectors handle their waste, and what impacts do differences among the three PRTR programs have on what is reported?
- What are the potential health and environmental impacts of the reported pollutants, and do the data shed light on actions needed, especially those directed at substances of special concern?

A central objective of this year's report is to provide additional context, as well as a more inclusive and transparent picture of reported industrial releases and transfers of pollutants in North America. Regular readers of the report will notice changes in the presentation of data:

- Releases and transfers are disaggregated, with a stronger emphasis on the release media (e.g., to air, water, land) and transfer types (e.g., recycling).
- The report includes all available data reported in 2005 to the national PRTR programs, and looks at similarities and differences in the industries and pollutants under each program. This approach differs from that used in past *Taking Stock* reports, which focused only on subsets of "matched" data (i.e., data reported according to common requirements among the countries, such as common pollutants, thresholds and sectors).
- This year's *Taking Stock* does not include a trends analysis. However, future reports will include additional analyses of trends for pollutants and sectors of special interest.

As in past years, the current report presents:

- data for specific groups of substances, such as carcinogens and developmental/ reproductive toxicants, and toxicity equivalency potential (TEP) values for some of these substances;
- information on reported criteria air contaminants and greenhouse gases; and
- a special feature analysis: an in-depth look at releases and transfers from the petroleum industry in North America.

As with any report that is data-intensive, presentation is of utmost importance. *Taking Stock* presents the data reported in each country and explains the differences among the three PRTR programs, thereby providing the context needed to interpret and compare the data. This year's report reflects the reality of current PRTR reporting in North America, which is characterized by some important differences. By analyzing available PRTR data, as well as the current gaps in reporting, *Taking Stock* can help identify areas in which further action is needed.

Update on Mexico's PRTR Program

Reporting to Mexico's PRTR, the *Registro de Emisiones y Transferencia de Contaminantes*, became mandatory in 2004. Because 2005 was only the second year of mandatory RETC reporting (and therefore only the second year for which Mexican data are included in *Taking Stock*), readers may find a brief overview of the progress in Mexican PRTR reporting useful.

The RETC is a national reporting program that covers all 32 Mexican states. In addition, slightly less than half of the states have their own programs that collect and transfer PRTR data to the federal government. Since 2002, the Mexican Secretariat of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales*, Semarnat) has conducted many workshops with industry associations to provide guidance for PRTR reporting, with the objectives of raising awareness of the importance of reporting, coordinating state-federal data exchanges and improving data quality. In these efforts, Semarnat has benefitted from collaboration, through the CEC, with Canadian and US PRTR officials.

The industrial sectors required to report in Mexico are those under federal jurisdiction. Facilities under state or municipal jurisdiction that undertake specific kinds of activities, transfer hazardous wastes or release wastewater into national water bodies also must report to the RETC.

In 2004 some 1,700 facilities reported to the Mexican RETC. In 2005 the number of reporting facilities increased by about 700, for a total of almost 2,500 facilities. In terms of releases and transfers, Mexican facilities reported almost 19 million kilograms in 2004 (not including greenhouse gases and criteria air contaminants). In 2005 this number increased to over 67 million kilograms. The reporting increases from 2004 to 2005 were from a variety of industrial activities and sectors.

The list of pollutants subject to RETC reporting has not changed since 2004. It includes 104 substances, each with a corresponding "release" or "activity" threshold. In 2004 reporting facilities provided data on 76 of these 104 substances; in 2005 facilities reported on 79 pollutants.[1] **Chapter 3** details the amounts and types of releases and transfers reported by Mexican facilities in 2005.

Organization of the *Taking Stock 2005* Report

Chapter 2 describes the three national PRTRs and the methodology used in this report. **Chapter 3** then presents PRTR data from Canada, Mexico and the United States for 2005. It also includes information on pollutants of special interest and toxicity weighting values. **Chapter 4** takes a detailed look at releases and transfers from the petroleum industry in North America.

The **appendix** to this report lists pollutants common to the three countries and contains pertinent information on reporting requirements. The complete lists of pollutants subject to reporting in each country are available on the national websites; the integrated data set with all pollutants is also available at *Taking Stock Online* <http://www.cec.org/takingstock>.

[1] This number includes all individually listed RETC pollutants. However, for purposes of comparability among the three countries, *Taking Stock* groups certain substances (e.g., arsenic with arsenic compounds). The number of pollutants also includes three greenhouse gases, which are presented and discussed separately from other reported PRTR substances.

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2 Using and Understanding This Report

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Using and Understanding This Report

The challenge for the CEC in compiling this report is to combine data from the PRTRs in Canada, Mexico and the United States to achieve an overview of the releases and transfers of pollutants in North America. In last year's report, the CEC had its first opportunity to combine PRTR data from all three countries, because 2004 was the first year of mandatory reporting in Mexico. This year's *Taking Stock* report presents data for the 2005 reporting year, the most recently available from the three countries at the time of this writing.

The Three Pollutant Release and Transfer Registers of North America

Taking Stock is based on information provided by North America's three national PRTR programs. Each country's PRTR has evolved with its own list of pollutants, industrial sectors and reporting requirements. **Table 2–1** compares features of the North American PRTRs.

Table 2–1. Features of North American PRTRs

Feature	Canadian National Pollutant Release Inventory (NPRI)	*Mexican Registro de Emisiones y Transferencia de Contaminantes* (RETC)	US Toxics Release Inventory (TRI)
First reporting year	**1993**	**2004**	**1987**
Industrial activities or sectors covered (as of 2005)	Any facility manufacturing or using a listed chemical, except for exempted activities such as research, repair, retail sale, agriculture and forestry. Mining extraction activities were exempt for 2004 reporting, but have been added for 2005 and later years.	Facilities under federal jurisdiction: petroleum, chemical/petrochemical, paints/inks, metallurgy (iron/steel), automobile manufacture, cellulose/ paper, cement/limestone, asbestos, glass, electric power generation and hazardous waste management. Other facilities with specific activities that transfer hazardous wastes or release wastewater to national water bodies.	Manufacturing and federal facilities, electric utilities (oil- and coal-fired), coal and metal mines, hazardous waste management and solvent recovery facilities, chemical wholesalers and petroleum bulk terminals.
Number of pollutants subject to reporting (as of 2005)	Over 300 pollutants	104 pollutants	About 600 pollutants
Employee threshold	Generally 10 employees or more. For certain activities, such as waste incineration, wood preservation and wastewater treatment, the 10-employee threshold does not apply.	No employee thresholds.	10 or more full-time employees (or equivalent).
Chemical "activity" (manufacture, process or otherwise use) and release thresholds	"Activity" thresholds of 10,000 kg for most chemicals, but lower for persistent bioaccumulative toxicant (PBT) chemicals; lower release thresholds for polycyclic aromatic hydrocarbons, dioxins and furans, and criteria air contaminants.	Release and "activity" thresholds for each chemical (facility must report whether it is meeting or exceeding either threshold). Release thresholds range from 1 kg to 1,000 kg. "Activity" thresholds range from 5 kg to 5,000 kg. Dioxins and furans must be reported for any "activity" or release. Any release of polychlorinated biphenyls (PCBs) and sulfur hexafluoride is reportable.	"Activity" thresholds of about 11,340 kg (with an "otherwise use" threshold of about 5,000 kg); lower thresholds for PBT chemicals; lower release thresholds for pollutants such as dioxins and furans.
Types of releases and transfers covered	On-site releases to air, water and land, and disposal, including underground injection; transfers off-site for disposal, treatment prior to final disposal (including sewage); recycling and energy recovery.	On-site releases to air, water and land; transfers off-site for disposal, recycling, reutilization, energy recovery, treatment, co-processing (input from another production process) and sewage. Underground injection is not practiced in Mexico.	On-site releases to air, water and land, and underground injection; transfers off-site to disposal; recycling, energy recovery, treatment and sewage.

Which Pollutants Must Be Reported?

Each PRTR system covers a specific list of substances of concern. NPRI spans over 300 pollutants, RETC 104 and TRI approximately 600. As of April 2006, the Chemical Abstracts Service (CAS) listed more than 27 million chemical substances and identified more than 239,000 of them as regulated or covered by chemical inventories worldwide <http://www.cas.org>.

Which Industries Report?

The three countries have adopted the North American Industry Classification System (NAICS), whose codes are used to categorize the industrial activities of a facility. Reporting facilities are generally divided into manufacturing and non-manufacturing industries.

Manufacturing industries include the large variety of activities listed under primary NAICS codes 31–33. These industries produce, among other things, food and beverages, textiles, pulp and paper, chemicals and plastics, primary and fabricated metals, machines, electronics and transportation equipment.

Nonmanufacturing industries include:

- resource and resource-related industries (primary NAICS codes 11–21), such as agriculture, forestry and mining and other extraction activities;
- utilities (e.g., water supply, sewage treatment, electricity generation) and construction (primary NAICS codes 22 and 23); and
- a variety of service sectors (primary NAICS codes 41–93), including wholesale and retail trade, transportation, administration and finance activities, education and health care, culture and entertainment.

Each country requires PRTR reporting by facilities in specific industrial sectors or undertaking specific industrial activities. PRTR reporting requirements are based in part on the industrial activity undertaken within a facility, and not only the industry code assigned to that facility. Therefore, not all facilities within a given sector might have to report. For example, within the economic sector that includes dry-cleaning only those facilities undertaking the actual dry-cleaning process, and not clothing drop-off points, might be required to report. Another example is a food processing plant that is required to report because it has its own power plant to generate electricity.

In Canada, all facilities that meet reporting thresholds and requirements report to the NPRI, with the exception of oil and gas exploration and certain activities such as research laboratories.

In Mexico, all industrial sectors regulated under federal law are required to report to the RETC, along with facilities in other sectors (under state or municipal jurisdiction) that engage in activities subject to federal regulation. These facilities include those that use boilers, transfer hazardous wastes or release wastewater into national water bodies.

In the United States, TRI requires reporting by federal facilities, most manufacturing facilities and industries that service manufacturing facilities (e.g., electric utilities and hazardous waste management facilities). A few resource-based sectors, including some related to oil and gas, are exempt from reporting.

North American Industry Classification System

Canada, Mexico and the United States have adopted the North American Industry Classification System (NAICS), in which codes are used to categorize the industrial activities of a facility. NAICS codes were established in 2002, and since 2006 they have been incorporated into PRTR reporting to replace the individual industrial classification codes used by each country. Although there is some variation among the three countries in the subsector categorizations and codes used, the breakdown of industrial sectors into general categories is the same and is used throughout this report. For more information about the system in the three countries, see <http://www.naics.com/info.htm>.

North American Industry Classification System, 2002

NAICS code	Industry
11	Agriculture, forestry, fishing and hunting
21	Mining, quarrying and oil and gas extraction
22	Utilities (electricity, water and gas distribution)
23	Construction
31/32/33	Manufacturing
41/42/43	Wholesale trade
44/45/46	Retail trade
48/49	Transportation and warehousing
51	Information and cultural industries
52	Finance and insurance
53	Real estate and rental and leasing
54	Professional, scientific and technical services
55	Management of companies and enterprises
56	Administrative and support, waste management and remediation services
61	Educational services
62	Health care and social assistance
71	Arts, entertainment and recreation
72	Accommodation and food services
81	Other services (except public administration)
91/92/93	Public administration

When Is a Facility Required to Report?

Even within the covered industrial sectors, only facilities meeting specific reporting thresholds are required to report to PRTRs. Typically, there are two reporting thresholds: (1) an "activity" threshold, based on the amount of chemical manufactured, used in a process (e.g., as a reagent or catalyst) or otherwise used (e.g., in cleaning industrial equipment); and (2) an employee threshold based on number of employees.

In general for NPRI and TRI a facility must report if it manufactures, processes or otherwise uses 10,000 kilograms (NPRI) or 11,340 kilograms (TRI) of a pollutant. Mexico's RETC has both an "activity" threshold and a "release" threshold (i.e., the amount of chemical released during the year). A facility must report if it meets or exceeds either threshold. Generally, the "activity" threshold is typically either 2,500 kilograms or 5,000 kilograms, depending on the substance; the "release" threshold is 1,000 kilograms.

For certain pollutants, the reporting requirements for each PRTR are more stringent. These requirements are based on chemical toxicity and the potential for risk to human health and the environment. For some pollutants, such as dioxins/furans and hexachlorobenzene, authorities have recognized the need for lower PRTR reporting thresholds in order to capture releases of concern. Similarly, lead and mercury are reported under lower thresholds to all three PRTRs.

Thresholds may vary considerably among the PRTRs. For example, although arsenic and cadmium are subject to reporting in the three countries, their NPRI and RETC reporting thresholds range from 1 kilogram to 50 kilograms, whereas the US TRI threshold is 11,340 kilograms. More information about reporting requirements for specific pollutants appears in the **appendix**.

Both NPRI and TRI also have an employee threshold, generally corresponding to the equivalent of 10 full-time employees. Recently, NPRI required that for some chemicals, such as dioxins and furans, all facilities of certain types (such as incinerators) report, regardless of the number of employees. Mexico's RETC does not have an employee threshold.

More information on reporting instructions is available on the NPRI, RETC and TRI websites: <http://www.ec.gc.ca/pdb/npri/npri_gdocs_e.cfm> for NPRI guidance documents, <http://app1.semarnat.gob.mx/retc/index.html> for RETC reporting instructions, and <http://www.epa.gov/triinter/report/index.htm> for TRI reporting materials and guidance.

What Does a Facility Report?

Facilities report the amounts of each pollutant they have released to the environment at their own location (on-site). They also report how much of the chemical was sent off-site for disposal, recycling or other waste management.

The *Taking Stock* report uses the word *release* to describe chemicals released either on-site or off-site to the air, water, or land, injected into underground wells, and deposited in landfills. This terminology differs somewhat from that used by the individual PRTRs (see the section "Terminology" in this chapter for details). Although this report analyzes releases, it also looks at total releases and transfers as the most accurate estimate of the total amounts of pollutants arising from a facility that require handling or management. These totals are central to the efforts of pollution prevention programs and can help to answer questions such as: What kinds of waste are being sent off-site? What portion of materials is being recycled or transferred for disposal? What portion of pollutants is being released on-site?

Limitations of PRTR Data

PRTR data are valuable for what they reveal: releases and transfers of pollutants from an individual facility, industrial sector or geographic region. They can help identify trends and overall progress in reducing pollutant releases and transfers. However, because of the PRTR reporting requirements, only a portion of all industrial pollution is being captured. Also, industrial facilities are only one of many sources of pollution in North America.

Substances released or transferred by industrial facilities have physical and chemical characteristics that influence their ultimate disposition and consequences for human and ecological health—information that PRTR data alone cannot provide. Therefore, although this report can answer some questions, readers may need to consult other sources for more information.

PRTR data do not provide information on the following:

- *All potentially harmful substances*. The report provides information only on those pollutants reported to each country's PRTR.
- *All sources of contaminants*. The report includes only those facilities in the countries' industrial sectors, or undertaking specific industrial activities, that are subject to reporting to the national PRTR programs. The North American PRTRs do not include emissions from automobiles or other mobile sources, from natural sources such as forest fires or from agricultural sources. For some pollutants, these mobile, natural and agricultural sources can be large contributors to the overall amounts.
- *Releases and transfers of all pollutants from a facility*. Only those chemicals for which reporting thresholds are met are included.
- *All facilities within required reporting sectors*. In Canada and the United States, only facilities with the equivalent of 10 full-time employees must report (with certain exceptions).
- *Environmental fate of or risks* from the chemicals released or transferred.
- *Levels of exposure* of human or ecological populations to the pollutants.
- *Legal limits* of a pollutant from a facility.

PRTR data represent information on amounts of substances released to the environment at specific locations. Identifying and assessing the potential harm from particular releases of a pollutant to the environment are complex tasks, requiring more information than that provided by PRTRs, and the results are always tentative or, at best, relative. The potential of a substance to cause harm arises primarily from its inherent toxicity—how harmful is it?— and the exposure to it—how much, how long, by what route, and what is its behavior in the environment?

Taking Stock cannot draw conclusions about the risks to human health and the environment posed by the industrial pollutants it discusses. However, PRTR data can be used in combination with other information to help set priorities and target pollution prevention initiatives. For additional information, readers can consult the three countries' PRTR websites just listed. Other sources of information about toxic substances are the

- Canadian Centre for Occupational Health and Safety, <http://www.ccohs.ca/oshanswers/>;
- State of New Jersey, Department of Health, Right-to-Know Hazardous Substances Fact Sheets, <http://web.doh.state.nj.us/rtkhsfs/indexFs.aspx>;
- US National Toxicology Program (NTP), <http://ntp-server.niehs.nih.gov>; and
- *ToxFAQs*, US Agency for Toxic Substances and Disease Registry, <http://www.atsdr.cdc.gov/toxfaq.html>.

Additional information about pollutant releases and transfers can be obtained directly from industry associations and individual companies and facilities.

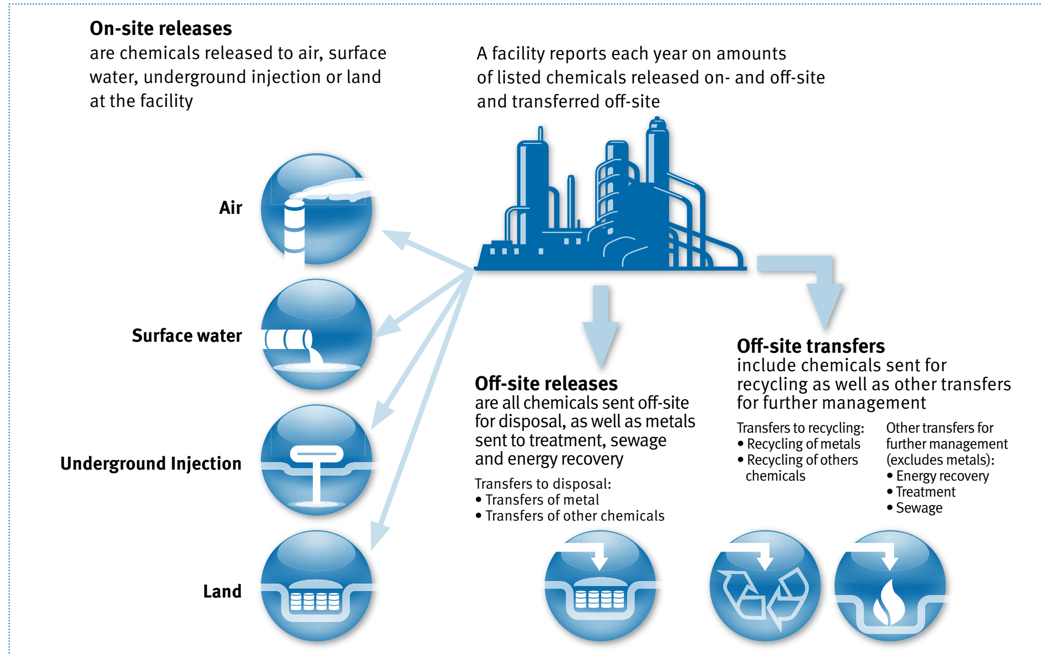
Data and Methodology Used in *Taking Stock*

Data from the three countries' PRTRs were retrieved by the CEC from the three governments or from their publicly accessible websites. The CEC received the data for this year's edition of *Taking Stock* from Canada and the United States in February 2008 and from Mexico in May 2008. The data sets of the national PRTR systems are constantly evolving as facilities revise previous submissions to correct reporting errors or make other changes. The CEC is aware that changes have occurred to the data sets for the reporting year 2005 that are not reflected in this report. In the same way, data in this report for years prior to 2005 may not be the same as in previous *Taking Stock* reports.

The methodology used in preparation of the annual *Taking Stock* report and online database includes the following:

- The PRTR data from each country are compiled and integrated into the CEC's North American PRTR database. This process involves standardizing data fields used in the three countries—for example, aggregating off-site transfers to disposal (NPRI) into an "off-site releases" category to make the data comparable (see the next section, "Terminology," for details).

Figure 2–1. Pollutant Releases and Transfers in North America



- Certain individual reported substances are aggregated into pollutant groups or categories (e.g., metals and their compounds, xylene isomers).
- The data are submitted to a general review in order to identify inconsistencies or possible errors, which are then communicated to the national PRTR programs. Although the CEC cannot be responsible for erroneous reporting by facilities, a goal of the North American PRTR project is to use the best data possible in *Taking Stock*.
- Data for each reporting year (going back to 1998) are refreshed at least annually for the current *Taking Stock* report and website—a fact readers are urged to remember, particularly when using *Taking Stock* data to analyze time trends.
- For the special feature in **Chapter 4** on the petroleum industry, data from the US National Emissions Inventory were used to supplement PRTR data for certain petroleum subsectors. Important information was also obtained from interviews with facility representatives. The chapter was reviewed by experts in the three countries.

Terminology

Taking Stock uses the following categories for presenting information on pollutant releases and transfers (see **Figure 2–1**).

Releases On-site and Off-site

On-site releases describes releases that occur at a facility—that is, pollutants that are released into the air or water, injected into underground wells, or put in landfills "inside the fence line."

Off-site releases describes pollutants "transferred off-site" (this is the phrase used in the tables) for disposal. Waste sent off-site to another facility for disposal may be disposed of on land, in landfills or by underground injection. These methods are the same as on-site releases, but they occur at locations other than at the originating facility.

An important note: "Transfers of metals off-site" for disposal, sewage, treatment or energy recovery are included in the *off-site releases* category. The US TRI classifies all transfers of metals as "transfers to disposal," because metals sent to energy recovery, treatment or sewage treatment may be captured and removed from waste and disposed of in landfills or by other disposal methods. Although this approach may be confusing to those accustomed to seeing the term *releases* used to describe activities on-site and *transfers* used to describe all activities that occur off-site, the categorization used in *Taking Stock* allows the CEC to compare data from the three countries. It also aggregates similar activities—for example, all pollutants sent to landfills are called "releases," regardless of where the landfill is located. This approach also recognizes the physical nature of metals, and acknowledges that metals sent to disposal, sewage, treatment or energy recovery are not likely to be destroyed, and therefore they may eventually enter the environment.

Total releases on-site and off-site (or simply, *total releases*) is the sum of on-site and off-site releases.

Because this terminology is specific to the *Taking Stock* report, the terms *release*, *disposal* and *transfer* as defined here may differ from their use in the NPRI, RETC and TRI reports.

Transfers Off-site

Transfers to recycling describes chemicals sent off-site for recycling.

Transfers for further management describes pollutants (other than metals) sent for treatment and energy recovery and to sewage treatment plants.

Total reported amounts of releases and transfers describes the sum of all of the above categories: on-site and off-site releases, transfers to recycling and transfers for further management.

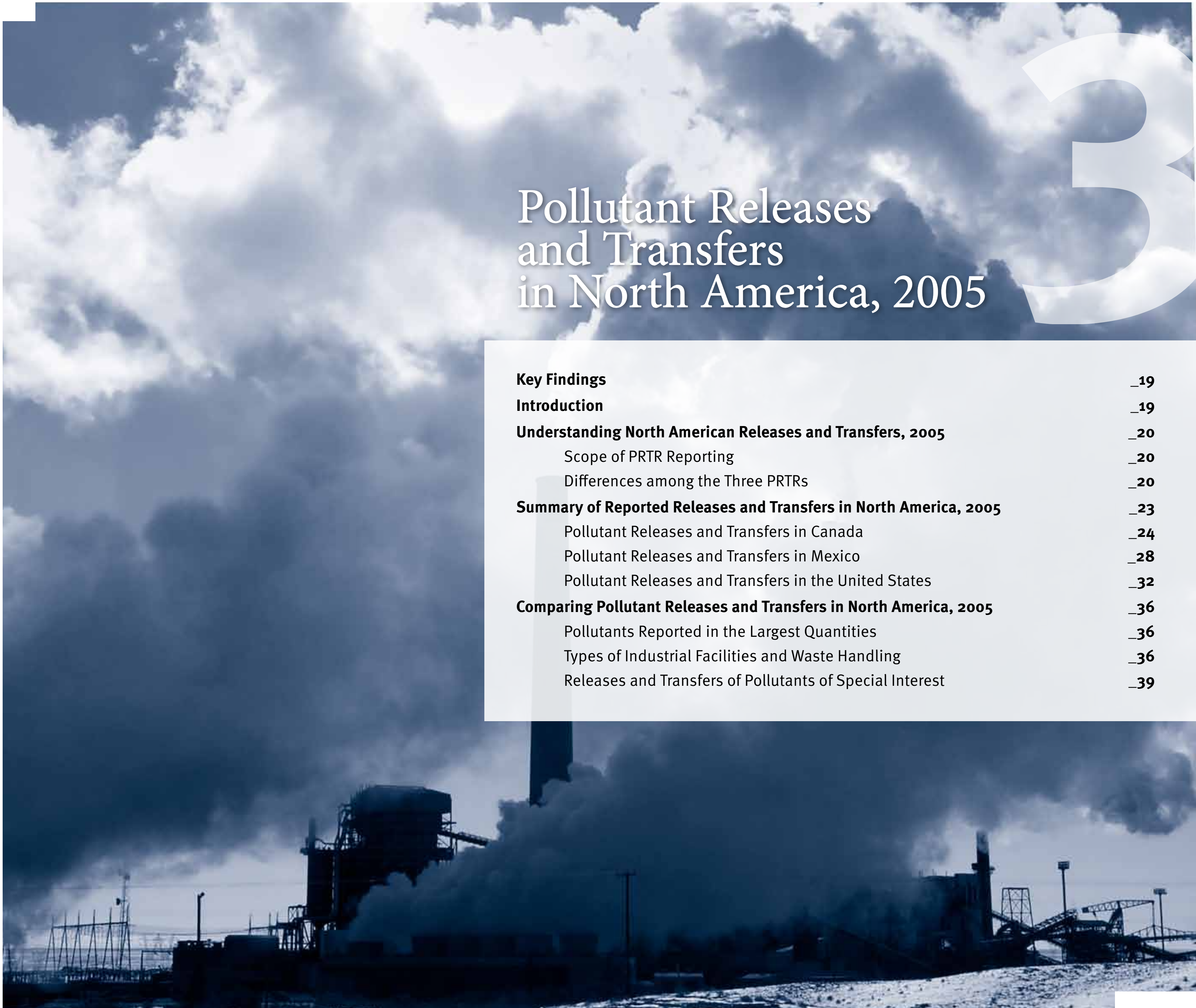
Ongoing Activities of the CEC's North American PRTR Project

In an effort to improve the overall quality and comparability of North American PRTR data, the CEC continues to work with the PRTR programs of the three countries. As part of this effort, the CEC and the three Parties developed the *Action Plan to Enhance the Comparability of Pollutant Release and Transfer Registers in North America* (available at<http://www.cec.org//pubs_docs/documents/index.cfm?varlan=english&ID=1830>), which outlines specific reporting issues to address in the three countries, and recommendations on how to do so.

Other planned initiatives include the development of sector-based work that would facilitate the identification of specific data quality issues and allow for increased collaboration among North American industry sectors.

An essential component of the North American PRTR Project is stakeholder involvement. Every year, the CEC convenes the public North American PRTR Consultative Group meeting to bring together government officials, non-governmental organizations, industry representatives, and citizens. This meeting represents an opportunity for all stakeholders to exchange information and provide input regarding the direction of the project and the *Taking Stock* report. The meeting summary and all comments and suggestions received are compiled and made public on the CEC's website.

The CEC also participates in international PRTR efforts, including the annual meeting of Organization for Economic Co-operation and Development partners, other chemicals and air quality management initiatives and of course, related CEC projects.



3

Pollutant Releases and Transfers in North America, 2005

3

Taking Stock

Pollutant Releases and Transfers in North America, 2005

Key Findings

- **In 2005 releases and transfers of more than 5.5 billion kilograms of pollutants (excluding criteria air contaminants and greenhouse gases) were reported in the three North American countries by almost 35,000 industrial facilities. These facilities reported an additional 32 billion kilograms of criteria air contaminants. US facilities accounted for more than 80 percent of all reporting facilities, Canadian facilities 12 percent and Mexican facilities 6 percent.**

- **Differences in reporting requirements from country to country in chemical and employee thresholds or in mandatory reporting sectors can limit the amount of information available about common industrial activities in North America. This can be especially significant in cases where the releases and transfers reported are substantial. For example, about 30 substances from 15 industrial sectors accounted for at least 90 percent of all reported releases and transfers across North America in 2005. However, only nine of these top-reported pollutants were subject to reporting in all three countries, resulting in gaps in the picture of industrial pollution in North America.**

- **A small number of industrial sectors accounted for very large releases and transfers in 2005. The top-reporting sectors varied by country: oil and gas extraction activities, primary metals and wastewater treatment in Canada; metal mines, electric utilities and electrical equipment manufacturing in Mexico; and chemicals manufacturing, primary metals and mines in the United States.**

- **Canadian facilities transferred almost 50 percent of total reported pollutants to recycling; Mexican facilities released about 70 percent off-site to disposal; and in the United States air releases, land releases, and transfers to recycling each accounted for almost one-third of the total.**

- **The majority of pollutants transferred by Canadian, Mexican and US facilities across borders in 2005 were metals to recycling. However, lack of details about the receiving facilities raises questions about the ultimate fate of these pollutants. Among the other substances transferred between Canada and the United States for recycling or other treatment were large amounts of sulfuric acid, phosphorus, toluene and xylenes.**

- **Of the pollutants reported by North American industrial facilities in 2005, some were known or suspected carcinogens and developmental or reproductive toxicants, and several were among the top pollutants reported that year. Some were also hazardous air pollutants or persistent, bioaccumulative and toxic (PBT) substances.**

- **Although comparing the releases and transfers reported in the three countries presents challenges, such an exercise serves as a tool for examining the state of PRTR reporting. It also can provide insight into further actions required to enhance comparability among the three PRTRs and improve understanding of industrial pollution in North America.**

Introduction

This chapter presents an overview of releases and transfers of chemical contaminants from North American industrial sectors in 2005, as reported to their respective national PRTRs: Canada's National Pollutant Release Inventory (NPRI), Mexico's *Registro de Emisiones y Transferencia de Contaminantes* (RETC) and the US Toxics Release Inventory (TRI). By providing information on the amounts, sources and types of pollutants released and transferred by industrial facilities, this report supports key objectives of the CEC's North American PRTR project, including:

- providing information for decision making;
- promoting greater comparability among PRTR data; and
- supporting the integration of PRTR data into an overarching framework for managing chemicals in North America.

Bringing the data from the three countries together into one report is challenging. Differences in the industrial makeup of the countries, pollutant coverage, PRTR reporting requirements, methodologies used to estimate releases and transfers, and accuracy of reporting all affect what is reported and therefore what can be presented at the North American level.

This chapter begins by summarizing, by country, all the data reported in 2005. It then describes, by country, the industrial sectors reporting the largest quantities of pollutants, the pollutants with the largest releases and transfers, and the facilities reporting the largest releases. This description is followed by a comparison of the pollutant releases and transfers in North America: the similarities and differences in what was reported in the three countries and the effects of differences in PRTR reporting requirements on the picture presented of pollutant releases and transfers in North America.

Finally, the chapter looks at the reported pollutants of special interest, such as carcinogens and developmental or reproductive toxicants. Readers can use the reported data and information about a pollutant's chemical properties as a starting point for learning more about its potential health and environmental impacts.

This examination of data reported in 2005 reveals that more than 5.5 billion kilograms of industrial contaminants were released or transferred by PRTR facilities in Canada, Mexico and the United States—by far the most complete picture to date of industrial pollution in North America. However, comparisons among the three countries reveal important gaps in this information. For example, certain pollutants released or transferred in large quantities from industrial activities common to the three countries were not subject to reporting under all of the PRTR programs. Similarly, gaps among the countries in sector reporting raise questions, particularly when certain industrial activities generated releases of pollutants of concern. Chemical and employee thresholds also can result in a limited picture of industrial pollution and therefore a limited understanding of the potential for cumulative impacts. Finally, because of a lack of information on cross-border transfer destinations, the final fate of substantial quantities of pollutants remains uncertain.

Comparing releases and transfers reported in the three countries can be challenging, but it does serve as a tool for examining the current state of PRTR reporting. It can thus provide insight into what actions are further required to enhance comparability among the three PRTRs and improve understanding of industrial pollution in North America.

Comparing PRTR data from Canada, the United States and Mexico

Taking Stock presents PRTR data from Canada, Mexico and the United States, thereby providing the most complete picture currently available of industrial releases and transfers of pollutants in North America. This picture includes data that might be reported differently in each country because of national reporting requirements. The features unique to each PRTR are described in **Chapter 2**, so that readers have the context they need to better understand pollutant releases and transfers in the three countries.

Understanding North American Releases and Transfers, 2005

Scope of PRTR Reporting

In 2005 the population of North America was about 433 million: 297 million in the United States, 104 million in Mexico and 32 million in Canada. The same year, the gross national product (US dollars) of the United States was $12.376 billion, Mexico $1.173 billion and Canada $1.113 billion.[1]

The total number of manufacturing establishments in 2003 was about 488,000 in the United States, 338,000 in Mexico[2] and 63,065 in Canada.[3] The proportion of manufacturing businesses with fewer than 10 employees (the threshold for PRTR reporting in both Canada and the United States is facilities with 10 or more full-time employees) was 92 percent in Mexico,[4] 58 percent in Canada[5] and 57 percent in the United States.[6]

Differences among the Three PRTRs

Chapter 2 presented the features unique to each PRTR program, including the industrial sectors or activities subject to reporting in each country and the number of pollutants that must be reported. This section serves as a brief reminder of some specific differences in national reporting requirements, and in doing so it provides context for the data in the tables and figures in this chapter.

Industrial Facilities

In 2005 each country in North America required facilities in specific industrial sectors, or involved in certain industrial activities, to report to the national PRTR:

- In Canada, most facilities (with the exception of oil and gas exploration and certain activities, such as research laboratories) report.
- In Mexico, all 11 federally regulated industrial sectors are required to report, along with facilities in other sectors (under state or municipal jurisdiction) that use boilers, transfer hazardous wastes or release wastewater into national water bodies.
- In the United States, federal facilities, most manufacturing facilities and industries that service manufacturing establishments (including electric power plants and hazardous waste management facilities) report. A few resource-based sectors, including some related to oil and gas, are exempt from reporting.
- All electric utilities are required to report in Canada and Mexico (including oil, coal, natural gas, nuclear and hydroelectric), whereas the US TRI requires only coal- and oil-fired power plants to report.
- Sewage treatment plants are required to report to Canada's NPRI, but not to the US TRI or Mexico's RETC.
- Both Canada's NPRI and the US TRI have a 10 full-time employee (or equivalent) reporting threshold (with a few exceptions in Canada). Mexico has no such threshold.

In Mexico (and in some cases the United States), PRTR reporting requirements are based in part on the industrial activity within a facility rather than on the industrial sector. Therefore, not all facilities within a given sector might have to report. For example, within the economic sector that includes dry-cleaning, only those facilities involved in the actual dry-cleaning process, not clothing drop-off points, might be required to report.

Table 3–1 presents the number of facilities in each sector that reported to the three national PRTRs in 2005. In the tables in this chapter, differences in industrial sector reporting among the three countries (e.g., only certain activities in a sector are required to report under one PRTR) are indicated by a note.

In the sectors shown in **Table 3–1**, 8,773 Canadian facilities, 2,452 Mexican facilities and 23,798 US facilities reported in 2005. Data for criteria air contaminants and greenhouse gases for facilities reporting to the three PRTR programs are also presented in this chapter, but separately from other pollutants.

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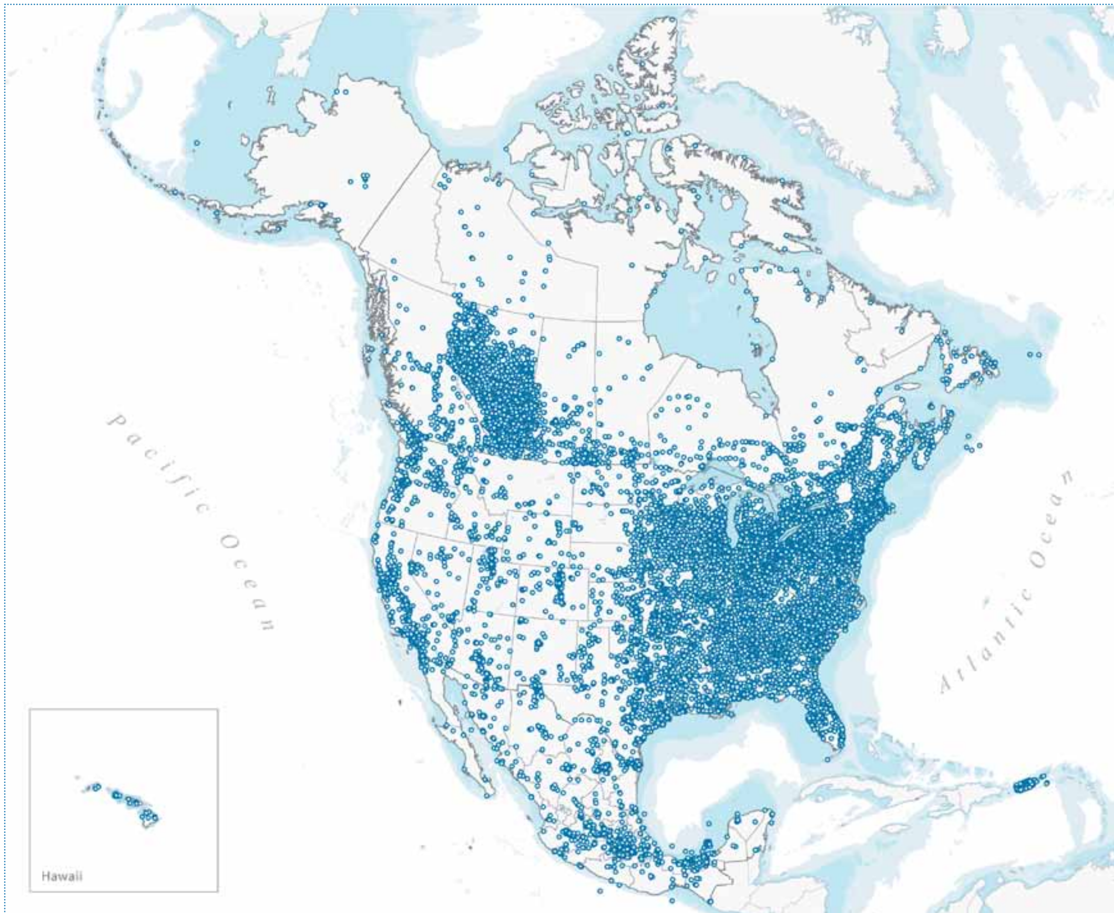
[1] Organisation for Economic Co-operation and Development (OECD), *OECD factbook: Economic, environmental and social statistics*, 2008 <http://www.oecd.org/> or <http://caliban.sourceoecd.org/vl=8880729/cl=35/nw=1/rpsv/factbook/>.
[2] Organisation for Economic Co-operation and Development, Dataset: Structural business statistics, 2008 <http://webnet.oecd.org/wbos/index.aspx>.
[3] Personal communication, David Backstrom, Environment Canada, 27 March 2007, based on Statistics Canada. *2003 Dataset: Canadian Business Patterns*.
[4] *Supra* note 2.
[5] *Supra* note 3.
[6] *Supra* note 2.

Table 3–1. Facilities Reporting to Each National PRTR, by North American Industry Classification System (NAICS)

NAICS code		Industry	Number of Facilities NPRI	RETC	TRI
11		Agriculture, forestry, fishing and hunting	63	6	7
21		Mining, quarrying and oil and gas extraction			
	211	Oil and gas extraction	3,428	136	
	212	Mining and quarrying (except oil and gas)	254	38	126
	213	Services and support activities for mining, quarrying and oil and gas extraction	159	16	
22		Utilities (electricity, water and gas distribution)			
	2211	Generation and distribution of electricity	223	93	683
	2212/2222	Natural gas distribution	130		
	2213/2221	Water supply, sewage treatment and other systems	208	13	5
23		Construction	66	2	
31/32/33		Manufacturing			
	311	Food	348	90	1,622
	312	Beverages/tobacco	34	52	90
	313	Textiles	17	21	193
	314	Textile products	8	3	80
	315	Apparel	2	9	8
	316	Leather	4	3	42
	321	Wood products	388	7	881
	322	Paper	161	67	495
	323	Printing and publishing	118	8	203
	324	Petroleum products	140	34	661
	325	Chemicals	499	440	3,784
	326	Plastics and rubber	266	94	1,581
	327	Stone/clay/glass/cement	253	94	1,574
	331	Primary metals	264	178	1,785
	332	Fabricated metals	327	159	3,128
	333	Machinery	58	47	1,142
	334	Computers/electronic products	37	124	1,232
	335	Electrical equipment	64	114	691
	336	Transportation equipment	315	288	1,576
	337	Furniture	90	2	292
	339	Miscellaneous manufacturing	101	41	479
41/42/43		Wholesale trade	141	4	995
44/45/46		Retail trade	1	22	
48		Transportation	232	46	1
49		Warehousing/local transportation	55	116	1
51		Information and cultural industries	5	1	11
52		Finance and insurance			
53		Real estate and rental and leasing	52		
54		Professional, scientific and technical services	13	4	10
56		Administrative and support, waste management and remediation Services	144	42	228
61		Educational services	24	1	3
62		Health care and social assistance	20	23	5
71		Arts, entertainment and recreation		1	
72		Accommodation and Food Services		3	
81		Other services (except public administration)	16	10	2
91/92/93		Public administration	45		235
		Total	**8,773**	**2,452**	**23,798**

Note: The numbers of facilities reporting to the Canadian NPRI and Mexican RETC includes those facilities in Canada that also reported criteria air contaminants and Mexican facilities that also reported greenhouse gases.

Map 3–1. All Facilities Reporting to National PRTRs



Note: Differences in national reporting requirements, such as mandatory reporting sectors and chemical and employee thresholds, affect which facilities appear on the map.

All reporting facilities for 2005 are shown in **Map 3–1**, where differences in national reporting requirements, such as mandatory reporting sectors and chemical and employee thresholds, affect which facilities are included.

Pollutants

In 2005 the pollutants (or pollutant groups) subject to PRTR reporting in North America were 323 under Canada's NPRI, 104 under Mexico's RETC and more than 600 under the US TRI. Of these mandatory substances, in 2005 Canadian facilities reported on 203 (excluding certain individually-speciated VOCs), Mexican facilities on 76 and US facilities on 512. The substances reported to the three PRTRs include certain pollutants that have been grouped in *Taking Stock* for purposes of comparability among the countries (e.g., arsenic and its compounds, xylene isomers).

In addition, seven criteria air contaminants (CACs) were subject to NPRI reporting, and four greenhouse gases (GHGs) were subject to RETC reporting, but these substances were not subject to reporting under the US TRI. In each country, other programs (e.g., national emissions inventories, greenhouse gas registers) collect data on these particular groups of substances (though not necessarily at the facility level). As noted earlier, in this chapter CAC and GHG data for each country are presented and discussed separately from data on other PRTR substances.

The three PRTRs also differ in their reporting requirements for common substances. One difference is reporting thresholds: Mexican "activity" and "release" thresholds are generally lower than those under Canada's NPRI and the US TRI (see

Chapter 2). In addition, reporting requirements vary for certain pollutants, depending on their form of release (e.g., only air releases of sulfuric acid are reported to the US TRI).

The NPRI (and in some cases the RETC) requires reporting facilities to group most elemental metals with their compounds. It is therefore impossible to determine whether a metal or one of its compounds was released or transferred by a facility. In recognition of this situation, *Taking Stock* refers to an element (such as lead) *and its compounds*. For the same reason, other substances, such as nitric acid and nitrate compounds, and all xylene isomers, are also grouped in this report.

In some tables in this chapter, the CA, MX, or US next to each pollutant indicates in which country (Canada, Mexico or the United States) reporting of that substance is mandatory. The pollutants common to two or all three countries, as well as the specific reporting thresholds, are also presented in the **appendix** of this report. The individual complete lists of pollutants subject to PRTR reporting in each country can be found on the national PRTR websites.

Summary of Reported Releases and Transfers in North America, 2005

This section presents a summary of the data reported to the three PRTRs in 2005 (excluding criteria air contaminants and greenhouse gases, which are dealt with in a separate section). More specifically, it reveals which industrial sectors contributed the largest proportions of the total reported in each country, which pollutants were reported in the largest quantities and by which medium of release or transfer type, and which facilities reported the largest releases.

Table 3–2 summarizes North American industrial reporting of PRTR pollutants (other than criteria air contaminants and greenhouse gases) in 2005, and reveals the following:

- Canadian facilities represented 12 percent of all reporting facilities in North America and contributed about 36 percent of all reported releases and transfers.

- Mexican facilities represented almost 6 percent of all reporting facilities and accounted for about 1 percent of all reported releases and transfers.

- US facilities represented 82 percent of all reporting facilities in North America and contributed about 62 percent of all reported releases and transfers.

As for the types of releases and transfers reported in 2005:

- In Canada, the largest quantities reported were transfers of nonmetals to recycling (46 percent of the total), followed by off-site releases (transfers to disposal) of metals and underground injection (both with 14 percent of the total).

- In Mexico, off-site releases (transfers to disposal) of metals dominated all other methods (70 percent of the total). Transfers of metals to recycling followed (18 percent of the total).

- In the United States, the largest reported quantities in 2005 were releases to land and air (24 percent and 20 percent of the total, respectively). Large transfers of metals to recycling were observed as well (23 percent of the total).

Table 3–2. Summary of Total Reported Releases and Transfers in Canada, Mexico and United States, 2005

	NPRI		RETC		TRI	
Total Number of Facilities	3,528 (of 8,773)*		1,678 (of 2,452)**		23,798	
Total Number of Forms	34,821		10,315		90,245	
Number of pollutants reported (no CAC or GHG)	196 (of 203)*		73 (of 76)**		512	
	kg	**% of total**	**kg**	**% of total**	**kg**	**% of total**
On-site Releases	**551,729,042**	**27**	**6,317,767**	**10**	**1,732,682,088**	**49**
Air	114,252,704	6	6,088,772	9	685,984,101	20
Surface Water	116,803,795	6	171,752	0	113,566,677	3
Underground Injection	284,317,135	14	NA	NA	105,069,582	3
Land	36,355,408	2	57,243	0	828,061,727	24
Off-site Releases	**318,725,823**	**16**	**46,024,140**	**71**	**290,106,327**	**8**
Transfers to Disposal (except metals)	30,340,975	1	548,997	1	29,102,317	1
Transfers of Metals***	288,384,848	14	45,475,143	70	261,004,010	7
Total On- and Off-site Releases	**870,454,865**	**43**	**52,341,907**	**80**	**2,022,788,415**	**58**
Off-site Transfers to Recycling	**1,124,862,429**	**55**	**12,250,860**	**19**	**940,694,432**	**27**
Transfers to Recycling of Metals	177,524,946	9	11,645,176	18	816,864,437	23
Transfers to Recycling (except metals)	947,337,483	46	605,684	1	123,829,995	4
Off-site Transfers for Further Management	**51,050,325**	**2**	**641,296**	**1**	**547,457,852**	**16**
Energy Recovery (except metals)	11,094,959	1	564,299	1	275,876,568	8
Treatment (except metals)	27,035,766	1	74,755	0	152,370,025	4
Sewage (except metals)	12,919,600	1	242	0	119,211,259	3
Total Reported Amounts of Releases and Transfers	**2,046,367,619**	**100**	**65,232,064**	**100**	**3,510,940,698**	**100**

NA: not applicable (underground injection is not practiced in Mexico).

* The number of NPRI reporting facilities includes those reporting on criteria air contaminants (CAC). Of these, 3528 facilities reported on the PRTR substances for which amounts are presented in this table. CAC data are presented separately in this chapter.

** The number of RETC reporting facilities includes those reporting on greenhouse gases (GHG). Of these, 1678 facilities reported on the PRTR substances for which amounts are presented in this table. GHG data are presented separately in this chapter.

*** Includes transfers of metals and metal compounds to energy recovery, treatment, sewage and disposal.

Pollutant Releases and Transfers in Canada

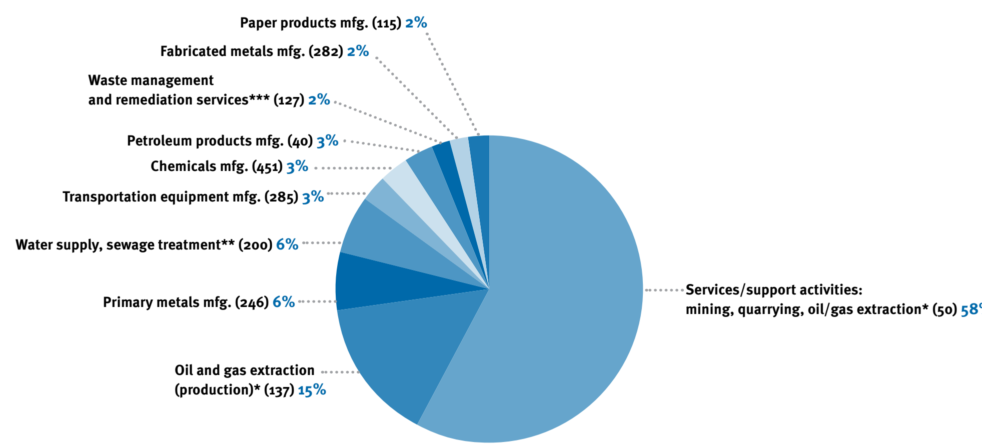
The amounts discussed in this section do not include reporting of criteria air contaminants to the NPRI.

Industrial Sectors Reporting the Largest Quantities

In 2005, 1,933 facilities in 10 industrial sectors accounted for over 95 percent of the approximately 2 billion kilograms of releases and transfers reported to the NPRI (see **Figure 3–1**).

Two industries related to oil and gas production activities were responsible for two-thirds of the total reported in 2005. NAICS code 213—services in support of mining, quarrying and oil and gas extraction—comprises facilities such as natural gas plants and compressor stations. These petroleum sectors are required to report to the NPRI and to Mexico's RETC, but not to the US TRI. For more information on releases and transfers by the petroleum industry, see **Chapter 4** of this report.

Figure 3–1. Industries with Largest Releases and Transfers, NPRI, 2005 (excluding CAC reporting)



Note: Number of facilities reporting is in parentheses.

* These sectors are required to report to the NPRI and the RETC, but not the US TRI.

** This sector is required to report only to the NPRI.

*** In this sector, only hazardous waste/solvent recovery facilities must report to the US TRI.

Table 3–3. Pollutants (excluding CACs) with Largest Reported Total Releases and Transfers, NPRI, 2005 (kilograms)

		On-site releases				Off-site releases		Transfers for further management			
CAS No.	Pollutant	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Transfers to energy recovery	Transfers to treatment	Transfers to sewage	Total releases and transfers
7783-06-4	Hydrogen sulfide [CA, MX]	3,146,312	46,995	268,623,624	33	250,947,922	840,230,472	0	4,756	5	1,363,003,010
7664-93-9	Sulfuric acid [CA, US]	11,041,540	33,510	0	123,490	8,464,486	72,230,190	0	2,486,267	79,480	94,466,128
--	Ammonia [CA, US]	20,201,876	53,105,248	6,398,370	407,242	2,494,034	729,939	0	1,966,270	2,401,530	87,720,433
--	Zinc and its compounds [CA, US]	653,614	262,991	479	10,077,327	13,309,361	50,412,243	0	0	0	74,722,335
--	Nitrate compounds [CA, US]	8,741	52,181,960	268,652	168,608	972,154	15,611	0	111,077	4,886,259	58,613,944
--	Lead and its compounds [CA, MX, US]	224,272	17,801	18	3,126,391	2,946,646	41,541,536	0	0	0	47,856,666
--	Copper and its compounds [CA, US]	376,996	85,647	32	929,388	1,878,807	38,043,495	0	0	0	41,318,377
67-56-1	Methanol [CA, US]	16,484,184	1,261,899	5,864,804	36,547	4,087,731	757,699	870,163	2,075,609	1,035,418	32,495,006
--	Manganese and its compounds [CA, US]	165,188	1,438,184	136	5,366,583	6,240,065	19,012,575	0	0	0	32,229,518
--	Phosphorus [CA, US]	121,665	6,921,767	1,296,185	3,466,692	9,394,466	3,373,704	32	1,578,934	1,056,406	27,213,543

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. CAS = Chemical Abstracts Service. This table groups (1) metals with their compounds and (2) nitric acid and nitrate compounds. Reporting in Canada and the United States may differ for ammonia, sulfuric acid and phosphorus. Reporting thresholds in each country for lead and its compounds are lower than the standard PRTR reporting thresholds (see **appendix**).

Pollutants with the Largest Reported Quantities

Table 3–3 presents the pollutants with the largest total releases and transfers reported to Canada's NPRI in 2005. **Table 3–4** lists the industrial sectors responsible for the majority of these releases and transfers.

These two tables reveal that, of all pollutants reported by Canadian facilities in 2005, just 10 substances represented more than 1.8 billion kilograms, or about 91 percent of all reported releases and transfers in that country. Some of the findings from these tables include the following.

The majority of the reported amounts of **hydrogen sulfide** were mainly transferred to recycling and released off-site to disposal and underground injection; more than 3 million kilograms were also released to air. This pollutant was primarily reported by oil and gas extraction facilities (and facilities providing related services). It is prevalent in the types of oil and natural gas found in western Canadian oilfields.

Releases of **ammonia** and **nitrate compounds** to water were dominated by sewage treatment plants. Chemical manufacturers and sewage treatment plants also released large amounts of ammonia to air.

Methanol was released to air, particularly by the paper products manufacturing sector. This sector, as well as oil and gas extraction (production) facilities, also released important amounts to water.

Sulfuric acid releases to air were driven by the petroleum products sector. This sector and the chemicals manufacturing sector also transferred very large quantities of sulfuric acid to recycling.

Lead, **copper** and **zinc and their compounds** were transferred in large quantities to recycling, as well as released off-site to disposal, mainly by the primary metals, fabricated metals and transportation equipment manufacturing sectors. Important amounts of these metals were also released to air and water.

Table 3–4. Industrial Sectors with Largest Reported Releases and Transfers, NPRI, 2005 (kilograms)

Industry name	Total releases and transfers reported by this sector	No. of facilities reporting in this sector	Top pollutants reported by this sector	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers	Total releases and transfers
			Hydrogen sulfide [CA, MX]	58,560	0	31,902,200	0	240,375,600	840,226,500	0	1,112,562,860
			Carbon disulfide [CA, US]	1,144,340	0	0	0	0	0	0	1,144,340
Services/support activities: mining, quarrying, oil/gas extraction (NAICS 213)*	1,115,606,972	50	Methanol [CA, US]	4,530	0	100,435	130	329,323	0	4,810	439,228
			n-Hexane [CA, US]	212,967	0	0	4	495	184,436	5,064	402,966
			Toluene [CA, US]	26,733	0	0	4	399	184,155	9,103	220,394
			Hydrogen sulfide [CA, MX]	1,230,903	0	236,704,943	0	10,565,998	265	0	248,502,109
			Methanol [CA, US]	132,765	950,594	5,354,665	0	3,207,499	973	93	9,646,589
Oil and gas extraction (production) (NAICS 211)*	279,041,189	137	Ammonia [CA, US]	1,838,577	216,779	8,658	0	0	0	153	2,064,167
			Carbonyl sulfide [CA, US]	1,916,138	0	0	0	0	0	0	1,916,138
			Carbon disulfide [CA, US]	1,852,722	0	0	0	0	0	0	1,852,722
			Lead and its compounds [CA, MX, US]	108,113	3,001	0	646,454	1,021,425	32,503,382	0	34,282,375
			Zinc and its compounds [CA, US]	390,555	25,111	0	4,663,843	8,207,717	14,181,540	0	27,468,766
Primary metals (NAICS 331)	124,265,288	246	Copper and its compounds [CA, US]	109,169	4,409	0	300,424	315,903	11,586,404	0	12,316,309
			Sulfuric acid [CA, US]	61,340	869	0	0	1,025	10,572,276	1,308,013	11,943,523
			Hydrochloric acid [CA, US]	366,328	6,727	0	0	56,531	6,194,590	270,346	6,894,522
			Ammonia [CA, US]	4,378,897	48,234,418	0	131,004	2,364,435	122,331	3,154,343	58,385,428
			Nitrate compounds [CA, US]	0	45,287,278	0	11,965	21,574	15,412	5,706	45,341,935
Water supply, sewage treatment (NAICS 2213)**	120,661,709	200	Phosphorus [CA, US]	6,106	4,718,028	0	242,175	6,818,270	1,255,407	2,010,707	15,050,693
			Aluminum (fume/dust) [CA, US]	4	2,408	0	0	446,039	0	0	448,451
			Zinc and its compounds [CA, US]	238	151,591	0	7,950	193,861	6,320	0	359,960
			Zinc and its compounds [CA, US]	20,107	167	0	0	206,337	24,250,033	0	24,476,644
			Manganese and its compounds [CA, US]	6,534	10	0	839	152,226	12,020,521	0	12,180,130
Transportation equipment mfg (NAICS 336)	67,957,206	285	Chromium and its compounds [CA, MX, US]	1,906	13	0	0	106,615	6,229,453	0	6,337,988
			Lead and its compounds [CA, MX, US]	790	0	0	1	154,469	5,921,092	0	6,076,353
			Xylenes [CA, US]	1,694,477	0	0	0	0	1,690,149	67,511	3,452,137
			Sulfuric acid [CA, US]	77,928	0	0	0	6,491,835	10,538,738	568,198	17,676,699
			Ammonia [CA, US]	9,831,741	67,043	1,801,190	24,330	2,012	0	422,596	12,148,912
Chemicals mfg (NAICS 325)	62,933,371	451	Nitrate compounds [CA, US]	6,676	604,380	267,116	60,920	355,818	18,545	3,393,091	4,706,546
			Methanol [CA, US]	1,183,722	4,943	169,046	140	105,141	336,717	2,571,180	4,370,889
			Xylenes [CA, US]	518,245	24	16	0	23,202	1,152,449	2,096,508	3,790,444
			Sulfuric acid [CA, US]	1,786,149	0		6,724	0	50,270,098	4,005	52,066,976
			Ammonia [CA, US]	41,429	182,528		0	1,143	127	126,987	352,214
Petroleum products mfg (NAICS 324)	62,308,587	40	Asbestos (friable) [CA, MX, US]	0	0		0	591,442	0	0	591,442
			Toluene [CA, US]	317,436	1,742		656	7,312	3,382	659	331,187
			Xylenes [CA, US]	279,907	214		652	6,920	18,217	3,320	309,230
			Asbestos (friable) [CA, MX, US]	0	0	0	6,129,990	33,001	0	0	6,162,991
			Zinc and its compounds [CA, US]	5,590	0	0	3,600,672	1,305,154	172,830	0	5,084,246
Waste management and remediation services (NAICS 56)***	43,020,253	127	Toluene [CA, US]	55,946	0	0	3,481	408,527	339,300	3,228,289	4,035,543
			Xylenes [CA, US]	92,964	0	0	13,253	424,576	431,757	3,000,715	3,963,265
			Nitrate compounds [CA, US]	0	2,110,501	0	0	780,208	105	17,443	2,908,257
			Copper and its compounds [CA, US]	4,461	52	0	0	76,132	12,760,856	0	12,841,501
			Zinc and its compounds [CA, US]	5,949	225	0	0	923,532	8,143,073	0	9,072,779
Fabricated metals mfg (NAICS 332)	38,467,447	282	Hydrochloric acid [CA, US]	36,737	0	0	0	188,451	9,449	3,652,320	3,886,957
			Nitrate compounds [CA, US]	3,930	12,426	0	0	96	5,095	2,126,423	2,147,970
			Chromium and its compounds [CA, MX, US]	2,357	62	0	45	122,938	1,826,267	0	1,951,670
			Methanol [CA, US]	10,935,380	288,202	0	28,677	14,040	8,202	322,181	11,596,682
			Phosphorus [CA, US]	13,785	1,996,293	0	1,560,471	1,229,739	346,915	5,550	5,152,753
Paper products mfg (NAICS 322)	34,593,571	115	Manganese and its compounds [CA, US]	44,094	1,262,202	0	1,662,265	1,285,778	179,053	0	4,433,392
			Ammonia [CA, US]	2,087,636	1,805,393	0	12,824	12,075	11,734	12,643	3,942,305
			Hydrochloric acid [CA, US]	2,029,188	0	0	0	0	0	0	2,029,188

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. This table groups (1) metals with their compounds, (2) nitric acid and nitrate compounds, and (3) xylenes. Reporting in Canada and the United States may differ for ammonia, sulfuric acid, hydrochloric acid and phosphorus. Reporting thresholds in each country for a number of these pollutants are lower than the standard PRTR reporting thresholds (see **appendix**).

* 211 and 213: These sectors are not required to report to the US TRI.

** Reporting required only under Canadian NPRI.

*** In this sector, only hazardous waste management/solvent recovery facilities are required to report to US TRI.

Table 3–5. Facilities Reporting Largest Releases, NPRI, 2005 (kilograms)

	Name	NPRI_ID	City	Province	Integrated NAICS code	Detailed sector description	Air releases	Water releases	Underground injection	Land releases	Off-site disposal-nonmetals	Off-site disposal-metals	Total releases	% of total NPRI releases
1	Duke Energy Gas Transmission	0000007718	Chetwynd	British Columbia	Support activities-mining	Support activities for mining	1,530	0	0	0	240,375,600	0	240,377,130	27.6
2	Husky Energy	0000001439	Rainbow Lake	Alberta	Oil and gas extraction	Oil and gas extraction	7,245	0	53,587,320	0	0	0	53,594,565	6.2
3	Keyera Energy Ltd.	0000001362	Drayton Valley	Alberta	Oil and gas extraction	Oil and gas extraction	27,810	0	52,416,460	0	0	0	52,444,270	6.0
4	Canadian Natural Resources Ltd	0000005286	Charlie Lake	British Columbia	Oil and gas extraction	Oil and gas extraction	25,510	0	41,686,164	0	10,678,687	0	52,390,361	6.0
5	Duke Energy Midstream Services Canada Corp	0000005125	Fort St. John	British Columbia	Support activities-mining	Support activities for mining	7,780	0	31,902,200	0	3,600	0	31,913,580	3.7
6	Conoco Phillips Canada	0000000536	N/A	Alberta	Oil and gas extraction	Oil and gas extraction	3,967	0	30,229,288	0	12,118	0	30,245,373	3.5
7	Apache Canada	0000005285	Zama	Alberta	Oil and gas extraction	Oil and gas extraction	15,159	0	27,160,962	0	0	0	27,176,121	3.1
8	City of Toronto	0000002240	Toronto	Ontario	Utilities	Water, sewage and other systems	0	16,295,443	0	0	1,574,900	83,489	17,953,832	2.1
9	Keyera Energy Ltd.	0000016152	Drayton Valley	Alberta	Oil and gas extraction	Oil and gas extraction	13,695	0	16,105,440	0	0	0	16,119,135	1.9
10	City of Calgary	0000005308	Calgary	Alberta	Utilities	Water, sewage and other systems	326,803	9,152,489	0	0	0	22,738	9,502,030	1.1
11	Ville de Montréal	0000003571	Montréal	Québec	Utilities	Water, sewage and other systems	268	5,410,776	0	0	1,249,000	116,728	6,776,773	0.8
12	Paramount Resources Ltd.	0000017420	N/A	Alberta	Oil and gas extraction	Oil and gas extraction	7,432	0	6,709,680	0	5	0	6,717,117	0.8
13	Ethyl Canada Inc.	0000002734	Corunna	Ontario	Chemical manufacturing	Basic chemical manufacturing	737	5	0	0	6,334,198	258	6,335,880	0.7
14	Keyera Energy Ltd.	0000000689	Drayton Valley	Alberta	Oil and gas extraction	Oil and gas extraction	7,801	0	6,167,540	0	0	0	6,175,341	0.7
15	City of Ottawa	0000000770	Gloucester	Ontario	Utilities	Water, sewage and other systems	355,001	4,996,907	0	0	187,007	1,874	5,540,789	0.6
16	Greater Vancouver Reg'l District	0000001338	Delta	British Columbia	Utilities	Water, sewage and other systems	96,977	5,362,474	0	0	13,269	1,435	5,474,155	0.6
17	City of Toronto	0000004435	Toronto	Ontario	Utilities	Water, sewage and other systems	334	4,572,656	0	228,819	193,000	17,889	5,012,698	0.6
18	IPSCO Saskatchewan Inc.	0000002740	Regina	Saskatchewan	Primary metal manufacturing	Iron and steel mills and ferroalloy manufacturing	7,265	0	0	230	15,770	4,709,412	4,733,495	0.5
19	Stablex Canada	0000005491	Blainville	Québec	Waste management and remediation services	Waste treatment and disposal	0	0	0	4,670,761	0	0	4,670,761	0.5
20	Agrium	0000002134	Redwater	Alberta	Chemical manufacturing	Pesticide, fertilizer, and other agricultural chemical manufacturing	2,767,050	31,015	1,638,862	0	9,830	66	4,446,823	0.5
21	Syncrude Canada	0000002274	Fort McMurray	Alberta	Oil and gas extraction	Oil and gas extraction	4,283,321	0	0	8,179	0	11,180	4,302,680	0.5
22	CVRD Inco	0000000444	Copper Cliff	Ontario	Mining (except oil and gas)	Metal ore mining	4,222,209	0	0	0	0	0	4,222,209	0.5
23	Petro-Canada	0000003903	Edmonton	Alberta	Petroleum and coal products manufacturing	Petroleum and coal products manufacturing	203,206	1,607	3,818,159	350	34,625	60,282	4,120,973	0.5
24	Regional Municipality of Halton	0000004771	Burlington	Ontario	Utilities	Water, sewage and other systems	81,389	3,311,572	0	0	569,865	292	3,963,118	0.5
25	City of Edmonton	0000005390	Edmonton	Alberta	Utilities	Water, sewage and other systems	205,400	3,468,209	0	0	0	13,095	3,686,704	0.4

N/A = not available.

Facilities Reporting the Largest Releases

Twenty-five Canadian facilities accounted for about 70 percent of all reported releases to air, water, land, underground injection or disposal (see **Table 3–5**).

The top-ranking facilities were in the oil and gas extraction sector, as well as the sector that provides services for mining, quarrying, and oil and gas extraction activities (NAICS code 213). The top-ranked facility, Duke Energy Gas Transmission (with more than 27 percent of all releases reported in 2005), provides services and support to oil and gas extraction operations in the province of British Columbia. In 2005 this facility released very large amounts of hydrogen sulfide, mainly to disposal. The other top-reporting facilities in this sector were located in western Canada as well. Underground injection of hydrogen sulfide was another release method commonly used by facilities in the oil and gas sectors. For details about releases and transfers from the petroleum industry, see **Chapter 4**.

The water and sewage sector was also well represented among the top-releasing facilities in Canada. Municipal wastewater treatment plants in large Canadian cities such as Toronto, Montreal, Ottawa and Vancouver reported large releases to water of ammonia and nitrate compounds, in particular. More than 4 million kilograms of ammonia were also released to air by facilities in this sector.

Pollutant Releases and Transfers in Mexico

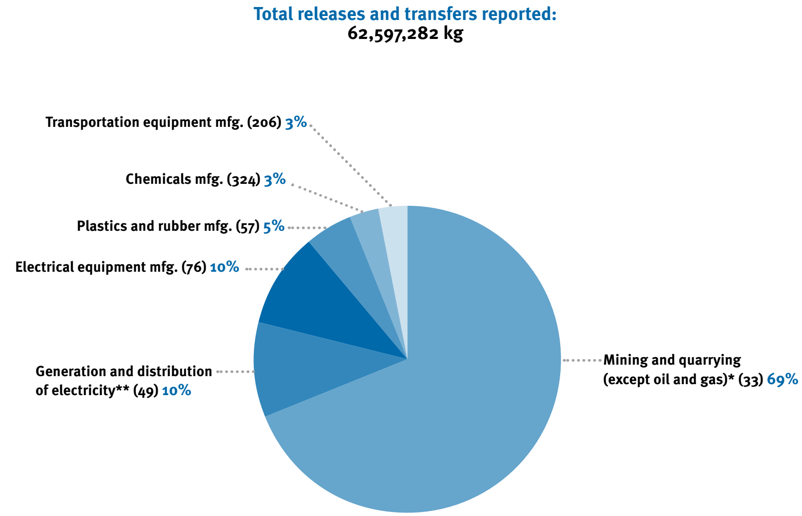
The amounts discussed in this section do not include reporting of greenhouse gases to the RETC.

Industrial Sectors Reporting the Largest Quantities

In 2005, 745 facilities in six industrial sectors contributed about 96 percent of the more than 65 million kilograms of releases and transfers reported to Mexico's RETC (see **Figure 3–2**).

One sector alone, metal ore mining, contributed 64 percent of all reported releases and transfers in 2005. The sectors contributing the next largest amounts were electric utilities and electrical equipment manufacturing facilities.

Figure 3–2. Industries with Largest Releases and Transfers, RETC, 2005 (excluding GHG reporting)



Note: Number of facilities reporting is in parentheses.

* The PRTRs differ in the types of activities required to report under this sector.

** In this sector, only coal- and oil-fired power plants must report to the US TRI.

Table 3–6. Pollutants (excluding GHGs) with Largest Reported Total Releases and Transfers, RETC, 2005 (kilograms)

		On-site releases				Off-site releases	Transfers for further management				
CAS No.	Pollutant	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Transfers to energy recovery	Transfers to treatment	Transfers to sewage	Total releases and transfers
--	Lead and its compounds CA, MX, US	67,580	34,923	0	1,904	37,821,041	9,814,713	0	0	0	47,740,160
--	Arsenic and its compounds CA, MX, US	2,147	26,636	0	3	6,582,241	93,406	0	0	0	6,704,434
7783-06-4	Hydrogen sulfide CA, MX	5,483,091	587	0	0	917	0	0	0	0	5,484,595
--	Nickel and its compounds CA, MX, US	25,501	40,832	0	6,594	866,782	939,819	0	0	0	1,879,528
--	Chromium and its compounds CA, MX, US	3,522	21,259	0	9,469	191,188	789,800	0	0	0	1,015,239
75-09-2	Dichloromethane CA, MX, US	19,809	0	0	5	9,799	278,020	404,880	0	0	712,513
1332-21-4	Asbestos (friable form) CA, MX, US	715	0	0	430	308,167	0	1,390	0	0	310,703
100-42-5	Styrene CA, MX, US	111,338	338	0	13,488	8,501	4,667	148,806	16,291	0	303,430
107-06-2	1,2-Dichloroethane CA, MX, US	0	0	0	0	0	219,463	1,548	0	0	221,011
50-00-0	Formaldehyde CA, MX, US	159,768	188	0	0	3,721	300	0	0	185	158,162

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. This table groups metals with their compounds. Reporting thresholds in each country for a number of these pollutants are lower than the standard PRTR reporting thresholds (see **appendix**).

Pollutants Reported in the Largest Quantities

Table 3–6 presents the pollutants with the largest total releases and transfers reported to Mexico's RETC. **Table 3–7** lists the largest releases and transfers by the top-reporting sectors in 2005.

These tables reveal that, of all pollutants reported by Mexican facilities in 2005, just 10 substances, totaling some 64.5 million kilograms, represented 99 percent of all reported releases and transfers in that country. Some of the findings from these tables include the following.

Lead and its compounds were the pollutants reported to the RETC in the largest amounts in 2005. Most were released off-site to disposal or transferred to recycling, mainly by the metal ore mining sector. Lead and its compounds were also released to the air by electrical equipment manufacturers and chemicals manufacturing facilities.

The metal ore mining sector sent other metals to disposal as well, including **arsenic**, **nickel** and **chromium and their compounds**. Nickel and chromium and their compounds were also reported by transportation equipment manufacturing facilities (mainly sent to recycling and disposal, but large quantities also were released to water). In addition, large quantities of nickel and its compounds were sent to disposal by Mexican electric utilities.

Electric utilities released more than 5 million kilograms of **hydrogen sulfide** to air as a by-product of burning oil or coal containing sulfur. This sector also released **formaldehyde** to air. Other pollutants released in large amounts to air were **styrene**, primarily by the plastics and rubber industry and the chemicals manufacturing sector.

In general, very few substances were reported as land releases by Mexican facilities. Underground injection is not practiced in Mexico.

Facilities Reporting the Largest Releases

Twenty-five Mexican facilities accounted for almost 98 percent of all reported releases to air, water, land, or disposal in 2005 (see **Table 3–8**).

Two metal ore mining facilities and two electric utilities together accounted for more than 92 percent of all releases reported by Mexican facilities in 2005. The top-ranking facility, *Compañia Fresnillo* in the state of Chihuahua, is a lead and zinc mining operation. It reported releases of more than 36 million kilograms, mainly of lead and its compounds to disposal (zinc is not subject to RETC reporting). The second-ranking facility, *Compañia Minera Nuevo Monte* in the state of Hidalgo, is involved in "other mineral mining." It reported that almost 6 million kilograms, primarily arsenic and its compounds, were sent to disposal.

The third- and fourth-ranking electricity-generating facilities, both operated by the Federal Electricity Commission (*Comisión Federal de Electricidad*), released more than 5 million kilograms of hydrogen sulfide to air. Formaldehyde was also released to air by other facilities in this sector.

Large amounts of metal compounds (e.g., lead, nickel and chromium) were released to disposal, particularly by fabricated metals facilities, electric equipment manufacturers and transportation equipment manufacturers.

Table 3–7. Industrial Sectors with Largest Reported Releases and Transfers, RETC, 2005 (kilograms)

Industry name	Total releases and transfers reported by this sector	No. of facilities reporting in this sector	Top pollutants reported by this sector	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers	Total releases and transfers of this pollutant
			Lead and its compounds [CA, MX, US]	0	438	NA	1	37,062,290	0	0	37,062,729
			Arsenic and its compounds [CA, MX, US]	0	162	NA	0	6,092,530	0	0	6,092,692
Mining and quarrying (except oil and gas) (NAICS 212)*	43,180,503	33	Cyanides [CA, MX, US]	0	57	NA	0	15,706	0	0	15,763
			Cadmium and its compounds [CA, MX, US]	0	410	NA	0	8,416	0	0	8,826
			Nickel and its compounds [CA, MX, US]	0	289	NA	0	0	0	0	289
			Hydrogen sulfide [CA, US]	5,474,617	0	NA	0	0	0	0	5,474,617
			Nickel and its compounds [CA, MX, US]	0	1,556	NA	0	490,614	20,370	0	512,541
Generation and distribution of electricity (NAICS 2211)**	6,102,060	49	Formaldehyde [CA, MX, US]	76,140	0	NA	0	0	0	0	76,140
			Asbestos (friable form) [CA, MX, US]	0	0	NA	0	19,140	0	0	19,140
			Arsenic and its compounds [CA, MX, US]	0	7,414	NA	0	0	0	0	7,414
			Lead and its compounds [CA, MX, US]	24,350	390	NA	37	350,477	5,628,679	0	6,003,934
			Polychlorinated biphenyls (PCBs) [CA, MX, US]	0	0	NA	0	0	0	27,200	27,200
Electrical equipment mfg. (NAICS 335)	6,069,268	76	Chromium and its compounds [CA, MX, US]	0	55	NA	0	11,995	3,261	0	15,311
			Nickel and its compounds [CA, MX, US]	0	306	NA	0	7,917	1,458	0	9,682
			Phenol [CA, MX, US]	0	0	NA	0	383	6,763	0	7,146
			Lead and its compounds [CA, MX, US]	0	56	NA	5	0	3,197,010	0	3,197,072
			Styrene [CA, MX, US]	33,281	0	NA	4,667	58	4,667	131,070	173,742
Plastics and rubber mfg. (NAICS 326)	3,391,482	57	Dichloromethane [CA, MX, US]	0	0	NA	0	9,450	0	0	9,450
			HCFC-141b [CA, MX, US]	8,435	0	NA	0	0	0	0	8,435
			Phenol [CA, MX, US]	1,148	4	NA	0	0	0	0	1,152
			Dichloromethane [CA, MX, US]	9,912	0	NA	0	309	275,500	404,400	690,121
			Arsenic and its compounds [CA, MX, US]	0	672	NA	0	399,171	0	0	399,843
Chemicals mfg. (NAICS 325)	1,983,852	324	1,2-Dichloroethane [CA, MX, US]	0	0	NA	0	0	219,463	1,548	221,011
			Lead and its compounds [CA, MX, US]	4,040	5,210	NA	9	164,629	11,808	0	185,696
			Styrene [CA, MX, US]	41,472	0	NA	0	4,173	0	31,911	77,557
			Nickel and its compounds [CA, MX, US]	1,034	13,780	NA	47	10,619	808,180	0	833,660
			Chromium and its compounds [CA, MX, US]	27	3,819	NA	40	8,472	739,760	0	752,118
Transportation equipment mfg. (NAAICS 336)	1,870,117	206	Lead and its compounds [CA, MX, US]	269	7,494	NA	10	46,992	82,089	0	136,854
			Phenol [CA, MX, US]	72	0	NA	0	900	40,070	0	41,042
			Asbestos (friable form) [CA, MX, US]	9	0	NA	0	26,880	0	0	26,889

NA = not applicable.

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. This table groups metals with their compounds. Reporting thresholds in each country for a number of these pollutants are lower than the standard PRTR reporting thresholds (see **appendix**).

* The PRTRs differ in the types of activities required to report under this sector.

** In this sector, only coal- and oil-fired power plants must report to the US TRI.

Table 3–8. Facilities Reporting the Largest Releases, RETC, 2005 (kilograms)

	Name	RETC_ID	City	State	Integrated NAICS code	Detailed sector description	Air releases	Water releases	Under-ground injection	Land releases	Off-site disposal-nonmetals	Off-site disposal-metals	Total releases	% of total RETC releases
1	Compañia Fresnillo S.A. de C.V.	FRE140806211	Saucillo	Chihuahua	Mining (except oil and gas)	Metal ore mining	0	4	NA	0	15,204	36,220,000	36,235,208	69.2
2	Compañía Minera Nuevo Monte	MNMMK1308411	Zimapan	Hidalgo	Mining (except oil and gas)	Metal ore mining	0	6	NA	0	0	6,774,920	6,774,926	12.9
3	Comisión Federal de Electricidad Campo y Central Geotermoeléctrica Los Azufres	CFELS1603411	Hidalgo	Michoacan	Utilities	Electric power generation, transmission and distribution	3,998,000	0	NA	0	0	0	3,998,000	7.6
4	Comisión Federal de Electricidad Central Geotermoelectrica Humeros	CFELS2105511	Chignautla	Puebla	Utilities	Electric power generation, transmission and distribution	1,453,700	0	NA	0	0	0	1,453,700	2.8
5	Comisión Federal de Electricidad Central Termoelec. José Aceves Pozos	CFEAD2501211	Mazatlan	Sinaloa	Utilities	Electric power generation, transmission and distribution	0	0	NA	0	0	488,190	488,190	0.9
6	Solvay Fluor México S.A. de C.V.	SFM5I0803711	Juarez	Chihuahua	Chemicals mfg.	Basic chemical mfg.	0	0	NA	0	0	399,171	399,171	0.8
7	Ideal Standard	IST8A1901211	Cienega de Flores	Nuevo León	Fabricated metal product mfg.	Coating, engraving, heat treating, and allied activities	1	3	NA	0	0	393,306	393,310	0.8
8	Empresas Ca Le de Tlaxcala. S.A. de C.V.	ECL8Z2903111	Tetla de la Solidaridad	Tlaxcala	Electrical equipment, appliance, component mfg.	Other electrical equipment and component mfg.	9,258	23	NA	0	0	234,200	243,481	0.5
9	ADM Bio Productos S.A. de C.V.	ABP1Z2601811	Cajeme	Sonora	Warehousing and storage	Warehousing and storage	0	0	NA	0	204,640	0	204,640	0.4
10	Minera Bismark S.A de C.V	MBS140800511	Ascension	Chihuahua	Mining (except oil and gas)	Metal ore mining	0	0	NA	0	0	168,316	168,316	0.3
11	PEMEX -Petroquímica Morelos SA de CV	PMOV13003911	Coatzacoalcos	Veracruz	Chemicals mfg.	Basic chemical mfg.	0	1,243	NA	0	0	110,400	111,643	0.2
12	Cobre de México S.A. de C.V.	CME7N0900211	Azcapotzalco	Distrito Federal	Primary metal mfg.	Nonferrous metal (except aluminum) production/ processing	0	0	NA	0	0	92,906	92,906	0.2
13	Prym Fashion México SA de CV	PFM7X1510911	Tultitlan	México	Fabricated metal product mfg.	Other fabricated metal product mfg.	0	257	NA	0	0	90,248	90,505	0.2
14	Power Sonic, S.A. de C.V.	PSO8Z0200411	Tijuana	Baja California	Electrical equipment, appliance, component mfg.	Other electrical equipment and component mfg.	351	20	NA	0	0	64,280	64,651	0.1
15	Arteva Specialities S. de R.L. de C.V.	ASP5S2201411	Queretaro	Querétaro	Chemicals mfg.	Resin, synthetic rubber, and artificial synthetic fibers and filaments mfg.	33,088	8	NA	248	28,548	0	61,892	0.1
16	Acabados de Calidad Tecate S.A. de C.V.	ACT7X0200311	Tecate	Baja California	Fabricated metal product mfg.	Other fabricated metal product mfg.	0	0	NA	0	0	52,740	52,740	0.1
17	Aceites Grasas y Derivados S.A. de C.V.	AGDMC1412011	Zapopan	Jalisco	Food product mfg.	Grain and oilseed milling	2,280	0	NA	0	0	44,710	46,990	0.1
18	Vivsil SA de CV	VIVQA2201611	San Juan del Rio	Querétaro	Merchant wholesalers (equiv. to NAICS 424)		55	0	NA	0	45,000	0	45,055	0.1
19	Enerya S.A. de C.V.	ENE8Z1904811	Santa Catarina	Nuevo León	Electrical equipment, appliance, component mfg.	Other electrical equipment and component mfg.	129	4	NA	2	0	40,000	40,135	0.1
20	Austin Bacis S.A. de C.V.	ABA621000711	Gomez Palacio	Durango	Chemical mfg.	Other chemical product and preparation mfg.	0	0	NA	0	700	35,730	36,430	0.1
21	Productos y Diseños de Marmol S.A. de C.V.	PDM9D0200412	Tijuana	Baja California	Plastics and rubber products mfg.	Plastics product mfg.	30,838	0	NA	0	0	0	30,838	0.1
22	Forjas Spicer S.A de C.V.	FSP7T2903911	Xaloztoc	Tlaxcala	Primary metal mfg.	Foundries	0	5	NA	0	29,380	0	29,385	0.1
23	Balatas Méxicanas S.A. de C.V.	BME9L2802711	Nuevo Laredo	Tamaulipas	Transportation equipment mfg.	Motor vehicle parts mfg.	9	0	NA	0	26,880	0	26,889	0.1
24	PEMEX - Complejo Procesador de Gas Matapionche	PGP5G3004921	Cotaxtla	Veracruz	Chemicals mfg.	Basic chemicals mfg.	0	0	NA	0	22,210	4,330	26,540	0.1
25	Layne de México S.A. de C.V.	LMEB22603011	Hermosillo	Sonora	Support activities for mining	Support activities for mining	0	0	NA	0	24,530	0	24,530	0.0

NA = not applicable.

Pollutant Releases and Transfers in the United States

Industrial Sectors Reporting the Largest Quantities

In the United States, 14,118 facilities in 10 industrial sectors contributed more than 3.1 billion kilograms (almost 91 percent) of the total of about 3.5 billion kilograms of releases and transfers reported to the US TRI in 2005 (see **Figure 3–3**).

The chemicals manufacturing sector had the most reporting facilities and the largest reported releases and transfers, accounting for about 19 percent of all reported releases and transfers in 2005. Reporting quantities similar in magnitude were three other sectors: primary metals facilities (including smelters and steel mills), mines and quarries, and electric utilities. Only coal- and oil-fired electric utilities are required to report to the US TRI.

Pollutants with the Largest Reported Quantities

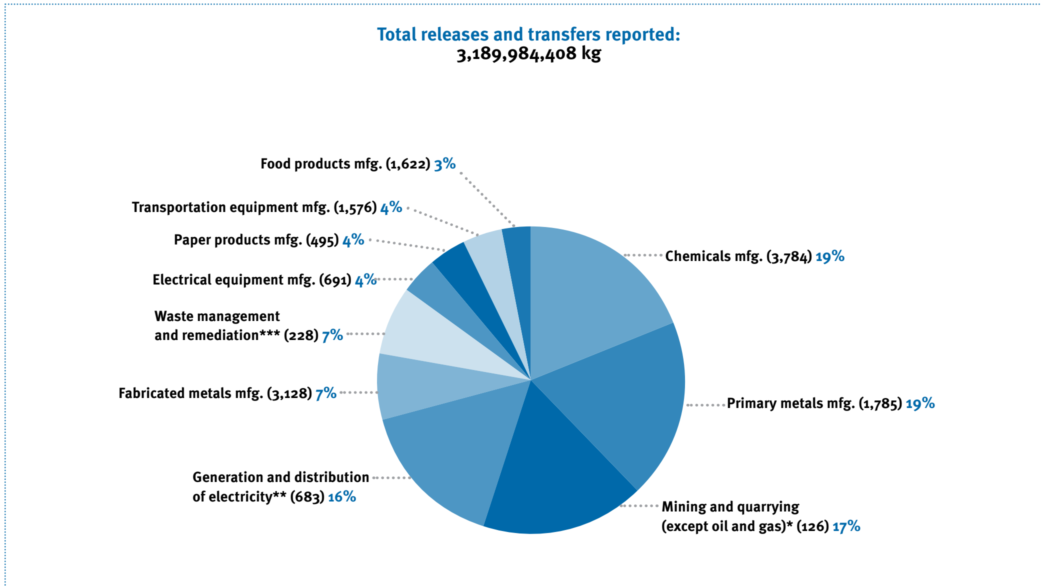
Table 3–9 presents the pollutants with the largest total releases and transfers reported to the US TRI in 2005. **Table 3–10** lists the sectors contributing the most to these releases and transfers.

These tables reveal that, of all substances reported, 25 pollutants represented more than 3 billion kilograms, or about 89 percent, of all reported releases and transfers in the United States in 2005. Some of the findings from these tables include the following.

Ten of the 25 pollutants were metals (or their compounds). Four sectors—primary metals, metal ore mining, electrical equipment manufacturing and transportation equipment manufacturing—reported large amounts of **zinc**, **copper**, **manganese** and **lead and their compounds**, most of which were released to land, sent off-site to disposal in landfills or transferred to recycling. However, these metals were also released to air and water.

Coal- and oil-fired power plants released the largest amounts of **barium** and **vanadium and their compounds** to either land or disposal.

Figure 3–3. Industries with Largest Releases and Transfers, TRI, 2005



Note: Number of facilities reporting is in parentheses.
* The PRTRs differ in the types of activities required to report under this sector.
** In this sector, only coal- and oil-fired power plants must report to the US TRI.
*** In this sector, only hazardous waste/solvent recovery facilities must report to the US TRI.

Table 3–9. Pollutants with Largest Reported Total Releases and Transfers, TRI, 2005 (kilograms)

		On-site releases				Off-site releases		Other transfers for further management			
CAS No.	Pollutant	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Transfers to energy recovery	Transfers to treatment	Transfers to sewage	Total releases and transfers
--	Zinc and its compounds [CA, US]	3,201,140	470,938	5,243,209	253,107,743	122,941,572	179,830,030	0	0	0	564,794,632
--	Copper and its compounds [CA, US]	628,064	190,914	165,339	72,955,145	10,254,063	296,997,813	0	0	0	381,191,338
--	Lead and its compounds [CA, MX, US]	450,916	53,134	2,792,173	195,622,346	18,312,101	140,939,148	0	0	0	358,169,819
7647-01-0	Hydrochloric acid [CA, US]	256,412,321	0	7,132	216,559	76,092	598,172	5,259	2,426,704	57,481	259,799,720
--	Nitrate compounds [CA, US]	239,144	100,515,230	20,034,087	8,110,987	7,813,061	329,166	17,095	6,162,691	59,803,277	203,024,738
67-56-1	Methanol [CA, US]	71,338,722	2,721,507	9,391,678	875,629	1,973,161	6,587,433	63,071,838	21,458,420	25,562,867	202,981,255
--	Manganese and its compounds [CA, US]	978,966	2,824,979	3,568,504	59,289,037	37,069,246	60,857,383	0	0	0	164,588,116
--	Barium and its compounds [US]	1,272,626	519,425	13,050	81,933,250	26,243,156	1,379,155	0	0	0	111,360,662
108-88-3	Toluene [CA, US]	24,012,740	13,706	630,165	559,061	753,140	12,011,484	50,069,271	13,376,712	110,690	101,536,968
--	Chromium and its compounds [CA, MX, US]	304,838	53,377	861,669	13,358,608	14,413,527	57,894,801	0	0	0	86,886,820
--	Arsenic and its compounds [CA, MX, US]	57,041	51,622	632,519	82,272,547	1,014,650	253,613	0	0	0	84,281,992
--	Ammonia [CA, US]	54,066,850	2,453,448	11,380,772	1,687,209	3,447,879	1,177,338	44,137	1,709,105	4,840,372	80,807,109
	Xylenes [CA, US]	15,324,548	12,414	443,843	637,490	481,905	14,217,519	38,943,434	6,709,011	181,314	76,951,478
--	Nickel and its compounds [CA, MX, US]	528,345	93,245	319,691	9,796,785	7,133,225	57,662,910	0	0	0	75,534,200
7664-93-9	Sulfuric acid [CA, US]	71,089,245	64	234,592	1,967	507,143	58,164	210,228	191,659	5,785	72,298,847
107-21-1	Ethylene glycol [CA, US]	1,304,164	246,678	696,318	346,204	774,757	34,249,745	5,282,125	2,963,011	8,936,077	54,799,080
7664-39-3	Hydrogen fluoride [CA, US]	33,684,672	18,899	541,320	99,177	226,898	140,391	0	1,287,005	117,336	36,115,698
100-42-5	Styrene [CA, MX, US]	22,960,970	2,203	444,515	39,288	1,117,902	1,244,950	7,130,814	1,907,166	45,223	34,893,030
110-54-3	n-Hexane [CA, US]	17,359,121	7,390	44,542	21,083	60,140	1,966,415	7,473,716	6,629,371	30,936	33,592,714
--	Vanadium and its compounds [CA, US]	565,787	203,603	415,648	20,730,165	3,770,019	4,902,619	0	0	0	30,587,841
9/2/1975	Dichloromethane [CA, MX, US]	2,772,407	2,587	88,845	45,677	127,515	8,986,730	5,560,222	11,877,497	60,496	29,521,975
7429-90-5	Aluminum (fume or dust) [CA, US]	583,840	1	0	4,261,930	16,070,270	6,497,759	0	0	0	27,413,799
74-85-1	Ethylene [CA, US]	9,204,438	209	2,414	3	91	69	9,578,311	2,695,512	125	21,481,170
--	Glycol ethers [US]	8,863,455	57,912	6,892	19,321	1,041,400	964,322	6,365,785	1,613,309	2,307,449	21,239,844
71-36-3	n-Butyl alcohol [CA, US]	6,913,272	24,632	690,009	1,811	26,772	892,157	6,354,626	2,441,306	945,050	18,289,635

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. This table groups (1) metals with their compounds, (2) nitric acid and nitrate compounds, and (3) xylenes. Reporting in Canada and the United States may differ for ammonia, sulfuric acid and phosphorus. Reporting thresholds for certain metal compounds are lower than the standard PRTR reporting thresholds in certain countries (see **appendix**).

Pollutants released in large quantities to air were **hydrochloric acid**, **sulfuric acid** and **hydrogen fluoride** (by coal- and oil-fired electric utilities); **methanol** (by the chemicals manufacturing and paper products manufacturing sectors); **toluene** (by chemicals manufacturing and hazardous waste management facilities); **ammonia** (by the chemicals, paper products and food products manufacturing sectors); and **styrene** (by the plastics and rubber and chemicals manufacturing sectors).

Nitrate compounds, generated by the chemicals, primary metals and food products manufacturing sectors, dominated releases to water in the United States. Methanol, manganese and ammonia were also released in large quantities to water in 2005.

Facilities reporting the largest releases

Twenty-five US facilities accounted for about 30 percent of all reported releases to air, water, land, underground injection or disposal in 2005 (see **Table 3–11**).

The top seven facilities were in the metal ore mining sector, and four of them were located in the state of Nevada. Together, they accounted for about 20 percent of all reported releases in 2005. This sector was prevalent among the top-reporting facilities, with one metal ore mining facility, Red Dog Operations in Alaska, accounting for about 11 percent of the total releases reported to the TRI in 2005. It reported releases to land of more than 142 million kilograms of zinc and its compounds, as well as about 82 million kilograms of lead and its compounds.

The second-ranking facility, Kennecott Utah Copper Mine in the state of Utah, released more than 26 million kilograms of copper and its compounds to land in 2005. The third-ranking facility was Newmont Mining Corporation's Twin Creeks Mine in Nevada. It released more than 29 million kilograms of arsenic to land. Metal ore mining facilities also released metal compounds to air and water.

Other top reporters were hazardous waste management facilities that released pollutants to land, including large quantities of zinc. In the United States, only hazardous waste management and solvent remediation facilities are required to report within the "waste management/remediation" sector.

Coal- and oil-fired power plants, most of them located in the eastern United States, were also among the top-reporting facilities in 2005. These plants reported large air releases, particularly of hydrochloric acid, sulfuric acid and hydrogen fluoride. They also sent large quantities of barium and vanadium and their compounds to disposal.

Table 3–10. Industrial Sectors with Largest Reported Releases and Transfers, TRI, 2005 (kilograms)

Industry name	Total releases and transfers reported by this sector	No. of facilities reporting	Top pollutants reported by this sector	Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers	Total releases and transfers of this pollutant
Chemicals mfg. (NAICS 325)	646,623,642	3,784	Methanol [CA, US]	8,986,572	209,707	5,722,983	23,003	1,718,880	5,755,391	74,760,869	97,177,405
			Nitrate compounds [CA, US]	259,150	16,351,282	22,401,785	518,163	4,800,959	3,649	25,729,568	70,064,556
			Ammonia [CA, US]	23,083,303	842,916	10,729,113	66,337	1,838,191	489,571	3,311,232	40,360,662
			Toluene [CA, US]	3,273,957	2,612	17,466	4,330	352,530	4,551,123	31,051,823	39,253,841
			Xylenes [CA, US]	1,981,938	1,915	12,502	5,312	162,826	7,469,174	22,761,336	32,395,005
Primary metals (NAICS 331)	607,918,780	1,785	Zinc and its compounds [CA, US]	1,480,016	52,818	857	17,347,693	102,933,709	140,772,712	0	262,587,806
			Copper and its compounds [CA, US]	337,189	16,707	20,583	8,173,720	3,892,283	108,368,067	0	120,808,549
			Manganese and its compounds [CA, US]	446,985	105,244	816	8,870,242	22,501,987	24,410,285	0	56,335,559
			Lead and its compounds [CA, MX, US]	183,037	9,081	425	5,816,286	9,849,202	26,758,744	0	42,616,774
			Nitrate compounds [CA, US]	136,726	18,729,748	2	327,076	844,634	181,614	5,765,403	25,985,204
Mining and quarrying (except oil and gas) (NAICS 212)*	540,456,591	126	Zinc and its compounds [CA, US]	54,691	15,678	4,993,009	188,296,864	4,669	298,059	0	193,662,970
			Lead and its compounds [CA, MX, US]	37,643	3,373	2,622,709	177,185,951	25,284	762,980	0	180,637,939
			Arsenic and its compounds [CA, MX, US]	4,741	1,951	412,699	77,252,696	28	24,552	0	77,696,666
			Copper and its compounds [CA, US]	25,337	1,901	40,363	49,290,745	23,088	268,356	0	49,649,790
			Manganese and its compounds [CA, US]	6,855	62,675	17,226	12,659,401	1,057,662	36,891	0	13,840,710
Generation and distribution of electricity (NAICS 2211)**	500,132,327	683	Hydrochloric acid [CA, US]	233,167,080	0	0	172,779	25,850	907	0	233,366,616
			Barium and its compounds [US]	795,580	333,195	0	73,734,469	21,429,340	557,159	0	96,849,743
			Sulfuric acid [CA, US]	57,742,273	0	0	0	0	0	93	57,742,366
			Hydrogen fluoride [CA, US]	28,081,597	0	0	3,900	4,590	42	0	28,090,129
			Vanadium and its compounds [CA, US]	288,802	41,504	0	13,487,917	2,961,968	2,232,142	0	19,012,333
Fabricated metals mfg. (NAICS 332)	226,979,649	3,128	Copper and its compounds [CA, US]	35,848	3,299	0	104,904	545,184	93,294,437	0	93,983,672
			Zinc and its compounds [CA, US]	180,611	11,565	4,989	22,400	6,224,221	23,651,175	0	30,094,961
			Nickel and its compounds [CA, MX, US]	74,357	2,624	0	15,149	895,492	22,311,150	0	23,298,772
			Chromium and its compounds [CA, MX, US]	56,354	975	0	2,736	1,779,920	19,060,576	0	20,900,562
			Manganese and its compounds [CA, US]	54,475	1,908	0	8,845	1,338,629	15,842,067	0	17,245,924
Waste management and remediation (NAICS 56)***	211,765,533	228	Zinc and its compounds [CA, US]	2,681	310	126,622	34,836,735	2,324,943	159,189	0	37,450,480
			Lead and its compounds [CA, MX, US]	3,087	243	102,810	7,006,161	1,825,395	19,503,622	0	28,441,318
			Toluene [CA, US]	31,405	1,340	574,803	474,756	146,974	245,439	21,976,718	23,451,434
			Xylenes [CA, US]	26,874	6,639	416,074	549,809	144,919	438,295	15,187,412	16,770,023
			Methanol [CA, US]	9,774	2,513	3,655,650	130,736	45,729	19,973	9,750,337	13,614,712
Electrical equipment mfg. (NAICS 335)	127,040,711	691	Lead and its compounds [CA, MX, US]	14,647	373	0	2,915	2,184,260	78,957,510	0	81,159,706
			Copper and its compounds [CA, US]	5,678	633	0	32,622	76,397	34,927,957	0	35,043,287
			Manganese and its compounds [CA, US]	29,795	366	0	2,368	496,200	1,607,888	0	2,136,617
			Nitrate compounds [CA, US]	10,318	20,806	0	0	1,479	157,200	1,291,301	1,481,105
			Chromium and its compounds [CA, MX, US]	456	1	0	2	34,240	1,083,060	0	1,117,759
Paper products mfg. (NAICS 322)	121,025,321	495	Methanol [CA, US]	50,941,249	2,480,541	0	419,243	38,445	1,929	15,211,280	69,092,687
			Ammonia [CA, US]	7,297,254	795,765	0	4,904	2,552	115	25,613	8,126,204
			Manganese and its compounds [CA, US]	69,562	1,981,153	0	4,596,852	1,411,168	58,276	0	8,117,011
			Hydrochloric acid [CA, US]	7,101,704	0	0	0	0	0	0	7,101,704
			Toluene [CA, US]	3,608,104	0	0	0	12,794	1,044,930	1,529,732	6,195,560
Transportation equipment mfg. (NAICS 336)	112,454,822	1,576	Copper and its compounds [CA, US]	42,090	2,206	0	119,952	678,896	18,549,604	0	19,392,749
			Manganese and its compounds [CA, US]	32,971	1,908	0	4,879	510,714	10,747,757	0	11,298,230
			Zinc and its compounds [CA, US]	39,365	9,192	0	17,711	1,017,307	9,677,960	0	10,761,535
			Nickel and its compounds [CA, MX, US]	38,944	1,572	0	1,962	270,648	9,736,728	0	10,049,854
			Xylenes [CA, US]	4,255,198	440	0	2,411	15,741	3,919,776	822,306	9,015,872
Food products mfg. (NAICS 311)	95,587,032	1,622	Nitrate compounds [CA, US]	26,885	41,662,840	68,852	5,393,459	1,518,745	110,218	16,163,349	64,944,346
			n-Hexane [CA, US]	10,271,420	1,485	0	410	336	0	70,765	10,344,417
			Ammonia [CA, US]	5,978,803	146,545	11,225	672,171	239,855	171,008	1,515,768	8,735,375
			Hydrochloric acid [CA, US]	2,133,223	0	0	0	0	0	0	2,133,223
			Ethylene glycol [CA, US]	14,552	0	0	4,202	0	7,294	1,790,011	1,816,059

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. This table groups (1) metals with their compounds, (2) nitric acid and nitrate compounds, and (3) xylenes. Reporting in Canada and the United States may differ for ammonia, sulfuric acid, hydrochloric acid and phosphorus. Reporting thresholds in each country for a number of these pollutants are lower than the standard PRTR reporting thresholds (see **appendix**).

* The PRTRs differ in the types of activities required to report under this sector.

** In this sector, only coal- and oil-fired power plants must report to the US TRI.

*** In this sector, only hazardous waste management/solvent recovery facilities are required to report to the US TRI.

Table 3–11. Facilities Reporting the Largest Releases, TRI, 2005 (kilograms)

	Name	TRI_ID	City	State	Integrated NAICS code	Detailed sector description	Air releases	Water releases	Under-ground injection	Land releases	Off-site disposal-nonmetals	Off-site disposal-metals	Total releases	% of total TRI releases
1	Red Dog Operations	99752RDDGP90MIL	Kotzebue	Alaska	Mining (except oil and gas)	Metal ore mining	146,284	1,077	0	226,040,478	0	345	226,188,184	11
2	Kennecott Utah Copper Mine Concentrators & Power Plant	84006KNNCT12300	Copperton	Utah	Mining (except oil and gas)	Metal ore mining	9,612	3,159	0	43,974,481	0	509	43,987,760	2
3	Newmont Mining Corp. Twin Creeks Mine	89414NWMNT35MIL	Golconda	Nevada	Mining (except oil and gas)	Metal ore mining	41,537	44	0	36,665,389	0	436	36,707,407	1
4	Newmont Mining Corp. Carlin South Area	89822NWMNT6MAIL	Carlin	Nevada	Mining (except oil and gas)	Metal ore mining	18,619	0	0	27,373,623	0	6,018	27,398,260	1
5	Barrick Goldstrike Mines Inc.	89803BRRCK27MIL	Elko	Nevada	Mining (except oil and gas)	Metal ore mining	23,277	0	0	22,245,266	0	793	22,269,335	1
6	Cœur Rochester Inc.	89419CRRCH180EX	Lovelock	Nevada	Mining (except oil and gas)	Metal ore mining	3,881	0	0	21,643,132	0	0	21,647,013	1
7	Kennecott Greens Creek Mining Co.	99801KNNCT13401	Juneau	Alaska	Mining (except oil and gas)	Metal ore mining	8,656	1,366	8,032,777	11,623,595	0	0	19,666,394	1
8	Envirosafe Services of Ohio Inc.	43616NVRSF876OT	Oregon	Ohio	Waste management and remediation services	Waste treatment and disposal	385	0	0	15,712,582	0	234	15,713,200	1
9	US Ecology Idaho Inc.	83624NVRSF1012M	Grand View	Idaho	Waste management and remediation services (hazardous waste/solvent recovery only)	Waste treatment and disposal	1,332	0	0	14,430,211	0	0	14,431,543	1
10	Solutia Inc.	32533MNSNT3000O	Cantonment	Florida	Chemicals mfg.	Resin, synthetic rubber, and artificial and synthetic fibers and filaments manufacturing	149,809	0	14,201,641	0	33	200	14,351,684	1
11	Kennecott Utah Copper - Smelter & Refinery	84006KNNCT8362W	Magna	Utah	Primary metals mfg.	Nonferrous metal (except aluminum) production and processing	55,144	3,741	0	13,605,386	0	23,764	13,688,036	0.68
12	Phelps Dodge Miami Inc.	85532NSPRTPOBOX	Claypool	Arizona	Mining (except oil and gas)	Metal ore mining	144,893	0	0	11,955,830	0	272	12,100,995	0.60
13	Newmont Mining Corp Lone Tree Mine	89438NWMNTSTONE	Valmy	Nevada	Mining (except oil and gas)	Metal ore mining	28,748	50,086	0	11,926,713	0	70	12,005,618	0.59
14	Montana Resources LLP	59701MNTNR600SH	Butte	Montana	Mining (except oil and gas)	Metal ore mining	345	0	0	11,956,058	0	0	11,956,402	0.59
15	Nucor Steel	47933NCRST400SO	Crawfordsville	Indiana	Primary metals mfg.	Iron and steel mills and ferroalloy manufacturing	11,396	368	0	0	113	11,861,586	11,873,464	0.59
16	Mittal Steel USA Inc. - Indiana Harbor East	46312NLNDS3210W	East Chicago	Indiana	Primary metals mfg.	Iron and steel mills and ferroalloy manufacturing	42,505	18,313	0	2,014	0	11,627,749	11,690,581	0.58
17	Buick Mine/Mill	65440BCKMNHWYKK	Boss	Missouri	Mining (except oil and gas)	Metal ore mining	18,570	7,486	0	11,556,420	0	0	11,582,476	0.57
18	AK Steel Corp. (Rockport Works)	47635KSTLC6500N	Rockport	Indiana	Primary metal mfg.	Iron and steel mills and ferroalloy manufacturing	6,758	10,851,757	0	0	0	456,787	11,315,302	0.56
19	Solutia Chocolate Bayou	77511SLTNCFM291	Alvin	Texas	Chemicals mfg.	Basic chemical manufacturing	42,089	5,308	10,695,986	137,671	0	0	10,881,054	0.54
20	Energy Solutions LLC	84029NVRCRUSINT	Clive	Utah	Waste management and remediation services	Waste treatment and disposal	0	0	0	10,602,979	803	0	10,603,782	0.52
21	Peoria Disposal Co. #1	61615PRDSP4349W	Peoria	Illinois	Waste management and remediation services	Waste treatment and disposal	2	1	0	9,987,560	0	21	9,987,584	0.49
22	Steel Dynamics Inc.	46721STLDY4500C	Butler	Indiana	Primary metals mfg.	Iron and steel mills and ferroalloy manufacturing	267,424	0	0	0	6608	9,519,295	9,793,327	0.48
23	American Electric Power Amos Plant	25213JHNMS1530W	Winfield	West Virginia	Utilities	Electric power generation, transmission and distribution	8,150,846	6,580	0	578,416	0	665,888	9,401,730	0.46
24	Robinson Nevada Mining Co.	89319BHPCP7MILE	Ruth	Nevada	Mining (except oil and gas)	Metal ore mining	390	0	0	9,333,357	0	0	9,333,747	0.46
25	Bowen Steam Electric Generating Plant	30120BWNST317CO	Cartersville	Georgia	Utilities	Electric power generation, transmission and distribution	8,442,061	6,421	0	822,709	0	65	9,271,256	0.46

Comparing Pollutant Releases and Transfers in North America, 2005

Based on this overview of PRTR data from Canada, Mexico and the United States, how do the three countries compare in pollutants reported, the industrial sectors reporting them and the ways in which substances were handled? This section examines these data more closely, in the context of national PRTR reporting requirements, to gain a better understanding of industrial pollution in North America and some of the areas requiring additional attention.

Pollutants Reported in the Largest Quantities

Thirty pollutants (excluding criteria air contaminants and greenhouse gases) contributed at least 90 percent of all reported amounts across North America in 2005:

- 10 metals (and their compounds): aluminum, arsenic, barium, chromium, copper, lead, manganese, nickel, vanadium and zinc; and
- 20 nonmetals: 1,2-dichloroethane, ammonia, asbestos, dichloromethane, ethylene, ethylene glycol, formaldehyde, glycol ethers, hydrochloric acid, hydrogen fluoride, hydrogen sulfide, methanol, n-butyl alcohol, n-hexane, nitric acid and nitrate compounds, phosphorus, styrene, sulfuric acid, toluene and xylenes.

Only nine of the 30 pollutants reported in the largest amounts by North American industrial facilities in 2005 were subject to reporting under all three PRTRs: four metals (and their compounds)—arsenic, chromium, lead, and nickel—and five other pollutants—1,2-dichloroethane, asbestos, dichloromethane, formaldehyde and styrene.

In Canada, 28 of the 30 pollutants were subject to NPRI reporting (the exceptions were barium and glycol ethers, which were mandatory only under the US TRI). In the United States, 29 of the 30 pollutants were subject to reporting (the exception was hydrogen sulfide). In Mexico, 10 of the 30 pollutants were reportable to the RETC in 2005: the nine common to all three countries and hydrogen sulfide. Some of the substances released or transferred in the largest amounts in Canada and the United States (metals such as zinc and copper, along with others such as ammonia, hydrogen fluoride, methanol, toluene and xylenes) were not subject to RETC reporting.

The picture of pollution, based on the top-reported substances across North America in 2005, indicates the impacts of different national reporting requirements. Mexican facilities represented about 6 percent of the total number of reporting facilities, but accounted for about 1 percent of all reported releases and transfers in North America (see **Table 3–2**). However, these proportions might be different if more of these 30 pollutants were subject to RETC reporting, and if they were reported in Mexico by the same sectors reporting them in Canada and the United States.

And yet reporting thresholds for these 30 substances were generally lower in Mexico than they were in Canada and the United States. For example, nickel and its compounds (with a 1–5 kilogram RETC reporting threshold, but a 10,000 kilogram NPRI and TRI threshold) were reported in very large quantities by Mexican facilities (e.g., transportation equipment manufacturers). If the NPRI and TRI thresholds matched those for the RETC, one might expect more reporting of nickel and its compounds by transportation equipment manufacturers in Canada and the United States.

Types of Industrial Facilities and Waste Handling

Across the three countries, facilities in 15 sectors (nine manufacturing and six nonmanufacturing) reported the majority of all pollutant releases and transfers in 2005. Of these sectors, only two reported large quantities in all three countries: the chemicals and transportation equipment manufacturing sectors. The other 13 top-reporting industries reported the largest quantities in one or two, but not all three, countries. Among those reporting sectors common to at least two of the countries in 2005, some similarities and differences included the following.

The **mining** (**excluding oil and gas**) sector reported large quantities of pollutants in Mexico and the United States, but not in Canada. In the United States, zinc and its compounds were reported in large quantities, but none was reported in Mexico. The Mexican facility reporting the largest releases in 2005 was a lead and zinc mining operation. It reported large releases of lead, but zinc was not subject to RETC reporting in 2005.

Lead and arsenic and their compounds were reported in large amounts by mining operations in both Mexico and the United States. Mexican facilities primarily sent these metals to disposal, whereas US facilities released the largest proportions to land. Land releases of metals can include disposal in landfills or holding ponds, where they settle over time, or in "land treatment/application farming," where the pollutants are incorporated into the soil. Land release of lead and arsenic (along with other metals such as zinc, copper and manganese) was a common practice of US metal mines.

Metal ore mines were not among the top-reporting sectors in Canada, but data for releases of lead and arsenic and their compounds indicate that Canadian mining facilities sent the bulk of their metal wastes to disposal.

The **electric utilities** sector reported large quantities of pollutants in Mexico and the United States, but not in Canada. In the United States, coal- and oil-fired power plants released very large amounts of hydrogen fluoride, sulfuric acid and hydrochloric acid to air, as well as relatively smaller amounts of barium and vanadium and their compounds (these metals were mainly released to land). None of these top US pollutants was subject to RETC reporting.

In 2005 the United States had 13 times as many reporting electric utilities as Mexico, but the US coal- and oil-fired power plants reported 65 times the amount of air releases. Without information on factors such as plant generating capacity, inputs and emission controls—information generally not available through PRTR reports—it is difficult to know what is contributing to this reporting difference. The United States generates half of its electricity from coal, whereas more than two-thirds of Mexico's electricity is derived from oil and natural gas. Typical contaminants generated by fossil fuel–powered utilities are (aside from criteria air contaminants) metals such as arsenic, nickel, manganese and mercury, as well as hydrogen fluoride and sulfuric acid.

Mexican electric utilities reported more than 5 million kilograms of hydrogen sulfide releases to air (along with other pollutants). Hydrogen sulfide, a component of petroleum and natural gas, was not subject to reporting under the US TRI. In Canada, this substance was the top-reported pollutant by oil and gas extraction and production facilities, a sector not subject to US TRI reporting.

In reporting by electric utilities in Mexico and the United States, the types of fuel used and differences in the pollutants subject to PRTR reporting likely had impacts on the releases and transfers reported by that sector in each country.

Paper products manufacturers were among the top-reporting sectors in Canada and the United States, but not in Mexico. Four out of five of the top pollutants reported were common to both countries and were handled in much the same way. The four were methanol, ammonia and hydrochloric acid, which were released in substantial amounts to air, and manganese and its compounds, which were released in large amounts to water and land and to disposal. The similarities in reporting by this sector to both the Canadian and US PRTRs reflect the fairly standard method of paper production in both countries, using inputs such as chlorine for bleaching and sulfur in the chemical pulping (or Kraft) process.

The paper products manufacturing sector is required to report under the Mexican RETC, and 67 facilities reported in 2005. However, the pollutants reported by paper products manufacturers in the largest proportions in Canada and the United States were not subject to RETC reporting. Instead, Mexican paper products manufacturers reported air and water releases of hydrogen sulfide, nickel and chromium and their compounds, and PCBs.

The **transportation equipment manufacturing** sector was among the top-reporting industries in all three countries, and, as might be expected, metals such as nickel, chromium, lead, zinc, manganese and copper and their compounds were among the top pollutants reported (however, zinc, manganese and copper and their compounds were not subject to RETC reporting). All three countries sent the bulk of these metals to recycling, followed by releases to disposal (with smaller amounts also released to land, air or water). As the next section reveals, some of these metals were also transferred for recycling across national borders.

This look at the common industrial sectors has concentrated on those that reported some of the largest releases and transfers in 2005. However, only facilities with at least 10 full-time employees (or the equivalent) are required to report to Canada's NPRI and the US TRI, whereas Mexico's RETC has no such threshold. Information on the number of employees is provided with NPRI and RETC data, but not with TRI data. In Mexico, 167 facilities reported having fewer than 10 full-time employees (or equivalent). Each of these facilities reported fairly small amounts of pollutants in 2005 and was not among the 25 facilities that accounted for about 98 percent of all releases that year.

In Canada, about 300 facilities reported having fewer than 10 full-time employees (or the equivalent). Certain activities such as waste incineration, bulk storage of fuels and wastewater collection are subject to reporting regardless of the number of employees, which explains the reporting by these 300 facilities in 2005. Two of them were among the top reporters that year, including the Duke Energy Gas Transmission (pipeline and bulk storage) facility in Chetwynd, British Columbia, and the Regional Municipality of Halton, a wastewater treatment plant in Burlington, Ontario. If these facilities were subject to the same employee thresholds as other NPRI facilities, they probably would not have reported in 2005, indicating that this reporting requirement can limit the picture of industrial pollution in Canada and the United States.

Information on the numbers of employees in North American industrial sectors is limited. For example, the employment statistics provided earlier in this chapter in the section "Scope of PRTR Reporting" indicate that at least 50 percent of manufacturing facilities in each country have less than 10 employees, but statistics by sector are not easily available, nor are those for other nonmanufacturing sectors in each country. Thus it is difficult to ascertain the extent of the impact of the 10-employee threshold on the level of PRTR reporting.

Cross-border transfers

The off-site transfers reported by North American facilities in 2005 (excluding transfers to sewage, which tend to be local) included pollutants sent across national borders (see **Map 3–2**). PRTR reporting forms normally indicate the sending facility, type of transfer (e.g., to disposal or recycling) and the name and location of the receiving facility.

Pollutants Transferred across Canadian Borders. In 2005 cross-border transfers accounted for about 8 percent (or almost 115 million kilograms) of Canada's total off-site transfers. Almost all (99 percent) of these cross-border transfers went to the United States; no transfers to Mexico were reported.

Five of the top-reported pollutants in 2005 made up about 85 percent of these transfers, including sulfuric acid, most of which was sent by the petroleum and chemicals manufacturing sectors to the United States for recycling or regeneration. More than 23 million kilograms of zinc and copper and their compounds were sent mainly from the primary and fabricated metals sectors to be recycled or reused by metals companies in the United States. Approximately 2.7 million kilograms of nitrate compounds, generated by the fabricated metals, waste management and chemicals manufacturing sectors, were sent to the United States for treatment, disposal or recycling. Phosphorus was also sent to the United States, with the largest proportions sent by electric utilities for either land disposal or recycling at cement plants.

Pollutants Transferred across Mexican Borders. In 2005 Mexican facilities sent to unknown destinations more than 43 million kilograms of pollutants (of the total of about 59 million kilograms of off-site transfers reported by Mexican facilities that year). These transfers could have included both Mexican and non-Mexican facilities, because the receiving locations were not indicated on the RETC forms.

However, the destinations of an additional 2 million kilograms of transfers were indicated on the RETC forms, and these were to the United States. Lead and its compounds, one of the top-reported pollutants in Mexico in 2005, accounted for more than 1.83 million kilograms (about 92 percent) of this amount, primarily sent to the United States by Mexican electrical equipment manufacturers for recycling.

Map 3–2. Cross-border Transfers in North America, 2005

Pollutants Transferred across US Borders. In 2005 US facilities transferred about 65 million kilograms (4 percent of all reported off-site transfers) across borders. Transfers to Canada accounted for about 16 million kilograms, or almost 25 percent, of US cross-border transfers.

About half of the transfers to Canada were metals to recycling. Five metals—copper, lead, nickel, zinc and manganese and their compounds—accounted for more than 7.2 million kilograms (over 85 percent) of this amount. These pollutants were sent to recycling by a variety of industrial sectors, mainly manufacturers of nonmetallic mineral (e.g., limestone, marble) products, electrical equipment, fabricated metals, chemicals and transportation equipment. Less than 1 million kilograms of pollutants were also sent to disposal in Canada. The five metals just listed represented 75 percent of this amount.

More than 4.5 million kilograms of chemicals were sent to Canada for treatment, primarily from US hazardous waste management and chemical manufacturing facilities. Toluene, xylenes and methanol accounted for about 83 percent of this total.

About 2.5 million kilograms of pollutants were also sent to Canada for energy recovery. Five chemicals—xylenes, toluene, benzal chloride, n-hexane and benzyl chloride—represented 95 percent of these transfers. The sending facilities were from the hazardous waste management, chemicals, and petroleum and coal products manufacturing sectors.

US transfers to Mexico totaled 37.5 million kilograms and represented about 57 percent of all US cross-border transfers in 2005. About 99 percent of these transfers were five metals (zinc, lead, manganese, copper and chromium and their compounds) sent by the primary metals sector for recycling. Zinc, which represented about 80 percent of this total, was sent primarily to the Mexican facility *Zinc Nacional* in Monterrey, Nuevo Leon. It recycles the zinc from zinc-bearing products from Mexico and the United States. Less than 1 million kilograms of pollutants (consisting mostly of a variety of metals) were also sent from US primary metals manufacturers to Mexico for disposal.

This picture of reported cross-border transfers by North American facilities reveals that a small number of substances—half a dozen metals and as many nonmetals—accounted for the majority of all such transfers. The markets for the sulfuric acid and phosphorus sent to the United States from Canadian facilities can make these transfers economically attractive. Similarly, certain metals have high market value that can make cross-border transfers for recycling viable. *Taking Stock 2004* included a special feature chapter that described how the recycling of metals that have a high market value has grown in recent years.

And yet because of gaps in the reported information, such as the locations of receiving facilities for the bulk of Mexican cross-border transfers, it is difficult to track the flows of substances. As a result, there is a degree of uncertainty about the actual fate of substances reportedly sent to recycling, particularly materials sent to intermediary facilities such as waste brokers. Some of the materials are indeed recycled, but others might be sent to landfills, to other treatment, or to other destinations.

Releases and Transfers of Pollutants of Special Interest

Some of the pollutants reported to the three PRTRs in 2005 are of special interest because of their potential health or environmental effects. For example, some contribute to acid rain, smog and climate change. Criteria air contaminants and greenhouse gases, which are such substances, are discussed later in this section. Other pollutants, such as nitrates, can cause eutrophication (excessive plant growth and decay) of water bodies, thereby depriving fish and other marine populations of oxygen and reducing water quality.

Among the pollutants released to air by North American facilities in 2005, many are considered to be hazardous air pollutants (HAPs). HAPs can pose significant threats to the environment or cause or contribute to death or serious illness such as cancer. These substances are subject to California's Safe Drinking Water and Toxic Enforcement Act of 1986, which requires publication of a list of priority substances, commonly known as "California Proposition 65" <http://www.oehha.org/prop65.html>. Substances that are known, probable or possible carcinogens are also listed by the World Health Organization's International Agency for Research on Cancer (IARC, <http://www.iarc.fr>).

The California Proposition 65 and IARC lists are the basis for the categorization of carcinogens and developmental or reproductive toxicants used in *Taking Stock*. Of the pollutants reported in 2005 by North American facilities, 75 are known or suspected carcinogens, and 10 of them are reported in the largest amounts. Twenty-five are considered to be developmental or reproductive toxicants, and four are among the pollutants reported in the largest amounts in 2005.

Certain pollutants, including some carcinogens and developmental or reproductive toxicants, are considered to be persistent, bioaccumulative and toxic (PBT) substances. Certain metals are also considered to be PBTs. Metals occur naturally, but particular human activities such as mining and smelting enlarge the proportions of metals in the environment. The toxicity of metals and their compounds (e.g., chromium, nickel, arsenic, cadmium, lead and mercury) depends in part on the forms they take in the environment.

PBTs have properties that render them a long-term environmental and health threat, even in small quantities. When PBTs are released into the environment, they persist over long periods of time and do not break down easily into other compounds; they can be transported in the atmosphere over long distances, ending up far from the sources of their release; and they bioaccumulate in the food chain (increasing in concentration at higher levels). They are also toxic, often causing damage to humans, plants and wildlife.

Assessing potential harm to the environment from particular releases of a pollutant is a complex task, because the potential of a substance to cause harm arises from various factors, including its inherent toxicity and the nature of the exposure to the substance (e.g., the potential risk posed by asbestos sent to a secure landfill is considered to be much lower than the risk posed by asbestos released to air). However, the data and information reported about a pollutant's chemical properties and toxicity can serve as a starting point for learning more about its potential impacts. More information about reported releases of carcinogens, developmental or reproductive toxicants, and metals can be obtained by searching *Taking Stock Online*.

Toxic Equivalency Potential (TEP) Weightings

To put pollutant releases into context, *Taking Stock* includes a chemical ranking system that takes into account both a pollutant's toxicity and its potential for human exposure, using toxic equivalency potentials. TEPs indicate the relative human health risk associated with the release of one unit of a pollutant compared with the risk posed by the release of one unit of a reference chemical. The reference chemical for carcinogens is benzene, and the reference chemical for recognized developmental and reproductive toxicants is toluene.

TEPs were developed as a screening tool for relative risk ranking, but they do not address all the toxicity and exposure factors that will affect the risk to human health in a particular situation. The TEP approach was developed by scientists at the University of California at Berkeley, and reviewed by the Science Advisory Board of the US Environmental Protection Agency (EPA). TEPs, which are provided at the website Scorecard (http://www.scorecard.org/env-releases/def/tep_gen.html), are one of many different screening tools, each of which is based on a series of assumptions. Therefore, different screening tools yield different results.

TEPs depend on the pollutant and the medium of exposure. This report includes TEP values for carcinogens and for recognized developmental or reproductive toxicants, both for air and for surface water releases. The TEP is multiplied by the amount of the release, and the result is used to rank the pollutants.

Carcinogenicity and Developmental or Reproductive Toxicity Rankings for Air and Water Releases of the Top Pollutants Reported in 2005

Table 3–12 presents the 30 pollutants reported in the largest amounts by North American facilities in 2005, ranked in descending order by overall releases and transfers. Ten of these pollutants are known or suspected carcinogens, and four (lead, arsenic, nickel and toluene) are developmental or reproductive toxicants. Lead, arsenic and nickel and their compounds are also known or suspected carcinogens. Six of the metals are also considered to be PBTs.

Tables 3–13 and **3–14** provide TEP weightings for air and water releases of these same pollutants, with the exception of 1,2-dichloroethane for which no air or water releases were reported in 2005. A much different ranking emerges when the pollutants are weighted by their potential carcinogenicity or developmental or reproductive toxicity, as illustrated in the sections that follow.[7]

Air releases. According to **Table 3–13**, arsenic was released to air by North American facilities in 2005 in smaller quantities than many other pollutants, but, when weighted by TEP, arsenic is ranked first for carcinogenicity and third for potential developmental or reproductive toxicity. Chromium and lead and their compounds, other pollutants with relatively small quantities released to the air, ranked second and third, respectively, when weighted by TEP for carcinogenicity (with lead and its compounds ranking first when weighted for developmental or reproductive toxicity).

Among nonmetals, hydrochloric acid, with the highest reported releases to air in 2005, ranked fourth place when weighted by TEP for developmental or reproductive toxicity. Examples of other nonmetals with high rankings when weighted by TEP scores for developmental or reproductive toxicity are hydrogen sulfide, ammonia and hydrogen fluoride.

Water releases. **Table 3–14** shows that, much like their air release rankings, arsenic and lead and their compounds ranked as top pollutants when weighted by TEP for both carcinogenicity and developmental or reproductive toxicity, despite their relatively small releases to water in 2005. Nine metals ranked highest when weighted by TEP for developmental or reproductive toxicity. Other pollutants, such as hydrogen sulfide, n-hexane and dichloromethane, ranked higher because of their TEP weightings, while pollutants with very large releases to water in 2005—for example, nitrate compounds, ammonia and phosphorus—had very low rankings when weighted by TEP.

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[7] A pollutant might have a TEP weighting for carcinogenicity or developmental/reproductive toxicity, but it might not be designated as a known or suspected carcinogen or developmental/reproductive toxicant by the sources referenced in this chapter.

Table 3–12. Percentage of Top 30 Pollutants Released and Transferred in North America, 2005

			On-site and off-site releases (% by releases medium)					Transfers for further management (% by management method)				
	Pollutant ranked by total releases and transfers		Air releases	Water releases	Underground injection	Land releases	Off-site disposal	Recycling	Energy	Treatment	Sewage	Total releases and transfers (kg)
1	Hydrogen sulfide [CA, MX]		1	0	20	0	18	61	0	0	0	1,368,487,605
2	Zinc and its compounds [CA, US]	MP	1	0	1	41	21	36	0	0	0	639,516,966
3	Lead and its compounds [CA, MX, US]	DCMP	0	0	1	44	13	42	0	0	0	453,766,645
4	Copper and its compounds [CA, US]	MP	0	0	0	17	3	79	0	0	0	422,509,715
5	Nitrate compounds [CA, US]		0	58	8	3	3	0	0	2	25	261,638,682
6	Hydrochloric acid [CA, US]		99	0	0	0	0	0	0	1	0	259,799,720
7	Methanol [CA, US]		37	2	6	0	3	3	27	10	11	235,476,261
8	Manganese and its compounds [CA, US]	M	1	2	2	33	22	41	0	0	0	196,817,633
9	Ammonia [CA, US]		44	33	11	1	4	1	0	2	4	168,527,542
10	Sulfuric acid [CA, US]		49	0	0	0	5	43	0	2	0	166,764,975
11	Barium and its compounds [US]	M	1	0	0	74	24	1	0	0	0	111,360,662
12	Toluene [CA, US]	D	24	0	1	1	1	12	49	13	0	101,536,968
13	Arsenic and its compounds [CA, MX, US]	DCMP	0	0	1	90	8	0	0	0	0	90,986,426
14	Chromium and its compounds [CA, MX, US]	CMP	0	0	1	15	17	67	0	0	0	87,902,059
15	Nickel and its compounds [CA, MX, US]	DCMP	1	0	0	13	10	76	0	0	0	77,413,728
16	Xylenes [CA, US]		20	0	1	1	1	18	51	9	0	76,951,478
17	Ethylene glycol [CA, US]		2	0	1	1	1	63	10	5	16	54,799,080
18	Hydrogen fluoride [CA, US]		93	0	1	0	1	0	0	4	0	36,115,698
19	Styrene [CA, MX, US]	C	66	0	1	0	3	4	21	5	0	35,196,460
20	n-Hexane [CA, US]		52	0	0	0	0	6	22	20	0	33,592,714
21	Vanadium and its compounds [CA, US]	CM	2	1	1	68	12	16	0	0	0	30,587,841
22	Dichloromethane [CA, MX, US]	C	9	0	0	0	0	31	20	39	0	30,234,488
23	Aluminum (fume or dust) [CA, US]	M	2	0	0	16	59	24	0	0	0	27,413,799
24	Phosphorus [CA, US]		0	25	5	13	35	12	0	6	4	27,213,543
25	Ethylene [CA, US]		43	0	0	0	0	0	45	13	0	21,481,170
26	Glycol ethers [US]		42	0	0	0	5	5	30	8	11	21,239,844
27	n-Butyl alcohol [CA, US]		38	0	4	0	0	5	35	13	5	18,289,635
28	Asbestos (friable form) [CA, MX, US]	C	0	0	0	0	99	0	0	0	0	310,703
29	1,2-Dichloroethane [CA, MX, US]	C	0	0	0	0	0	99	1	0	0	221,011
30	Formaldehyde [CA, MX, US]	C	99	0	0	0	1	0	0	0	0	158,162
												5,056,311,213

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory. C, M, D, P = known or suspected carcinogen, metal, developmental/reproductive toxicant, or PBT.

Table 3–13. TEP Scores for Carcinogens and Developmental/Reproductive Toxicants Released to Air in North America, 2005

	Pollutant ranked by TEP scoring for carcinogens	Amount released to air (kg)	TEP score for carcinogens		Pollutant ranked by TEP scoring for developmental/reproductive	Amount released to air (kg)	TEP score for developmental/reproductive
1	Arsenic and its compounds	59,188	947,012,948	1	Lead and its compounds	742,768	430,805,713,353
2	Chromium and its compounds	308,360	40,086,810	2	Copper and its compounds	1,005,060	13,065,783,137
3	Lead and its compounds	742,768	20,797,517	3	Arsenic and its compounds	59,188	4,971,817,978
4	Glycol ethers	8,863,455	8,863,455	4	Hydrochloric acid	256,412,321	3,076,947,848
5	Hydrogen sulfide	8,629,403	8,629,403	5	Nickel and its compounds	553,846	1,772,308,629
6	Nickel and its compounds	553,846	1,550,770	6	Chromium and its compounds	308,360	955,916,234
7	Dichloromethane	2,792,216	558,443	7	Manganese and its compounds	1,144,154	892,440,410
8	Formaldehyde	159,768	3,195	8	Zinc and its compounds	3,854,754	732,403,214
9	Hydrochloric acid	256,412,321	0	9	Vanadium and its compounds	565,787	678,944,400
10	Methanol	87,822,906	0	10	Barium and its compounds	1,272,626	470,871,520
11	Sulfuric acid	82,130,785	0	11	Hydrogen sulfide	8,629,403	293,399,706
12	Ammonia	74,268,726	0	12	Ammonia	74,268,726	282,221,159
13	Hydrogen fluoride	33,684,672	0	13	Hydrogen fluoride	33,684,672	121,264,819
14	Toluene	24,012,740	0	14	Aluminum (fume or dust)	583,840	35,614,240
15	Styrene	23,072,308	0	15	Toluene	24,012,740	24,012,740
16	n-Hexane	17,359,121	0	16	Dichloromethane	2,792,216	19,545,511
17	Xylenes	15,324,548	0	17	Glycol ethers	8,863,455	8,863,455
18	Ethylene	9,204,438	0	18	Methanol	87,822,906	7,904,062
19	n-Butyl alcohol	6,913,272	0	19	n-Butyl alcohol	6,913,272	4,908,423
20	Zinc and its compounds	3,854,754	0	20	Xylenes	15,324,548	4,137,628
21	Ethylene glycol	1,304,164	0	21	Formaldehyde	159,768	2,556,285
22	Barium and its compounds	1,272,626	0	22	Styrene	23,072,308	1,845,785
23	Manganese and its compounds	1,144,154	0	23	n-Hexane	17,359,121	520,774
24	Copper and its compounds	1,005,060	0	24	Nitrate compounds	247,885	520,559
25	Aluminum (fume or dust)	583,840	0	25	Ethylene glycol	1,304,164	326,041
26	Vanadium and its compounds	565,787	0	26	Sulfuric acid	82,130,785	0
27	Nitrate compounds	247,885	0	27	Ethylene	9,204,438	0
28	Phosphorus	121,665	0	28	Phosphorus	121,665	0
29	Asbestos (friable form)	715	0	29	Asbestos (friable form)	715	0

Note: The pollutant 1,2-dichloroethane is not included because no air releases were reported in 2005. Reporting thresholds for certain pollutants vary among the three countries (see **appendix**).

Table 3–14. TEP Scores for Carcinogens and Developmental/Reproductive Toxicants Released to Water in North America, 2005

	Pollutant ranked by TEP scoring for carcinogens	Amount released to water (kg)	TEP score for carcinogens		Pollutant ranked by TEP scoring for developmental/reproductive	Amount released to water (kg)	TEP score for developmental/reproductive
1	Arsenic and its compounds	78,258	313,032,410	1	Lead and its compounds	105,858	4,446,050,931
2	Lead and its compounds	105,858	211,717	2	Copper and its compounds	276,561	3,318,727,570
3	Glycol ethers	57,912	57,912	3	Arsenic and its compounds	78,258	1,565,162,049
4	Hydrogen sulfide	47,582	47,582	4	Vanadium and its compounds	203,603	144,558,130
5	Dichloromethane	2,587	336	5	Chromium and its compounds	74,636	32,840,024
6	Formaldehyde	188	0	6	Barium and its compounds	519,425	24,932,390
7	Nitrate compounds	152,697,190	0	7	Manganese and its compounds	4,263,163	14,921,071
8	Ammonia	55,558,696	0	8	Zinc and its compounds	733,929	10,275,006
9	Phosphorus	6,921,767	0	9	Nickel and its compounds	134,077	3,485,991
10	Manganese and its compounds	4,263,163	0	10	Hydrogen sulfide	47,582	2,807,340
11	Methanol	3,983,406	0	11	Ammonia	55,558,696	555,587
12	Zinc and its compounds	733,929	0	12	Glycol ethers	57,912	57,912
13	Barium and its compounds	519,425	0	13	n-Hexane	7,390	45,818
14	Copper and its compounds	276,561	0	14	Methanol	3,983,406	39,834
15	Ethylene glycol	246,678	0	15	Toluene	13,706	12,061
16	Vanadium and its compounds	203,603	0	16	Dichloromethane	2,587	11,383
17	Nickel and its compounds	134,077	0	17	Xylenes	12,414	6,952
18	Chromium and its compounds	74,636	0	18	n-Butyl alcohol	24,632	4,187
19	Sulfuric acid	33,574	0	19	Ethylene glycol	246,678	1,036
20	n-Butyl alcohol	24,632	0	20	Styrene	2,541	864
21	Hydrogen fluoride	18,899	0	21	Formaldehyde	188	55
22	Toluene	13,706	0	22	Aluminum (fume or dust)	1	9
23	Xylenes	12,414	0	23	Nitrate compounds	152,697,190	0
24	n-Hexane	7,390	0	24	Phosphorus	6,921,767	0
25	Styrene	2,541	0	25	Sulfuric acid	33,574	0
26	Ethylene	209	0	26	Hydrogen fluoride	18,899	0
27	Aluminum (fume or dust)	1	0	27	Ethylene	209	0
28	Asbestos (friable form)	0	0	28	Asbestos (friable form)	0	0
29	Hydrochloric acid	0	0	29	Hydrochloric acid	0	0

Note: The pollutant 1,2-dichloroethane is not included because no water releases were reported in 2005. Reporting thresholds for certain pollutants vary among the three countries (see **appendix**).

Table 3–15. TEP Scores for Other Carcinogens and Developmental/Reproductive Toxicants Released to Air in North America, 2005

Pollutant ranked by TEP scoring for air releases		Amount released to air	Unit	TEP score for carcinogens	TEP score for developmental/reproductive
Mercury and its compounds	DMP	69,659	kg	0	975,227,497,277
Benzene	DC	3,438,039	kg	3,438,039	27,848,118
Vinyl chloride	C	298,423	kg	567,004	20,591,189
Hexachlorobenzene	DCP	400	g	880,000	8,400,000

Note: D, C, M, P = developmental/reproductive toxicant, known or suspected carcinogen, metal or PBT. Mercury compounds and hexachlorobenzene have lower reporting thresholds under all three PRTRs. Reporting thresholds for certain pollutants vary among the three countries (see **appendix**).

Table 3–16. TEP Scores for Other Carcinogens and Developmental/Reproductive Toxicants Released to Water in North America, 2005

Pollutant ranked by TEP scoring for water releases		Amount released to water	Unit	TEP score for carcinogens	TEP score for developmental/reproductive
Mercury and its compounds	DMP	14,421	kg	0	187,470,610,426
Benzene	DC	114,414	kg	86,955	1,144,141
Hexachlorobenzene	DCP	31	g	106,778	1,036,377
Vinyl chloride	C	482	kg	2,216	67,432

Note: D, C, M, P = developmental/reproductive toxicant, known or suspected carcinogen, metal or PBT. Mercury compounds and hexachlorobenzene have lower reporting thresholds under all three PRTRs. Reporting thresholds for certain pollutants vary among the three countries (see **appendix**).

Other PRTR Pollutants with High TEP Scores

In addition to these top-reported pollutants, other substances recognized for their potential to cause health effects were also released to air and water by North American industrial facilities. The four pollutants presented in **Tables 3-15** and **3-16** include those released to either air or water but not included among the top-reported substances for 2005, as well as pollutants reported in very small quantities. But all are known to be carcinogens, developmental or reproductive toxicants, or both. As in the previous tables, they are ranked by TEP weightings for carcinogenicity and developmental or reproductive toxicity.

The tables reveal that these pollutants have high TEP weightings. Mercury (and its compounds), a PBT released in relatively small quantities by North American facilities in 2005, has a TEP weighting in the millions, giving it an extremely high ranking as a developmental or reproductive toxicant for both air and water releases. Benzene, the reference chemical for TEP weightings for carcinogens, also scores high as a developmental or reproductive toxicant, particularly for air releases, as does vinyl chloride. Hexachlorobenzene (reported in grams) also has very high TEP weightings, particularly for developmental or reproductive toxicity, but also for carcinogenicity.

For certain pollutants, the three PRTR programs have set stricter reporting requirements, such as very low reporting thresholds, or even reporting of any amount, however small. These requirements have been developed on the basis of chemical toxicity and potential for risk to human health and the environment. For some pollutants such as the PBTs hexachlorobenzene and dioxins/furans, the need for very low reporting thresholds and units in order to capture releases of concern has been widely recognized.[8] Similarly, lead and mercury and their compounds are reported under lower thresholds to all three PRTRs.

However, the thresholds for some substances can vary considerably among the PRTRs. For example, the Canadian NPRI and Mexican RETC thresholds for arsenic and cadmium and their compounds

[8] As noted, hexachlorobenzene is reported in grams, and in Canada and certain other countries dioxins and furans are reported in grams in International Toxic Equivalency (gTEQ).

vary from 1 to 50 kilograms, whereas the US TRI threshold is 11,340 kilograms for both arsenic and cadmium. More information about reporting requirements for specific pollutants is provided in the **appendix**.

Uses and Chemical Properties of Pollutants of Special Interest

This section describes the uses and chemical properties of some of the pollutants of special interest reported to the North American PRTRs in 2005.

As illustrated in the previous section, TEPs are one indicator of potential risk. However, in the absence of other information such as route and length of exposure, it is difficult to determine the actual risk posed by a substance. Alternatively, it cannot be assumed that pollutants with low or nonexistent TEP scores pose no harm to human health or to the environment. Only a small number of all pollutants reported by North American facilities are discussed in this section. Readers are encouraged to refer to the sources used in compiling this section for additional information.[9]

Arsenic, a naturally occurring metal, cannot be destroyed, only transformed. Inorganic arsenic compounds are commonly used to preserve wood; organic arsenic compounds are used as pesticides. Humans may be exposed to this substance by ingesting small amounts in food and water, or breathing sawdust or burning smoke from wood treated with arsenic. Exposure may also result from living in areas with unusually high natural levels of arsenic in rock, or working in jobs involving arsenic production or use (e.g., copper or lead smelting, wood treating or pesticide application). Trace amounts of arsenic are also present in coal and petroleum, and therefore they can be released through combustion.

Breathing high levels of inorganic arsenic can irritate the throat and lungs; ingesting very high levels can result in death. Exposure to lower levels may cause nausea and vomiting, damage to blood vessels and a sensation of "pins and needles" in hands and feet. Long-term ingestion or respiration of low levels of inorganic arsenic can change skin appearance; and skin contact may cause redness and swelling. Inorganic arsenic is a human carcinogenic. There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores, and that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

Asbestos is the common name of a group of mineral fibers that occur naturally in the environment. Because of its heat-resistant characteristics, asbestos has been used in a wide variety of manufactured goods and building materials—examples are roofing shingles, ceiling and floor tiles, paper products, cement products and automobile parts such as brake linings. Just by breathing the air in most cities and industrial areas, people are exposed to very low levels of asbestos. Those working with asbestos products, removing asbestos from buildings or working in asbestos mining may be exposed to high levels of asbestos in the air, as are those living in proximity to these industrial activities.

Breathing high levels of asbestos fibers over a long period of time can lead to asbestosis, the development of scar-like tissue in the lungs and in the pleural membrane (lining) that surrounds the lung. The sufferer will have difficulty breathing and a cough, and sometimes an enlarged heart. The disease can eventually lead to death. Breathing lower levels of asbestos may result in changes in the pleural membranes that restrict breathing. Breathing asbestos increases one's risk of cancer, especially lung cancer and mesothelioma (cancer of the pleural membrane or abdominal cavity). Studies of workers also suggest that breathing asbestos can increase the chances of getting other types of cancer. Cigarette smoke and asbestos together significantly increase the chances of developing lung cancer.

Benzene is a colorless, highly flammable liquid that evaporates into the air very quickly and dissolves slightly in water. It is formed by both natural processes and human activities. Benzene is used widely to make other chemicals, which are then used in the production of plastics, resins and synthetic fibers, as well as rubber, lubricants, dyes, detergents, drugs and pesticides. Natural sources of benzene are emissions from volcanoes and forest fires. Benzene is also a component of crude oil and gasoline. Exposure occurs through inhalation of industrial emissions, tobacco smoke, vehicle exhaust and vapors from glues, paints and other benzene-containing products.

Breathing high levels of benzene can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion and unconsciousness. Very high levels can result in death. Eating foods and drinking beverages that contain high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate and death. The major effect of long-term exposure to benzene is a decrease in red blood cells, leading to anemia. It can also cause excessive bleeding and affect the immune system. Benzene is a carcinogen; long-term exposure to high levels of benzene in the air can lead to leukemia.

Chromium, a naturally occurring element found in nature, exists in several different forms—liquid, solid or gas. It can change form fairly easily in water and soil. The most common forms of chromium are chromium(0), the metal, as well as chromium(III) and chromium(VI). The metal chromium is used in making steel. Chromium(VI), also known as hexavalent chromium, and chromium(III) are used in chrome plating, dyes and pigments, leather tanning and wood preserving. Exposure to chromium can occur through eating food containing chromium(III), breathing contaminated air (e.g., during the manufacture of chrome-based products), skin contact, drinking contaminated well water, or living near uncontrolled hazardous waste sites that contain chromium or industries that use chromium.

The hazards associated with chromium depend on its form. Breathing high levels of chromium(VI) can irritate the lining of the nose and cause breathing problems such as asthma, coughing or shortness of breath. Chromium(VI) compounds are known human carcinogens, and in workers inhalation has been linked with lung cancer. An increase in stomach tumors has been observed in humans and animals exposed to chromium(VI) in drinking water. Damage to the male reproductive system has also been observed in laboratory animals exposed to chromium(VI).

[9] This section is based on the following sources: ToxFAQs, US Agency for Toxic Substances and Disease Registry <http://www.atsdr.cdc.gov/toxfaq.html>; Chemical Fact Sheets, Office of Pollution Prevention and Toxics, US Environmental Protection Agency <http://www.epa.gov/chemfact/>; Hazardous Substance Fact Sheets, New Jersey Department of Health and Senior Services <http://web.doh.state.nj.us/rtkhsfs/indexFs.aspx>; and Scorecard <http://www.scorecard.org>.

The pollutant **1,2-dichlorethane**, also called ethylene dichloride, is a manufactured chemical that takes the form of a clear liquid. The most common use of 1,2-dichloroethane is in the production of vinyl chloride, which is used to make a variety of plastic and vinyl products, such as polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, housewares and automobile parts. It is also used as a solvent and paint remover, and is added to leaded gasoline to remove lead. Exposure can occur through breathing air or drinking water that contains 1,2-dichloroethane, or living near industrial activities that use this chemical. People residing close to uncontrolled hazardous waste sites also may be exposed to higher than usual levels of 1,2-dichloroethane.

Exposure to 1,2 dicholorethane can cause nausea, vomiting, headache, dizziness, confusion, tremor, loss of memory and even loss of consciousness. Liver and kidney diseases, as well as lung effects such as irritation, cough and shortness of breath, have been reported in humans ingesting or inhaling large amounts of 1,2-dichloroethane. Animal studies also suggest that 1,2-dichloroethane may damage the immune system. And it can irritate the skin and eyes, and may be a human carcinogen. Studies in animals indicate that 1,2-dichloroethane does not affect reproduction.

Formaldehyde is a colorless, flammable gas (at room temperature) that has a distinct pungent smell. It is used in the production of fertilizer, paper, plywood and urea-formaldehyde resins, and as a preservative in some foods and in many products used around the house such as antiseptics, medicines and cosmetics. Formaldehyde dissolves easily, but it does not last a long time in water. Although most formaldehyde in the air breaks down into formic acid and carbon monoxide, exposure to formaldehyde can occur through inhalation (e.g., in manufacturing industries and institutions such as hospitals). Smog and cigarette smoke are sources of exposure as well, and manufactured wood products used in homes emit formaldehyde as a gas.

Low levels of formaldehyde irritate the eyes, nose, throat and skin, and people with asthma may be more sensitive to the effects of inhaled formaldehyde. Drinking large amounts of formaldehyde can result in severe pain, vomiting, coma and even death. And formaldehyde is a possible human carcinogen. Animal studies suggest that formaldehyde will not cause birth defects in humans.

Hexachlorobenzene is a white crystalline solid that is not very soluble in water and does not occur naturally in the environment. It is formed as a by-product of the manufacture of other chemicals, in the waste streams of chloralkali and wood-preserving plants, and through the burning of municipal waste. In the past, hexachlorobenzene was used as a pesticide and fungicide, as well as to make fireworks, ammunition and synthetic rubber. It was first banned in the United States in the 1960s, followed by Canada in the 1970s and Mexico in 1991. However, small amounts of this substance are still created as an unintentional by-product of the manufacture of chlorine-containing compounds or pesticides, from the chlorination of wastewater, and from the incineration of municipal and hazardous wastes.

Because it is a PBT, hexachlorobenzene remains in the environment for very long periods of time. Human exposure can occur from eating contaminated food and fish, drinking contaminated milk or water, eating dairy products or meat from cattle that grazed on contaminated pastures, breathing contaminated air, or working in an industrial setting in which hexachlorobenzene is an unintentional by-product. Exposure can lead to changes in urine and skin color, skin sores, arthritis and problems of the liver and of the nervous system, immune and endocrine systems. Hexachlorobenzene may be a human carcinogen.

Hydrogen sulfide is a flammable, colorless gas with a characteristic odor of rotten eggs. It occurs naturally in crude petroleum, natural gas, volcanic gases and hot springs. It also can be formed from the bacterial breakdown of organic matter and human and animal wastes. Hydrogen sulfide is a by-product of certain industrial activities, such as food processing, coke ovens, Kraft paper mills, tanneries and petroleum refineries. Human exposure occurs from breathing contaminated air or drinking contaminated water. People living near wastewater treatment plants, gas and oil drilling, farms with manure or landfills may be exposed to higher levels of this gas.

Exposure to low concentrations of hydrogen sulfide may irritate the eyes, nose or throat, and cause difficulty in breathing for asthmatics. Prolonged exposure at low concentrations can produce sleeplessness, blurred vision and hemorrhage, and even result in death. Brief exposures to high concentrations of hydrogen sulfide can cause loss of consciousness, as well as long-term effects such as headaches, poor attention span, and loss of memory and motor function, or even death.

Lead is a naturally occurring, bluish-gray metal found in nature. It does not break down, but can be transformed by sunlight, air and water. Much of the lead found in the environment is from human activities such as burning fossil fuels, mining and manufacturing. Lead is found in vehicle batteries, pigments, plastics, glass, electronics, plumbing, cigarettes, ammunition and consumer products such as jewelry and pottery. It is also used in ammunition, explosives and devices to shield X-rays, as well as insecticides, rodenticides and ointments. Human exposure can occur through eating food or drinking water that contains lead. Water pipes in some older homes may contain lead solder, and lead can leach out into the water. Deteriorating lead paint can contribute to lead dust and exposure through inhalation. Industrial activities using lead are another source of exposure.

Because of health concerns, the lead in paints and ceramic products, caulking and pipe solder has been dramatically reduced in recent years, and it is no longer used as an additive to gasoline. Exposure to lead through inhalation or swallowing can affect almost every organ and system in the body, especially the nervous system, in both adults and children. Exposure to high lead levels can severely damage the brain and kidneys of adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage, growth defects and mental impairment in offspring. At much lower levels of exposure, lead can affect a child's mental and physical growth, and because it is a PBT, it is stored in the bones and accumulates over time. Inorganic lead is likely a human carcinogen.

Mercury is a naturally occurring metal that takes several forms. Metallic mercury is a shiny, silver-white, odorless liquid that, when heated, becomes a colorless, odorless gas. Mercury combines with other elements, such as chlorine, sulfur or oxygen, to form inorganic mercury compounds. Mercury also combines with carbon to make organic mercury compounds, including methylmercury, commonly produced by microscopic organisms in the water and soil. Metallic mercury is used to produce chlorine gas and caustic soda, and it is used in thermometers, dental fillings and batteries. In addition to erosion and volcanic activity, major sources of human exposure are emissions from coal-fired power plants, mining, smelters, cement plants and incinerators and the disposal of consumer products such as switches, thermometers and lamps.

The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic or organic mercury can permanently damage the brain, kidneys and a developing fetus. Effects on brain function may result in irritability, tremors, changes in vision or hearing and memory problems. Very young children are more sensitive to mercury than adults.

Mercury transported over long distances through the atmosphere is deposited in soils and in water far from the originating sources. Because mercury is a PBT and bioaccumulates in fish, humans are exposed to mercury when they consume fish, shellfish and marine mammals.

Toluene is a clear, colorless liquid that occurs naturally in crude oil and in the tolu tree. It is also produced when using crude oil to make gasoline and other fuels and using coal to make coke. Toluene is used in paints, paint thinners, fingernail polish, lacquers, adhesives and rubber and in some printing and leather tanning processes. Humans may be exposed to toluene when breathing contaminated workplace air or automobile exhaust; working with gasoline, kerosene, heating oil, paints and lacquers; drinking contaminated well water; or living near uncontrolled hazardous waste sites containing toluene products.

Toluene can affect the nervous system. Even low levels can cause tiredness, confusion, weakness, memory loss, nausea, loss of appetite, and loss of hearing and color vision. Acute inhalation of high levels of toluene can affect the kidneys and lead to dizziness and fatigue, unconsciousness and even death. Breathing very high levels of toluene during pregnancy can result in birth defects and slower mental abilities and growth in offspring.

Releases of Criteria Air Contaminants and Greenhouse Gases

In 2005 many of the facilities reporting to the three North American PRTR programs were also associated with releases of criteria air contaminants and greenhouse gases.[10] Criteria air contaminants are carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter (total PM, PM_{10} and $PM_{2.5}$), sulfur oxides (SO_x) and volatile organic compounds (VOCs). These contaminants are associated with various health and environmental effects, including ground-level ozone formation, smog, acid rain, regional haze, respiratory illness and lung damage, and fatigue. Exposure to high levels of carbon monoxide can be fatal.

Greenhouse gases are produced by natural processes, as well as by human activities such as burning fossil fuels. The main greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs), and sulfur hexafluoride (SF_6). These gases contribute to climate change by trapping heat in the earth's atmosphere.

[10] This section is based on the following sources: Canada: NPRI <http://www.ec.gc.ca/pdb/npri/>, GHG Inventory <http://www.ec.gc.ca/pdb/ghg>, GHG Emissions Reporting program <http:www.ec.gc.ca/pdb/ghg/facility_e.cfm>; United States: US NEI 2005 (version 2, October 2008), US GHG Inventory <http://www.epa.gov/climatechange/emissions/>, US Powerplants reference: e-grid 2007 (version 1.1) <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>; Mexico: Mexican NEI, Semarnat, Dirección General de Gestión de la Calidad del Aire y RETC, 2005 <http://app1.semarnat.gob.mx/retc/index.html>, Mexican GHG Inventory <http://www.ine.gob.mx/publicaciones/libros/489/inventario.pdf>.

Although some of these substances are reported to Canada's NPRI and Mexico's RETC, they are not subject to US TRI reporting. Other national programs in the three countries, such as emissions inventories and greenhouse gas registers, collect data on these pollutants at various levels of aggregation (national, state/province, sectoral or by facility).

In Canada, CACs are reported through the NPRI, and certain facility-level GHG data are reportable under the GHG Emissions Reporting program. This reporting applies only to industrial sources emitting more than 100,000 metric tons a year of CO_2 equivalents.[11] Data for all other sources are aggregated and available through the national GHG Inventory.

In Mexico, GHGs and certain CACs are reported through the *Cédula de Operación Anual* (COA). Although GHGs are included in the list of RETC substances, CAC data from reporting facilities are used as the basis for the Mexican National Emissions Inventory (MNEI), which is published every three years (the most recently published data are for 1999). The MNEI is currently being updated for the data year 2005. For this report, data on six CACs from RETC reporting facilities were obtained from the COA and supplemented with the preliminary MNEI data for 2005.

In the United States, CACs and GHGs are not subject to US TRI reporting. However, facilities, including many of those reporting to the TRI, report their CAC emissions to local and state agencies. The states then transfer the information to the EPA for inclusion in the National Emissions

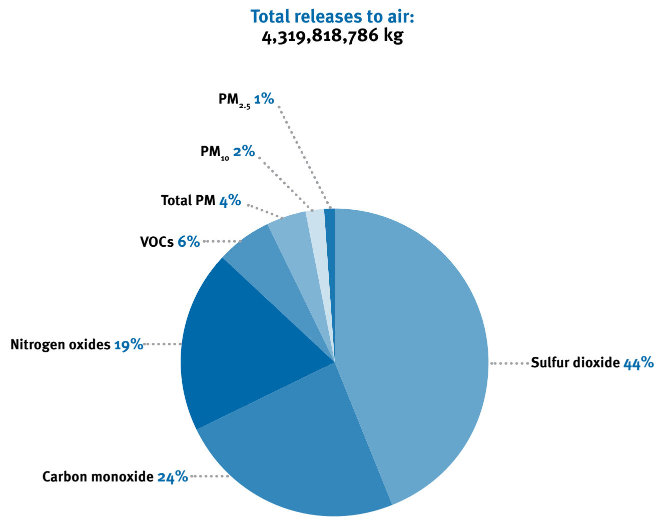
[11] CO_2 equivalent units describe the amount of CO_2 that would have the equivalent global warming potential (GWP) of the amount released of a given greenhouse gas (e.g., carbon dioxide has a GWP of 1, methane has a GWP of 21, and nitrous oxide has a GWP of 310).

Criteria Air Contaminants and Greenhouse Gases

Criteria air contaminants—carbon monoxide, nitrogen oxides, particulate matter, sulfur oxides and volatile organic compounds—are a group of chemicals associated with environmental effects such as smog, acid rain and regional haze, and health effects such as respiratory illnesses. Major sources of CACs are the burning of fossil fuels, as well as natural resource extraction and a variety of manufacturing activities.

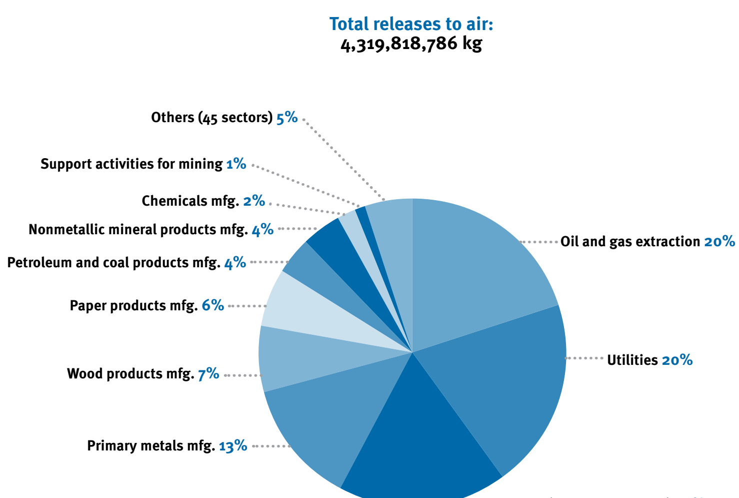
Greenhouse gases contribute to climate change by trapping heat within the earth's atmosphere. GHGs are the subject of the international Kyoto Protocol, which came into force in 2005. The major gases include carbon dioxide, methane, nitrous oxide and three groups of fluorinated gases. Some of the main anthropogenic sources of GHGs are the burning of fossil fuels, deforestation and agricultural activities.

Figure 3–4. CACs, by Type, Reported by Canadian Facilities to NPRI, 2005



Source: NPRI, 2005.

Figure 3–5. Reporting of CACs by Industrial Sector, NPRI, 2005



Source: NPRI, 2005.

Inventory (NEI), which is updated every three years. CAC data for TRI reporting facilities were obtained from the 2005 NEI (version 2, October 2008).

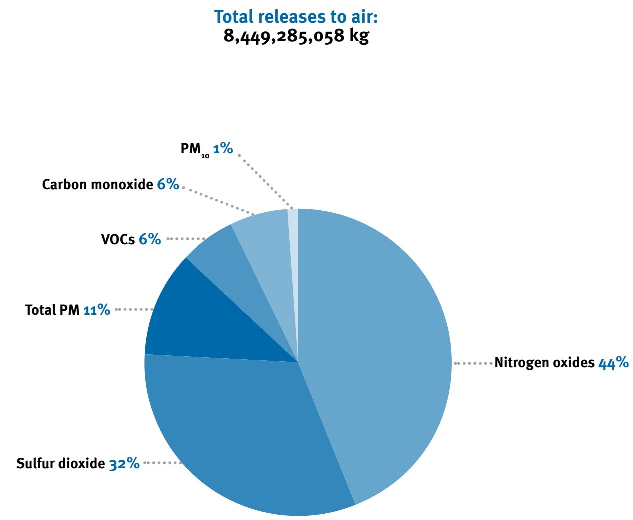
Readers wishing to find out more about CAC and GHG reporting in the three countries can consult the sources referenced in this chapter.

Criteria Air Contaminants Reporting, 2005. The data for emissions of CACs by PRTR reporting facilities reveal that industrial activities such as resource extraction, combustion of fossil fuels, and certain types of manufacturing released substantial quantities of these pollutants to air in 2005.

In Canada, the 7,284 facilities reporting to the NPRI in 2005 released about 4.3 billion kilograms of CACs to air (**Figure 3–4**). Oil and gas extraction facilities, electric utilities and the mining and primary metals manufacturing sectors accounted for more than 70 percent of the total (**Figure 3–5**). About 44 percent of these emissions (1.8 billion kilograms) were sulfur dioxide, mainly from metal mines and electric utilities. Just over 1 billion kilograms of carbon monoxide were released mainly from the primary metals (particularly aluminum products) and wood products manufacturing sectors. Nitrogen oxides were released in large amounts by electric utilities, along with oil and gas extraction activities and cement and concrete manufacturers. Volatile organic compounds were reported primarily by the oil and gas extraction, wood products, paper products and transportation equipment manufacturing sectors. Particulate matter was released by electric utilities, paper products manufacturing, metal ore mines and the primary metals sector.

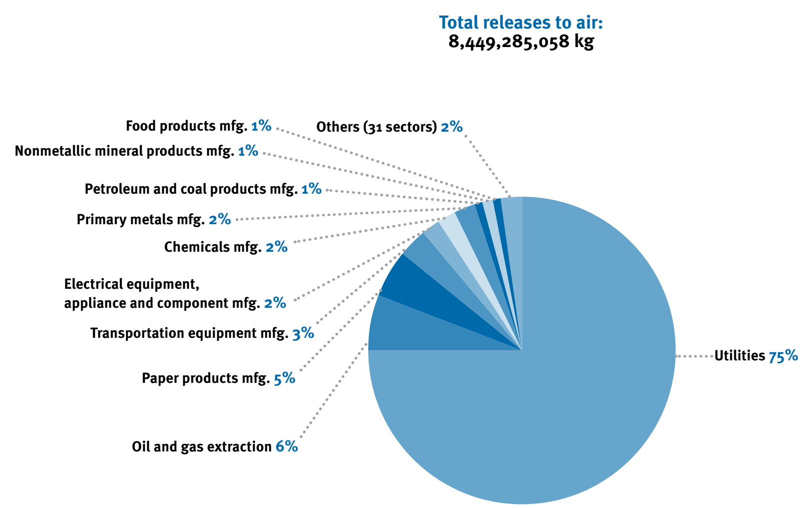
In Mexico 1,939 facilities reported to the RETC releases of almost 8.5 billion kilograms of CACs in 2005 (**Figure 3–6**). Electric utilities reported a majority (75 percent) of these releases, particularly nitrogen oxides and sulfur dioxide (**Figure 3–7**). Oil and gas extraction activities generated large releases of carbon monoxide, as well as volatile organic compounds. Mexican electric utilities, electrical equipment manufacturers and the paper products manufacturing sector reported the largest proportions of particulate matter. Transportation equipment manufacturers reported large releases of volatile organic compounds and carbon monoxide.

Figure 3–6. CACs, by Type, Reported by Mexican Facilities to RETC, 2005



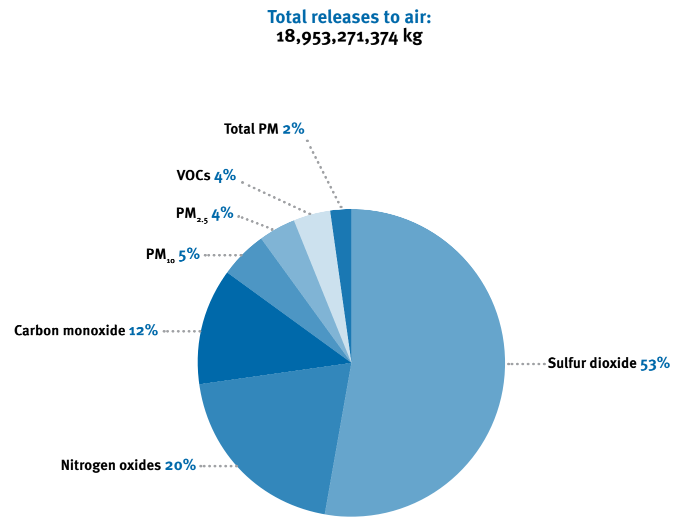
Source: RETC, 2005.
Note: Data for $PM_{2.5}$ are not included.

Figure 3–7. Reporting of CACs by Industrial Sector, RETC, 2005



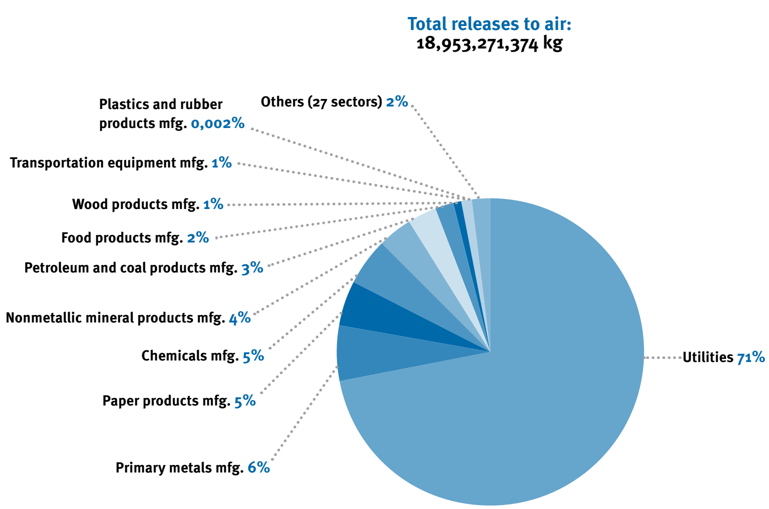
Source: RETC, 2005.

Figure 3–8. CACs, by Type, Reported by US Facilities to TRI, 2005



Source: US National Emissions Inventory 2005 (version 2, October 2008).

Figure 3–9. Reporting of CACs by Industrial Sector, TRI, 2005



Source: US National Emissions Inventory 2005 (version 2, October 2008).

In the United States, 8,134 facilities reporting to the TRI in 2005 reported almost 19 billion kilograms of CAC emissions (**Figure 3–8**). According to these data obtained from the US National Emissions Inventory (version 2, October 2008), the CACs reported by TRI facilities accounted for about 80 percent of the 24.5 billion kilograms of CACs reported by all sources in 2005. Sulfur dioxide was released in the largest proportion; more than 10 billion kilograms were reported. Approximately 4 billion kilograms of nitrogen oxides, 2.2 billion kilograms of carbon monoxide, 1.8 billion kilograms of particulate matter and 675 million kilograms of volatile organic compounds were also released.

US electric utilities (coal- and oil-fired power plants) accounted for the majority of releases (almost 72 percent), particularly of sulfur dioxide, nitrogen oxides and particulate matter (**Figure 3–9**). Primary metals manufacturers released very large quantities of carbon monoxide. This sector and four others—paper products, chemicals, petroleum products and nonmetallic mineral products manufacturers such as granite and limestone—accounted for very high releases of all types of CACs.

Greenhouse Gas Reporting, 2005. Because limited GHG data are available at the facility level, data from the national greenhouse gas inventories are also presented here in order to provide a broad overview of GHG releases in each country. These data are estimates from all sources, which generally include energy, industry, transportation, residential, agriculture, waste, land use and forestry. However, the source categories vary somewhat among the three inventories, and therefore are not easily comparable. The data are provided in CO_2 equivalent units.

Data from specific industrial facilities reporting in Canada, Mexico and the United States reveal that certain activities (such as fossil fuel–based electricity generation, oil and gas extraction and landfills) contributed substantial amounts to the total GHG releases in each country.

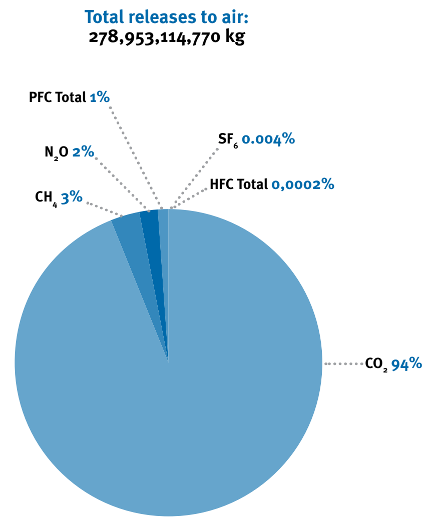
In Canada, total GHG emissions in 2005 from all sources considered were estimated at 747 billion kilograms (CO_2 equivalents).[12]

Facility-specific data are available only for industrial sources that release more than 100,000 metric tons per year of CO_2 equivalent emissions (see **Figures 3–10** and **3–11**). These facilities have to report to Canada's GHG Emissions Reporting program <http://www.ec.gc.ca/pdb/ghg/facility_e.cfm>.

In 2005, 354 industrial facilities reported to this program releases of 278 billion kilograms of GHGs (many of them also reported releases and transfers of other pollutants to the NPRI). Carbon dioxide accounted for 94 percent of all GHG emissions, followed by methane and relatively small amounts of nitrous oxides and other gases. Facilities in four sectors contributed more than 70 percent of these GHG releases in 2005. Of this amount, 122.6 billion kilograms (44 percent) were released by electric utilities, and 99 percent of these releases were carbon dioxide. Another 11 percent (about 30 billion kilograms) of the total was released by 15 oil and gas extraction facilities, and more than 93 percent of these emissions were carbon dioxide. In 2005 Canadian primary metals manufacturers released more than 17 billion kilograms of GHGs, and cement manufacturers released more than 13 billion kilograms (the majority of releases from both industries were carbon dioxide). Facilities involved in landfill operations reported the largest releases of methane in 2005.

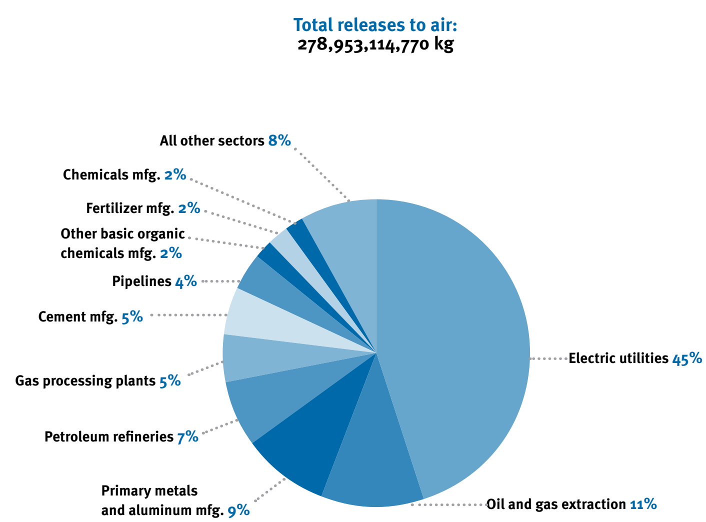
In Mexico, total GHG emissions for 2002 (the most recent statistics available) from all sources considered were 643 billion kilograms (CO_2 equivalents). Seventy-four percent of these releases were carbon dioxide, 23 percent methane, and 2 percent nitrous oxide. Other gases—hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride—made up the remaining 1 percent.[13]

Figure 3–10. GHGs, by Type, Reported by Canadian Facilities to the GHG Emissions Reporting Program, 2005



Source: GHG Emissions Reporting Program <http://www.ec.gc.ca/pdb/ghg/facility_e.cfm>, accessed December 2008.

Figure 3–11. Reporting of GHGs by Industrial Sector, GHG Emissions Reporting Program, 2005



Source: GHG Emissions Reporting Program <http://www.ec.gc.ca/pdb/ghg/facility_e.cfm>, accessed December 2008.

[12] These data were provided by Canada's GHG Inventory <http://www.ec.gc.ca/pdb/ghg/inventory_report/2005/2005summary_e.cfm>, accessed December 2008.
[13] These data were provided by the Mexican GHG Inventory <http://www.ine.gob.mx/publicaciones/libros/489/inventario.pdf>.

Table 3–17. Reporting of GHGs by Mexican Facilities, RETC, 2005

GHG	Total Releases (CO_2-equivalents kg)	Industry Sectors Accounting for 50 Percent or more of the Total
Carbon dioxide	94,546,714,594	Electric Utilities, Petroleum, Chemicals
Nitrogen dioxide	99,856,386	Electric Utilities
Methane	76,566,286	Oil and Gas Extraction

Source: RETC, 2005.

Table 3–18. Releases of GHG from US electric utilities, 2005

GHG	Releases (CO_2 equivalents)
Carbon dioxide	2,696 billion kg
Methane	50,169,700 kg
Nitrous oxides	37,908,063 kg

Source: US Powerplants reference: e-grid 2007 (version 1.1) <http://www.epa.gov/cleanenergy/energy-resources/egrid/index.html>.

Facility-specific GHG data are available only for certain facilities that reported to the RETC through the *Cédula de Operación Anuál*. In 2005, 1,546 RETC facilities reported the releases of GHG shown in **Table 3–17**.

These facilities released more than 94 billion kilograms of GHG, 99 percent of which was carbon dioxide. The main industrial sources of CO_2 were electric utilities and the petroleum and chemicals sectors. Electric utilities and the oil and gas extraction sector also released nitrogen dioxide and methane.

In the United States, total GHG emissions in 2005 from all sources considered were 7,094 billion kilograms (CO_2 equivalents).[14]

Facility-specific greenhouse gas data are available only for US coal- and oil-fired electric utilities for carbon dioxide, methane and nitrous oxides (US Powerplants—see source to **Table 3–18**). In 2005, 4,998 electric utilities released these three GHGs in the amounts shown in **Table 3–18**.

Total reported releases from electric utilities were 2,696 billion kilograms (more than 99 percent of this amount was carbon dioxide). The releases from these facilities accounted for 37 percent of all reported GHG emissions from all US sources in 2005.

[14] These data were provided by the US GHG Inventory <http://www.epa.gov/climatechange/emissions/>.

Taking Stock

4

Releases and Transfers from the Petroleum Industry in North America, 2005

4

Taking Stock

Releases and Transfers from the Petroleum Industry in North America, 2005

Key Findings

- **In 2005, 15,461 facilities in the petroleum industry reported to the pollutant release and transfer registers (PRTRs) of Canada, Mexico and the United States. Of the four sectors discussed in this chapter—oil and gas production, pipeline transport of petroleum and natural gas, petroleum refineries and bulk storage terminals—two, oil and gas production and pipelines, were not subject to US Toxics Release Inventory (TRI) reporting, and therefore US National Emissions Inventory (NEI) data were used for air releases from facilities in these sectors. When all data sources are considered, US facilities numbered 11,331, Canadian facilities 3,867 and Mexican facilities 263.**

- **Petroleum facilities reported about 1.5 billion kilograms, or one-quarter, of the 5.5 billion kilograms of toxic pollutants* reported by all sectors in 2005 (see Chapter 3). Hydrogen sulfide, reported by Canadian facilities only, accounted for about 1.36 billion kilograms (90 percent) of this amount, with a variety of other toxics making up the remainder.**

- **In addition to toxic pollutants, the petroleum industry released some 3.7 billion kilograms of criteria air contaminants, a group of pollutants associated with a variety of health and environmental issues. Although facility-level data for greenhouse gas releases by petroleum facilities are not generally available, the country-level data presented in Chapter 3 indicate that this industry also contributed large amounts of GHG releases in 2005.**

- **A review of consistent reporting by Canadian and US refineries and bulk storage terminals over the four years from 2002 to 2005 reveals that an average of about 7 million kilograms of carcinogens and developmental or reproductive toxicants were released on- or off-site annually, with many of them released to air or water.**

- **In each of the four petroleum sectors presented in this chapter, about 30 substances accounted for the majority of all reported releases and transfers, with CAC releases accounting for the bulk of reporting by each sector. Like CAC reporting, some of the toxic pollutants reported in very large amounts to one PRTR program were not subject to reporting under another. Hydrogen sulfide is one example: this pollutant ranked first in amounts reported by Canadian facilities, but it was not subject to reporting under the US TRI and NEI. In Mexico, hydrogen sulfide is reportable under the country's PRTR, *Registro de Emisiones y Transferencia de Contaminantes* (RETC), but it was not reported by any Mexican petroleum facility in 2005.**

- **Differences in national reporting requirements and the wide variations in reporting overall result in gaps in the picture of pollution from the North American petroleum industry. These findings can be used to further the efforts of the three governments to improve the reliability and comparability of North American PRTR data and to prioritize areas for further action on pollution prevention and reduction.**

* The terms "toxic pollutants" or "toxics" are employed to distinguish all pollutants reported to PRTRs from the group of Criteria Air Contaminants.

Introduction

Petroleum is a nonrenewable resource found in nature, an important source of energy, and a building block for industrial chemicals and the plastics that are turned into consumer products. Many people and facilities across North America are involved in the exploration, production, refining and transportation of petroleum. Some of these facilities are familiar, such as the cluster of large oil and gas storage tanks in some cities or the refineries dotting the Texas and Louisiana coastlines. Others are less visible, such as the thousands of kilometers of pipelines buried underground and their associated compressor stations that help move oil, gas and petroleum products from one area to another. However, each of these facilities has a role in petroleum products reaching North American markets, and each presents environmental challenges.

This chapter examines releases and transfers reported in 2005 by four sectors of the petroleum industry in North America: oil and gas production, pipeline transport of petroleum and natural gas, petroleum refineries and bulk storage terminals. More specifically, this chapter includes:

- a description of the North American petroleum industry and its main activities (sectors);
- a discussion of the associated environmental and health issues;
- a description of the current regulatory climate in each country;
- an examination of the releases and transfers of pollutants reported by each petroleum sector in each country; and
- a review of pollutants of concern released from 2002 to 2005 by Canadian and US refineries and bulk storage terminals.

This investigation of releases and transfers in 2005 by the petroleum industry in North America reveals that the industry contributed 1.5 billion kilograms, or about one-quarter, of the 5.5 billion kilograms of toxic pollutants reported by all sectors that year (see **Chapter 3**). One pollutant, hydrogen sulfide, accounted for at least 90 percent of this amount, with a variety of other toxics making up the remainder. The petroleum industry also released about 3.7 billion kilograms of criteria air contaminants, a group of pollutants associated with a variety of health and environmental issues. A review of consistent reporting by Canadian and US refineries and bulk storage terminals from 2002 to 2005 produces yet another finding: an average of about 7 million kilograms of carcinogens and developmental or reproductive toxicants were released annually.

By supplementing PRTR data with other available data on releases to air of criteria air contaminants and toxic pollutants, *Taking Stock* provides the most complete picture of releases and transfers by the industry to date. However, although this picture reveals certain similarities in petroleum sector reporting among Canada, Mexico and the United States, it also uncovers important gaps in PRTR reporting for this industry. For pollutants such as CACs, data from other sources can be used to supplement the available PRTR information, but for other pollutants reported in significant amounts in one country, such as hydrogen sulfide, major gaps remain.

The discrepancies in the petroleum sector profiles of each of the three countries underscore the impacts of different national PRTR reporting requirements, such as incomplete pollutant coverage, as well as the absence of reporting by certain facilities and sectors. The findings of this special chapter devoted to the petroleum industry will be of particular interest to the ongoing efforts of the three PRTR programs to improve the reliability and comparability of North American PRTR data and to assign priority to areas for further action aimed at preventing and reducing pollution.

Methodology

This chapter was developed primarily through analysis of PRTR data, other facility-based data, information from government and industry reports, interviews with facilities and associations, and a peer review process.[1]

[1] For this report, eighteen facilities—eight in Canada, seven in the United States and three in Mexico—consented to interviews about their operations, environmental policies and management systems, and pollution control practices. The CEC is grateful to the representatives of those facilities who generously gave their time to respond to questions (they are listed in the last section of this report). Information obtained from these interviews helped to clarify the operations of the facilities, and many of the observations throughout this chapter benefit from inclusion of this material.

Identification of Facilities

The petroleum industry facilities included in this chapter were identified through their North American Industry Classification System (NAICS) codes, industry lists, review of facility operations information and discussions with PRTR program officials.

The US TRI has up to six industry codes for each chemical report from a facility. Facilities were identified based on these codes, which included both the Standard Industrial Classification (SIC) code as reported in 2005 and the NAICS code as reported in 2006. In addition, a list of US refineries was used to search for refineries[2] in the TRI database. The initial list of refineries was sent to the US Environmental Protection Agency for review. If, in addition to refining operations, the facility also reported an industry code in the chemical manufacturing sector, it was classified as a petrochemical refinery.

The Canadian National Pollutant Release Inventory (NPRI) assigns one industry code per facility (one NAICS code and one corresponding US SIC code), and facilities were identified on the basis of both codes. The list of oil refining facilities was supplemented with information from the Canadian Association of Petroleum Producers.[3] Environment Canada reviewed the information and confirmed the proper classifications for petrochemical refineries, heavy oil refineries and oil sands upgraders.

Mexico's RETC assigns one NAICS code per facility, and it includes a brief description of the industrial activity (*actividad principal*). Facilities were identified for a sector based on the NAICS code only.

The specific petroleum activities and corresponding industry sector[4] codes are presented in **Table 4–1**. Because of the methodology used, the number of reporting facilities in each petroleum sector may vary slightly from the numbers presented in **Chapter 3**.

[2] See <http://www.eia.doe.gov/neic/rankings/refineries.htm>.

Sources of Data

In Canada and Mexico, facilities in the four petroleum sectors discussed in this chapter report releases and transfers of "toxics" to their respective PRTRs. Many of these facilities also report releases of criteria air contaminants. Mexican facilities report their CAC emissions to the *Cédula de Operación Anual* (COA).

[3] See <http://www.capp.ca>.

[4] The term *sector* is used in this chapter to designate the main groups of petroleum industry activities under discussion: production, pipelines, refining and bulk storage terminals.

Table 4–1. NAICS Codes Used to Identify Facilities Reporting to PRTRs and the US NEI

	PRTR, NAICS code	US SIC code	NAICS code (US NEI)	NAICS description, US NEI
Oil and gas extraction/production				
NPRI*	211113, 211114, 213118	13	21111/1	Crude petroleum and natural gas extraction
RETC	211110, 213111, 213119		211112	Natural gas liquid extraction
			21311/1	Drilling oil and gas wells
			213112	Support activities for oil and gas operations
Pipelines				
NPRI	486110, 486210, 486990	4612, 4922	48611/0	Pipeline transportation of crude oil
RETC	486110, 486210, 486990		48621/0	Pipeline transportation of natural gas
			48691/0	Pipeline transportation of refined petroleum products
Petroleum and petrochemical refineries				
NPRI*	324110	2911		Petroleum refineries
RETC	324110			Petroleum refineries
TRI	324110	2911		Petroleum refineries
Bulk storage terminals				
NPRI	412110, 493190	5171		Petroleum products wholesalers and distributors, other warehousing and storage
RETC	49311			General warehousing and storage
TRI	424710	5171		Petroleum bulk stations and terminals

*In Canada, three oil sands upgraders are classified under nonconventional oil and gas extraction/production. One heavy oil upgrader is classified as a refinery.

In this report, the term *criteria air contaminants* refers to nitrogen oxides, carbon monoxide, volatile organic compounds, sulfur oxides and particulate matter, including $PM_{2.5}$, PM_{10} and total PM.

US oil and gas production[5] facilities and pipeline operations are not required to report to the TRI. For these facilities, data on hazardous air pollutants reportable under the TRI, as well as on criteria air contaminants, were obtained from the US National Emissions Inventory 2005 (Version 2, October 2008). Data on the CAC emissions from refineries and bulk storage terminals (petroleum sectors reporting to the US TRI) were also obtained from the NEI. These data are primarily reported to the US Environmental Protection Agency by local, state and regional agencies, and thus reporting thresholds for air pollutants may vary from those of the TRI program.

In Mexico, facilities also report their greenhouse gas emissions to the RETC, but because of the limited, facility-specific GHG data for Canada and the United States, these pollutants are not included in this chapter. A discussion of the major sources of GHG emissions, including the petroleum industry, is, however, presented in **Chapter 3**.

Releases of pollutants of concern (known or suspected carcinogens and developmental or reproductive toxicants) are examined by means of data extracted for on- and off-site releases from Canadian and US petroleum refineries and bulk storage terminals for the 2002–2005 reporting period. Only data on those pollutants common to both countries and reported consistently over this period were retained. This examination excludes Mexico because only 2004 and 2005 RETC data were available. It also excludes the oil and gas production and pipeline sectors, because in the United States these sectors do not report to the TRI.

Readers are reminded that each country has its own specific PRTR reporting requirements. These include the pollutants that must be reported, specific chemical thresholds, and in Canada and the United States a 10-employee reporting threshold (with the exception of Canadian pipelines and bulk storage terminals). Therefore, this chapter presents all data reported in each country, but because of reporting requirements not all sources are covered. **Chapter 2** describes national PRTR reporting requirements in more detail.

An Overview of the Petroleum Industry

Petroleum is the name given to the typical mixture of oil and natural gas found in nature. Most oil is found in the pores of deep underground sedimentary rock; deposits contain mostly crude oil, a mixture of oil and natural gas, or mainly natural gas. Before petroleum-related activities can commence, extensive surveys are made of the land to determine which drilling sites are most likely to yield productive wells. Drilling then begins, and the results are closely monitored to determine whether a well can produce enough of a minimum-quality grade of petroleum (or natural gas) to be financially worthwhile. If the results are promising, the well is completed. If not, the drilling rig is dismantled and moved to another location.

After successful exploration, it is a long road from the oil and gas fields to the gasoline station or to the use of polyethylene bags in a supermarket. Subsequent activities, or sectors, within the petroleum industry can be divided into "upstream" sectors—extraction, production and processing of oil and gas—and "downstream" sectors—further refining, manufacturing and the sale and use of oil and gas products. This chapter presents a profile of pollutants released and transferred by four sectors of the North American petroleum sector: oil and gas production, transportation through pipelines, petroleum refining and bulk terminals for storage and distribution of products.

Oil and Gas Exploration

During exploration, extensive surveys are made of the land to determine which drilling sites are most likely to yield productive wells. Drilling then begins, and the results are closely monitored to determine whether the well can produce enough of a minimum-quality grade of petroleum (or natural gas) to be financially viable. If the results are promising, the well is completed. If not, the drilling rig is dismantled and moved to another location.

All three countries are home to thousands of unused and abandoned oil and gas wells. If improperly closed or sealed, these wells can pose a hazard to humans and wildlife by allowing contaminants from the surface to enter groundwater. Indeed, large areas of salty and contaminated drilling fluids and muds can often be found nearby. In an ideal situation, the unused well is capped, any associated pipeline is also capped, surface equipment is removed, drilling wastes are treated, the land is replanted, and records of such steps are carefully created and maintained (CAPP 2007).

Facilities engaging in oil and gas exploration are not required to report to any of the three North American PRTR programs, and thus data for this sector are not available for inclusion in this chapter.

[5] Oil and gas production is sometimes called "extraction" or "extraction and production." For simplicity's sake, the term *oil and gas production* is used in this chapter.

Scale of the Petroleum Industry in North America

The national petroleum industry is an important economic driver in all three countries of North America. Indeed, it supplies about two-thirds of the energy needs of Canada and of the United States (Centre for Energy 2008d; IER 2008). Mexico's petroleum industry supplies about 86 percent of the country's energy needs (EIA 2008b).

Petroleum companies can be vertically integrated, with operations in all aspects of petroleum from exploration, production and processing to marketing. Or they may specialize in one part of the petroleum production cycle, such as pipelines, or in one product, such as natural gas. Canada and the United States share some of the same multinational petroleum companies. In Mexico, PEMEX was created in 1938 by nationalizing the existing foreign oil companies, and it is now one of the world's largest oil companies. It has the exclusive right to develop Mexico's energy reserves, mainly oil and gas, and is an integrated company that carries out all aspects of oil and gas activities. The petroleum industry is also closely integrated with the chemical manufacturing sector, because petroleum products supply many of the raw materials and much of the feedstock for chemical processes and products.

In 2005 about 25 percent of Canadian petroleum industry revenues went to local, provincial and federal governments in the form of royalties and taxes (Centre for Energy 2008d). Many oil and gas fields are in areas in which the resource is owned by the citizens and managed on their behalf by provincial governments. Since the early 1900s, mineral rights cannot be purchased, only leased, by individuals or companies. As a result, the mineral rights to more than 90 percent of Canada's land are currently owned by governments. About 97 percent of Canada's oil and gas is extracted from the Western Canadian Sedimentary basin, which underlies most of Alberta and parts of British Columbia, Saskatchewan, Manitoba and the Northwest Territories (Centre for Energy 2008a). Alberta produced 68 percent of Canada's national oil in 2007 (EIA 2008a).

In Mexico, oil revenues accounted for more than one-third of total government revenues and about 15 percent of the country's export earnings in 2007 (EIA 2008b). Oil fields are legally owned by the people of Mexico through the federal government, and revenues go to the government. About 80 percent of Mexico's oil is produced by offshore facilities such as Cantarell, located in the Campeche Basin in the Gulf of Mexico. In 2004 these oil fields produced about 61 percent of Mexico's total crude oil output (PEMEX 2007). In 2005 production in Mexico's offshore oil platforms was shut down for a few days because of the arrival of Hurricane Emily (EIA 2008b).

In the United States, oil and gas fields typically are privately owned, or leased when on federal, state or tribal lands, and royalties are paid based on the amount of production. In 2005 royalties were about US$8.7 billion (MMS 2008). The major US crude oil-producing areas are in the federal offshore areas in the Gulf of Mexico and off the coasts of California (accounting for one-fourth of US production), Texas and Alaska. Texas produces the largest amount of natural gas; it has one-fourth of the proven natural gas reserves in the United States. Wyoming holds the second-largest reserves (EIA 2008c). Some of the 158 US petroleum refineries were affected in 2005 by Hurricane Katrina, which hit the US Gulf Coast in August, temporarily shutting down refineries along the coast from Texas to Florida.

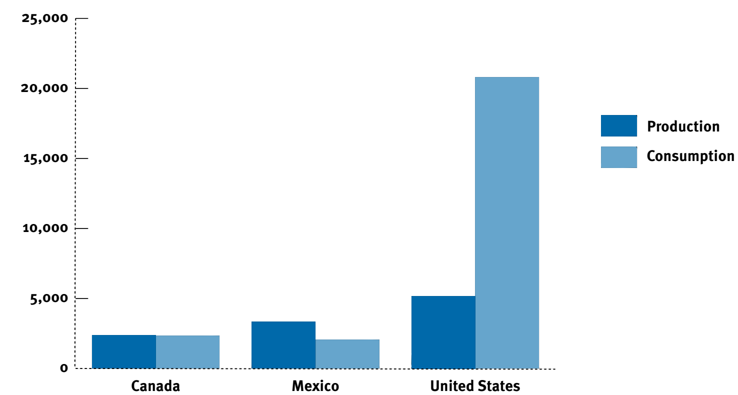
In 2005 the United States was the largest producer of crude oil in North America (5 million barrels per day), followed by Mexico (3 million barrels per day) and Canada (2.6 million barrels per day)—see **Figure 4–1**. US production ranked third in the world after Russia and Saudi Arabia. In addition to being a large oil producer, the United States is the world's largest oil importer—3.95 billion barrels of crude oil in 2005, which is more than twice the amount of oil it produces (EIA 2006).

Both Mexico and Canada are among the top 10 oil exporters in the world. Eleven percent of US imports are from Mexico and 18 percent from Canada (IER 2008). Although Canada is a net oil exporter, with most of its exports going to the United States, it also imports sizable quantities of crude oil and refined products (EIA 2006).

Mexico exports 57 percent of its crude oil, mostly to the United States. The United States also imports refined petroleum products from Mexico, such as residual fuel oil, naphtha and gasoline blending components. Despite being one of the world's largest crude oil exporters, Mexico is a net importer of refined petroleum products, with gasoline representing about half of these imports (EIA 2008b).

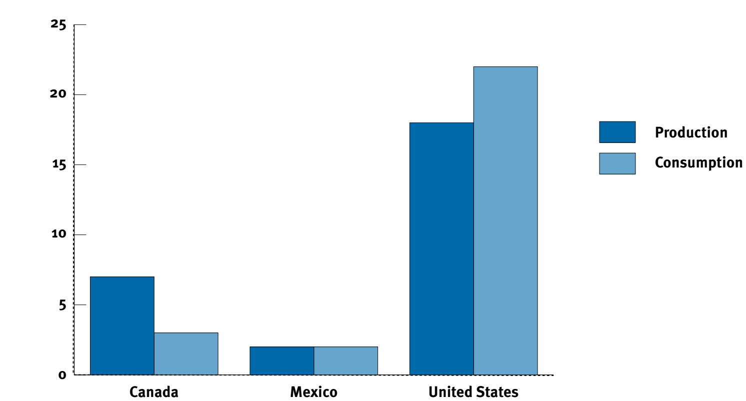
In natural gas production, the United States was the second-largest producer in the world in 2005 at 18.4 billion cubic feet per year, followed by Canada at 6.5 billion cubic feet (**Figure 4–2**). The United States is also the largest importer of natural gas in the world. Canada exports a large amount of natural gas, mainly to the United States. It is the second-largest exporter of natural gas in the world. Mexico produced 1.7 billion cubic feet of natural gas in 2005, but also imported large amounts (EIA 2008b).

Figure 4–1. North American Petroleum Production and Consumption, 2005 (thousand barrels per day)



Source: EIA, 2006.

Figure 4–2. North American Natural Gas Production and Consumption, 2005 (billion cubic feet)



Source: EIA, 2006.

Environmental and Health Issues Associated with the Petroleum Industry

Each sector of the petroleum industry is associated with environmental and health issues that can have local, regional, national or global impacts. These issues arise from the different operating conditions and stages of production, and they include:

- air emissions of toxic pollutants and other substances;
- water releases—discharges of contaminants to lakes, rivers and groundwater, including storm water runoff;
- water use for drilling, processing and refining;
- spills from pipelines, transportation, refineries and other operations;
- waste—chemicals and materials requiring treatment and disposal; and
- land use, including tailings ponds, land reclamation and abandoned wells.

The petroleum industry generates a range of substances that may contribute to various health and environmental effects, including:

- criteria air contaminants, such as nitrogen oxides and sulfur dioxide (associated with smog, acid rain, haze and respiratory impacts) and dust, also called particulate matter (associated with respiratory impacts);
- metals and organic pollutants, such as lead, mercury and benzene, associated with environmental contamination (and some are considered carcinogens, developmental or reproductive toxicants, or persistent, bioaccumulative and toxic substances); and
- greenhouse gases, such as carbon dioxide and methane.

Environmental Regulations Governing the Industry

The petroleum industry in each country is governed by various environmental laws, regulations and programs. These are briefly described in this section.

Canada

The major federal environmental legislation in Canada is the Canadian Environmental Protection Act (CEPA), which contains several specific initiatives relevant to the petroleum industry. For example, some of the substances emitted by the petroleum industry, such as benzene, polycyclic aromatic hydrocarbons (PAHs, also referred to as polycyclic aromatic compounds, or PACs) and dioxins and furans, are considered "toxic" under CEPA.

In December 2006, the federal government announced a new method to manage chemicals in Canada, which includes the Petroleum Sector Stream Approach. This approach is designed to assess and manage the 160 chemicals related to the petroleum industry that have been identified as high-priority chemicals under the CEPA chemicals categorization process. Data are collected on the use and releases of these 160 substances, and based on these data a screening assessment is developed as needed, followed by a risk management document. The NPRI also plays a role in supporting the assessment of substances (e.g., criteria air contaminants) for the development of regulations under the Clean Air Regulatory Agenda. Currently, petroleum companies are in the first stage of the process, which is expected to be completed by 2010.

The petroleum industry is also governed by provincial legislation, regulations and programs to limit toxic pollutant emissions and discharges. In coordination with Canadian provinces and territories, the Canadian Council of Ministers of the Environment (CCME) plays a key role in establishing national guidelines for air pollution, toxic chemicals and waste management.

Mexico

In Mexico, various federal environmental laws regulate pollutants released to air, water and land, Among them are the General Act on Ecological Equilibrium and Environmental Protection, the General Law on Prevention and Integrated Waste Management and the National Water Act, all of which apply to industrial operations generally. In addition, petroleum refineries must meet the maximum permitted air emission standards for volatile organic compounds and sulfur compounds. The Mexican government has decentralized—to the Mexican states and, in some cases, municipalities—many environmental regulations and their implementation.

Facilities under Mexican federal jurisdiction must complete a Certificate of Annual Operations (*Cédula de Operación Anual*). The COA is an annual compilation of reporting on releases and transfers of pollutants to air, water, soil and subsoil and on the production and transfer of chemical materials and hazardous waste, which includes data on emissions of CACs and on pollutants in wastewater. The RETC is the section of the COA that requires reporting on releases and transfers of 104 listed chemicals. The petroleum industry is considered a federally regulated industry.

Recent Mexican regulations on pollution from the oil and gas sector include specifications for environmental protection during the drilling and maintenance of oil wells and for the minimum efficiency of emission controls or recovery of sulfur in gas plant desulfurization units. Since 2005, Mexico also has published new environmental regulations on the transportation and distribution of oil and petrochemicals, sulfur recovery in petroleum refineries, criteria used to determine concentrations of heavy metals in contaminated soil, and petroleum exploration activities in Mexico's marine zones.

United States

Petroleum facilities in the United States are subject to various legislative and regulatory requirements, including the Clean Air Act and the Clean Water Act. The Clean Air Act sets national ambient air quality standards for pollutants in air, sets emissions and other limits on pollutants from specific industrial sources and requires facilities to obtain permits. Many states, local governments and tribal nations are involved in implementation of the act.

Clean Air Act amendments require the US Environmental Protection Agency to regulate the sources of 188 substances identified as hazardous air pollutants. Three petroleum sectors—oil and gas production, petroleum refineries and transmission and storage—were identified as sources of HAPs, and therefore the EPA developed regulations to control emissions from major sources based on the maximum achievable control technology (MACT) used in the industry. National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations have also been established for these petroleum activities. Eight years after MACT standards are issued for a source category, the EPA is required to review those standards to determine whether any residual risk exists and, if necessary, to revise the standards to address such a risk.

Facilities that generate, handle, transport and dispose of hazardous waste are also required to provide information about their activities to state environmental agencies. This information is then transmitted to the EPA and made available through the national Resource Conservation and Recovery Act information system.

Figure 4–3. Reported Releases and Transfers, North American Petroleum Facilities, 2005

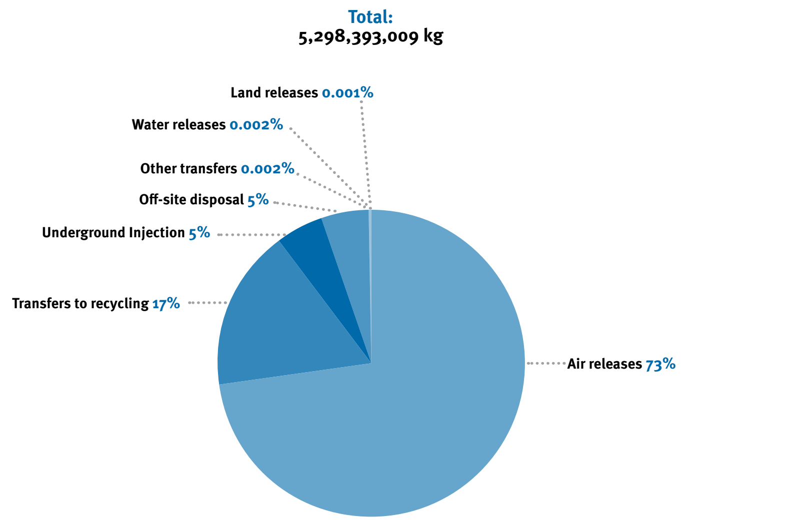
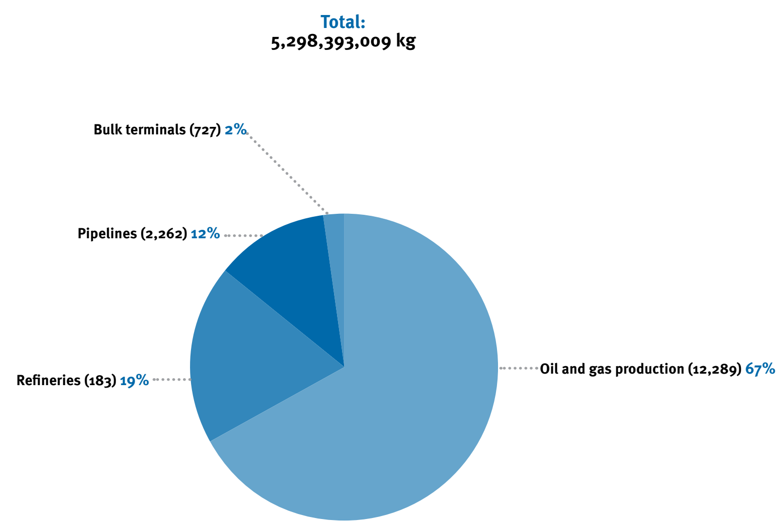


Figure 4–4. Reported Releases and Transfers by Petroleum Sector, North America, 2005



Note: Number of facilities reporting is in parentheses.

Releases and Transfers Reported by the North American Petroleum Industry in 2005

This section presents a description and profile of reported releases and transfers for each of the four North American petroleum sectors for which data are available: oil and gas production, transportation through pipelines, petroleum refining, and bulk terminals for storage and distribution of products.

As mentioned earlier, data for oil and gas exploration activities are not subject to PRTR reporting, and therefore releases and transfers from that sector cannot be presented.

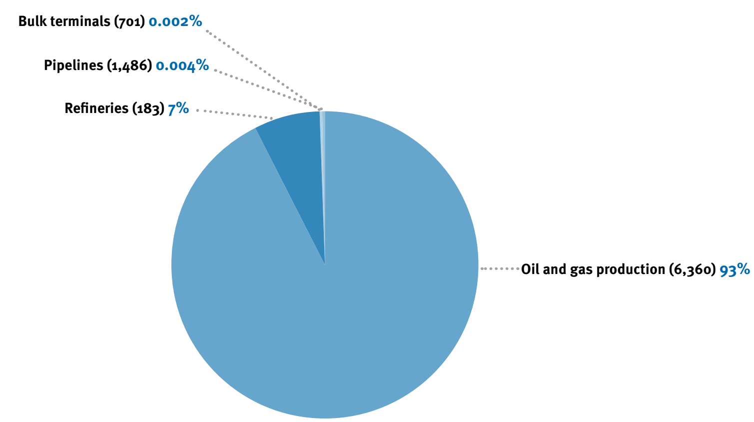
As shown in **Figure 4–3**, North American facilities in the four petroleum sectors reported releases and transfers of pollutants of about 5.3 billion kilograms in 2005 (only air release data for US oil and gas production facilities and pipeline operations are available). More than 3.8 billion kilograms were released to air, and more than 99 percent of this amount (3.7 billion kilograms) was releases of criteria air contaminants.[6]

Figure 4–4 depicts the releases and transfers, by petroleum industry sector, of the 15,461 North American facilities that reported in 2005. US facilities accounted for about 73 percent of all reporting facilities, Canadian facilities 25 percent and Mexican facilities 2 percent. When releases of criteria air contaminants are included, North American oil and gas production facilities contributed over two-thirds of the total releases and transfers.

[6] The data presented in this chapter exclude greenhouse gas emissions, because comparable facility-level data on GHGs are not available in all three countries. The number of reporting facilities excludes those Mexican facilities that reported only GHG emissions in 2005.

When criteria air contaminants are excluded and only reporting of toxic pollutants is considered, the total amount reported in 2005 drops from about 5.3 billion kilograms to just more than 1.5 billion kilograms. Of this amount, hydrogen sulfide accounted for about 1.36 billion kilograms. Oil and gas production facilities accounted for 93 percent of the total reported amount of toxic pollutants. As shown in **Figure 4–4**, 15,461 facilities reported both toxic substances and CACs in 2005, whereas 8,730 facilities reported on toxic substances only, with most of the decrease in the oil and gas production sector (**Figure 4–5**).

Figure 4–5. Reported Releases and Transfers (excluding criteria air contaminants) by Petroleum Sector, North America, 2005



Note: Number of facilities reporting is in parentheses.

Oil and Gas Production

Oil and gas are stored in the pores and fractures of certain sedimentary rocks, much like water in a sponge. After exploration, if an oil and gas deposit is judged to be economically viable, the well is prepared for production, which involves casing the well, perforating the casing and pumping the oil that seeps through the perforations into the casing. Usually, an oil field has multiple wells, thereby facilitating more rapid and complete extraction of the entire oil field, which may extend thousands of square kilometers. Traditionally, most wells have been dug vertically, but now wells can be drilled horizontally or directionally. Multiple wells can also be drilled from a single site (Centre for Energy 2008b).

Several "recovery" methods are used to maximize the yields of the oil and gas extraction process. In primary recovery, oil is pumped to the surface. In secondary recovery, some oil or natural gas is selectively pumped into the well to maintain reservoir pressure and force more oil out. In tertiary recovery, natural gas liquids are injected through special wells, helping to push more oil out of the rock. Sometimes carbon dioxide is used for tertiary recovery (CPPI 2007a).

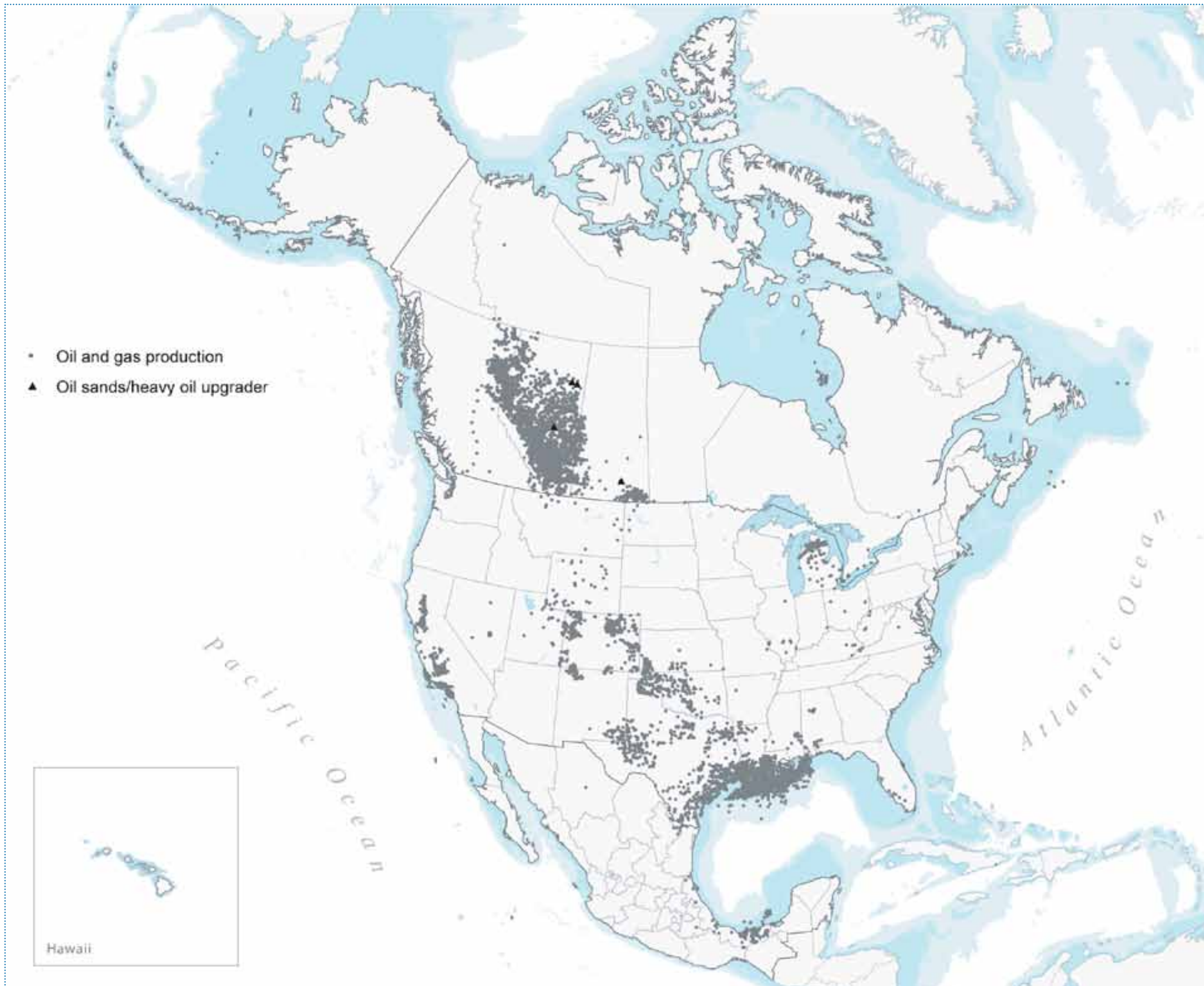
In 2005 more than 200,000 wells were producing oil and gas in Canada (Centre for Energy 2008a). Mexico had about 6,280 wells and 215 offshore platforms (PEMEX 2007). The United States was home to more than 500,000 oil and gas wells and 4,000 oil and gas platforms in US waters (US EPA 2008b). **Map 4–1** shows the oil and gas production facilities that report to the PRTR programs in Canada and Mexico and to the National Emissions Inventory in the United States. One oil and gas production facility can have multiple wells.

Drilling

During drilling operations, specialized drilling fluids commonly known as "muds" are pumped down the drill casing to lubricate the drill bit, flush the drill bore of crushed rock and maintain pressure in the well. When the mud returns to the surface, water and cuttings are separated, and the drilling fluids are recirculated to the well. Chemicals called drilling fluid additives are often part of the mud formulation, helping to lubricate the drill bit, provide cooling and so on. Some additives are known to be toxic, and some contain high levels of heavy metals (Alberta Government 2007). Often the disposal of these drilling wastes consists of spraying them onto land, land treatment or mixing and burying the waste in soil. The drilling waste often has a high chlorine (salt) concentration, which can then limit reclamation of the land.

Drilling wastes from offshore oil and gas wells are sometimes released into the water. US regulations passed in 2001 allow a controlled release of cuttings from rigs three miles from shore. The drilling permits limit the amount of oil that can be discharged and the amount of mercury and cadmium in the stock materials, prohibit the discharge of synthetic drilling fluids that are not part of cuttings and

Map 4–1. North American Oil and Gas Production Facilities Reporting Releases and Transfers in 2005



require monthly toxicity tests of the materials (US EPA 2001). Mexican regulations prohibit the discharge of oil-based drilling fluids before they are treated. In addition, a 2006 regulation established environmental protection specifications for drilling activities and maintenance and abandonment of oil wells in Mexican marine zones.[7]

When crude oil comes to the surface, it is often in a mixture of oil, natural gas, fluids, drill cuttings and varying amounts of water. This "produced water" is one of the largest waste streams from oil and gas production. Contaminated with benzene, heavy metals, oil and grease, and salts (US EPA 2000c), this produced water must be carefully managed to avoid contamination of land, surface waters, groundwater and wildlife. In the United States and Canada, the regulation of produced water varies by state or province. In Mexico, a federal regulation specifies the management of wastewater associated with hydrocarbons.

Some wastes from oil and gas production are exempt from US federal waste management legislation, including the 1980 amendments to the Resources Conservation and Recovery Act. However, some of these wastes are covered by state regulations.

[7] NOM-149-SEMARNAT-2006 (DOF: 31 January 2007).

Nonconventional Oil and Gas Production

As energy demand increases, oil and gas can also be extracted from deposits not previously considered economical. Examples of nonconventional oil and gas production are natural gas from coal, tight sands, gas hydrates and shale gas in Canada (Centre for Energy 2008c). The reserves found in oil shale, particularly in North Dakota in the United States, become more attractive for exploration as prices for oil rise (API 2008).

In western Canada, Alberta's oil sands are the second-largest oil reserves in the world, after Saudi Arabia's. In 2005 oil sands production surpassed 1.1 million barrels per day, and it is expected to reach 3 million barrels per day by 2015. The oil sands contain tar-like bitumen, a thick mixture of oil and sand. This mixture is too thick to flow through rocks, wells or pipelines. The oil sands near the surface are extracted using open pit mining techniques. But because the vast majority of oil sand deposits are too deep to be mined, other methods, often referred to as in situ methods, are required. Among the technologies that can be used to extract the bitumen are cyclic steam stimulation (CSS) and Steam Assisted Gravity Drainage (SAGD), the latter of which uses two parallel rows of wells, one injecting steam and one collecting the bitumen.

Oil sands mining operations use a significant volume of both surface water and recycled water. The current approved oil sands mining projects are licensed to divert 2.3 billion barrels of freshwater per year from the Athabasca River in Alberta. The mines now in the planning stages would increase that volume to 3.3 billion barrels per year, but at the current rates of withdrawal there is not enough water to support these planned projects. There is also debate about whether the wastewater from large tailings ponds can be reclaimed so that the ponds can become biologically productive ecosystems. Although the in situ oil sands projects using the SAGD method minimize the use of freshwater aquifers by employing freshwater mixed with saline groundwater, treating saline groundwater produces large volumes of solid waste. This waste has a high concentration of acids, hydrocarbon residues, trace metals and other contaminants that could affect nearby soil and groundwater if placed in landfills (National Energy Board 2006).

In 2005 oil sands production contributed 3.5 percent of the total greenhouse gas emissions in Canada. The government of Canada is developing regulations that will impose stringent targets on oil sands operations to reduce GHG emissions (Environment Canada 2008).

Heavy Oil and Bitumen Processing in Upgraders

Upgraders are large industrial facilities that process heavy oil or bitumen before shipment in pipelines or additional refining. Upgrading is necessary because many refineries were built to process light and medium crude oil, not the heavy oil and bitumen now being produced. Upgraders use processes similar to those used by refineries to produce synthetic crude, which is similar to the light crude oil used by refineries. However, upgraders, unlike refineries, are usually located near oil and gas fields. Depending on the specific operations, an upgrader can be considered an oil and gas production facility or a refinery. The four upgraders included in this report are Canadian; three have been classified by Environment Canada as nonconventional oil and gas production facilities (NAICS code 211114) and the other as a refinery (NAICS code 324110).

In addition to synthetic crude oil, fuel oil, naphtha and kerosene are produced by upgraders. These products can either be sold as is or shipped through pipelines to downstream refineries for further processing. Because heavy oil and bitumen may contain large amounts of sulfur, upgrading can produce large quantities of sulfur as a by-product. As in gas processing, some of this sulfur is sold as a commercial product and some is released into the air. Coke can also be sold as a product or used as a fuel for the upgrader (Centre for Energy 2008b).

Most upgraders are located in western Canada, in an area in northeastern Alberta commonly known as the Industrial Heartland. As of 2008, more facilities were under construction or in the planning phase (Pembina Institute 2008). Several US companies are investing in expanding and upgrading pipelines and refineries to process the Canadian oil derived from oil sands and upgraders (API 2009). In 2007 the government of Alberta proposed a Cumulative Effects Management Framework to address the multiple impacts from this sector. It placed emission caps on nitrogen oxides and sulfur dioxide for an entire area rather than facility by facility or process by process (Alberta Government 2007). Upgrading is very energy-intensive, with vast amounts of natural gas used to process bitumen. On average, 2 tonnes of oil sands must be processed to produce one barrel (159 liters) of synthetic crude oil.

Natural Gas Processing

Natural gas is often processed at gas processing plants before it is transported through pipelines. Contaminants such as hydrogen sulfide, carbon dioxide and water are removed, because these contaminants create acids that corrode the pipeline and pumps along the pipeline. The processed natural gas is mainly methane, which is used to heat homes and buildings, to generate electricity and for cooking. Natural gas processing facilities are usually more numerous than oil refineries and are located closer to oil and gas fields.

Natural gas that contains hydrogen sulfide (which is toxic at low concentrations) is referred to as "sour gas." In Canada, about 30 percent of natural gas reserves are "sour," containing more than 10 parts per million of hydrogen sulfide (CPPI 2007a). The hydrogen sulfide removed from sour gas is often made into sulfur, which is sold for fertilizers, pharmaceuticals and other uses; it may also be injected underground or flared—that is, burned in an open flame at the top of a chimney flue (CPPI 2007a).

Emissions of sulfur dioxide and hydrocarbons, such as benzene, are other products of natural gas processing. Alberta regulations limiting sulfur dioxide emissions from sour gas recovery facilities were revised in 2002 to apply to older, previously exempt facilities. In 1995 a multistakeholder committee developed a "best management practices" guideline, which resulted in reduced benzene emissions from many Canadian sources, including the glycol dehydrators used to remove water from natural gas (CPPI 2007a).

In Mexico, the sulfur recovered during natural gas processing is also commercialized. Minimum efficiency standards for sulfur recovery and emission control in desulfurization units at PEMEX gas plants are regulated.[8]

[8] NOM-137-SEMARNAT-2003 (DOF: 30 May 2003).

CPG Cactus Gas Processing Complex (Mexico)

PEMEX, Mexico's national petroleum company , operates a gas processing complex known as CPG Cactus in the state of Chiapas, about 1,000 kilometers south of Mexico City. This facility, which was built in 1974 and has about 2,000 employees, processes gas from offshore oil and gas fields into natural gas, light sweet gas, liquefied natural gas and basic petrochemicals. The processing includes removing sulfur from the incoming sour gas. A new sulfur recovery plant has substantially reduced emissions of sulfur dioxide. About 1,600 tonnes of sulfur per day are recovered and sold. By 2005, 12 sulfur recovery units had been installed at all gas processing plants, representing a US$400 million investment. These units are covered by a new law, NOM-137- SEMARNAT-2003, which regulates sulfur emissions from gas desulfurization plants. Sulfur dioxide emissions fell from 2001 to 2005 as a result of the reduction in the flaring of natural gas at offshore platforms.

Another environmental priority at PEMEX is reducing greenhouse gases. At the Cactus plant, the installation of two heat and vapor recovery units in 2001 reduced greenhouse gas emissions by 103 tonnes a day, resulting in a gas savings of 1.5 million cubic feet per day. Reduction of flaring at offshore platforms also reduced GHG emissions from 400,000 tonnes of carbon dioxide per month in 2001 to 100,000 tonnes per month in 2005.

Processing gas often requires large inputs of water. The gas processing plants in Mexico consumed about 42 million cubic meters of water in 2005 (about half the amount used by refineries). Because water is a scarce resource in many parts of Mexico, many of the newer projects consume less water, and, together, they represent a reduction in water use at PEMEX of about 20 percent from 2001 to 2005.

Gas produced from the Cactus facility travels through a pipeline serving mostly the south of Mexico. Like all PEMEX facilities, information is fed into a corporate management system known as PEMEX Safety Health and Environmental Protection (SSPA). The Cactus facility also has a customized system, SIGSSPA, for its own processes and products. These systems provide daily, monthly and annual information on production and environmental measures. Some of this information is then used to report to the Mexican COA and RETC.

Source: CEC, 2008.

In the United States, oil and gas production is considered a major source of hazardous air pollutants under the Clean Air Act. Under this act, the EPA is required to develop standards based on maximum achievable control technology. In 1999 the EPA issued National Emission Standards for Oil and Gas Production Facilities. This rule requires controls at process vents of certain glycol dehydrators, certain storage tanks and fugitive emissions at natural gas processing plants (US EPA 2000b).

Environmental and Health Issues Associated with Oil and Gas Production

The main issues associated with petroleum production are emissions to air of criteria air contaminants, toxic pollutants and greenhouses gases; emissions to surface and groundwater, contaminated drilling wastes, water use and spills; and degradation of large areas of land from contaminated tailings and treatment ponds, including fugitive air releases of chemicals, which can be an important source of overall emissions.

Gas processing is associated with air emissions, especially of sulfur dioxide and hydrogen sulfide, as well as of benzene and other toxics from glycol dehydrators and emissions from flaring.

Environmental and health issues associated with upgraders are substantial air emissions of greenhouse gases, criteria air contaminants such as sulfur dioxide, nitrogen oxides and particulates, and toxic pollutants such as benzene, metals and polycyclic aromatic hydrocarbons; emissions to water; and intensive water use and spills.

Pollution Prevention and Control

Interviewed representatives of oil and gas production facilities described additions of pollution control equipment or installation of improved technologies to reduce pollution. For example, sulfur recovery plants remove sulfur from tailings gas and convert it into liquid sulfur, and naphtha recovery units remove volatile organic compounds from tailings streams.

Gas processing plants often use meters on flares to gauge and minimize emissions. At some facilities, flare gas recovery compressors are used to cut down on nitrogen oxide emissions. Some facilities have also installed acid gas reinjection equipment, which injects the carbon dioxide removed from the gas back into a depleted oil or gas well instead of releasing it to the air. Some companies use incinerators with more efficient combustion of total reduced sulfurs and vapor recovery systems on condensate tanks.

Reported Releases and Transfers

Facilities involved in oil and gas production are required to report to Canada's NPRI and Mexico's RETC, but not to the US TRI. Therefore, the data on emissions of criteria air contaminants and hazardous air pollutants from US facilities in this sector were obtained from the US National Emissions Inventory. **Figures 4–7**, **4–9** and **4–10** present the air releases reported in each country. Other releases and transfers reported in Canada and Mexico are presented in **Figures 4–6** and **4–8**.

Figure 4–6. Canadian Releases and Transfers (excluding air) from Oil and Gas Production, 2005

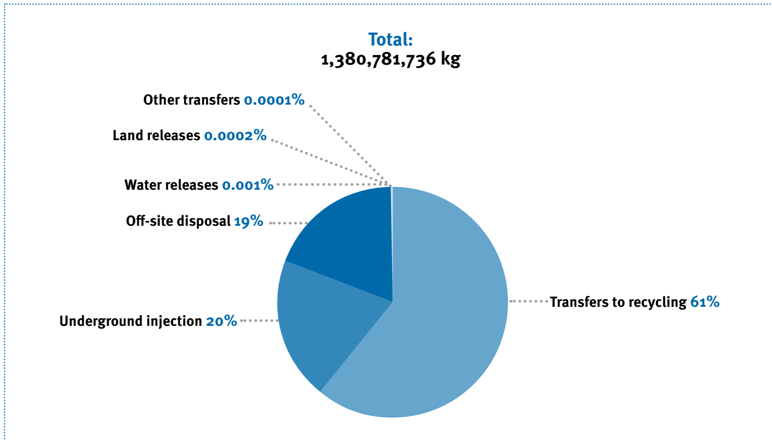


Figure 4–7. Canadian Air Releases (CACs and toxic pollutants) from Oil and Gas Production, 2005

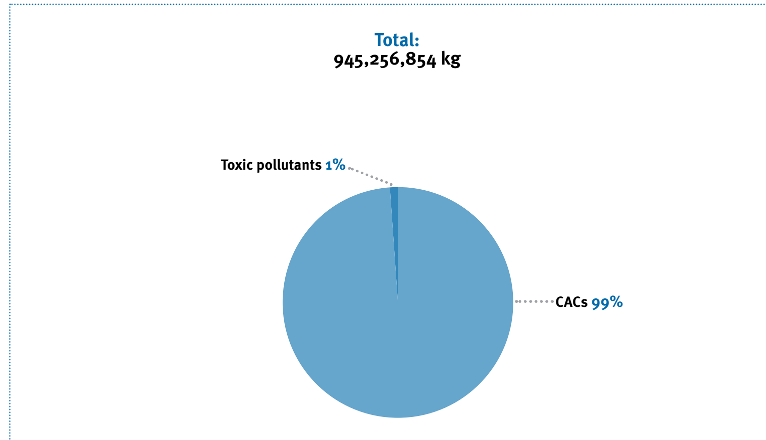


Figure 4–8. Mexican Releases and Transfers (excluding air) from Oil and Gas Production, 2005

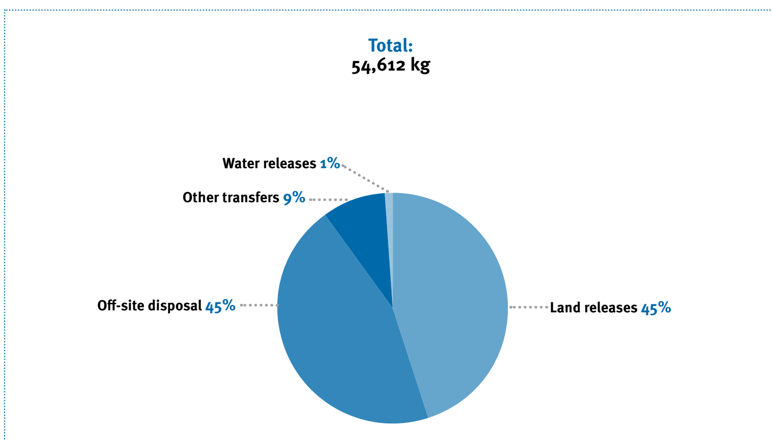


Figure 4–9. Mexican Air Releases (CACs and toxic pollutants) from Oil and Gas Production, 2005

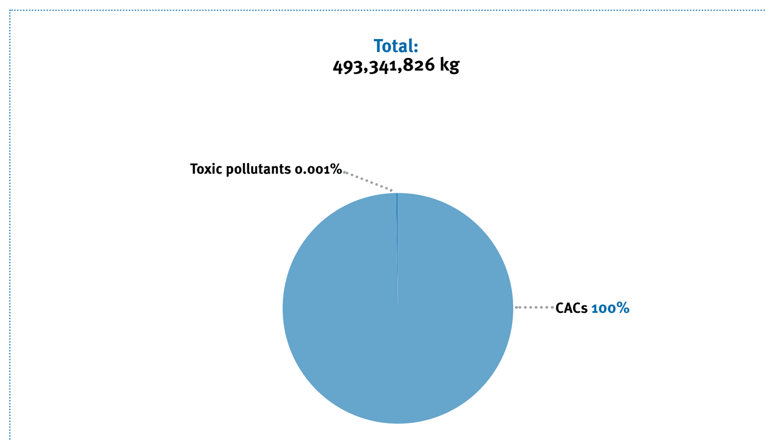


Figure 4–10. US Air Releases (CACs and toxic pollutants) from Oil and Gas Production, 2005

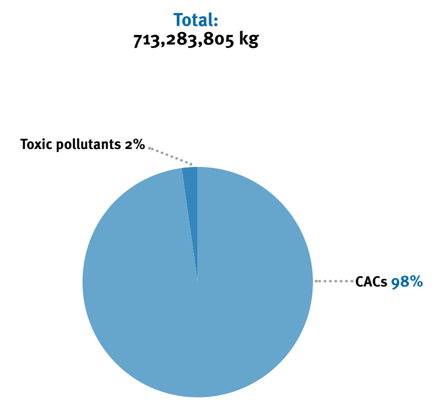


Table 4–2a. Releases of CACs by Country, Oil and Gas Production, 2005

	NPRI*		RETC		US NEI		Total
Criteria air contaminant	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Air releases (kg)
Oxides of nitrogen	2,582	348,114,028	127	148,405,128	3,798	302,091,490	798,610,646
Sulfur oxides	296	313,735,958	79	46,377,170	2,981	63,479,473	423,592,601
Carbon monoxide	1,561	184,696,255	123	23,277,023	3,816	203,582,497	411,555,775
Volatile organic compounds	418	66,417,931	105	271,512,964	4,195	115,731,135	453,662,030
Total particulate matter (PM)	58	6,480,254	89	6,858,186	652	1,109,015	14,447,455
PM_{10}	1,171	6,807,258	97	1,901,549	3,228	5,903,641	14,612,448
$PM_{2.5}$**	1,690	5,277,988	N/A	N/A	3,226	5,750,367	11,028,355
Total		**931,529,672***		**498,332,020**		**697,647,618**	**2,127,509,310**

N/A = not available.

* CAC releases for NPRI include both conventional and nonconventional oil and gas production facilities (see **Table 4–2b** data for facilities with oil sands upgraders only).

Table 4–2b. Releases of CACs, Facilities with Oil Sands Upgraders, NPRI, 2005

Criteria air contaminant	Number of facilities reporting	Air releases (kg)
Oxides of nitrogen	3	23,431,716
Sulfur oxides	3	116,737,631
Carbon monoxide	3	28,934,601
Volatile organic compounds	3	24,560,542
Total particulate matter (PM)	3	4,251,516
PM_{10}	3	2,655,940
$PM_{2.5}$	3	1,392,342
Total	**3**	**201,964,288**

In 2005, 3,586 Canadian oil and gas production facilities, including nonconventional (e.g., oil sands) facilities reported 2.32 billion kilograms of releases and transfers. About 945 million kilograms were released to the air, 99 percent of which were CACs reported by 3,565 facilities. In Mexico, 136 facilities in this sector reported almost 500 million kilograms of releases and transfers, 99 percent of which were air releases of CACs reported by 133 facilities. In the United States, 8,567 facilities in the oil and gas production sector reported about 713 million kilograms in air releases, 98 percent of which were releases of CACs reported by 4,210 facilities.

These figures reveal that in the three countries air releases dominated reporting by this sector in 2005, with **criteria air contaminants** accounting for at least 98 percent of all air releases. **Tables 4–2a** and **4–2b** present CAC releases reported by oil and gas production facilities in each country. Four CACs—oxides of nitrogen, sulfur oxides, VOCs and carbon monoxide—accounted for about 98 percent of the total CACs released.

Three Canadian oil sands facilities with upgrading operations (classified under NAICS code 211114) contributed almost 202 million kilograms of CAC releases, or 22 percent of total CAC releases reported by Canadian oil and gas production facilities in 2005. These facilities also accounted for about one-third of the total reported releases of sulfur oxides and volatile organic compounds.

Compared with the number of Mexican and US facilities reporting SO_x and VOCs, the number of Canadian facilities reporting these substances was relatively low. Mexican facilities released substantially higher amounts of VOCs than did Canadian and US facilities.

In 2005 North American oil and gas production facilities also reported releases and transfers of **toxic pollutants**. Reporting only toxics were 184 Canadian facilities, 36 Mexican facilities and 6,140 US facilities.

Air releases of toxic pollutants in each country are presented in **Tables 4–3** to **4–5**. Other reported releases and transfers in Canada and Mexico are presented in **Tables 4–6** and **4–7**.

Canadian facilities in the oil and gas production sector reported 13.7 million kilograms of 47 toxic pollutants. The 18 substances shown in **Table 4–3** represent 99 percent of this amount. Between one and three of the nonconventional oil and gas production facilities also reported many of the same substances and, in fact, accounted for about 37 percent of the total air releases of toxic pollutants reported in 2005.

In Mexico, releases to air of the 11 reported toxic pollutants amounted to 9,806 kilograms (**Table 4–4**). Only a small fraction of all facilities in this sector reported air releases. Two other toxic pollutants, vinyl chloride and biphenyl, were also reported by a few facilities, but in amounts of less than 1 kilogram each.

US oil and gas production facilities reported air releases of 81 toxic pollutants under the US NEI in 2005, amounting to 15,636,187 kilograms. Eighteen of these pollutants accounted for 99 percent of the total emissions (**Table 4–5**). These 81 pollutants are also reportable under the TRI program.

Just over 30 pollutants accounted for most of the releases to air of toxic pollutants reported in all three countries. However, the profile of pollutants released to air by this sector in each country varied. In some cases, there were significant differences in the number of facilities reporting large quantities—for example, about 1.9 million kilograms of carbonyl sulfide were reported by only 26 Canadian facilities compared with 4.5 million kilograms reported by 2,706 US facilities. Carbonyl sulfide was not subject to RETC reporting.

For hydrogen sulfide, 92 Canadian oil and gas production facilities reported air releases of more than 1.2 million kilograms. This pollutant was not subject to reporting under either the US NEI or TRI. Hydrogen sulfide was reportable to Mexico's RETC, but it was not reported in 2005 by Mexican oil and gas production facilities. Another example of differences in reported air releases is formaldehyde, a chemical subject to reporting in all three countries, but with wide variations in both amounts and numbers of reporting facilities.

Table 4–3. Reported Releases to Air of Toxic Pollutants, Oil and Gas Production, NPRI, 2005

Pollutant	Amount (kg) reported, oil and gas production (number of facilities reporting)	Amount (kg) reported, three oil sands facilities with upgrading operations (number of facilities reporting)
Carbon disulfide CA, US	2,943,879 (27)	53,183 (2)
Carbonyl sulfide CA, US	1,853,932 (24)	58,729 (2)
n-Hexane CA, US	1,242,846 (108)	153,603 (3)
Hydrogen sulfide CA, MX	1,230,826 (89)	57,362 (3)
Formaldehyde CA, MX, US	203,837 (7)	0
Toluene CA, US	157,734 (107)	352,546 (3)
Methanol CA, US	137,295 (99)	0
Cyclohexane CA, US	131,997 (91)	209,679 (2)
Benzene CA, MX, US	116,471 (88)	68,485 (3)
1,2,4–Trimethylbenzene CA, US	13,417 (63)	101,114 (2)
Ethylene glycol CA, US	84,565 (84)	0
Propylene CA, US	0	90,164 (2)
Xylenes CA, US	70,560 (110)	712,730 (3)
Sulfuric acid CA, US	60,143 (14)	1,498,465 (2)
Ethylene CA, US	51,569 (2)	62,842 (1)
Ethylbenzene CA, US	14,450 (61)	115,819 (3)
Cumene CA, US	0	11,516 (1)
Ammonia CA, US	6,938 (5)	1,831,639 (2)
Total	**8,249,899**	**5,337,876**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–4. Reported Releases to Air of Toxic Pollutants, Oil and Gas Production, RETC, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by oil and gas production facilities
Formaldehyde CA, MX, US	7	8,691
Acetaldehyde CA, MX, US	6	642
Acrolein CA, MX, US	6	304
Benzene CA, MX, US	5	144
1,1,2-Trichloroethane CA, MX, US	1	14
Dichloromethane CA, MX, US	1	4
1,1,2,2-Tetrachloroethane CA, MX, US	1	2
Carbon tetrachloride CA, MX, US	1	2
Chloroform CA, MX, US	1	1
Chlorobenzene CA, MX, US	1	1
Styrene CA, MX, US	1	1
Total		**9,806**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–5. Reported Releases to Air of Toxic Pollutants, Oil and Gas Production, US NEI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by oil and gas production facilities
Carbonyl sulfide CA, US	2,706	4,516,964
Benzene CA, MX, US	5,670	2,988,098
n-Hexane CA, US	3,654	2,366,955
Formaldehyde CA, MX, US	3,786	2,153,207
Toluene CA, US	3,769	1,796,627
Xylenes CA, US	3,621	1,047,011
Ethylbenzene CA, US	3,198	160,546
Acetaldehyde CA, MX, US	3,291	146,910
Methanol CA, US	202	144,918
Acrolein CA, MX, US	287	88,740
Ammonia CA, US	105	82,629
Ethylene glycol CA, US	2,709	32,350
Naphthalene CA, US	3,165	21,723
Nickel and its compounds CA, MX, US	85	19,056
Chlorobenzene CA, MX, US	78	10,310
Chlorine CA, US	22	10,298
1,1,1-Trichloroethane MX, US	8	9,841
Carbon disulfide CA, US	2,702	6,934
Hydrochloric acid CA, US	44	6,583
Tetrachloroethylene CA, US	18	4,749
Total		**15,614,451**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–6. Releases and Transfers (excluding air), Oil and Gas Production, NPRI, 2005 (kilograms)

Pollutant	Water releases	Land releases	Underground injection	Off-site disposal	Transfers to recycling	Other transfers
Methanol CA, US	950,594	130	5,455,100	3,536,822	0	0
Ethylene glycol CA, US	446,331	3,492	0	0	0	0
Ammonia CA, US	216,779	0	0	0	0	0
Benzene CA, MX, US	107,178	636	0	0	0	0
Phenol CA, MX, US	72,450	0	0	0	0	0
Toluene CA, US	65,187	33	0	0	0	0
Phosphorus CA, US	41,370	0	1,276,600	0	0	0
Xylenes CA, US	25,653	199	0	0	0	0
Hydrogen sulfide CA, MX	0	0	268,607,143	250,941,598	840,226,765	0

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–7. Releases and Transfers (excluding air), Oil and Gas Production, RETC, 2005 (kilograms)

Pollutant	Water releases	Land releases	Underground injection	Off-site disposal	Transfers to recycling	Other transfers
Benzene CA, MX, US	0	24,550	NA	0	0	4,950
Hydrofluorocarbons*	0	0	NA	24,530	0	0
Nickel and its compounds CA, MX, US	362	0	NA	0	0	0
Lead and its compounds CA, MX, US	85	0	NA	0	0	0
Cadmium and its compounds CA, MX, US	54	0	NA	0	0	0
Chromium and its compounds CA, MX, US	51	0	NA	0	0	0
Arsenic and its compounds CA, MX, US	20	0	NA	0	0	0
Cyanides CA, MX, US	10	0	NA	0	0	0
Mercury and its compounds CA, MX, US	1	0	NA	0	0	0

NA = not applicable.
Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.
*The specific hydrofluorocarbons reportable to each PRTR vary.

Less than half of the 30 toxic pollutants accounting for the bulk of releases to air reported across North America were subject to RETC reporting, and thus pollutants reported in relatively large quantities in Canada and the United States (e.g., carbonyl sulfide, toluene and n-hexane) were not reported in Mexico. Some of the differences in the amounts of pollutants reported might be attributable to differences in reporting thresholds among NPRI, RETC and the US NEI.

Other releases and transfers reported by Canadian and Mexican oil and gas production facilities—releases to water, land, underground injection and disposal and transfers to recycling or other treatment—are presented in **Tables 4–6** and **4–7**, respectively. As mentioned earlier, data for non-air releases and transfers from US facilities in this sector are not covered under the TRI program and therefore cannot be presented.

Canadian facilities reported about 1.38 billion kilograms in releases and transfers (other than air) in 2005, of which more than 800 million kilograms were transferred to recycling (**Table 4–6**). Most of this amount was hydrogen sulfide; less than 1 percent was other substances, including metals such as vanadium, copper, aluminum and nickel and their compounds. Large amounts of hydrogen sulfide were also released to underground injection and to off-site disposal.

Almost 2 million kilograms of toxic pollutants were released to water. Eight pollutants (methanol, ethylene glycol, ammonia, benzene, phenol, toluene, phosphorus and xylenes) out of a total of 27 accounted for 98 percent of reported water releases.

Table 4–7 reveals that Mexican facilities reported about 55,000 kilograms of pollutants in 2005, with about 90 percent (mainly) as releases to land and off-site disposal (underground injection is not practiced in Mexico). Almost 5,000 kilograms of benzene made up the remaining 10 percent, reported as transfers for further management. Seven pollutants were also released to surface waters by Mexican oil and gas production facilities in 2005, for a total of 582 kilograms. Although the amounts reported were small, pollutants such as arsenic, chromium, nickel and lead and their compounds have potentially important human and environmental risks that make them reportable under lower reporting thresholds.

Overall, the pollutants reported by Canadian and Mexican oil and gas production facilities were different, with only benzene reported in both countries. Six of the pollutants reported in Canada were not subject to RETC reporting. Hydrogen sulfide is a RETC pollutant, but it was not reported by the oil and gas production sector in Mexico. However, large quantities of hydrogen sulfide were sent by Canadian oil and gas production facilities to underground injection, disposal and recycling.

In Canada, the amounts of pollutants released (other than to air) or transferred by oil and gas production facilities in 2005 suggest that the lack of coverage of this sector by the US TRI creates a significant gap in the information about pollution from this industry in the United States. With the exception of hydrogen sulfide, all of the pollutants reported by both Canadian and Mexican oil and gas production facilities are reportable under the US TRI.

Oil and Gas Transportation through Pipelines

A pipeline consists of any piping within or outside a facility through which liquids (crude oil, petroleum products) or gases (natural gas, carbon dioxide) are transported. Pipelines also consist of the valves and other equipment attached to the pipe, compressor units, pumping stations, metering stations and regulator stations (CEPA 2008).

The types of pipelines vary. Gathering pipelines move raw oil and gas to processing plants and transportation. Trunk lines transport crude oil and other materials to refineries and refined product to marketing terminals. Gas transmission pipelines carry natural gas from producing areas to consuming areas. And local distribution networks deliver natural gas to homes and businesses (CPPI 2007a).

Oil and other products are put in the pipeline in batches that move through the pipeline at 3–8 kilometers per hour. Chemicals known as drag reducing agents are added at pumping stations to reduce turbulence along the pipeline. Natural gas is not batched and travels in its own pipelines at about 40 kilometers per hour. Compressor (pumping) stations are located every 60–100 kilometers along natural gas pipelines to maintain sufficient pressure in the pipelines and maintain the flow. Operators monitor pipelines for pressure, temperature and flow rates as a way of identifying leaks, spills and equipment failure. In all three countries, pipelines are cleaned internally of waxes, paraffin and other materials by means of mechanical "pigs," moveable plugs that flow along with the product in the pipeline to dislodge the debris clinging to the inside (CEPA 2008).

Pipeline Operations in North America

In Canada and the United States, most pipeline operators do not own the oil and gas they ship. Instead, oil and gas producers, refineries, utilities and industrial customers own the oil and gas and pay the pipeline operator to transport it (CEPA 2008). Canada has over 580,000 kilometers of pipelines that carry crude oil, natural gas and refined products (Centre for Energy 2008d). When pipelines cross provincial boundaries, they are regulated by the National Energy Board (CPPI 2007b).

In the United States, about 88,500 kilometers of crude oil trunk lines connect regional markets, including oil fields in Canada, to US refineries. An estimated 48,000–64,000 kilometers of smaller lines are located primarily in Texas, Oklahoma, Louisiana and Wyoming; they connect oil wells to the larger trunk lines. The United States also has about 32,200 kilometers of natural gas gathering pipelines and 447,400 kilometers of natural gas transmission pipelines. In addition, there are almost 153,000 kilometers of refined product pipelines (Pipeline 101 2008).

Terasen Gas Pipeline Operations (Canada)

Terasen Gas, a subsidiary of Fortis Inc., delivers natural gas and piped propane to most of the province of British Columbia. Terasen operates 11 compressor stations, 416 gate and regulator stations, over 43,000 kilometers of pipeline and a liquefied natural gas storage facility.

On Vancouver Island, the compressor station contains five gas turbines that increase the pressure of the gas, allowing it to be shipped in the pipeline. The turbines move an average of 90 million cubic feet of natural gas per day. These gas turbines were recently upgraded to "low NO_x" turbines, reducing the amount of nitrogen oxides released. A Predictive Emission Monitoring system is now used to measure NO_x emissions from the compressor station. Measurements are taken of air temperature, relative humidity, fuel gas pressure, temperature, and fuel and air amounts entering the system. Based on these measurements, an onboard computer calculates the NO_x emissions each minute and then the hourly average.

This pipeline operator is regulated by Metro Vancouver and the Oil and Gas Commission. Environmental regulations have become stricter over the last five years. The peak limit for NO_x has been lowered from 42 to 30 parts per million, but there is no established limit for carbon monoxide. The company is considering a program to reduce fugitive gas emissions, such as changing from wet to dry seals on compressors.

Terasen Gas also assesses potential impacts and mitigation activities as part of its work plan for a project. This effort can include protecting wildlife and nesting areas by scheduling fieldwork outside of nesting season, creating gaps in trenches and pipe joints so wildlife has easy passage, or mitigating impacts by using an existing right-of-way, such as a highway, rather than imposing a new corridor. Terasen is currently building a new pipeline to Whistler for the 2010 Winter Olympics. For more information,visit ‹http://www.terasengas.com›.

In Mexico, PEMEX operates a pipeline network that connects major production centers (including offshore and inland operations) with domestic refineries and export terminals. This network consists of 8,800 kilometers of oil pipelines and 1,200 kilometers of natural gas pipelines, with the largest concentration in the southern part of the country. Mexico does not have international pipeline connections; most exports leave the country via tanker from three export terminals on the southern coastline (EIA 2008b; PEMEX 2007). The North American pipeline networks and facilities are depicted in **Map 4–3**, which appears later in this chapter.

Because most pipelines in Canada cross provincial boundaries, they are regulated by the National Energy Board. The NEB regulates the construction and operation of pipelines, including the development of environmental protection programs, but it does not specify emission standards or limits on emissions arising from spills or leaks. The Canadian Standards Association and the Transportation Safety Board of Canada also have guidelines for pipeline operations. Within a province, pipelines are often regulated by the provincial energy board or environmental department.

In Mexico, two federal regulations govern pipelines, providing specifications for pollution controls during installation and maintenance and environmental protection specifications for site preparation, construction, operation, maintenance and abandonment of natural gas distribution networks. In recent years, pipelines have been tapped by local people for supply, resulting in serious accidents and spills.

In the United States, pipeline safety standards and procedures are regulated by the Department of Transportation, Pipeline and Hazardous Materials Safety Administration, and the Federal Energy Regulatory Commission.

Environmental and Health Issues Associated with Pipeline Operations

The main issues associated with pipeline facilities are emissions of criteria air contaminants, including sulfur dioxide, nitrogen oxides and particulates, from the pump motors; fugitive emissions of toxic pollutants, criteria air contaminants and greenhouse gases from the pipeline and its seals, valves and connectors; and releases to land and water from spills and leaks that contribute to groundwater and land contamination.

Pollution Prevention and Control

Representatives of pipeline operations provided details about their pollution control and prevention efforts. For example, some facilities have installed low-emission gas turbines at the compressor (pumping) stations placed along the pipelines.

Leak detection and repair have also been improved in recent years. Fugitive emissions can be measured or estimated along the pipeline, and the leak detection process can include major surveys every few years, using infrared cameras. Regular maintenance typically involves checking for visible leaks. Within buildings, LEL (lower explosive limit) detectors can be used to find methane leaks.

Reported Releases and Transfers

Facilities in Canada and Mexico that transport petroleum-related liquids through pipelines to off-site locations are required, respectively, to report to Canada's NPRI and Mexico's RETC. The standard 10-employee reporting threshold for NPRI does not apply to pipeline operations, which means that all Canadian pipeline facilities must report. US pipeline operations are not subject to TRI reporting. Emissions data for criteria air contaminants and hazardous air pollutants from US facilities in this sector were obtained from the US National Emissions Inventory. **Figures 4–12**, **4–14** and **4–15** present the air releases reported in each country. Other releases and transfers reported in Canada and Mexico are presented in **Figures 4–11** and **4–13**.

Figure 4–11. Canadian Releases and Transfers (excluding air) from Pipeline Operations, 2005

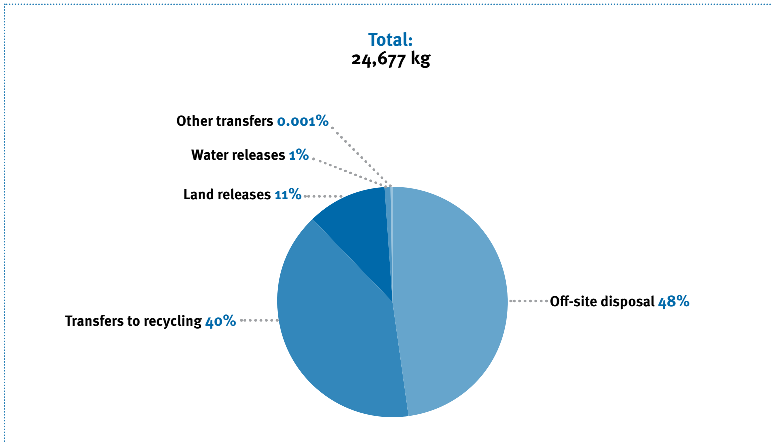


Figure 4–12. Canadian Air Releases (CACs and toxic pollutants) from Pipeline Operations, 2005

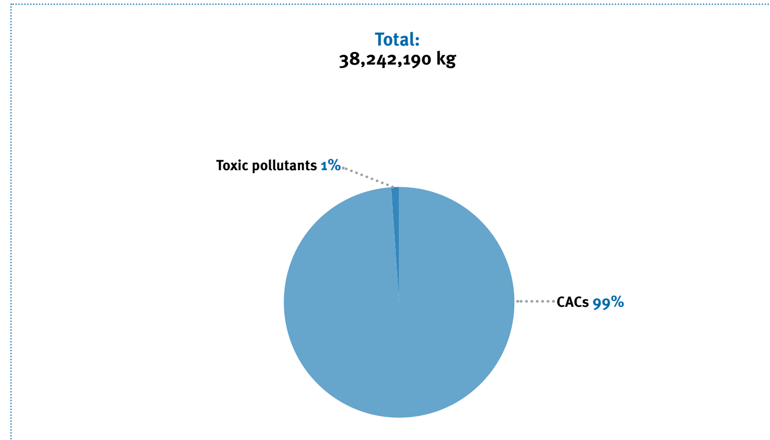


Figure 4–13. Mexican Releases and Transfers (excluding air) from Pipeline Operations, 2005

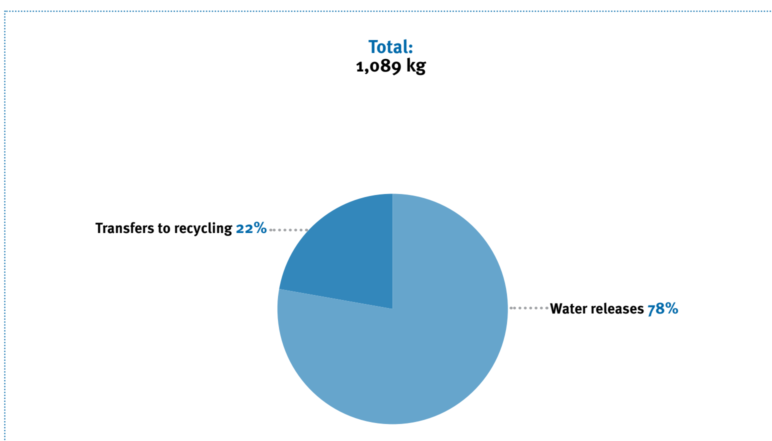


Figure 4–14. Mexican Air Releases (CACs and toxic pollutants) from Pipeline Operations, 2005

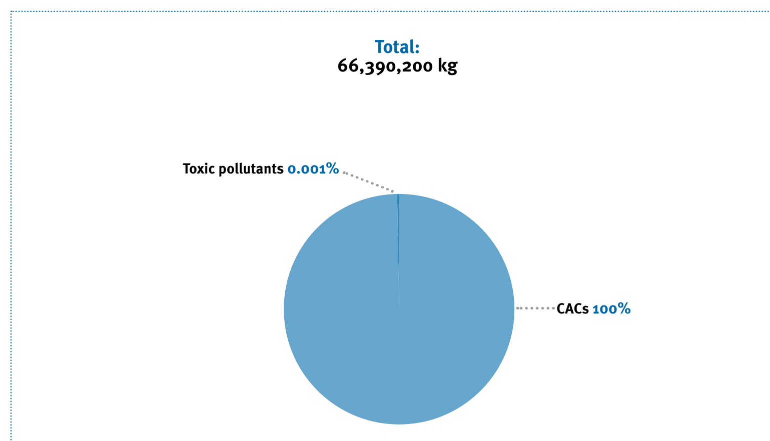


Figure 4–15. US Air Releases (CACs and toxic pollutants) from Pipeline Operations, 2005

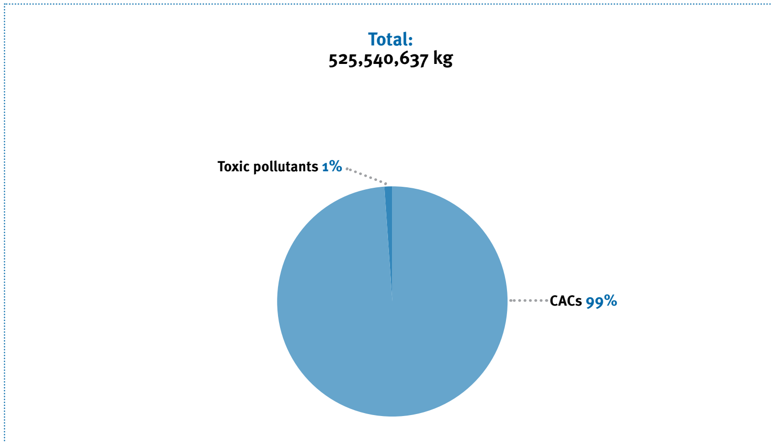


Table 4–8. Releases of CACs by Country, Pipeline Operations, 2005

	NPRI		RETC		US NEI		Total
Criteria air contaminant	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Air releases (kg)
Oxides of nitrogen	136	25,223,099	21	6,309,744	1,702	345,816,496	377,349,338
Carbon monoxide	101	9,133,750	20	2,183,445	1,730	100,781,472	112,098,667
Volatile organic compounds	36	3,226,150	15	56,056,632	2,023	54,106,028	113,388,811
Sulfur oxides		0	17	1,041,788	1,062	6,876,416	7,918,203
Total particulate matter (PM)	0	0	16	133,920	435	1,703,253	1,837,173
$PM_{2.5}$	117	209,562	N/A	N/A	1,306	4,391,287	4,600,849
PM_{10}	103	204,275	17	663,876	1,308	4,513,400	5,381,551
Total		**37,996,836**		**66,389,404**		**518,188,352**	**622,574,592**

N/A = not available.

In 2005, 178 Canadian pipeline facilities reported a total of more than 38.2 million kilograms of releases and transfers. Almost all was released to air, and 99 percent was releases of CACs reported by 166 facilities. In Mexico, 26 pipeline facilities reported about 66.4 million kilograms of pollutants, with air releases of CACs accounting for about 99 percent of the total (reported by all facilities). In the United States, 2,058 facilities in this sector reported about 525.5 million kilograms in air releases. More than 98 percent of these were releases of CACs reported by 1,924 facilities.

As in the oil and gas production sector, air releases (particularly of **criteria air contaminants**) dominated reporting by North American pipeline operations in 2005. Releases of three criteria air contaminants—oxides of nitrogen, carbon monoxide and VOCs—accounted for almost 97 percent of the total CACs released, as shown in **Table 4–8**.

In 2005 North American pipeline facilities also reported releases and transfers of **toxic pollutants**. Reporting only toxics were 40 Canadian facilities, 17 Mexican facilities and 1,429 US facilities.

Air releases of toxic pollutants in each country are presented in **Tables 4–9** to **4–11**. Other reported releases and transfers in Canada and Mexico are presented in **Tables 4–12** and **4–13**.

In Canada, relatively few air toxics were reported by pipeline operations in 2005. Many facilities reported air releases of most of the eight toxics in **Table 4–9** (with the exception of cyclohexane and 1,2,4–trimethylbenzene).

In Mexico, pipeline facilities reported air releases of only four toxic pollutants, and each of these was reported by only three or four facilities (**Table 4–10**).

In the United States, 99 percent of air releases of toxics reported by pipeline facilities in 2005 were from 15 pollutants (**Table 4–11**). Four of these pollutants—methyl tert-butyl ether, ethylene glycol, hydrochloric acid and hydrogen fluoride—were reported by a very small proportion of US pipeline facilities reporting on toxic pollutants; about half were reported by at least 40 percent of these facilities.

In addition to the 15 pollutants shown in **Table 4–11**, US pipeline operators reported relatively small amounts of 63 other pollutants (11 were reported in amounts of less than 1 kilogram each). In general, the 63 other pollutants were reported by relatively few facilities. These pollutants were all reportable under the TRI, with many of them also subject to NPRI reporting and about 20 subject to RETC reporting.

Air releases of toxic pollutants by North American pipeline operations reveal a wide range in the number of facilities reporting each pollutant and in the amounts and types of toxics reported. Some of the differences in the amounts of pollutants reported might be attributable to differences in reporting thresholds among NPRI, RETC and the US NEI, along with operational considerations such as the type of product being transported, fuel use by compressor stations, and so on.

Table 4–9. Reported Releases to Air of Toxic Pollutants, Pipeline Operations, NPRI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by pipeline facilities
n-Hexane [CA, US]	36	212,018
Hydrogen sulfide [CA, MX]	22	15,565
Benzene [CA, MX, US]	29	8,382
Toluene [CA, US]	29	5,893
Xylenes [CA, US]	29	2,540
Ethylbenzene [CA, US]	26	726
Cyclohexane [CA, US]	1	200
1,2,4–Trimethylbenzene [CA, US]	2	30
Total		**245,354**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–10. Reported Releases to Air of Toxic Pollutants, Pipeline Operations, RETC, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by pipeline facilities
Formaldehyde [CA, MX, US]	4	785
Benzene [CA, MX, US]	3	5
Acetaldehyde [CA, MX, US]	3	4
Acrolein [CA, MX, US]	3	1
Total		**795**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–11. Reported Releases to Air of Toxic Pollutants, Pipeline Operations, US NEI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by pipeline facilities
Formaldehyde [CA, MX, US]	961	3,897,232
n-Hexane [CA, US]	722	643,442
Benzene [CA, MX, US]	979	476,071
Toluene [CA, US]	837	469,859
Acetaldehyde [CA, MX, US]	556	445,131
Acrolein [CA, MX, US]	457	333,540
Xylenes [CA, US]	749	294,337
Ammonia [CA, US]	160	197,555
Methanol [CA, US]	278	153,363
Methyl tert-butyl ether [CA, US]	50	144,767
Ethylene glycol [CA, US]	31	106,946
Ethylbenzene [CA, US]	605	79,049
Hydrochloric acid [CA, US]	14	40,819
Hydrogen fluoride [CA, US]	3	14,415
1,3-Butadiene [CA, MX, US]	190	11,766
Total		**7,308,292**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–12. Releases and Transfers (excluding air), Pipeline Operations, NPRI, 2005 (kilograms)

Pollutant	Water releases	Land releases	Underground injection	Off-site disposal	Transfers to recycling	Other transfers
n-Hexane [CA, US]	184	2,741	6,441	6,441	3,170	0
Hydrogen sulfide [CA, MX]	0	0	4,283	4,283	3,473	0
Benzene [CA, MX, US]	0	0	97	97	148	0
Toluene [CA, US]	0	0	324	324	408	0
Xylenes [CA, US]	0	0	571	571	660	0
Ethylbenzene [CA, US]	0	0	133	133	159	0
1,2,4–Trimethylbenzene [CA, US]	0	0	0	0	0	39
Lead and its compounds [CA, MX, US]	0	0	0	0	1,834	0

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–13. Releases and Transfers (excluding air), Pipeline Operations, RETC, 2005 (kilograms)

Pollutant	Water releases	Land releases	Underground injection	Off-site disposal	Transfers to recycling	Other transfers
Lead and its compounds [CA, MX, US]	59	0	NA	0	244	0
Chromium and its compounds [CA, MX, US]	266	0	NA	0	0	0
Arsenic and its compounds [CA, MX, US]	21	0	NA	0	0	0
Cadmium and its compounds [CA, MX, US]	13	0	NA	0	0	0
Nickel and its compounds [CA, MX, US]	475	0	NA	0	0	0
Mercury and its compounds [CA, MX, US]	7	0	NA	0	0	0
Cyanides [CA, MX, US]	5	0	NA	0	0	0

NA = not applicable.
Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Other releases and transfers reported by Canadian and Mexican pipeline facilities—releases to water, land, underground injection and disposal and transfers to recycling or other treatment—are presented in **Tables 4–12** and **4–13**, respectively. As noted earlier, data for non-air releases and transfers from US facilities in this sector are not covered under the TRI program and therefore cannot be presented.

In 2005 Canadian pipeline facilities reported almost 12,000 kilograms of six pollutants released off-site to disposal (n-hexane and hydrogen sulfide accounted for most of this amount), and almost 10,000 kilograms of these same substances, along with lead and its compounds, were transferred to recycling. Aside from land releases of n-hexane, the amounts released to water and otherwise transferred by this sector were very small.

Like the releases of hazardous air pollutants, other reported releases and transfers by Mexican facilities in this sector were small (just over 1,000 kilograms), consisting mainly of seven pollutants released to water. Although the amounts reported are small, some of these pollutants—arsenic, chromium, nickel and lead and their compounds—are considered important in terms of their potential risk to human health and the environment, and they generally have lower PRTR reporting thresholds.

Pipeline facilities, like facilities in the US oil and gas production sector, do not have to report to the TRI. Because the pollutants reported in Canada and Mexico, with the exception of hydrogen sulfide, are all reportable under the US TRI, this sector exemption likely has had an impact on the picture of pollution from the petroleum industry in the United States.

Map 4–2. North American Petroleum Refineries, 2005

Petroleum Refining

Refineries process crude oil into many different petroleum products such as gasoline, home heating fuel, asphalt and chemical feedstocks. These facilities are built to match their crude oil inputs, as well as the impurities, such as sulfur and wax, requiring specialized equipment during the refining process. Refineries use a variety of processes to separate the different sizes of molecules in crude oil, including distillation and "cracking," or further breaking down and rearranging chains of molecules. These processed fractions are then treated to remove impurities such as sulfur, nitrogen, water, metals and salts, and finally blended into products that may be stored on-site.

Petroleum Refineries in North America

In 2005 Canada had 19 refineries (including one petrochemical refinery and one heavy oil processing facility), Mexico had 6 and the United States had 158, 15 of them petrochemical refineries (see **Map 4–2**).

Many **Canadian refineries** have operational permits from their provincial governments (or in some cases, municipal authorities). These permits vary widely from one refinery to another. Some permits apply to one contaminant, others to a particular unit or process (CCME 2003). The Canadian Council of Ministers of the Environment has developed a National Framework for Petroleum Refinery Emission Reductions.[9] The framework identifies tools that provincial governments can use to set facility-wide emission caps for criteria air contaminants and benzene, and it proposes an emission monitoring and reporting strategy.

[9] The CCME is not a regulatory body; rather, it develops guidelines that can be adopted by Canadian provinces.

CCME also has developed a two-phase Canada-Wide Standard for Benzene, calling for a 30 percent reduction in benzene emissions by 2000 (from 1995 levels) and a further 6,000 tonne reduction in benzene by 2010 (CCME 2001).

Mercury emissions from refineries stem largely from the mercury present in crude oil, which varies widely from one region to another. In 2002 Environment Canada and the Canadian Petroleum Products Institute (CPPI) tested crude oils in Canada to determine mercury concentrations. The new values for average mercury concentration in crude oil are 2.6 ± 0.5 parts per billion of oil. At this concentration, a refinery using about 41,000 barrels per day of crude oil would trigger NPRI reporting of mercury at 5 kilograms per year (CPPI 2007b).

Many refineries have primary and secondary wastewater treatment. In Canada, water releases from some refineries are regulated by the federal Petroleum Refinery Liquid Effluent Regulations, which set limits for oil and grease, phenols, sulfide, ammonia nitrogen and total suspended solids. In Quebec, liquid effluents from refineries are under provincial jurisdiction. Some refineries in western Canada report underground injection of chemicals. They may also spread refinery sludges on land. Not all provinces allow these practices, because they can lead to soil and surface or groundwater contamination.

As noted earlier, upgraders are large industrial facilities that process heavy oil or bitumen into a synthetic crude before shipment in pipelines or before additional refining. Upgraders resemble refineries and use similar processes, but they are usually located near the oil and gas fields. Depending on the specific nature of its operations and the type of oil being processed, an upgrader can be considered either an oil and gas production facility or a refinery. The four upgraders included in this report are Canadian. Three have been classified by Environment Canada as oil and gas production facilities and the fourth as a refinery. The processes typically carried out by upgraders are also carried out in certain refineries in the United States and Mexico.

Mexican refineries are operated by the national petroleum company, PEMEX, and all six have comparable capacities, ranging from about 200,000 to 300,000 barrels per day. PEMEX *Refinación* (PREF) processes crude oil and produces petroleum products and derivatives. In addition to its six refineries, PREF also includes the related transportation and storage infrastructure, such as land and marine terminals, tankers and pipelines.

Since 1999, PEMEX has had in place a corporate environmental and safety management system for its refineries. In 2007–2008, the company introduced an improved system based on an electronic reporting platform known as PEMEX SSPA (*Seguridad, Salud y Protección Ambiental*), and it set new corporate environmental goals. These goals included a 30 percent reduction in sulfur dioxide emissions by 2010.

A regulation adopted in 2005 requires a 90 percent recovery of sulfur by 2008 for some refineries and by 2010 for other refineries.[10] This regulation may require major investments in existing refineries.

Comprehensive national regulations govern **US refineries**. The 1974 New Source Performance Standards under the US Clean Air Act have been amended several times to add sulfur oxide limits for sulfur recovery and fluidized catalytic cracking units (FCCUs). In addition, an amendment passed in April 2008, but stayed in May, set more stringent limits on PM and SO_x emissions, on NO_x emissions from new FCCUs and coking units and process heaters, and on SO_2 emissions for all sulfur recovery units. It also required particulate monitoring using operating parameters or continuous emission monitors (US EPA 2008a).

US refineries are also regulated by the 1995 National Emission Standards for Hazardous Air Pollutants under the Clean Air Act. The EPA is required to review MACT standards every eight years to account for improvements in pollution control and prevention and to then determine whether more protective health standards are necessary. The EPA recently decided that risks to human health and the environment are low enough that no further controls are warranted (US EPA 2008a). Refineries are also regulated by other federal, state and local requirements, including federal regulations governing VOC emissions.

Since 2000, officials acting on behalf of the EPA's National Petroleum Refinery Initiative have negotiated legally binding pollution reduction agreements with 96 refineries. These agreements will require reductions in emissions of nitrogen oxides, sulfur dioxides, benzene, VOCs and particulates (US EPA 2008b).

Fuel Quality

In recent years, because of concerns about air quality and the need to meet requirements for new vehicle emission control systems, the amounts of sulfur and benzene in fuels have been reduced in Canada, Mexico and the United States (see **Table 4–14**). These changes in fuel quality have required significant changes at refineries. In all three countries, the amounts of sulfur in regular gasoline,

[10] NOM-148-SEMARNAT-2006 (DOF: 28 November 2007) establishes the efficiency of sulfur recovery in petroleum refineries, with different compliance dates for existing refineries.

Table 4–14. Sulfur Content of Regular Gasoline and Diesel by Country, 2004–2008 (parts per million)

	Canada		Mexico		United States	
Year	Gasoline	Diesel	Gasoline	Diesel	Gasoline	Diesel
2004	150	500	500	500	300	500
2005	30	500	300	300	30	500
2006	30	15	300	300	30	500
2007	30	15	300	15	30	15
2008	30	15	30	15	30	15

Note: These are general guidelines; each country has specific requirements that may vary seasonally or by region.

low sulfur gasoline, diesel fuel and low sulfur diesel fuel have been reduced, although not always to the same levels or on the same timetable.

Fuel quality regulations have also had an impact on refinery releases and transfers. Efforts to reduce sulfur levels in diesel and gasoline normally require a catalytic process. Many catalysts contain a range of metals, and over time, as the catalysts become spent, they must be regenerated or sent for disposal when a unit goes offline for maintenance. The process to reduce sulfur in diesel and gasoline also produces refinery emissions containing sulfur oxides.

Canada, Mexico and the United States are working together to declare coastal waters and the Great Lakes sulfur emission control areas under the International Marine Organisation MARPOL agreement. The sulfur content of marine fuels would be limited to 1.5 percent (CAPP 2007). Although lead is no longer added to gasoline for automobiles in all three countries, it is still added to certain types of aviation fuel.

Flaring

At refineries, flares can be used to incinerate oil and gas products to prevent them from being directly released into the air (e.g., to reduce VOC emissions). However, when a petroleum stream is routed to a flare, it normally bypasses other pollution control devices and can release large amounts of sulfur dioxide and other pollutants to air. Indeed, one day of acid gas flaring can release more sulfur dioxide than is recovered in a sulfur recovery unit in a year (US EPA 2000a). US Clean Air Act regulations exempt flaring from sulfur dioxide emission limits when there is a process upset or an emergency malfunction. Current emission factors are based on the assumption that flaring destroys 98–99 percent of hazardous air pollutants. However, this high level of combustion may be achieved only under optimal conditions, suggesting that flares that smoke (rather than provide a clear exhaust plume) or flaring operations that are undertaken during high wind speeds may increase emissions (Environmental Integrity Project 2007).

Environmental and Health Issues Associated with Petroleum Refining

The main issues associated with petroleum refining are stack air emissions of criteria air contaminants (e.g., sulfur dioxide, nitrogen oxide, particulates, VOCs and carbon monoxide), toxic pollutants (e.g., benzene, metals and PAHs), and greenhouse gases, as well as releases to water, groundwater, and land; spills and leaks; and the methods associated with the disposal of petroleum wastes.

In addition to stack emissions, fugitive emissions from valves, joints, flanges, connectors, vents and pipes are a concern at refineries. Although each of these emissions may be small, they are often continuous, numerous and emitted close to the ground, thereby increasing the potential exposure of workers and others in proximity to the installation.

Pollution Prevention and Control

Representatives of petroleum refineries provided details about their pollution prevention and control technologies. For example, to remove sulfur from diesel and gasoline, refineries often route the sulfur through a sulfur recovery unit, which can reduce sulfur oxides by 95 percent. Some refineries employ wet gas scrubbers to eliminate SO_x emissions from the FCCU regenerator exhaust. These scrubbers use a soda ash solution to reduce most SO_x emissions as well as to greatly reduce particulate matter. Low-NO_x burners on furnaces and boilers have also been phased in at several refineries, and some facilities continuously monitor emissions from turbines in the combustion units.

Because it is time-consuming to measure fugitive emissions directly, they have commonly been estimated through the use of emission factors. Once identified, these emissions can be controlled, resulting in significant savings because the product is no longer evaporating. Today's leak detection and repair programs set the definition of a leak (which can vary widely, from 10 to 10,000 parts per million), require regular inspection of all sources (which can range from daily to annually), and set timetables to fix the leaks (which can also vary). The Clean Air Act requires US refineries to have leak inspection and repair programs. Monitors for highly reactive VOCs have been installed on cooling towers and flares at some plants. In one case, leakage accounted for about 90,700 kilograms a year, and so reducing the leaks saved the facility US$127,000.

Refineries typically have storage tanks and containment basins. High-density polypropylene liners can prevent storage tank spills from reaching groundwater, redundant level gauges and alarms on storage tanks can prevent overfills, and vapor recovery units can also be installed on tanks. New hand-held technology (laser DIAL analyzer) allows measurements from a distance, unlike older methods in which a probe had to be held at each joint or seal. Some of these new devices have painted a different picture of fugitive emissions than that produced using emission factors. For example, the amounts of VOCs and benzene measured at a Canadian refinery using DIAL analyzers were up to10 times greater than those estimated using emission factors. In Canada, the CCME and industrial associations have developed guidelines to reduce fugitive emissions.

Although no specific Mexican regulations cover leak detection and repair, PEMEX has reduced losses through improved maintenance programs, inspection procedures and responses to complaints from the public. Remote monitoring (SCADA) systems are used to inspect the interior of pipelines. Spills and leakages represented 3,528 tonnes of total refinery emissions in 2005 (PEMEX 2005).

Refinery wastewater contains oil that must be removed. Installing control equipment on sewer drains and wastewater system junction boxes can reduce emissions. A few refineries in Canada and the United States have biological wastewater effluent treatment systems that use microbes to break down hydrocarbons. Mexican refineries and natural gas processing plants have had wastewater treatment plants for several years. Refineries are making new efforts to reduce the use of groundwater by applying recycling technologies.

Carson Refinery, BP West Coast Products LLC (United States)

The Carson refinery of BP West Coast Products LLC is located in a suburb of Los Angeles, California. The BP Carson refinery uses crude oil mainly from Alaska to produce gasoline, diesel, jet fuel and petroleum coke. It produces about 25 percent of southern California's gasoline, about 40 percent of its diesel fuel and about 50 percent of the jet fuel used at Los Angeles's airport (LAX). The refinery has a capacity of about 265,000 barrels a day, and so it is a midsized refinery among the five US refineries owned by the parent company, BP America. Also on-site is the Watson Cogeneration Plant, one of the largest cogeneration plants in California. It produces electricity for 400,000 homes in the Los Angeles area. The refinery used to have chemical operations, but they were sold in 2005. Today, Carson is mainly a refinery with large bulk storage tanks. The cogeneration plant and refinery report as one facility to the US TRI.

The crude oil received at the refinery is heated to separate oil into various intermediate and final products. The refinery has a vast network of pipes, valves, compressors and pumps to transfer the feedstocks, fuels and products to and from the process units, storage tanks and various types of delivery equipment. Catalysts are used to assist with the chemical reactions in the refinery. The reactor undergoes maintenance every three to five years, and during these shutdown periods the old catalysts are replaced with new ones and the air pollution control systems are cleaned and serviced. Metals from the spent catalyst (such as molybdenum, zinc and nickel) are reported to the TRI. These metals can vary, depending on the type and amount of spent catalyst shipped off-site for disposal in any given year. Flare emissions may occur more frequently during start-up and shutdown of units, but they are offset by the absence of emissions during unit downtime.

Materials such as feedstocks, intermediate products and final products are stored in above-ground tanks around the refinery. The modern design for storage tanks for volatile petroleum liquids includes a floating roof with gaskets and seals on all roof penetrations and openings and a primary seal that covers the gap between the floating roof and the tank wall. Many of the tanks are also domed. Tanks containing less volatile liquids usually have fixed roofs.

Like most refineries, BP Carson has a sulfur recovery unit; it removes hydrogen sulfide from various off-gases. An on-site wastewater separator separates oil from water, which is then sent to the publicly owned treatment plant. Some gases from process units are flared to remove noncombusted fuel gas. The BP Carson refinery has been ISO 14001 certified since 2002 and has installed several selective catalytic reduction systems to reduce NO_x emissions from heaters and from the fluidized catalytic converter unit. It also recently upgraded the electrostatic precipitator to reduce particulate emissions from the FCCU.

The refinery reports its criteria air contaminant emissions to the local South Coast Air Quality Management District. Currently, greenhouse gases do not have to be reported to regulatory agencies, but they are estimated internally for the corporate environmental statement and reported voluntarily to California's Climate Action Registry. For more information, see ‹http://www.bp.com/printsectiongenericarticle.do?categoryId=9005027&contentId=7009099›.

Reported Releases and Transfers

In North America, petroleum refineries are required to report to their respective PRTRs. CAC data for US refineries reporting to the TRI were obtained from the US National Emissions Inventory. **Figures 4–17**, **4–19** and **4–21** present the air releases reported in each country, and **Figures 4–16**, **4–18** and **4–20** present other releases and transfers.

In 2005, 19 Canadian petroleum refineries, including one petrochemical refinery and one heavy oil refinery, reported about 230 million kilograms of releases and transfers. About 75 percent of this amount (172 million kilograms) was released to the air, and most of the air releases (168.5 million kilograms) were CACs reported by all 19 refineries. In Mexico, six refineries reported a total of 125,731,188 kilograms in releases and transfers, almost of which was air releases of CACs reported by all six refineries. In the United States, 158 refineries, including 15 petrochemical facilities, reported about 677 million kilograms in releases and transfers, of which almost 653 million kilograms were air releases. About 97 percent of these releases were CACs reported by up to 129 facilities.

Figure 4–16. Canadian Releases and Transfers (excluding air) from Petroleum Refineries, 2005

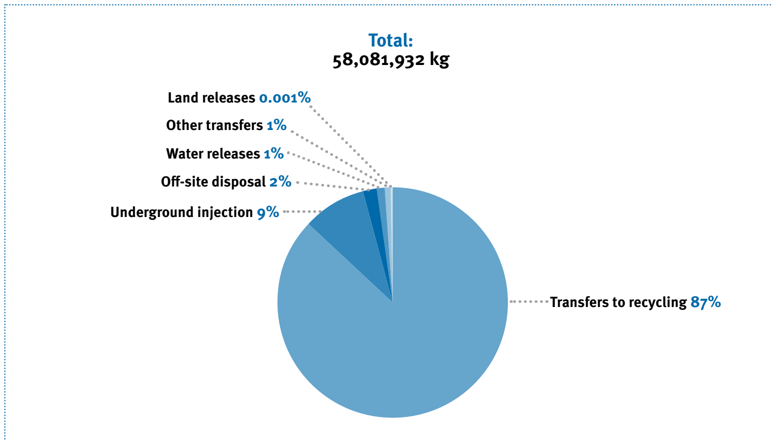


Figure 4–17. Canadian Air Releases (CACs and toxic pollutants) from Petroleum Refineries, 2005

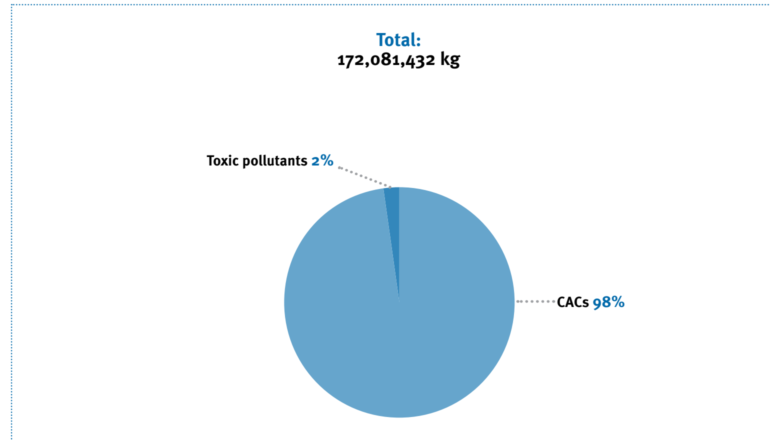


Figure 4–18. Mexican Releases and Transfers (excluding air) from Petroleum Refineries, 2005

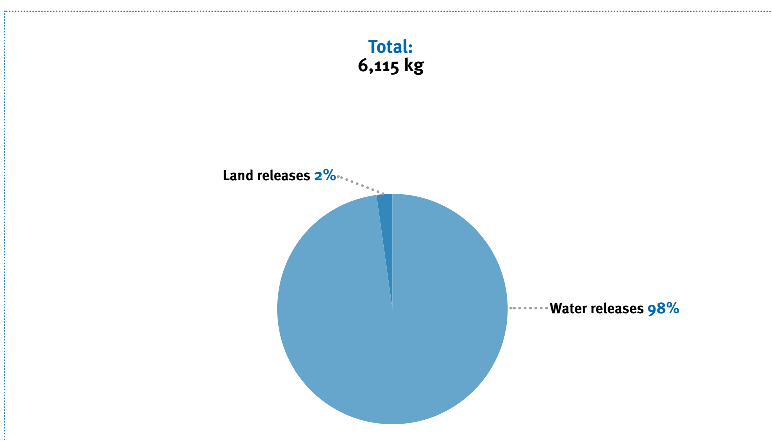


Figure 4–19. Mexican Air Releases (CACs and toxic pollutants) from Petroleum Refineries, 2005

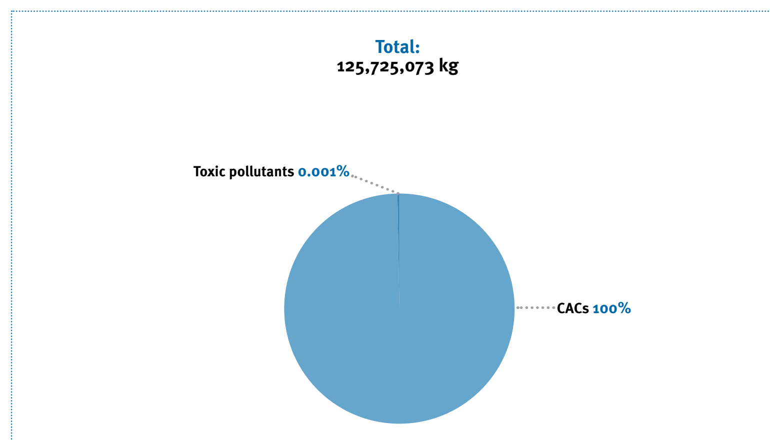


Figure 4–20. US Releases and Transfers (excluding air) from Petroleum Refineries, 2005

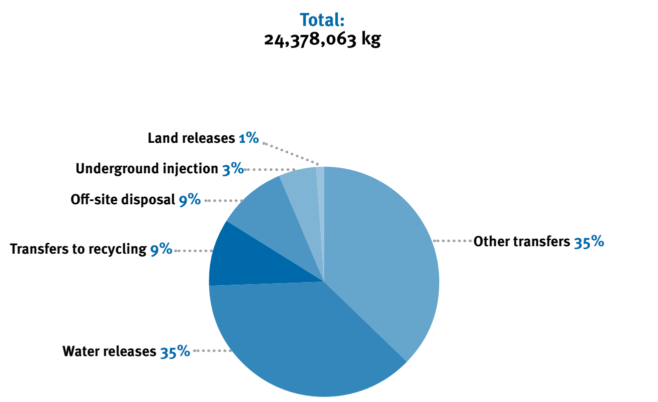


Figure 4–21. US Air Releases (CACs and toxic pollutants) from Petroleum Refineries, 2005

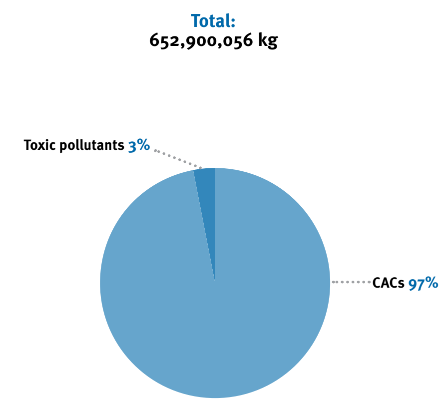


Table 4–15. Releases of CACs by Country, Petroleum Refineries, 2005

	NPRI		RETC		US NEI		Total
Criteria air contaminant	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Air releases (kg)
Sulfur dioxide	19	94,028,332	6	68,544,560	129	224,701,720	387,274,612
Oxides of nitrogen	19	28,355,495	6	16,418,364	129	131,846,102	176,619,961
Carbon monoxide	19	18,093,708	6	10,034,568	129	119,411,835	147,540,111
Volatile organic compounds	19	14,396,528	6	10,981,688	129	90,358,650	115,736,866
Total particulate matter (PM)	18	6,203,253	6	10,803,476	129	8,329,349	25,336,078
PM_{10}	19	4,526,561	6	8,902,874	129	31,339,500	44,768,935
$PM_{2.5}$	19	2,941,175	N/A	N/A	129	27,170,589	30,111,764
Total		**168,545,052**		**125,685,531**		**633,157,744**	**927,388,327**

N/A = not available.

Much like the situations already described for the oil and gas production and pipeline operations sectors, releases and transfers reported in 2005 by North American petroleum refineries were dominated by air releases, particularly of CACs. Sulfur dioxide, oxides of nitrogen, VOCs and carbon monoxide accounted for about 90 percent of the 927 million kilograms of the **criteria air contaminants** released (see **Table 4–15**).

In 2005 all of the refineries reporting in each country reported releases and transfers of **toxic pollutants**. The amounts and types of releases and transfers from petroleum facilities in each sector and country depend on various factors. This is particularly true of petroleum refining, where factors include the nature of the processes used, the feedstock, the type and age of the facility and the maintenance and pollution controls used.

Air releases of toxic pollutants in each country are presented in **Tables 4–16** to **4–18**. Other reported releases and transfers are presented in **Tables 4–19** to **4–21**.

In Canada, a majority of refineries reported 15 of the 22 toxic pollutants shown in **Table 4–16**. These accounted for 98 percent of the almost 3.5 million kilograms of toxic pollutants released to air and reported by these facilities in 2005. In all, 62 toxic pollutants were reported released to air by Canadian refineries.

In Mexico, all six Mexican refineries reported air releases of eight of the nine toxic pollutants shown in **Table 4–17** (one refinery did not report 1,1,1-trichloroethane) for a total of 39,542 kilograms.

In the United States, a large majority of the 158 US refining operations reported releases to air of 11 of the 22 toxic pollutants shown in **Table 4–18**. These 22 pollutants accounted for 97 percent of the 19.7 million kilograms reported in 2005. In all, 85 toxic pollutants were reported as released to air by US refineries.

Across the three countries, 35 pollutants made up the bulk of the reported air releases of toxic pollutants by petroleum refineries. Thirty-one of the 35 were subject to PRTR reporting in both Canada and the United States, but only 13 were subject to RETC reporting.

Toxic pollutants reported in large quantities in both Canada and the United States were ammonia, 1,2,4–trimethylbenzene, ethylbenzene, hydrochloric acid, hydrogen fluoride, methyl isobutyl ketone, sulfuric acid and xylenes. Among the other pollutants released to air in relatively small amounts but by a majority of facilities (and not shown in **Tables 4–16** to **4–18**), there were differences between Canada and the United States. A main difference is that more pollutants were reported by US facilities than by Canadian facilities. Pollutants reported in both countries included lead and mercury and their compounds as well as polycyclic aromatic compounds (PACs).

In Mexico, only two toxic pollutants released to air were reported in substantial quantities: formaldehyde and nickel and its compounds. Nickel and its compounds were also reported by Canadian and US refineries.

Table 4–16. Reported Releases to Air of Toxic Pollutants, Petroleum Refineries, NPRI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by petroleum refineries
Sulfuric acid [CA, US]	17	1,613,713
Xylenes [CA, US]	19	256,825
Toluene [CA, US]	19	249,370
n-Hexane [CA, US]	19	224,165
Propylene [CA, US]	14	136,770
Vanadium and its compounds [CA, US]	9	126,203
Benzene [CA, MX, US]	19	98,641
Hydrogen sulfide [CA, MX]	17	81,732
Methyl ethyl ketone [CA]	3	80,224
Methyl isobutyl ketone [CA, US]	3	71,737
Methyl tert-butyl ether [CA, US]	2	66,652
Hydrochloric acid [CA, US]	4	65,584
Ethylbenzene [CA, US]	19	65,555
Cyclohexane [CA, US]	19	65,451
1,2,4–Trimethylbenzene [CA, US]	19	55,055
Nickel and its compounds [CA, MX, US]	10	54,755
Ethylene [CA, US]	12	51,984
Ammonia [CA, US]	16	35,417
Hydrogen fluoride [CA, US]	4	34,295
Naphthalene [CA, US]	15	17,692
Aluminum (fume or dust) [CA, US]	2	14,523
Chlorine [CA, US]	3	12,437
Total		**3,478,780**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–17. Reported Releases to Air of Toxic Pollutants, Petroleum Refineries, RETC, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by petroleum refineries
Nickel and its compounds [CA, MX, US]	6	23,389
Formaldehyde [CA, MX, US]	6	14,080
Benzene [CA, MX, US]	6	650
Lead and its compounds [CA, MX, US]	6	449
Arsenic and its compounds [CA, MX, US]	6	377
Chromium and its compounds [CA, MX, US]	6	311
Cadmium and its compounds [CA, MX, US]	6	182
1,1,1-Trichloroethane [MX, US]	5	57
Mercury and its compounds [CA, MX, US]	6	48
Total		**39,542**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–18. Reported Releases to Air of Toxic Pollutants, Petroleum Refineries, TRI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by petroleum refineries
Ammonia [CA, US]	115	3,892,174
Sulfuric acid [CA, US]	73	3,680,671
n-Hexane [CA, US]	145	1,925,824
Toluene [CA, US]	146	1,716,478
Propylene [CA, US]	116	1,590,147
Xylenes [CA, US]	148	1,379,918
Benzene [CA, MX, US]	149	942,966
Ethylene [CA, US]	113	649,712
Hydrochloric acid [CA, US]	55	504,575
Cyclohexane [CA, US]	138	427,731
Methanol [CA, US]	78	400,824
Methyl tert-butyl ether [CA, US]	33	344,192
Ethylbenzene [CA, US]	145	282,466
Carbonyl sulfide [CA, US]	73	277,295
1,2,4–Trimethylbenzene [CA, US]	129	252,704
Methyl isobutyl ketone [CA, US]	7	162,519
Naphthalene [CA, US]	128	130,092
Cyanides [CA, MX, US]	15	126,358
Cumene [CA, US]	83	121,537
1,3-Butadiene [CA, MX, US]	92	115,884
Hydrogen fluoride [CA, US]	50	115,819
Phenol [CA, MX, US]	75	110,678
Total		**19,150,564**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–19. Releases and Transfers (excluding air), Petroleum Refineries, NPRI, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Sulfuric acid [CA, US]	0	0	179	0	50,270,098	4,005
Ammonia [CA, US]	182,528	4,588,522	0	1,143	127	27,437
Asbestos (friable) [CA, MX, US]	0	0	0	580,798	0	0
Nitrate compounds [CA, US]	309,726	1,536	0	0	0	0
Methanol [CA, US]	0	240,658	0	0	0	1,045
Toluene [CA, US]	368	198,210	1,867	32,014	3,382	388
Molybdenum trioxide [CA, US]	0	0	0	3,810	203,329	0
Calcium fluoride [CA]	0	0	0	0	0	169,400
Nickel and its compounds [CA, MX, US]	86	0	1,654	31,326	112,707	0
Phosphorus [CA, US]	4,921	0	6,528	21,188	44,995	55,495
Xylenes [CA, US]	204	88,887	2,280	32,152	4,831	2,233
Phenol [CA, MX, US]	3,637	80,148	14	4	33,796	35
Zinc and its compounds [CA, US]	160	397	58	66,460	37,580	0
Diethanolamine [CA, US]	3,726	23,773	31	1,147	510	72,722
Ethylene glycol [CA, US]	1,898	59,548	288	2,654	0	3,025
Aluminum [CA, US]	1,445	0	0	46,982	0	0
Benzene [CA, MX, US]	244	32,557	830	12,029	1,750	111
Cyclohexane [CA, US]	77	8,544	1,262	26,735	1,955	8,400
n-Hexane [CA, US]	0	32,740	321	8,096	1,298	0
1,2,4–Trimethylbenzene [CA, US]	38	25,662	676	1,941	951	625
Chromium and its compounds [CA, MX, US]	0	0	145	8,892	19,500	0
Vanadium and its compounds [CA, US]	658	0	1,775	17,719	6,962	0
N-Methyl-2-pyrrolidone [CA, US]	0	25,479	0	0	0	0
Ethylbenzene [CA, US]	99	16,114	456	6,768	1,394	242
Hydrogen sulfide [CA, MX]	137	16,481	33	2,041	79	4,756

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

In addition to air releases, petroleum refineries in Canada, Mexico and the United States reported **other releases and transfers** in 2005. The releases to water, land, underground injection and disposal and the transfers to recycling or other treatment reported by refineries in each country are presented in **Tables 4–19** to **4–21**.

In addition to air releases of toxic pollutants, Canadian refineries reported 58 million kilograms in other releases and transfers. Twenty-five of the 71 reported pollutants accounted for more than 99 percent of the total (see **Table 4–19**). Of this amount, sulfuric acid and ammonia made up about 95 percent. More than 50 million kilograms were transfers to recycling (most of it sulfuric acid). About 4.5 million kilograms of ammonia were sent to underground injection. Ammonia and nitrate compounds were also released to water in 2005.

In Mexico, refineries released 6,115 kilograms of the eight toxic pollutants listed in **Table 4–20**, with seven of the eight pollutants released to water. Almost all of the substances released were metals.

In 2005 US refineries reported about 24 million kilograms in releases (other than air) and transfers. Twenty-five of the 72 reported pollutants accounted for more than 97 percent of the total (see **Table 4–21**). The top five pollutants made up more than half of the total amount. Large amounts of nitrate compounds and ammonia were released to water and to other media. Some metals, including vanadium, nickel, cobalt, manganese and lead and their compounds, were either released to land or off-site disposal or transferred to recycling.

Tables 4–19 to **4–21** reveal that almost all of the pollutants reported in the largest amounts by petroleum refineries in the three countries were common to both Canada and the United States. Some differences between the two countries include the large amounts of ethylene reported by US refineries, but not by Canadian refineries. By contrast, calcium fluoride and hydrogen sulfide were reported by most Canadian refineries, but these pollutants were not subject to reporting under the TRI.

Of all pollutants reported in any amount in the three countries (63 in Canada, 8 in Mexico and 67 in the United States), about a dozen were also subject to RETC reporting. They included benzene, hydrogen sulfide, formaldehyde, styrene and asbestos, along with some metals (e.g., mercury, lead, nickel, chromium and cadmium) and their compounds.

Seven of these toxic pollutants were reported as releases to water by refineries in Mexico, with an additional 152 kilograms of chlorine dioxide released to land. Differences in the pollutants subject to PRTR reporting in Mexico likely explain the smaller number of pollutants reported by refineries in that country. However, some of the pollutants reported in large quantities in either Canada or the United States (e.g., benzene and hydrogen sulfide) were also subject to RETC reporting.

Table 4–20. Releases and Transfers (excluding air), Petroleum Refineries, RETC, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Nickel and its compounds [CA, MX, US]	1,991	0	0	0	0	0
Chromium and its compounds [CA, MX, US]	1,630	0	0	0	0	0
Lead and its compounds [CA, MX, US]	1,120	0	0	0	0	0
Cyanides [CA, MX, US]	895	0	0	0	0	0
Arsenic and its compounds [CA, MX, US]	178	0	0	0	0	0
Chlorine dioxide [CA, MX, US]	0	0	152	0	0	0
Cadmium and its compounds [CA, MX, US]	123	0	0	0	0	0
Mercury and its compounds [CA, MX, US]	26	0	0	0	0	0

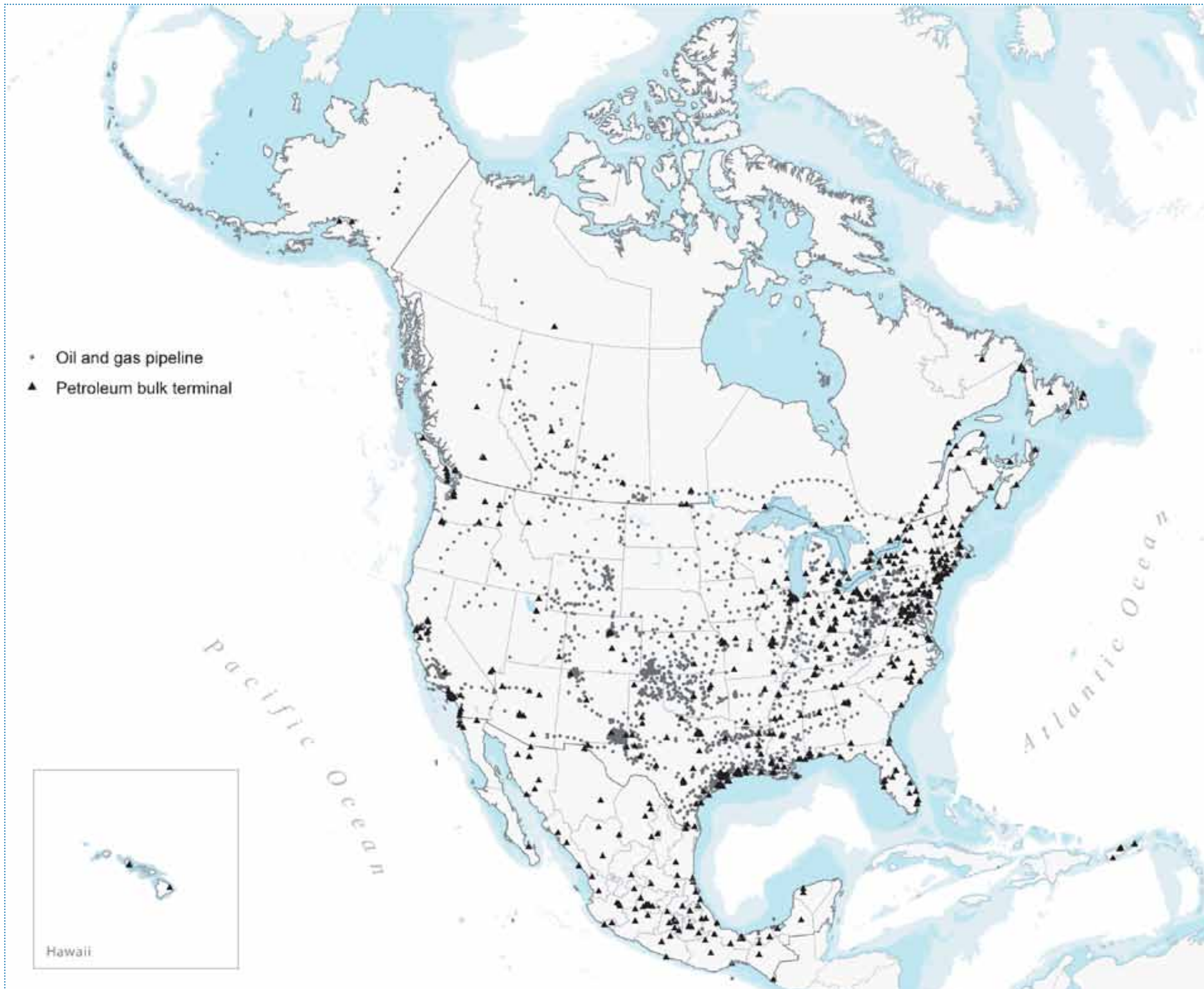
Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–21. Releases and Transfers (excluding air), Petroleum Refineries, TRI, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Nitrate compounds [CA, US]	7,985 145	31,079	12,546	16,382	0	5,481
n-Hexane [CA, US]	760	688	1,177	5,976	157,110	1,851 276
Diethanolamine [CA, US]	1,696	0	262	140,362	122,314	1,360 484
Ethylene [CA, US]	209	2,414	3	8	0	1,461 673
Vanadium and its compounds [CA, US]	21,618	0	4,597	167,150	1,112,558	0
Molybdenum trioxide [CA, US]	1,986	0	680	192,461	990,197	13,535
Nickel and its compounds [CA, MX, US]	6,465	135	19,065	367,002	799,424	0
Ammonia [CA, US]	248,371	454,011	2,092	150,025	1,350	208,589
Phenol [CA, MX, US]	28,870	26,618	113	28,591	118	797,305
Benzene [CA, MX, US]	3,526	37,216	1,076	10,049	21,258	526,044
1,2,4–Trimethylbenzene [CA, US]	1,414	1,322	457	3,487	3,547	566,292
Propylene [CA, US]	301	12,864	0	123	2	559,265
Methanol [CA, US]	17,194	13,045	0	2,913	6	411,491
Zinc and its compounds [CA, US]	29,282	753	7,751	38,784	7,413	0
Cresols [CA, US]	26,733	29,210	3	4,456	250,960	111,248
Toluene [CA, US]	9,028	37,896	1,567	18,029	24,706	296,022
Asbestos [CA, MX, US]	0	0	0	331,002	0	0
Xylenes [CA, US]	2,586	15,267	2,105	30,562	27,808	227,981
Cobalt and its compounds [CA, US]	1,446	0	502	26,704	211,209	0
Naphthalene [CA, US]	1,385	1,035	88,317	8,348	12,861	47,413
Ethylbenzene [CA, US]	1,755	3,343	1,015	5,451	21,530	105,029
Manganese and its compounds [CA, US]	9,249	0	82	24,112	68,530	0
Lead and its compounds [CA, MX, US]	2,947	66	10,834	76,079	10,616	0
N-Methyl-2-pyrrolidone [CA, US]	2	2,593	153	0	75,918	14,930
N-butyl alcohol [CA, US]	4	0	0	0	0	87,253

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Map 4–3. North American Bulk Storage Terminals Reporting Releases and Transfers in 2005 and Pipeline Networks



Terminals for Storage and Distribution of Petroleum Products

Many of the products of refineries are stored in large on-site tanks or bulk storage terminals for future use or additional blending. Tanks containing petroleum products can also be located off-site and serviced by railroads, roads or tankers. Many storage tanks are equipped with floating roofs, often with a primary seal covering the gap between the floating roof and the tank wall designed to reduce emissions. As the tank is emptied, the floating roof comes to rest on the legs or supports at the bottom of the tank, which may open the vent and increase emissions. Emissions also occur when tanks are filled or cleaned.

Bulk Storage Terminals in North America

In Canada, 84 bulk storage terminal facilities reported to the NPRI in 2005. In the United States, 548 petroleum bulk storage terminals reported to the TRI, and in Mexico 95 bulk storage terminals operated by PEMEX in 2005 reported to the RETC. **Map 4–3** shows the locations of these bulk storage terminals, along with the pipeline networks in each country.

In Canada, federal and provincial regulations govern bulk storage terminal operations. Air emissions from gasoline distribution networks are regulated by the provinces and, in some cases, by municipalities.

Regulations apply to vapor control (e.g., during the transfer of fuels) and specify the use of pollution control equipment, such as floating roofs, to prevent the discharge of hydrocarbons. Provincial and local regulations on the recovery of gasoline vapors respond to the CCME initiatives for terminals and bulk plants and service stations. In 1998 the Canadian

Petroleum Products Institute initiated a pilot project involving the participation of various levels of government, which contributed to the development of the Canadian General Standards Board's Standard for Vapour Control Systems in Gasoline Distribution Networks (CPPI 1991). Certain provinces also have leak detection requirements for above-ground and underground fuel bulk storage tanks.

In the United States, both US federal and state regulations govern bulk storage of fuels. EPA regulations for bulk storage tanks at liquid terminals stipulate that inspection processes be subject to Spill Prevention, Containment and Countermeasure regulations. In 1983 the EPA set performance standards for bulk gasoline terminals to limit and control emissions of volatile organic compounds. The 1994 National Emission Standards for bulk gasoline terminals and pipeline breakout stations set limits for emissions of hazardous air pollutants (US EPA 2003). The American Petroleum Institute recently developed methods to calculate emissions during the filling or cleaning of tanks, and many of these methods have been incorporated into the widely used EPA guidance on emission factors, AP-42.

In Mexico, PEMEX Refining (PREF) is responsible for the 77 inland storage terminals and 15 marine terminals. No specific regulations govern bulk storage terminals in Mexico, but these facilities must comply with the same regulations as other industries and, in particular, safety and material standards. Bulk storage terminals are subject to RETC reporting and to federal legislation on the discharge of wastewater to federal water bodies or municipal sewage systems. The storage tanks at PEMEX terminals have internal floating roofs, leak detection systems, vapor recovery systems that are used during loading, on-site water treatment systems and monitoring wells to verify the quality of the surrounding soil.

Environmental and Health Issues Associated with Bulk Storage Terminals

The main issues associated with bulk storage terminals are emissions of criteria air contaminants, toxic pollutants and greenhouse gases; fugitive emissions, spills and leaks; and land and groundwater contamination.

Pollution Prevention and Control

The representatives of bulk storage terminals who were interviewed provided additional information about their pollution prevention and control equipment. For example, vapor recovery systems to control emissions during the fueling of tankers have become commonplace in this sector. Certain terminal operators have changed from top loading to bottom loading in some tanks, which reduces fugitive emissions. New tanker trucks are also equipped with vapor recovery systems to prevent the vapors that occur during tank filling from escaping into the atmosphere. Many refineries are requiring tankers that load at their facilities to have vapor recovery systems.

Spill containment is also a priority at bulk storage terminals. One representative explained that regulations require a facility to upgrade its spill containment controls whenever it adds or upgrades equipment. At another facility, products are blended on-site, generating waste when hoses and drums are rinsed. This facility instituted new procedures to dedicate hoses to certain categories of products (e.g., hoses for solvents are not used for oils or glycols). The rinse water can then be reused or sold because it contains only solvents, for example. Other terminals have placed dams around the platforms on which the tanks sit in order to contain spills, segregated systems for rainwater drainage and oily water to prevent soil contamination, and added monitoring wells to monitor groundwater.

Reported Releases and Transfers

Bulk storage terminals report to the PRTRs of Canada, Mexico and the United States. Terminal operations were first required to report to Canada's NPRI in 2002; however, the standard 10-employee NPRI reporting threshold does not apply to these facilities. Data on the CACs released by US bulk storage terminals reporting to the TRI were obtained from the US National Emissions Inventory.

Figures 4–23, **4–25** and **4–27** present air releases reported in each country; **Figures 4–22**, **4–24** and **4–26** present other releases and transfers.

In 2005, 84 Canadian bulk storage terminals reported about 12 million kilograms of releases and transfers. About 99 percent of this amount was released to the air, of which some 11.6 million kilograms were releases of CACs. In Mexico, 95 bulk storage terminals reported releases and transfers of 66.5 million kilograms. Almost 100 percent of this amount was air releases of CACs. In the United States, 548 bulk storage terminals reported approximately 18.7 million kilograms in releases and transfers, of which about 16.1 million kilograms were air releases. Of these air releases, 14.7 million kilograms (91 percent) were releases of CACs, reported by up to 190 of the 548 US bulk terminals.

Figure 4–22. Canadian Releases and Transfers (excluding air) from Bulk Storage Terminals, 2005

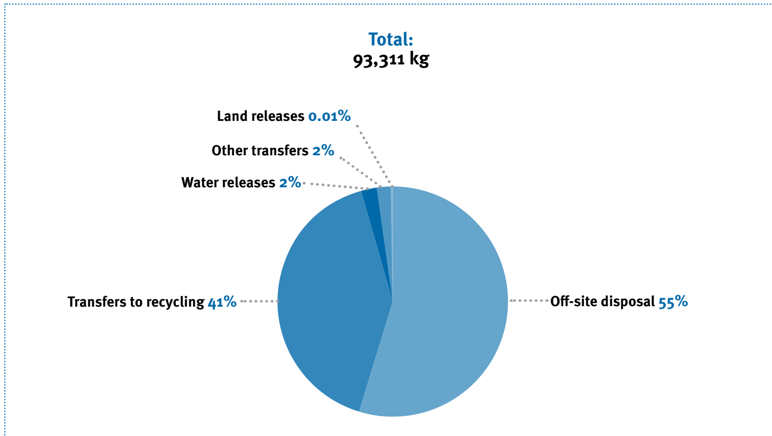


Figure 4–23. Canadian Air Releases (CACs and toxic pollutants) from Bulk Storage Terminals, 2005

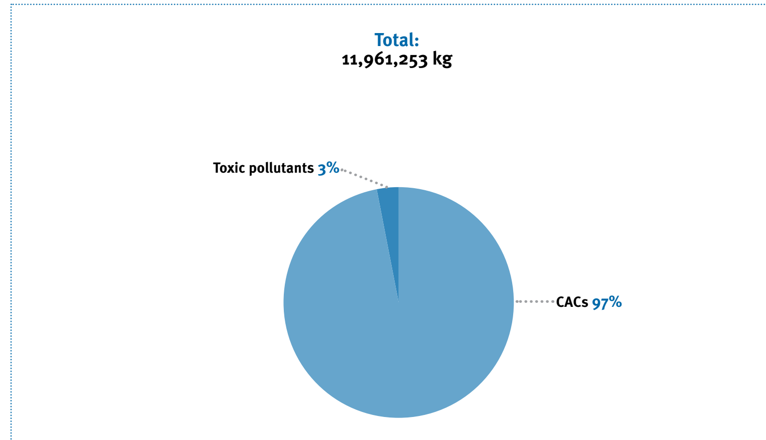


Figure 4–24. Mexican Releases and Transfers (excluding air) from Bulk Storage Terminals, 2005

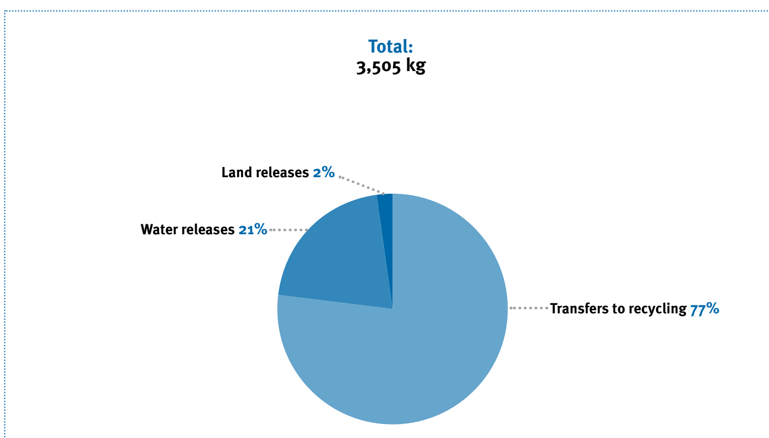


Figure 4–25. Mexican Air Releases (CACs and toxic pollutants) from Bulk Storage Terminals, 2005

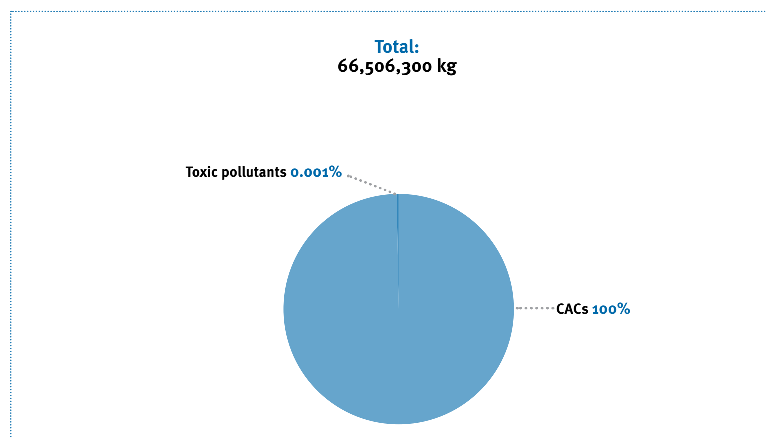


Figure 4–26. US Releases and Transfers (excluding air) from Bulk Storage Terminals, 2005

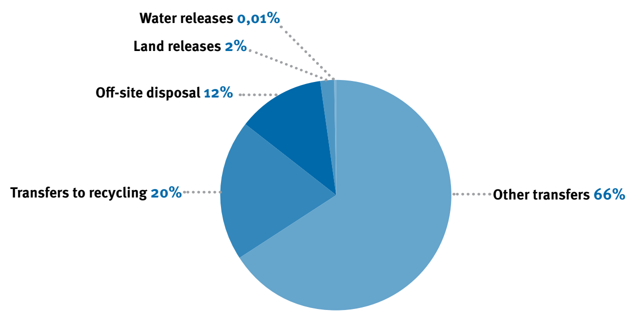
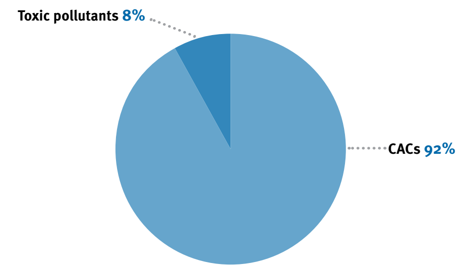


Figure 4–27. US Air Releases (CACs and toxic pollutants) from Bulk Storage Terminals, 2005



As in the other petroleum sectors examined in this chapter, reporting in 2005 by North American petroleum bulk storage terminals was dominated by air releases, particularly of **criteria air contaminants**. Volatile organic compounds accounted for about 92 percent of the total of 92.8 million kilograms of CACs released (see **Table 4–22**).

In 2005 North American bulk storage terminals also reported releases and transfers of **toxic pollutants**. Almost all of the facilities in this sector (70 Canadian facilities, 83 Mexican facilities and 548 US facilities) reported releases and transfers of toxics.

Table 4–22. Releases of CACs by Country, Bulk Storage Terminals, 2005

	NPRI		RETC		US NEI		Total
Criteria air contaminant	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Number of facilities reporting	Air releases (kg)	Air releases (kg)
Volatile organic compounds	77	11,398,407	82	63,683,596	190	10,614,297	85,696,300
Sulfur dioxide	6	135,297	70	786,678	190	445,856	1,367,831
Oxides of nitrogen	6	27,629	77	1,370,470	190	1,951,521	3,349,620
Carbon monoxide	5	9,779	75	509,660	190	959,045	1,478,474
Total particulate matter (PM)	5	2,256	71	112,335	190	18,249	132,840
PM_{10}	6	8,199	69	40,173	190	689,639	738,011
$PM_{2.5}$*	6	5,391	N/A	0	190	97,436	102,827
Total		**11,586,958**		**66,502,912**		**14,776,043**	**92,865,903**

N/A = not available.

Table 4–23. Reported Releases to Air of Toxic Pollutants, Bulk Storage Terminals, NPRI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by bulk terminals
n-Hexane [CA, US]	70	117,229
Toluene [CA, US]	70	104,583
Xylenes [CA, US]	69	48,678
Benzene [CA, MX, US]	51	37,184
Ethylbenzene [CA, US]	65	23,559
Propylene [CA, US]	6	17,002
Cyclohexane [CA, US]	29	12,250
1,2,4-Trimethylbenzene [CA, US]	64	8,276
Ethylene [CA, US]	4	4,306
Methanol [CA, US]	8	740
Naphthalene [CA, US]	6	395
Cumene [CA, US]	4	83
Phenol [CA, MX, US]	4	5
Cresols [CA, US]	5	4
Biphenyl [CA, MX, US]	2	1
Total		**374,295**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–24. Reported Releases to Air of Toxic Pollutants, Bulk Storage Terminals, RETC, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by bulk terminals
Acrylonitrile [CA, MX, US]	1	1,655
Styrene [CA, MX, US]	1	778
Formaldehyde [CA, MX, US]	61	401
Acetaldehyde [CA, MX, US]	61	314
Benzene [CA, MX, US]	64	198
Acrolein [CA, MX, US]	61	41
Total		**3,388**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–25. Reported Releases to Air of Toxic Pollutants, Bulk Storage Terminals, TRI, 2005

Pollutant	Number of facilities reporting	Amount (kg) reported by bulk terminals
Methyl tert-butyl ether [CA, US]	189	270,151
n-Hexane [CA, US]	452	201,878
Toluene [CA, US]	439	188,343
Propylene [CA, US]	22	182,283
Xylenes [CA, US]	438	152,731
Benzene [CA, MX, US]	423	115,636
Ethylene [CA, US]	4	88,543
Ethylbenzene [CA, US]	404	41,578
1,2,4-Trimethylbenzene [CA, US]	440	40,019
Cyclohexane [CA, US]	172	23,664
Ammonia [CA, US]	3	22,713
Naphthalene [CA, US]	367	14,340
Methanol [CA, US]	27	11,532
tert-Butyl alcohol [CA, US]	8	3,242
Dichloromethane [CA, MX, US]	2	3,052
1,3-Butadiene [CA, MX, US]	3	2,158
Metham sodium [US]	1	2,121
Cumene [CA, US]	77	1,037
Polycyclic aromatic compounds*	312	601
Methyl isobutyl ketone [CA, US]	4	479
Total		**1,366,100**

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.
*The PACs subject to reporting in each country vary.

Air releases of toxic pollutants in each country are presented in **Tables 4–23** to **4–25**. Other reported releases and transfers are presented in **Tables 4–26** to **4–28**.

Of the air releases of toxic pollutants reported by Canadian bulk storage terminals, 15 pollutants represented about 100 percent of the total (**Table 4–23**). Of the 15, six were reported by more than half of all facilities. Another 14 pollutants were also reported, but their combined amount was less than 1 kilogram, and they were reported by very few facilities.

In Mexico, air releases of six toxic pollutants, in amounts totaling 3,388 kilograms, were reported. Four of these pollutants were reported by about 70 percent of Mexican bulk storage terminals (**Table 4–24**).

In the United States, 20 pollutants accounted for 99 percent of the total air releases of toxic pollutants in 2005. Eight of them were reported by at least 60 percent of US bulk storage terminals (**Table 4–25**). Another 29 pollutants were reported in quantities ranging from 1 to 443 kilograms by relatively few facilities (with the exception of lead and its compounds and benzo(g,h,i)perylene, which were reported by about 40 percent of facilities).

Of 28 toxic pollutants comprising most of the air releases reported by bulk storage terminals across North America, benzene was reported by over 50 percent of facilities in each country. This pollutant was the only one common to bulk storage facilities in all three countries; the other pollutants reported by Mexican facilities were not reported in either Canada or the United States, although they were subject to reporting under the NPRI and TRI.

Eleven pollutants—1,2,4-trimethylbenzene, cumene, cyclohexane, ethylbenzene, ethylene, methanol, naphthalene, n-hexane, propylene, toluene and xylenes—were commonly reported by Canadian and US bulk storage terminals. US facilities reported more pollutants than did Canadian facilities, and for some toxic pollutants (e.g., naphthalene) the proportion of facilities reporting differed substantially between the two countries.

Other releases and transfers reported in 2005 by North American bulk storage terminals—releases to water, land, underground injection and disposal and transfers to recycling or other treatment—are presented in **Tables 4–26** to **4–28**.

Canadian bulk storage terminals reported 93,311 kilograms in releases and transfers of toxic pollutants (other than to air) in 2005. The 13 pollutants shown in **Table 4–26** accounted for almost all (93,304 kilograms) of this amount; another five pollutants accounted for the remaining 7 kilograms. Facilities released about 50,000 kilograms off-site to disposal and transferred about 40,000 kilograms to recycling (small amounts were also transferred for other treatment). Eight of the pollutants reported were released to water.

Mexican bulk storage terminals reported 3,505 kilograms in releases and transfers of the nine pollutants shown in **Table 4–27**. Lead and its compounds were released in the largest amount, and most were transferred to recycling. Benzene (84 kilograms) was released to land, and eight pollutants were released to water.

Table 4–26. Releases and Transfers (excluding air), Bulk Storage Terminals, NPRI, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Toluene CA, US	237	0	1	16,858	0	380
n-Hexane CA, US	688	0	0	0	0	0
Xylenes CA, US	398	0	0	4,593	13,386	635
Benzene CA, MX, US	149	0	0	1,553	0	34
Ethylbenzene CA, US	51	0	0	2,934	0	115
Cresols CA, US	18	0	0	0	25,099	0
Chlorobenzene CA, MX, US	0	0	0	17,367	0	370
Cyclohexane CA, US	300	0	0	0	0	0
1,2,4–Trimethylbenzene CA, US	7	0	0	0	0	0
Lead and its compounds CA, MX, US	0	0	0	6,019	0	0
Zinc and its compounds CA, US	0	0	0	1,184	0	0
Copper and its compounds CA, US	0	0	0	884	0	0
Phenanthrene CA, US	0	0	0	43	0	1

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–27. Releases and Transfers (excluding air), Bulk Storage Terminals, RETC, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Benzene CA, MX, US	0	NA	84	0	0	0
Lead and its compounds CA, MX, US	132	NA	0	0	2,674	0
Arsenic and its compounds CA, MX, US	8	NA	0	0	0	0
Chromium and its compounds CA, MX, US	86	NA	0	0	0	0
Cadmium and its compounds CA, MX, US	21	NA	0	0	0	0
Mercury and its compounds CA, MX, US	2	NA	0	0	0	0
Nickel and its compounds CA, MX, US	124	NA	0	0	0	0
Hydrazine CA, MX, US	356	NA	0	0	0	0
Cyanides CA, MX, US	18	NA	0	0	0	0

NA = not applicable.
Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.

Table 4–28. Releases and Transfers (excluding air), Bulk Storage Terminals, TRI, 2005 (kilograms)

Pollutant	Water releases	Underground Injection	Land releases	Off-site disposal	Transfers to recycling	Other transfers
Propylene CA, US	0	0	0	0	0	1,018,134
Xylenes CA, US	540	0	22,340	58,854	75,061	75,249
Ethylene CA, US	0	0	0	0	0	220,892
Toluene CA, US	444	0	19,474	59,244	71,649	66,477
n-Hexane CA, US	2,658	0	4,778	13,068	44,147	77,173
Ethylene glycol CA, US	2	0	2	0	79,257	49,419
1,2,4–Trimethylbenzene CA, US	2,141	0	5,878	21,285	40,604	52,180
Diethanolamine CA, US	2	0	0	116,324	0	1,715
Naphthalene CA, US	1,545	0	627	5,918	84,625	10,748
Ethylbenzene CA, US	100	0	4,780	13,405	40,960	36,940
Benzene CA, MX, US	589	0	1,528	10,822	23,492	32,234
Methyl tert-butyl ether CA, US	961	0	25	15,250	31,370	10,327
Cyclohexane CA, US	19	0	2,817	914	16,025	34,361
Lead and its compounds CA, MX, US	16	0	0	2,779	260	0
Polycyclic aromatic compounds*	35	0	3	2,067	23	328
Zinc and its compounds CA, US	246	0	0	1,549	345	0
Cumene CA, US	4	0	233	134	211	1,061
Dicyclopentadiene CA, US	0	0	0	0	0	1,136
tert-Butyl alcohol CA, US	12	0	0	291	502	24
Ammonia CA, US	454	0	0	0	0	0
Methanol CA, US	0	0	2	0	0	410
1,3-Butadiene CA, MX, US	0	0	0	0	0	345
Styrene CA, MX, US	2	0	1	2	186	98
Methyl isobutyl ketone CA, US	0	0	0	7	0	201
Mercury and its compounds CA, MX, US	0	0	0	0	78	0
sec-Butyl alcohol CA, US	2	0	2	0	0	50
Tetrachloroethylene CA, US	0	0	0	0	0	40
Benzo(g,h,i)perylene*	4	0	0	19	1	3

Note: CA, MX, US designate the country(ies) in which reporting of that pollutant is mandatory.
*The PACs subject to reporting in each country vary.

In 2005 US bulk storage terminals reported about 2.6 million kilograms in releases and transfers of 33 pollutants. Of these, 28 are shown in **Table 4–28**, representing almost 100 percent of the total (five others were reported in amounts ranging from 1 to 5 kilograms). Sixty-five percent of the total was transferred to other treatment, and almost 20 percent was transferred to recycling. Relatively large amounts of certain pollutants, such as xylenes, toluene, ethylbenzene, 1,2,4–trimethylbenzene, benzene and cyclohexane, were released to land; these pollutants, along with others, were also released to water in 2005.

These tables reveal that benzene and lead and mercury and their compounds were reported by bulk storage terminals in all three countries, but there were differences in how these pollutants were handled. The other six pollutants reported by Mexican bulk storage terminals were not reported in Canada and the United States, although they are subject to reporting to the NPRI and TRI. Pollutants reported in the largest quantities by bulk storage terminals in these two countries (e.g., xylenes and toluene) were not reported in Mexico because they were not subject to RETC reporting.

Many of the reported pollutants were common to both Canada and the United States. However, some (e.g., cyclohexane, diethanolamine, ethylbenzene, n-hexane and propylene) subject to reporting to both PRTRs and reported in large amounts in the United States were either not reported at all in Canada, or reported in much smaller proportions.

Releases of Pollutants of Concern, 2002–2005

This section examines reported on- and off-site releases of pollutants of concern (i.e., known or suspected carcinogens and developmental or reproductive toxicants) common to both Canada and the United States and reported consistently by two petroleum sectors—petroleum refineries and bulk storage terminals—from 2002 to 2005. US oil and gas production facilities and pipeline operations do not have to report to the TRI, and therefore those sectors are not included in this analysis. Also not included are data for Mexico, because public RETC data were available only for the 2004 and 2005 reporting years.

Chapter 3 provides information about some of these pollutants, as well as their toxicity equivalency potential (TEP) values. Readers can also search *Taking Stock Online* for the specific categories of pollutants and retrieve more information from the sources cited in **Chapter 3**.

Pollutants of Concern Released by Canadian and US Petroleum Refineries, 2002–2005

In Canada, refineries reported in 2005 on- and off-site releases of 18 contaminants that are known or suspected carcinogens or developmental or reproductive toxicants. Four of them—benzene, nickel and lead and their compounds, and 1,3-butadiene—are considered to be both. Of these 18 pollutants, 15 were reported consistently since 2002 (see **Table 4–29**).

Of the average 1.4 million kilograms of these 15 pollutants reported per year, four of them—asbestos, toluene, benzene and vanadium and its compounds—accounted for 85 percent. The asbestos reported by refineries is related to the removal of asbestos-containing materials such as pipe insulation. The proportion of Canadian refineries reporting each pollutant varied, but 100 percent reported vanadium and mercury and their compounds and n-methyl-2-pyrrolidone. Eight pollutants overall were reported by at least 50 percent of facilities. The types of releases also varied. For example, almost all of the reported asbestos was released off-site to disposal. Pollutants released to air in the highest proportions were ethylbenzene, benzene, toluene, naphthalene and antimony and its compounds (which were also released to water). Underground injection accounted for 100 percent of the reported amount of n-methyl-2-pyrrolidine.

In the United States, refineries reported on- and off-site releases of 28 carcinogens or developmental/reproductive toxicants in 2005 (see **Table 4–30**). Of these pollutants, 23 were reported consistently since 2002, for an average total of about 5 million kilograms per year.

Ten of these 23 pollutants accounted for 95 percent of total average releases of carcinogens and developmental or reproductive toxicants. Two substances, benzene and toluene, made up about 62 percent (mostly as air releases). These two substances were reported by about 95 percent of US refineries. Nine other pollutants were also primarily

Table 4–29. Releases (on- and off-site) of Pollutants of Concern, Petroleum Refineries, NPRI, 2002–2005

	Pollutant category		Reporting year (kg)								Release (average, 2002–2005) as percentage of total releases and transfers				
Pollutant	C	D/R	2002	2003	2004	2005	Average release, 2002–2005 (kg)	Percentage of total releases	Average number of reporting refineries, 2002–2005	Percentage of total refineries	To air	To water	To underground injection	To land	To disposal off-site
Asbestos (friable)	x		361,093	459,858	586,807	580,798	497,139	35.30	4	18	0.00	0.00	0.00	0.24	99.76
Toluene		x	340,602	390,832	417,033	482,596	407,766	28.96	2	8	64.95	0.19	21.91	0.42	11.93
Benzene	x	x	147,488	171,550	160,228	145,109	156,094	11.08	10	50	68.98	0.28	16.40	0.23	12.90
Vanadium and its compounds	x		136,539	146,397	131,725	146,406	140,267	9.96	19	100	41.93	0.21	0.00	0.66	4.36
Ethylbenzene	x		68,883	89,529	86,035	89,464	83,478	5.93	2	11	75.75	0.24	8.83	0.35	13.04
Nickel and its compounds	x	x	63,819	84,300	69,305	87,900	76,331	5.42	5	26	20.87	0.07	0.00	0.71	8.73
N-Methyl-2-pyrrolidone		x	15,454	11,731	21,836	25,479	18,625	1.32	19	100	0.00	0.00	100.00	0.00	0.00
Naphthalene	x		10,600	9,397	11,464	25,012	14,118	1.00	13	68	60.12	0.02	12.36	0.77	3.56
Cobalt and its compounds	x		668	1,226	25,199	5,061	8,039	0.57	16	83	1.36	0.00	0.25	0.11	37.21
Chromium and its compounds	x		2,089	193	2,110	9,142	3,383	0.24	11	55	1.32	0.00	0.00	1.02	38.63
Lead and its compounds	x	x	2,593	1,303	3,332	1,644	2,218	0.16	5	26	12.77	3.66	1.15	7.86	36.78
Antimony and its compounds	x		523	417	456	214	403	0.03	9	47	28.70	38.26	0.00	0.00	33.04
Tetrachloroethylene	x		412	118	123	126	195	0.01	13	68	7.60	1.28	0.00	0.00	0.00
1,3-Butadiene	x	x	164	89	65	47	91	0.01	1	5	33.42	0.00	0.00	0.00	0.00
Mercury and its compounds		x	99	39	44	102	71	0.01	19	100	21.18	1.23	0.00	2.13	19.40

C = known or suspected carcinogen.

D/R = developmental or reproductive toxicant.

released to air, while only one, selenium and its compounds, was released mainly to water. Of the asbestos reported, 100 percent was released off-site to disposal.

The pollutants, amounts and media of release reported by petroleum refineries in Canada and the United States reveal certain similarities. For example, 22 of the 38 pollutants reported from 2002–2005 were common to both countries. These pollutants include the carcinogen benzene, some metals and their compounds, and developmental or reproductive toxicants such as toluene and mercury. In addition to their carcinogenicity and developmental or reproductive toxicity, some of these pollutants are persistent, bioaccumulative and toxic substances (see **Chapter 3**).

About half of the 22 pollutants common to both the NPRI and TRI were also subject to Mexican RETC reporting. However, other pollutants released to air in large amounts by many facilities in Canada and the United States (e.g., toluene, ethylbenzene and naphthalene) were not reportable pollutants under RETC.

Pollutants of Concern Released by Canadian and US Bulk Storage Terminals, 2002–2005

A maximum of 10 out of the 70 Canadian bulk storage terminals reported on- and off-site releases of five contaminants in 2005 that are known or suspected carcinogens or developmental or reproductive toxicants (see **Table 4–31**). These pollutants were reported consistently from 2002 to 2005. Of the average 82,000 kilograms of these substances released per year, toluene accounted for over 68 percent. About 74 percent of these toluene releases were to air. Air releases were the main medium of release for the largest proportions of all the pollutants except for lead and its compounds, which were released off-site to disposal. In general, relatively few Canadian bulk storage terminals reported on these substances between 2002 and 2005.

In the United States, releases of 10 carcinogens or developmental or reproductive toxicants were reported consistently from 2002 and 2005 by a wide range of the 548 bulk storage terminals for an average total of about 440,000 kilograms per year (see **Table 4–31**). Two substances, toluene and benzene, accounted for 80 percent of the total amount (32 and 47 percent, respectively, were released to air). Other pollutants released in high proportions to air were dichloromethane and 1,3-butadiene. Relatively small proportions of these substances were released to water and land. Of the lead compound releases, 76 percent were sent off-site to disposal.

Overall, the number of known or suspected carcinogens or developmental or reproductive toxicants reported in 2005 by Canadian and US bulk storage terminals was not large. However, about three-quarters of these releases in both countries were to air (e.g., toluene, a developmental or reproductive toxicant, and the carcinogen 1,3-butadiene).

Table 4–30. Releases (on- and off-site) of Pollutants of Concern, Petroleum Refineries, TRI, 2002–2005

	Pollutant category		Reporting year (kg)								Release (average, 2002–2005) as percentage of total releases and transfers				
Pollutant	C	D/R	2002	2003	2004	2005	Average release, 2002–2005 (kg)	Percentage of total releases	Average number of reporting refineries, 2002–2005	Percentage of total refineries	To air	To water	To underground injection	To land	To disposal off-site
Toluene		x	2,354,043	1,907,189	2,102,979	1,782,998	2,036,802	41.25	150	95	80	1	4	0	1
Benzene	x	x	1,117,313	1,043,996	1,003,064	994,832	1,039,801	21.06	152	96	70	0	4	0	1
Ethylbenzene	x		412,321	332,851	407,492	294,031	361,673	7.33	148	93	66	0	5	0	7
Nickel and its compounds	x	x	326,380	255,112	346,673	413,198	335,341	6.79	76	48	2	1	0	4	23
Vanadium and its compounds	x		311,568	341,083	326,198	203,528	295,594	5.99	39	24	1	2	0	7	12
Naphthalene	x		111,277	137,676	137,212	229,177	153,836	3.12	123	78	53	0	0	10	4
Asbestos (friable)	x		33,914	132,898	98,141	331,002	148,989	3.02	3	2	0	0	0	0	100
1,3-Butadiene	x	x	87,699	86,468	174,912	129,065	119,536	2.42	95	60	24	0	6	0	0
N-Methyl-2-pyrrolidone		x	93,281	185,413	117,608	59,137	113,860	2.31	7	5	80	0	4	0	0
Lead and its compounds	x	x	105,469	90,458	51,066	93,274	85,067	1.72	133	84	3	3	0	5	60
Formaldehyde	x		47,913	42,195	90,211	64,850	61,292	1.24	6	3	100	0	0	0	0
Carbon disulfide		x	49,453	59,305	64,137	25,239	49,534	1.00	56	35	99	0	0	0	0
Cobalt and its compounds	x		29,527	46,489	33,144	28,945	34,526	0.70	40	25	0	1	0	0	14
Chromium and its compounds	x		23,759	56,626	19,409	13,678	28,368	0.57	19	12	3	2	0	22	10
Tetrachloroethylene	x		30,671	30,716	29,199	20,560	27,786	0.56	66	42	71	0	0	0	1
Trichloroethylene	x		10,475	14,583	12,348	13,914	12,830	0.26	6	4	99	0	0	0	0
Antimony and its compounds	x		12,552	8,160	11,870	14,816	11,849	0.24	16	10	14	9	0	10	35
Styrene	x		5,597	9,358	9,335	11,300	8,897	0.18	22	14	42	0	0	0	0
Selenium and its compounds	x		2,625	8,463	3,658	2,737	4,371	0.09	4	2	0	55	0	0	44
Ethylene oxide	x	x	1,560	2,414	3,991	2,532	2,624	0.05	1	1	100	0	0	0	0
Mercury and its compounds		x	1,979	1,970	2,158	1,876	1,996	0.04	121	76	36	2	2	4	39
1,2-Dichloroethane	x		3,536	1,166	961	1,218	1,720	0.03	11	7	95	1	3	0	0
Carbon tetrachloride	x		1,475	910	932	1,058	1,094	0.02	2	1	18	0	0	0	0

C = known or suspected carcinogen.

D/R = developmental or reproductive toxicant.

All of the pollutants reported by Canadian bulk storage terminals were reported in the largest amounts by US facilities, which also reported five other substances. Three pollutants—toluene, naphthalene and ethylbenzene—reported by bulk storage terminals in both countries were not subject to RETC reporting in 2005.

This comparison of reported releases of pollutants of concern by two petroleum sectors in Canada and the United States reveals both similarities and differences between the countries and thus reflects the overall findings of this report. Various factors, including differences in processes and material inputs, might explain some of the variations, and differences in national PRTR reporting requirements may play a role as well. The inclusion of Mexican data in such analyses in the future might better demonstrate how differences in national reporting requirements affect the picture of pollution for this industry. This presentation of data provides the three North American PRTR programs with information that can be used to prioritize areas for further action on pollution prevention and reduction.

Table 4–31. Releases (on- and off-site) of Pollutants of Concern, Bulk Storage Terminals, Canada and United States, 2002–2005

	Pollutant category		Reporting year (kg)								Releases (average, 2002–2005), as percentage of total releases and transfers				
Pollutant	**C**	**D/R**	**2002**	**2003**	**2004**	**2005**	**Average releases, 2002–2005 (kg)**	**Percentage of total releases**	**Average number of reporting bulk storage terminals, 2002–2005**	**Percentage of total bulk storage terminals**	**To air**	**To water**	**To underground injection**	**To land**	**To disposal off-site**
Canada															
Toluene		x	27,833	57,814	70,972	68,724	56,336	68.30	10	11	73.95	0.11	0.00	0.06	13.69
Benzene	x	x	9,076	15,488	17,412	16,500	14,619	17.72	8	10	85.78	0.28	0.00	0.08	5.13
Ethylbenzene	x		3,336	9,824	11,866	11,679	9,176	11.13	8	9	65.04	0.14	0.00	1.51	14.37
Lead and its compounds	x	x	1,212	1,653	3,471	1,697	2,008	2.43	4	4	0.18	0.01	0.00	0.00	99.81
Naphthalene	x		300	311	365	378	339	0.41	2	2	100.00	0.00	0.00	0.00	0.00
United States															
Toluene		x	218,095	205,817	228,613	267,506	230,008	52.25	417	76.00	32.35	0.08	0.00	1.41	5.22
Benzene	x	x	144,751	113,965	111,982	128,575	124,818	28.36	393	71.72	46.93	0.28	0.00	0.38	3.38
Ethylbenzene	x		44,182	36,950	42,829	59,863	45,956	10.44	378	68.98	24.99	0.10	0.00	1.28	5.25
Naphthalene	x		34,241	31,037	31,107	22,429	29,704	6.75	225	41.06	14.86	0.47	0.00	0.71	8.55
Lead and its compounds	x	x	3,957	3,797	3,767	2,967	3,622	0.82	210	38.37	5.12	0.36	0.00	0.01	75.97
1,3-Butadiene	x	x	2,731	3,842	1,920	2,158	2,663	0.60	3	0.55	89.02	0.00	0.00	0.00	0.00
Dichloromethane	x		2,251	3,011	2,034	3,052	2,587	0.59	2	0.32	100.00	0.00	0.00	0.00	0.00
Styrene	x		569	499	1,763	310	785	0.18	18	3.24	48.23	0.24	0.00	6.93	0.09
Nickel and its compounds	x	x	87	1	1	1	23	0.01	3	0.55	11.51	0.00	0.00	0.00	0.79
Mercury and its compounds		x	24	3	2	2	8	0.00	72	13.18	19.03	1.36	0.00	0.00	4.23

C = known or suspected carcinogen.
D/R = developmental or reproductive toxicant.

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Taking Stock

Appendix

Appendix – Pollutants common to at least two of the three North American PRTRs, 2005

				NPRI		RETC		TRI		PRTRs under which the pollutant is reportable		
Chemical Name	**Substance**	**Sustancia**	**CAS No.**	**NPRI qualifier**	**NPRI threshold (kg/year)**	**RETC MPO[1] threshold (kg/year)**	**RETC emission threshold (kg/year)**	**TRI qualifier**	**TRI threshold (kg/year)**	**Canada**	**Mexico**	**United States**
1,1,1,2-Tetrachloroethane	1,1,1,2-Tétrachloroéthane	1,1,1,2-Tetracloroetano	630-20-6		10,000				11,340	x		x
1,1,1-Trichloroethane	1,1,1-Trichloroéthane	1,1,1-Tricloroetano	71-55-6			2,500	1,000		11,340		x	x
1,1,2,2-Tetrachloroethane	1,1,2,2-Tétrachloroéthane	1,1,2,2-Tetracloroetano	79-34-5		10,000	5,000	1,000		11,340	x	x	x
1,1,2-Trichloroethane	1,1,2-Trichloroéthane	1,1,2-Tricloroetano	79-00-5		10,000	5,000	1,000		11,340	x	x	x
1,1,2-Trichlorotrifluoroethane (CFC-113)	1,1,2-Trichloro-1,2,2-trifluoroéthane (CFC-113)	CFC-113	76-13-1			2,500	1,000		11,340		x	x
1,1-Dichloro-1-fluoroethane (HCFC-141b)	1,1-Dichloro-1-fluoroéthane (HCFC-141b)	1,1-Dicloro-1-fluoroetano (HCFC-141b)	1717-00-6		10,000	5,000	1,000		11,340	x	x	x
1,1-Methylenebis (4-isocyanatocyclohexane)	1,1'-Méthylènebis 4-isocyanatocyclohexane)	1,1-Metilenobis (4-isocianato ciclohexano)	5124-30-1		10,000				11,340	x		x
1,2,4-Trichlorobenzene	1,2,4-Trichlorobenzène	1,2,4-Triclorobenceno	120-82-1		10,000	5,000	1,000		11,340	x	x	x
1,2,4-Trimethylbenzene	1,2,4-Triméthylbenzène	1,2,4-Trimetilbenceno	95-63-6	VOC	10,000				11,340	x		x
1,2-Butylene oxide	1,2-Époxybutane	Óxido de 1,2-butileno	106-88-7		10,000				11,340	x		x
1,2-Dichlorobenzene	o-Dichlorobenzène	1,2-Diclorobenceno	95-50-1		10,000	5,000	1,000		11,340	x	x	x
1,2-Dichloroethane	1,2-Dichloroéthane	1,2-Dicloroetano	107-06-2	VOC	10,000	5,000	1,000		11,340	x	x	x
1,2-Dichloropropane	1,2-Dichloropropane	1,2-Dicloropropano	78-87-5		10,000				11,340	x		x
1,3-Butadiene	Buta-1,3-diène	1,3-Butadieno	106-99-0	VOC	10,000	5,000	100		11,340	x	x	x
1,3-Dichloro-1,2,2,3,3-Pentafluoropropane (HCFC-225cb)	1,3-Dichloro-1,2,2,3,3-pentafluoropropane (HCFC-225cb)	HCFC-225cb	507-55-1			2,500	1,000		11,340		x	x
1,4-Dichlorobenzene	p-Dichlorobenzène	1,4-Diclorobenceno	106-46-7	VOC	10,000	5,000	1,000		11,340	x	x	x
1,4-Dioxane	1,4-Dioxane	1,4-Dioxano	123-91-1		10,000	5,000	100		11,340	x	x	x
1-Chloro-1,1-difluoroethane (HCFC-142b)	1-Chloro-1,1-difluoroéthane (HCFC-142b)	1-Cloro-1,1-difluoroetano (HCFC-142b)	75-68-3		10,000	5,000	1,000		11,340	x	x	x
2,2,4-Trimethylhexamethylene diisocyanate	Diisocyanate de 2,2,4-triméthylhexamethylène	Diisocianato de 2,2,4-trimetilhexametileno	16938-22-0		10,000				11,340	x		x
2,4,4-Trimethylhexamethylene diisocyanate	Diisocyanate de 2,4,4-triméthylhexamethylène	Diisocianato de 2,4,4-trimetilhexametileno	15646-96-5		10,000				11,340	x		x
2,4,5-Trichlorophenol	Trichloro-2,4,5 phénol	2,4,5-Triclorofenol	95-95-4			2,500	1,000		11,340		x	x
2,4,6-Trichlorophenol	Trichloro-2,4,6 phénol	2,4,6-Triclorofenol	6/2/1988			2,500	1,000		11,340		x	x
2,4-Diaminotoluene	2,4-Diaminotoluène	2,4-Diaminotolueno	95-80-7		10,000				11,340	x		x
2,4-Dichlorophenol	2,4-Dichlorophénol	2,4-Diclorofenol	120-83-2		10,000				11,340	x		x
2,4-Dichlorophenoxyacetic acid	Acide dichloro-2,4 phénoxyacétique	Acido 2,4-diclorofenoxiacético	94-75-7			2,500	100		11,340		x	x
2,4-Dinitrotoluene	2,4-Dinitrotoluène	2,4-Dinitrotolueno	121-14-2		10,000	5,000	1,000		11,340	x	x	x
2,6-Dinitrotoluene	2,6-Dinitrotoluène	2,6-Dinitrotolueno	606-20-2		10,000				11,340	x		x
2-Ethoxyethanol	2-Éthoxyéthanol	2-Etoxietanol	110-80-5		10,000	2,500	100		11,340	x	x	x
2-Mercaptobenzothiazole	Benzothiazole-2-thiol	2-Mercaptobenzotiazol	149-30-4		10,000				11,340	x		x
2-Methoxyethanol	2-Méthoxyéthanol	2-Metoxietanol	109-86-4		10,000				11,340	x		x
2-Methylpyridine	2-Méthylpyridine	2-Metilpiridina	109-06-8		10,000				11,340	x		x
2-Naphthylamine	bêta-Naphthylamine	Beta-naftalina	91-59-8			50	100		11,340		x	x
2-Nitropropane	2-Nitropropane	2-Nitropropano	79-46-9		10,000	2,500	100		11,340	x	x	x
2-Phenylphenol	o-Phénylphénol	2-Fenilfenol	90-43-7		10,000				11,340	x		x
3,3-Dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)	Dichloro-3,3 pentafluoro-1,1,1,2,2 propane (HCFC-225ca)	HCFC-225ca	422-56-0			2,500	1,000		11,340		x	x
3,3'-Dichlorobenzidine dihydrochloride	Dichlorhydrate de 3,3'-dichlorobenzidine	Dihidrocloruro de 3,3'-diclorobencidina	612-83-9		10,000				11,340	x		x
3-Chloro-2-methyl-1-propene	3-Chloro-2-méthylpropène	3-Cloro-2-metil-1-propeno	563-47-3		10,000				11,340	x		x
3-Chloropropionitrile	3-Chloropropionitrile	3-Cloropropionitrilo	542-76-7		10,000				11,340	x		x
4,4'-Isopropylidenediphenol	p,p'-Isopropylidènediphénol	4,4'-Isopropilidenodifenol	80-05-7		10,000				11,340	x		x
4,4'-Methylenebis(2-chloroaniline)	p,p'-Méthylènebis(2-chloroaniline)	4,4'-Metilenobis(2-cloroanilina)	101-14-4		10,000				11,340	x		x
4,4'-Methylenedianiline	p,p'-Méthylènedianiline	4,4'-Metilenodianilina	101-77-9		10,000				11,340	x		x
4,6-Dinitro-o-cresol	4,6-Dinitro-o-crésol	4,6-Dinitro-o-cresol	534-52-1		10,000	2,500	100		11,340	x	x	x
4-Aminobiphenyl	Amino-4 diphényle	4-Amino Difenilo	92-67-1			2,500	1,000		11,340		x	x
4-Nitrophenol	p-Nitrophénol	4-Nitrofenol	100-02-7		10,000				11,340	x		x
7H-Dibenzo(c,g)carbazole	7H-Dibenzo(c,g)carbazole	7H-Dibenzo(c,g)carbazol	194-59-2	PAH	50			PAC	100	x		x
Acetaldehyde	Acétaldéhyde	Acetaldehído	75-07-0		10,000	2,500	100		11,340	x	x	x
Acetonitrile	Acétonitrile	Acetonitrilo	75-05-8		10,000				11,340	x		x
Acetophenone	Acétophénone	Acetofenona	98-86-2		10,000				11,340	x		x
Acrolein	Acroléine	Acroleína	107-02-8		10,000	2,500	100		11,340	x	x	x
Acrylamide	Acrylamide	Acrilamida	79-06-1		10,000	2,500	100		11,340	x	x	x
Acrylic acid	Acide acrylique	Ácido acrílico	79-10-7		10,000				11,340	x		x
Acrylonitrile	Acrylonitrile	Acrilonitrilo	107-13-1		10,000	2,500	100		11,340	x	x	x
Aldrin	Aldrine	Aldrin	309-00-2			50	100		100		x	x

[1] MPO = manufacturing, processing and otherwise used.

Appendix (*continued*)

				NPRI		RETC		TRI		PRTRs under which the pollutant is reportable		
Chemical Name	Substance	Sustancia	CAS No.	NPRI qualifier	NPRI threshold (kg/year)	RETC MPO[1] threshold (kg/year)	RETC emission threshold (kg/year)	TRI qualifier	TRI threshold (kg/year)	Canada	Mexico	United States
Allyl alcohol	Alcool allylique	Alcohol alílico	107-18-6		10,000				11,340	x		x
Allyl chloride	Chlorure d'allyle	Cloruro de alilo	107-05-1		10,000				11,340	x		x
Aluminum (fume or dust)	Aluminium (fumée ou poussière)	Aluminio (humo o polvo)	7429-90-5		10,000				11,340	x		x
Aluminum oxide (fibrous forms)	Oxyde d'aluminium (formes fibreuses)	Óxido de aluminio (formas fibrosas)	1344-28-1		10,000				11,340	x		x
Ammonia	Ammoniac	Amoniaco			10,000				11,340	x		x
Aniline	Aniline	Anilina	62-53-3	VOC	10,000	5,000	1,000		11,340	x	x	x
Anthracene	Anthracène	Antraceno	120-12-7		10,000				11,340	x		x
Antimony and its compounds	Antimoine et ses composés	Antimonio y compuestos	--		10,000				11,340	x		x
Arsenic and its compounds	Arsenic et ses composés	Arsénico y compuestos	--		50	5	1		11,340	x	x	x
Asbestos (friable form)	Amiante (forme friable)	Asbestos (friables)	1332-21-4		10,000	5	1		11,340	x	x	x
Benzene	Benzène	Benceno	71-43-2	VOC	10,000	5,000	1,000		11,340	x	x	x
Benzidine	Benzidine	Bencidina	92-87-5			5,000	1,000		11,340		x	x
Benzo(a)anthracene	Benzo(a)anthracène	Benzo(a)antraceno	56-55-3	PAH	50			PAC	100	x		x
Benzo(a)phenanthrene	Benzo(a)phénanthrène	Benzo(a)fenantreno	218-01-9	PAH	50			PAC	100	x		x
Benzo(a)pyrene	Benzo(a)pyrène	Benzo(a)pireno	50-32-8	PAH	50			PAC	100	x		x
Benzo(b)fluoranthene	Benzo(b)fluoranthène	Benzo(b)fluoranteno	205-99-2	PAH	50			PAC	100	x		x
Benzo(g,h,i)perylene	Benzo(g,h,i)pérylène	Benzo(g,h,i)perileno	191-24-2	PAH	50			PAC	10	x		x
Benzo(j)fluoranthene	Benzo(j)fluoranthène	Benzo(j)fluoranteno	205-82-3	PAH	50			PAC	100	x		x
Benzo(k)fluoranthene	Benzo(k)fluoranthène	Benzo(k)fluoranteno	207-08-9	PAH	50			PAC	100	x		x
Benzoyl chloride	Chlorure de benzoyle	Cloruro de benzoilo	98-88-4		10,000				11,340	x		x
Benzoyl peroxide	Peroxyde de benzoyle	Peróxido de benzoilo	94-36-0		10,000				11,340	x		x
Benzyl chloride	Chlorure de benzyle	Cloruro de bencilo	100-44-7		10,000				11,340	x		x
Biphenyl	Biphényle	Bifenilo	92-52-4		10,000	5,000	1,000		11,340	x	x	x
Bis (Chloromethyl) Ether	Éther de bis (chlorométhyle)	Eter bis-cloro metílico	542-88-1			2,500	1,000		11,340		x	x
Boron trifluoride	Trifluorure de bore	Trifluoruro de boro	7637-07-2		10,000				11,340	x		x
Bromine	Brome	Bromo	7726-95-6		10,000				11,340	x		x
Bromochlorodifluoromethane (Halon 1211)	Bromochlorodifluorométhane (Halon 1211)	Bromoclorodifluorometano (Halon 1211)	353-59-3		10,000	5,000	1,000		11,340	x	x	x
Bromoform	Bromoforme	Bromoformo	75-25-2			2,500	1,000		11,340		x	x
Bromomethane	Bromométhane	Bromometano	74-83-9		10,000	5,000	1,000		11,340	x	x	x
Bromotrifluoromethane (Halon 1301)	Bromotrifluorométhane (Halon 1301)	Bromotrifluorometano (Halon 1301)	75-63-8		10,000	5,000	1,000		11,340	x	x	x
Butyl acrylate	Acrylate de butyle	Acrilato de butilo	141-32-2		10,000				11,340	x		x
Butyraldehyde	Butyraldéhyde	Butiraldehído	123-72-8		10,000				11,340	x		x
C.I. Acid Green 3	Indice de couleur Vert acide 3	Verde 3 ácido	4680-78-8		10,000				11,340	x		x
C.I. Basic Green 4	Indice de couleur Vert de base 4	Verde 4 básico	569-64-2		10,000				11,340	x		x
C.I. Basic Red 1	Indice de couleur Rouge de base 1	Rojo 1 básico	989-38-8		10,000				11,340	x		x
C.I. Direct Blue 218	Indice de couleur Bleu direct 218	Índice de color Azul directo 218	28407-37-6		10,000				11,340	x		x
C.I. Disperse Yellow 3	Indice de couleur Jaune de dispersion 3	Amarillo 3 disperso	2832-40-8		10,000				11,340	x		x
C.I. Food Red 15	Indice de couleur Rouge alimentaire 15	Rojo 15 alimenticio	81-88-9		10,000				11,340	x		x
C.I. Solvent Orange 7	Indice de couleur Orange de solvant 7	Naranja 7 solvente	3118-97-6		10,000				11,340	x		x
C.I. Solvent Yellow 14	Indice de couleur Jaune de solvant 14	Amarillo solvente 14	842-07-9		10,000				11,340	x		x
Cadmium and its compounds	Cadmium et ses composés	Cadmio y compuestos	--		5	5	1		11,340	x	x	x
Calcium cyanamide	Cyanamide calcique	Cianamida de calcio	156-62-7		10,000				11,340	x		x
Carbon disulfide	Disulfure de carbone	Disulfuro de carbono	75-15-0		10,000				11,340	x		x
Carbon tetrachloride	Tétrachlorure de carbone	Tetracloruro de carbono	56-23-5		10,000	5,000	1,000		11,340	x	x	x
Carbonyl sulfide	Sulfure de carbonyle	Sulfuro de carbonilo	463-58-1		10,000				11,340	x		x
Catechol	Catéchol	Catecol	120-80-9		10,000				11,340	x		x
Chlordane	Chlordane	Clordano	57-74-9			5	100		10		x	x
Chlorendic acid	Acide chlorendique	Ácido cloréndico	115-28-6		10,000				11,340	x		x
Chlorine	Chlore	Cloro	7782-50-5		10,000				11,340	x		x
Chlorine dioxide	Dioxyde de chlore	Dióxido de cloro	10049-04-4		10,000	5,000	100		11,340	x	x	x
Chloroacetic acid	Acide chloroacétique	Ácido cloroacético	79-11-8		10,000				11,340	x		x
Chlorobenzene	Chlorobenzène	Clorobenceno	108-90-7	VOC	10,000	5,000	1,000		11,340	x	x	x
Chlorodifluoromethane (HCFC-22)	Chlorodifluorométhane (HCFC-22)	Clorodifluorometano (HCFC-22)	75-45-6		10,000	5,000	1,000		11,340	x	x	x
Chloroethane	Chloroéthane	Cloroetano	75-00-3		10,000				11,340	x		x
Chloroform	Chloroforme	Cloroformo	67-66-3		10,000	5,000	1,000		11,340	x	x	x
Chloromethane	Chlorométhane	Clorometano	74-87-3		10,000	5,000	1,000		11,340	x	x	x
Chlorotrifluoromethane (CFC-13)	Chlorotrifluorométhane (CFC-13)	Clorotrifluorometano (CFC-13)	75-72-9		10,000	5,000	1,000		11,340	x	x	x

[1] MPO = manufacturing, processing and otherwise used.

Appendix (*continued*)

Chemical Name	Substance	Sustancia	CAS No.	NPRI qualifier	NPRI threshold (kg/year)	RETC MPO[1] threshold (kg/year)	RETC emission threshold (kg/year)	TRI qualifier	TRI threshold (kg/year)	PRTRs under which the pollutant is reportable: Canada	Mexico	United States
				NPRI		RETC		TRI				
Chromium and its compounds	Chrome et ses composés	Cromo y compuestos	--	*	10,000	5	1		11,340	x	x	x
Cobalt and its compounds	Cobalt et ses composés	Cobalto y compuestos	--		10,000				11,340	x		x
Copper and its compounds	Cuivre et ses composés	Cobre y compuestos	--		10,000				11,340	x		x
Creosote	Créosote	Creosota	8001-58-9	VOC	10,000				11,340	x		x
Cresol (all isomers and their salts)	Crésol (mélange d'isomères)	Cresol (mezcla de isómeros)	--		10,000				11,340	x		x
Crotonaldehyde	Crotonaldéhyde	Crotonaldehído	4170-30-3		10,000				11,340	x		x
Cumene	Cumène	Cumeno	98-82-8		10,000				11,340	x		x
Cumene hydroperoxide	Hydroperoxyde de cumène	Cumeno hidroperóxido	80-15-9		10,000				11,340	x		x
Cyanides	Cyanures	Cianuros	--		10,000	5,000	100		11,340	x	x	x
Cyclohexane	Cyclohexane	Ciclohexano	110-82-7		10,000				11,340	x		x
Cyclohexanol	Cyclohexanol	Ciclohexanol	108-93-0		10,000				11,340	x		x
Decabromodiphenyl oxide	Oxyde de décabromodiphényle	Óxido de decabromodifenilo	1163-19-5		10,000				11,340	x		x
Di(2-ethylhexyl) phthalate	Phtalate de bis(2-éthylhexyle)	Di(2-etilhexil) ftalato	117-81-7		10,000				11,340	x		x
Dibenz(a,j)acridine	Dibenz(a,j)acridine	Dibenzo(a,j)acridina	224-42-0	PAH	50			PAC	100	x		x
Dibenzo(a,h)anthracene	Dibenzo(a,h)anthracène	Dibenzo(a,h)antraceno	53-70-3	PAH	50			PAC	100	x		x
Dibenzo(a,i)pyrene	Dibenzo(a,i)pyrène	Dibenzo(a,i)pireno	189-55-9	PAH	50			PAC	100	x		x
Dibutyl phthalate	Phtalate de dibutyle	Dibutil ftalato	84-74-2		10,000	5,000	100		11,340	x	x	x
Dichlorodifluoromethane (CFC-12)	Dichlorodifluorométhane (CFC-12)	Diclorodifluorometano (CFC-12)	75-71-8		10,000	5,000	1,000		11,340	x	x	x
Dichloromethane	Dichlorométhane	Diclorometano	75-09-2		10,000	5,000	1,000		11,340	x	x	x
Dichlorotetrafluoroethane (CFC-114)	Dichlorotétrafluoroéthane (CFC-114)	Diclorotetrafluoroetano (CFC-114)	76-14-2		10,000	5,000	1,000		11,340	x	x	x
Dicyclopentadiene	Dicyclopentadiène	Dicloropentadieno	77-73-6		10,000				11,340	x		x
Diethanolamine	Diéthanolamine	Dietanolamina	111-42-2		10,000				11,340	x		x
Diethyl sulfate	Sulfate de diéthyle	Sulfato de dietilo	64-67-5		10,000				11,340	x		x
Dimethyl phthalate	Phtalate de diméthyle	Dimetil ftalato	131-11-3		10,000				11,340	x		x
Dimethyl sulfate	Sulfate de diméthyle	Sulfato de dimetilo	77-78-1		10,000				11,340	x		x
Dimethylamine	Diméthylamine	Dimetilamina	124-40-3		10,000				11,340	x		x
Dinitrotoluene (mixed isomers)	Dinitrotoluène (mélange d'isomères)	Dinitrotolueno (mezcla de isómeros)	25321-14-6		10,000				11,340	x		x
Dioxins and furans	Dioxines et furanes	Dioxinas y furanos		**		**		**		x	x	x
Diphenylamine	Dianiline	Difenilamina	122-39-4		10,000				11,340	x		x
Epichlorohydrin	Épichlorohydrine	Epiclorohidrina	106-89-8		10,000	5,000	1,000		11,340	x	x	x
Ethyl acrylate	Acrylate d'éthyle	Acrilato de etilo	140-88-5		10,000				11,340	x		x
Ethyl chloroformate	Chloroformiate d'éthyle	Cloroformiato de etilo	541-41-3		10,000				11,340	x		x
Ethylbenzene	Éthylbenzène	Etilbenceno	100-41-4		10,000				11,340	x		x
Ethylene	Éthylène	Etileno	74-85-1	VOC	10,000				11,340	x		x
Ethylene glycol	Éthylèneglycol	Etilén glicol	107-21-1		10,000				11,340	x		x
Ethylene oxide	Oxyde d'éthylène	Óxido de etileno	75-21-8		10,000				11,340	x		x
Ethylene thiourea	Imidazolidine-2-thione	Etilén tiourea	96-45-7		10,000				11,340	x		x
Fluoranthene	Fluoranthène	Fluoranteno	206-44-0	PAH	50			PAC	100	x		x
Fluorine	Fluor	Fluor	7782-41-4		10,000				11,340	x		x
Formaldehyde	Formaldéhyde	Formaldehído	50-00-0	VOC	10,000	5,000	100		11,340	x	x	x
Formic acid	Acide formique	Ácido fórmico	64-18-6		10,000				11,340	x		x
Gamma-Hexachlorocyclohexane (lindane)	Lindane	Lindano (HCH)	58-89-9			5	100		11,340		x	x
HCFC 124 (and all isomers)	Chlorotétrafluoroéthane	Clorotetrafluoroetano	--		10,000	5,000	1,000		11,340	x	x	x
HCFC-123 (and all isomers)	Dichlorotrifluoroéthane	Diclorotrifluoroetano	--		10,000	5,000	1,000		11,340	x	x	x
Heptachlor	Heptachlore	Heptacloro	76-44-8			5	100		10		x	x
Hexachlorobenzene	Hexachlorobenzène	Hexaclorobenceno	118-74-1	**		**		**		x	x	x
Hexachlorobutadiene	Hexachlorobutadiène	Hexacloro-1,3-butadieno	87-68-3			2,500	1,000		11,340		x	x
Hexachlorocyclopentadiene	Hexachlorocyclopentadiène	Hexaclorciclopentadieno	77-47-4		10,000	5,000	1,000		11,340	x	x	x
Hexachloroethane	Hexachloroéthane	Hexacloroetano	67-72-1		10,000	5,000	1,000		11,340	x	x	x
Hexachlorophene	Hexachlorophène	Hexaclorofeno	70-30-4		10,000				11,340	x		x
Hydrazine	Hydrazine	Hidracina	302-01-2		10,000	5,000	100		11,340	x	x	x
Hydrochloric acid	Acide chlorhydrique	Ácido clorhídrico	7647-01-0		10,000				11,340	x		x
Hydrogen cyanide	Cyanure d'hydrogène	Ácido cianhídrico	74-90-8		10,000				11,340	x		x
Hydrogen fluoride	Fluorure d'hydrogène	Ácido fluorhídrico	7664-39-3		10,000				11,340	x		x
Hydrogen sulfide	Sulfure d'hydrogène	Acido sulfhídrico	6/4/7783		10,000	5,000	1,000			x	x	
Hydroquinone	Hydroquinone	Hidroquinona	123-31-9		10,000				11,340	x		x

[1] MPO = manufacturing, processing and otherwise used.

* In Canada only, hexavalent chromium compounds are reported separately from other chromium compounds (with a reporting threshold of 50 kg)

** The following individual or groups of substances are reported differently (and/or in grams) in each country: (a) dioxins, dioxin-like compounds, and furans; and (b) hexachlorobenzene.

Appendix *(continued)*

Chemical Name	Substance	Sustancia	CAS No.	NPRI		RETC		TRI		PRTRs under which the pollutant is reportable		
				NPRI qualifier	NPRI threshold (kg/year)	RETC MPO[1] threshold (kg/year)	RETC emission threshold (kg/year)	TRI qualifier	TRI threshold (kg/year)	Canada	Mexico	United States
Indeno(1,2,3-c,d)pyrene	Indeno(1,2,3-c,d)pyrène	Indeno(1,2,3-c,d)pireno	193-39-5	PAH	50			PAC	100	x		x
Iron pentacarbonyl	Fer-pentacarbonyle	Pentacarbonilo de hierro	13463-40-6		10,000				11,340	x		x
Isobutyraldehyde	Isobutyraldéhyde	Isobutiraldehído	78-84-2		10,000				11,340	x		x
Isophorone diisocyanate	Diisocyanate d'isophorone	Diisocianato de isoforona	4098-71-9		10,000				11,340	x		x
Isopropyl alcohol	Alcool isopropylique	Alcohol isopropílico	67-63-0	VOC	10,000				11,340	x		x
Isosafrole	Isosafrole	Isosafrol	120-58-1		10,000				11,340	x		x
Lead and its compounds	Plomb et ses composés	Plomo y compuestos	--		50	5	1		100	x	x	x
Lithium carbonate	Carbonate de lithium	Carbonato de litio	554-13-2		10,000				11,340	x		x
Maleic anhydride	Anhydride maléique	Anhídrido maleico	108-31-6		10,000				11,340	x		x
Manganese and its compounds	Manganèse et ses composés	Manganeso y compuestos	--		10,000				11,340	x		x
Mercury and its compounds	Mercure et ses composés	Mercurio y compuestos	--		5	5	1		10	x	x	x
Methanol	Méthanol	Metanol	67-56-1	VOC	10,000				11,340	x		x
Methoxychlor	Méthoxychlore	Metoxicloro	72-43-5			50	100		100		x	x
Methyl acrylate	Acrylate de méthyle	Acrilato de metilo	96-33-3		10,000				11,340	x		x
Methyl iodide	Iodométhane	Yoduro de metilo	74-88-4		10,000				11,340	x		x
Methyl isobutyl ketone	Méthylisobutylcétone	Metil isobutil cetona	108-10-1	VOC	10,000				11,340	x		x
Methyl methacrylate	Méthacrylate de méthyle	Metacrilato de metilo	80-62-6		10,000				11,340	x		x
Methyl tert-butyl ether	Oxyde de tert-butyle et de méthyle	Éter metil terbutílico	1634-04-4		10,000				11,340	x		x
Methylenebis(phenylisocyanate)	Méthylènebis (phénylisocyanate)	Metileno bis (fenilisocianato)	101-68-8		10,000				11,340	x		x
Michler's ketone	Cétone de Michler	Cetona Michler	90-94-8		10,000				11,340	x		x
Molybdenum trioxide	Trioxyde de molybdène	Trióxido de molibdeno	1313-27-5		10,000				11,340	x		x
Monochloropentafluoroethane (CFC-115)	Chloropentafluoroéthane (CFC-115)	Cloropentafluoroetano (CFC-115)	76-15-3		10,000	5,000	1,000		11,340	x	x	x
N,N-Dimethylaniline	N,N-Diméthylaniline	N,N-Dimetilanilina	121-69-7		10,000				11,340	x		x
N,N-Dimethylformamide	N,N-Diméthylformamide	N.N-Dimetilformamida	68-12-2		10,000				11,340	x		x
Naphthalene	Naphtalène	Naftaleno	91-20-3		10,000				11,340	x		x
n-Butyl alcohol	Butan-1-ol	Alcohol n-butílico	71-36-3		10,000				11,340	x		x
n-Hexane	n-Hexane	n-Hexano	110-54-3	VOC	10,000				11,340	x		x
Nickel and its compounds	Nickel et ses composés	Níquel y compuestos	--		10,000	5	1		11,340	x	x	x
Nitric acid and nitrate compounds	Acide nitrique et composés de nitrate	Ácido nítrico y compuestos nitrados	--		10,000				11,340	x		x
Nitrilotriacetic acid	Acide nitrilotriacétique	Ácido nitrilotriacético	139-13-9		10,000				11,340	x		x
Nitrobenzene	Nitrobenzène	Nitrobenceno	98-95-3		10,000				11,340	x		x
Nitroglycerin	Nitroglycérine	Nitroglicerina	55-63-0		10,000				11,340	x		x
N-Methyl-2-pyrrolidone	N-Méhyl-2-pyrrolidone	N-Metil2-pirrolidona	872-50-4		10,000				11,340	x		x
N-Methylolacrylamide	N-(Hydroxyméthyl)acrylamide	N-Metilolacrilamida	924-42-5		10,000				11,340	x		x
N-Nitrosodimethylamine	N-Nitrosodiméthylamine	Nitrosodimetilamina	62-75-9			2,500	100		11,340		x	x
N-Nitrosodiphenylamine	N-Nitrosodiphénylamine	N-Nitrosodifenilamina	86-30-6		10,000				11,340	x		x
Paraldehyde	Paraldéhyde	Paraldehído	123-63-7		10,000				11,340	x		x
Parathion Methyl	Méthyl parathion	Metil paration	298-00-0			5	100		11,340		x	x
PCBs	Biphényles polychlorés	Bifenilos policlorados	1336-36-3			5	any		10		x	x
Pentachloroethane	Pentachloroéthane	Pentacloroetano	76-01-7		10,000				11,340	x		x
Pentachlorophenol	Pentachlorophénol	Pentaclorofenol	87-86-5			2,500	1,000		11,340		x	x
Peracetic acid	Acide peracétique	Ácido peracético	79-21-0		10,000				11,340	x		x
Phenanthrene	Phénanthrène	Fenantreno	85-01-8	PAH	50				11,340	x		x
Phenol	Phénol	Fenol	108-95-2		10,000	5,000	1,000		11,340	x	x	x
Phosgene	Phosgène	Fosgeno	75-44-5		10,000				11,340	x		x
Phosphorus	Phosphore	Fósforo			10,000				11,340	x		x
Phthalic anhydride	Anhydride phtalique	Anhídrido ftálico	85-44-9		10,000				11,340	x		x
p-Nitroaniline	p-Nitroaniline	p-Nitroanilina	100-01-6		10,000				11,340	x		x
P-Nitrobiphenyl	Nitro-4 diphényle	4-Nitrodifenilo	92-93-3			2,500	1,000		11,340		x	x
Polychlorinated alkanes (C10-C13)	Alcanes poychlorés (C10-C13)	Alcanos policlorinados (C10-C13)	--		10,000				11,340	x		x
Polymeric diphenylmethane diisocyanate	Diisocyanate de diphénylméthane (polymérisé)	Diisocianato de difenilmetano polimerizado	9016-87-9		10,000				11,340	x		x
Potassium bromate	Bromate de potassium	Bromato de potasio	7758-01-2		10,000				11,340	x		x
p-Phenylenediamine	p-Phénylènediamine	p-Fenilenodiamina	106-50-3		10,000				11,340	x		x
Propargyl alcohol	Alcool propargylique	Alcohol propargílico	107-19-7		10,000				11,340	x		x
Propionaldehyde	Propionaldéhyde	Propionaldehído	123-38-6		10,000				11,340	x		x
Propylene	Propylène	Propileno	115-07-1	VOC	10,000				11,340	x		x
Propylene oxide	Oxyde de propylène	Óxido de propileno	75-56-9		10,000				11,340	x		x

[1] MPO = manufacturing, processing and otherwise used.

Appendix *(continued)*

				NPRI		RETC		TRI		PRTRs under which the pollutant is reportable		
Chemical Name	**Substance**	**Sustancia**	**CAS No.**	**NPRI qualifier**	**NPRI threshold (kg/year)**	**RETC MPO[1] threshold (kg/year)**	**RETC emission threshold (kg/year)**	**TRI qualifier**	**TRI threshold (kg/year)**	**Canada**	**Mexico**	**United States**
Pyridine	Pyridine	Piridina	110-86-1		10,000	5,000	1,000		11,340	x	x	x
Quinoline	Quinoléine	Quinoleína	91-22-5		10,000				11,340	x		x
Quinone	p-Quinone	Quinona	106-51-4		10,000				11,340	x		x
Safrole	Safrole	Safrol	94-59-7		10,000				11,340	x		x
sec-Butyl alcohol	Butan-2-ol	Alcohol sec-butílico	78-92-2		10,000				11,340	x		x
Selenium and its compounds	Sélénium et ses composés	Selenio y compuestos	--		10,000				11,340	x		x
Silver and its compounds	Argent et ses composés	Plata y compuestos	--		10,000				11,340	x		x
Sodium nitrite	Nitrite de sodium	Nitrato de sodio	7632-00-0		10,000				11,340	x		x
Styrene	Styrène	Estireno	100-42-5	VOC	10,000	5,000	1,000		11,340	x	x	x
Styrene oxide	Oxyde de styrène	Óxido de estireno	96-09-3		10,000				11,340	x		x
Sulfur hexafluoride	Hexafluorure de soufre	Hexafluoruro de azufre	2551-62-4		10,000	5,000	any			x	x	
Sulfuric acid	Acide sulfurique	Ácido sulfúrico	7664-93-9		10,000				11,340	x		x
tert-Butyl alcohol	2-Méthylpropan-2-ol	Alcohol terbutílico	75-65-0		10,000				11,340	x		x
Tetrachloroethylene	Tétrachloroéthylène	Tetracloroetileno	127-18-4		10,000				11,340	x		x
Tetracycline hydrochloride	Chlorhydrate de tétracycline	Clorhidrato de tetraciclina	64-75-5		10,000				11,340	x		x
Thiourea	Thio-urée	Tiourea	62-56-6		10,000				11,340	x		x
Thorium dioxide	Dioxyde de thorium	Dióxido de torio	1314-20-1		10,000				11,340	x		x
Titanium tetrachloride	Tétrachlorure de titane	Tetracloruro de titanio	7550-45-0		10,000				11,340	x		x
Toluene	Toluène	Tolueno	108-88-3	VOC	10,000				11,340	x		x
Toluene-2,4-diisocyanate	Toluène-2,4-diisocyanate	Toluen-2,4-diisocianato	584-84-9		10,000				11,340	x		x
Toluene-2,6-diisocyanate	Toluène-2,6-diisocyanate	Toluen-2,6-diisocianato	91-08-7		10,000				11,340	x		x
Toluenediisocyanate (mixed isomers)	Toluènediisocyanate (mélange d'isomères)	Toluendiisocianatos (mezcla de isómeros)	26471-62-5		10,000	5,000	1,000		11,340	x	x	x
Toxaphene	Toxaphène	Toxafeno	8001-35-2			5	100		10		x	x
Trichloroethylene	Trichloroéthylène	Tricloroetileno	79-01-6		10,000	5,000	1,000		11,340	x	x	x
Trichlorofluoromethane (CFC-11)	Trichlorofluorométhane (CFC-11)	Triclorofluorometano (CFC-11)	75-69-4		10,000	5,000	1,000		11,340	x	x	x
Triethylamine	Triéthylamine	Trietilamina	121-44-8		10,000				11,340	x		x
Vanadium and its compounds	Vanadium et ses composés	Vanadio y compuestos	--		10,000				11,340	x		x
Vinyl acetate	Acétate de vinyle	Acetato de vinilo	108-05-4	VOC	10,000				11,340	x		x
Vinyl chloride	Chlorure de vinyle	Cloruro de vinilo	75-01-4		10,000	5,000	1,000		11,340	x	x	x
Vinylidene chloride	Chlorure de vinylidène	Cloruro de vinilideno	75-35-4		10,000				11,340	x		x
Warfarin	Warfarin	Warfarina	81-81-2			5	100		11,340		x	x
Xylene (all isomers)	Xylènes	Xilenos	--	VOC	10,000				11,340	x		x
Zinc and its compounds	Zinc et ses composés	Zinc y compuestos	--		10,000				11,340	x		x

[1] MPO = manufacturing, processing and otherwise used.

Taking Stock

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