

Children's Health and the Environment in North America

A First Report on Available Indicators and Measures



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Disclaimer:

This report was prepared by the CEC Secretariat in coordination with the Steering Group for the Development of Indicators of Children's Health and the Environment in North America, which is composed of officials of the Governments of Canada, Mexico and the United States, and representatives of the CEC, the International Joint Commission's Health Professionals Task Force (IJC HPTF), the Pan American Health Organization (PAHO), and the World Health Organization (WHO). This North American report is based primarily on information contained in separate "Country Reports" prepared by Canada, Mexico and the United States (available at http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1813).

Not all information and statements in the report necessarily reflect the views of the Governments of Canada, Mexico and/or the United States, or the CEC Secretariat, IJC, PAHO and/or WHO, in part because the report is a compilation of information provided separately by the three different countries.

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List of Abbreviations

µg	microgram
µg/dL	microgram per deciliter
ARI	Acute respiratory infection
ADHD	Attention-deficit/hyperactivity disorder
BaP	benzo[a]pyrene
BLLs	blood lead levels
Conapo	<i>Consejo Nacional de Población</i> (National Population Council) (Mexico)
CEC	Commission for Environmental Cooperation
CEPA	<i>Canadian Environmental Protection Act</i>
CNA	<i>Comisión Nacional del Agua</i> (National Water Commission) (Mexico)
CO	carbon monoxide
CTUMS	Canadian Tobacco Use Monitoring Survey
DGE	<i>Dirección General de Estadística</i> (Statistics Department) (Mexico)
EPA	(US) Environmental Protection Agency
ETS	environmental tobacco smoke
Fonart	<i>Fondo Nacional para el Fomento de las Artesanías</i> (Mexico)
Imeca	<i>Índice Metropolitano de la Calidad del Aire</i>
INEGI	<i>Instituto Nacional de Estadística, Geografía e Informática</i> (National Institute of Statistics, Geography and Informatics) (Mexico)
ISAAC	International Study of Asthma and Allergies in Childhood
IJC HPTF	International Joint Commission Health Professionals Task Force
MCMZ	Mexico City Metropolitan Zone
MEME	multiple exposure-multiple effect

MUD	Municipal Water Use Database (Canada)
NAAQS	National Ambient Air Quality Standards (United States)
NO ₂	Nitrogen dioxide
NPHS	National Population Health Survey (Canada)
NPRI	National Pollutant Release Inventory (Canada)
OECD	Organization for Economic Cooperation and Development
PAHO	Pan American Health Organization
PPB	parts per billion
PICCA	<i>Programa Integral Contra la Contaminación Atmosférica en el Valle de México</i> (Mexico)
PM _{2.5}	fine particulate matter
PM ₁₀	particulate matter
POPs	persistent organic pollutants
PRTR	pollutant release and transfer register
RETC	<i>Registro de Emisiones y Transferencia de Contaminantes</i> (Mexico)
SHS	secondhand smoke
SIDS	sudden infant death syndrome
SSa	<i>Secretaría de Salud</i> (Secretariat of Health) (Mexico)
SMOC	Sound Management of Chemicals (CEC)
SO ₂	sulfur dioxide
TEL	tetraethyl lead
TRI	Toxics Release Inventory (United States)
UNEP	United National Environmental Programme
UNICEF	United Nations Children's Fund
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

DRAFT

Executive Summary

Introduction

As we learn more about the unique vulnerabilities and susceptibilities of children to environmental risks, there is an increasing call for data and information that can be used to improve public policy in this area. This document, *Children's Health and the Environment in North America: A First Report on Available Indicators and Measures*, is the first, integrated, regional report providing indicators for a series of children's health and environment issues.

The objective of this report is to inform decision-makers and the public on the status of key factors related to children's health and the environment in North America. The aim is to increase awareness of the relationship between environmental risks and children's health and to provide a means of measuring and promoting change. Since this is the first report of its kind, it also marks an initial step towards the goal of improving the reporting over time, through trilateral collaboration.

The First Regional Initiative on Indicators of Children's Health and the Environment

In June 2002, the Council of the Commission for Environmental Cooperation (CEC) of North America adopted, through Resolution 02-06 (see Appendix 1), the *Cooperative Agenda for Children's Health and the Environment in North America*, a blue-print for regional action on children's health and the environment. Among the elements of the *Cooperative Agenda* was a commitment to develop indicators of children's health and the environment for North America.¹ The CEC joined forces with the International Joint Commission Health Professionals Task Force (IJC HPTF), the World Health Organization (WHO), the Pan American Health Organization (PAHO), and together with the three member countries, Canada, Mexico and the United States, embarked upon the development of the first regional report on indicators of children's health and the environment. The Organization for Economic Cooperation and Development (OECD) participated in this initiative as an observer.

This CEC-led effort also forms part of the Global Initiative on Children's Environmental Health Indicators (CEHI), which was endorsed at the World Summit on Sustainable Development (WSSD) and is led by WHO <<http://www.who.int/ceh/indicators/en/>> with support from the US Environmental Protection Agency (EPA). As such, this report represents a significant regional learning opportunity that may help to inform similar projects in other parts of the world.

The indicators in this report reflect the CEC priorities, as defined by the Council. The CEC priority areas for children's health and the environment include: asthma and respiratory disease, lead and other toxic substances, and waterborne diseases. The countries committed to presenting information on an initial set of twelve indicators (see Appendix 2). These were selected based on the availability of data to present information on them, and on their relevance to the priority issues. From this initial set of twelve indicators, the Steering Group for this report elected to add an additional pollutant release and transfer register (PRTR) indicator on lead. Also, for reporting purposes, the Steering Group elected to merge two indicators on drinking water into one, and two indicators on waterborne diseases into one. Essentially, there are thirteen indicators, organized under eleven thematic headings, for this report. Recognizing the value of building on existing data

¹ The CEC Council is composed of the top-ranking environmental officials from the three North American countries, Canada, Mexico and the United States. Council Resolutions, including CR02-06, can be found at <http://www.cec.org/who_we_are/council/members/>.

and improving over time, a flexible approach was adopted to enable countries to report related information if they were not able to present information on any of these indicators. As a result, not all indicators are comparable across the three countries.

Children in North America

The following information serves as a brief introduction to the populations of children in each country, their health status and several other important determinants of health to provide context for this report. For the purposes of this report, the definition of children includes all persons up to the age of 18 years, although other age distributions are sometimes cited, depending on the data involved.

As of 2003, there were approximately 7 million children in Canada, or 22 percent of the total population. Mexico had nearly 40 million children in 2003, representing approximately 38 percent of its total population. US children numbered almost 76 million, or nearly 26 percent of the total population for the same year. All three countries have a high rate of urbanization, with the majority of their populations living in cities: Canada (80 percent), Mexico (75 percent) and United States (80 percent) (UNICEF, State of the World's Children 2005).

The infant mortality rates were 5.1, 16.8 and 6.9 deaths per 1,000 live births in Canada (2001), Mexico (2002) and the United States (2000), respectively. The leading cause of death for children in all three countries was unintentional injuries (e.g., accidents and poisonings). The leading cause of death for children under one year of age in Canada (1999) was birth defects. In Mexico (2002), the leading cause of death for children under one year of age was complications associated with pregnancy and birth (including prematurity, complications of delivery, and major birth defects). The leading cause of death for children under one year of age in the United States was birth defects, including structural and chromosomal abnormalities. The primary reason for hospitalization in children in all three countries was respiratory conditions.

The availability and accessibility to public health services are important contributing factors to the health status of children. Measles immunization rates were selected as an indicator of the availability of public health services for children. All three countries posted rates above 90 percent.

An important determinant of child health is economic status. Children living in poverty are more likely to be exposed to multiple environmental risks. While poverty is defined and measured differently in the three countries, a proportion of children are living in poverty in all of them. In Canada, 15.6 percent of children lived in families with an income level below the low-income cut-off in 2001, while 24.2 percent of Mexico's total population reported difficulty in obtaining basic necessities such as food. In the United States, 16.1 percent of children were living in conditions below the nationally defined poverty level in 2001

The Indicators

The report presents thirteen indicators that fall within three priority areas that have been defined by the CEC Council for the countries' cooperative work on children's health and the environment, namely: asthma and respiratory disease, lead and other chemicals, and waterborne diseases. These thirteen indicators, which are organized under eleven thematic headings, are summarized in Chart I-1 below.

Chart I-1: List of Indicators for *Children's Health and the Environment in North America*

Asthma and Respiratory Disease	
Issue Area	Current Indicator
Outdoor Air Pollution	Percentage of children living in areas where air pollution levels exceed relevant air quality standards
Indoor Air Pollution	Measure of children exposed to environmental tobacco smoke (Canada, United States) Measure of children exposed to emissions from the burning of biomass fuels (Mexico)
Asthma	Prevalence of asthma in children
Effects of Exposure to Lead and Other Toxic Substances	
Issue area	Current Indicator
Lead Body Burden	Blood lead levels in children
Lead in the Home	Children living in homes with a potential source of lead
Industrial Releases of Lead	Pollutant release and transfer register (PRTR) data on industrial releases of lead
Industrial Releases of Selected Chemicals	PRTR data on industrial releases of 153 chemicals
Pesticides	Pesticide residues on foods
Waterborne Diseases	
Issue area	Current Indicator
Drinking Water	(a) Percentage of children (households) without access to treated water (b) Percentage of children living in areas served by public water systems in violation of local standards
Sanitation	Percentages of children (households) that are not served with sanitary sewers
Waterborne Diseases	(a) Morbidity: number of cases of childhood illnesses attributed to waterborne diseases (Canada, Mexico, United States) (b) Mortality: number of child deaths attributed to waterborne diseases (Mexico)

Source: Compiled by author.

The countries' efforts to compile these indicators revealed a number of data gaps and opportunities for improvement. None of the countries were able to compile all of the indicators but often were able to present related data sets. Lack of comparability among the data held by the three countries also posed a considerable challenge to compiling a North American set of indicators.

Indicators related to Asthma and Respiratory Disease

Indicator No. 1—Outdoor Air Pollution

Exposure to ambient air pollution has been associated with the development and exacerbation of asthma and other respiratory diseases in healthy children. More recent evidence suggests that maternal exposure to air pollution during pregnancy is associated with adverse pregnancy outcomes. This indicator is intended to measure the percentage of children living in areas where air pollution levels exceed relevant air quality standards.

Canada is unable to present information on this indicator, but in its place Canada presents ambient air quality monitoring trends for several common air contaminants. Existing information on ambient air quality shows that levels of several important air pollutants have dropped over the last 10 years, in Canadian urban areas. However, levels of ground-level ozone, which have not dropped in most areas, and fine particulate matter (PM_{2.5}) are still of concern. Within Canada, Southern Ontario experienced the highest numbers of days on which ground-level ozone and PM_{2.5} levels exceeded the Canadian standards.

In Mexico, population-based exceedance data are not available; however, air quality exceedance data are presented as a proxy indicator. The observations from this data indicate that air quality standards for several selected pollutants in key metropolitan areas are exceeded, most notably for ground-level ozone and particulate matter (PM₁₀). There are several regions of greatest concern, including the Mexico City Metropolitan Zone and the Guadalajara Metropolitan Zone. Mexico also provides a map depicting metropolitan areas with air quality programs, such as air monitoring.

The United States presents data on the percentage of children living in counties in which air quality standards were exceeded. The data indicate that a high percentage of children are living in counties where levels of ground-level ozone exceed standards. A smaller, but still significant, percentage of children are living in counties where PM_{2.5} levels exceed standards; however, this has been decreasing.

Indicator No. 2—Indoor Air Pollution

This indicator measures children's potential exposure to indoor air pollution, with a focus on environmental tobacco smoke (in the case of Canada and the United States) and emissions from burning of biomass fuels (in the case of Mexico). Children who are exposed to environmental tobacco smoke are at increased risk of adverse health effects, including sudden infant death syndrome, pneumonia and asthma. Children exposed to emissions from burning of biomass fuels are at increased risk for respiratory problems and exacerbation of asthma.

For this indicator, Canada presents survey data on the percentage of children, of various age groups from zero (birth) to 19 years old, who are exposed to environmental tobacco smoke in the home. Canada's survey data suggest that the exposure of children to environmental tobacco smoke has declined in the last four years (1999–2002). For example, the percent of children aged zero to five who are exposed to environmental tobacco smoke in the home decreased from 23 percent in 1999 to 14 percent in 2002.

Mexico presents geographical data on the use of wood fuel at the municipal level. Indoor air pollution in homes caused by the burning of firewood or charcoal for cooking is a public health problem in Mexico. The map indicates that biomass use is highest in southern Mexico and North Central Mexico.

The United States reports survey data for children aged six and under who were regularly exposed to environmental tobacco smoke in the home. The percent of children exposed to

environmental tobacco smoke in the home declined 16 percent between 1994 and 2003, from 27 percent to 11 percent. The United States also presents data on the measurement of cotinine levels in blood (cotinine is a breakdown product of nicotine and is a marker for recent exposure to ETS). These data show reduced cotinine levels in children between 1988 and 2000. Detectable levels of serum cotinine in blood fell 24 percent over this period for children aged four to 11 years. The US data for 1999–2000 also indicate that 86 percent of Black, non-Hispanic children aged four to 11 had cotinine in their blood, compared with 63 percent of White, non-Hispanic children and 49 percent of Mexican American children.

Indicator No. 3—Asthma

This indicator tracks asthma in children, a disease of the lungs that affects millions of children in North America. Asthma is a major cause of child hospitalization and is the most common chronic disease of childhood in North America.

Canada reports on the prevalence of physician-diagnosed asthma among children. These data indicate that asthma prevalence among children has continued to increase in most age groups, between 1994 and 1999. For example, the percent of boys aged eight to 11 who were diagnosed with asthma increased from approximately 16 percent in 1994/1995 to approximately 20 percent in 1998/1999. For girls of the same age range, the increase was from approximately 11 percent to approximately 15 percent.

Mexico presents data on the incidence of asthma among children. These data show an increase in nearly all age groups over the period 1998 to 2002. For example, in 2002, 35 children out of every 10,000 aged five to 14 years had asthma, up from 28 per 10,000 in 1998. Mexico also presents national incidence of acute respiratory infections (ARI) among children. The number of new cases of ARI was stable or up slightly over the period 1998 to 2002, with the highest prevalence among children under one year of age.

The United States presents survey data on asthma prevalence for all age groups between 1980 and 2003. Over the period 1980 to 1995, the percentage of children with asthma doubled. In 2003, 13 percent of American children had been diagnosed with asthma at some point in their lives.

Indicators related to Lead and Other Chemicals, including Pesticides

Indicator No. 4—Blood Lead Levels

Lead is a major environmental hazard for young children. Exposure to lead can result in neurological damage in young children that can lead to behavioral disorders, learning disabilities and lower IQ. The selected indicator provides information on blood lead levels in children.

Canada is unable to report this indicator as there are no recent nationally representative data on blood lead levels in children. Instead, Canada presents a case study on blood lead levels in children in Ontario. This case study shows the association between decreasing blood lead levels in Ontario children and the removal of lead from gasoline, over the period 1982 to 1992.

Mexico is also unable to present this indicator as it does not have national data on blood lead levels. Instead, Mexico presents data from a series of local studies involving children in rural and urban populations. The data, which cover the period 1979 to 2000, show blood lead levels in children. Mexico also presents a case study on air monitoring for lead, for the period 1990 to 2000, that confirms the substantive drop in lead in ambient air that was achieved with the introduction of unleaded fuel. Another case study illustrates that industrial releases of lead can accumulate in sufficient quantities in neighboring communities and pose a serious health threat

for children. It also illustrates that remediation is possible and that some of the potential health effects can be mitigated if actions are taken.

The United States presents blood lead level data from its national lead biomonitoring program for children. The median concentration of lead in the blood of children five years old and under dropped from 15 micrograms per deciliter ($\mu\text{g}/\text{dL}$) during 1976–80 to 1.7 $\mu\text{g}/\text{dL}$ during 2001–2002, a decline of about 85 percent. In 1999–2000, Mexican-Americans and non-Hispanic African-Americans had higher blood lead levels than non-Hispanic whites. The United States presents a case study on the relationship between blood lead levels in children, the removal of lead from gasoline and the implementation of other lead reduction measures.

Indicator No. 5—Lead in the Home

Children may be exposed to lead found in homes and other indoor environments due to the widespread past uses of lead in gasoline, paint, plumbing and building products and other consumer goods. Indoor lead sources include lead in dust, lead-based paint and lead in plumbing, in Canada and the United States. In Mexico, a major source of indoor lead is home-based pottery operations using lead-based glaze. Lead-based glazes may also result in exposure to lead through the use of this pottery in food preparation, serving and storage. This indicator provides information on children's potential exposures to sources of lead in the home.

For this indicator, Canada presents information on the percentage of children living in homes built before 1960. In Canada, homes built before 1960 are more likely to contain paint with high concentrations of lead. This lead can increase the potential for exposure through lead dust if the older paint is exposed due to renovations or deterioration (i.e., peeling and flaking). According to the data provided, there has been a modest decline in the number of children living in homes built before 1960. For example, in 1991, 28 percent of children four years and under lived in housing built prior to 1960. This had declined to 24 percent by 2001.

Mexico is unable to present data on this indicator. Instead, Mexico presents geographic information on the density of home-based pottery operations in various states. The map shows that the distribution of pottery facilities is most dense in southern Mexico.

The United States is unable to present child-specific information for this indicator. Instead, the United States provides data from a nationally representative sample on the percentage of housing contaminated with lead-based paint, lead-based dust or lead-based soil. This indicator shows that between 1998 and 2000, 40 percent of homes had some lead-based paint. Twenty-five percent of the homes had a significant lead-based paint hazard.

Indicator No. 6—Industrial Releases of Lead

In this section, PRTR data² serve as an action indicator and depict trends in industrial releases of lead to the environment over time, including on-site releases to air, water, land and underground injection as well as off-site releases. While they do not provide information on children's exposures, the data can indicate whether actions are being taken to reduce or prevent industrial releases of lead to the environment. The PRTR data come from manufacturing facilities that are subject to similar reporting requirements in Canada and the United States.

² Data reported by industrial facilities to the National Pollutant Release Inventory (NPRI) in Canada and the Toxics Release Inventory (TRI) in the United States on certain chemical substances released to air, water, land or transferred off-site for further management. Only those data elements (i.e., chemicals and industry sectors) that are comparable between the Canadian and US systems are included. Comparable data not yet available under the Mexican PRTR.

Canada reports an overall reduction of 46 percent in on-site and off-site releases of lead and its compounds from manufacturing facilities, between 1995 and 2000 (from 4,124 tonnes in 1995 to 2,220 tonnes in 2000). Off-site releases (primarily transfers to landfills) accounted for the largest portion of releases and also for the largest portion of reductions over this time period.

Mexico's PRTR system, the *Registro de Emisiones y Transferencia de Contaminantes* (RETC), is not yet fully operational and, therefore, Mexico does not have data to report on this indicator.

The United States reports an increase of 9 percent in on-site and off-site releases of lead and its compounds from manufacturing facilities, between 1995 and 2000, from 19,492 tonnes in 1995 to 21,211 tonnes in 2000). The largest decreases in lead releases over the reporting period occurred for on-site releases to air and land, while the largest increases were in off-site releases (off-site releases are primarily transfers to landfills).

Indicator No. 7—Industrial Releases of Selected Chemicals

There are 153 chemicals for which both the Canadian and US governments require industrial facilities to report their releases and transfers to the national PRTR programs over the period 1998-2002. With the aim of tracking progress in reducing or preventing the release of such chemicals from industrial activities, this PRTR data-based indicator presents trends in on-site releases to air, water, land and underground injection, as well as in off-site releases (primarily off-site disposal in landfills).

In Canada, on-site and off-site releases of the 153 matched chemicals decreased by 11 percent, from 1998 to 2002 (from 154,000 tonnes in 1998 to 137,000 tonnes in 2002), while the number of facilities reporting over that period increased by 41 percent. The reduction in releases was realized in part through reductions reported by the primary metals sector (with a decrease of 33 percent) and the chemical manufacturing sector (a decrease of 36 percent).

Mexico did not report this indicator, given that the mandatory PRTR program in Mexico is not yet operational.

The US data for the 153 matched chemicals depict an overall reduction of 11 percent, from 1998 to 2002 (from 1.45 million tonnes in 1998 to 1.28 million tonnes in 2002), with a slight reduction in the number of reporting facilities over the same period. Reductions were reported by various sectors, including the electric utilities sector (9 percent reduction), the chemical manufacturing sector (24 percent reduction) and the hazardous waste management/solvent recovery sector (36 percent reduction). The primary metals sector, reporting the second largest amount of releases behind electric utilities in 2002, had an increase of 16 percent.

Indicator No. 8—Pesticides

Children and infants may be more vulnerable to potential health effects from pesticides, due to their unique susceptibilities (especially the growth and development of body systems) and higher intake as a result of their dietary habits and immature detoxification systems. While there are numerous ways in which a child may be exposed to pesticides (e.g., exposure to pesticides used on lawns or in the home, or through contaminated drinking water), the focus of the present indicator is on pesticide residues on foods.

Canada reports on the percentage of fresh fruits and vegetables, both domestic and imported, that have detectable residues of organophosphate pesticides. The percentage of imported and domestic fruit and vegetables sampled that had organophosphate pesticides decreased from 12 percent in 1995 to 3 percent in 2002.

Mexico reports on the incidence of pesticide poisonings for the general public and for children under 15 years of age. The data suggest that the number of poisonings reported for children under the age of 15 has fallen by half between 1998 and 2002. In 2001, the total number of reported pesticide poisonings among children under the age of 15 in Mexico was 2,532.

The United States presents data on the percentage of fruits, vegetables, and grains with detectable residues of organophosphate pesticides. Between 1994 and 2001, the proportion of fruits, vegetable and grains sampled with detectable organophosphate residues ranged between 19 percent and 29 percent

Indicators related to Waterborne Diseases

Indicators No. 9 and 10—Drinking Water

The presence of pathogens and chemical contaminants in drinking water can result in a wide range of health effects for children, from gastrointestinal discomfort to death. The indicators in this section measure the percentage of children (represented by households containing children) without access to treated water, as well as the percentage of children living in areas served by public water systems in violation of local standards.

Canada is unable to present child-specific data for the percentage of children without access to treated water, but presents data on the percentage of the general population not connected to public water distribution systems, for the period 1991 to 1999. The percentage for this period remained stable, with, approximately 24 percent of Canadians without central water distribution systems in 1999. It is assumed that this group relies on private water supplies, with the principal source being groundwater wells. Canada does not report on the second indicator in this section, the percentage of children served by drinking water systems with violations. Such data are requested from the municipal systems and collected by the provinces, but are not available in a consistent form that could be used to generate a national indicator.

Mexico is unable to present child-specific data for the percentage of children without access to treated water, but instead presents the percentage of the general population without access to potable water. Between 1980 and 2000, the percentage of the population without access to potable water decreased from approximately 29 to 12. The indicator shows that urban populations have greater access, with only 5 percent of people without access, while in rural areas 32 percent lack access as of 2000. Mexico also provides a geographic representation of the lack of piped water as of 2000. The northern and central states of Mexico were the best served, with between 0 to 20 percent without coverage. Mexico is not able to report on the second indicator, the percentage of children served by drinking water systems with violations.

The United States does not present data for the percentage of children not served with treated water. For the second indicator, the United States reports on the percentage of children served by public water systems that exceed or violate a drinking water standard. Between 1993 and 1999, the percentage of children living in areas with any health-based violation decreased from 20 percent to 8 percent. The United States also reports on the percentage of children living in areas with major violations of drinking water monitoring and reporting requirements. From 1993 to 1999, the percentage of children living in areas that had any major violation of water monitoring and reporting dropped from 22 to approximately 10 percent.

Indicator No. 11—Sanitation

Untreated human sewage is an important source of bacterial contamination for surface and ground water. Contamination of source waters with pathogens presents risk to children through drinking water, bathing and swimming. This indicator measures the percentages of children (represented as households containing children) that are not served by sanitary sewers.

Mexico is unable to provide child-specific data; instead Mexico provides data on the percentage of the population that does not have sewage removed from its immediate surroundings, between 1980 and 2000. The indicator demonstrates that the percentage of the population without sewage removal decreased from 50 percent in 1980 to 24 percent by 2000. The indicator shows that urban populations have greater access, with 10 percent of people in urban setting without sewage removal, whereas 63 percent lack access in rural areas, as of 2000. Mexico also provides a geographic representation of households without sewer services as of 2000. The northern and central states of Mexico were the best served.

Canada and the United States elected not to report on this indicator due to the high percentage of sewage collection and treatment in both urban and rural environments in both countries. Most urban and rural communities are served by sewer and sanitation services or have septic systems to collect and treat sewage. Canada has presented this indicator in the Canadian country report (see Volume II of this report).

Indicator No. 12 and 13—Waterborne Diseases

The risk of microbial disease associated with drinking water continues to be a concern in North America. Numerous past outbreaks, together with recent studies suggesting that drinking water may be a substantial contributor to endemic (non-outbreak-related) gastroenteritis, demonstrate the need to monitor waterborne illnesses, which is the focus of this indicator. However, enteric infections can be food-borne, waterborne or occur through a fecal-oral route, thus identifying the actual cause of the infection can be problematic. The indicators in this section measure the number of childhood illnesses attributed to waterborne diseases (in the case of Canada, Mexico and the United States) and the number of child deaths attributed to waterborne diseases (in the case of Mexico).

Canada reports on the number of cases of childhood illness attributed to waterborne diseases by presenting incidence of giardiasis among different age groups, between 1988 and 2000. Giardiasis, sometimes called “beaver fever,” is an intestinal parasitic infection characterized by chronic diarrhea and other symptoms. Giardiasis may be foodborne, but waterborne transmission is common where unsanitary conditions exist or animal contamination occurs. The data show that children aged one to four are more likely to be infected with giardiasis than the rest of the population and that the number of cases of giardiasis in Canada has been declining since 1992. Canada has elected not to report on the second indicator, mortality from waterborne diseases, due to low mortality rates.

Mexico reports on the number of cases of childhood illness attributed to waterborne diseases by presenting incidence of giardiasis, by age group, for the period 1998 to 2002. The prevalence of giardiasis for all three age groups has declined since 1998. Children one to four years of age seem to be the most likely to be infected; however, the number of new cases declined from 21 per 10,000 in 1998 to 16 per 10,000 in 2002. Mexico also reports on the percentage of cases of cholera among children of various age groups. The age group most affected by cholera is that of one to four years old, with the percentage of cases ranging from 6 percent to 18 percent of all cases Mexico also presents on the second indicator by supplying data on the mortality rates for diarrhea. The mortality rate, of children under five, for diarrheic diseases declined from 125 per 100,000 in 1990 to 20 per 100,000 in 2002. These data suggest that advances are being made through actions to improve sewage management and drinking water treatment. In addition, programs to manage diarrheic diseases are reducing the mortality from this illness.

The United States is unable to provide child-specific data for the numbers of childhood illness attributed to waterborne diseases, but is able to present some data on reported waterborne disease outbreaks for the general population by year and type of water system. The data show that there were 751 voluntarily reported waterborne disease outbreaks associated with drinking

water systems between 1971 and 2000. The last two years of the monitoring presented a total of 44 outbreaks associated with drinking water, reported by 25 states (18 from private wells, 14 from non-community systems, and 12 from community systems). The United States has elected not to report on the second indicator, mortality from waterborne diseases, due to low mortality rates.

Conclusions and Opportunities for Improvement

This report represents a first step in creating a set of indicators of children's health and the environment for the North American region. Increased effort, including trilateral collaboration, is needed to improve the quality of future reports. The following are some of the observations and opportunities for improvement:

- Despite an overall picture of stable or improving national indicators of child health, specific and substantial sub-populations of children remain at risk from environmental risks. Future indicator reports will need to better track such populations. Case studies, regional monitoring and data mapping could be used to increase our understanding of those specific populations of children at risk.
- The impacts of social and economic disparities are an important feature in defining sub-populations of children that are disproportionately at risk from environmental exposures. Some of the indicators and measures investigated highlight the importance of socio-economic conditions in determining a child's risk of exposure and the risk of a poor health outcome.
- Data were unavailable or limited for a number of the indicators. Where data were not available, countries utilized a flexible approach to present related data or elected not to report on the indicator. Addressing data gaps will be part of the ongoing efforts of the countries to present information on these indicators in the future.
- There is a considerable amount of epidemiological research linking environmental exposures to health effects. However, there remain major questions in understanding the specific susceptibilities of children to environmental risks. Likewise, many uncertainties remain in understanding the environmental contribution to many common childhood diseases. The need to develop more definitive evidence in these areas should be the focus of ongoing scientific inquiry.
- Indicators which report prevalence and incidence offer different information useful to understanding and interpreting the progress of disease and disorders (e.g., asthma). This report reflects a greater use of prevalence data; however, to the extent that indicators will continue to evolve, there may be more focus on indicators of incidence in the future.
- The thematic areas investigated in this report represent a relatively small sample of all potential environmental risks to children's health. Furthermore, the primary focus is on pollutants known to pose risk to children's health, but it is well accepted that there are thousands of substances that have yet to be fully tested for their potential to harm children. Therefore, this effort should not be thought of as comprehensive, but rather as indicative of the relationship between children's health and the environment.

1.0 An Overview of the Children's Health and the Environment Indicators Initiative

1.1 Children's Health and the Environment

The recognition that children have unique and specific vulnerabilities to certain environmental risks has resulted in increased attention among the scientific community, policy makers and the public. Children are not little adults; relative to their size, children breathe more air, eat more food and drink more water than adults and thus may have a relatively higher exposure to contaminants per body weight. In addition, children have unique exposure patterns and behaviors, such as putting things in their mouths, that may put them in contact with different contaminants (US EPA 2003)

Children also may be more vulnerable to the effects of exposure to some contaminants. There are specific windows of vulnerability, from conception through infancy and childhood, when the child may be particularly sensitive to the deleterious effects of environmental contaminants. Furthermore, children may have less protection from environmental risks because their bodies' natural defenses may be less developed. For example, an immature immune system may increase a child's risk of contracting a waterborne disease and may increase the severity of the illness.

Furthermore, children's vulnerability is influenced by their limited knowledge of potential risks and their inability to shape their own environment to avoid risks to their health. For protection from environmental risks, children must rely upon adults to provide safe conditions for them. There are many organizations and individuals that share a responsibility for creating safer environments for children in which to live, learn and play. Federal governments have a particularly important role to ensure that national policies are in place to address environmental risks to human health, and that these policies are effective at protecting the health of the most vulnerable populations.

1.2 The Need for North American Indicators of Children's Health and the Environment

Indicators improve our understanding of the quality of the environment that influences children's health, assist in assessing the effectiveness of our interventions and policies, and allow us to identify priority areas for future actions. An important lesson learned through this first regional effort is that the process of compiling health-environment indicators also can reveal gaps and weaknesses in our knowledge and information resources, and underscores the importance of enhancing data comparability within and among countries.

In 1999, the top-ranking environmental officials from Canada, Mexico and the United States, as members of the Council of the Commission for Environmental Cooperation (CEC), initiated a process to investigate the environmental risks to children's health and to consider opportunities for greater coordination and cooperation to protect children from such threats in North America. The investigation, which included a broad-based consultation with experts and the general public, identified children as having particular vulnerabilities to environmental risks and identified the need to develop a cooperative agenda that would promote the protection of children's health from those risks.

In June 2002, the CEC Council adopted the "Cooperative Agenda for Children's Health and the Environment in North America," through Resolution 02-06 (see Appendix 1), which includes a commitment to publish a set of indicators of children's health and the environment in North

America. This commitment was reaffirmed by the CEC Council Session of June 2003, through the adoption of Council Resolution 03-10 (see Appendix 3).

The Cooperative Agenda builds upon CEC Council Resolution 00-10,³ which identified respiratory diseases and exposure to lead and toxic substances as priority areas for consideration. The list of priorities was later expanded to include waterborne diseases, recognizing water as an important source of enteric disease and exposure to other contaminants that can lead to illness in children.

The CEC's Cooperative Agenda recognizes the valuable role that indicators can play in assessing the status of an issue, raising its profile, and tracking the progress of the issue relative to set goals. The Cooperative Agenda states that the objective of the indicators report is to provide decision-makers and the public with periodic (e.g., every two to three years), understandable information on the status of key parameters related to children's health and the environment in North America as a means of measuring and promoting change (CEC June 2002).

The CEC Secretariat, in collaboration with the governments of Canada, Mexico and the United States, and working in partnership with the International Joint Commission Health Professionals Task Force (IJC HPTF), the Pan American Health Organization (PAHO) and the World Health Organization (WHO), established a Steering Group to oversee the development of the first North American indicators report. The Organization for Economic Cooperation and Development (OECD) participated as an observer. A feasibility study⁴ was completed and the Steering Group developed recommendations for the development of a core set of indicators.⁵

The development of this North American report was based on country reports prepared by the governments of Canada, Mexico and the United States in 2003–2005. The country reports, which are reproduced in Volume II, provide data, where feasible, for the set of thirteen agreed-upon indicators. They also present additional contextual information, supporting data and technical templates for the indicators.

This North American report has been reviewed by experts in the respective governmental departments. In addition, both reports (Volume I and Volume II) have been subject to an in-depth review by a panel of nine nongovernmental experts, as well as a public consultation process, to ensure that the information is both technically sound and relevant to the reader.

1.3 Who Will Use This Report

Government policy makers are the primary audience for this report, as they play a key role in designing and implementing policies that will impinge upon the health of children and their environments. Indicators can assist policy makers as they prioritize issues, implement monitoring and surveillance programs and develop policies to better protect children. The report also provides information that can help measure the effectiveness of existing policies. It identifies trends over time for indicators on numerous issues of concern for protecting children's health from environmental risks, in the areas of toxic substances, air quality, and water quality. In some cases, these trends may suggest the need for additional action on the part of governments, such as to address specific research objectives or policy interventions. In other cases, this report

³ CEC Council Resolution 00-10 is available at <www.cec.org>.

⁴ Feasibility Study for the Development of Indicators of Children's Health and the Environment in North America, April 2003 is available at <http://www.cec.org/files/pdf/POLLUTANTS/CHE-Feasibility-Study_en.pdf>.

⁵ Recommendations for the Development of Children's Health and the Environment Indicators in North America, June 2003 is available at <http://www.cec.org/files/pdf/POLLUTANTS/CHE-Recommendations_en.pdf>.

identifies opportunities to improve data availability and consistency, and to develop future indicators that can be used to better assess the health of children and their environment.

Governments, though, are not the only potential users of this report. Other groups and individuals actively involved in the protection of children's health may find this information useful in their efforts to communicate and to advocate for policy change. Members of the general public, parents, grandparents, teachers and caregivers, who also play an active part in protecting children's health from environmental exposures, also may find this report useful. In all instances, increased awareness of the role of the environment as a determinant of children's health is important knowledge that can result in changes to improve the health of children.

1.4 Selecting the Indicators for This Report

The selection of a core set of indicators for this first North American report began with three priority areas previously identified by the CEC Council for the countries' cooperative work on children's health and the environment, namely asthma and respiratory disease, the effects of exposure to lead and other toxic substances, and waterborne diseases. The Steering Group applied the criteria listed in Box 1 to identify a set of recommended indicators that would be useful and relevant, scientifically sound, available and understandable.

Box 1: Criteria Used by the Steering Group in Selecting the Recommended Indicators

- 1. Useful and relevant.** Each indicator must be related to a specific question or issue of interest that highlights a trend or concern regarding children's health and the environment.
- 2. Scientifically sound and credible.** Each indicator must be unbiased, reliable, valid, and based upon high-quality data. The methodology for collecting the data should be robust and repeatable. There must be a credible link between the environmental condition that the indicator addresses and the health outcome (for example air quality and asthma rates).
- 3. Availability.** It is agreed that because not all countries will be able to report on all indicators, countries will choose indicators from this list that are most appropriate and available, from their national perspective (e.g., whether or not nationally representative) and based on information that already exists, since governments may be unable to commit resources for collecting new data.
- 4. Applicable and understandable.** The indicator must be useful for policy-makers and a non-specialist audience

(CEC June 2003)

The CEC Council endorsed the Steering Group's set of 12 recommended indicators in June 2003 through Council Resolution 03-10 (Appendix 3), and committed to providing the information needed to report this initial set in 2004 and periodically thereafter. In compiling the indicators for the first report, the Steering Group made several minor adjustments to improve the relevance and consistency of certain indicators. The original set of Council-endorsed indicators and the current set, contained in this report, are summarized in Chart 1-1.

Chart 1-1: North American Indicators for Children’s Health and the Environment, by Issue Area

Asthma and Respiratory Disease		
Issue Area	Current Indicator	Purpose of Indicator
Outdoor Air Pollution	Percentage of children living in areas where air pollution levels exceed relevant air quality standards	To provide information on children’s potential exposures to outdoor air pollution, with a focus on common air contaminants
Indoor Air Pollution	Measure of children exposed to environmental tobacco smoke (Canada, United States); measure of children exposed to emissions from the burning of biomass fuels (Mexico)	To provide information on children’s potential exposures to indoor air pollution, with a focus on environmental tobacco smoke and emissions from the burning of biomass fuels
Asthma	Prevalence of asthma in children	To track asthma in children
Effects of Exposure to Lead and Other Toxic Substances		
Issue area	Current Indicator	Purpose of Indicator
Lead Body Burden	Blood lead levels in children	To provide information on children’s exposure to lead
Lead in the Home	Children living in homes with a potential source of lead	To provide information on children’s potential exposure to sources of lead in the home
Industrial Releases of Lead	Pollutant release and transfer register (PRTR) data on industrial releases of lead	To provide information on industrial releases of lead
Industrial Releases of Selected Chemicals	PRTR data on industrial releases of 153 chemicals	To provide information on industrial releases of selected chemicals
Pesticides	Pesticide residues on foods	To provide information on children’s potential exposure to pesticides
Waterborne Diseases		
Issue area	Current Indicator	Purpose of Indicator
Drinking Water	(a) Percentage of children (households) without access to treated water	To provide information on the percentage of children potentially exposed to contaminants and pathogens in drinking water
	(b) Percentage of children living in areas served by public water systems in violation of local standards	
Sanitation	Percentages of children (households) that are not served by sanitary sewers	To provide information on the percentage of children who are potentially exposed to untreated sewage in their immediate surroundings

Waterborne Diseases	(a) Morbidity: number of cases of childhood illnesses attributed to waterborne diseases (Canada, Mexico, United States)	To provide information on children who have been sick from or have died as a result of waterborne diseases
	(b) Mortality: number of child deaths attributed to waterborne diseases (Mexico)	

Source: Compiled by author.

It was understood that not all countries would be able to report on all indicators, depending on data availability. The Steering Group recommended that a flexible approach be used that would allow countries to report other relevant data in the event that they were not able to present information for a specific indicator. This approach was designed to allow the countries to use existing data and methodologies, while building over the longer term towards a core set of harmonized indicators for the region.

1.5 A Common Approach to Indicator Development

The relationships between environmental exposures and human health effects are complex and multifaceted. In previous indicator efforts, models have been developed to explain these relationships and to serve as a guiding framework for indicator development. The Steering Group for the North American report concluded that the World Health Organization's multiple exposure-multiple effect (MEME) model best captured the complex interactions between the environment and children's health. The MEME model highlights that exposure and health outcomes are based on many links between the environment and health and are rarely based on simple, direct relationships (see Figure 1) (Briggs 2003).

The model also illustrates that environmental exposures and health outcomes are influenced by social, economic and demographic factors. These factors are among a number of aspects that are known to influence health outcomes and are frequently referred to as socioeconomic determinants of health. For example, being poor may mean that families are forced to live in sub-standard housing, are less able to afford nutritious food and may have limited or no access to clean drinking water. These circumstances contribute to poor health while increasing the likelihood of environmental exposures and related health outcomes.

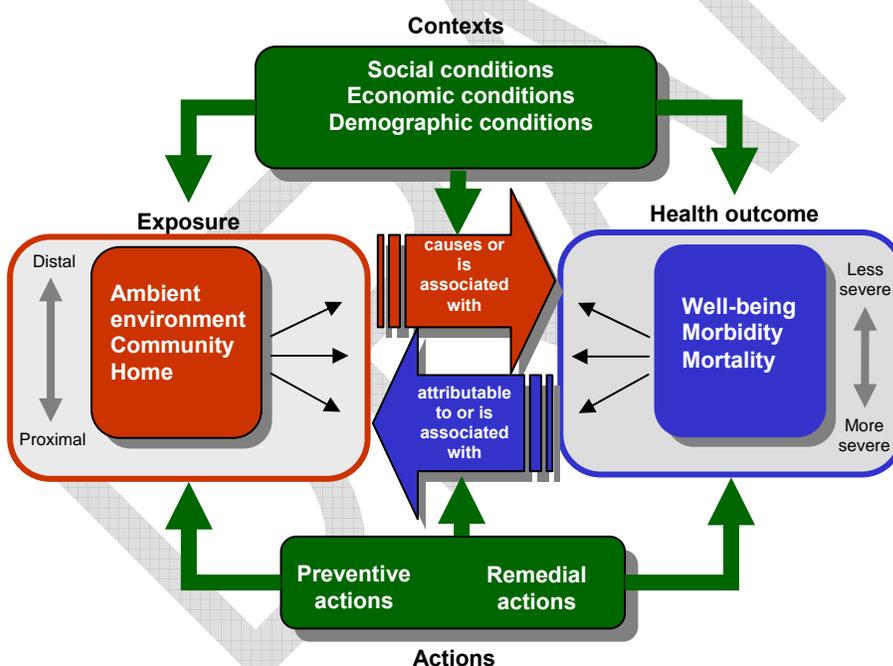
Sections 3–5 present topic-specific MEME models that have been included to illustrate the issues addressed by each set of indicators. On the environment side, the models indicate the range of possible exposures, from distal (e.g., in the wider community) to proximal (e.g., in the home). Where applicable, possible sources of the pollutant(s) are also indicated. On the health side, the models list a variety of health outcomes that can be associated with the exposure(s) in question. An attempt has been made to order the health outcomes from less severe to more severe, although it is recognized that the severity of any given outcome (with the exception of death) can vary from one instance to the next.

Each of the indicators in this report is focused on a specific aspect of the complex relationships illustrated by the MEME models. For example, the indicator on outdoor air quality is focused on the exposure side of the picture, while the asthma indicator reflects a specific health outcome. In the topic-specific MEME models presented in the following sections, the relevant box (either the exposure box or the child health outcome box) is highlighted to reflect the focus of the particular indicator. Within the exposure box, a further distinction can be made between the agent and its source(s). For example, if the indicator is focused on the agent (e.g., common air pollutants) the agent will be capitalized and italicized.

As noted in Section 1.4, most of the indicators presented in this report are measures of exposure. In some cases, direct measures of exposure (e.g., blood lead levels) were not possible and surrogate exposures were chosen (e.g., children living in homes with a potential source of lead). Surrogate exposures are an important source of information as specific exposure data are rarely available for national indicators. Health outcome indicators are presented for asthma and for waterborne diseases, while action indicators have been presented for industrial releases of pollutants. In several cases, indicators present information on various sub-populations of children at increased risk.

The linkages between environmental exposure and health outcomes are important to consider. For some of the substances for which exposure or surrogate exposure is presented, the presence or extent of cause-effect relationships may not be fully understood (e.g., pesticides). In these cases, it is advisable to refer to the link between environmental exposures and health outcomes by referring to these factors as "associated with" one another. Limited evidence can reflect a number of research challenges in health and environment, such as the challenge of estimating the dose or timing of exposures which may have occurred many years earlier and relating the exposure to illness or disease in a population. For some indicators, exposure and the presence of illness have a well-established link, as with giardiasis.

Figure 1: Multiple Exposure – Multiple Effect (MEME) Framework



Source: Adapted from Briggs 2003.

The indicators presented in this report reflect areas of concern where there is scientific evidence of a relationship between the exposure to an environmental contaminant(s) and related health effects, although in some of these cases the evidence may not be conclusive. The need for additional research to ensure that the potential risks from these exposures are better understood and managed is of paramount importance.

1.6 The First North American Report

Never before has an integrated report on children's health and the environment for North America been available. This CEC-led effort forms part of the Global Initiative on Children's Environmental Health Indicators, being led by WHO. Initiated by the US Environmental Protection Agency (EPA), the Global Initiative was launched at the WSSD in August 2002. The Global Initiative is being coordinated and implemented by WHO with EPA support. Partners for the Global Initiative include: the governments of Canada, Mexico, Italy, South Africa and the United States; international organizations: OECD, CEC, UNEP, UNICEF, and WHO; and nongovernmental organizations: International Society of Doctors for the Environment, International Network for Children's Health and Environmental Safety, and Physicians for Social Responsibility. This CEC report represents a significant regional contribution to the global effort and is further distinguished as the first regional product of that effort. This regional pilot will hopefully be informative to similar projects in other parts of the world. More information on the Global Initiative is available online at www.who.int/ceh/indicators/.

The outcome of this effort will allow those involved in various aspects of health and environmental protection to consider what information is available and what is not. This initial effort is very much a learning process where the partners have agreed to share information in order to advance thinking on the creation of a set of unique North American indicators of children's health and the environment. It also will make that learning available to a broader audience in a way that will improve similar initiatives that are planned elsewhere in the world.

All three countries have policies and programs in place to reduce the threats of exposure to environmental contaminants, and the corresponding risks to health. These actions clearly contribute to the protection of children's health; however, no single source of information enables interested parties to look at the effectiveness of these measures collectively. The indicators presented in this North American report provide an important first effort to track the status and trends of these issues on a broad scale. As such, caution is in order when attempting to draw comparisons between countries, given the differences in definitions, methodologies and standards. Efforts to increase the comparability among these indicators over time and to identify the need for further research and collaboration on data collection and analysis will be ongoing.

While considerable effort has been made to select indicators that are important to children's health, the information in this report is by no means exhaustive. Many environmental risks and thousands of substances have yet to be fully investigated for their potential impact on the health of children. Thus this report presents only a fraction of the information that could be included. Inevitably, those who review this report will find gaps or limited dialogue on issues that are important to children's health and the environment.

2.0 An Introduction to the Participating Countries

Canada, Mexico and the United States, as this report will illustrate, share some common areas of interest and approach where the environment is concerned. For example, all three countries have approached air quality through the use of national air quality standards/objectives and all have made investments in drinking water treatment and the management of sewage to better protect the health of their citizens. These similarities are important to note; however, it is equally important to look at differences among the three countries to better interpret the indicators of children's health and the environment presented in this report. Although this introduction is not a comprehensive picture of the countries, the information presented here provides context on various aspects of each country's population and factors that are important to health outcomes.

In addition to the introductory health status indicators presented in this section, additional data and source information are also contained in the country reports found in Volume II of this report.

For the purposes of this report, the definition of children includes all persons up to the age of 18 years, although other age distributions are sometimes cited, depending on the data involved.

2.1 Population Data and Birth Rates

The percentage of each country's population under 18 years of age is presented, as are the birth rates, which provide an indicator of the rate of population growth.

As of 2003, there were approximately 7 million children in Canada, or 22 percent of the total population of 31.5 million (UNICEF State of the World's Children 2005). Canada's birthrate was approximately 11 live births per 1000 population, as of 2000 (see Canada's Country Report). As of 2003, 80 percent of the Canada's population lived in urban areas (UNICEF, State of the World's Children 2005).

Mexico had nearly 40 million children in 2003, representing approximately 38 percent of its total population of nearly 103.5 million (UNICEF State of the World's Children 2005). Mexico's birthrate was 17 live births per 1000 population, as of 2000 (see Mexico's Country Report). As of 2003, 75 percent of Mexico's population lived in urban settings (UNICEF, State of the World's Children 2005).

In 2003, US children numbered nearly 76 million, or almost 26 percent of the total population of 294 million (UNICEF *State of the World's Children* 2005). The United States birth rate in 2000 was 14 live births per 1000 population (United States Census Bureau 2004). As of 2003, 80 percent of the population of the United States lived in urban areas (UNICEF, State of the World's Children 2005).

2.2 Child Mortality and Morbidity

Mortality rates for infants (under one year of age) and children (one to four years of age) are presented, as are morbidity rates and the primary causes of death and hospitalization for a number of age groups.

Canada's infant mortality rate was 5.1 deaths per 1000 live births in 2001 and the child mortality rate per 1000 for ages one to four years was 0.2 in the same year. The leading cause of infant death in Canada in 1999 was birth defects, while unintentional injuries were the leading cause of

death for children after the first year of life. The leading cause of infant hospitalization was respiratory disease. Children from one to 14 years of age were also most likely to be hospitalized due to illnesses of the respiratory system (see Canada's Country Report).

Mexico's infant mortality rate was 16.8 deaths per 1000 live births in 2002 and the child mortality rate per 1000 was 0.75 in 2002. Perinatal complications were the leading cause of infant mortality, while accidents were the leading cause of death for all age groups after the first year of life. The leading cause of infant and child hospitalization for all age groups was respiratory diseases (see Mexico's Country Report).

In the United States infant mortality rates were 6.9 deaths per 1000 live births in 2000, while child mortality for children one to four years old was 0.3 per 1000, in the same year. The leading cause of child mortality for children up to one year was congenital malformations, deformations and chromosomal abnormalities. The leading cause of death for children after the first year of life was injuries, both intentional and unintentional. The leading cause of hospitalization for ages one to nine years was respiratory disease, whereas the leading cause of hospitalization for children 10 to 14 years of age was mental disorders. Lastly, for 15- to 19-year-olds, the leading cause of hospitalization in the United States was pregnancy/childbirth (see the US Country Report).

2.3 Immunization Rates as an Indicator of Availability of Public Health Services

The presence and availability of public health services and health care have been shown to influence child health in a positive way. Immunization programs are one example of public health services that provide protection from communicable diseases; thus immunization rates provide an indicator of the access to public health for the population.

All three countries reported immunization rates for measles of more than 90 percent. Canada provided immunization for 94.5 percent of two-year-old children by 2002. Mexico posted immunization rates of close to 100 percent for a series of diseases in 2002/2003 while the United States presented a measles immunization rate of 91 percent in 2000 (see the US Country Report).

2.4 Socioeconomic Determinants of Health

It is widely recognized that poverty is a major determinant of health outcomes and is an important contributor to increased exposure to environmental risks in children (see Canada's Country Report). Children living in poverty are more likely to be exposed to multiple environmental risks. For example, children living in poor families are more likely to live near industrial sources of pollution and live in substandard housing (European Environment Agency and the WHO Regional Office of Europe 2002).

Maternal education has also been shown to be important to a child's development and higher maternal education levels contribute to improved academic and social performance in children (see Canada's Country Report). Children born to mothers with less education can be at higher risk for other fetal exposures, such as exposures to alcohol and tobacco during pregnancy.

Children living in poor families in Canada are more likely to live in areas of heavy traffic, to live in substandard housing and to be exposed to environmental tobacco smoke in their homes (see Canada's Country Report). In 2001, 15.6 percent of children in Canada lived in families with income levels below the low-income cut-off. In 1994/1995, 17.2 percent of children under the age

of two years had a mother who had not completed high school compared with 13.4 percent in 1998/1999.

In Mexico, the proportion of children under 18 years of age living in poverty (homes with per capita income below the requirements to satisfy basic food needs, equivalent to 15.4 and 20.9 pesos per day in rural and urban areas) was 27.4 percent in 2003. Women's levels of education have increased over the last 40 years. Women in Mexico with postsecondary and higher education increased from 2.4 percent in 1960 to 26.7 percent in 2000.

In the United States, 21.7 percent of children were born to mothers with less than 12 years of education in 2000 (Centers for Disease Control 2003). The proportion of children living in absolute poverty (living under nationally defined poverty level) in 2000 was 16.1 percent (United States Census Board 2001).

Although not covered here, there are other socioeconomic determinants of child health that may also be important to consider, such as race, ethnicity, geographic distribution (e.g., urban vs. rural) and parental occupation, among others.

3.0 Asthma and Respiratory Disease

The air children breathe is an important source of exposure to substances that may potentially harm their health (US EPA 2003). Exposures in early childhood when the lungs and immune systems are not fully developed raise concerns that children may respond more adversely than adults would (Schwartz 2004). The specific health concerns associated with exposure to air pollutants can vary considerably depending on the pollutant of concern and the nature of the exposure.

The indicators presented in this chapter reflect the “common” air-borne pollutants of concern present in outdoor air and other select sources of indoor air pollutants and the associated respiratory illness and disease. As illustrated in the MEME diagrams, some of the measures presented here address environmental sources of exposure (e.g., outdoor air pollutants) while others address health outcomes (e.g., asthma).

Section 3.1 presents indicators of exposure to common air pollutants of concern to human health. These indicators indirectly measure the potential for exposure for a population (United States). Where population-based indicators are not available, air quality monitoring data (Canada) and air quality index data (Mexico) are presented.

Section 3.2 presents data on the number of children exposed in the home to environmental tobacco smoke (Canada and the United States) and to non-vented biomass emissions (Mexico). These two sources of pollution in indoor environments are considered important factors in the development and exacerbation of asthma and respiratory diseases in children.

Section 3.3 provides data and trends on the prevalence of asthma among children in all three countries. This indicator provides a direct measure of the prevalence of the disease, using survey data (Canada and the United States) and physician reporting (Mexico).

3.1 Outdoor Air Pollution

Purpose: This indicator provides information on children’s potential exposure to outdoor air pollution, with a focus on common air contaminants.

CEC Council target indicator: “Percent of children living in urban areas where air pollution levels exceed relevant air quality standards.”

Current indicator: Percentage of children living in areas where air pollution levels exceed relevant air quality standards. (The target indicator was revised to encompass urban and non-urban areas).

Children spend more time outside and inhale more air per unit body weight compared to adults, potentially exposing them to higher concentrations of outdoor air pollutants emitted from traffic, power-plants, and other sources. These exposures can begin before a child’s immune system and lungs are fully developed, giving rise to concerns that their responses may be different from those of adults.

Air pollution has long been considered a source of exacerbation of asthma and other respiratory conditions; however, recent studies of the effects of air pollution on children’s health suggest that air pollution is associated with infant mortality and the development of asthma, and may influence lung development, causing lasting effects on respiratory health (Schwartz 2004). A long-term study of the effects of chronic air pollution in California on children’s respiratory health indicated that children’s health is adversely affected by current ambient levels of air pollution. The study’s results indicated that children’s lung function growth was adversely affected by the chronic exposures and that new cases of asthma and asthma exacerbations were also associated with these levels (Peters et al. 2004).

Particulate matter, a common air pollutant, has been associated with acute bronchitis in children. Research has shown that rates of bronchitis and chronic cough are reduced when particulate levels decline. There is new evidence that air pollution may also play a role in adverse birth outcomes, such as early fetal loss, pre-term delivery and lower birth weight associated with prenatal exposures (Schwartz 2004).

Air pollutants such as ground-level ozone can also cause a variety of respiratory health effects from short-term exposure, including inflammation of the lung, reduced lung function, and respiratory symptoms such as cough, chest pain, and shortness of breath. Short-term exposures to ambient concentrations of ground-level ozone have been associated with the exacerbation of asthma, bronchitis and respiratory effects serious enough to require emergency room visits and hospital admissions (US EPA 2003).

Other air pollutants of concern include carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Ground-level ozone and particulate matter are two common pollutants of concern to public health and are the focus of national air quality standards in all three countries.

As the multiple exposure–multiple effects (MEME) model for ambient air pollution in Figure 2 suggests, a number of air contaminants—individually or in combination—can produce a number of health outcomes (Briggs 2003). Conversely, a single health outcome may be associated with multiple exposures to multiple substances over time.

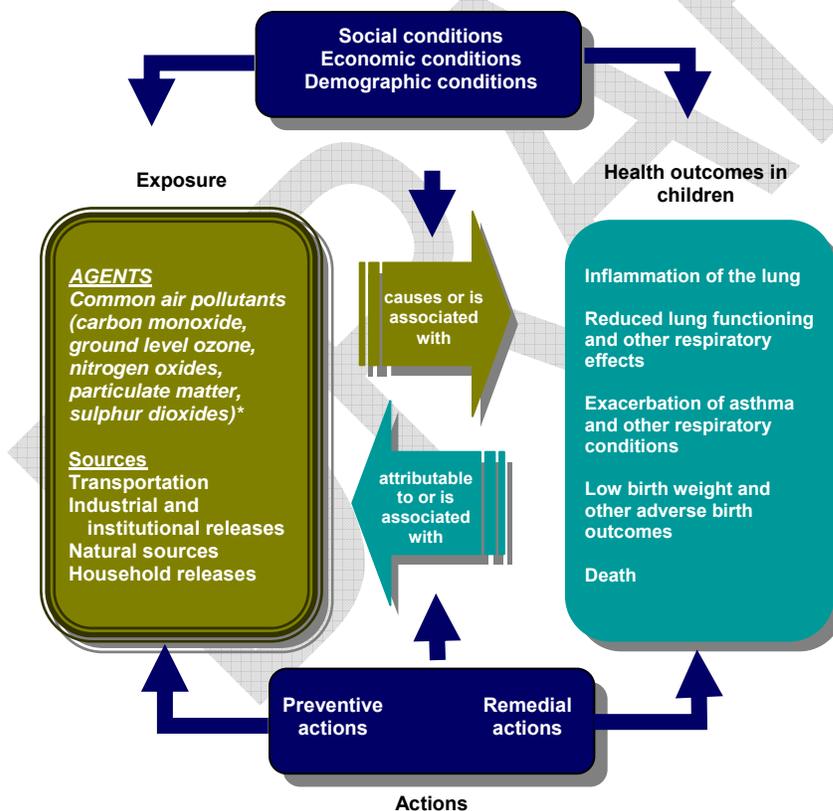
Socio-economic conditions and other factors affect the risk of exposure, as well as the health outcomes. For example, families living in low-income housing in crowded inner city environments may be at increased risk from higher concentrations of airborne pollutants, in particular where there is close proximity to high-traffic density (Peters et al. 2004). Other conditions such as a

region’s geography and weather patterns may contribute to greater (or lesser) exposures. Adverse health outcomes associated with exposure to outdoor air pollution may have a greater impact in communities where there is limited access to health care services and medications.

Each country uses different air quality standards to report on their indicators (for more information, please see the country reports). Current scientific evidence does not point to discernable thresholds for ambient air pollutants below which there are no adverse health effects. As a result, even air pollutant levels below current air quality standards should be treated with caution. Even in areas that meet a nation’s air quality standards, there are likely some children who could experience adverse health effects, especially children with pre-existing medical conditions.

The indicator, “percentage of children living in areas where air pollution levels exceed relevant air quality standards,” is intended to reflect the percentage of children that are exposed to exceedances in national standards. To present information on this indicator, countries require ongoing local or regional air quality monitoring that can be combined with population census data to determine the percentage of children that are experiencing exposures above the established standards over time.

Figure 2: MEME Framework for Issues Covered in the Section on Outdoor Air Pollution



Source: Adapted from Briggs 2003.

Note: * The United States includes lead in its list of criteria lead contaminants.

3.1.1 Canada

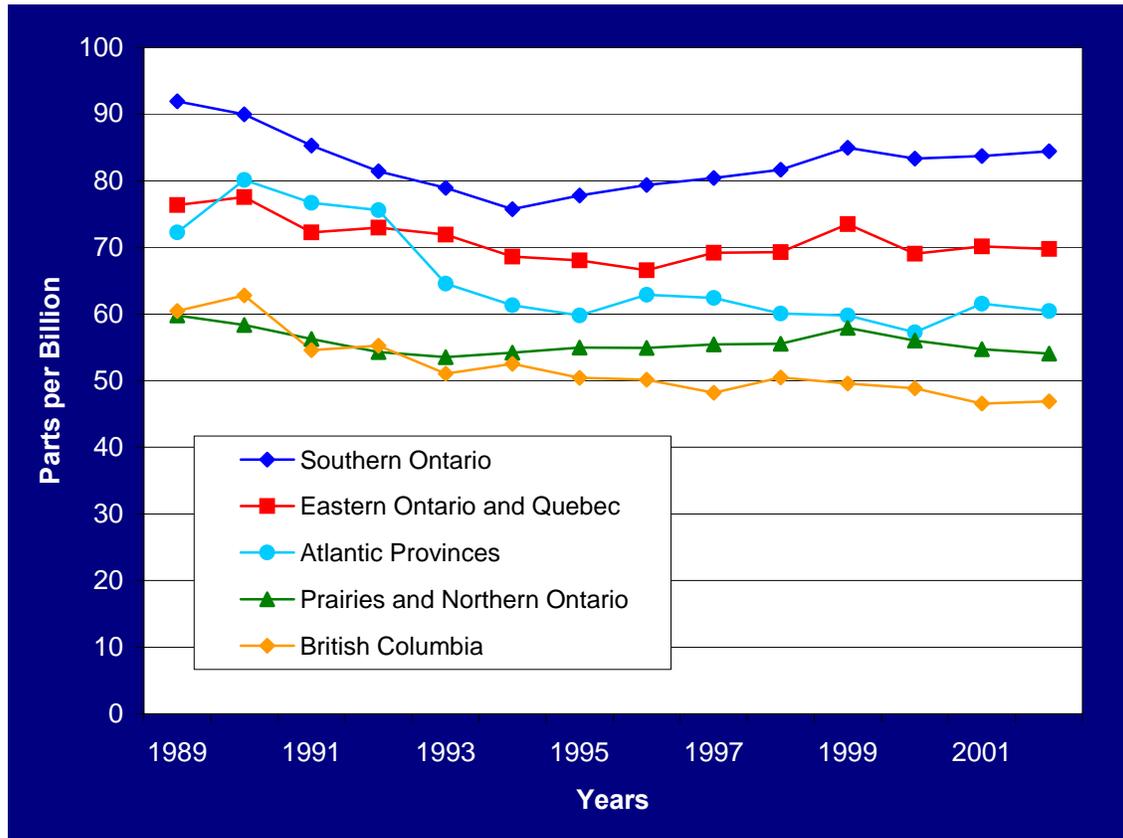
In Canada, the ability to adequately model the spatial dispersion of specific air pollutants and to link this information to populations in matching areas was not sufficiently developed to present information on the current indicator at this time. Canada is currently reviewing options to address the outdoor air pollution indicator identified in Section 3.1, including an assessment of the national ambient monitoring network. In the interim, Canada presents information based on data collected at ambient monitoring stations.

Chart 3-1 displays **peak levels of ground-level ozone for selected regions of Canada** for the period 1989–2002.

Chart 3-2 illustrates **the number of days in 2002 on which ground-level ozone levels exceeded the Canada-wide Standard** of 65 ppb, for various locales across Canada.

Chart 3-3 presents **the number of days in 2002 on which PM_{2.5} levels exceeded the Canada-wide Standard** of 30 µg/m³ in various locales across Canada.

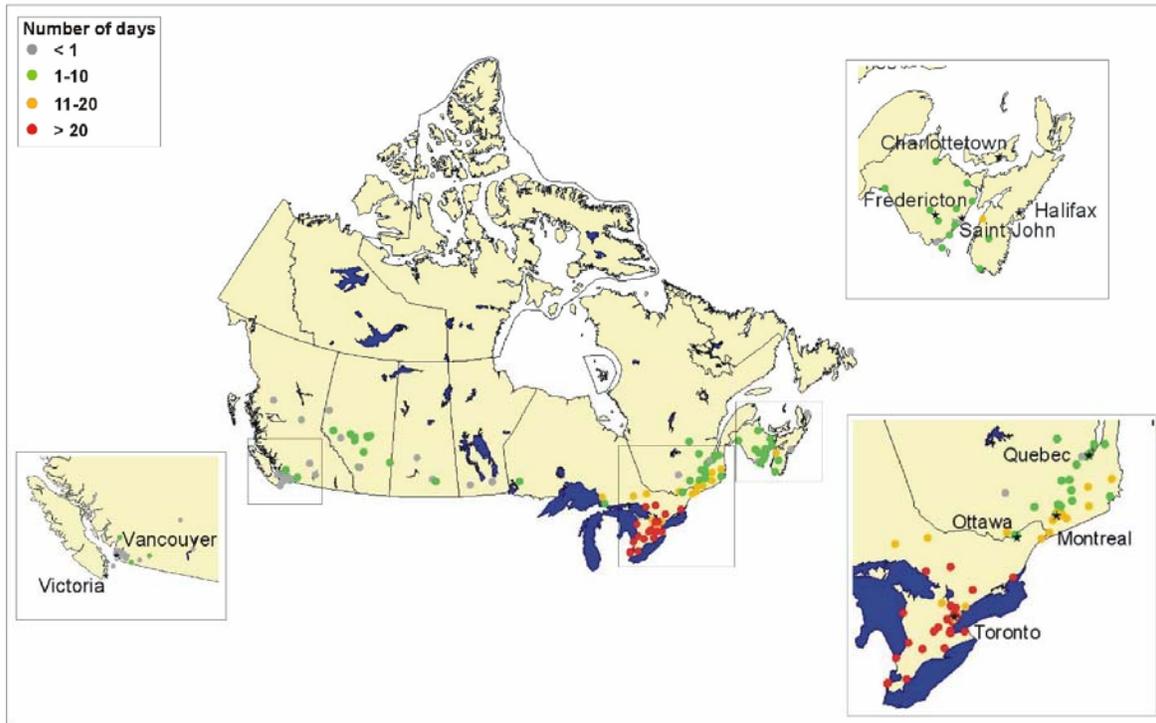
Chart 3-1: Peak Levels of Ground-level Ozone, for Selected Regions of Canada, 1989–2002



Source: National Air Pollution Surveillance Network, Environment Canada.

Note: The yearly values for each station were calculated by averaging the peaks (i.e., four highest measurements over eight hours) for three consecutive years. The yearly values for each station were then averaged for the region.

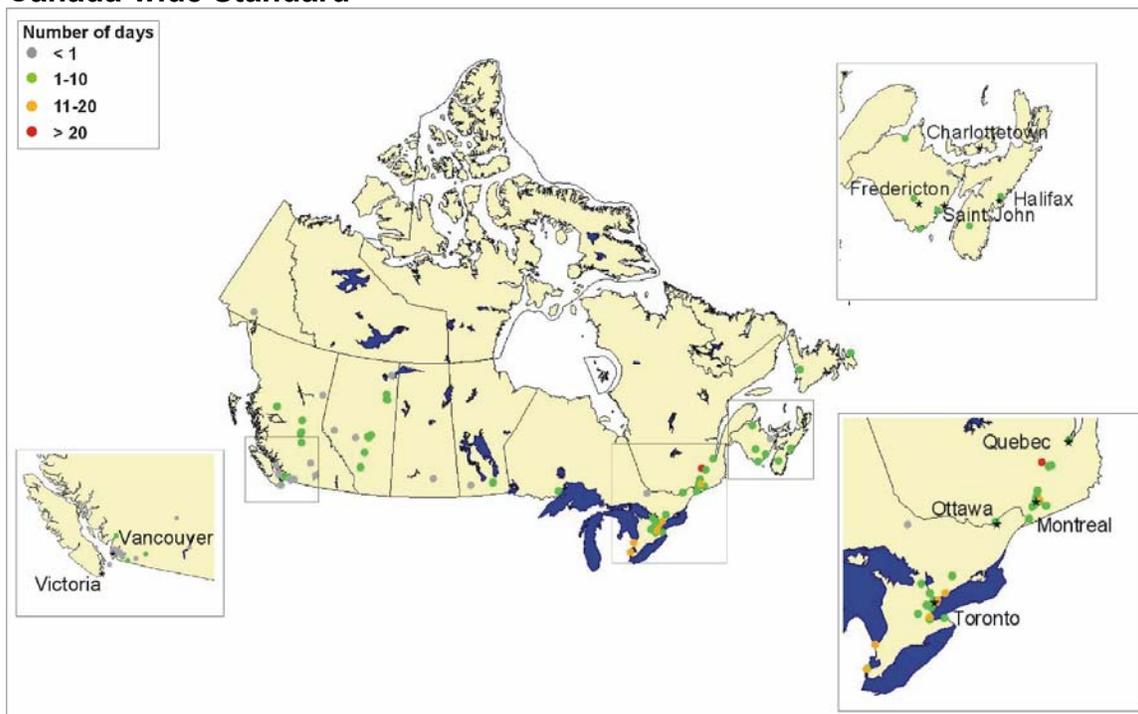
Chart 3-2: Number of Days in 2002 on which Ground-level Ozone Levels Exceeded the Canada-wide Standard



Source: National Air Pollution Surveillance Network Database, Environment Canada (consulted March 2004).

Note: The points represent the number of days on which 8-hour ground-level ozone measurements exceeded the Canada-wide Standard of 65 ppb. The standard comes into force in 2010 and achievement will be measured using three years of data.

Chart 3-3: Number of Days in 2002 on which PM_{2.5} Levels Exceeded the Canada-wide Standard



Source: National Air Pollution Surveillance Network Database, Environment Canada (consulted March 2004).

Note: The points represent the number of days on which 24-hour PM_{2.5} measurements exceeded the Canada-wide Standard of 30 ppb.

Key Observations:

- Although ground-level ozone levels fluctuate from year to year, they have not decreased significantly in the Prairies, Ontario and Quebec over the last 13 years (Chart 3-1).
- Ground-level ozone levels have decreased in British Columbia and the Atlantic provinces (Chart 3-1).
- In 2002, southern Ontario experienced the highest numbers of days on which ground-level ozone levels exceeded the Canada-wide Standard. The number of high-ozone days will fluctuate from year to year, which can partly depend on the occurrence of hot, stagnant weather conditions (Chart 3-2).
- Southern Ontario experiences the highest number of days with elevated PM_{2.5}, followed by the eastern Ontario/southern Quebec region (Chart 3-3).

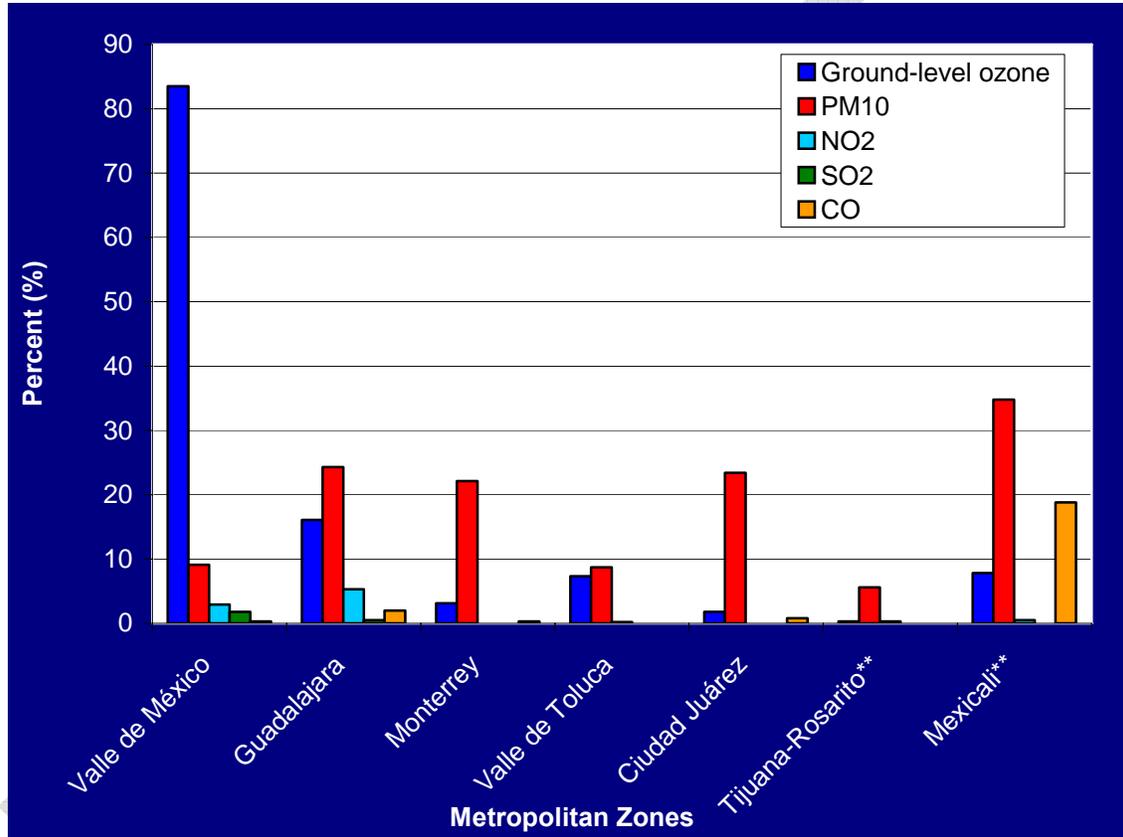
3.1.2 Mexico

Mexico does not currently have the ability to link local air quality monitoring data to population-based data for the corresponding locales. Therefore, Mexico was unable to report the current indicator. Instead, Mexico presents data on the exceedances of its national air quality standards for “common” pollutants in key urban centers.

Chart 3-4 presents the **percentage of days on which the Metropolitan Air Quality Index (Indice Metropolitano de la Calidad del Aire—Imeca) was exceeded in key metropolitan zones during the period 1999–2002**. The Imeca is a 100-point index in which each pollution standard corresponds to a value of 100.

Chart 3-5 illustrates **metropolitan areas with air quality programs including air monitoring**. This chart also presents the Imeca information for ground-level ozone and PM₁₀ for each of the metropolitan areas.

Chart 3-4: Percentage of Days on which the Air Quality Index (Imeca) was Exceeded in Key Metropolitan Areas in Mexico, 1999–2002*

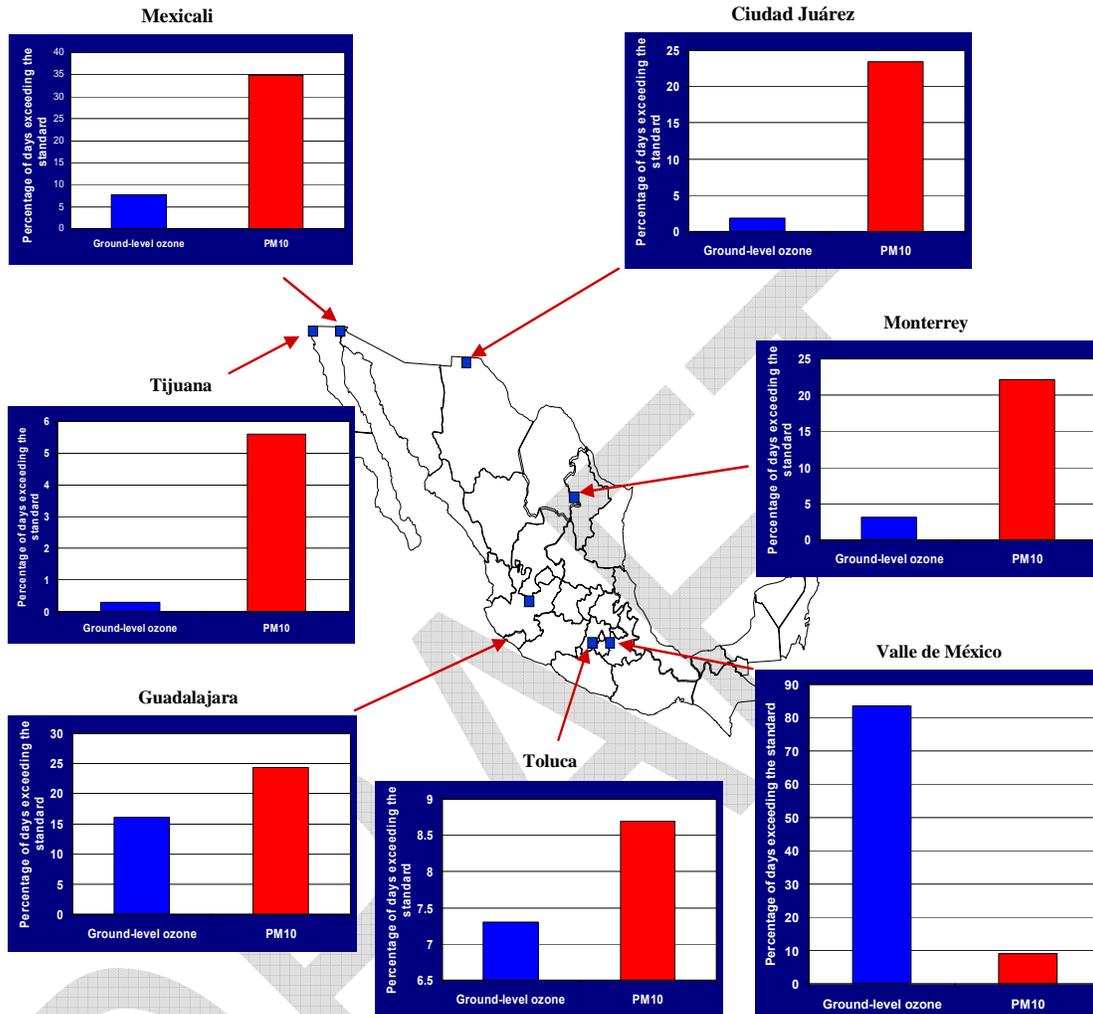


Source: Instituto Nacional de Ecología (INE).

Note: * 4-year arithmetic mean.

** 3-year arithmetic mean, 1997–99.

Chart 3-5: Metropolitan Areas in Mexico with Air Quality Programs Including Air Monitoring, 1999–2002*



Source: *Instituto Nacional de Ecología* (INE). Graphic: Cofepris 2004.

Note: *4-year arithmetic mean; but for Mexicali and Tijuana, 3-year arithmetic mean, 1997–99.

Key Observations:

- The percentage of days for which the Imeca level for suspended particles was exceeded in a number of metropolitan zones was 20 percent or above; for PM₁₀, for example, approximately 35 percent of days were in exceedance in Mexicali, and Guadalajara, and in Ciudad Juárez and Monterrey, the daily percentage of exceedance topped 20 percent (Chart 3-4).
- The daily percentage of exceedance for ground-level ozone was over 80 percent in the Mexico City Metropolitan Zone (MCMZ) (Chart 3-4).
- In Mexicali, approximately 35 percent of days were in exceedance for PM₁₀ and 19 percent of days were in exceedance for carbon monoxide levels (Chart 3-4).

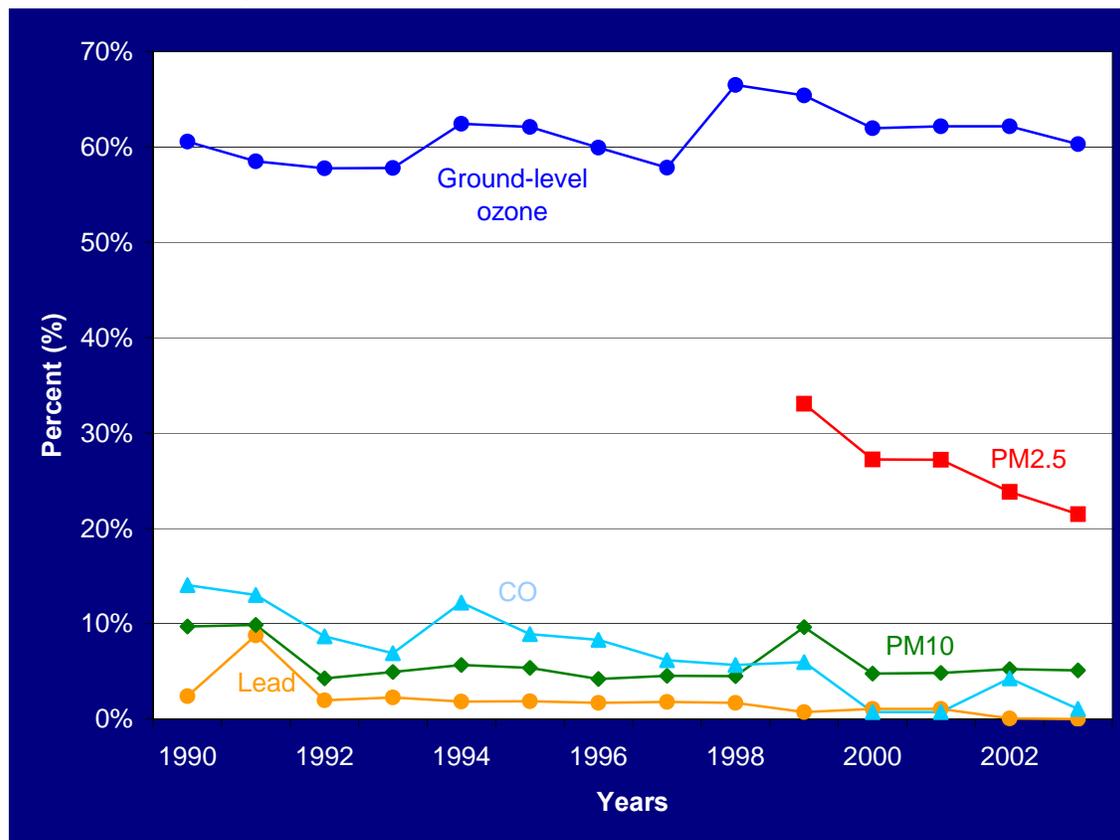
- A number of metropolitan zones have air quality monitoring programs. Daily percentages of exceedences for the Imeca level for particulate matter were above 20 percent in Mexicali, Guadalajara, Ciudad Juárez and Monterrey. Daily ozone exceedence percentages were more than 80 percent in Valle de México (Chart 3-5).

3.1.3 United States

The United States reports the current indicator by using EPA air quality data from counties with monitors across the United States as compared to the National Ambient Air Quality Standards (NAAQS). The indicator shows the percentage of children living in counties where any of the standards was exceeded at any time during the year. These children may be exposed to poor daily air quality at some point during a year. The measure includes air quality data for ozone, particulate matter, lead, and carbon monoxide (nitrogen dioxide and sulfur dioxide had essentially no exceedences). This measure does not differentiate between counties in which the indicators are exceeded frequently or by a large margin, and counties in which indicators are exceeded only rarely or by a small margin.

Chart 3-6 presents the **percentage of children living in counties in which air quality standards were exceeded** for 1990–2003. The measure indicates whether the level of any standard was exceeded at any time during a year. This measure does not differentiate between counties in which the indicators are exceeded frequently or by a large margin and counties in which indicators are exceeded only rarely or by a small margin.

Chart 3-6: Percentage of Children Living in Counties in the United States in which Air Quality Standards were Exceeded, 1990–2003



Source: US EPA 2003. *America's children and the environment: Measures of contaminants, body burdens, and illnesses*. <www.epa.gov/envirohealth/children>.

Data Source: US EPA, Office of Air and Radiation, Aerometric Information Retrieval System

Note: It should be noted that this measure is slightly different from the air quality standard used by EPA to identify areas that must develop plans to lower air pollution levels. For example, for ozone, the standard for developing plans is based on the day with the fourth highest eight-hour average ozone concentration.

Key Observations:

- The highest number of exceedances is consistently reported for ground-level ozone. In 1990, approximately 61 percent of children lived in counties in which the eight-hour ozone standard was exceeded on at least one day per year. In 2003, approximately 60 percent of children lived in such counties (Chart 3-6).
- In 1999, approximately 33 percent of children lived in counties that exceeded the annual PM_{2.5} standard. In 2003, approximately 21 percent of children lived in such counties. The standard for particulate matter was revised in 1997 to include PM_{2.5}. The standard is intended to protect against both short-term and long-term health effects (Chart 3-6).
- In 1990, approximately 14 percent of children lived in counties in which the carbon monoxide standard was exceeded. In 2003, approximately 1 percent of children lived in such counties (Chart 3-6).

- From 1990 to 2001, the percentage of children living in counties that exceeded the one-day standard for PM₁₀ fluctuated, but was as high as 10 percent in 1990, 1991, and 1999. The percentage remained around 5 percent during 2000–2003 (Chart 3-6).
- In 1990, about 2 percent of children lived in counties that exceeded the three-month standard for lead. In 2003, only one county had lead measurements that exceeded the standard for lead (Chart 3-6).
- Few exceedances of the sulfur dioxide and nitrogen dioxide standards have occurred since 1993. Consequently, they were not included on the graph (Chart 3-6).

3.1.4 Opportunities for Strengthening Indicators of Outdoor Air Pollution in North America

All of the indicators for outdoor air pollution rely on ambient air quality monitoring for national data. Only the United States was in a position to combine population data with air quality monitoring data to report the percentage of children that are exposed to degraded air quality. The following opportunities were identified for future improvement:

- Determining the percentage of children living in areas where air pollution levels exceed relevant air quality standards requires a more common understanding of the relationship between population and air quality monitors among the three countries.
- The ability to identify the specific geographic areas of high pollutant levels (e.g., along main transportation corridors or downwind from pollutant sources), would improve our ability to identify potential populations at risk.
- The percentage of children living in areas where air pollution levels exceed relevant air quality standards does not provide a complete measure of the degree of exposure for the population. For example, the indicator does not tell the user where the highest rates of exceedance for multiple pollutants occur, nor does it reveal how high the pollution was above the standard. Future efforts could attempt to provide more information relative to the intensity of local/regional exceedances.
- Future efforts to improve the utility of this indicator could include linking of ambient concentrations of air pollutants with health outcomes. This could include links with health outcome data such as emergency room visits and admissions for respiratory and other related illnesses, school absenteeism and medication usage.
- There is a need to improve the understanding of the chemistry of pollutants in the atmosphere, their migration and the health effects associated with aggregate exposure to multiple air pollutants in children (Canada, Environment Canada 2005).
- The ideal indicator would provide for consistent measures across all three countries over a reasonable time period (e.g., 10 years) so that trends could be monitored. The indicator would provide information that was nationally relevant to all children within a country while providing detail on the situation in various subpopulations according to their race/ethnicity, economic status, and specific geographic locales.
- These outdoor air indicators reflect only a few of the pollutants of concern to children's health. There are other air pollutants of concern to children's health that could be included in future indicators work.

3.2 Indoor Air Pollution

Purpose: This indicator provides information on children's potential exposures to indoor air pollution, with a focus on environmental tobacco smoke and emissions from the burning of biomass fuels.

CEC Council target indicator: "Indoor air quality."

Current indicator: Indoor air quality: Measure of children exposed to environmental tobacco smoke (Canada, United States); measure of children exposed to emissions from the burning of biomass fuels (Mexico).

Children who are exposed to environmental tobacco smoke (ETS) indoors are at increased risk of adverse health effects. Exposure to ETS⁶ is associated with an increased risk for bronchitis, pneumonia, lower respiratory tract infections, otitis media (fluid in the middle ear), and sudden infant death syndrome (SIDS) (President's Task Force on Environmental Health Risks and Safety Risks to Children 2000a, US EPA 2003, Health Canada 2005). Furthermore, ETS is one of the irritants known to trigger asthma attacks and plays a role in the development of asthma (US EPA 2003). Other contributions to the cause and exacerbation of asthma remain the subject of ongoing research.

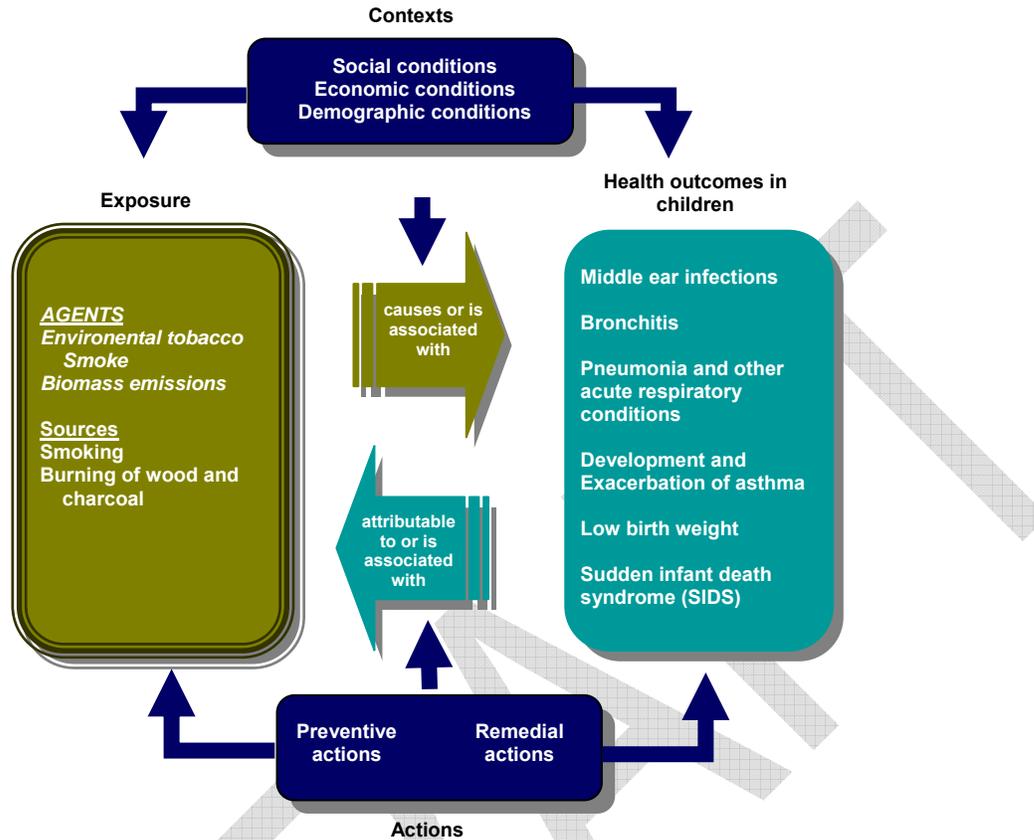
Children who are exposed to biomass emissions from the burning of wood are also at risk for a number of health effects. These may include susceptibility to sinus and respiratory infections, bronchitis, exacerbation of asthma, and decreased lung function (California Air Resources Board 2005). The World Health Organization notes that "there is consistent evidence that exposure to indoor air pollution can lead to acute lower respiratory infections in children under five" (World Health Organization 2005a). Indoor smoke contains a number of pollutants associated with potential health effects, including: particles (complex mixtures of chemicals in solid form and droplets), carbon monoxide, nitrous oxides, sulphur oxides (mainly from coal), formaldehyde and carcinogens (chemical substances known to increase the risk of cancer) such as benzo[a]pyrene and benzene (World Health Organization 2005b). Indoor air pollution in homes, caused by the burning of firewood or charcoal for cooking, is a public health problem in Mexico (see Mexico's Country Report).

Other pollutants of concern that may be found in North American homes include PM_{2.5}; dusts and allergens such as pet dander; moulds; gases and aerosols from consumer products such as cleaners and furniture polishes; pesticides; and other gases and vapors associated with combustion sources in the home. Outdoor air pollution that finds its way into the home is another source of pollution.

As the MEME model in Figure 3 indicates, the measures for indoor air pollution present surrogate exposure measures of the percentage of children exposed to ETS in their homes in Canada and the United States, and fugitive emissions from the burning of biomass indoors in Mexico. The United States also provides an additional measure of exposure with blood cotinine levels (cotinine is a breakdown product of nicotine and is a marker for recent exposure to ETS) (US EPA 2003). Blood cotinine provides a marker of exposure to ETS from all exposure sources, including exposure to ETS in the home and in public places.

⁶ Canada refers to fugitive emissions associated with smoking as "second-hand smoke" (SHS) Mexico refers to fugitive emissions associated with smoking as "passive smoke."

Figure 3: MEME Framework for Issues Covered in the Section on Indoor Air Pollution



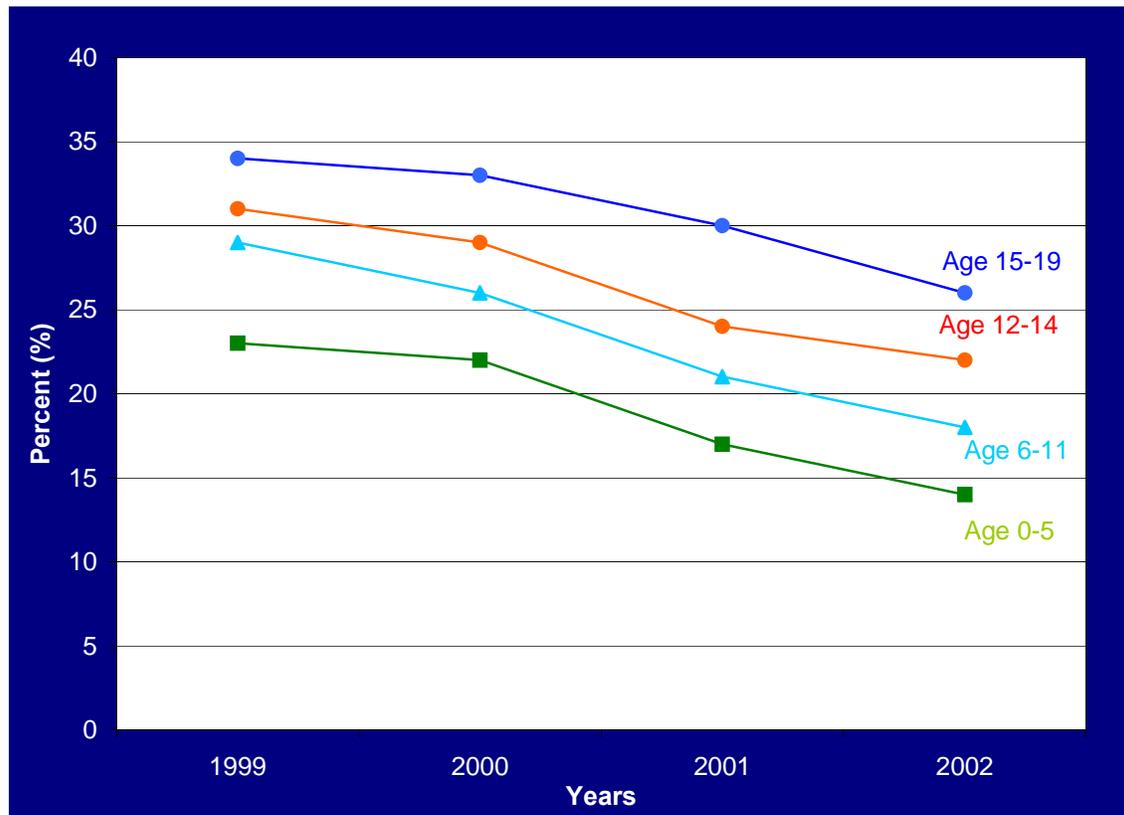
Source: Adapted from Briggs 2003.

3.2.1 Canada

Canada addresses the current indicator by using data obtained from the Canadian Tobacco Use Monitoring Survey (CTUMS) Report and the National Population Health Survey (NPHS).

Chart 3-7 shows the **percentage of children exposed to environmental tobacco smoke in Canadian homes**, for ages zero to five years, six to 11 years, 12 to 14 years, and 15 to 19 years.

Chart 3-7: Percentage of Children Exposed to Environmental Tobacco Smoke in Canadian Homes, by Age Groups, 1999–2002



Source: Canadian Tobacco Use Monitoring Survey (CTUMS) Report and the National Population Health Survey

Key Observations:

- Generally, the percentages of children (in all four age categories: zero to five, six to 11, 12 to 14, and 15 to 19) exposed to ETS in Canadian homes is decreasing (Chart 3-7).
- In 2002, more than one in four children aged 15 to 19 years were exposed to tobacco smoke in the home (Chart 3-7).
- Approximately 14 percent of infants and young children (aged zero to five years) were exposed in 2002, down from 23 percent in 1999 (Chart 3-7).
- It is also evident that for all four years, (1999–2002) exposure to ETS was highest among children aged 15 to 19 years and lowest among those aged zero to five years (Chart 3-7).

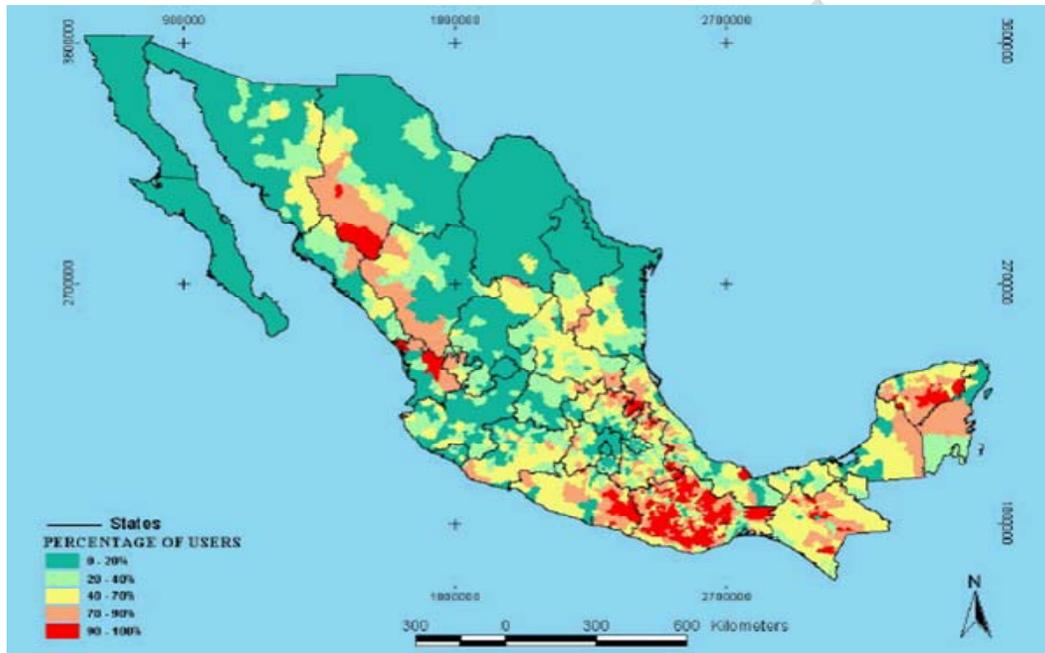
3.2.2 Mexico

Mexico reports on the current indicator by providing information on the use of biomass fuels, which includes wood and charcoal, at the municipal level in Mexico. Data on the percentage of children exposed to environmental tobacco smoke in Mexican households is not available. However, environmental tobacco smoke is recognized as a significant public health threat in Mexico. Mexico, therefore, provides data on smoking prevalence in urban and rural populations,

as well as survey data of smoking percentages of urban adolescents, in its country report (see Mexico's Country Report).

Chart 3-8 is a map of the geographical distribution of the percentage of total households of **fuel wood users, at the municipal level, in Mexico.**

Chart 3-8: Percentage of Fuel Wood Users, at the Municipal Level, in Mexico, 2000



Fuente: Food and Agriculture Organization of the United Nations. 2003

Source: Food and Agriculture Organization of the United Nations 2003.

Key Observations:

- The heaviest biomass usage is in southern Mexico and north central Mexico, where areas of 90–100 percent utilization may be found in some locales. These are largely rural states with some of Mexico's poorest populations (see Mexico's Country Report) (Chart 3-8).

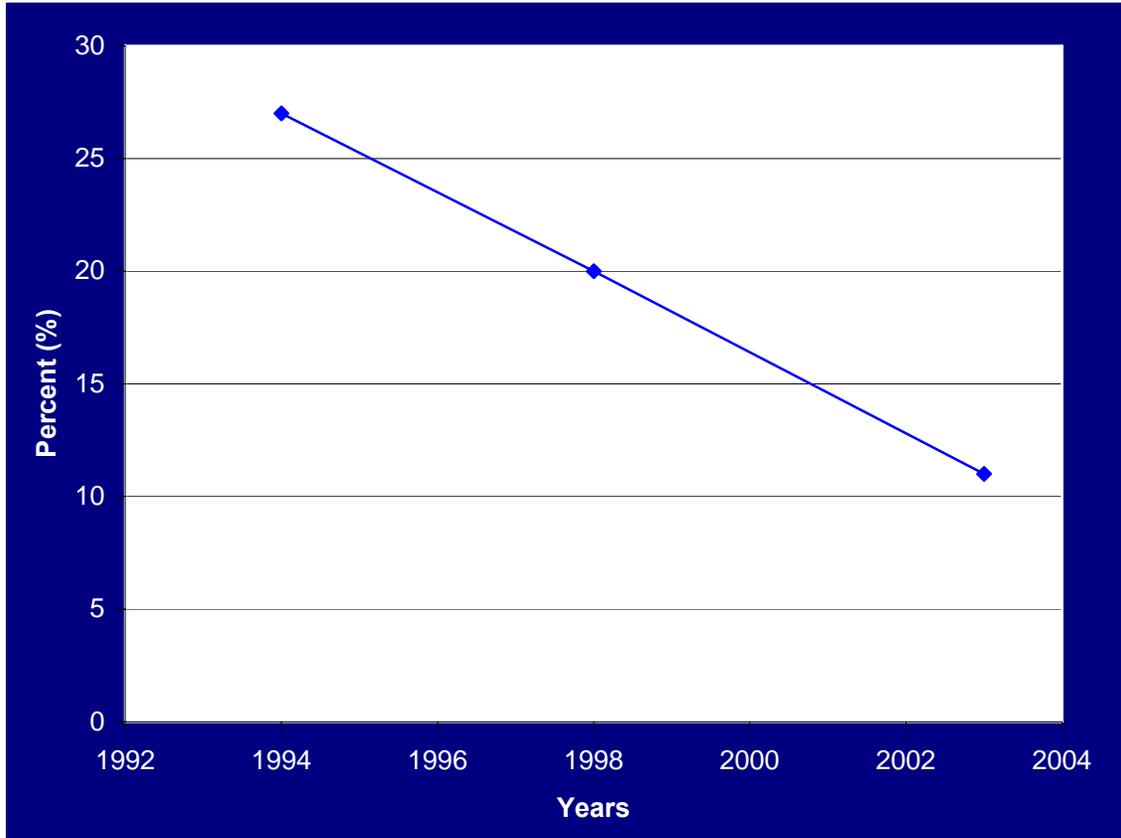
3.2.3 United States

The United States presents several measures of ETS exposure in children to fulfill the current indicator. National surveillance data, which are collected annually, provide information on smoking in the home, where children are present. The United States also has included an additional indicator, serum cotinine, which is a bio-marker for ETS exposure.

Chart 3-9 shows the **percentage of children aged six and under who are regularly exposed to environmental tobacco smoke in US homes**, for the years 1994–2003.

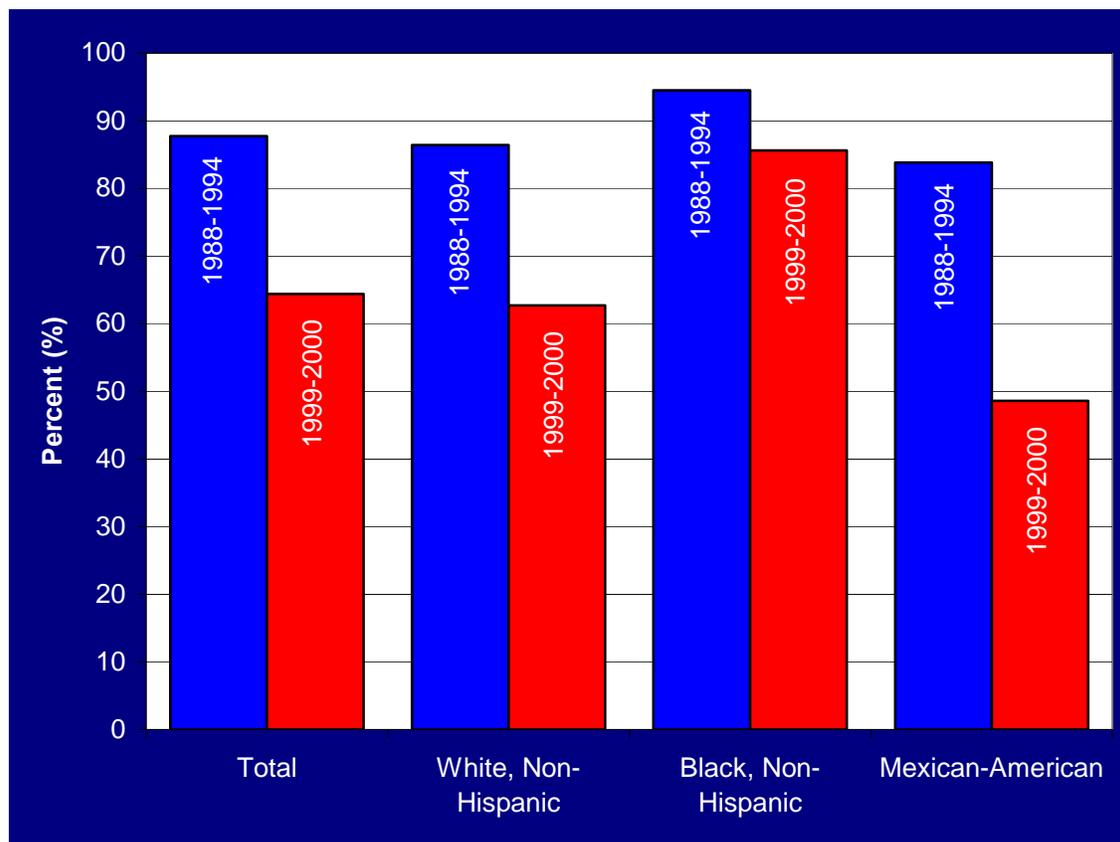
Chart 3-10 shows the percentage of children aged four to 11 with detectable levels of blood cotinine, by race and ethnicity, in the United States for the periods 1988–94 and 1999–2000.

Chart 3-9: Percentage of Children Aged Six and Under Regularly Exposed to Environmental Tobacco Smoke in US Homes, 1994–2003



Source: Data for 1994 and 1998: National Health Interview Survey. National Center for Health Statistics, Centers for Disease Control and Prevention. Data for 2003: National Survey on Environmental Management of Asthma and Children's Exposure to Tobacco Smoke. United States Environmental Protection Agency Indoor Environments Division.

Chart 3-10: Percentage of Children Aged Four to 11 with Detectable Levels of Blood Cotinine, by Race and Ethnicity, in the United States, 1988–94 and 1999–2000



Source: National Health and Nutrition Examination Survey. National Center for Health Statistics, Centers for Disease Control and Prevention.

Note: Cotinine is detectable at or above 0.05 nanograms per milliliter (ng/mL) in both the 1988–94 and the 1999–2000 data sets.

Key Observations:

- The percentage of children ages six and under who are regularly exposed to environmental tobacco smoke in the home decreased from 27 percent in 1994 to 20 percent in 1998 and 11 percent in 2003 (Chart 3-9).
- In 1999–2000, the median levels of cotinine in children aged three to 11 and 12 to 19 were more than twice the median levels in non-smoking adults. (Data not shown; see the Centers for Disease Control and Prevention, 2003, *Second National Report on Human Exposure to Environmental Chemicals*, <<http://www.cdc.gov/exposurereport/>>.)
- The percentage of children exposed to environmental tobacco smoke, as indicated by presence of detectable blood cotinine levels, dropped between the periods 1988–94 and 1999–2000. Overall, 64 percent of children ages four to 11 had cotinine in their blood in 1999–2000, down from 88 percent in 1988–94 (Chart 3-10).

- In 1999–2000, 86 percent of Black, non-Hispanic children ages four to 11 were exposed to environmental tobacco smoke, compared with 63 percent of White, non-Hispanic children and 49 percent of Mexican American children (Chart 3-10).

3.2.4 Opportunities for Strengthening Indicators of Indoor Air Pollution in North America

Exposure to environmental tobacco smoke and biomass emissions are important environmental indicators for child health because of the substantive health risks associated with these sources of indoor air pollution. A number of indicators have been presented, as well as suggestions to improve the quality and comparability of the indicators for future reports.

- Different time frames and age groups have been used to reflect household exposure to environmental tobacco smoke (Canada and the United States) and biomass emissions (Mexico). Use of standard age groups and time periods would improve subsequent reports and provide better comparability of results.
- Some of the surveillance activities (e.g., national surveys) are not annual events, thus it would be helpful to look for the most comprehensive sample period, as well as make efforts to synchronize future survey periods.
- Biomonitoring data (e.g., blood cotinine levels) provide an excellent source of information that can augment data obtained by surveys. Biomonitoring of blood cotinine levels in Canada and Mexico would provide additional information on exposure to environmental tobacco smoke.
- The need for better monitoring of exposure to environmental tobacco smoke during the age bracket birth-to-three-years was identified. This is an important area for improvement, given the concerns over the susceptibility of infants.
- Cotinine levels in the United States, by race and ethnicity, and indoor biomass use in Mexico, by municipality, suggest that in these two countries' socio-economic conditions are important factors influencing exposure to environmental tobacco smoke and fugitive emissions from biomass use. These indicators suggest that increased attention should be paid to subpopulations at risk in future reporting efforts.
- The focus on environmental tobacco smoke and biomass emissions present two priority indoor air issues, however there are numerous other indoor pollutants of concern. Future efforts could develop indicators for other sources of indoor air pollutants such as consumer products and radon, particularly those most likely to impact children. Additionally, other indoor environments frequented by children, such as day-care centers and schools, could be included in indicators reporting.

3.3 Asthma

Purpose: This indicator tracks asthma in children.

CEC Council target indicator: "Prevalence of asthma in children."

Current indicator: Prevalence of asthma in children.

Asthma is a chronic inflammatory disease of the lungs that affects millions of children and adults in North America (National Institutes of Health 1997). It is a major cause of child hospitalization and is the most common chronic disease of childhood in North America. Asthma can produce wheezing, difficulty in breathing, and chest pain, (US EPA 2003) symptoms that can be triggered and exacerbated by numerous environmental factors. Thus, children with asthma are considered to be among the most sensitive to the respiratory effects of air pollution (US EPA 2003). Many children and family members suffer from poor quality of life associated with asthma and asthma-related morbidities. Children with severe and uncontrolled asthma have to reduce their levels of physical activity and require regular and heavy use of medications to effectively manage their asthma.

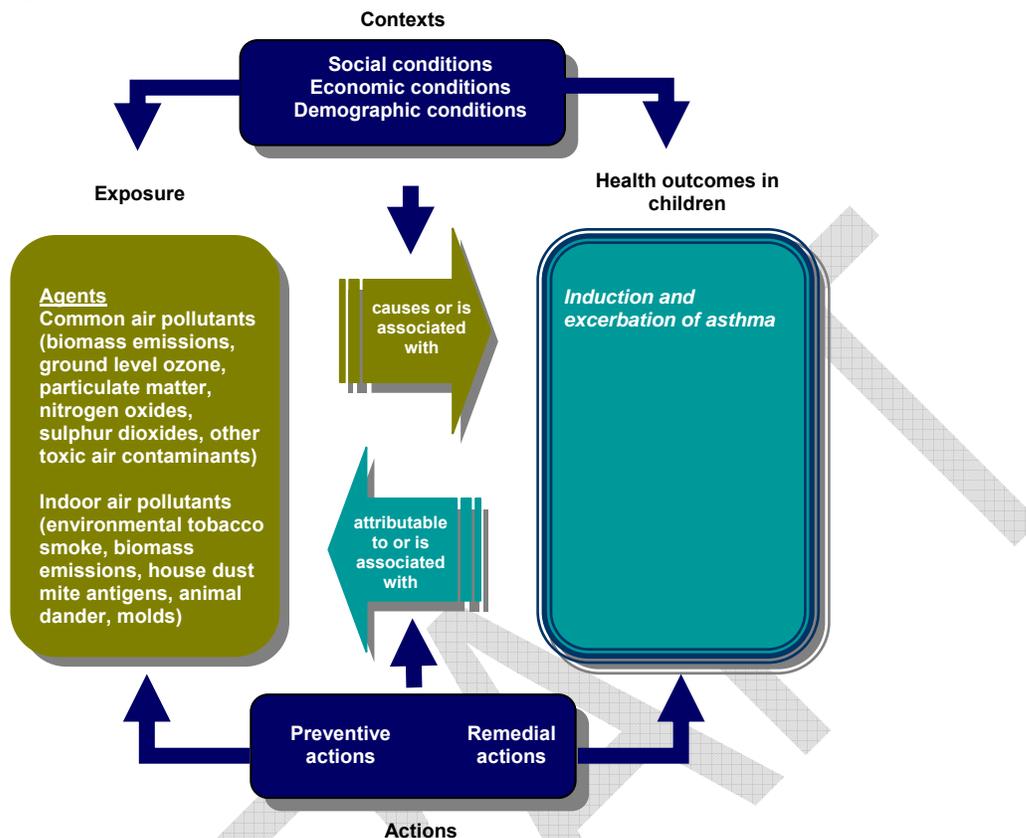
While the prevalence of asthma varies in North America, it has been noted that its prevalence among children has been increasing for several decades. In some regions of North America there has been a four-fold increase in asthma prevalence in the last 20 years. The increase in the prevalence of asthma represents a tremendous human and economic burden for millions of children and adults in North America (President's Task Force on Environmental Health Risks and Safety Risks to Children 2000b).

The exact cause of asthma in children is unknown, (President's Task Force on Environmental Health Risks and Safety Risks to Children 2000b) but it appears to be the result of a complex interaction of many factors (see Canada's Country Report):

1. **Predisposing factors**, such as atopy—a tendency to have an allergic reaction to foreign substances.
2. **Environmental causal factors**, such as indoor air pollutants (e.g., environmental tobacco smoke and house dust mite antigen) and outdoor air pollutants (e.g., ground-level ozone).
3. **Aggravating factors**, which increase the frequency and/or severity of asthma episodes and include environmental tobacco smoke, certain indoor air allergens, outdoor air pollutants, including PM and ground-level ozone, and respiratory infections.

While heredity plays a role in the development of asthma; it alone cannot adequately explain the large increase in asthma prevalence (US EPA 2003). Research into the causes of asthma have identified factors in the environment as being important to the frequency and severity of asthma episodes. More recent evidence suggests environmental exposures such as smoking (or environmental tobacco smoke) and poor air quality are attributed to pro-inflammatory effects and airway remodeling (Black and Johnson 2002). A long-term study investigating the chronic effects of air pollution on children's health identified an association between outdoor air pollutants and the development of the disease among healthy children (Peters et al. 2004). There is growing evidence that exposure to dust mite antigen and environmental tobacco smoke in very young children can cause development of new-onset asthma. Other indoor pollutants such as nitrogen dioxide, pesticides, plasticizers, and volatile organic compounds may play a role in the development of the disease (US EPA 2003). Some pollutants may cause the development of asthma, and precipitate wheezing and coughing episodes in asthmatic children (Schwartz 2004).

Figure 4: MEME Framework for Issues Covered in the Section on Asthma



Source: Adapted from Briggs 2003.

Asthma is known for its disproportionate burden on certain populations (US EPA 2003). For example, lower-income inner city populations are at greater risk to develop asthma because of sub-optimal levels of care and control and because they may have higher exposures. Therefore, lower-income inner city populations may suffer more from morbidities associated with the disease.

In Mexico, it has been reported that the residents of coastal states are more likely to exhibit asthma. Researchers have speculated that this may be due to the high ambient humidity, where dust in homes has a higher probability of entering the respiratory tract in the form of suspended particles. The higher prevalence of asthma in these regions has also been attributed to the use of air conditioning systems, which harbor a large quantity of dust and moulds that can trigger asthmatic episodes (see Mexico's Country Report).

Asthma is a complex disease. Diagnosing asthma is often a challenge in infants, where bronchiolitis, is common in children under six years of age, who may have common wheezing disorders that may not be associated with asthma. Clinical diagnosis of asthma in young children is often based on reported risk factors, symptoms, and response to medications. Therefore, the clinical definitions of asthma may vary between countries. As well, the surveillance techniques used in identifying asthmatics vary amongst countries. For example, as of 1997 the US National Health Interview Survey began differentiating between those children who may no longer have asthma and those whose asthma is well controlled. Based on these differences, the indicators

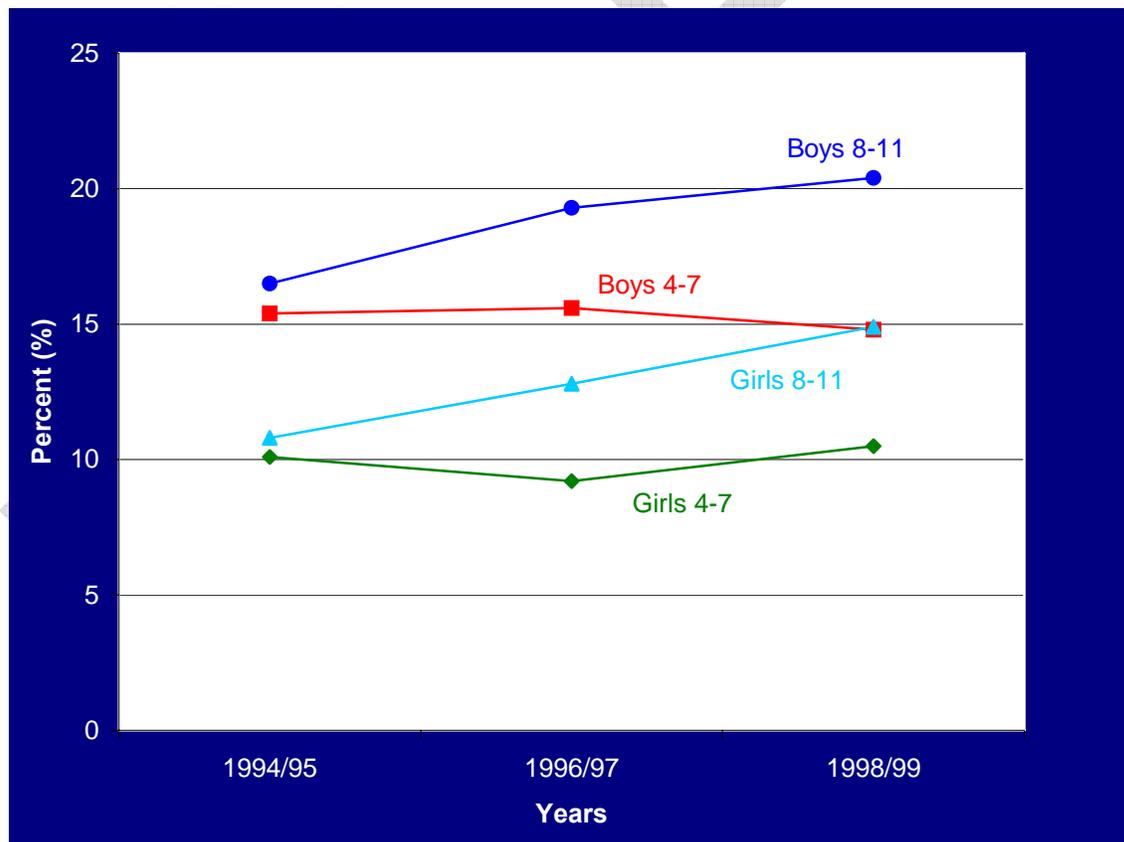
presented should be interpreted with caution and comparisons between countries should be avoided.

3.3.1 Canada

Canada reports on the percentage of children who have been diagnosed with asthma by their physician. This information is provided through the National Longitudinal Survey of Children and Youth, which poses questions to parents on the health of their children. The survey provides data on the percentage of children who have reported a diagnosis of asthma. Since it is difficult to differentiate in the survey those with other respiratory conditions (such as wheezing) from those with asthma, children under the age of four were excluded from the analyses.

Chart 3-11 presents **prevalence of physician-diagnosed asthma among children**, by age group and by gender, in national survey results for three periods: 1994/1995, 1996/1997 and 1998/1999.

Chart 3-11: Prevalence of Physician-diagnosed Asthma (ever) among Children, by Age Group, in Canada, 1994/1995, 1996/1997 and 1998/1999



Source: Centre for Chronic Disease Prevention and Control, Health Canada, using data adapted from the National Longitudinal Survey of Children and Youth (cross-sectional component), Statistics Canada, 1994–95, 1996–97, 1998–99.

Key Observations:

- Since 1994, asthma prevalence has increased among children (except for boys aged four to seven years) (Chart 3-11).
- Boys of all ages have a higher prevalence of asthma than girls (Chart 3-11).
- Currently, approximately 20 percent of boys aged eight to 11 have been diagnosed with asthma, the highest prevalence group among children (Chart 3-11).

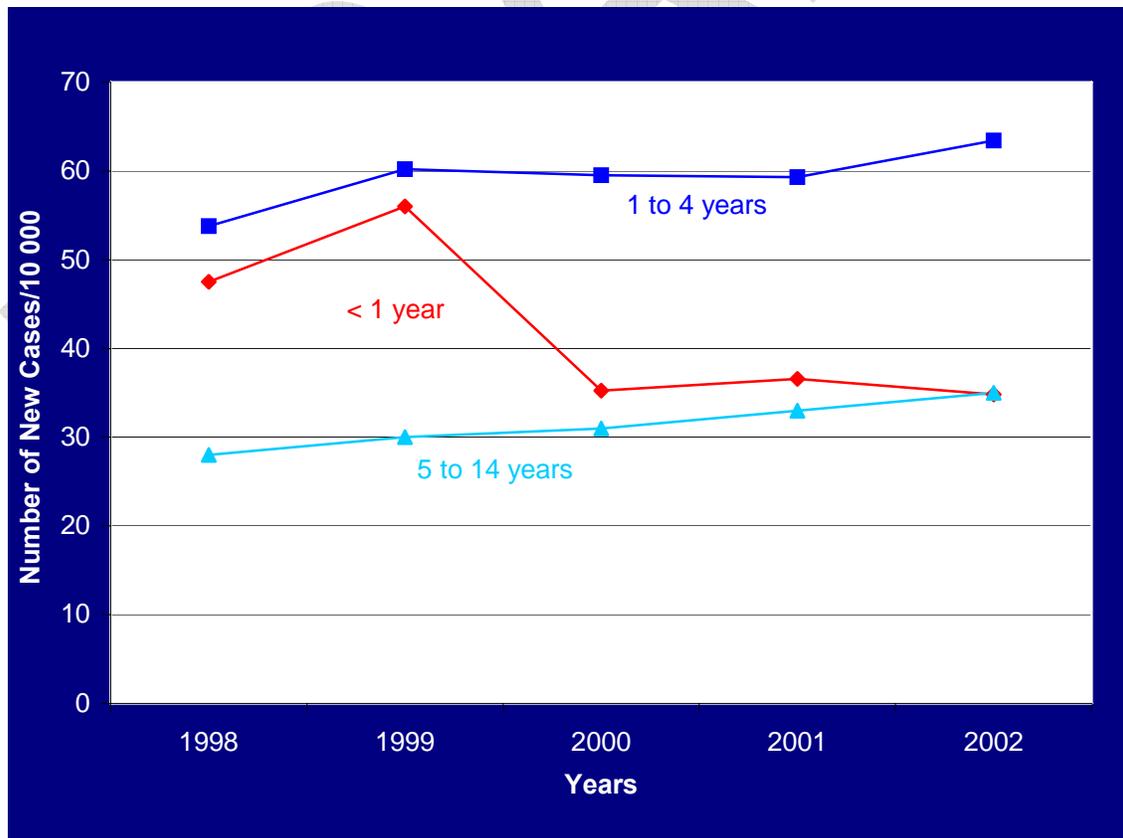
3.3.2 Mexico

Mexico presents data on childhood asthma. Furthermore, Mexico also includes national surveillance data for acute respiratory infections (ARI), a condition that is also associated with exposure to air pollution.

Chart 3-12 depicts the **incidence of asthma** for the age groups of under one, one to four and five to 14 years. Incidence rates were calculated as number of new cases per 10,000 population and were provided for the years 1998 to 2002.

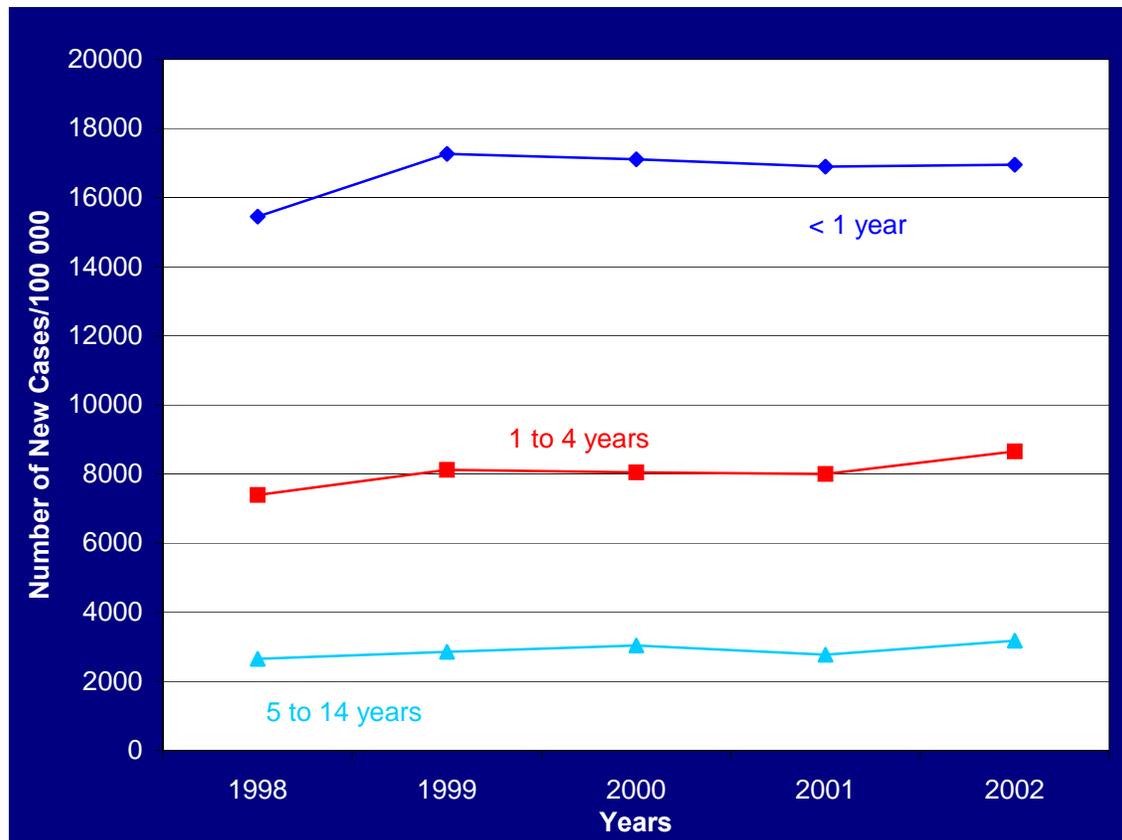
Chart 3-13 depicts **incidence of acute respiratory infections**. This chart provides ARI rates for 1998 to 2002, based on the number of new cases per 100,000 population.

Chart 3-12: Incidence of Asthma among Children, by Age Group, in Mexico, 1998–2002



Source: Epidemiological Information Bulletin 1998–2002, Population projections 1990–2010/Conapo.

Chart 3-13: Incidence of Acute Respiratory Infections (ARI) among Children, by Age Group, Mexico, 1998–2002



Source: Epidemiological Information Bulletin 1998–2002. Population projections 1990–2010/Conapo.

Key Observations:

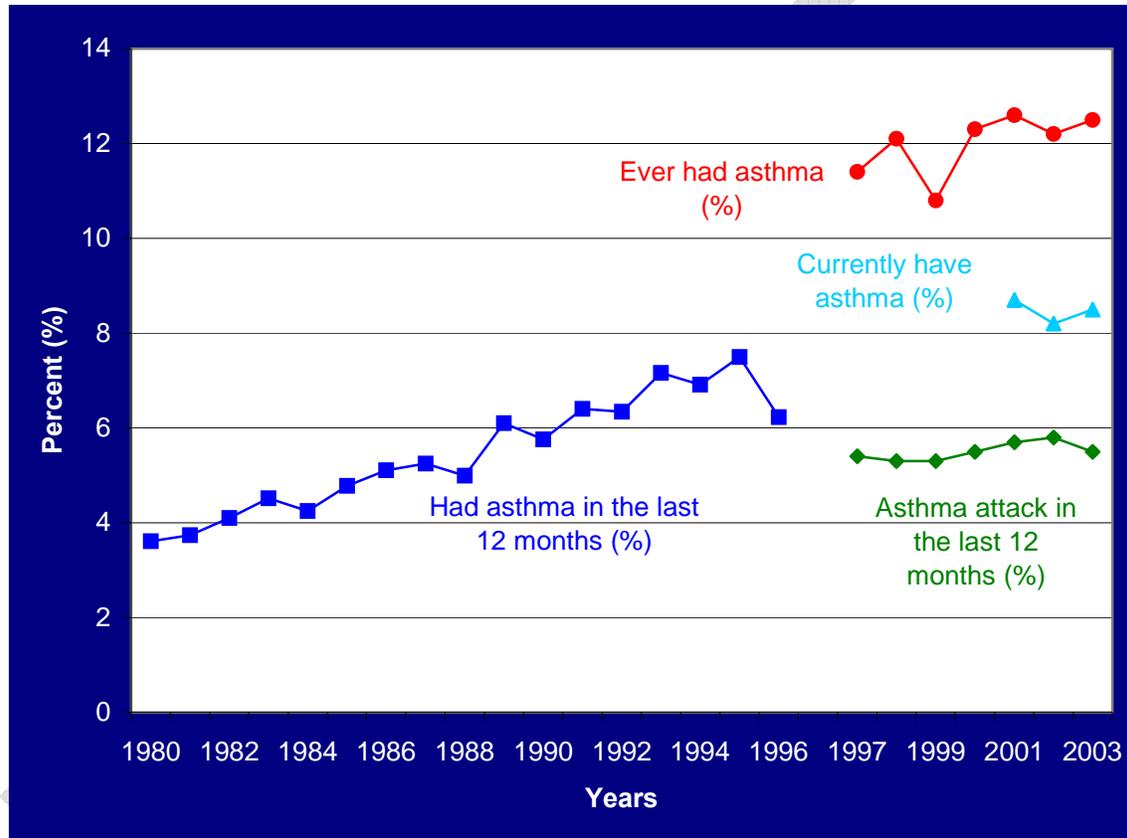
- The highest rates of asthma consistently appear for the group aged one to four years, with a trend of increase, from 54 new cases per 10,000 children in 1998 to 63 new cases per 10,000 children in 2002 (Chart 3-12).
- The asthma incidence rate in children less than 1 year old showed a decline since 2000, and currently remains at 33 new cases per 10,000 population. As opposed to a true change in disease incidence, this decline was directly attributable to a change in the immediate notice form (Epi-1 2000) for medical unit reporting. This occurred due to the difficulty in diagnosing asthma in this age group.
- In the five to 14 age group, the rates have grown slightly, from 28 to 32 new cases per 10,000 children over the sampling period (Chart 3-12).
- For acute respiratory infections (ARI), the most affected population is children below one year of age, with annual new cases averaging 16,000 per 100,000 children. Only in 1998 were fewer new cases reported during this period. Children aged one to four years showed a slight increase in new cases, from 7500 in 1998 to 8100 per 100,000 children in 2002. The lowest rates are observed for children aged five to 14 years (Chart 3-13).

3.3.3 United States

The United States reports on the current indicator by providing national asthma surveillance data obtained through the National Health Interview Survey.

Chart 3-14 shows the **percentage of children with asthma**, taken from annual survey results since 1980. This indicator covers the period 1980 to 2003.

Chart 3-14: Percentage of Children with Asthma, in the United States, 1980–2003



Source: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey.

Note: The survey questions for asthma changed in 1997; data before 1997 cannot be directly compared to data in 1997 or later.

Key Observations:

- In 2003, about 13 percent of children had been diagnosed with asthma at some time in their lives, though some of those children may no longer have asthma (Chart 3-14).
- About 9 percent of children were reported to currently have asthma. These include children with active asthma symptoms and those whose asthma is well-controlled (Chart 3-14).
- Between 1980 and 1995, the percentage of children with asthma (as measured by “children with asthma in past twelve months”) doubled, from 3.6 percent in 1980 to 7.5

- percent in 1995. A decrease in the percentage of children occurred between 1995 and 1996, but it is difficult to interpret single-year changes (Chart 3-14).
- Prior to 1997, the percentage of children with asthma was measured by asking parents if a child in their family had asthma during the previous 12 months. In 1997–2000, a parent was asked if his or her child had ever been diagnosed with asthma by a health professional. If the parent answered yes, then he or she was asked if the child had an asthma attack or episode in the last 12 months. The percentage of children with an asthma attack in the last 12 months measures the population with incomplete control of asthma. For 1997–2000, available data do not distinguish between those children who may no longer have active asthma and those whose asthma is well controlled. In 2001, a question was added to ask the parents if their child currently had asthma (Chart 3-14).
 - Approximately 6 percent of all children had one or more asthma attacks in the previous 12 months. These children have ongoing asthma symptoms that could put them at risk for poorer outcomes, including hospitalizations and death. About two-thirds of children who currently have asthma have on-going asthma symptoms (Chart 3-14).

3.3.4 Opportunities for Strengthening Indicators of Asthma and Respiratory Disease in North America

The prevalence of asthma in all three countries appears to be stable or increasing. However, the specific rate of increase may be confounded by a number of issues related to the definition of the illness and the methods of surveillance. The following suggestions have been made to increase the reliability of data and the comparability of future indicators on asthma prevalence and on the incidence of pneumonia and other forms of acute lower respiratory infection:

- The data periods reported by each country currently differ. Some standardization of reporting periods and definitions would improve future comparability. To achieve a better view of trends, future reports of asthma prevalence could include historical data or narrative that is several decades in duration (e.g., 20–30 years, where possible).
- Changes to definitions (e.g., ever diagnosed vs. active illness) and data collection methods (e.g., Canada and the United States use surveys, while Mexico data are based on physician reporting) have increased the challenges associated with comparing within and between countries. Where possible, the clinical and survey definitions of asthma used by the three countries should be made uniform or at least be described in detail so that variations can be addressed in future reports. Common diagnostic criteria for young children (i.e., aged zero to five) could assist with more consistent diagnosis in an age group where differential diagnosis is difficult. Through the CEC and other fora, the three countries have begun to work together towards more comparable asthma surveillance systems.
- Further efforts of the international community (International Study of Asthma and Allergies in Childhood—ISAAC) to develop globally applicable asthma diagnostics could enhance future comparability of North American indicator efforts with other international asthma initiatives.
- Future research initiatives that collect information on environmental factors that may contribute to the development of asthma and to the triggering and severity of asthma attacks could provide further opportunities for indicator development and analysis.
- Acute lower respiratory infections are most closely correlated to indoor smoke from biomass burning. It would be useful to have acute lower respiratory infections (rather than all respiratory infections) as a separate indicator. Furthermore, this indicator could be broken down by state to synchronize with the biomass fuel use indicator.

4.0 Lead and Other Chemicals, including Pesticides

Children can be exposed to toxic substances from multiple sources or exposure pathways, including air (indoor and outdoor), soil, food, water, building materials, and consumer products. Exposure may result from local sources such as lead-based paint used in homes, local applications of pesticides, nearby industrial emissions, or the use of chemicals in the home. By contrast, some environmental contaminants may originate from activities thousands of miles away, having been transported long distances by wind or water and/or bioaccumulated in the food chains on which humans depend.

The degree of risk varies with the toxicity of the contaminant, the magnitude and duration of the exposure, and the susceptibility of the individual. In some cases the health effects in children are reasonably well understood, as in the case of lead, whereas knowledge of health effects associated with exposure to other toxic substances is still evolving.

Determining the body burden of contaminants such as lead in children and the presence of contaminants in different media with which children may come into contact are important steps in protecting children's health. This chapter provides several indicators, as well as case studies, that present information on the presence of toxic substances in children (i.e., body burden) and in their environments.

Section 4.1 provides a measure of body burden for lead in children (US biomonitoring data—blood lead levels) and presents several case studies in Canada, Mexico and the United States investigating blood lead levels in children and adults. The relationship between the elimination of lead from gasoline and other sources and the decline in children's blood levels is also reviewed.

Section 4.2 presents data on lead in homes. Canada provides data on the percentage of children living in homes with a potential source of lead. The United States presents data on housing units with lead-based paint, lead-contaminated dust, and lead-contaminated soil. These are proxy exposure indicators which provide a measure of potential exposure to lead in the home.

Section 4.3 provides estimated releases of lead emitted from industrial facilities in Canada and the United States. This is an action indicator that presents data and trends for releases of lead to different media from manufacturing sectors.

Section 4.4 provides estimated releases of selected chemicals emitted from industrial facilities in Canada and the United States. This is an action indicator that presents data and trends for releases of selected chemicals to different media and from various sectors.

Section 4.5 presents various indicators on exposure to pesticides. Mexico provides data on pesticide poisonings in children and adults, while the United States and Canada present detectable levels of organophosphate pesticide residues on fruits and vegetables as a proxy exposure indicator.

4.1 Blood Lead Levels

Purpose: This indicator provides information on children's exposure to lead.

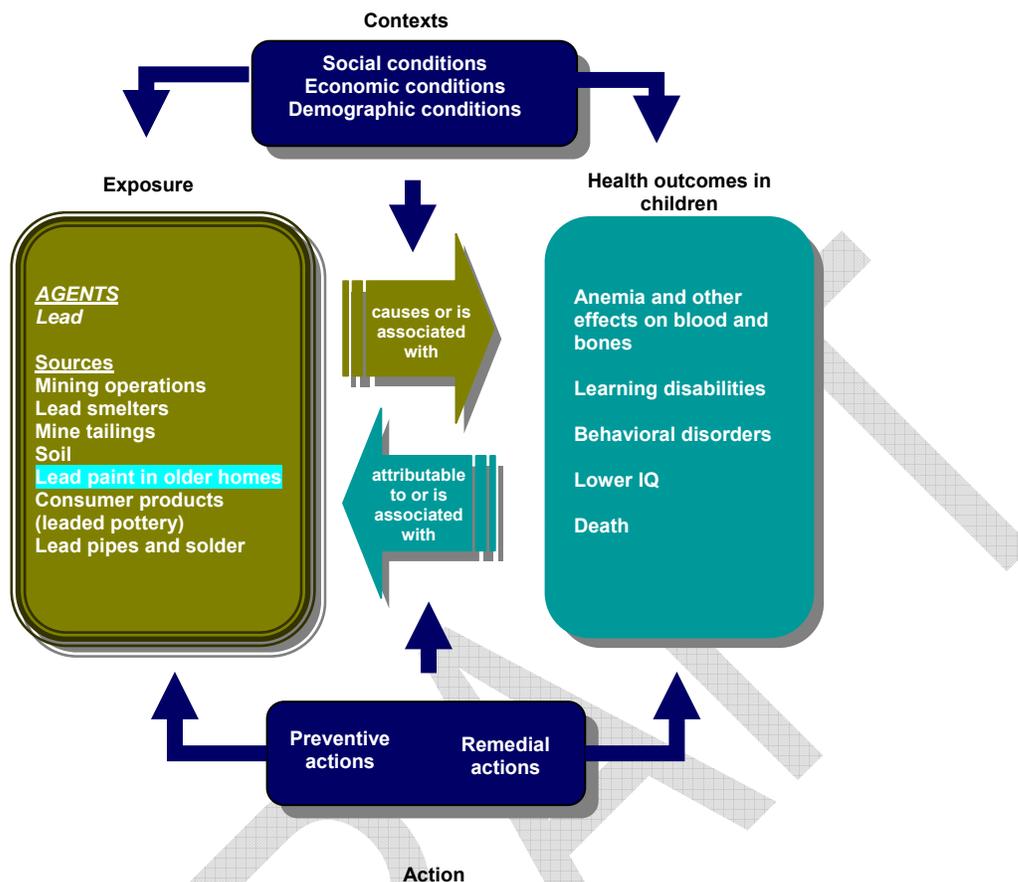
CEC Council target indicator: "Blood lead levels in children."

Current indicator: Blood lead levels in children.

Lead is an environmental contaminant of major concern to children's health. Health effects associated with exposure to lead include, but are not limited to, cognitive deficits, developmental delays, hypertension, impaired hearing acuity, impaired hemoglobin synthesis, and male reproductive impairment. Importantly, many of lead's health effects may occur without overt signs of toxicity. Exposure to lead early in childhood has been shown to contribute to learning disabilities, such as reduced intelligence and cognitive deficits. Other studies have found relationships between exposures to lead and attention problems, hyperactivity, and impulsivity, which are the common behavioral problems of attention deficit hyperactivity disorder (ADHD) (US EPA 2003). In the United States and Mexico a blood lead level of 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$) or greater is considered elevated (Meyers et al. 2003, Mexico, Cofepris Date unknown). It is now recognized that there is no known "safe" blood lead level for children or no level of exposure that is not without some risk of adverse health effects, though the risks are less at lower concentrations (US Environmental Protection Agency 1997).

Children and the developing fetus are more susceptible to the negative effects of lead exposure than adults. Studies suggest that children are most susceptible to the neurological effects of lead in the first three years of life because of the brain development which takes place during this time (US EPA 2003). Children are more efficient than adults at absorbing and retaining some substances such as lead. It has been estimated that children and pregnant women can absorb up to 50 percent of the dietary source of lead, whereas adults absorb 10 percent to 15 percent) (see Canada's Country Report). This means that more lead is available to damage developing organs like the brain (Wigle 2003). Children under the age of six are more likely to be exposed to lead that is present in dust and soils because of hand-to-mouth behavior and a tendency to mouth or eat objects in their environments.

Figure 5: MEME Framework for Issues Covered in the Sections on Blood Lead Levels, Lead in the Home, and Industrial Releases of Lead



Source: Adapted from Briggs 2003.

As the MEME model in Figure 5 illustrates, numerous sources of lead continue to pose risk to children. There have been considerable improvements in the reduction of lead exposure with the elimination of lead from gasoline. Some of the decline in later years was also due to various other management efforts, such as reductions in the number of homes with lead-based paint, reducing lead levels in drinking water, reducing the use of lead in food and beverage containers and/or ceramic ware, and in addressing the lead content in products such as toys, miniblinds, and playground equipment. Several case studies provided by Canada, Mexico and the United States illustrate the strong correlation between the removal of lead from gasoline and decreases in ambient lead levels. In several of the case studies, reductions in children's blood lead levels have been observed.

The US national biomonitoring program for blood lead suggests that despite overall reductions of lead, there are situations where children may continue to be exposed. The US data suggest that children in low-income households are at the greatest risk of being exposed to lead from their environments.

4.1.1 Canada

There is no recent nationally representative survey of blood lead levels in children in Canada, thus Canada has not reported on the current indicator. However, there have been some samplings of blood lead levels conducted in certain regions of the country. The following case study in Ontario reveals that, as lead in gasoline for on-road vehicles was eliminated, children's blood lead levels also declined. While the blood lead level data is not sufficient to present information on a national indicator, it does provide a regional perspective.

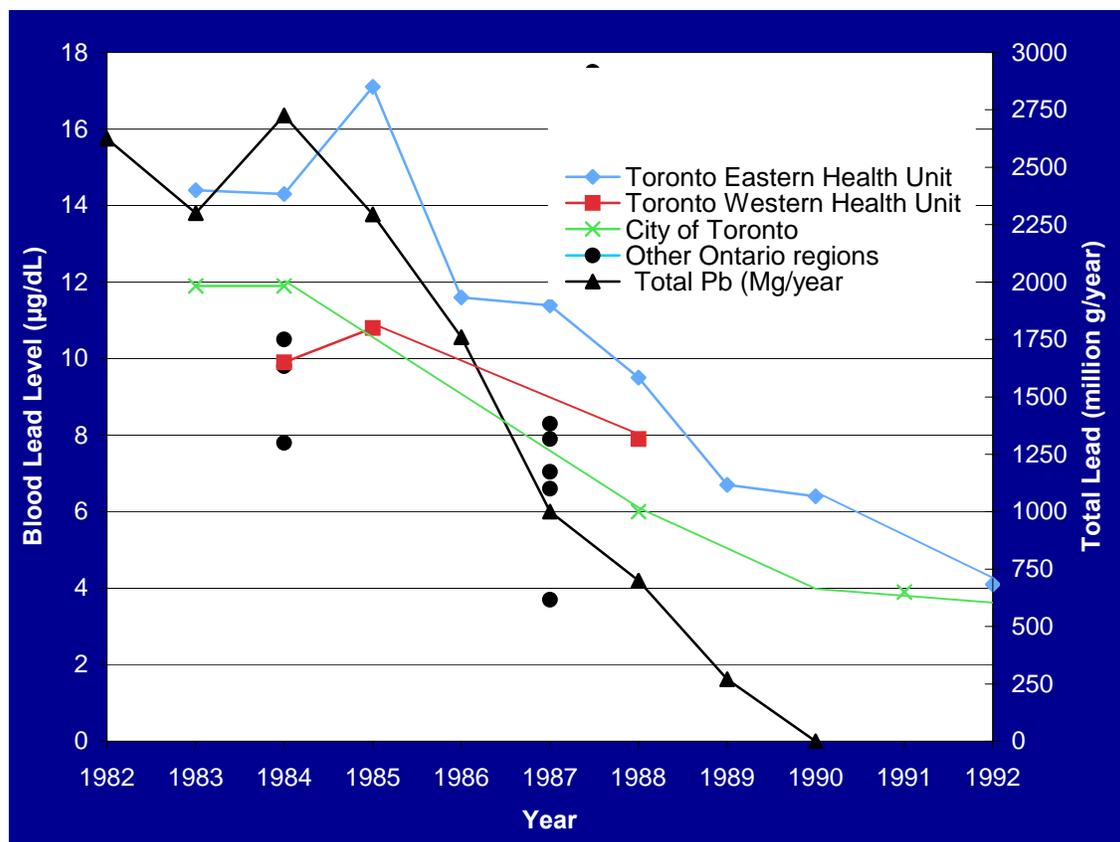
Chart 4-1 shows the **decline in the geometric mean of blood lead concentrations related to a decline in the consumption of leaded gasoline**. This chart illustrates a timeline from 1983 to 1992.

CASE STUDY

Blood Lead Levels in Children in Ontario, Canada—A Local Case Study

Since 1980, health departments in Ontario have conducted several blood lead screening surveys in children living in several cities and regions of the province. These surveys were not conducted on a random sample of children, as they were undertaken in response to a concern about an exposure to lead. The collection procedure of capillary finger-prick blood samples and the method for blood lead analysis were used identically in all the blood lead analyses across the province.

Chart 4-1: Decline in the Geometric Mean of the Blood Lead Concentrations related to a Decline in Consumption of Leaded Gasoline, in Ontario, Canada, 1983–92



Source: Adapted from Wang, S.T., S. Pizzolato, H.P. Demshar, and L. Smith. 1997. Decline in blood lead in Ontario children correlated to decreasing consumption of leaded gasoline, 1983–92. *Clinical Chemistry* 43: 1251–1252. <<http://www.clinchem.org/cgi/content/full/43/7/1251>>.

Key Observations:

- The findings from this analysis indicate that as lead levels in gasoline declined, so did children’s blood lead levels in Ontario (Chart 4-1).

4.1.2 Mexico

A nationally representative sample of blood lead levels in children is not available in Mexico, therefore Mexico is not able to present on the current indicator. Instead, Mexico presents several independent studies that have measured blood lead levels in children exposed to lead occupationally and non-occupationally. Mexico also presents a case study that reveals how lead emissions have decreased with the reduction of leaded gasoline. A final case study is also presented on lead exposure in the city of Torreón, Coahuila, a city that contains Latin America’s largest mining-metallurgical company.

In Mexico, the main source of lead exposure for children is from the use of lead oxide in low-temperature ceramic glazes (see Mexico’s Country Report). Children can be exposed to leaded

glaze by helping with the production of pottery, by being exposed to lead contamination in the home, and through the contamination of food prepared and/or stored in pottery with lead-based glazes. Lead is also mined and processed in Mexico. Lead emissions from this sector create another source of lead exposure in nearby communities through emissions to the air, water and soil and through “take-home exposures” from family members who work in the mining and smelting sectors (see Mexico’s Country Report).

Chart 4-2 presents **blood lead levels of children in rural and urban populations**. It illustrates the results of several studies which have measured blood lead levels in children exposed to lead occupationally and non-occupationally, in Mexico.

Chart 4-3 shows the **atmospheric monitoring of lead and principal activities to reduce lead emissions in the Mexico City Metropolitan Zone**. This chart illustrates a timeline from 1990 to 2000.

Chart 4-4 depicts the **local air quality data from metallurgical activities** in the city of Torreón in North Mexico. This chart illustrates a timeline from 1999 to 2003.

Chart 4-5 shows the **lead content in local soil samples taken in the area around the mining-metallurgical company Met-Mex Peñoles**. Met-Mex Peñoles is a major producer of lead, silver and gold.

Chart 4-6 depicts the **blood lead levels in children, after five years of participation in the Metals Program**. This program was established to coordinate health-related actions (detection, treatment and rehabilitation) for the population with environmental lead exposure.

Chart 4-2: Blood Lead Levels of Children in Rural and Urban Populations, in Mexico

Author and Year	Place	Community	Population	Exposure to Ceramic Glazes		Blood Lead Levels µg/dL		
				General Public	Occ.	N	Mean	SD
Azcona-Cruz, M., et al., 2000	Oaxaca	Rural	Children	No	Yes	220	10.50**	-
Olaiz, G., et al., 1994	Michoacán	Rural	Children	No	Yes	181	26.2**	-
Batriz, L., et al., 1994	San Luis Potosí	Rural	Children	Yes	No	37	16.5*	±1.3
Romieu, I., et al., 1991	Mexico City	Urban	Children	Yes	No	80 40	10.7* 15.3*	±4.7 ±8.5
Molina, B.G., et al., 1982 ¹	Tonala, Jalisco	Rural	Children	No	Yes	233 9 149	39.5* 81* 54.3*	-
Viniegra, G., et al., 1960	Mexico City	Urban	Children and Adults	Yes	No	48	Clinical Data	-

Source: Compiled by author.

Note: * Arithmetic mean. ** Geometric mean. N = Sample size; Occ. = Occupational; SD=Standard Deviation. Please see the Glossary for definitions of geometric mean and arithmetic mean.

Key Observations:

- Studies indicate that some populations of Mexican children have very elevated levels of blood lead (Chart 4-2), in some cases more than five times the action level of 10 µg/dL (Mexico, Cofepris Date unknown).

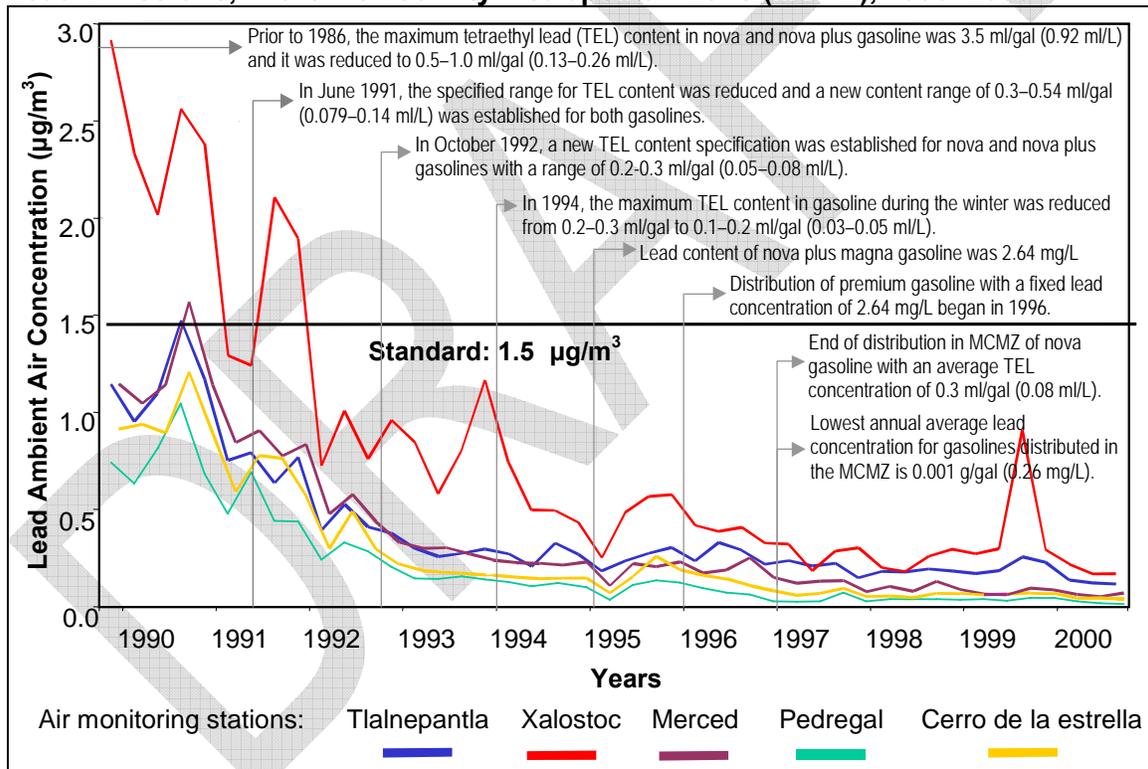
CASE STUDY

The Integrated Program for Air Pollution Control in the Mexico City Metropolitan Zone, Mexico

Ambient lead levels and lead exposures were dramatically reduced through a series of initiatives to reduce lead in gasoline and consumer products in Mexico. These actions, which were supported with regulations and consumer education, have produced substantial reduction in childhood exposure to lead.

In October 1990, it was agreed to establish the Integrated Program for Air Pollution Control in the Mexico City Metropolitan Zone (*Programa Integral Contra la Contaminación Atmosférica en el Valle de México—PICCA*). Lead levels in Mexican gasoline were reduced by 88 percent (average of 0.2 g/L) by 1992 (Michaelowa 1997). The transition to unleaded gasoline was assisted with a reduction of the price of lead-free gasoline to encourage its use. Over the course of the program a series of further reductions in the allowable levels of lead in gasoline were implemented across Mexico. These reductions resulted in an average annual and minimum recorded lead concentration in gasoline of 0.001 g/gal in the Mexico City Metropolitan Zone.

Chart 4-3: Atmospheric Monitoring of Lead, and Principal Activities to Reduce Lead Emissions, in the Mexico City Metropolitan Zone (MCMZ), 1990–2000



Source: *Programa para Mejorar la Calidad del Aire de la Zona Metropolitana del Valle de México 2002–2010* (Program to Improve the Quality of Air in the Mexico City Metropolitan Zone—Proaire).

<<http://www.sma.df.gob.mx/sma/modules.php?name=News&file=article&sid=253>>

Note: Tetraethyl lead (TEL) is a liquid. Nova, nova plus, and nova plus magna are grades of gasoline, ranked according to increasing octane levels.

Key Observations:

- Actions to eliminate lead from gasoline have reduced airborne emissions of lead in the Mexico City Metropolitan Zone (Chart 4-3).

CASE STUDY

Levels of Lead in Blood in a Child Population in Northern Mexico due to Metallurgical Activities—A Local Case Study

The city of Torreón, Coahuila, located in northern Mexico, has a population of approximately 530,000 inhabitants. Latin America's largest, and the world's fourth-largest mining-metallurgical company, Met-Mex Peñoles, is located in this town, producing lead, silver and gold. The presence of this industry has led to the chronic environmental exposure to lead in the non-occupational population, particularly in children.

The results of formal studies performed since 1997 have shown a high concentration of lead in the soil and air, thereby documenting prolonged, historic pollution. One of these studies (García, V.G. et al. 2001) corroborated the presence of lead in the blood of school children in a relationship directly proportional to their proximity to the metallurgical plant. This problem gave rise to an environmental emergency situation, as it represented both public health and social problems.

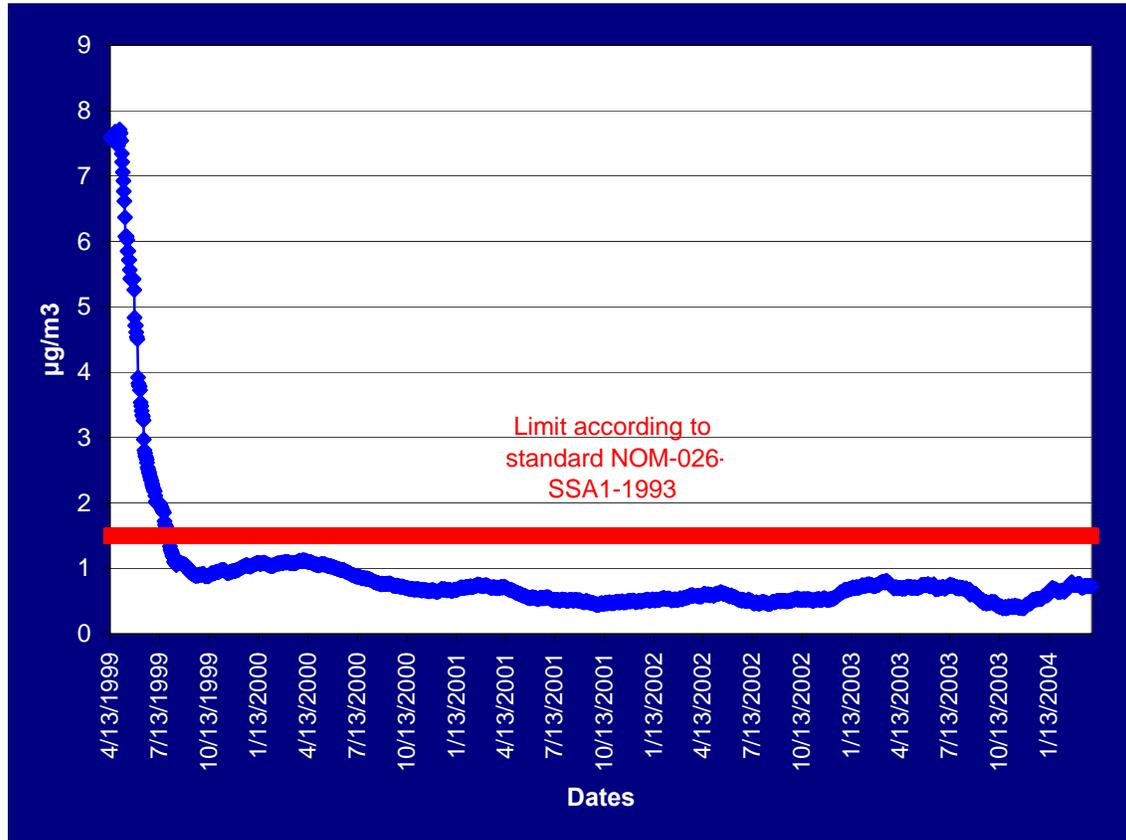
To handle this situation, the state Secretariat of Health (*Secretaría de Salud*), the Office of the Federal Attorney General for Environmental Protection (*Procuraduría Federal de Protección Ambiental—Profepa*) and the company Peñoles implemented a series of actions including, among others, emissions control and reductions and improved smelting processes in the facility, the oversight of the environmental authority by Profepa, and the oversight by the *Secretaría de Salud* of the medical care provided by the state secretariat of health for the environmentally exposed population.

A trust was set up with funding (60 million pesos) provided by the company in 1999, creating a Metals Program (*Programa de Metales*) to coordinate health-related actions (detection, treatment and rehabilitation) for the population with environmental lead exposure. To remediate the environment, teams with high-efficiency vacuums cleaned the streets, building roofs and house interiors within a radius of four kilometers of the facility to reduce the accumulated concentration of lead on surfaces and in the soil. Contaminated soil was removed, thorough cleaning of public and private living spaces was aggressively conducted, and streets and patios near the facility were paved.

On 31 May 2004, five years after its creation, the trust that originated the Metals Program ended, having accomplished its immediate goals of gradually reducing the risks and health effects of lead to the population. However, the success attained required vigilance and continuing efforts to assure the maintenance of good environmental quality and the health of the population, so the firm developed a new program for the protection and treatment of the population exposed to lead and other heavy metals in the ambient environment in Torreón, and funds it annually in the amount of 18 million pesos.

The following graphs show the results of the intervention of the health and environmental authorities to reduce the concentrations of lead in blood, as well as the decreased concentrations of lead in soil and air.

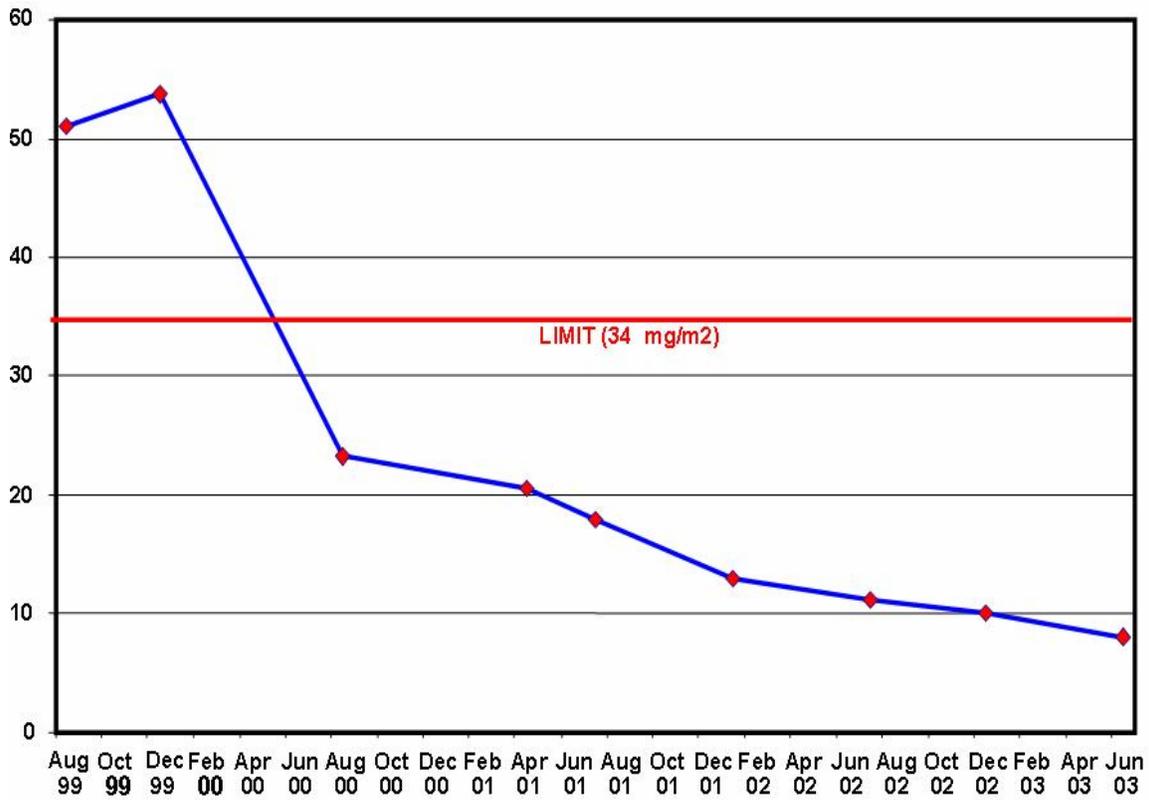
Chart 4-4: Local Air Quality Data from Metallurgical Activities, in Torreón, Mexico, 1999–2003



Source: *Secretaría de Salud* (Secretariat of Health—SSa), Metals Program, 1999–2003.

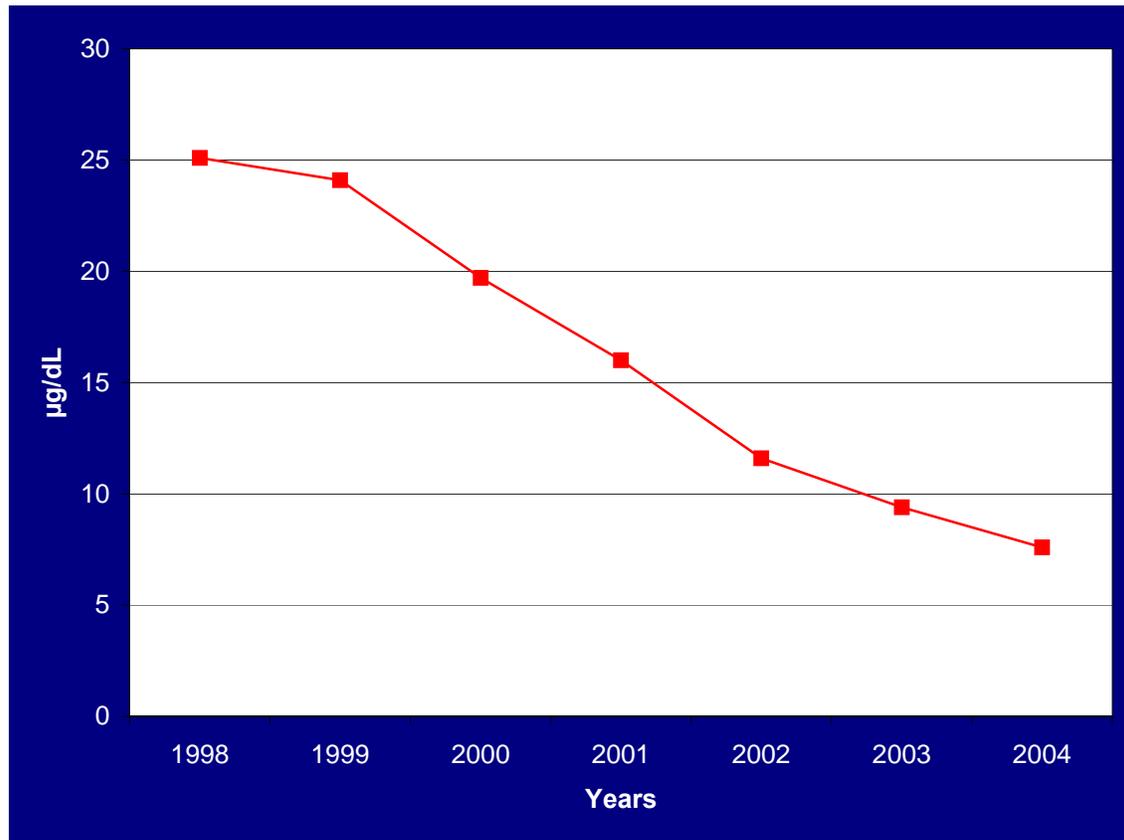
Note: Red line indicates level of the air quality standard for lead (NOM-026-SSA1-1993) = $1.5\mu\text{g}/\text{m}^3$.

Chart 4-5: Lead Content in Local Soil Samples Taken around Met-Mex Peñoles, in Mexico, 1999–2003



Source: *Secretaría de Salud* (Secretariat of Health—SSa), Metals Program, 1999–2003.

Chart 4-6: Annual Average Blood Lead Levels in Children 15 and under who participated in the Metals Program in Torreón, Mexico, 1998–2004



Source: *Secretaría de Salud* (Secretariat of Health—SSa), Metals Program, 1998–2003.

Key Observations:

- The average concentration of lead in the air around the mine changed from nearly 8 $\mu\text{g}/\text{m}^3$ in April 1999 to less than 1 $\mu\text{g}/\text{m}^3$ in December 2003 (the limit under Mexican Official Standard [*Norma Oficial Mexicana*] NOM-026-SSA1-1993 is 1.5 $\mu\text{g}/\text{m}^3$). Starting in August 1999, lead concentrations remained below the official standard (Chart 4-4).
- The actions dictated by the environmental authorities enabled a decline in lead levels in both air and soil. Lead concentrations found in soil samples taken in the area around the site of the company Peñoles dropped from 50 mg/m^2 in 1999 to 9 mg/m^2 in 2003. Since 2000, lead concentrations have remained below the standard's limit of 34 mg/m^2 (Chart 4-5).
- This chart demonstrates that 70 percent of the child population that has been attended to since the start of the Metals Program now has blood lead levels below 10 $\mu\text{g}/\text{dL}$ (Chart 4-6).
- Although the population's blood lead levels have declined, the risks of exposure persist. Children's exposure to lead continues to be a public health problem (Chart 4-6).

4.1.3 United States

The United States provides data from its national biomonitoring program, which include the measurement of blood lead levels in children of ages one to five years. The data is from the National Health and Nutrition Examination Survey (NHANES), a large survey sample of the general population of the United States. This data is intended to represent average population exposures and would not represent higher blood lead concentrations that could occur from exposures to particular sources. The United States also presents a case study on how removing lead from gasoline and other lead reduction policies has led to reduced children's blood lead levels.

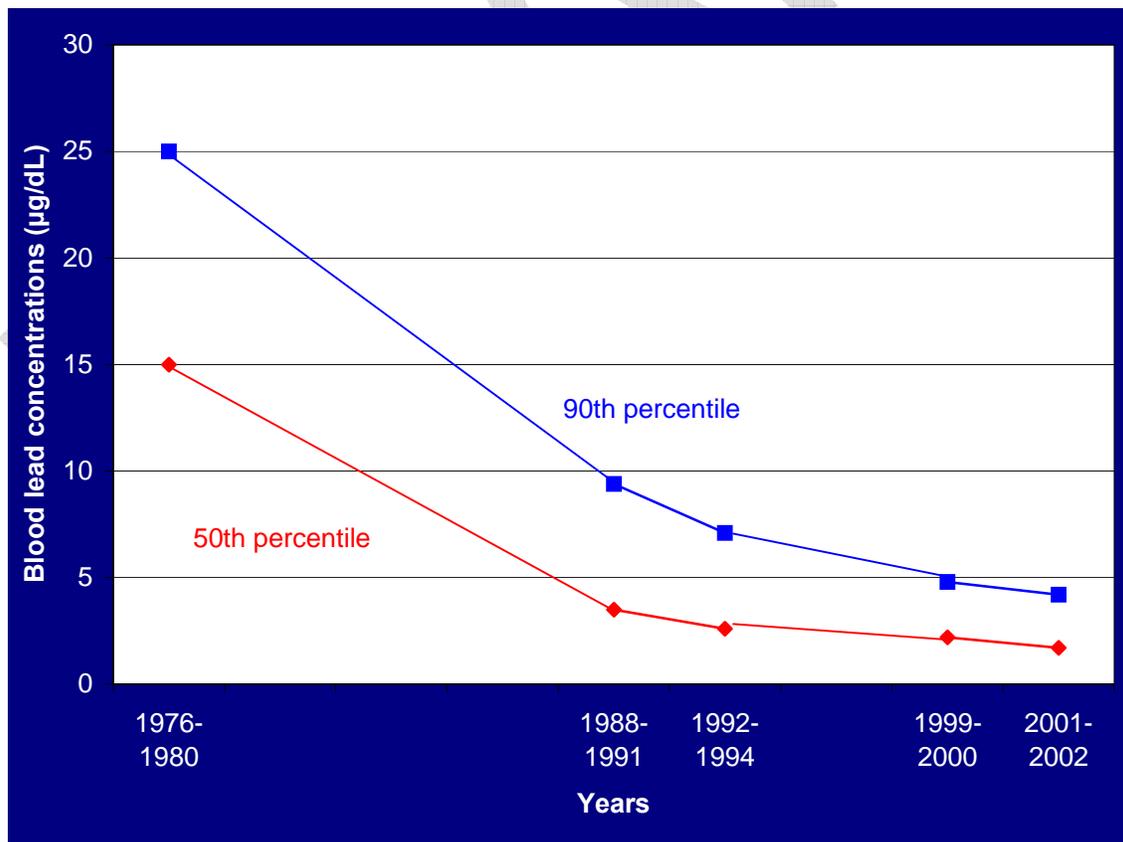
Chart 4-7 shows the **concentrations of lead in the blood of children, aged five and under**. This chart illustrates the time trend of blood lead levels during 1976–2000.

Chart 4-8 shows the **distribution of concentrations of lead in blood of children, aged one to five**, for the period 1999–2000.

Chart 4-9 shows **median concentrations of lead in blood of children, aged one to five**, by race/ethnicity and family income, 1999–2000.

Chart 4-10 depicts the **impact of lead poisoning prevention policy on reducing children's blood lead levels**, for the period 1971–2001.

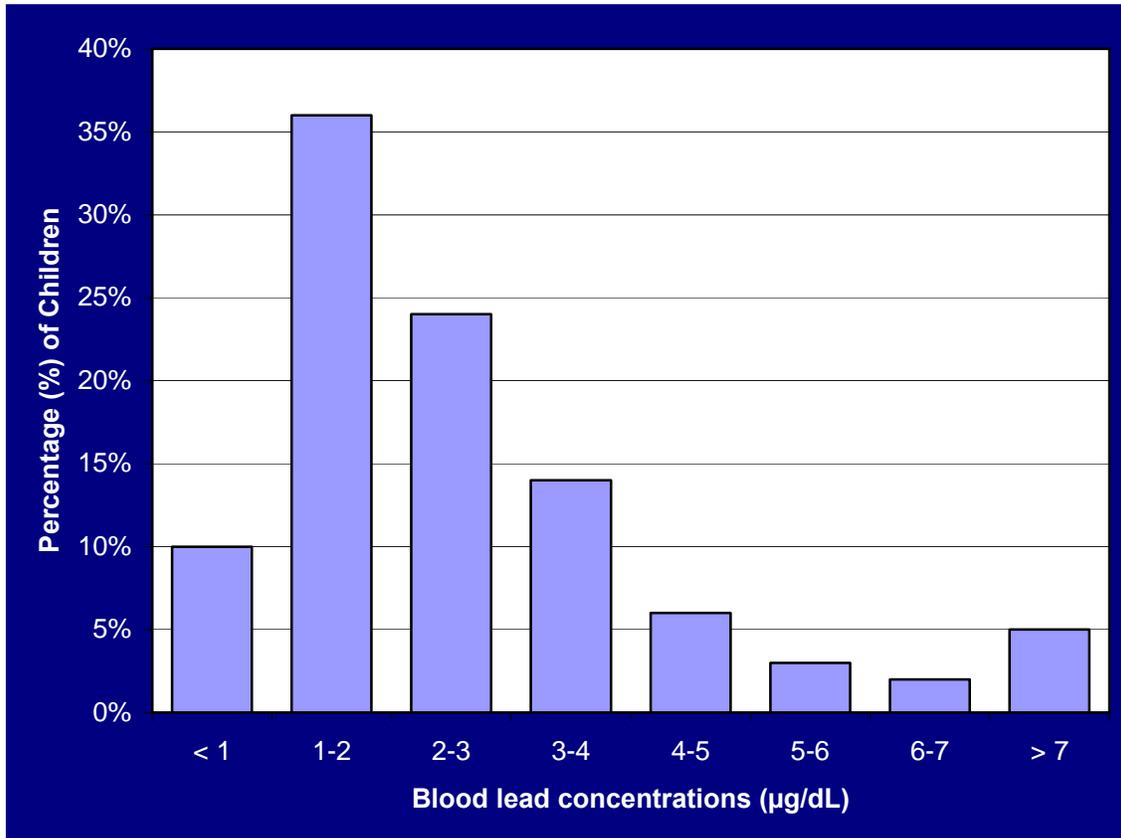
Chart 4-7: Concentration of Lead in the Blood of Children Five and Under, in the United States, 1976–2002



Source: United States Environmental Protection Agency. 2003 *America's children and the environment: Measures of contaminants, body burdens, and illnesses*. <www.epa.gov/envirohealth/children>.

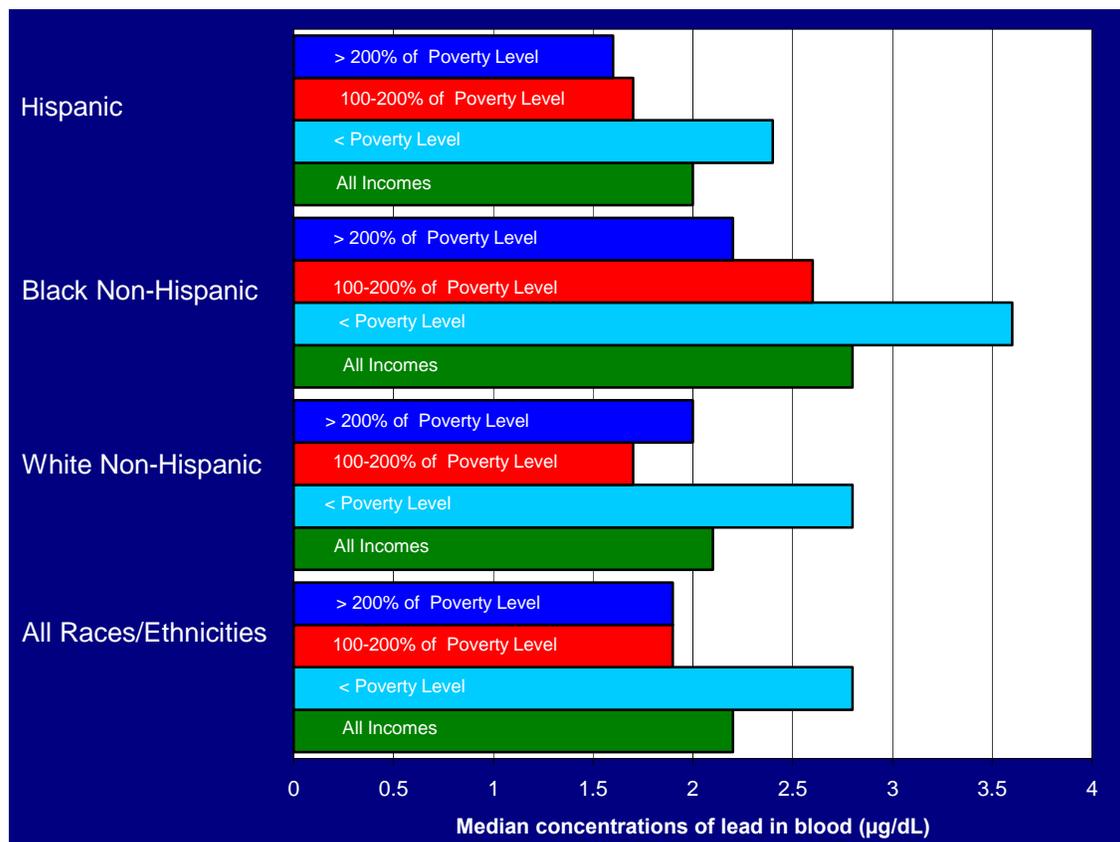
Data: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health and Nutrition Examination Survey.

Chart 4-8: Distribution of Concentrations of Lead in Blood of Children, Aged One to Five, in the United States, 1999–2000



Source: US EPA 2003. *America's children and the environment: Measures of contaminants, body burdens, and illnesses*. <www.epa.gov/envirohealth/children>.

Chart 4-9: Median Concentrations of Lead in Blood of Children, Aged One to Five, by Race/Ethnicity and Family Income, in the United States, 1999–2000



Source: US EPA 2003. *America's children and the environment: Measures of contaminants, body burdens, and illnesses.* <www.epa.gov/envirohealth/children>.

Key Observations:

- The median concentration of lead in the blood of children five years old and under dropped from 15 micrograms per deciliter (µg/dL) during 1976–80 to 1.7 µg/dL during 2001–2002, a decline of about 85 percent (Chart 4-7).
- The concentration of lead in blood at the 90th percentile in children five years old and under dropped from 25 µg/dL during 1976–80 to 4.2 µg/dL during 2001–2002. This means that 10 percent of children had blood lead levels above 4.2 µg/dL and 90 percent had blood lead levels below 4.2 µg/dL (Chart 4-7).
- Based on the 1999–2000 survey, 2.2 percent of US children aged one to five years have a blood lead level greater than or equal to 10 µg/dL. In the 1976–80 survey, 88.2 percent of children had a blood lead level above or equal to 10 µg/dL (Chart 4-8).
- In the 1999–2000 survey, 434,000 US children aged one to five years were estimated to have a blood lead level of 10 µg/dL or more. In the 1976–80 survey, the comparable estimate was 13,500,000 children (Chart 4-8).
- In the 1999–2000 the median blood lead level in children ages one to five was 2.2 µg/dL. The median blood lead level for children living in families with incomes below the poverty

level was 2.8 µg/dL and for children living in families with incomes above the poverty level it was 1.9 µg/dL (Chart 4-9).

- In 1999–2000, White non-Hispanic children ages one to five had a median blood lead level of about 2 µg/dL, unchanged from the level in 1992–94. In 1992–94, Black non-Hispanic children ages one to five had a median blood lead level of 3.9 µg/dL and, in 1999–2000, they had a median blood lead level of 2.8 µg/dL (Chart 4-9).

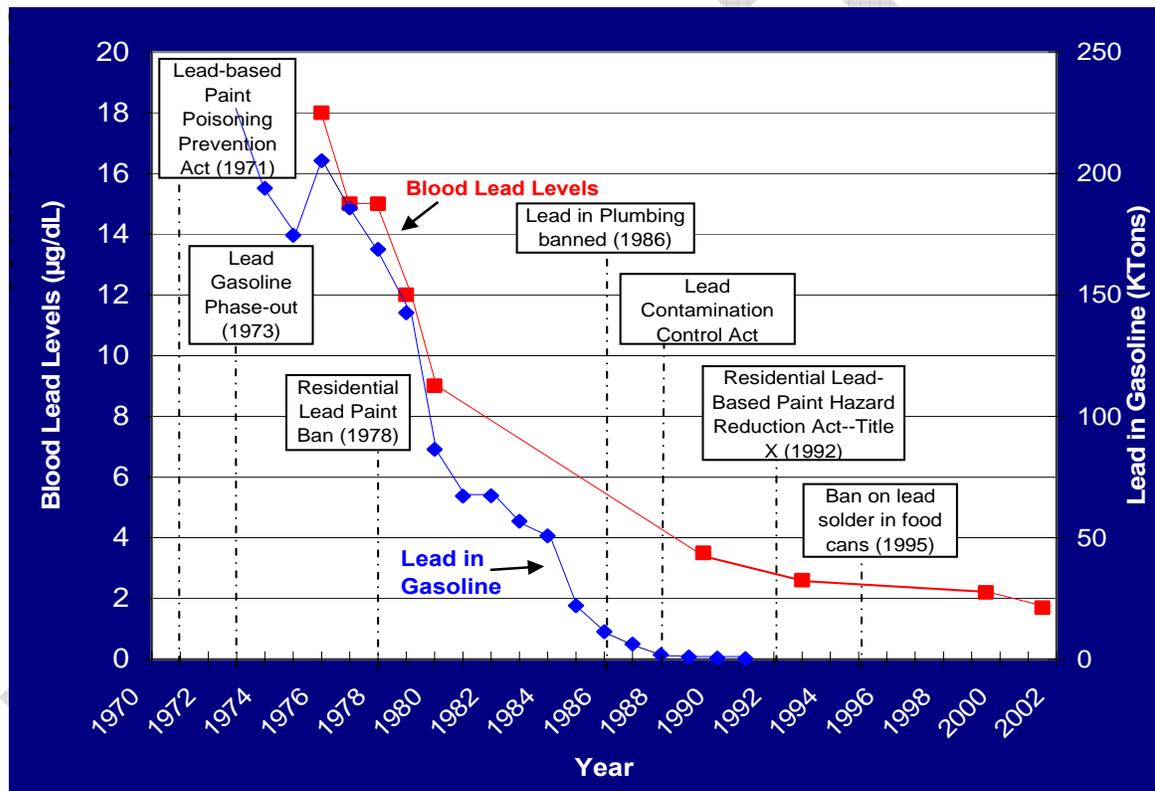
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CASE STUDY

Blood Lead Levels in Response to Restrictions on Lead in Gasoline, in the United States, 1971–2001

The decline in blood lead levels is due largely to the phasing out of lead in gasoline between 1973 and 1995 (US EPA 2000) and to the reduction in the number of homes with lead-based paint, from 64 million in 1990 to 38 million in 2000 (Jacobs et al. 2002). Some decline also was a result of EPA regulations reducing lead levels in drinking water, as well as legislation banning lead from paint and restricting the content of lead in solder, faucets, pipes, and plumbing. Lead also has been eliminated or reduced in food and beverage containers and ceramic ware, and in products such as toys, mini-blinds, and playground equipment. As a result of these past and ongoing efforts, children’s blood-lead levels have declined over 80 percent since the mid-1970s.

Chart 4-10: Impact of Lead Poisoning Prevention Policy on Reducing Children’s Blood Lead Levels, in the United States, 1971–2001



Source: Blood lead levels: National Health and Nutrition Examination Survey. National Center for Health Statistics, Centers for Disease Control and Prevention. Lead in gasoline: 1967–75: Unpublished data from industry, provided by US EPA 1976–91: Unpublished data from refiner reports to US EPA.

Key Observations:

- The median concentration of lead in the blood of children five years old and under dropped from 15 micrograms per deciliter (µg/dL) during 1976–80 to 1.7µg/dL during 2001–2002, a decline of about 85 percent (Chart 4-10).

4.1.4 Opportunities for Strengthening Indicators of Children's Exposure to Lead in North America

The measures presented in this section highlight the correlation between the reduction of lead from gasoline, local industrial emissions and other sources with the corresponding reductions in blood lead levels in children. The indicators also present the utility of blood lead levels as indicators of child exposure to lead and for monitoring the impact of policy initiatives. Furthermore, detailed results from a national biomonitoring program, such as those in the United States, can be used to direct future policy efforts at populations that remain at risk from exposure to lead (see Section 4.1.3 and Charts 4-7 and 4-8). The following opportunities address biomonitoring and other means of improving future indicators of lead exposure.

- National biomonitoring programs for lead in Canada and in Mexico would provide a direct measure of lead exposure in children. In addition, detailed information on blood lead levels by region, and by ethnic and socioeconomic groups, would identify sub-populations most at risk of lead exposure in those countries. This would also improve the comparability of this indicator between countries in future reports.
- Additional efforts, whether through national surveillance, targeted screening or localized surveys, to ensure a reasonable sampling of populations at greater risk of lead exposure could help focus government actions on improving public policy and programs so that better health benefits could be delivered. Collaboration between local and national authorities in study design, sampling and collection methods may ensure local and national information needs are met.
- Continuation of study efforts in the United States would be valuable, with publication of reports at least every two years on the continuing monitoring of blood lead levels in children.
- The established blood lead levels for the management of lead in children vary across governments and agencies. Currently, blood lead levels at which concerns are generated (10µg/dL for the United States (Centers for Disease Control and Prevention 2002), Mexico (Mexico, Cofepris, date unknown) and WHO (Gordon et al. 2004)) do not necessarily reflect the fact that there is no demonstrated safe concentration of blood lead. Future reporting efforts should reflect on the different reference levels in use while ensuring that the reader understands that there is no safe level of blood lead.

4.2 Lead in the Home

Purpose: This indicator provides information on children's potential exposures to sources of lead in the home.

CEC Council target indicator: "Children living in homes with a source of lead."

Current indicator: Children living in homes with a potential source of lead.

Indoor environments, particularly in older homes where lead paint or plumbing was used, remain an important source of lead exposure for children. As illustrated by the MEME model for lead (see Figure 5, in Section 4.1), there can be numerous sources of exposure to lead indoors in North America, including contaminated dust, paint and lead-based pottery glazes. Other consumer products may also contain lead. Cases have been found of inexpensive jewelry, candy wrappers and certain toys containing lead. In Mexico, home-based pottery operations can be a significant source of lead contamination when glazes containing lead oxides are used (see Mexico's Country Report). In Canada and the United States, lead paint and contaminated dust are the sources of lead of greatest concern indoors (US EPA 2003). Soil is a primary concern outdoors, where contamination may result from exterior paint, industrial emissions or historical deposits from vehicle emissions (prior to the elimination of lead from fuel) (US EPA 2003).

Children living in older homes are more likely to experience elevated blood lead levels (US EPA 2003). In the United States, children from low-income households can experience increased risk of exposure to lead, as they are more likely to live in older homes where paint deteriorates into dust, increasing opportunities for exposure. There is also an additional risk of exposure during renovations when scraping, sanding, and heating are used to remove older contaminated paint, making the lead available in the form of scrapings, dust and fumes.

The indicators presented in this section utilize information on the age of housing stock to report on the potential for exposure to lead. Canada presents data and trends on the number of children that live in pre-1960 homes. The United States presents data on the percentage of houses that have lead contamination in the house or soil around the house, above EPA standards.

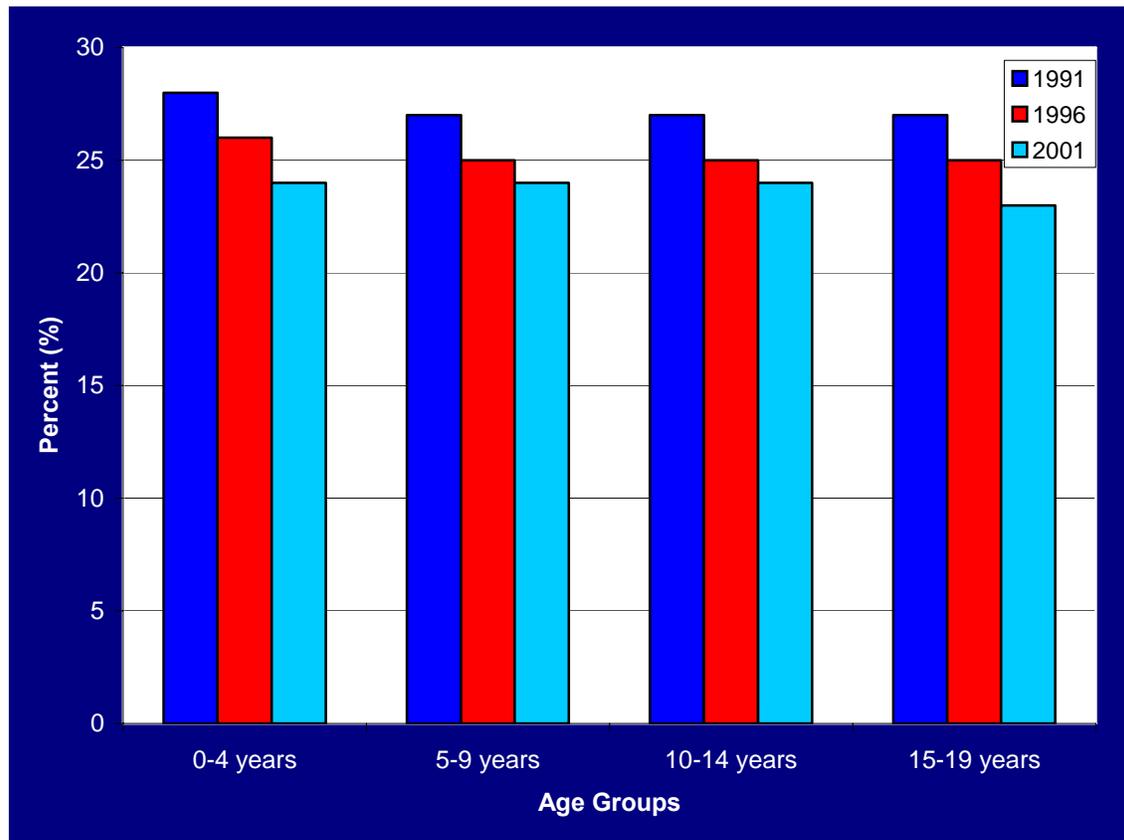
In Mexico, the cottage pottery industry continues to use glazes that are high in lead. Often based in or near the home, these pottery operations can cause lead exposures for children living and, in some cases, working there. People are also exposed to lead when ceramics containing lead in the glaze are used to cook or store food or beverages. Mexico provides a regional map illustrating the number of home-based pottery operations situated in various states. This is an exposure surrogate indicator that provides a general sense of the distribution of pottery operations that may cause increased exposure of children to lead from lead-based glaze or through contamination due to pottery operations.

4.2.1 Canada

Canada provides data on the percentage of children living in homes built prior to 1960. Children may be exposed to lead in these homes, as most indoor and outdoor paints produced before 1960 contained substantial amounts of lead (see Canada's Country Report). Also, as noted in Section 4.2, renovations can increase the amount of lead dust in a home.

Chart 4-11 shows the **percentage of children living in pre-1960 homes in Canada** for the years 1991, 1996, 2001.

Chart 4-11: Percentage of Children Living in Pre-1960 Homes, by Age Group, in Canada, 1991, 1996, 2001



Source: Statistics Canada, Census of Population, 1991, 1996, 2001.

Key Observations:

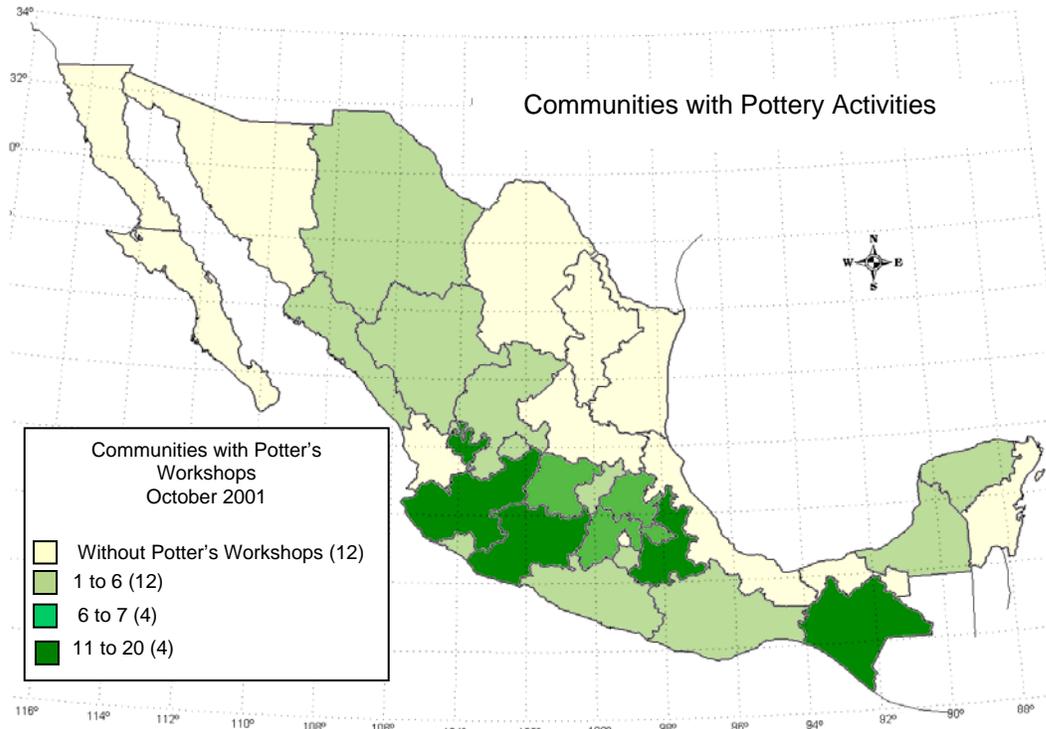
- In 2001, 24 percent of Canadian children under five years of age lived in housing built prior to 1960 (Chart 4-11).
- The number of children in the four age categories (under five, five to nine, 10 to 14 and 15 to 19) living in homes built prior to 1960 has declined slightly, between 1991 and 2001 (Chart 4-11).

4.2.2 Mexico

In Mexico, home-based pottery operations are a potential source of exposure to lead for children. While Mexico does not have data on the number of children living in homes with a potential source of lead, Mexico provides information on the number of pottery communities throughout the country. This artisan craft is carried on in 20 Mexican states, by approximately 5 million potters, many of whom are members of indigenous groups. As noted in Section 4.2, one of the main causes of environmental exposure to lead in Mexico derives from the manufacture of pottery with glaze containing lead oxide, as well as the use of this pottery in food preparation.

Chart 4-12 shows the number of **communities with pottery activities, by state**, as of October 2000.

Chart 4-12: Communities with Pottery Activities, by State, in Mexico, October 2001



Source: National Artisan Development Fund (*Fondo Nacional para el Fomento de las Artesanías—Fonart*), Lead Program.

Key Observations:

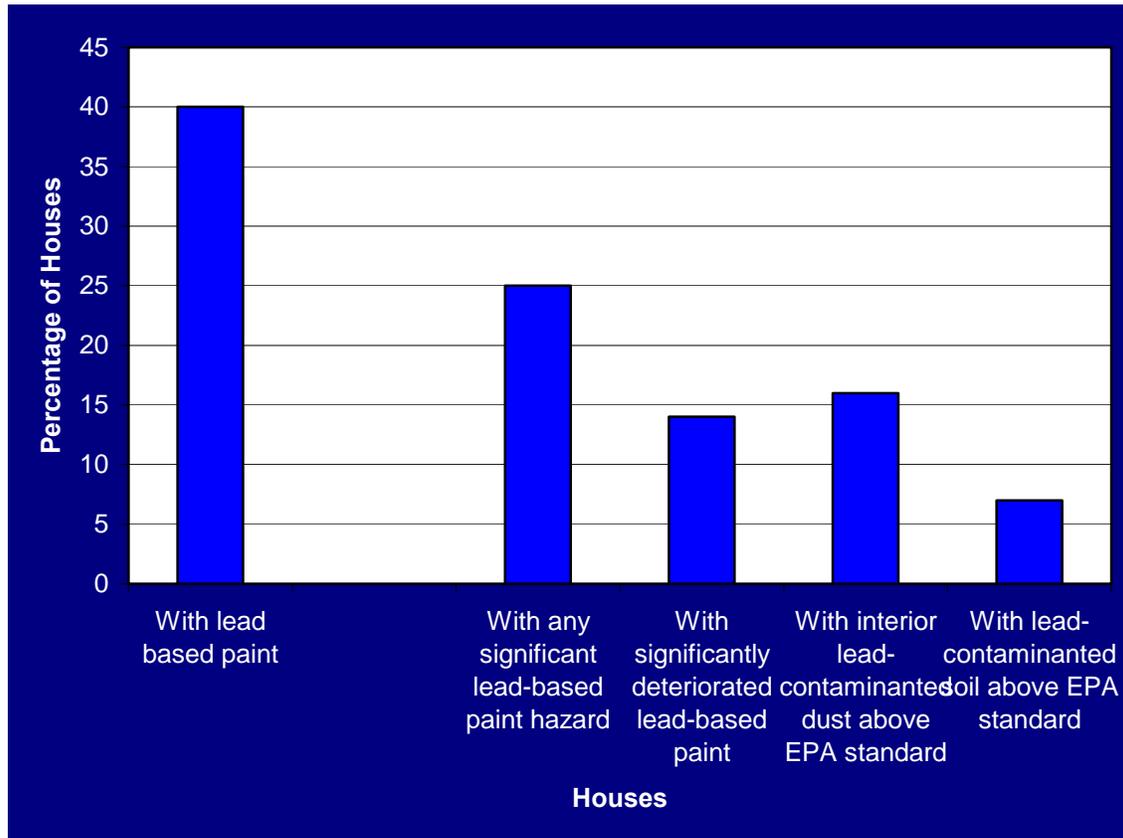
- Pottery production occurs mainly in the southern part of Mexico, including the heavily indigenous-populated state of Chiapas (Chart 4-12).

4.2.3 United States

The United States is not able to provide child-specific information on the current indicator. Instead, the United States provides information from the National Survey of Lead and Allergens in Housing on lead in US housing. Elevated blood lead levels in the United States are due mostly to ingestion of contaminated dust, paint and soil (Centers for Disease Control and Prevention 1997). Soil and dust that are contaminated with lead are important sources of exposure because children play outside, and very young children frequently put their hands in their mouths (Mielke and Reagan 1998, Mielke 1999, President's Task Force on Environmental Health Risks and Safety Risks to Children 2000a). Deterioration of lead-based paint can generate contaminated dust and soil, and past emissions of lead in gasoline that subsequently were deposited in the soil also contribute to lead-contaminated soil and house dust (Mielke and Reagan 1998, Mielke 1999, President's Task Force on Environmental Health Risks and Safety Risks to Children 2000a).

Chart 4-13 shows the percentage of **US houses with lead-based** paint and the percentage of houses that have lead contamination in the house or soil around the house, above EPA standards.

Chart 4-13: Lead in US Housing, 1998–2000



Source: US Department of Housing and Urban Development. 2001. *National survey of lead and allergens in housing, final report, volume I, analysis of lead hazards, Revision 6.0.*

Key Observations:

- Forty percent of homes in the United States had some lead-based paint (Chart 4-13).
- In the United States, 25 percent of houses had a significant lead-based paint hazard, which could be from deteriorating paint, contaminated dust, or contaminated soil outside the house (Chart 4-13).
- Fourteen percent of houses had significantly deteriorated lead-based paint and 16 percent of houses in the United States had lead in dust, above EPA standards. Seven percent of houses had lead in soil outside the house greater than the EPA standard (Chart 4-13). This is reduced from sixty-six percent of houses in the United States that were found in 1990 to have had paint that had some lead in them in (data not shown) (Jacobs et al. 2002)

4.2.4 Opportunities for Strengthening the Indicator on Children’s Exposure to Lead in the Home, in North America

This section highlights the challenges of using exposure surrogate indicators to monitor potential exposures to lead in indoor environments. Based on the limitations encountered, it is recommended that emphasis be put on reducing exposures and on exposure indicators such as

blood lead levels, combined with information on children's potential sources of exposure, to provide data on lead exposure in indoor environments.

- Additional efforts to ensure a reasonable sampling of low-income families and other populations at risk are an important consideration. Many children in inner-city communities may reside in poorer-quality housing stock where the availability of resources to remediate lead in homes may be limited.
- Information on renovations to pre-1960s homes could give an indication of the increased risk to children of exposure to lead through home renovations.
- The ability to overlay on a map the data on blood lead levels and housing stock, or on blood lead levels and pottery operations, would provide a geographical depiction of where children may be at higher risk of exposure to lead.
- Continued effort is necessary toward conducting national surveys of lead in housing, in order to estimate the levels of lead in paint, dust, and soil and the prevalence of hazardous levels of lead.
- Additional efforts to analyze and report lead concentrations in the house dust of homes with children would be valuable in future indicator efforts.

4.3 Industrial Releases of Lead

Purpose: This indicator provides information on industrial releases of lead.

CEC Council target indicator: “Pollutant release and transfer register (PRTR) data.”

Current indicator: PRTR data on industrial releases of lead. (The countries elected to report this indicator in addition to the more general PRTR data indicator presented in Section 4.4.)

Canada, Mexico and the United States all have systems in place to track the release or transfer of selected substances from industrial activities. These pollutant release and transfer registers, or PRTRs, are described briefly below.

- **Canada**—The Canadian National Pollutant Release Inventory (NPRI) is a legislated tracking program delivered by Environment Canada under the authority of the *Canadian Environmental Protection Act* (CEPA) and currently tracks approximately 270 chemicals.
- **Mexico**—The Mexican *Registro de Emisiones y Transferencia de Contaminantes* (RETC), which has been voluntary, is soon to be implemented as a mandatory reporting mechanism that will track more than 100 substances in addition to criteria air contaminants and data on energy and water use.
- **United States**—The US Toxics Release Inventory (TRI) is a legislated national program that is administered by the Environmental Protection Agency. The TRI tracks approximately 650 chemicals.

A core function of a PRTR is to make release and transfer information available to the public. The NPRI and TRI databases are communicated to the public through reports from their respective governments, and the databases themselves are made publicly accessible. Data from these PRTR programs are also presented through the *Taking Stock* report, an annual publication of the CEC. Mexico does not yet have publicly available PRTR data but plans to prepare a report for the 2005 reporting year.

As noted in Section 4.1, the health effects associated with lead exposure in children are well established. Lead is tracked through the PRTR programs of Canada and the United States; releases from covered industrial operations are presented for both countries in Sections 4.3.1 and 4.3.3. It is important to note that PRTR data do not provide information on exposures or related health risks. In addition, only facilities that meet reporting thresholds are required to report, thus small and diffuse sources (e.g., gas stations, dry cleaners, transportation sources, agricultural activities) are not covered.

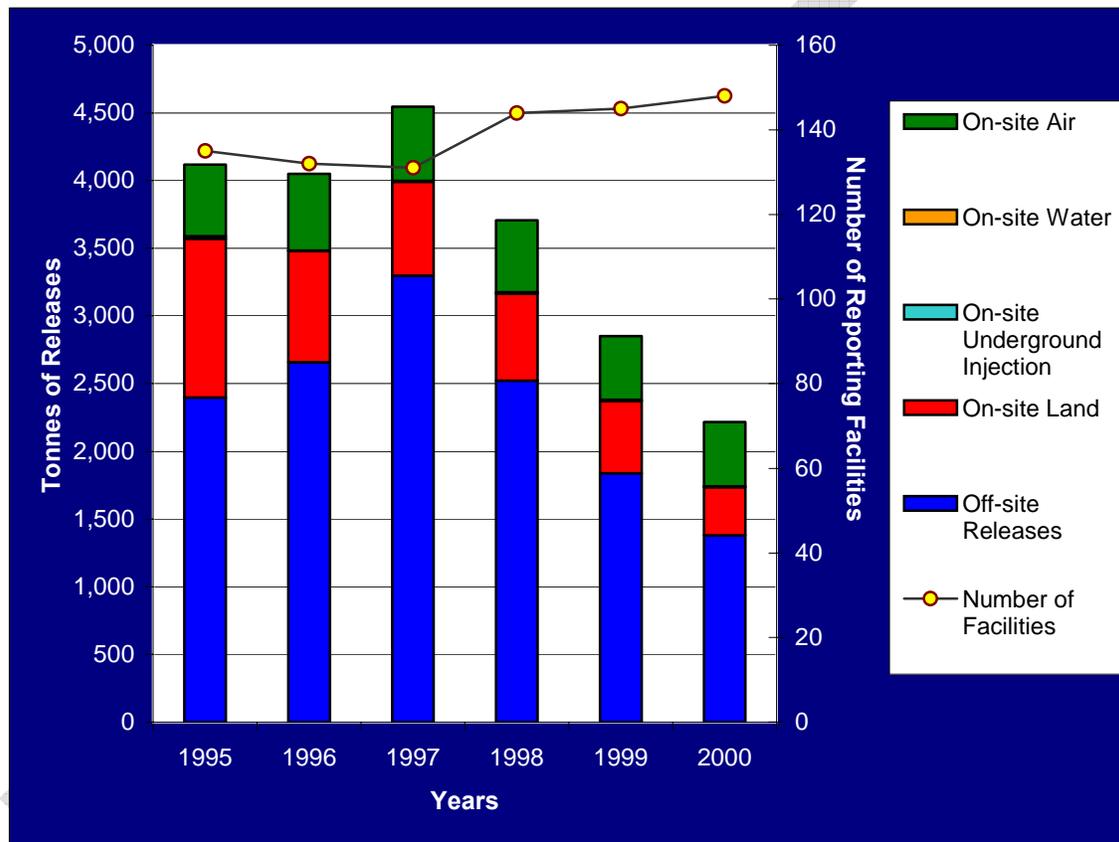
The data used for these analyses are for 1995–2000, and cover reporting from the manufacturing sectors only. Other sectors, such as mining and electric power-generating facilities, are not included since these were not added to the US TRI reporting until 1998. The reporting thresholds for lead and its compounds were lowered in both the US TRI and the Canadian NPRI, starting with the 2001 reporting year for TRI and 2002 for NPRI. The reporting thresholds were lowered from approximately 10 tonnes to approximately 50 kgs manufactured, processed or otherwise used during a calendar year. More facilities are now subject to reporting, thus a more complete picture of releases and transfers of lead from industrial sources will be available for future reports. This change resulted in a break in the trends between the 2001 and 2002 which resulted in unmatched data which was not comparable. Therefore, matched trend data are available only to the year 2000 for Canada and the US. Additional data for 2001, 2002 and 2003 are available from the National databases (see Canada and US Country Reports in Volume II)

4.3.1 Canada

Canada reports on the current indicator using a subset of NPRI data for on-site and off-site releases of lead and its compounds from facilities in the manufacturing sector.

Chart 4-14 depicts **on-site and off-site releases of lead and its compounds** reported by manufacturing facilities, in tonnes, for the period 1995 to 2000. This illustration combines information on the environmental releases and the number of facilities reporting for each year.

Chart 4-14: On- and Off-site Releases of Lead (and its compounds), in Canada, 1995–2000



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the National Pollution Release Inventory (NPRI), Environment Canada. The data shown are from a “matched” data set compiled by the CEC, in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: See Glossary for definitions of on-site air releases, on-site water releases, on-site underground injection, on-site land releases and off-site releases.

Key Observations:

- Overall, while the number of reporting facilities increased by 10 percent, total releases of lead and its compounds decreased 46 percent between 1995 and 2000. Releases increased moderately from 1995 to 1997, followed by a decrease in total releases from 1998 to 2000 (Chart 4-14).
- Off-site releases (primarily transfers to landfills) accounted for the largest portion of releases and variation over this time period (Chart 4-14).

- On-site land releases decreased by 70 percent from 1995 to 2000 (Chart 4-14).
- On-site releases to the air decreased from 1996 to 1999 but showed an increase (of 0.6 percent) from 1999 to 2000 (Chart 4-14).

4.3.2 Mexico

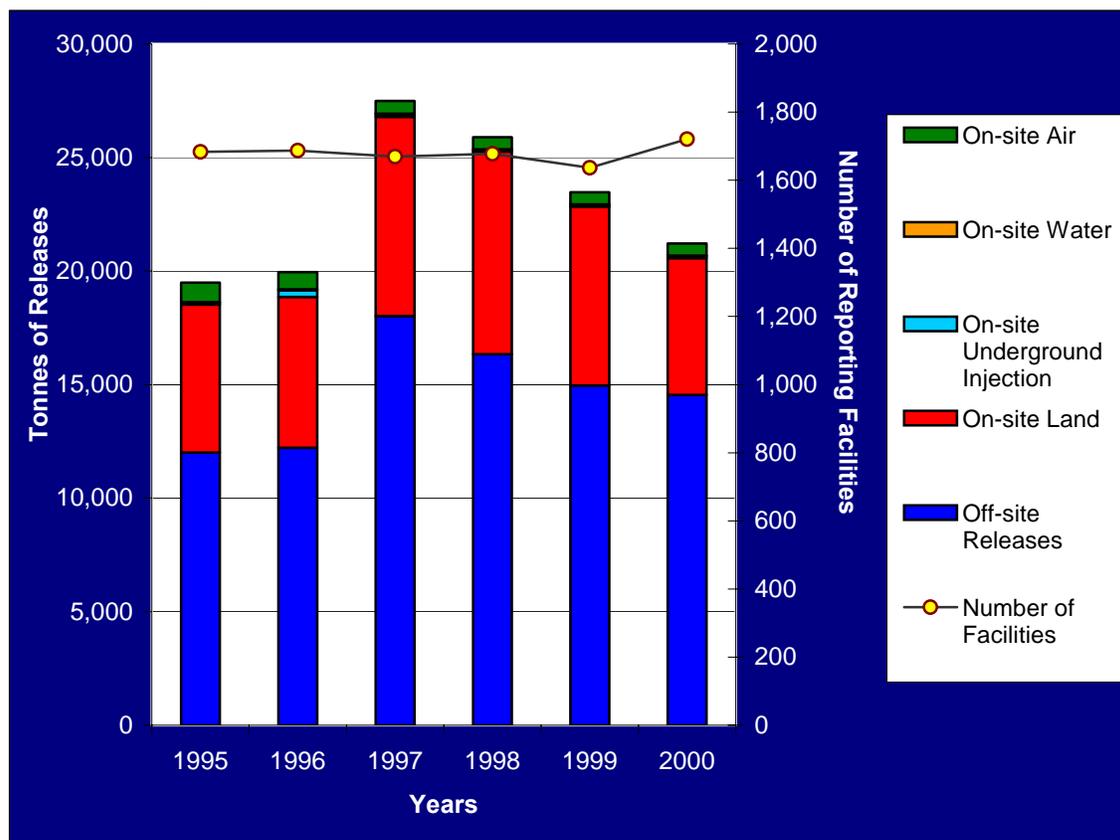
To date, Mexico has no information for this indicator, due to the fact that the contributions of information from Mexican companies to the *Registro de Emisiones y Transferencia de Contaminantes* (RETC) are currently voluntary and the number of facilities reporting is small. Legislation was enacted in 2001 for a mandatory, publicly accessible PRTR, and in June 2004 the implementing regulations were passed, thus Mexico will likely be in a position to present information on this indicator in future reports.

4.3.3 United States

The United States reports on the current indicator by using a subset of TRI data for on-site and off-site releases of lead and its compounds from manufacturing facilities.

Chart 4-15 depicts **on-site and off-site releases of lead and its compounds** for the period 1995 to 2000. This illustration combines information on the environmental releases and the number of facilities reporting for each year.

Chart 4-15: On- and Off-site Releases of Lead (and its compounds), in the United States, 1995–2000



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the Toxics Release Inventory (TRI), Environmental Protection Agency. The data shown are from a “matched” data set compiled by the CEC in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: See Glossary for definitions of on-site air releases, on-site water releases, on-site underground injection, on-site land releases and off-site releases.

Key Observations:

- An increase in the total releases was seen in 1997, with reductions in each subsequent reporting year up to 2000. Most of the increase was due to a 50 percent increase in the amount of lead and lead compounds released off-site (off-site releases are primarily transfers to landfills) between 1995 and 1997. The decrease in later years was not enough to offset the earlier increase, so that the change for the period 1995–2000 was an increase of 9 percent (Chart 4-15).
- The largest decrease in releases of lead and its compounds over the 1995 to 2000 period occurred for releases to on-site land with an overall decrease of 497 tonnes or 8 percent. Air releases of lead and its compounds decreased by about 325 tonnes, or 38 percent, over the reporting period (Chart 4-15).
- All types of releases, except off-site transfers to disposal (mainly landfills), increased from 1999 to 2000. The number of reporting facilities also increased, by 5 percent from 1999 to 2000 and overall by 2 percent from 1995–2000 (Chart 4-15).

- The amount of industrial releases of lead and its compounds was about 196,000 tonnes (metric tons) in 2003 (see Figure 13.6 in the US Country Report) for all facilities subject to reporting under the new requirements for TRI. These new requirements resulted in an approximately 90 percent change in tonnage, to about 175,000 tonnes, between 2000 and 2003. Note that the chart above and in the US Country Report are not comparable due to the difference in the number of industry sectors covered and the change in the reporting threshold (data not shown, see US Country Report).

4.3.4 Opportunities for Strengthening Indicators of Lead from Industrial Activities

The indicator on industrial releases of lead features the use of pollutant release and transfer register data from Canada and the United States. The anticipated availability of mandatory PRTR data in Mexico will be an important step towards making this indicator reportable for all of North America.

- Obtaining data on releases from smaller facilities could improve the quality of these indicators.
- PRTR data combined with monitoring data of ambient levels of pollutants in the environment (air, water and soil) would improve our understanding of the sources and presence of lead in the environment and potential contributions to lead exposure.
- Geographically-referenced lead emissions data could be combined with ambient monitoring data to get an indicator of communities with a potentially greater exposure to lead emissions due to heavy industrial activities. Such an indicator could identify geographic areas of concern for priority setting in interventions to reduce children's exposure to lead.
- Ensuring comparable reporting for lead under the Mexican RETC (i.e., similar reporting threshold and coverage of industrial sectors) is needed in order to have trilateral comparability for this indicator.

4.4 Industrial Releases of Selected Chemicals

Purpose: This indicator provides information on industrial releases of selected chemicals.

CEC Council target indicator: "Pollutant release and transfer register (PRTR) data."

Current indicator: PRTR data on industrial releases of 153 chemicals.

Hundreds of potentially toxic substances are released into the environment and transferred off-site for disposal or further management by industry each year. The relative toxicity of these chemicals varies. Some pose health risks only at high levels of exposure, whereas others are highly toxic even in extremely small concentrations.

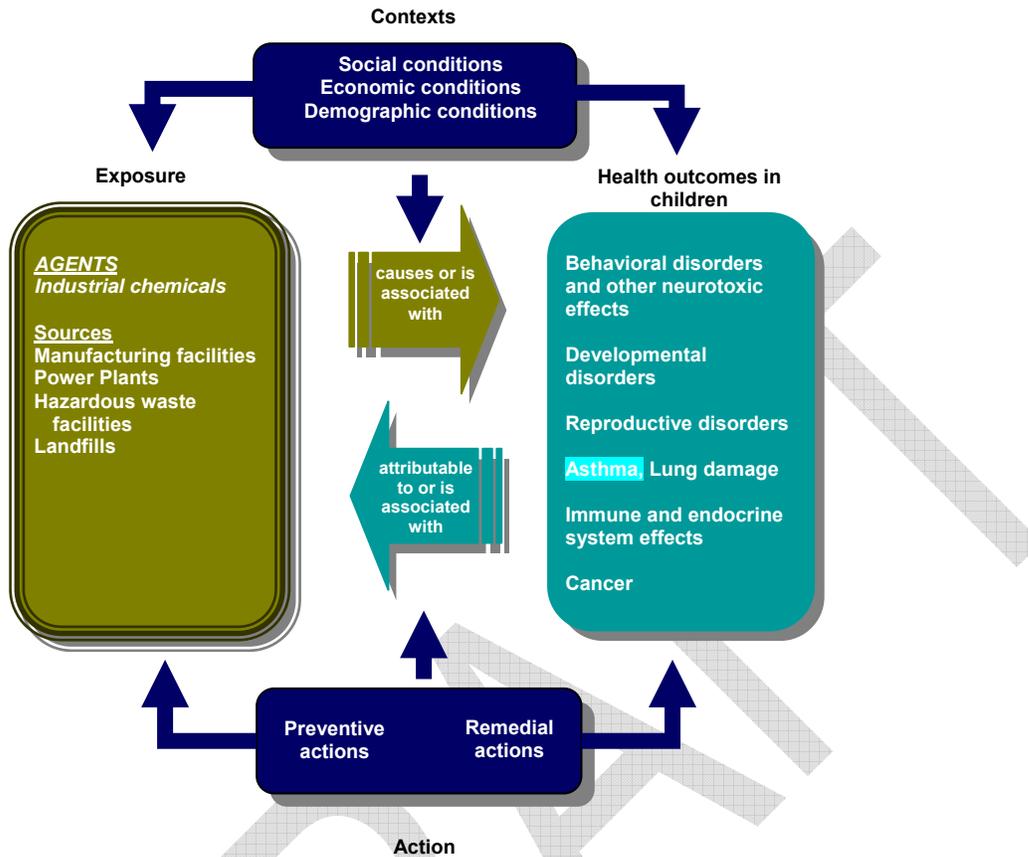
As mentioned in Section 4.3 above, Canada, Mexico and the United States all have systems in place to track the release or transfer of selected chemicals from industrial activities and to make this information publicly available. These pollutant release and transfer registers, or PRTRs, include:

- the Canadian National Pollutant Release Inventory (NPRI);
- the Mexican *Registro de Emisiones y Transferencia de Contaminantes* (RETC) (data not yet available); and
- the US Toxics Release Inventory (TRI).

As the MEME model in Figure 6 illustrates, industrial chemicals from numerous sources may pose health risks to children. There is increasing concern about the adverse effects that exposure to certain toxic substances may have on the developing fetus and child. A growing body of literature is drawing linkages between toxic exposures at various stages of fetal and child development and an array of health impacts, including behavioral disorders, neurological disorders, brain and kidney damage, decreased fertility, male reproductive disorders, acute toxicity, hormone disruption, various cancers, genetic damage, birth defects, developmental effects, immunological effects and other chronic diseases (US EPA 2003).

It is important to note that PRTR data document emission and do not provide information on human exposure to the listed chemicals or on related health risks. In addition, only facilities that meet reporting thresholds are required to report and thus small and diffuse sources (e.g., gas stations, dry cleaners, transportation sources, agricultural activities) are not covered.

Figure 6: MEME Framework for Issues Covered in the Section on Industrial Releases of Selected Chemicals



Source: Adapted from Briggs 2003.

The indicators presented in this section provide data on releases to air, water and land (primarily to landfills) of 153 “matched” chemicals. The matched chemicals are currently tracked by both the Canadian NPRI and the US TRI. A listing of the 153 chemicals is provided in Appendix 4. On-site and off-site releases of the matched chemicals are reported for the period 1998 to 2002. Data on transfers off-site for recycling or other management are not shown. The data also include the number of facilities reporting and the environmental media to which the chemicals are released. The total releases on- and off-site, by industry sector, are also provided for the same period.

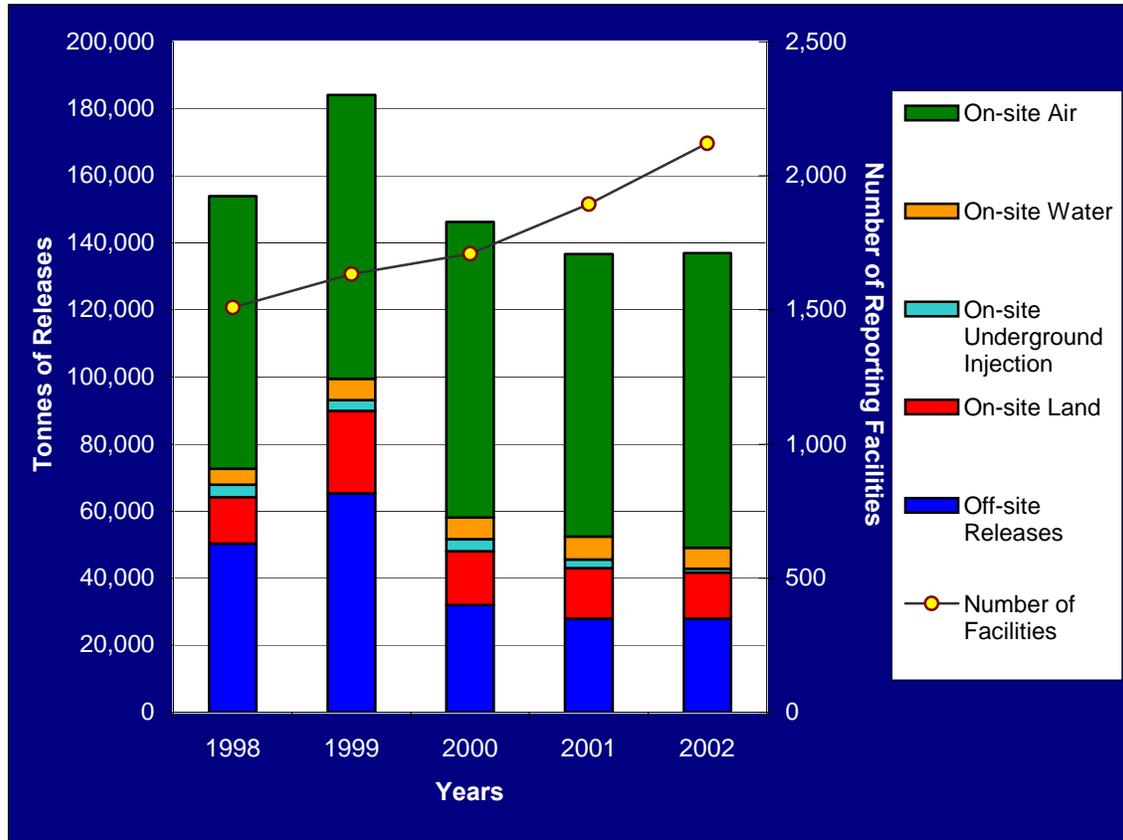
4.4.1 Canada

Canada reports on the pollutant releases for 153 “matched” chemicals—those chemicals reported in the NPRI that are also required to be reported in the United States. Canada also presents additional data on specific substances of concern to children’s health and additional PRTR analyses in Canada’s country report in Volume II of this report.

Chart 4-16 reports **on-site and off-site releases for 153 matched chemicals**, in tonnes, for the period 1998 to 2002. This illustration describes the environmental media to which the chemicals were released and also provides information on the number of facilities reporting for each year.

Chart 4-17 shows total releases, in tonnes, for **on-site and off-site releases for 153 matched chemicals, by industry sector**, for the period 1998 to 2002.

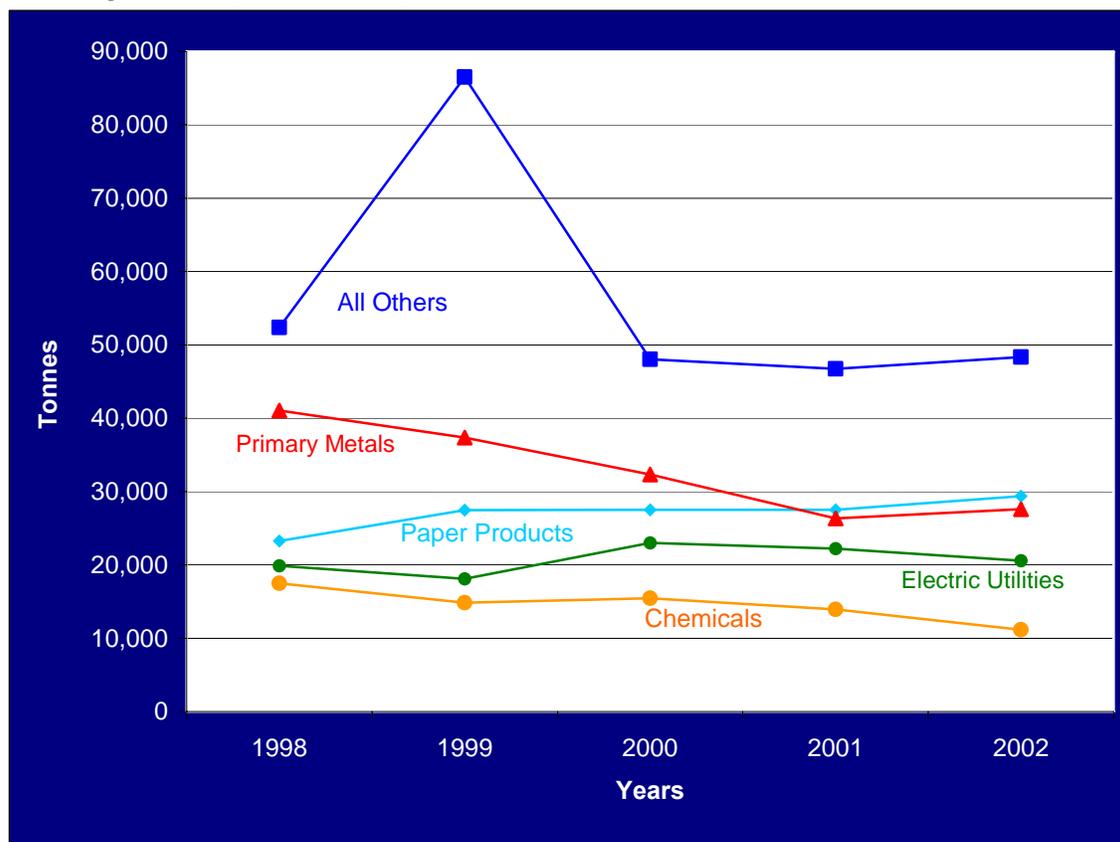
Chart 4-16: On- and Off-site Releases of Matched Chemicals, in Canada, 1998–2002



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the National Pollution Release Inventory (NPRI), Environment Canada. The data shown are from a “matched” data set compiled by the CEC, in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: See Glossary for definitions of on-site air releases, on-site water releases, on-site underground injection, on-site land releases and off-site releases.

Chart 4-17: Total On- and Off-site Releases of Matched Chemicals, by Industry Sector, in Canada, 1998–2002



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the National Pollution Release Inventory (NPRI), Environment Canada. The data shown are from a “matched” data set compiled by the CEC, in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: Industry sectors with largest total releases on- and off-site, 1998.

Key Observations:

- The number of facilities reporting to the NPRI for the matched chemicals set increased by 41 percent between 1998 and 2002, while total releases decreased by 11 percent during this period. Releases to on-site air and water increased, while releases to on-site underground injection and off-site transfers (primarily transfers to landfills) decreased and on-site land releases were about the same in 1998 and 2002 (Chart 4-16).
- Of the four industry sectors with the largest total releases in 1998, the primary metals and chemical manufacturing sectors reported reductions in releases of the matched set of chemicals of 33 percent and 36 percent, respectively between 1998 and 2002 while the paper products and electric utilities sectors both reported increases, of 26 percent and 4 percent respectively, over the same period (Chart 4-17).

4.4.2 Mexico

To date, Mexico has no information for this indicator, due to the fact that the contributions of information from Mexican companies to the RETC are currently voluntary and the percentage of companies reporting is small. Legislation was enacted in 2001 for a mandatory, publicly accessible PRTR, and in June 2004 the implementing regulations were passed; thus Mexico will likely be in a position to present information on this indicator in future reports.

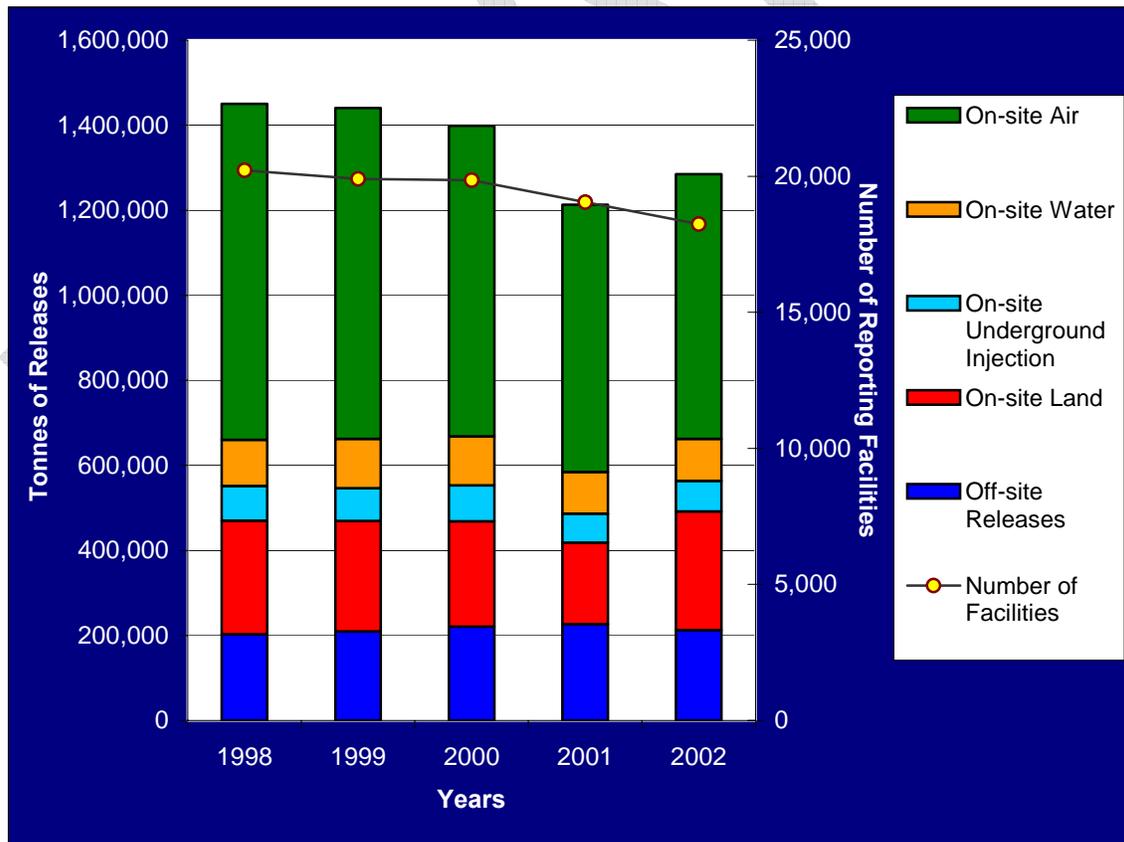
4.4.3 United States

The United States reports on the pollutant releases for 153 “matched” chemicals—those chemicals reported in the TRI that are also required to be reported in Canada.

Chart 4-18 reports on-site and off-site releases for 153 matched chemicals, in tonnes, for the period 1998 to 2002. This illustration describes the environmental media to which the chemicals were released and also provides information on the number of facilities reporting releases for each year.

Chart 4-19 reports the total releases on-site and off-site releases for 153 matched chemicals, by sector, for the period 1998 to 2002.

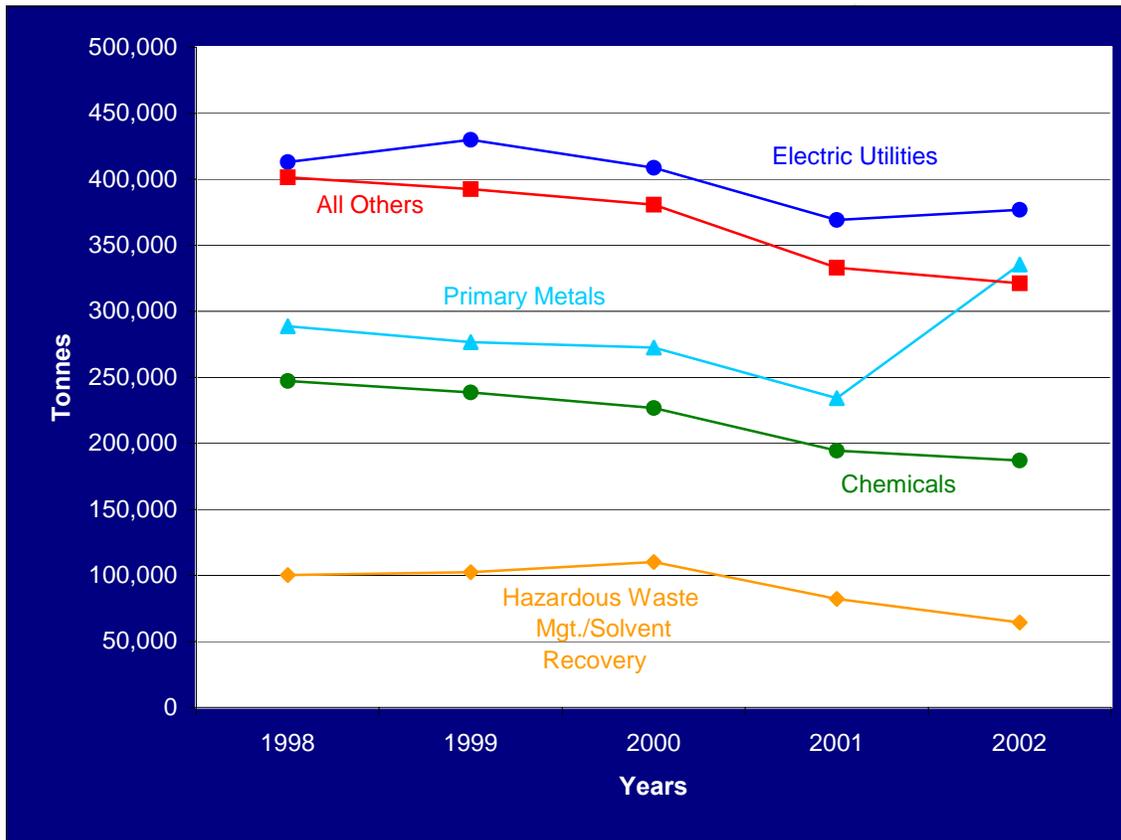
Chart 4-18: On- and Off-site Releases of Matched Chemicals, in the United States, 1998–2002



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the Toxics Release Inventory (TRI), US EPA. The data shown are from a “matched” data set compiled by the CEC, in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: See Glossary for definitions of on-site air releases, on-site water releases, on-site underground injection, on-site land releases and off-site releases.

Chart 4-19: Total On- and Off-site Releases of Matched Chemicals, by Industry Sector, in the United States, 1998–2002



Source: Data compiled by the CEC from a subset of original Pollutant Release Transfer Register data from the Toxics Release Inventory (TRI), US EPA. The data shown are from a “matched” data set compiled by the CEC, in which only data that are comparable between the Canadian NPRI and the US TRI are included.

Note: The chart depicts industry sectors with the largest total releases on- and off-site, in 1998.

Key Observations:

- The total facilities reporting releases of the 153 matched chemicals decreased over the reporting period 1998 to 2002, as did the total releases, which went from a high of 1,45 million tonnes in 1998 to a low of 1,21 million tonnes in 2001 but then increased to 1,28 million tonnes in 2002, for an overall decrease of 11 percent from 1998 to 2002. There were reductions in releases to on-site air, water and underground injection, with on-site land and off-site releases (primarily transfers to landfills) showing an increase (Chart 4-18).
- The electric utilities sector reported the largest total releases and showed a decrease of 9 percent from 1998 to 2002. The primary metals sector, the second largest sector,

reported an increase of 16 percent in releases over the same time period. The chemical manufacturing sector and the hazardous waste management sectors reported the third and fourth largest total releases, with overall decreases of 24 percent and 36 percent respectively. The other industry sectors combined, the “all others” category (which includes, among others, the food, paper, transportation equipment and plastics manufacturing industries), had about 401,000 tonnes of releases in 1998 and about 321,000 tonnes in 2002 (Chart 4-19).

DRAFT

4.4.4 Opportunities for Strengthening PRTR-based Indicators in North America

The indicator on industrial releases of selected chemicals features the use of pollutant release and transfer register data from Canada and the United States. The anticipated availability of mandatory PRTR data in Mexico will be an important step towards making this indicator reportable for all of North America. Other improvement efforts that are underway include the CEC's Action Plan to Enhance the Comparability of PRTRs in North America, adopted by the CEC Council in June 2002, under which the three countries are working together to improve the comparability of their PRTR data (available online at <www.cec.org>). As PRTR data from the three national systems become more comparable, we will get a clearer picture of the sources and management of pollutants that arise from industrial activities across North America.

- The indicator could be strengthened if countries could develop a priority list of matched chemicals of specific concern to children's health (e.g., carcinogens, developmental toxicants, neurotoxicants).
- Obtaining data on releases from smaller facilities could improve the quality of these indicators.
- PRTR data combined with monitoring data of ambient levels of pollutants in the environment (air, water and soil) would improve our understanding of the presence of these chemicals in the environment, potential sources and potential exposure levels.
- Estimation of non-point sources of pollutants (agriculture, transportation) would complement the point-source data available from the national PRTRs and thereby create a more complete picture of sources of toxic substances in North America.
- Geographically-referenced PRTR data could be combined with population data to get an indicator of surrogate exposures to the listed substances. Such an indicator could identify geographic areas of concern where nations might take action to reduce emissions of some chemicals. It is important to note that PRTR data are an input to determine exposure or calculate potential risks to human health and the environment, but by themselves are insufficient to indicate risk.
- Ensuring comparable reporting under the Mexican RETC (i.e., similar reporting thresholds and coverage of industrial sectors) is needed, in order to have trilateral comparability for this indicator in future reports.

4.5 Pesticides

Purpose: This indicator provides information on children’s potential exposures to pesticides.

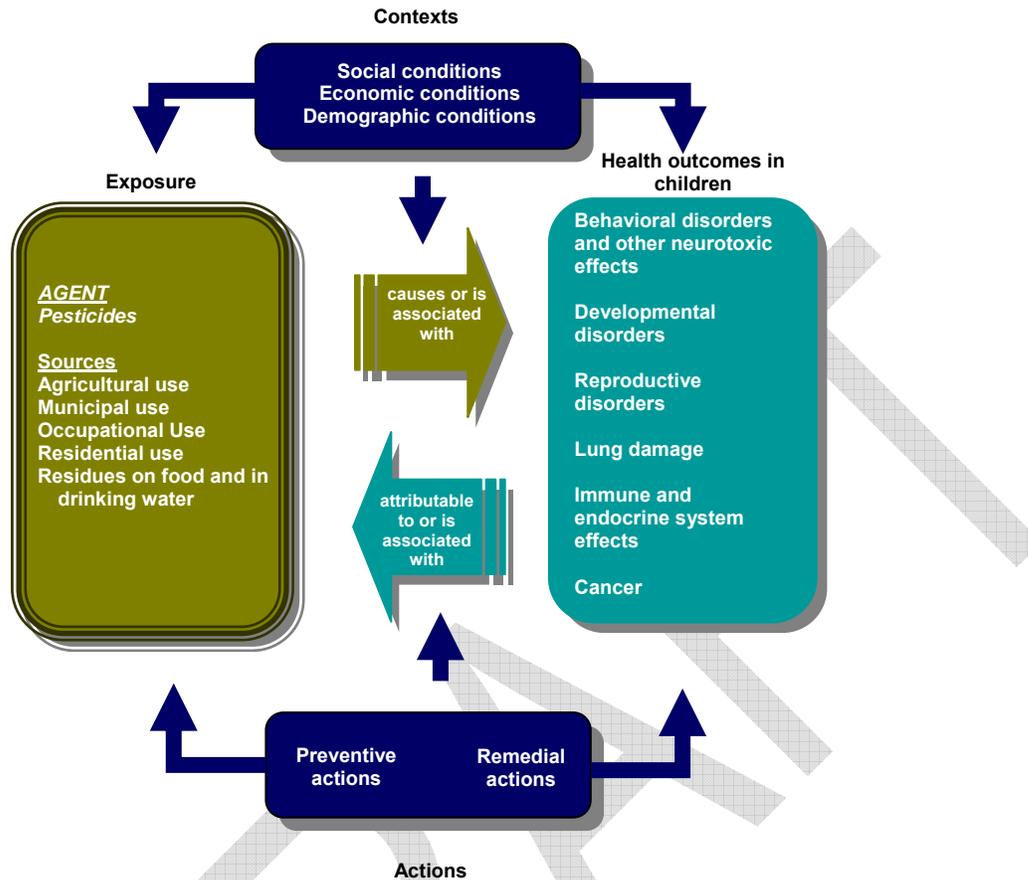
CEC Council target indicator: “Pesticides (body burden, residue levels on food, or use).”

Current indicator: Pesticide residues on foods.

Pesticides are in widespread use in North America and pesticide residues can be found in outdoor as well as indoor environments. Children can be exposed to pesticides in water, air, soil, and diet. Diet, via pesticide residues on food, is recognized as an important source of exposure (National Research Council 1993). Children may have greater exposure to pesticides than most adults, due to their eating habits and behaviors. Pound for pound, children eat more than adults and their diets contain foods which tend to have higher levels of pesticide residues, such as fruits and vegetables. Children’s behaviors may increase their potential for exposure. Behaviors such as crawling and mouthing increase their exposure to outdoor and indoor pesticide residues in or on grass, soil or house dust.

Pesticides vary in their potential to cause harm to children. Organophosphates, which are used in the production of many foods consumed by children can interfere with the proper functioning of the nervous system when exposure is sufficiently high (US EPA 2003). Other pesticides, depending on the extent of exposure (i.e., dose) may cause a range of adverse effects on human health, including cancer, acute and chronic injury to the nervous system, lung damage, reproductive dysfunction, and possibly dysfunction of the endocrine and immune systems (National Research Council 1993).

Figure 7: MEME Framework for Issues Covered in the Section on Pesticides



Source: Adapted from Briggs 2003.

The MEME model in Figure 7 illustrates that while food and water are important sources of exposure, other sources of pesticide exposure also contribute to a child's total body burden. Pesticides are used widely in agriculture in Canada, Mexico and the United States. Contamination of drinking water supplies is one means of exposure, as are exposures from over-spray and plant and soil residues. In some cases, children may be present in the fields where their parents work and thus be exposed to pesticides. In other cases, children may be exposed from parents bringing pesticide residues home on their persons. This type of exposure may occur primarily in rural agricultural communities. In larger urban centers, pesticide use tends to be associated with lawn care (outdoor) and insect management (indoor).

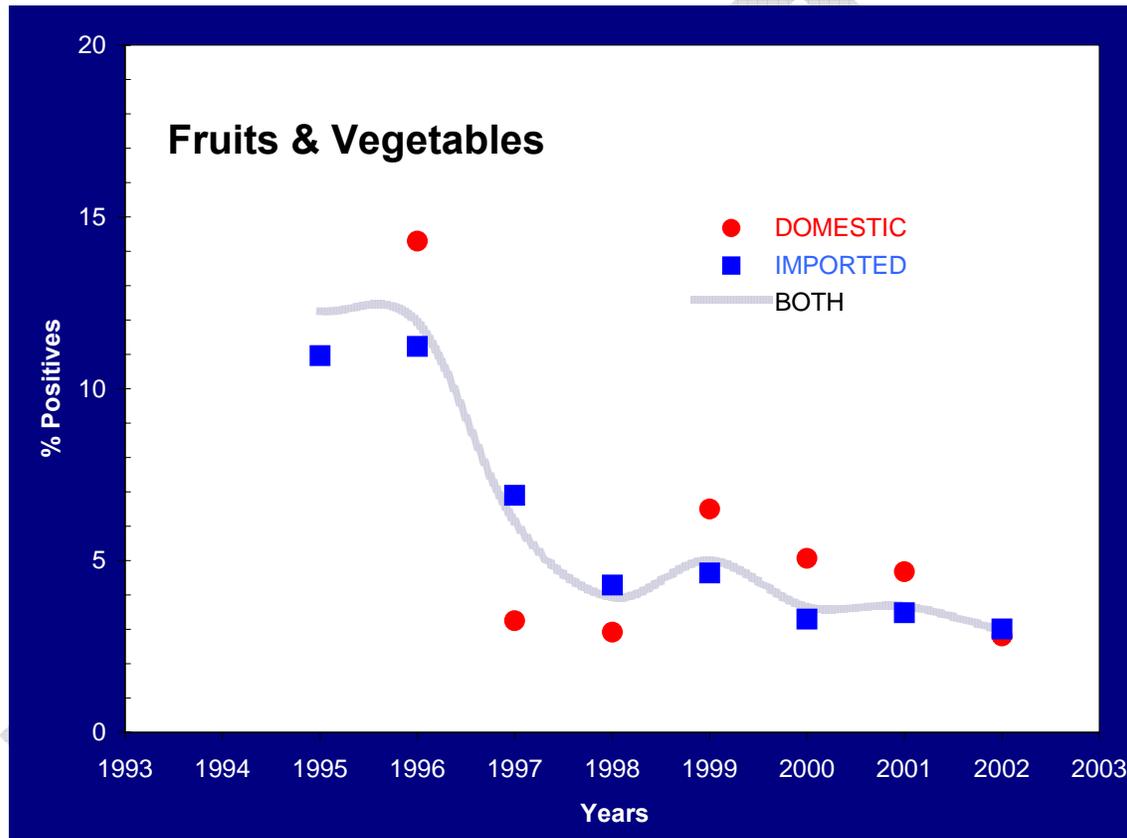
In this section, Canada and the United States provide data on detectable levels of organophosphate residues on food. Canada presents the percentage of tested samples of fresh fruit and vegetables (imported and domestic) with detectable organophosphate residues for the period 1995 to 2002. The United States provides data on detectable quantities of organophosphate residues on fruits, vegetables and grains for the period 1994 to 2001. The Canadian and US data are exposure surrogate indicators, as they represent the potential for exposure to pesticide residues on food (ingestion). Mexico provides trend data for acute pesticide poisonings for adults and for children under the age of 15 years. This is an exposure indicator, as the cases were reported to medical facilities; but there was no tracking of specific health effects. It should be noted that poisonings are acute events and are not an indicator of potential exposure levels for the general population and/or children.

4.5.1 Canada

Canada reports on the indicator by using data from chemical residue annual reports, 1995–2002, from the Canadian Food Inspection Agency. The indicator uses a yearly number of organophosphate pesticides detected on domestic and imported fruits and vegetables, expressed as percentage of sample size.

Chart 4-20 shows the **percentage, by weight, of sampled fresh fruit and vegetables with detectable organophosphate pesticide residues**, for the period 1995 to 2002.

Chart 4-20: Percentage of Sampled Fresh Fruits and Vegetables with Detectable Organophosphate Pesticide Residues, in Canada, 1995–2002



Source: Canadian Food Inspection Agency, Food Safety Directorate, Food Microbiology and Chemical Evaluation, Chemical Residue Annual Reports, 1995–2002.

Key Observations:

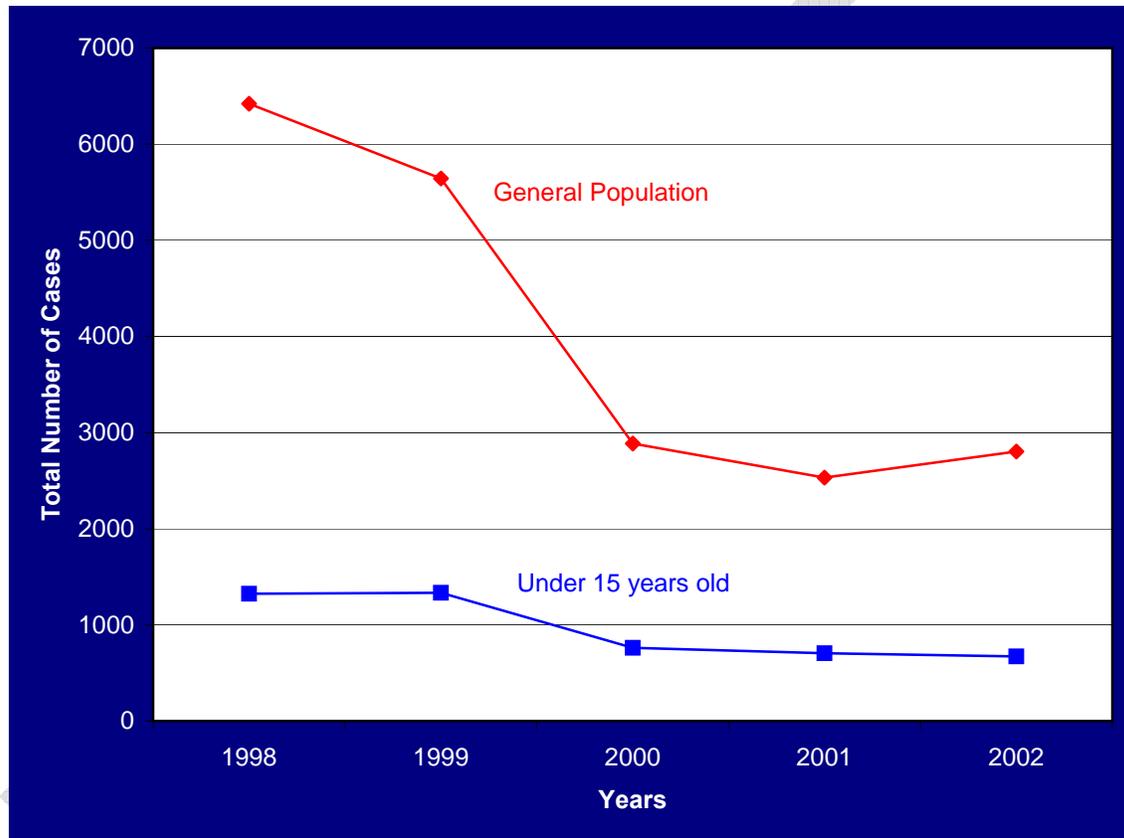
- From 1995 to 2002 the percentage of fresh fruits and vegetables with detectable organophosphate pesticide residues has decreased, suggesting reduced exposure from this source (Chart 4-20).

4.5.2 Mexico

Mexico is able to present data on the current indicator by using data on pesticide poisoning from health care facilities. In Mexico, incidents of pesticide poisonings are required to be reported to a level I or II health care facility.

Chart 4-21 presents **cases of pesticide poisonings in children and the general public**, for the period 1998 to 2002.

Chart 4-21: Cases of Pesticide Poisonings in Children (under 15 years old) and the General Public, in Mexico, 1998–2002



Source: *Sistema Único de Información de Vigilancia Epidemiológica*.

Key Observations:

- There were 6422 pesticide poisonings reported in 1998. A steady decline to 2802 in 2002 was observed (Chart 4-21).
- For poisoning cases recorded in children under the age of 15, the number decreased from a high of 1335 in 1999 to a low of 672 in 2002 (Chart 4-21).

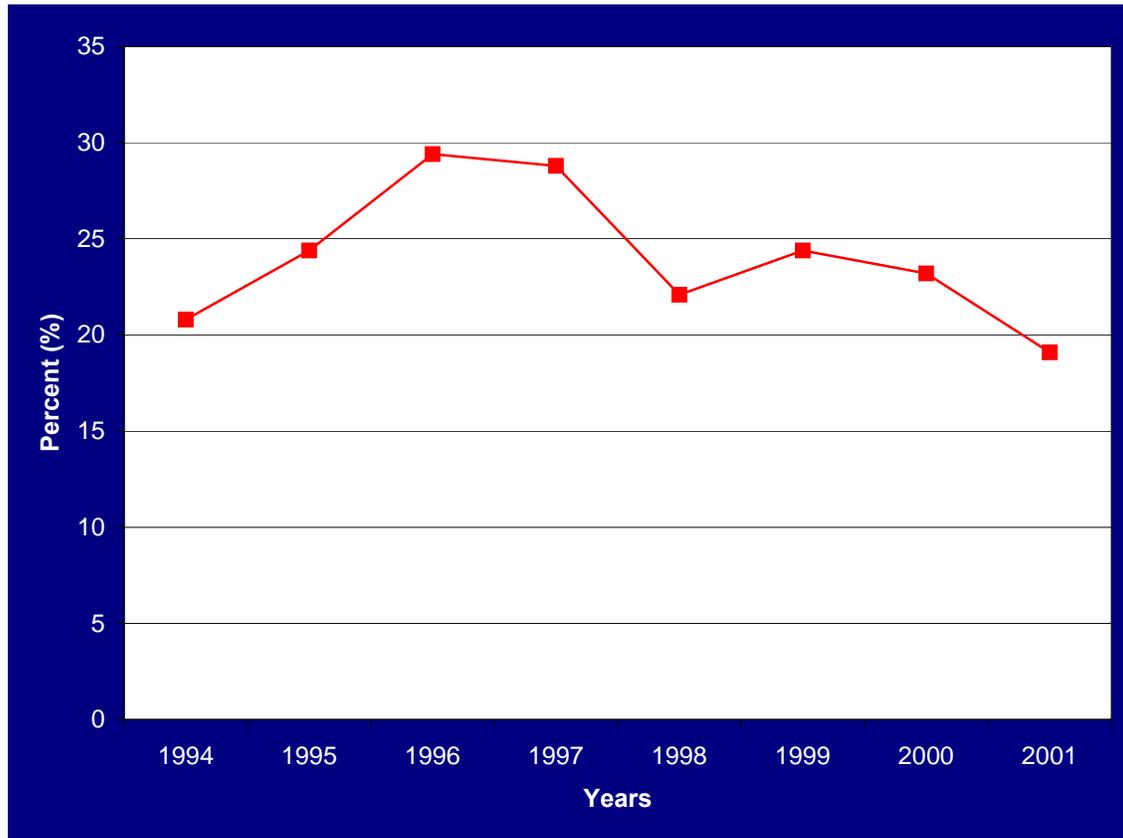
4.5.3 United States

The United States is able to present on the current indicator by using data on organophosphate pesticides from the US Department of Agriculture's Pesticide Data Program. Among the foods sampled by the Pesticide Data Program in recent years are several that are important parts of children's diets, including apples, apple juice, bananas, carrots, green beans, orange juice, peaches, pears, potatoes, and tomatoes.

The chart below displays the percentage of food samples with detectable organophosphate pesticide residues reported by the Pesticide Data Program from 1994 to 2001. The 34 organophosphates that were sampled in each of these years are included; other organophosphates that have been added to the program in recent years are excluded so that the chart represents a consistent set of pesticides for all years shown. This measure is a surrogate for children's exposure to pesticides in foods: If the frequency of detectable levels of pesticides in foods decreases, it is likely that exposures will decrease. However, this measure does not account for many additional factors that affect the risk to children. For example, some organophosphates pose greater risks to children than others do, and residues on some foods may pose greater risks than residues on other foods due to differences in amounts consumed. In addition, year-to-year changes in the percentage of samples with detectable pesticide residues may be affected by changes in the selection of foods that are sampled each year. It is important to note that having the technical ability to measure pesticide residues does not equate to a health risk.

Chart 4-22 shows the **percentage of fruits, vegetables and grains with detectable residues of organophosphate pesticide** reported from 1994–2001.

Chart 4-22: Percentage of Fruits, Vegetables and Grains with Detectable Residues of Organophosphate Pesticides, in the United States, 1994–2001



Source: US EPA 2003. *America's children and the environment: Measures of contaminants, body burdens and illnesses.* <www.epa.gov/envirohealth/children>.

Key Observations:

- Between 1994 and 2001, the percentage of food samples with detectable organophosphate pesticide residues ranged between 19 percent and 29 percent. The highest detection rates were observed during 1996 and 1997, while the lowest detection rate was observed in 2001 (Chart 4-22).
- Between 1993 and 2001, the amount of organophosphate pesticides used on foods most frequently consumed by children declined by 44 percent, from 11.3 million kilograms to 6.35 million kilograms (data not shown) (Doane Marketing Research 1993–2001).

4.5.4 Opportunities for Strengthening Indicators of Children's Exposure to Pesticides in North America

The measures presented provide two different approaches to monitoring pesticide exposures. The following bullets outline steps towards a more ideal indicator of pesticides exposures in children.

- Biomonitoring programs in each country, measuring the levels of pesticides and/or their metabolites in children's blood and urine, would provide the best measure of a child's exposure to pesticides from multiple sources.
- National surveillance programs for pesticide use in agriculture, the home, schools and elsewhere could provide important information on the potential routes of exposure of children to pesticides. The measurement of multiple exposures and resulting body burdens and effects in children would greatly enhance understanding and reporting in this area.
- Health effects surveillance could provide additional information on the adverse health effects in children associated with pesticide exposure.
- Data from poison-control centers and emergency clinics for pesticide poisonings, like that reported by Mexico, should be examined for potential use in the future.
- Data from state/provincial information systems to develop case study reports from exposure to pesticides should also be examined for potential use.

5.0 Waterborne Diseases

Children who are exposed to contaminants in drinking water may experience a range of health effects, depending on the nature of the contamination. Pathogens such as *E. coli* are an important source of risk to the health of children. Children's developing immune systems may not be able to protect them from an exposure that could result in serious illness and even death (even people with fully developed immune systems can still experience serious adverse effects from exposure to *E. coli*). Other contaminants found in drinking water, such as lead, may cause a range of diseases in children, including developmental effects, learning disorders, and cancer (US EPA 2003). Sources of water contamination can include leachate from landfills, runoff of pesticides and fertilizers from agricultural operations, effluent or spills from industrial and other sources, and municipal sewage (Canada, Environment Canada 2004).

The indicators presented in this chapter address a number of potential environmental health risks for children including microbial and chemical contaminants. Data and trends are provided on the percentages of the population that are served by drinking water treatment systems and sewage removal systems, respectively. Measures of illness and death linked to waterborne pathogens are also presented.

Section 5.1 provides measures of the availability and quality of drinking water. National data and trends for access to treated drinking water are presented by Canada and Mexico. The United States presents data on children living in areas where drinking water standards were exceeded, as well as children living in areas where drinking water monitoring and reporting requirements were violated.

Section 5.2 presents data on the availability of sewer systems, which is an important component of reducing biological contamination of the water supply and thereby preventing illness from waterborne diseases. In this section, Mexico reports on the availability of sewer systems over time in Mexico.

Section 5.3 focuses on the morbidity and mortality associated with waterborne pathogens. Canada and Mexico present data and trends on incidence of giardiasis in children. Mexico also presents infection rates for cholera infections and mortality data associated with waterborne diseases. The United States presents data on waterborne disease outbreaks.

5.1 Drinking Water

Purpose: The indicators in this section provide information on the percentage of children potentially exposed to contamination and/or pathogens in drinking water.

CEC Council target indicators:

1. "Percentage of children (households) served with treated water." (The percentage of children is expressed as households containing children.)
2. Percentage of children living in areas served by public water systems in violation of local standards.

Current indicators:

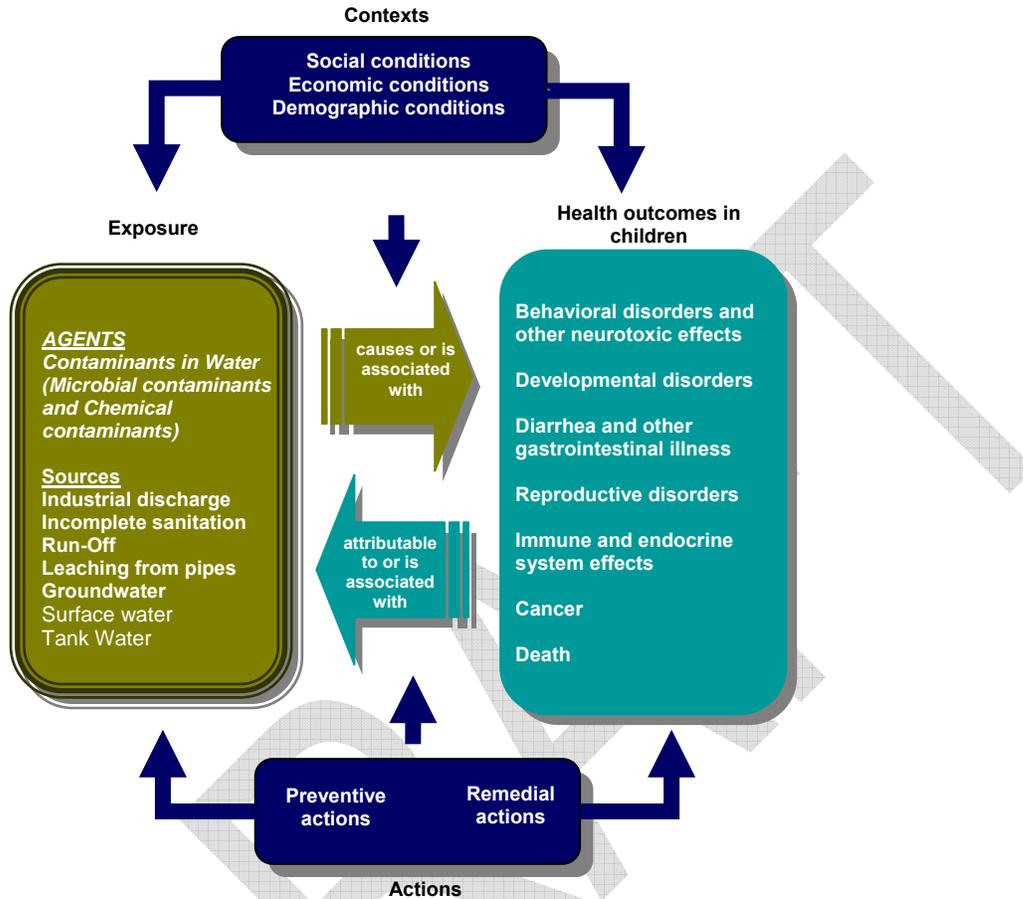
1. Percentage of children (households) without access to treated water. (For reasons of consistency, the target indicator was revised to track lack of access.)
2. Percentage of children living in areas served by public water systems in violation of local standards.

Access to clean water is critical in order to reduce the risk of exposure to microbials, chemicals, and radionuclides that are of concern to children's health. Contaminants can be responsible for a wide range of health effects in children. Children are sensitive to microbial contaminants, such as *E. coli*, because of their developing or suppressed immune systems.

Chemical and radionuclide contaminants found in water can produce a wide range of health effects, depending on the contaminant, its concentration and the duration of the exposure. Contaminants such as lead, which has recognized developmental toxicity, and arsenic, which can lead to cancer and other health effects, are some examples. Other metals that are of concern include mercury and cadmium, which are also toxic to children and adults. Nitrates and nitrites which stem from fertilizer use and animal and human waste can cause methemoglobinemia ("blue baby" syndrome) (US EPA 2003).

As the MEME model in Figure 8 suggests, there are other situations that may place children at risk to exposure of contaminated drinking water. For example, households and communities that rely on the use of ground water (i.e., well water) or surface water that is not pre-treated for removal of pathogens and other contaminants may be at greater risk of exposure to contamination. In Mexico, the availability of water is also a key determinant of risk. Residents of regions with limited supplies of water, such as remote rural areas, may have to store water in household cisterns or storage tanks, which can lead to contamination from improper sealing or cleaning. Residents in these same areas in Mexico may also be forced to use contaminated water and, in extreme cases, may not have water available for washing (especially hand washing), leading to increased risk of transmission of disease.

Figure 8: MEME Framework for the Issues Covered in the Section on Drinking Water



Source: Adapted from Briggs 2003.

Canada, Mexico and the United States have standards or guidelines that are designed to protect the health of the public from contaminants found in drinking water (US EPA 2003, see Canada's and Mexico's Country Reports). These standards are monitored and enforced for public water delivery systems but typically do not cover private wells, which are found more frequently in rural and remote communities. In some cases, as in the United States, regulations have been established to protect drinking water sources and to require water treatment where safety standards cannot be met. These rules apply to all drinking water sources. National rules vary, in terms of the contaminants that are included and the acceptable levels in drinking water. In some cases they are legally enforceable, while in other cases they are intended as guidelines. Therefore, caution is necessary when attempting to compare indicator results between countries.

Each of the indicators presented addresses the availability of safe drinking water either through measures pertaining to water treatment (e.g., disinfection processes such as chlorination, ozonation, and filtration) designed to kill bacteria and other pathogens, or through reporting on populations served by water systems that violate the existing regulations for safe drinking water. It is important to note that not being served by a centralized water system does not itself imply a risk. Some of the people not served by treated water may have access to water of good quality

from private wells or smaller systems, thus this indicator needs to be interpreted with caution (US EPA 2003).

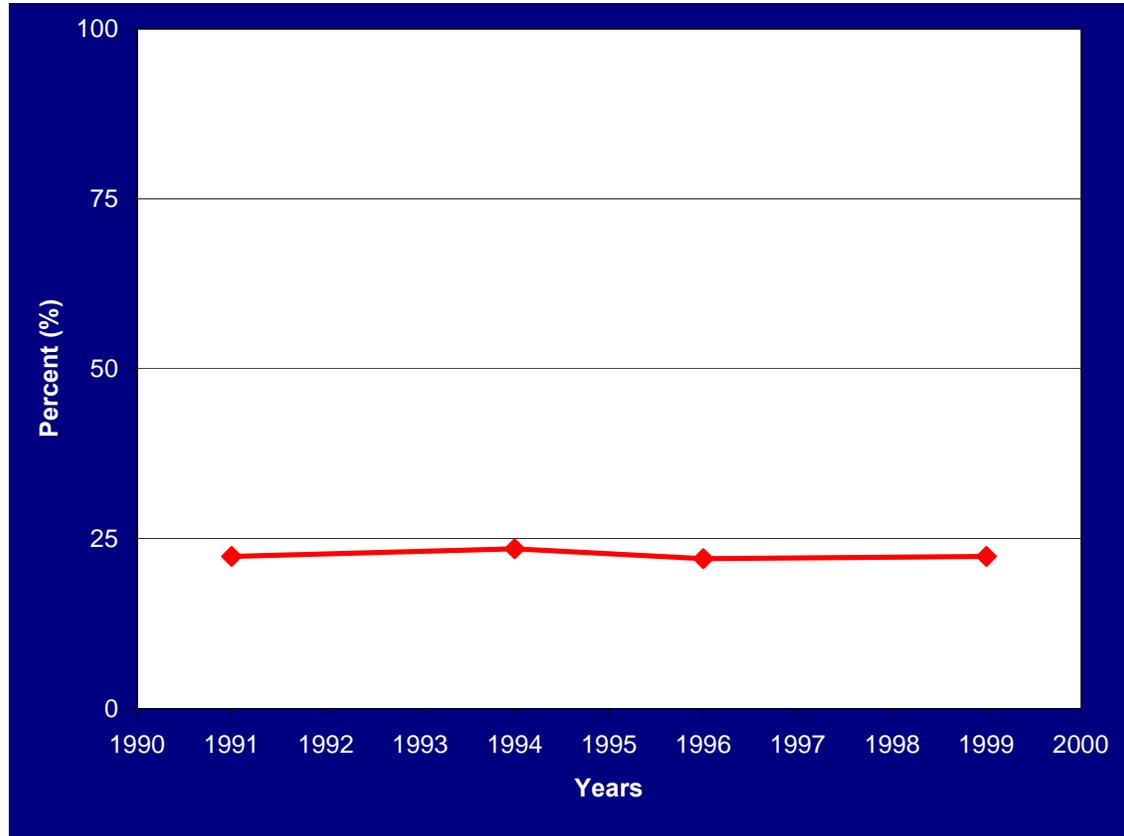
5.1.1 Canada

Drinking water pretreatment reduces the risk of exposure to waterborne bacteria and in some cases reduces or eliminates other contaminants.⁷ Canada is unable to present child-specific data for the first indicator (percentage of children, expressed as households containing children, without access to treated water); instead, Canada presents information on the portion of the general population that is not connected to public water distribution systems. Reporting on the second indicator (percentage of children living in areas served by public water systems in violation of local standards) is not currently possible as Canada does not have information at the national level, related to water system with violations.

Chart 5-1 shows the percentage of Canadians not connected to public water distribution systems. The trend is based on 1991, 1994, 1996 and 1999 data and does not include the child-specific population, or information on populations that rely on well water.

⁷ The contaminants that are removed are a function of the technology that is used to treat the water; for example, disinfection does not remove chemical contaminants.

Chart 5-1: Percentage of Canadians Not Connected to Public Water Distribution Systems, 1991, 1994, 1996 and 1999
Figure 9: MEME Framework for the Issues Covered in the Section on Sanitation



Source: Municipal Water Use Database, Environment Canada (consulted December 2003) and Statistics Canada, 2002 (for total population).

Note: It is assumed that Canadians not surveyed by the Municipal Water Use Database (MUD) survey, living in municipalities with a population below 1,000, are served by private water systems, mostly groundwater wells.

Key Observations:

- The percentage of Canadians with access, in their home, to water obtained from a private individual source has remained constant at about 22–23 percent, between 1991 and 1999. This represented about 6.8 million Canadians in 1999 (Chart 5-1).
- Canadians not connected to public water distribution systems live mostly in rural areas. Nationally, it is not known how many people have wells that are subject to contamination or how many treat or disinfect their water before consumption (Chart 5-1).

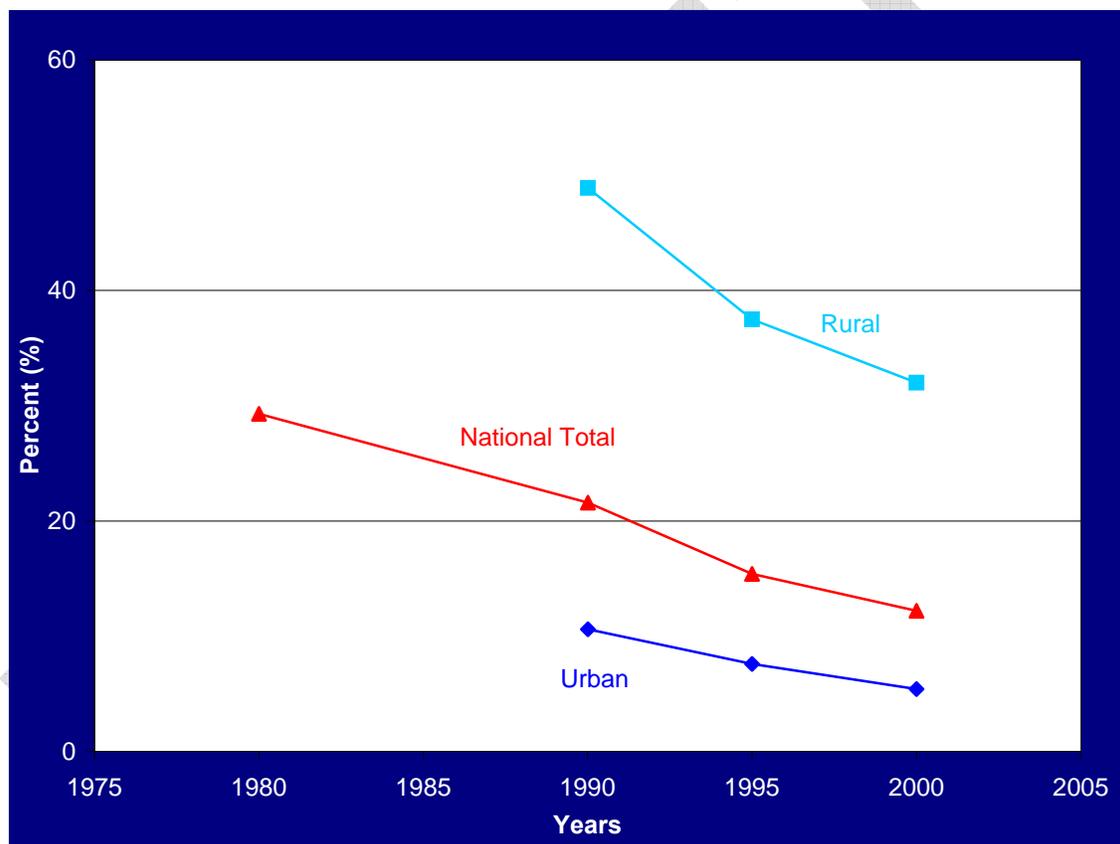
5.1.2 Mexico

Mexico is unable to present child-specific data on the first indicator (percentage of children [households] without access to treated water), but is able to present data on the percentage of the general population without access to clean water. Mexico does not present information on water systems with violations.

Chart 5-2 shows the **percentage of the population without potable water**. The trend is presented for the years 1980, 1990, 1995, and 2000.

Chart 5-3 presents the **percentage of the population without piped water**, by state, based on 2000 Mexican census data.

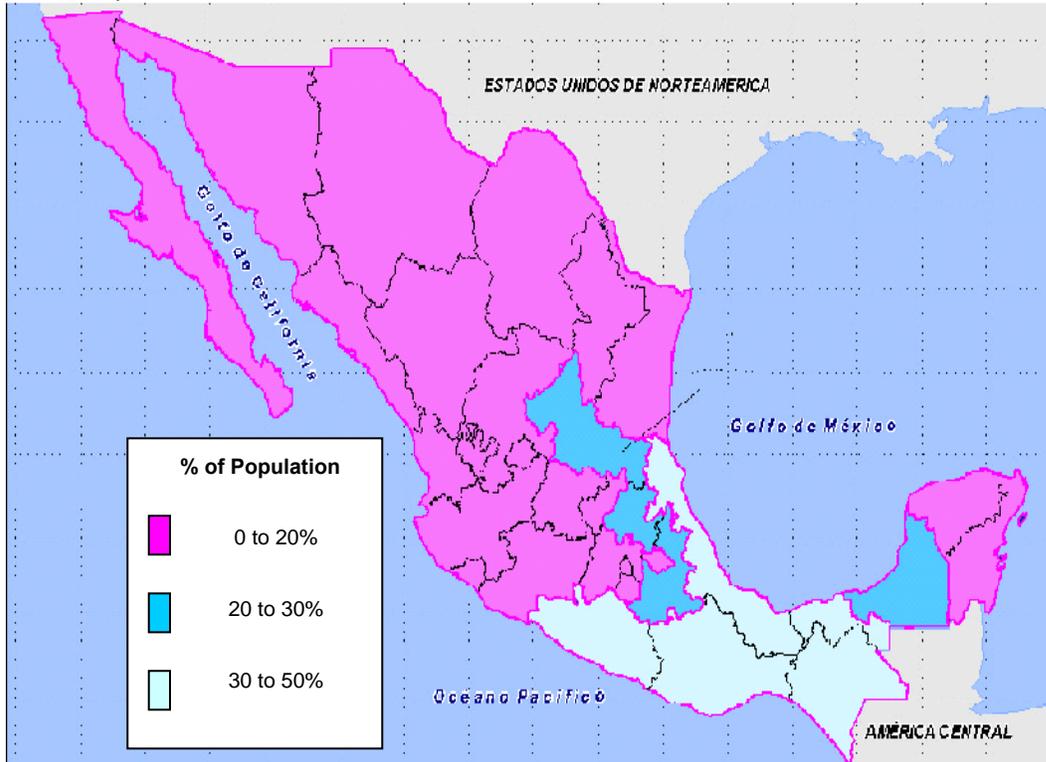
Chart 5-2: Percentage of the Population without Potable Water, in Mexico, 1980–2000



Source: Based on database of XII General Census of Population and Housing, 2000, *Instituto Nacional de Estadística, Geografía e Informática* (INEGI—National Institute of Statistics, Geography and Informatics).

Note: Rural and urban data were not available for 1980.

Chart 5-3: Percentage of the Population without Piped Water, by State, in Mexico, 2000



Source: *Comisión Nacional del Agua* (National Water Commission—CNA).

Key Observations:

- The 1980 Mexican census reported only national figures. National data show a decrease from 29 percent to 12 percent of the general population without access to potable water in the period 1980 to 2000 (Chart 5-2).
- The percentage of the population without access to potable water in urban areas decreased by 5.2 percent, from 10.6 percent in 1990 to 5.4 percent in 2000 (Chart 5-2).
- The percentage of the population without access to potable water in rural areas decreased by approximately 17 percent, from 48.9 percent in 1990 to 32 percent in the 2000 census (Chart 5-2).
- The highest percentage of the population without piped water supply is in the southern states, with 30 to 50 percent of the population without coverage (Chart 5-3).

5.1.3 United States

The United States does not present information on the first indicator (percentage of children [households] without access to treated water). The United States reports on the second indicator by presenting data on the percentage of children served by community water systems for which states have reported violations and the percentage of children living in areas with major violations of drinking water monitoring and reporting requirements.

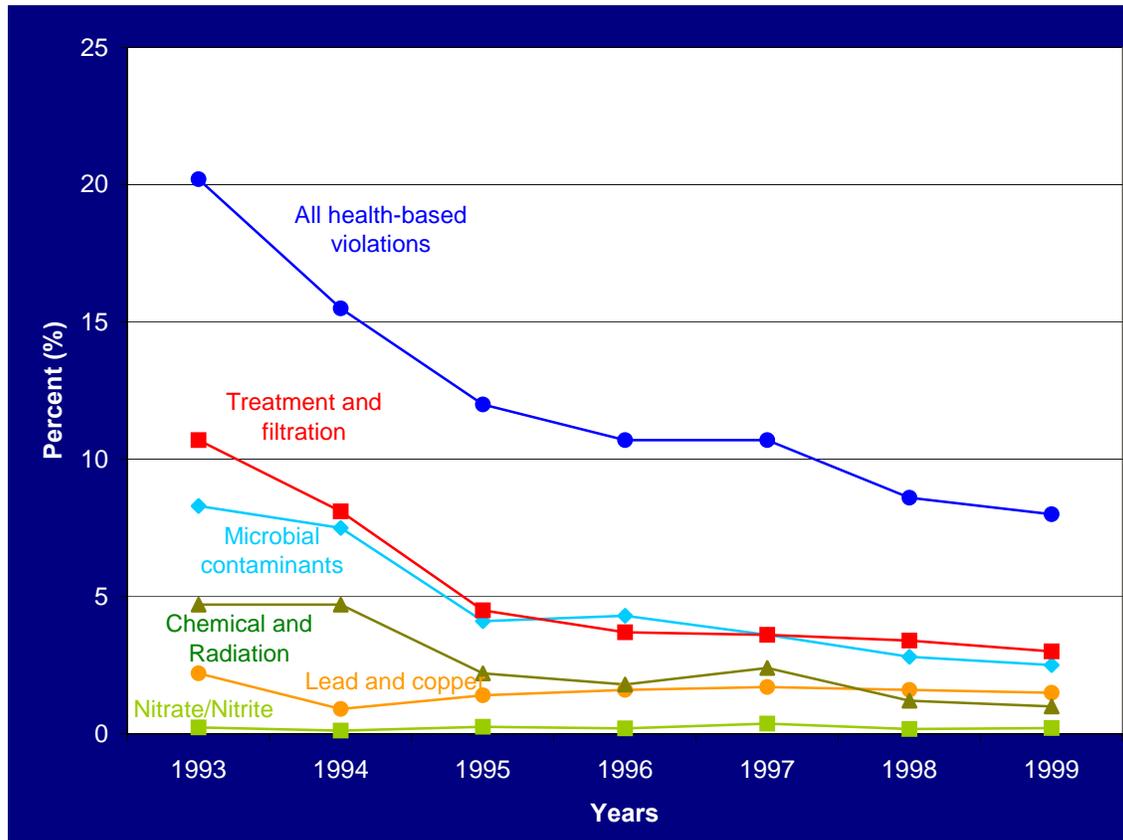
EPA sets drinking water standards for public water systems. These standards are designed to protect people against adverse health effects from contaminants in drinking water while taking into account the technical feasibility of meeting the standard and balancing costs and benefits. Public water systems are required to monitor individual contaminants at specific time intervals to assess whether they have achieved compliance with drinking water standards. When a violation of a drinking water standard is detected, the public water system is required to report the violation to state and federal governments. Information about exceedances can be used as a surrogate for exposure to unacceptably high levels of drinking water contaminants. It should be noted that a violation of drinking water standards does not necessarily mean that drinking water from a system is unsafe—it indicates that on at least one occasion, a water quality standard has been exceeded (see Chart 5-4).

Public water systems are required to monitor for contaminants and to report violations of drinking water standards to EPA. However, some public water systems do not conduct all of the required monitoring. Not all systems report violations. Such water systems violate monitoring and reporting requirements. Some monitoring and reporting violations, such as late reporting, are minor. However, many water systems have major violations. For example, some water systems fail to collect any water samples during specified monitoring periods. Children who live in areas that are not adequately monitoring for water contaminants or reporting violations may be at risk, but the extent of any possible exposures in violations of drinking water standards and their associated risks is unknown (see Chart 5-5).

Chart 5-4 shows the estimated **percentage of children living in areas served by public water systems that exceed a drinking water standard or violate treatment requirements** for which states have reported violations. A seven-year trend is presented for the period 1993 to 1999.

Chart 5-5 presents data on the estimated **percentage of children living in areas served by public water systems with major violations of drinking water monitoring and reporting requirements**, for the period 1993 to 1999.

Chart 5-4: Percentage of Children Living in Areas Served by Public Water Systems that Exceed a Drinking Water Standard or Violate Treatment Requirements, in the United States, 1993–99

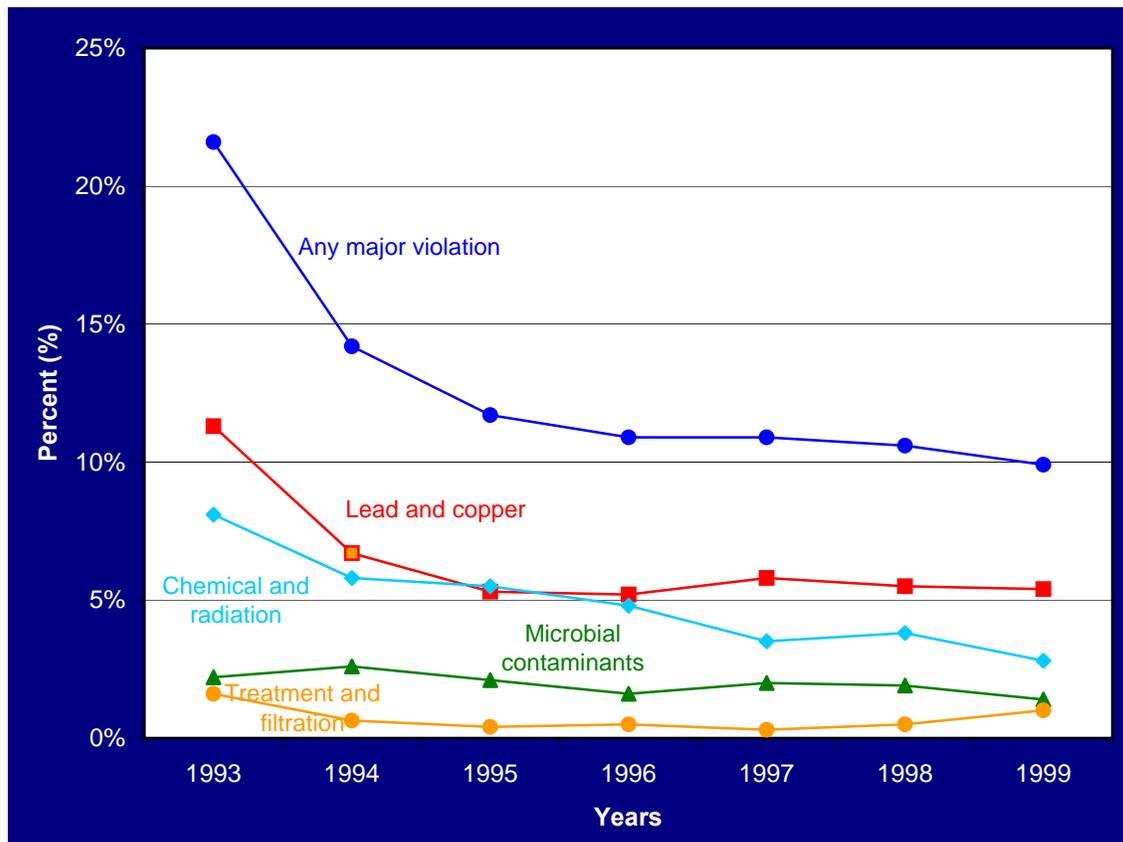


Source: US EPA 2003. *America's children and the environment: Measures of contaminants, body burdens, and illnesses.* <www.epa.gov/envirohealth/children>.

Data Source: Safe Drinking Water Information System. Office of Water, US Environmental Protection Agency.

Note: Percentages are estimated.

Chart 5-5: Percentage of Children Living in Areas Served by Public Water Systems with Major Violations of Drinking Water Monitoring and Reporting Requirements, in the United States, 1993–99



Source: US EPA 2003. *America's children and the environment: Measure of contaminates, body burdens, and illnesses*. <www.epa.gov/envirohealth/children>.

Data Source: Safe Drinking Water Information System. Office of Water, US Environmental Protection Agency.

Note: Percentages are estimated.

Key Observations:

- The percentage of children served by public water systems that reported exceeding a maximum contaminant level or violated a treatment standard decreased from 20 percent in 1993 to 8 percent in 1999 (Chart 5-4).
- Every category of reported violation decreased between 1993 and 1999 except for nitrates and nitrites, which remained steady. The largest decline was for violations of the treatment and filtration standards (Chart 5-4).
- In 1993, approximately 22 percent of children lived in an area served by a public water system that had at least one major monitoring and reporting violation. This figure decreased to about 10 percent in 1999 (Chart 5-5).
- The largest number of monitoring and reporting violations occurred for the lead and copper standards. Approximately 11 percent of children in 1993 were served by public

water systems with monitoring and reporting violations for lead and copper, decreasing to about 5 percent in 1995. The number has remained relatively constant since then (Chart 5-5).

5.1.4 Opportunities for Strengthening Indicators on Availability and Quality of Drinking Water in North America

The following observations and opportunities may be considered to improve the indicators and the comparability among indicators in future reports:

- Comparability in North America could be enhanced if reporting were to be standardized for key measures such as coliform counts, disinfection byproducts, etc.
- Standardization of the reporting cycles for the various data sets used to generate these indicators would be helpful for improving the match-up of data across borders.
- In some cases it was not possible to separate children from adults in the data presented. Aggregate data may be reasonable if the distribution of children in rural and urban areas is uniform. If not, it may be possible to develop surrogate measures for estimating the population of children.
- In Canada, water quality data would need to be collected by each province in a consistent manner to generate comparable data on a national level. Assessment could begin with a selected number of specific water quality standards that are of particular concern to children's health (e.g., certain bacteriological standards, chlorination disinfection byproducts, nitrates).
- All three countries reported a high percentage of the population served by treated drinking water. Future efforts focusing on the populations not served may be more worthwhile, in particular focusing on rural remote communities that are not serviced by sewage treatment or drinking water treatment systems.
- Since the focus of the indicators is on exposure, it may be helpful to categorize the type of water treatment so that reduced exposures to chemicals and/or pathogens can be reported where this technology is available.
- Information on whether safety guidelines and/or regulatory standards have been exceeded is useful for generating indicators. Ideally, such indicators also should describe the frequency and extent of the exceedances, and should specify the level of the safety guideline or regulatory standard in question. It would also be useful to collect the actual measurement data.
- Exceedances of safety guidelines and/or regulations for priority substances of concern to children's health would also be worthwhile if presented geographically.
- Some representation of water quality for groundwater sources (i.e., rural wells) would be helpful to address the rural and remote populations. Ground water quality is especially important in some North American locations.

5.2 Sanitation

Purpose: This indicator provides information on the percentage of children who are potentially exposed to untreated sewage in their immediate surroundings.

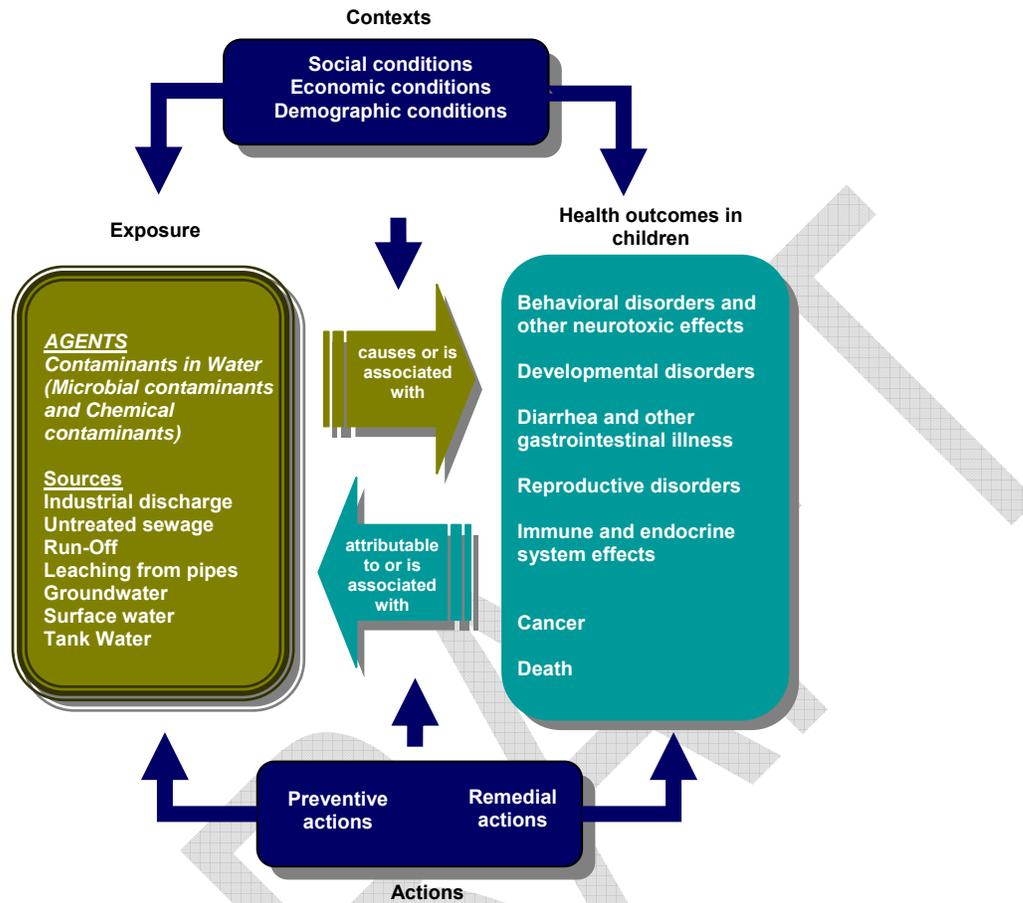
CEC Council target indicator: “Percent of children (households) served with sanitary sewers.” (The percentage of children is expressed as households containing children.)

Current indicator: Percentages of children (households) that are not served by sanitary sewers. (For reasons of consistency, the target indicator was revised to track lack of access.)

Municipal sewage can be an important source of biological and chemical contamination for surface water and groundwater. This contamination presents a potential risk for children who must rely on untreated water for drinking water, bathing and/or swimming. This is especially true in regions where water is in short supply and people are forced to use contaminated water. Therefore, untreated sewage remains an important source of water contamination, presenting potential health risks to children, as illustrated in Figure 9 (see Canada’s Country Report).

In Canada and the United States, most urban and rural communities are served by sewer and sanitation services, or have septic systems to collect and treat sewage. Because of the high percentage of coverage for sewage collection and treatment in both urban and rural environments, Canada and the United States have elected not to report this data in the North American report. However, due to the fact that some opportunities for improvement exist, Canada has presented this indicator in its country report in Volume II of this report.

In Mexico, there remains room for improvement in the availability of sewer collection systems, in particular in rural communities. Thus, Mexico is presenting an exposure surrogate indicator on the percentage of population served with sewer services for rural areas, urban areas and nationally, for the year 2000.



Source: Adapted from Briggs 2003.

5.2.1 Canada

In Canada most urban and rural communities are served by sewers and sanitation services or have septic systems to collect and treat sewage. Because of the high percentage of coverage for sewage collection and treatment in both urban and rural environments, Canada is not reporting this data in the North American report.

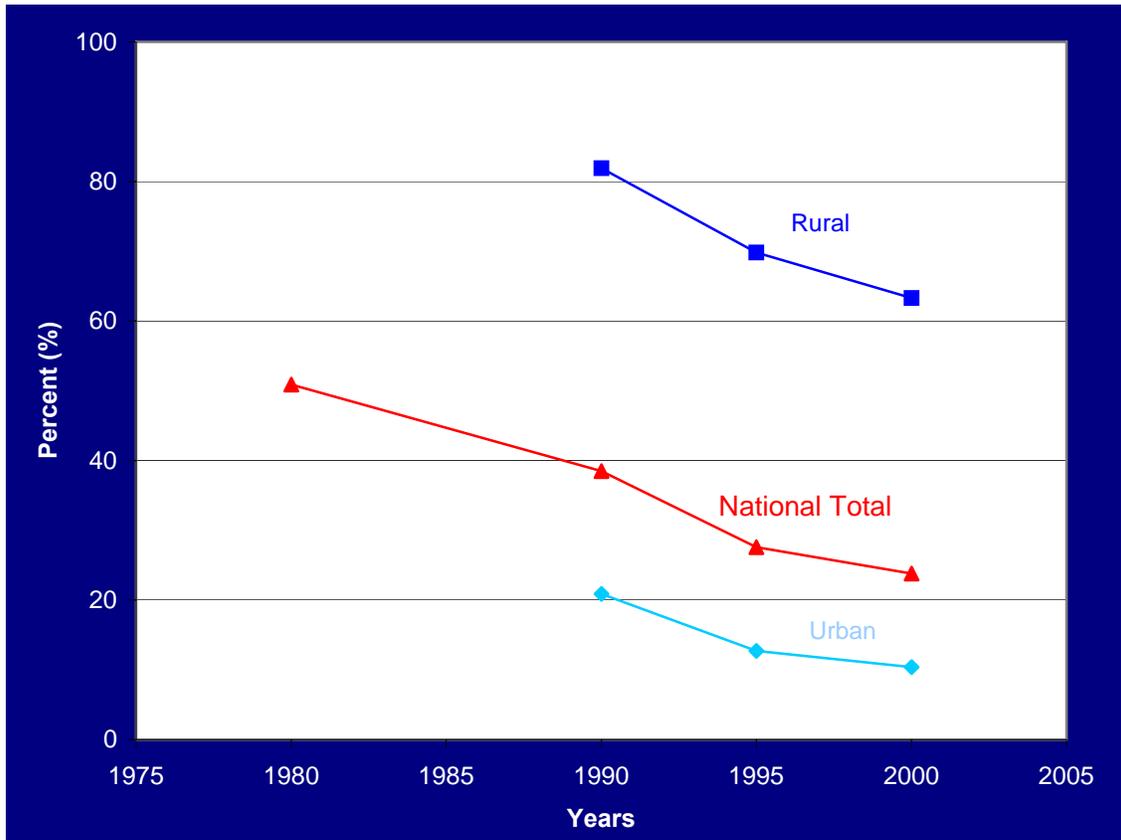
5.2.2 Mexico

Mexico is unable to provide child-specific data, but is able to present data on the households and general population not served by sewage services. Ensuring the adequate management of sewage is a high priority in Mexico, given the relationship between untreated waste and risks of waterborne diseases and, more specifically, the vulnerability of young children to pathogens and other toxic substances in the water.

Chart 5-6 shows the **percentage of the population not served by sewer services**. This 20-year trend is based on census data.

Chart 5-7 shows the **percentage of homes without sewer services, by state**. This information is presented as a map.

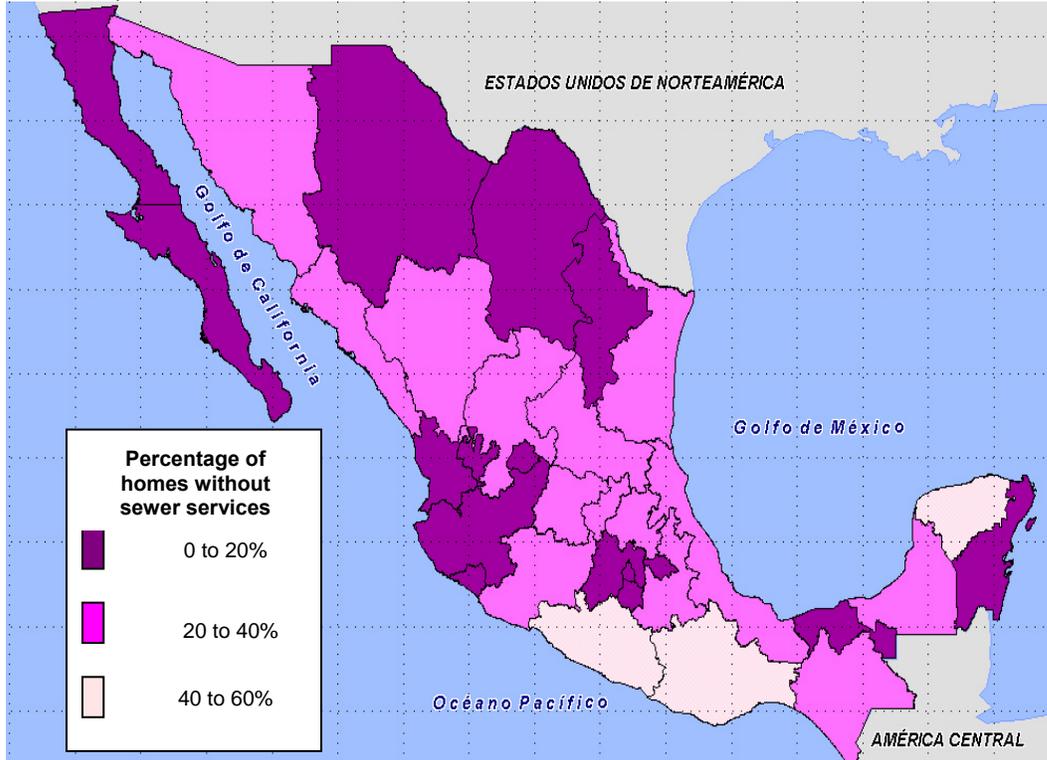
Chart 5-6: Percentage of the Population Not Served by Sewer Services, in Mexico, 1980–2000



Source: Based on database of XII General Census of Population and Housing, 2000, *Instituto Nacional de Estadística, Geografía e Informática* (INEGI—National Institute of Statistics, Geography and Informatics).

Note: Rural and urban data were not available for 1980.

Chart 5-7: Percentage of Homes without Sewer Services, by State, in Mexico, 2000



Source: Instituto Nacional de Estadística, Geografía e Informática (INEGI—National Institute of Statistics, Geography and Informatics) XII General Census of Population and Housing, 2000.

Key Observations:

- The population without sewer service coverage decreased approximately 27 percent nationally, from 50 percent to 23 percent, as reported in the 1980 and 2000 censuses respectively (Chart 5-6).
- Urban areas not covered by sewer services decreased from 21 percent to 10 percent, between collection of 1990 and 2000 census data (Chart 5-6).
- Rural areas without sewer service coverage decreased by approximately 19 percent, from 82 percent in the 1990 census to 63 percent in the 2000 census (Chart 5-6).
- The majority of homes without sewer services are located in southern Mexico, with 40 to 60 percent of households without coverage (Chart 5-7).

5.2.3 United States

In the United States, most urban and rural communities are served by sewage and sanitation services or have septic systems to collect and treat sewage. Because of the high percentage of coverage for sewage collection and treatment in both urban and rural environments, the United States is not reporting this data in the North American report.

5.2.4 Opportunities for Strengthening Indicators on Sewage Systems and Treatment in North America

The following observations and opportunities may be considered to improve the indicators in this area for future reports:

- Data on the populations who are not served by sanitary sewers combined with data on areas where sewage is carried away but not treated (disinfected) would provide a better indication of potential risk of exposure, since untreated sewage effluent also can be a source of exposure.
- Additional reporting potential and comparisons between countries could be improved if the countries were to categorize the level of treatment, i.e., no treatment, or primary, secondary or tertiary treatment. The quality of wastewater effluent is the focus of increasing attention due to the presence of toxic chemicals and pharmaceutical products and metabolites, which pose a potential risk to children, in addition to the presence of biological contamination. Determining the degree of wastewater treatment and reporting on the availability of such treatment systems and their capacity to address these pollutants could strengthen the information contained in future reports.
- An evaluation of the feasibility of separating out data on children from data covering the general population could determine whether such efforts would be worthwhile for future reports.
- Refining reporting to address children's specific exposure scenarios, in terms of recreational water quality or contact with untreated sewage, would provide more meaningful indicators.

5.3 Waterborne Diseases

Purpose: The indicators in this section provide information on children who have been sick from, or have died as a result of, waterborne diseases.

CEC Council target indicators:

1. "Morbidity (number of childhood illnesses attributed to waterborne disease)."
2. "Mortality (number of child deaths attributed to waterborne disease)."

Current indicators:

1. Morbidity: number of cases of childhood illnesses attributed to waterborne diseases.
2. Mortality: number of child deaths attributed to waterborne diseases.

The relationship between exposure to biologically contaminated water and adverse impacts on children's health is well understood. Recent outbreaks of pathogens, together with recent studies, suggest that drinking water may be a substantial contributor to endemic (non-outbreak-related) gastroenteritis (see Canada's Country Report).

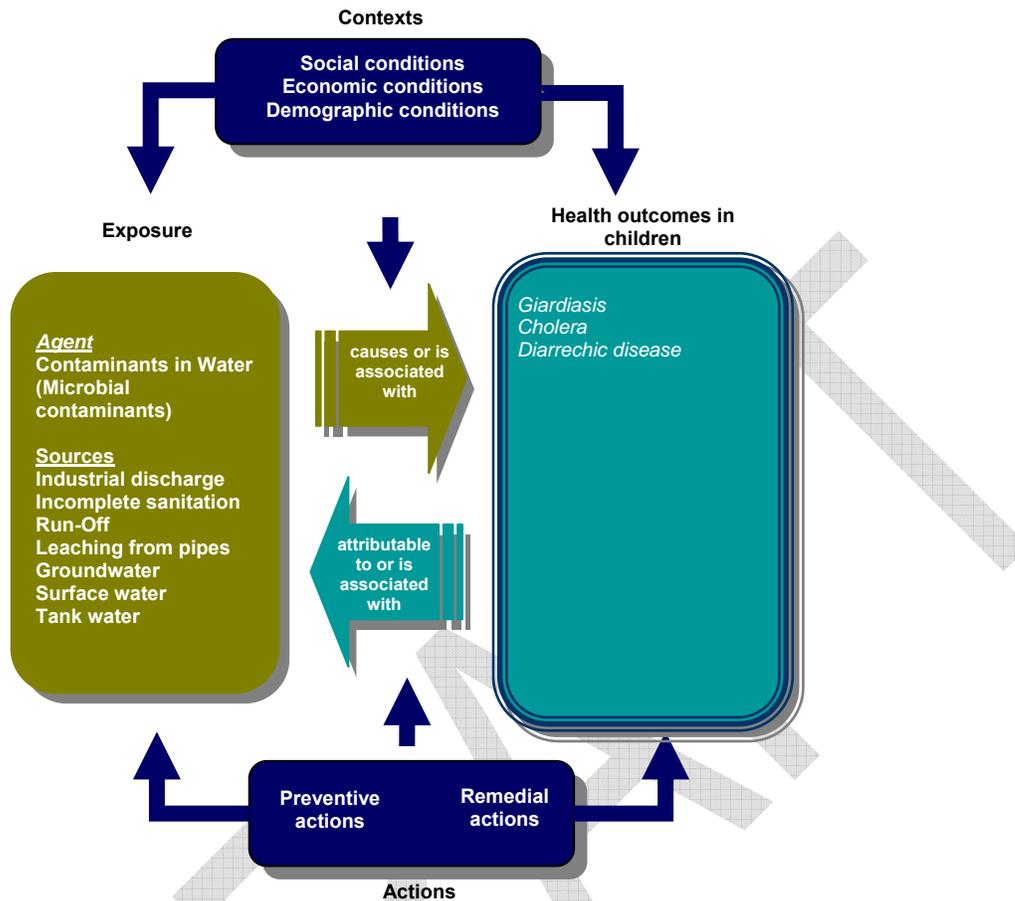
In this section, Canada and Mexico present data on giardiasis infections (caused by the microscopic parasite *Giardia intestinalis*). Mexico also presents data on the percentage of cholera cases that affect children, as well as mortality rates from diarrheic diseases. The United States presents data on voluntarily-reported waterborne disease outbreaks for the whole population, by type of water system. The relationships between environmental exposures and the health outcomes addressed in this section are illustrated in Figure 10.

Giardia is a source of waterborne illness in all three countries and was selected as an indicator due to its greater likelihood to cause illness by water contamination than would *Campylobacter* or other bacteria that are more likely to be food-borne.

Cholera has been a significant public health challenge in Mexico. Diarrhea, which can lead to death in some cases, is a major health outcome associated with waterborne diseases, thus the national mortality rates from diarrheic diseases for children under five years of age are also presented. Advances in the availability of sewers and pre-treatment of drinking water have contributed to reduced incidence of waterborne diseases and illnesses in Mexico.

There are many additional health effects associated with exposure to contaminants found in the water supply. However, waterborne disease was selected because a causal relationship is well established and pathogens are reasonably monitored in all three countries. Despite the presence of monitoring and reporting systems for waterborne diseases, there are inherent difficulties in differentiating cases of waterborne illness from food-borne illness. Identifying the causes of giardiasis was not possible for any of the countries.

Figure 10: MEME Framework for the Issues Covered in the Section on Waterborne Diseases



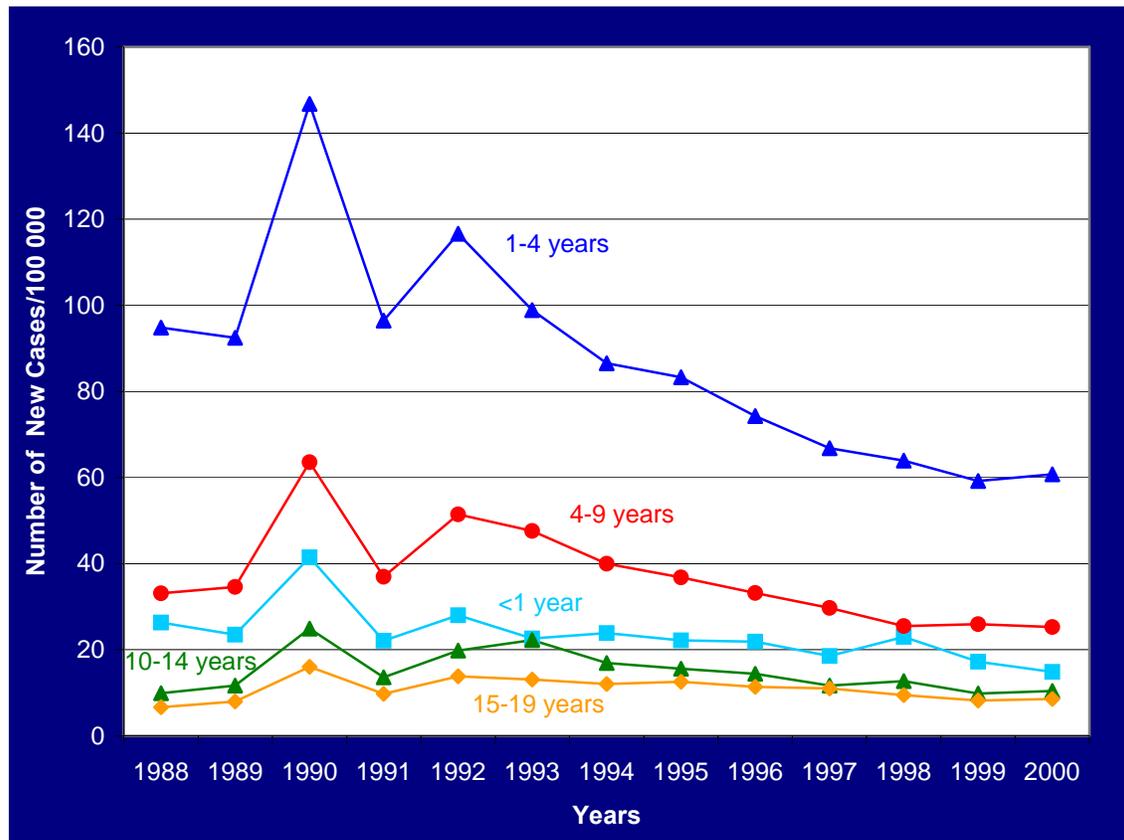
Source: Adapted from Briggs 2003.

5.3.1 Canada

Canada presents data collected on enteric infections by the Notifiable Disease Registry. Physicians report the number of cases of notifiable diseases to provincial/territorial health authorities and, in turn, the provincial/territorial health authorities report the number of reported cases per 100,000 population. Unfortunately, the sources of infection, which may be food-borne or from other sources, are not reliably distinguished from waterborne sources.

Chart 5-8 presents the **incidence of giardiasis among children**. Giardiasis was selected for reporting as it is more likely to be associated with water contamination than *Campylobacter* or other bacteria that are more likely to be food-borne.

Chart 5-8: Incidence of Giardiasis among Children, by Age Group, in Canada, 1988–2000



Source: Notifiable Diseases Registry, Health Canada.

Key Observations:

- The number of reported cases of giardiasis in Canada has been declining since 1988 (with the exception of the age groups 10 to 14 and 15 to 19, which showed an increase).
- Children aged one to four are more likely to be reported as infected with *Giardia*. In 2000, the incidence of giardiasis among children aged one to four years was 60 cases per 100,000. This may be because they are more likely to be brought to a primary care provider and because they are less likely to be breastfed than infants, but more vulnerable to infection than older children. They are also more likely to ingest contaminated recreational water.

5.3.2 Mexico

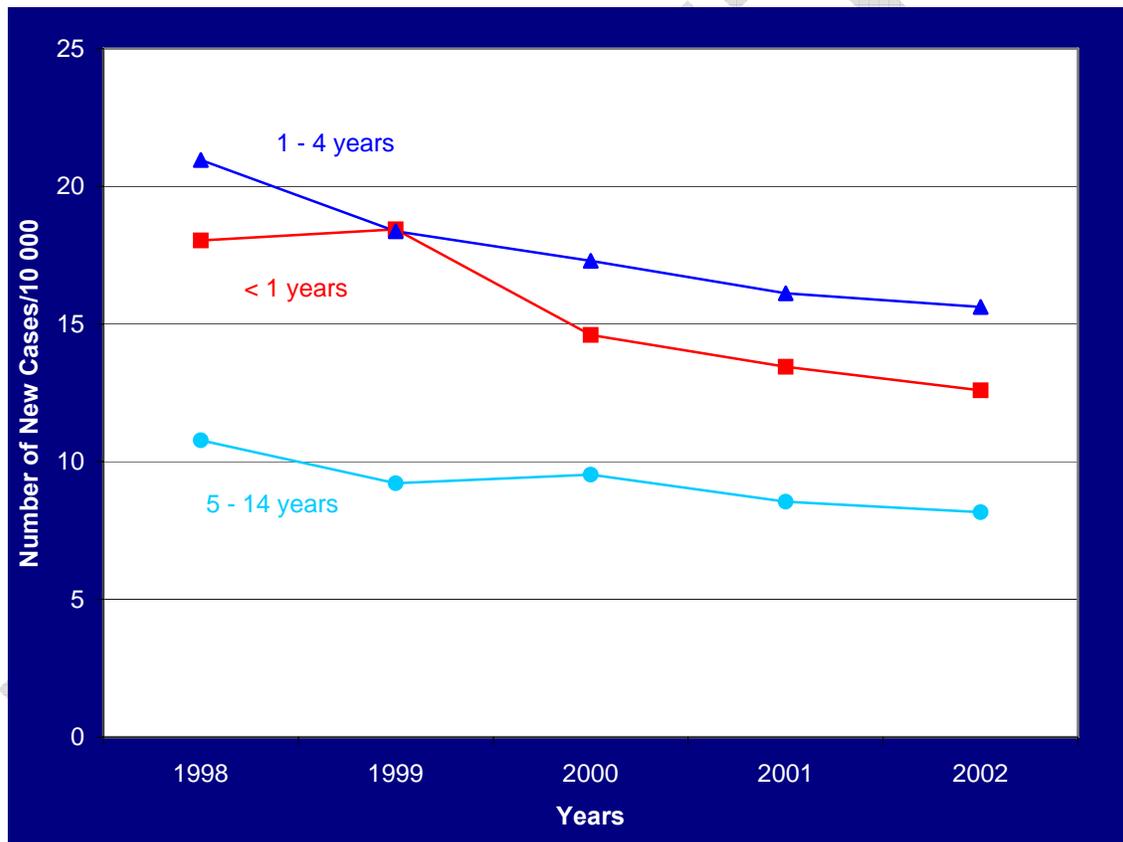
Mexico presents morbidity data on giardiasis and cholera, as well as mortality data on diarrheic disease. The impacts of waterborne diseases in Mexico have continued to fall, with improved coverage of water treatment and wastewater sewage systems. That said, waterborne diseases continue to be a high priority, based on the number of cases of illnesses that are thought to be linked to waterborne pathogens.

Chart 5-9 shows the **incidence of giardiasis** for children under the age of 15. The rate is based on the number of new cases per 100,000 children and the data are provided in a five-year trend for the period 1998 to 2002, for three different age groups.

Chart 5-10 shows the **percentage of cholera cases, by age group**. The trend was provided over an 8-year period, from 1991 to 1998, for three age groups.

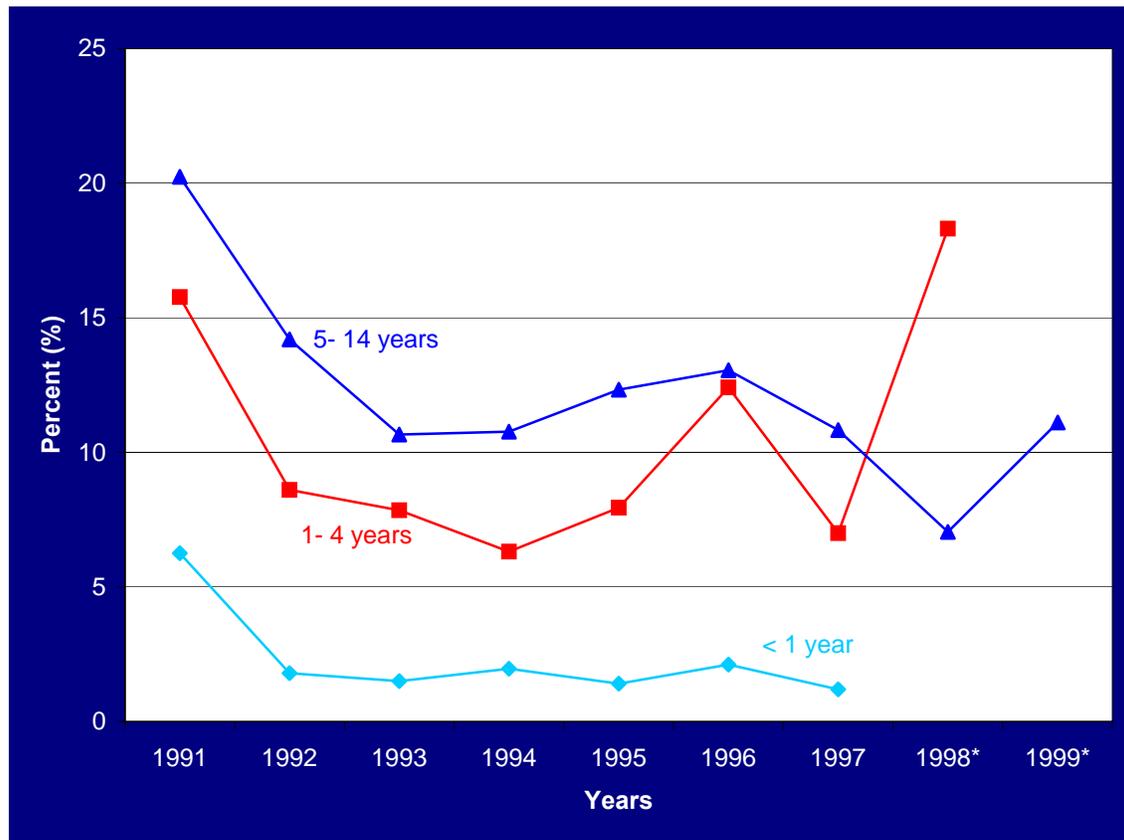
Chart 5-11 shows the **mortality rate from diarrheic diseases in children under five**. This rate is based on the number of cases per 10,000 children, in a 13-year period. While there are numerous potential causes of diarrhea, including contaminated food, the majority of cases are associated with waterborne diseases.

Chart 5-9: Incidence of Giardiasis among Children, by Age Group, in Mexico, 1998–2002



Source: Unique Epidemiological Information System (*Sistema Único de Información Epidemiológica—Suive*). *Secretaría de Salud* (Secretariat of Health—SSa), General Bureau of Epidemiology.

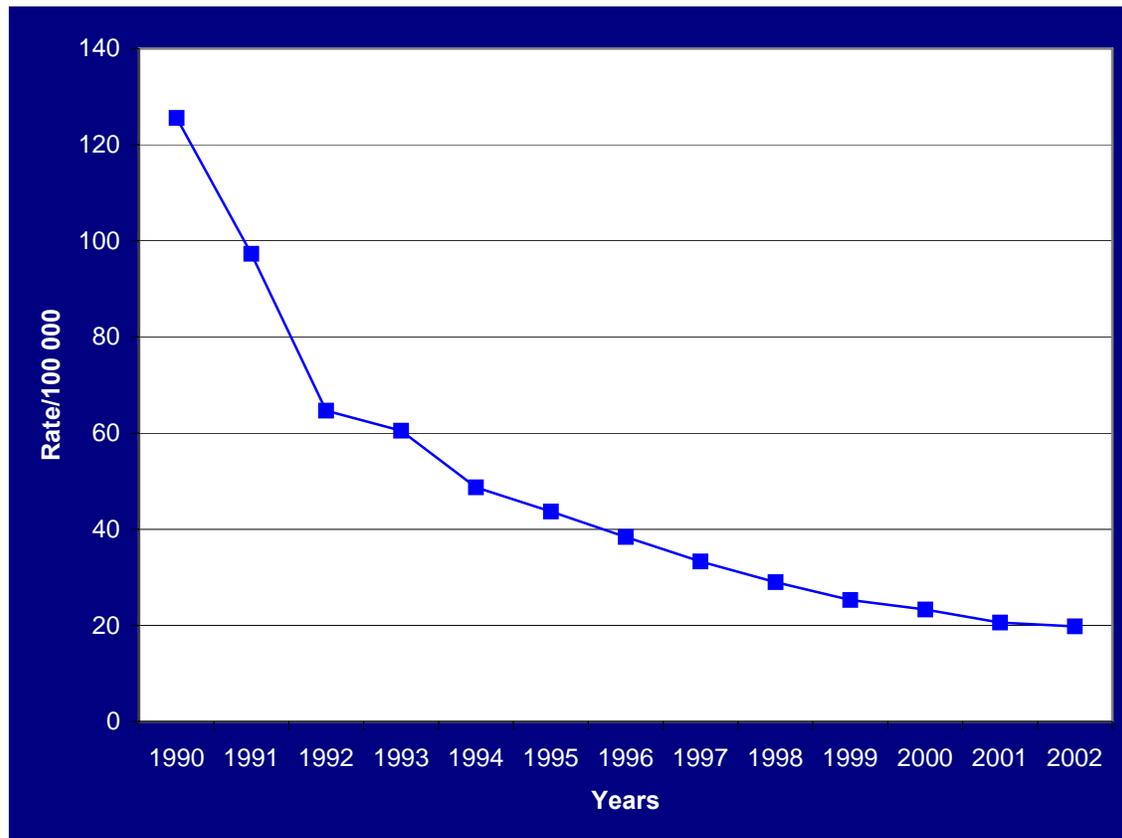
Chart 5-10: Percentage of Cases of Cholera among Children, by Age Group, in Mexico, 1991–99



Source: *Secretaría de Salud* (Secretariat of Health—SSa). Epidemiological Oversight Manual for Cholera (*Manual de Vigilancia Epidemiológica del Cólera*)

Note: * Data for children under one year old not available for 1998 or 1999, nor for one to four year olds for 1999.

Chart 5-11: Mortality Rate from Diarrheic Diseases in Children under five, in Mexico, 1990–2002



Source: INEGI, Dirección General de Estadística (DGE-- Statistics Department), *Secretaría de Salud* (Secretariat of Health—SSa). *Statistical Information Bulletin 1990–2002*. National Population Council (Consejo Nacional de Población—Conapo). *Population Projections 1990–2002*.

Key Observations:

- The epidemiological evidence of giardiasis demonstrates that the most vulnerable group is that of children one to four years old, showing a rate of incidence of 21 per 10,000 children for 1998 and diminishing to 16 in 2002 (Chart 5-9).
- In the group of children below one year of age, the measures implemented for the diarrhea programs have decreased the incidence of giardiasis, from 18 to 13 per 10,000 children, for 1998 and 2002, respectively (Chart 5-9).
- In the period from 1991 to 1998, children under one year of age had the lowest percentage of cases of cholera, with a general downward trend (Chart 5-10).
- The age group most affected by cholera is that from one to four years, with the percentage of cases ranging from 6 percent to 18 percent of all cases (Chart 5-10).
- Cholera declined for the five to 14-year-old age group, from 20 percent in 1991 to 7 percent in 1998. This can be attributed to the growing penetration of disinfected drinking water, and the fact that prevention measures to limit cholera outbreaks were effective in controlling this public health problem (Chart 5-10).

- The rate of mortality from diarrheic disease per 100,000 children under five decreased from 125.6 in 1990 to 33.32 in 1997, representing a reduction of 73.5 percent. This was above the original goal of 50 percent as stated in the World Children's Summit. By 2002, the mortality rate for children under five decreased to 20 per 100,000 children. This is primarily due to specific healthcare actions and the actions in other sectors, principally education and basic sanitation. It should be noted that the phenomenon is worse in marginalized urban and rural areas (Chart 5-11).
- In recent years, the main component in reducing mortality in children under five years of age has been the decrease in mortality from diarrheic diseases. Between 1990 and 1997, 55,043 deaths from such causes have been prevented, and 10,756 more were avoided in 1998 (data not shown).

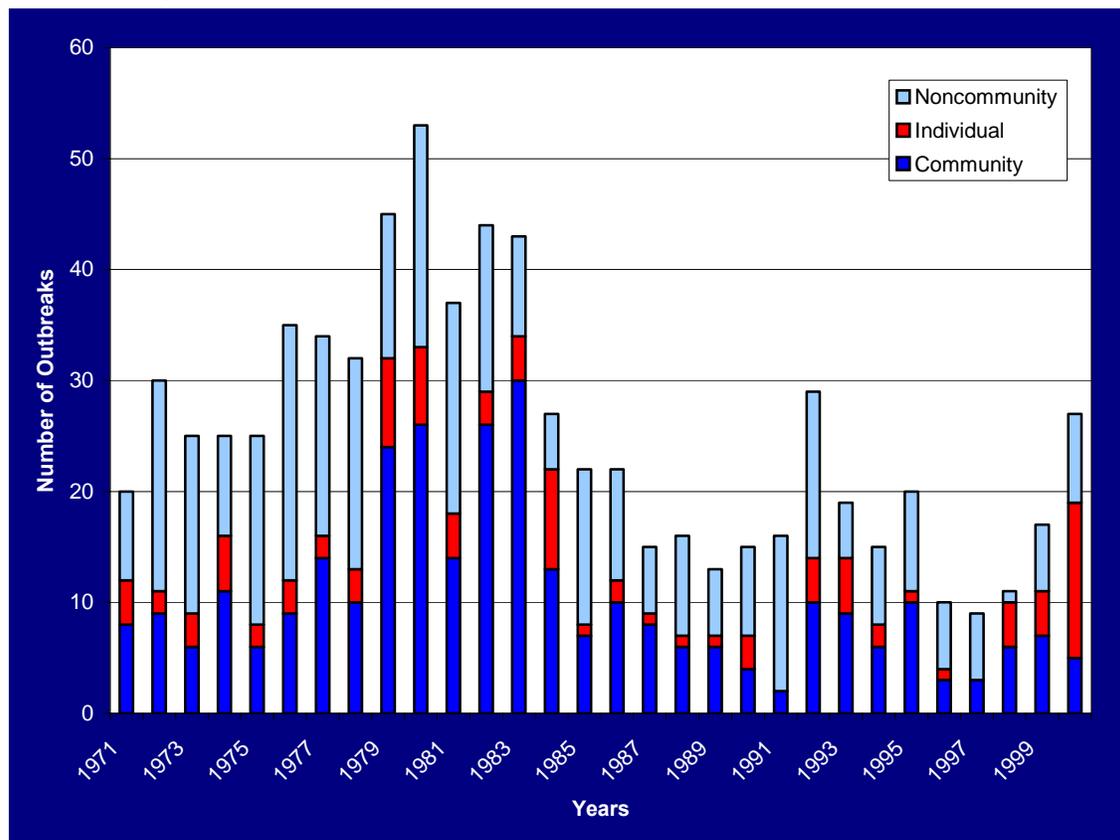
5.3.3 United States

The United States is unable to provide child-specific data for this indicator, but is able to provide data on the number of reported waterborne disease outbreaks for the general population that are associated with drinking water. The data are from a voluntary reporting system, covering the period 1971–2000, and include community water systems, non-community water systems and individual water systems.

Non-community water systems are systems that either: 1) regularly supply water to at least 25 of the same people at least 6 months per year but not year-round (e.g., schools, factories, office buildings, and hospitals that have their own water systems), or 2) provide water in a place where people do not remain for long periods of time (e.g., a gas station or campground). *Individual water systems* are not regulated by the Safe Drinking Water Act and serve fewer than 25 persons or 15 service connections, including many private wells. *Community water systems* provide water to at least 25 of the same people or service connections year-round.

Chart 5-12 shows **waterborne disease outbreaks, by year and type of water system**. These data are for the period 1971 to 2000.

Chart 5-12: Waterborne Disease Outbreaks in the General Population, by Year and Type of Water System, in the United States, 1971–2000



Source: Based on data presented by Craun, G.F., and R.L. Calderon. 2003. Waterborne outbreaks in the United States, 1971–2000. In *Drinking water regulations and health*, Frederick W. Pontius (ed.) (New York, NY: John Wiley & Sons), 40–56.

Note: A waterborne disease outbreak is defined as an event in which: 1) more than two persons have experienced an illness after either the ingestion of drinking water or exposure to water encountered in recreational or occupational settings, and 2) epidemiological evidence implicates water as the probable source of illness.

Key Observations:

- Between 1971 and 2000, there were 751 reported waterborne disease outbreaks associated with drinking water from individual, non-community systems and community water systems (Chart 5-12).
- During 1999–2000, a total of 44 outbreaks (18 from private wells, 14 from non-community systems, and 12 from community systems) associated with drinking water were reported by 25 states (Chart 5-12).

5.3.4 Opportunities for Strengthening Indicators on Childhood Morbidity and Mortality from Waterborne Diseases in North America

The following observations and opportunities may be considered in the effort to improve the indicators presented in this section in future reports:

- Waterborne disease is an area with reasonable evidence linking exposure to waterborne pathogens and the corresponding health effects in children. Yet the experiences of the three countries on reporting waterborne disease highlighted limitations in surveillance activities. Better surveillance and tracking systems are needed. Furthermore, these should be done in such a way to make it possible to distinguish diseases related to water based exposures as compared to those caused by food exposures. Indicators of exposure to other water contaminants, such as chemical contaminants of concern to children's health, could be worthwhile future indicators for future reports.
- Exposure data for priority chemicals of concern to children's health could be a worthwhile future indicator, to broaden the scope beyond pathogens. This indicator would need to be based on environmental water quality testing.
- Waterborne disease outbreak data are available in all three countries but differ considerably across the regions. The following opportunities could provide improved data quality and comparability:
 - Comparability will be enhanced if reporting can be standardized for all waterborne diseases.
 - Standardizing the reporting periods, beginning with the most current year for which all three countries can submit data would help with comparisons. Presenting morbidity data for different age groups would be worthwhile as well.
 - Further categorizing outbreak data to reflect the type of water system involved may provide additional useful information that could aid in defining priorities for action.

6.0 Lessons Learned and Actions Needed

A key focus of this initiative has been to focus on improving children's environments and health, and to bring attention to children's health, through a collective commitment to improve indicators of children's health and the environment in North America. Each country has gained considerable experience through the process of creating this initial report. Opportunities for improvement have been identified in each of the indicator discussions. In the absence of comparable data among the three countries, the use of a flexible approach that allows for the use of available data sets has proven to be critical. The active involvement of officials from the three countries, and their commitment to compiling the country-specific reports on which the North American volume is based, have been other invaluable features of the approach taken. The sharing of data, methodologies and surveillance strategies (i.e., experiences and approaches of the countries and other partners) presents an excellent opportunity for learning from one another. Further efforts should be made to promote improvements based on this collaborative approach.

As this is the first integrated regional effort within the broader context of the Global Initiative on Children's Environmental Health Indicators, led by WHO, there is the potential for sharing the collective experiences and lessons learned from this North American initiative with other interested countries or regions.

Each of the following observations and/or actions will be considered by the participating countries and the other partners. It is important to note that each country has unique circumstances and is at differing stages in addressing children's health and environmental issues and in developing their national and subnational surveillance systems. Thus these lessons and actions will need to be considered within the context of each country's priorities.

Understanding that the reduction/elimination of environmental risks to children's health is the ultimate goal, the following points focus on actions needed to improve our ability to report meaningful and useful indicators.

- Exposure surrogate indicators are an important source of information on potential environmental exposures that could impact on children's health. However, in situations where there is evidence that poor health outcomes result from exposure to environmental contaminants, future indicators should attempt, where possible, to measure and report direct exposures. This approach would require a greater reliance on surveillance activities in all three countries.
- Evidence from biomonitoring programs offers measures of direct exposure (e.g., blood cotinine indicates exposure to nicotine). This information can be extremely valuable to government decision makers in order to target policy and program activity and action to reduce exposures. The use of biomonitoring as a means of identifying and quantifying exposures should be encouraged and the resulting information used to create more specific indicators. The CEC's Sound Management of Chemicals (SMOC) initiative⁸ on blood monitoring of PCBs and metals in women of childbearing age is an encouraging example of regional cooperation in this area and could be built upon and expanded.⁹

⁸ For more information on the CEC's SMOC program, please see the pollutants and health section of the CEC website at <www.cec.org>.

⁹ CEC's Sound Management of Chemicals (SMOC) initiative will monitor the blood of women of childbearing age for metals in the categories (a) As, Cd, Co, Ni, Pb; (b) Be, Cu, Sn, Tl, Zn; and (c) Hg; and for persistent organic pollutants (POPs) in the categories (a) PCB congeners 28, 52, 99, 101, 105, 118, 128, 138, 153, 156, 170, 180, 183, and 187; and (b) OCS: Aldrin, cis-chlordane, trans-chlordane, pp'-DDE, pp'-DDT, dieldrin*, heptachlorepoxide*, hexachlorobenzene, α -hexachlorocyclohexane (α -HCH, or Lindane), mirex, cis-nonachlor, trans-nonachlor, oxychlordane.

- Exposure to environmental contaminants is higher for some segments of society than others. These particularly vulnerable sub-populations may also suffer the compounding effects of poverty, poorer nutrition and lack of access to health care. Improved surveillance associated with specific vulnerable sub-populations, including aboriginal children, children of ethnic minorities, and children in families who are economically disadvantaged, should be a priority for future reports.
- The relationship between federal governments, state/provincial and municipal governments and the multiple agencies addressing health and environment issues for all segments of society is an important consideration of future improvement efforts. Increased involvement at state/provincial levels of government in future compilation of the indicators may enhance data availability in some cases.
- Greater efforts to collect relevant health effects data from health information systems could enhance national surveillance in each country. Improved surveillance data would enhance the tracking of health effects indicators on topics such as waterborne morbidity and mortality, and asthma. Regional cooperation should also be promoted to ensure that surveillance systems generate comparable information (e.g., through the use of common data elements, synchronized data collection and similar periodicity of data collection).
- Health outcome indicators are constrained by our limited knowledge of cause and effect relationships between environmental contaminants and associated health outcomes in children. This is particularly challenging given that many of these exposures result from chronic low-dose exposures beginning in the womb. Further investment in research to improve knowledge in specific areas of concern for children's health should be a priority for all governments, and for the region. Regional cooperation and building upon the research investigations of the US National Children's Study should be pursued.
- Information on whether safety guidelines and/or regulatory standards have been exceeded is useful for generating indicators. Ideally, such indicators also should describe the frequency and extent of the exceedances, and should specify the level of the safety guideline or regulatory standard in question.
- Indicators which report prevalence and incidence offer different information useful to understanding and interpreting the progress of disease and disorders (e.g., asthma). This report reflects a greater use of prevalence data. However, to the extent that indicators will continue to evolve there may be more focus on indicators of incidence in the future.
- The current list of indicators is recognized as a starting point based on what was feasible for the initial report. The indicator set should be expanded over time as the current list is not sufficient to address all known environmental risks to children's health. Moreover, indicator development needs to keep up with the rapidly evolving epidemiological research in this field, as scientists continue to find associations between environmental exposures and child health outcomes.
- In addition to addressing the data gaps identified in the report, the countries should work together to develop specific action plans to address comparability of indicators of children's health and the environment such as data collection methodologies, comparability of time periods for data collection and action levels, etc.

All three countries recognize that the primary goal is to ensure that our children are healthy by preventing harmful environmental exposures and thereby reducing related diseases. The development and use of indicators play an important role in identifying where disease prevention and environmental protection efforts will provide the greatest benefit to children's health. It is our hope that the outcomes of our collective efforts to enhance indicators of children's health and the environment will ultimately result in the reduction of exposures and disease.

Glossary

Action Indicator	An indicator that aims to track actions and/or their impacts (e.g. governmental action, private sector action) to address a source of potential environmental health risk. For example, trends in PRTR data can provide an indication of the impact of governmental policies/regulations and/or industry action to reduce releases of toxic chemicals to the environment.
Acute respiratory infection (ARI)	Any acute viral or bacterial infection of the respiratory tract. Acute upper respiratory infections comprise infections of the upper respiratory tract, including the throat, nasopharynx, sinuses and larynx. Acute lower respiratory infections affect the trachea, bronchi and lungs.
Air Quality Standards	Maximum allowable concentrations of pollutants. Typically applies to the common air pollutants (carbon monoxide, ground-level ozone, particulate matter, sulphur dioxide, and nitrogen dioxide).
Allergens	An allergen is a substance that can cause an allergic reaction. Allergens are substances which are recognized by the immune system in some people as "foreign" or "dangerous," but cause no reaction in most people (US National Library of Medicine 2005).
Ambient air	Outdoor air, any unconfined portion of the atmosphere, open air (US EPA 2003).
Arithmetic mean	The sum of all the values of a set of measurements, divided by the number of values in the set, usually denoted by \bar{x} ; a measure of central tendency (US EPA 2005a).
Asthma	A chronic inflammatory disorder of the lungs. Symptoms include wheezing, breathlessness, chest tightening, and cough (US EPA 2003).
Atopy	The increased tendency, seen in some people, to produce immediate hypersensitivity reactions (usually mediated by IgE antibodies) against innocuous substances (Janeway et al. 2001).
Attention-deficit/hyperactivity disorder (ADHD)	A disorder in which the prominent symptoms are hyperactivity, inattention and impulsivity. Also referred to as ADD (attention deficit disorder) (US EPA 2003).
Benzene	A colorless, volatile, flammable, toxic liquid aromatic hydrocarbon. Benzene (C ₆ H ₆) is used in organic synthesis, as a solvent, and as a component of motor fuel. It is a known human carcinogen and an important hazardous air pollutant (US EPA 2003).
Benzo[a]pyrene (BaP)	BaP's molecular structure includes two or more fused aromatic rings and adjacent rings share two or more carbon atoms. The principal natural sources of BaP are forest fires and volcanoes during eruptions. Anthropogenic sources include the combustion of fossil fuels, coke oven emissions and vehicle exhausts (Canada, Health Canada 1988)
Bioaccumulation	A process by which chemical substances are ingested and retained by organisms, either from the environment directly or through consumption of food containing the substances (Canada, Greening the Government 2004).
Biomonitoring	Assessment of human exposure to chemicals by measuring the chemicals or their metabolites in human tissues or fluids such as hair, urine or blood

Birth rate	A measurement of the number of births in a year in relation to the population
Biomass	Biomass can include organic and inorganic matter such as wood, dung, agricultural residues, straw and wood. Combustion of these materials for cooking and heating leads to indoor air pollution and to the release of hundreds of pollutants which (may) cause mild to severe damage to health.
Blood lead level (BLLs)	Blood lead level is a biomonitoring measure of lead in venous blood to determine recent lead exposures. Eliminating blood lead levels (BLLs) >10 µg/dL in children is a goal of many national and international health and environmental organizations.
Body burden	The amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they are eliminated from the body (United States Agency for Toxic Substances and Disease Registry (ASTDR) 2004).
Bronchiolitis	Bronchiolitis is an inflammation of the bronchioles (small passages in the lungs), usually caused by a viral infection (US National Library of Medicine 2005).
Bronchitis	Bronchitis is an inflammation of the main air passages to the lungs. Bronchitis may be sudden (acute) and short-lived, or chronic, meaning that it lasts a long time and often recurs. To be classified as chronic, you must have a cough with mucus most days of the month for three months out of the year (US National Library of Medicine 2005).
<i>Campylobacter</i>	<i>Campylobacter</i> enteritis is an infection in the small intestine caused by <i>Campylobacter jejuni</i> , a type of bacterium (US National Library of Medicine 2005).
Carbon monoxide (CO)	A colorless, odorless, poisonous gas produced by incomplete combustion of fossil fuels (US EPA 2003).
Carcinogen	Specific substance or chemical that gives rise to a cancer. Also, a cancer-forming agent (Rothenberg and Chapman 2000).
Cholera	Cholera is an infection of the small intestine caused by the bacterium <i>Vibrio cholerae</i> . It results in profuse, watery diarrhea (US National Library of Medicine 2005).
Contaminant	Any physical, chemical, biological, or radiological substance or matter in air, water or soil that can have adverse health effects (US EPA 2003).
Cotinine	A major metabolite of nicotine found in blood and urine. Currently regarded as the best biomarker for exposure of nonsmokers to environmental tobacco smoke (US EPA 2003).
Deciliter	One-tenth of a liter (0.1 liter) (US EPA 2003).
<i>E. coli</i>	<i>E. coli</i> enteritis is an inflammation of the small intestine caused by <i>Escherichia coli</i> bacteria (US National Library of Medicine 2005).
Effect Indicator(Health Effect Indicator)	An effect indicator is intended to measure adverse impacts on health that are or may be due to exposures to environmental hazards. For example, an effect indicator could measure the number of illnesses or deaths that result from waterborne disease.
Endocrine system	Network of endocrine glands, which produce and secrete hormones directly into the bloodstream for transport to specific target organs, where they exert their effect. Along with the nervous system, the endocrine system coordinates and regulates many of the activities of the body, including growth, metabolism, sexual development, and reproduction (Rothenberg and Chapman 2000).

Environmental Health Indicator	An expression of the link between environment and health, targeted at an issue of specific policy or management concern and presented in a form which facilitates interpretation for effective decision-making (Corvalan, Briggs and Kjellstrom 1996)
Environmental tobacco smoke (ETS)	Mixture of smoke exhaled by a smoker and the smoke from the burning end of the smoker’s cigarette, pipe or cigar. Also known as secondhand smoke (SHM), or passive smoke (US EPA 2003).
Epidemiological studies	Studies that research the incidence, distribution and control of disease in a population (US EPA 2003).
Exacerbation of asthma	Increase in the frequency or severity of asthma attacks or symptoms in individuals who have asthma (US EPA 2003).
Exceedance	Occurrence of a pollutant being detected at a quantity above that of a regulatory standard or other target level.
Exposure	A measure of the occurrence and/or magnitude of human contact with environmental contaminants in media, including air, water, soil and food.
Exposure indicator	An exposure indicator measures exposure to an environmental hazard.
Fetus	The unborn child, at the stage of development occurring from the end of the 8th week after conception until birth. For the first eight weeks, the unborn child is called an <i>embryo</i> (Page 2002).
Formaldehyde	A colorless, pungent-smelling gas; an important hazardous air pollutant. High concentrations may trigger attacks in people with asthma. Sources include environmental tobacco smoke and other combustion sources; pressed wood products (such as particle board); and certain textiles, foams, and glues (US EPA 2003).
Fugitive emission	A release of chemicals to air that occurs through a valve (intentionally or unintentionally) or a leak. Classified as a “non-point” emission.
Gastrointestinal	Relating to, affecting, or including the stomach and/or intestine (US EPA 2003).
Geometric mean	The antilogarithm of the mean of the logarithms of all the values in a set (US EPA 2005a).
<i>Giardia intestinalis</i>	<i>Giardia intestinalis</i> is a protozoan that causes an infection of the small intestine. Also known as <i>Giardia lamblia</i> or <i>Giardia duodenalis</i> (United States National Library of Medicine 2005)
Giardiasis	Giardiasis is an intestinal infection caused by the protozoan <i>Giardia</i> , and is spread by contaminated water or contact with an infected person (United States National Library of Medicine 2005).
Ground-level ozone	Ground-level ozone (smog) is formed by a chemical reaction between volatile organic pollutants (VOCs) and oxides of nitrogen (NO _x), in the presence of sunlight. Ozone concentrations can reach unhealthy levels when the weather is hot and sunny, with little or no wind. Ozone at ground level causes adverse effects on lung function and respiration (US EPA 2003).
Hypertension	Persistently raised blood pressure, exceeding about 140 mm Hg (systolic) and 90 mm Hg (diastolic) at rest.
Incidence	Incidence is the number of new people who develop a condition during a specific time period.
Lower respiratory tract infections	Lower respiratory tract infections affect the breathing passage, notably the trachea, bronchi, and lungs, and include acute bronchitis, acute bronchiolitis, and pneumonia (Page 2002).
Media	Specific environments such as air, water, food, and soil (US EPA 2003).

Methemoglobinemia	A condition that reduces the ability of the blood to transport oxygen throughout the body for essential metabolism; it is due to the replacement of hemoglobin with methemoglobin in the blood. A small amount of methemoglobin is present in the blood normally, but injury or toxic agents—such as nitrites—convert a larger proportion of hemoglobin into methemoglobin (US EPA 2003).
Microgram (µg)	One-millionth of a gram ($=10^{-6}$) (US EPA 2003).
µg/dL	Microgram per deciliter (US EPA 2003).
Monitoring and reporting violation	Violation of monitoring and reporting requirements that specify how and when water must be tested for the presence of contaminants as defined by the US Safe Drinking Water Act (US EPA 2003).
Morbidity	Illness or disability rate, usually expressed per 1000 population (World Health Organization—Regional Office of Europe 2005).
Mortality	Death rate per defined population, usually expressed per 1000 (World Health Organization—Regional Office of Europe 2005).
National Pollutant Release Inventory (NPRI)	The Canadian database of information on annual releases to air, water, land and disposal or recycling, from all sectors—industrial, government, commercial and others.
Neuroblastoma	Cancer that arises in immature nerve cells and affects mostly infants and children (US EPA 2003).
Neurotoxicity	Extent of being poisonous or harmful to nerves and nerve cells (Rothenberg and Chapman 2000).
Nitrates (NO₃) and nitrites (NO₂)	Nitrogen-oxygen chemical units that combine with various organic and inorganic compounds. Once taken into the body, nitrates are converted into nitrites. The greatest use of nitrates is as a fertilizer. Other sources include animal manure and human sewage (US EPA 2003).
Nitrogen dioxide (NO₂)	A chemical that results from nitric oxide combining with oxygen in the atmosphere; a major component of photochemical smog (US EPA 2003).
Nitrogen oxides	A family of highly reactive gases (including nitrogen dioxide, above) that form when fuel is burned at high temperatures. Emitted principally from motor vehicle exhaust and stationary sources such as electric power plants and industrial boilers (US EPA 2003).
Off-site release	The disposal of chemicals in waste by removal off the grounds of the reporting facility to other facilities or other locations. A similar activity to on-site releases, but occurring at other locations. The classification also includes metals sent to disposal, treatment, sewage, and energy recovery. This approach recognizes the physical nature of metals and acknowledges that metals in such wastes are not likely to be destroyed or burned and so may eventually enter the environment (CEC 2004).
On-site release	The disposal of chemicals in waste by release on-site to air, water, underground injection, or land, at the location of the reporting facility (CEC 2004).
On-site air release	Releases to air that occur through identified outlets such as stacks (“smokestacks”) or vents are labeled “stack” or “point” emissions. Air releases that occur because of leaks or valves are labeled “fugitive” or “non-point” emissions.
On-site land release	Methods of release to land at the facility include burying chemical waste in landfills, incorporating it into soil (“land treatment”), holding it in surface impoundments, accumulating it in waste piles, or disposing of it by other means.

On-site underground injection	Facilities may inject listed chemicals in waste into deep underground wells. Underground injection is regulated, and deep wells that receive toxic waste are intended to isolate the pollutants from groundwater sources.
On-site water release	Releases to surface water bodies such as rivers and lakes generally occur through discharge pipes. Wastewater is usually treated first, to remove or minimize its pollutant content. Rainwater may also wash pollutants from on-site waste storage areas into surface waters; these releases from run-off should also be reported.
Organophosphate pesticides	A group of approximately 40 closely related pesticides that affect functioning of the nervous system. Examples include chlorpyrifos, phosmet, and methyl parathion (US EPA 2003).
Otitis media	Fluid in the middle ear; middle ear infection.
Parts per billion (PPB)	One part or unit of a substance in a billion parts or units of the medium in which it is contained (i.e., typically, air or water).
Particulate matter (PM_{2.5} and PM₁₀)	Particles in the air, such as dust, dirt, soot, smoke, and droplets. Small particles (PM ₁₀ [diameter 10 microns or less] or PM _{2.5} [diameter 2.5 microns or less]) have significant effects on human health (US EPA 2003).
Passive smoke	Mixture of smoke exhaled by a smoker and smoke from the burning end of the smoker's cigarette, pipe, or cigar. Also known as environmental tobacco smoke (ETS), or secondhand smoke.
Persistent Organic Pollutants (POPs)	Chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse health effects to human health and the environment (UNEP Date unknown)
Pesticides	Chemical agents used to kill insects or other organisms harmful to crops and other cultivated plants (Martin 2002).
Plasticizers	Small, often volatile molecules that are added to hard, stiff plastics to make them softer and more flexible (US EPA 2003).
Pollutant release and transfer register (PRTR)	A catalogue, or register, that comprises information on releases of specific chemicals to air, water and soil, as well as transfers to treatment and disposal sites. Examples include NPRI (Canada), RETC (Mexico) and TRI (United States) (Inter-Organisation Programme for the Sound Management of Chemicals Pollutant Release and Transfer Registers Co-ordinating Group 2003)
Potable water	Water which is suitable for human consumption and for all normal domestic purposes, including personal hygiene (Pan American Center for Sanitary Engineering and Environmental Sciences et al. 2002).

Poverty level	<p>The United States defines poverty level as an income level below which an individual or family is considered poor. The US Census Bureau defines poverty level based on a set of money income thresholds that vary by family size and composition. If a family's total income is less than that family's threshold, then that family, and every individual in it, is considered poor. The Census Bureau updates its poverty thresholds annually. In 2000, a family of two adults and two children with total income below \$17,463 was considered below the poverty level. Tables showing the Census Bureau's poverty thresholds are available at: http://www.census.gov/hhes/poverty/threshld.html (US EPA 2003).</p> <p>There is no official measure of poverty in Canada. However, relatively low income families are categorized using the low income cut-off (LICO) statistic. Families that spend 20% more than the average Canadian family on food, clothing and shelter are considered to be living on "low income" (Statistics Canada 2001)</p>
Pneumonia	Pneumonia is an inflammation of the lungs caused by an infection. Many different organisms can cause it, including bacteria, viruses, and fungi (US National Library of Medicine 2005).
Prenatal	Occurring, existing, or performed before birth (US EPA 2003).
Prevalence	The number of people in the population who have a condition at a specific time.
Radionuclides	Radioactive isotopes or unstable forms of elements (US EPA 2003).
Registro de Emisiones y Transferencia de Contaminantes (RETC)	Mexico's Pollutant Emissions and Transfers Register (RETC) is a publicly available database (PRTR) that compiles information on toxic chemical releases from companies in Mexico that voluntarily report releases, on an annual basis.
Respiratory effects	Effects on the process of breathing or on the lungs (US EPA 2003).
Secondhand smoke (SHS)	Mixture of smoke exhaled by a smoker and the smoke from the burning end of the smoker's cigarette, pipe, or cigar. Also known as environmental tobacco smoke (ETS), or passive smoke.
Sensitivity	The ability of a system to detect epidemics and other changes in disease occurrence. The proportion of persons with disease who are correctly identified by a screening test or case definition as having disease (Centers for Disease Control and Prevention (CDC) 2005).
Sewage	Human excreta and wastewater, flushed along a sewer pipe or drain (Mara and Cairncross 1989).
Solvent	Substance used to dissolve another substance. Some commonly used solvents, such as trichloroethylene, are important environmental contaminants (US EPA 2003).
Sudden infant death syndrome (SIDS)	The sudden and unexpected death of an apparently healthy infant, without an apparent cause (US EPA 2003).
Sulfur dioxide (SO₂)	A pungent, colorless, gaseous pollutant formed primarily by the combustion of fossil fuels (US EPA 2003).

Surrogate Exposure	A surrogate exposure indicator provides a measure of potential exposure to an environmental hazard. For example, the percentage of children living in urban areas where air pollution levels exceed relevant air quality standards is created by cross-referencing air quality data with census data for urban centers. The corresponding population based indicator provides a measure of the potential for exposure for the population but does not directly measure exposure in the population.
Tonne	The metric tonne, which is 1,000 kilograms, is equivalent to 1,1023 short tons, or 0.9842 long tons (CEC 2004)
Total releases	The sum of on-site and off-site releases, including the amounts released to the air, water, land and underground injection at the facility and all chemicals sent to other locations for disposal and any metals sent to treatment, sewage or energy recovery (CEC 2004).
Toxicity	The inherent potential or capacity of a material to cause adverse effects in a living organism (Canada, Greening the Government 2004).
Toxics Release Inventory (TRI)	The Toxics Release Inventory (TRI) is a publicly available United States Environmental Protection Agency (EPA) database (PRTR) that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities (US EPA 2005c)
Volatile organic compound (VOC)	Carbon-containing compound that has a high vapor pressure and easily changes from a solid to a gaseous form at normal temperatures and pressure. Sources include household products such as paints, paint strippers, and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products; hobby supplies; dry-cleaned clothing (US EPA 2003).
Wastewater	Liquid waste discharged from homes, commercial premises and similar sources to individual disposal systems or to municipal sewer pipes, and consists mainly of human excreta and used water (Mara and Cairncross 1989).

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Appendix 1: Council Resolution 02-06

Distribution: General
C/02-00/RES/06/Final
ORIGINAL: ENGLISH

Ottawa, 19 June 2002

COUNCIL RESOLUTION: 02-06

Cooperative Agenda for Children's Health and the Environment in North America

THE COUNCIL:

HAVING ADOPTED Council Resolution 00-10, whereby the Parties recognized the particular vulnerabilities of children to environmental risks and agreed to collaborate on the development of a cooperative agenda that promotes the protection of children's health from environmental risks;

IN ACCORDANCE with Council Resolution 00-10, whereby the Parties decided to focus, as a starting point, on specific health outcomes such as asthma and other respiratory diseases, the effects of lead including lead poisoning, and the effects of exposure to other toxic substances;

TAKING into consideration, with appreciation, Advice to Council 02-01 from the Expert Advisory Board on Children's Health and the Environment, Advice to Council 02-01 from the Joint Public Advisory Committee of the Commission for Environmental Cooperation (CEC), and comments received from the public;

NOTING the productive and informative meeting held with the Expert Advisory Board members during the Council's Ninth Regular Session on 18 June 2002 in Ottawa; ACKNOWLEDGING the progress of the CEC in integrating children's environmental health into its ongoing activities;

RECOGNIZING that effective domestic and trilateral solutions to address children's health and the environment require a solid knowledge base, education and outreach, and partnerships; and

RECOGNIZING that protecting children's health from environmental risks is an ongoing task and a long-term investment, and understanding that increased knowledge will continue to inform and shape planned activities and projects to maximize their effectiveness and relevance;

HEREBY:

ADOPTS the Cooperative Agenda for Children's Health and the Environment in North America (Cooperative Agenda);

CALLS UPON the Parties to work together with the CEC Secretariat to implement the Cooperative Agenda by undertaking the following new initiatives over the next two years:

- select and publish a core set of children's environmental health indicators for North America, working in partnership with the Pan American Health Organization, the International Joint Commission Health Professionals Task Force and others, and in coordination with parallel commitments made by the G-8 Environment Ministers and the Health and Environment Ministerial of the Americas;
- form strategic partnerships with health organizations, including the trilateral network of Pediatric Environmental Health Specialty Units, to strengthen professional training on children's environmental health, with a view toward enabling health professionals to serve as effective conduits of information and advice to parents, care givers, children, and communities;

- strengthen decision-making capacity by enhancing the understanding of the economic impacts of environment-related illnesses and effects on children, including the implications of action versus inaction;
- advance understanding of risk assessment approaches with a view to increasing collaboration on toxic substances and increasing the cadre of risk assessors trained in children's environmental health risk assessment; and
- work together trilaterally, in the context of increasing cross-border trade, to reduce the risks posed by lead in consumer products, in particular those intended for use by children.

AGREES to continue the integration of children's environmental health considerations into the CEC work program. This includes continuing work on the following projects:

- facilitating collaboration on longitudinal cohort studies with a view to improving our common understanding of children's exposures, body burdens, and health outcomes during the course of their growth and development, building on the National Children's Study in the United States;
- assessing the impact of diesel exhaust at congested border crossings as part of the CEC's Air Quality project, and exploring the use of the developed methodology to address other regions and contaminants of concern;
- working to prevent and reduce children's exposure to lead by promoting increased public awareness and improved practices within selected cottage industries, such as the ceramics industry in Mexico;
- continuing to ensure the integration of a children's environmental health perspective into the work of the CEC's Sound Management of Chemicals program;
- analyzing and publishing data on toxic chemicals that are of particular concern to children's health within the *Taking Stock* report series; and
- continuing efforts to build public awareness and facilitate access to information on issues of children's environmental health and preventive measures, through existing CEC projects and publications and in partnership with other groups;

AGREES, in addition to the focus on asthma and respiratory diseases and the effects of lead and other toxic substances, to include water-borne diseases as a priority health endpoint, and DIRECTS the CEC Secretariat, in coordination with the Parties, to develop options for collaborative action in this area;

CALLS FOR the North American Regional Action Plan on environmental monitoring and assessment to include bio-monitoring of persistent bioaccumulative toxics - in particular, mercury and lead - in infants, children, pregnant women, and women of child-bearing age; and

AGREES to bi-annually review progress achieved, assess relevance of planned activities in light of new knowledge acquired, and further advance the implementation of the Cooperative Agenda with the input and involvement of interested parties and members of the public.

APPROVED BY THE COUNCIL:

David Anderson
Government of Canada

Víctor Lichtinger
Government of the United Mexican States

Christine Todd Whitman
Government of the United States of America

Appendix 2: Overview of Recommended Indicators from the CEC Council

Following is the list of recommended indicators that the Steering Group on Children’s Health and Environment Indicators submitted for consideration by the CEC Council in June 2003, presented in a document entitled “Recommendations for the Development of Children’s Health and the Environment Indicators in North America.” Council subsequently endorsed the recommended indicators through Council Resolution 03-10 (see Appendix 3).

Priority Area	Indicator Name	Type of Measure	Type of Measure
Asthma and Respiratory Disease	Percent of children living in urban areas where air pollution levels exceed relevant air quality standards	Exposure surrogate	Obtainable by cross-referencing air quality data with census data for urban areas such as cities with fixed site monitoring stations. Either national or WHO air quality standards can be used.
	Indoor Air Quality	Exposure surrogate	Measure of children exposed to secondhand smoke in Canada and the US, and biomass fuels in Mexico.
	Prevalence of asthma cases	Effect	Can be the number of children under 18, 14, 5, or a combination of ages. In Canada and US, information is obtained by household surveys. In Mexico, doctors report cases on a diagnosis form.
Effects of Lead and Other Toxic Substances on Children’s Health	Blood lead levels (presented by range, e.g., below detectable level)	Exposure	Although lead may have health effects at lower levels, 10 µg/dL is considered a trigger for public health intervention.
	Children living in homes with a source of lead	Exposure	Sources of lead reflected in the indicators may vary by country, depending on the major sources of concern and data availability.

	Pesticides (body burden, residue levels on food, use or sales)	Exposure	Best measure is body burden, followed by residue levels on food and use data. Sales data is not desirable.
	Pollutant Release and Transfer Register (PRTR) data	Exposure	PRTR data exist in all three countries. These data can highlight releases of a range of chemicals.
Water-borne Diseases and Children's Health	Percent of children (households) served by treated water	Exposure	Counts how many children/ homes/people have access in their home to water piped from a centrally treated system. Alternative indicator could be children (households) without access to treated water.
	Percent of children (households) served by sanitary sewers	Exposure	The percentage of children (households) who have sewage removed from their immediate surroundings will require further discussion and refinement.
	Morbidity (number of childhood illnesses attributed to waterborne disease)	Effect	
	Mortality (number of child deaths attributed to waterborne disease)	Effect	
	Percentage of children served by drinking water systems in violation of local standards	Action	Consider additional criteria, such as systems with <x violations per year, number of days in violation, etc.

Appendix 3: Council Resolution 03-10

THE COUNCIL:

RECOGNIZING the importance of providing decision-makers and the public with periodic, understandable information on the status of children's health and the environment in North America as a means of tracking changes and promoting effective preventative action;

NOTING WITH ENCOURAGEMENT the significant progress that has been made, through collaboration among the Commission for Environmental Cooperation (CEC), the International Joint Commission (IJC) Health Professionals Task Force, the Pan American Health Organization (PAHO) and the World Health Organization (WHO), in creating a framework for the development of indicators of children's health and the environment in North America;

FURTHER RECOGNIZING the global partnership launched at the World Summit on Sustainable Development in 2002 to promote the development of indicators of children's health and the environment;

WELCOMING the emerging role for North America, through the CEC and its partners, to serve as a global leader in this area; and

RECOGNIZING the need for a flexible approach that takes differing national circumstances, priorities and data availability into account, while seeking to continuously improve data quality and comparability;

HEREBY:

DIRECTS the CEC Secretariat, with the involvement of the Parties and in continued partnership with the IJC, PAHO and WHO, to prepare a first report on indicators of children's health and the environment in North America, to be published in 2004;

UNDERTAKES to ensure that the CEC Secretariat be provided with the data, where available, to compile an initial set of twelve indicators of children's health and the environment as identified in the document "Recommendations for the Development of Children's Health and the Environment Indicators in North America," for inclusion in this indicator report (other relevant health indicators may be added as decided by the Parties and based on data availability);

RESOLVES to continuously improve, thereafter, the quality and comparability of the indicators and data across North America, in coordination with, and taking into account the developments of, the international effort on children's environmental health indicators; and

FURTHER RESOLVES to undertake a subsequent publication of indicators of children's health and the environment within five years of the publication of the first report, and periodically thereafter.

APPROVED BY THE COUNCIL:

David Anderson
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Victor Lichtinger
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Christine Todd Whitman
Government of the United States of America

Appendix 4: 153 Matched Chemicals

1995–2002 Matched Data Set	Special Chemical Group	Chemical Name	Nom Chimique	Sustancia
1	c,p	Formaldehyde	Formaldéhyde	Formaldehído
2		Nitroglycerin	Nitroglycérine	Nitroglicerina
3	c,p,t	Carbon tetrachloride	Tétrachlorure de carbone	Tetracloruro de carbono
4	p	Aniline	Aniline	Anilina
5	c,p	Thiourea	Thio-urée	Tiourea
6	c,p	Diethyl sulfate	Sulfate de diéthyle	Sulfato de dietilo
7		Methanol	Méthanol	Metanol
8	c,p	Chloroform	Chloroforme	Cloroformo
9	c,p	Hexachloroethane	Hexachloroéthane	Hexacloroetano
10		n-Butyl alcohol	Butan-1-ol	Alcohol n-butílico
11	c,p,t	Benzene	Benzène	Benceno
12	p,t	Bromomethane	Bromométhane	Bromometano
13		Ethylene	Éthylène	Etileno
14	p	Chloromethane	Chlorométhane	Clorometano
15	p	Methyl iodide	Iodométhane	Yoduro de metilo
16		Hydrogen cyanide	Cyanure d'hydrogène	Ácido cianhídrico
17	p	Chloroethane	Chloroéthane	Cloroetano
18	c,p,t	Vinyl chloride	Chlorure de vinyle	Cloruro de vinilo
19		Acetonitrile	Acétonitrile	Acetonitrilo
20	c,p,t	Acetaldehyde	Acétaldéhyde	Acetaldehído
21	c,p,t	Dichloromethane	Dichlorométhane	Diclorometano
22	p	Carbon disulfide	Disulfure de carbone	Disulfuro de carbono
23	c,p,t	Ethylene oxide	Oxyde d'éthylène	Óxido de etileno
24	t	Vinylidene chloride	Chlorure de vinylidène	Cloruro de vinilideno
25		Phosgene	Phosgène	Fosgeno

26	c,p	Propylene oxide	Oxyde de propylène	Óxido de propileno
27		tert-Butyl alcohol	2-Méthylpropan-2-ol	Alcohol terbutílico
28		Hexachlorocyclopentadiene	Hexachlorocyclopentadiène	Hexaclorociclopentadieno
29	c,p	Dimethyl sulfate	Sulfate de diméthyle	Sulfato de dimetilo
30		Isobutyraldehyde	Isobutyraldéhyde	Isobutiraldehído
31	p	1,2-Dichloropropane	1,2-Dichloropropane	1,2-Dicloropropano
32		sec-Butyl alcohol	Butan-2-ol	Alcohol sec-butílico
33		Methyl ethyl ketone	Méthyléthylcétone	Metil etil cetona
34	p	1,1,2-Trichloroethane	1,1,2-Trichloroéthane	1,1,2-Tricloroetano
35	c,p,t	Trichloroethylene	Trichloroéthylène	Tricloroetileno
36	c,p	Acrylamide	Acrylamide	Acrilamida
37		Acrylic acid	Acide acrylique	Ácido acrílico
38		Chloroacetic acid	Acide chloroacétique	Ácido cloroacético
39		Peracetic acid	Acide peracétique	Ácido peracético
40	p	1,1,2,2-Tetrachloroethane	1,1,2,2-Tétrachloroéthane	1,1,2,2-Tetracloroetano
41	c,p	2-Nitropropane	2-Nitropropane	2-Nitropropano
42		4,4'-Isopropylidenediphenol	p,p'-Isopropylidènediphénol	4,4'-Isopropilidenodifenol
43		Cumene hydroperoxide	Hydroperoxyde de cumène	Cumeno hidroperóxido
44		Methyl methacrylate	Méthacrylate de méthyle	Metacrilato de metilo
45	p	C.I. Food Red 15	Indice de couleur Rouge alimentaire 15	Rojo 15 alimenticio
46		Dibutyl phthalate	Phtalate de dibutyle	Dibutil ftalato
47		Phthalic anhydride	Anhydride phtalique	Anhídrido ftálico
48	p	N-Nitrosodiphenylamine	N-Nitrosodiphénylamine	N-Nitrosodifenilamina
49	p	2-Phenylphenol	o-Phénylphénol	2-Fenilfenol
50	c,p	Michler's ketone	Cétone de Michler	Cetona Michler
51	c	Toluene-2,6-diisocyanate	Toluène-2,6-diisocyanate	Toluen-2,6-diisocianato
52		Naphthalene	Naphtalène	Naftaleno
53	p	Quinoline	Quinoléine	Quinoleína
54		Biphenyl	Biphényle	Bifenilo
55		Benzoyl peroxide	Peroxyde de benzoyle	Peróxido de benzoilo
56	c,p	Safrole	Safrole	Safrol
57		1,2-Dichlorobenzene	o-Dichlorobenzène	1,2-Diclorobenceno

58		1,2,4-Trimethylbenzene	1,2,4-Triméthylbenzène	1,2,4-Trimetilbenceno
59	c,p	2,4-Diaminotoluene	2,4-Diaminotoluène	2,4-Diaminotolueno
60	c,p	Styrene oxide	Oxyde de styrène	Óxido de estireno
61		Methyl acrylate	Acrylate de méthyle	Acrilato de metilo
62	c,p	Ethylene thiourea	Imidazolidine-2-thione	Etilén tiourea
63		Cumene	Cumène	Cumeno
64		Benzoyl chloride	Chlorure de benzoyle	Cloruro de benzoilo
65	c,p	Nitrobenzene	Nitrobenzène	Nitrobenceno
66		4-Nitrophenol	p-Nitrophénol	4-Nitrofenol
67	c	Ethylbenzene	Éthylbenzène	Etilbenceno
68	c	Styrene	Styrène	Estireno
69	c,p	Benzyl chloride	Chlorure de benzyle	Cloruro de bencilo
70	c,p	4,4'-Methylenebis(2-chloroaniline)	p,p'-Méthylènebis(2-chloroaniline)	4,4'-Metilenobis(2-cloroanilina)
71	c,p	4,4'-Methylenedianiline	p,p'-Méthylènedianiline	4,4'-Metilenodianilina
72	c,p	1,4-Dichlorobenzene	p-Dichlorobenzène	1,4-Diclorobenceno
73		p-Phenylenediamine	p-Phénylènediamine	p-Fenilenodiamina
74	c	Quinone	p-Quinone	Quinona
75	c	1,2-Butylene oxide	1,2-Époxybutane	Óxido de 1,2-butileno
76	c,p,t	Epichlorohydrin	Épichlorohydrine	Epiclorohidrina
77	c,p,t	1,3-Butadiene	Buta-1,3-diène	1,3-Butadieno
78		Allyl chloride	Chlorure d'allyle	Cloruro de alilo
79	c,p,t	1,2-Dichloroethane	1,2-Dichloroéthane	1,2-Dicloroetano
80	c,p,t	Acrylonitrile	Acrylonitrile	Acrilonitrilo
81		Allyl alcohol	Alcool allylique	Alcohol alílico
82		Ethylene glycol	Éthylèneglycol	Etilén glicol
83	c	Vinyl acetate	Acétate de vinyle	Acetato de vinilo
84		Methyl isobutyl ketone	Méthylisobutylcétone	Metil isobutil cetona
85		Maleic anhydride	Anhydride maléique	Anhídrido maleico
86	p	Toluene	Toluène	Tolueno
87		Chlorobenzene	Chlorobenzène	Clorobenceno
88		Phenol	Phénol	Fenol

89	p	2-Methoxyethanol	2-Méthoxyéthanol	2-Metoxietanol
90	p	2-Ethoxyethanol	2-Éthoxyéthanol	2-Etoxietanol
91		Cyclohexane	Cyclohexane	Ciclohexano
92		Pyridine	Pyridine	Piridina
93		Diethanolamine	Diéthanolamine	Dietanolamina
94		Propylene	Propylène	Propileno
95	c,p,t	Di(2-ethylhexyl) phthalate	Phtalate de bis(2-éthylhexyle)	Di(2-etilhexil) ftalato
96		Anthracene	Anthracène	Antraceno
97	p	Isosafrole	Isosafrole	Isosafrol
98	c,p	Catechol	Catéchol	Catecol
99		1,2,4-Trichlorobenzene	1,2,4-Trichlorobenzène	1,2,4-Triclorobenceno
100		2,4-Dichlorophenol	2,4-Dichlorophénol	2,4-Diclorofenol
101	c,p	2,4-Dinitrotoluene	2,4-Dinitrotoluène	2,4-Dinitrotolueno
102		N,N-Dimethylaniline	N,N-Diméthylaniline	N,N-Dimetilanilina
103		Hydroquinone	Hydroquinone	Hidroquinona
104		Propionaldehyde	Propionaldéhyde	Propionaldehído
105		Butyraldehyde	Butyraldéhyde	Butiraldehído
106	c,p	1,4-Dioxane	1,4-Dioxane	1,4-Dioxano
107	c,p,t	Tetrachloroethylene	Tétrachloroéthylène	Tetracloroetileno
108		Dimethyl phthalate	Phtalate de diméthyle	Dimetil ftalato
109	c,p	Nitrilotriacetic acid	Acide nitrilotriacétique	Ácido nitrilotriacético
110	c,p	Ethyl acrylate	Acrylate d'éthyle	Acrilato de etilo
111		Butyl acrylate	Acrylate de butyle	Acrilato de butilo
112		Calcium cyanamide	Cyanamide calcique	Cianamida de calcio
113	c,p	Hydrazine	Hydrazine	Hidracina
114		4,6-Dinitro-o-cresol	4,6-Dinitro-o-crésol	4,6-Dinitro-o-cresol
115		Ethyl chloroformate	Chloroformiate d'éthyle	Cloroformiato de etilo
116		C.I. Basic Green 4	Indice de couleur Vert de base 4	Verde 4 básico
117	c	Toluene-2,4-diisocyanate	Toluène-2,4-diisocyanate	Toluen-2,4-diisocianato
118	c,p	2,6-Dinitrotoluene	2,6-Dinitrotoluène	2,6-Dinitrotolueno
119	p	C.I. Solvent Yellow 14	Indice de couleur Jaune de solvant 14	Amarillo 14 solvente
120		C.I. Basic Red 1	Indice de couleur Rouge de base 1	Rojo 1 básico

121		Decabromodiphenyl oxide	Oxyde de décabromodiphényle	Óxido de decabromodifenilo
122		Molybdenum trioxide	Trioxyde de molybdène	Trióxido de molibdeno
123	p	Thorium dioxide	Dioxyde de thorium	Dióxido de torio
124	c,p,t	Asbestos (friable form)	Amiante (forme friable)	Asbestos (friables)
125		Aluminum oxide (fibrous forms)	Oxyde d'aluminium (formes fibreuses)	Óxido de aluminio (formas fibrosas)
126		Methyl tert-butyl ether	Oxyde de tert-butyle et de méthyle	Éter metil terbutílico
127		C.I. Disperse Yellow 3	Indice de couleur Jaune de dispersion 3	Amarillo 3 disperso
128		C.I. Solvent Orange 7	Indice de couleur Orange de solvant 7	Naranja 7 solvente
129		C.I. Acid Green 3	Indice de couleur Vert acide 3	Verde 3 ácido
130	m	Aluminum (fume or dust)	Aluminium (fumée ou poussière)	Aluminio (humo o polvo)
131		Titanium tetrachloride	Tétrachlorure de titane	Tetracloruro de titanio
132		Hydrochloric acid	Acide chlorhydrique	Ácido clorhídrico
133	t	Hydrogen fluoride	Fluorure d'hydrogène	Ácido fluorhídrico
134		Sulfuric acid	Acide sulfurique	Ácido sulfúrico
135		Nitric acid***	Acide nitrique***	Ácido nítrico***
136		Phosphorus (yellow or white)	Phosphore (jaune ou blanc)	Fósforo (amarillo o blanco)
137		Chlorine	Chlore	Cloro
138		Chlorine dioxide	Dioxyde de chlore	Dióxido de cloro
139	p	Dinitrotoluene (mixed isomers)	Dinitrotoluène (mélange d'isomères)	Dinitrotolueno (mezcla de isómeros)
140	c,p	Toluenediisocyanate (mixed isomers)	Toluènediisocyanate (mélange d'isomères)	Toluendiisocyanatos (mezcla de isómeros)
141	m	Antimony and its compounds*	Antimoine (et ses composés)*	Antimonio y compuestos*
142	m,c,p,t	Chromium and its compounds*	Chrome (et ses composés)*	Cromo y compuestos*
143	m,c,p	Cobalt and its compounds*	Cobalt (et ses composés)*	Cobalto y compuestos*
144	m	Copper and its compounds*	Cuivre (et ses composés)*	Cobre y compuestos*
145		Cresol (mixed isomers)**	Crésol (mélange d'isomères)**	Cresol (mezcla de isómeros)**
146		Cyanide compounds	Cyanure (et ses composés)	Cianuro y compuestos
147	m	Manganese and its compounds*	Manganèse (et ses composés)*	Manganeso y compuestos*

148	m,c,p,t	Nickel and its compounds*	Nickel (et ses composés)*	Níquel y compuestos*
149		Nitric acid and nitrate compounds***	Acide nitrique et composés de nitrate***	Ácido nítrico y compuestos nitrados***
150	m	Selenium and its compounds*	Sélénium (et ses composés)*	Selenio y compuestos*
151	m	Silver and its compounds*	Argent (et ses composés)*	Plata y compuestos*
152		Xylenes****	Xylènes****	Xilenos****
153	m	Zinc and its compounds*	Zinc (et ses composés)*	Zinc y compuestos*

m = Metal and its compounds.

c = Known or suspected carcinogen

p = California Proposition 65 chemical

t = CEPA toxic chemical

* Elemental compounds are reported separately from their respective element in TRI and aggregated with it in NPRI and in the matched data set.

** o-Cresol, m-cresol, p-cresol and cresol (mixed isomers) are aggregated into one category called cresols in the matched data set.

*** Nitric acid, nitrate ion and nitrate compounds are aggregated into one category called nitric acid and nitrate compounds in the matched data set.

**** o-Xylene, m-xylene, p-xylene and xylene (mixed isomers) are aggregated into one category called xylenes in the matched data set.