Environment Canada Environnement Canada

ENVIRONMENTAL MONITORING AND SURVEILLANCE IN SUPPORT OF THE CHEMICALS MANAGEMENT PLAN

Canada

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Environmental Monitoring and Surveillance in Support of the Chemicals Management Plan

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Photo: © Photos.com – 2011

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Environmental Monitoring and Surveillance in Support of the Chemicals Management Plan

Chemical substances are used every day to enhance the quality of our lives. While the majority of these do not affect the environment or human health, a number of them are potentially harmful in certain concentrations. They should only be used when the associated risks are properly assessed and managed.

Many legislative tools and standards are in place to protect Canadians and their environment against the risks of potentially harmful chemicals. The Government of Canada is responsible for over 25 different pieces of legislation by which it manages chemicals in order to protect human health and the environment, including the *Canadian Environmental Protection Act, 1999* (CEPA 1999), the *Pest Control Products Act*, the *Hazardous Products Act*, and the *Food and Drugs Act*.

As of 1994, chemicals introduced into Canada must first be assessed to determine the risk posed to human health and the environment. If a chemical is found to pose a risk to health or the environment, control measures must be put in place before it enters the Canadian marketplace or can be used by industry. If the risks cannot be managed, permission to use the chemical in Canada can be denied. The Government of Canada assesses over 500 new chemicals each year.

Prior to 1994, many of the chemicals used in Canada were not subject to ecological or health risk assessments. Between 1999 and 2006, the Government of Canada classified these "existing" chemicals using specific criteria and then identified those requiring risk assessments. As a result of this process, 4300 chemicals were divided into high, medium and low priorities for action. This served to allow the Government of Canada to focus immediately on chemicals of greatest concern. These actions, and many others, are currently being undertaken through the Government of Canada's Chemicals Management Plan.

Photo: © Michel Arseneau
Sediment sample collection

For more information about the Government of Canada's Chemicals Management Plan please visit: **www.chemicalsubstanceschimiques.gc.ca/plan/index_e.html**

Chemicals Management Plan

In 2006, the Government of Canada launched the Chemicals Management Plan (CMP) to enhance its role in protecting Canadians and their environment from exposure to harmful chemicals. The CMP provides funding for research and monitoring to increase our understanding of the possible effects of chemicals on Canadians and their environment. This fact sheet presents an overview of the Environmental Monitoring and Surveillance Program being undertaken in support of CMP.

Risk Assessment and Risk Management (CEPA, 1999)

The Government of Canada, through its Chemicals Management Plan, is committed to protecting Canadians and their environment from chemical substances that could be harmful. Crucial to the success of this plan is the need for sound risk assessment and risk management components.

What is Risk Assessment?

Risk assessment is the evaluation of scientific information to determine the hazardous properties of a chemical substance and its exposures to both the environment and humans. Under the *Canadian Environmental Protection Act, 1999* (CEPA, 1999), assessments are done to determine whether the substance does or may present a risk to the environment or human health.

What is Risk Management?

Simply put, risk management is the process of protecting the environment and human health by controlling conditions that might cause harm, including the use, release or manufacture of chemical substances.

Fundamentally, risk management is responsible for implementing tools that reduce, eliminate or prevent risks to the environment and human health. There is an assortment of risk management tools available to control harmful chemical substances. Most common are regulations. These are enforceable laws that can, for example, restrict certain chemical substances, or limit concentrations allowed under a variety of conditions. Other risk management tools include, but are not limited to, pollution prevention notices, codes of practice and voluntary agreements.

In order to minimize the effects of these harmful chemical substances on the environment and human health, risk management tools must be developed and enforced within a concise timeline.

CMP Environmental Monitoring and Surveillance Program

Monitoring and surveillance involve the regular collection of physical, chemical and biological data using standard methods and protocols to detect and characterize environmental change.

Canada has an impressive series of environmental monitoring programs to monitor chemical substances in air, water, sediment and biota. Recently, these programs have been integrated and augmented under the CMP to provide a fully national, multi-media program capable of meeting the Government of Canada' s existing monitoring commitments (such as those under the Great Lakes Water Quality Agreement). This program also serves to respond to newer emerging chemicals of concern. The CMP Environmental Monitoring and Surveillance (M&S) Program measures specific chemicals in outdoor air, water, sediment, fish and birds across Canada. Figure 1 shows the locations of sampling sites for the various environmental compartments. The substances monitored in each environmental compartment (e.g. air, water, sediments, etc.) can vary over time.

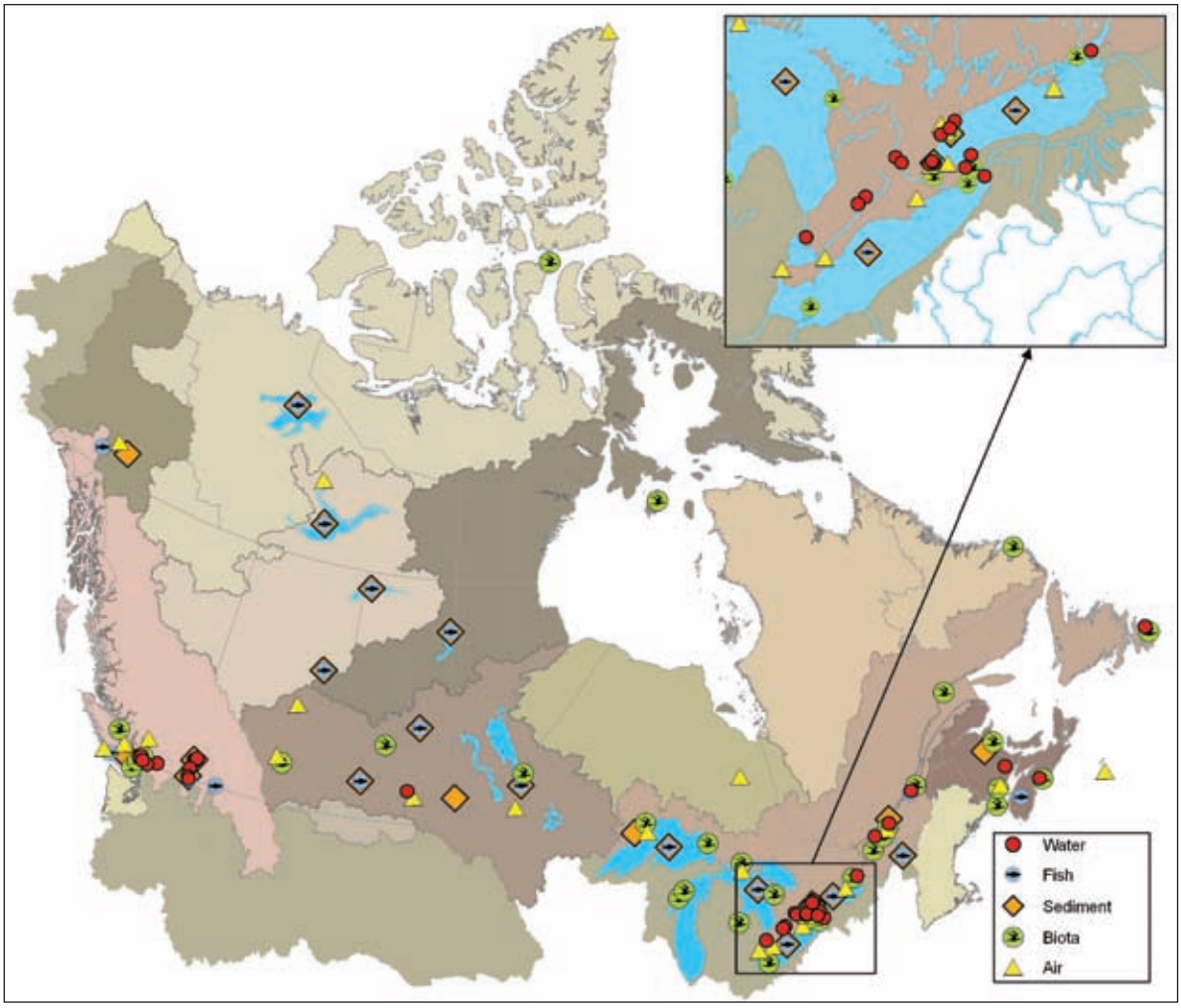

Figure 1: Sampling sites under the CMP's Environmental Monitoring and Surveillance Program

Currently, bisphenol A (BPA), siloxanes, chlorinated paraffins, metals (including platinum group elements, PGEs) perfluorinated compounds (PFCs), polybrominated diphenyl ethers (PBDEs) and other flame retardants are being examined in at least one environmental compartment. Priorities for monitoring are reviewed annually.

Many emerging chemicals of concern are found in products that routinely end up in landfills or wastewater at end-of-life. As such, monitoring programs for wastewater and landfills have been initiated across Canada under the CMP Environmental M&S Program. The wastewater component aims to characterize trends of priority compounds in effluents and biosolids and assess the effectiveness of treatment systems for removing these substances before release to the environment. Similarly, the landfill component aims to provide information on the current state of releases of priority compounds to the Canadian environment from landfill leachate, landfill gas, incineration and incineration by-products.

A concise outline of each monitoring component of the CMP Environmental M&S Program is provided below.

Air

Stations: The air component (which includes measurements in air, rain and snow) uses current atmospheric network infrastructure to support CMP needs:

(i) the Integrated Atmospheric Deposition Network (IADN) in the Great Lakes; (ii) the Northern Contaminants Program (NCP) within the Arctic region; (iii) Canadian sites within the Global Atmospheric Passive Sampling (GAPS) network; and (iv) the National Air Pollution Surveillance (NAPS) network across Canada.

Measurements for CMP chemicals are carried out at two air and five precipitation monitoring sites in the Great Lakes, as well as two Arctic air sites and 10 urban and rural air stations across Canada.

Sampling and Analytical Methods: Air samples are collected using different methods, including high-volume samples (in which the gas and particulate phases are separated) and passive sampling (which collects the gas-phase fraction only). Samples

Photo: © Bruce Harrison

Air and precipitation sampling at an urban location

undergo clean-up and fractionation after they are extracted. Measurements are at trace levels, so highly sensitive, state-of-the-art analytical techniques such as gas chromatography/mass spectrometry are applied.

Precipitation samples are collected over a 28-day period using MIC-B samplers fitted with collection vessels suitable for the target analyte. These samplers collect only during a rain/snow event. Samples are taken in a way to maintain their integrity from the collection point to the laboratory, where they are extracted and analyzed. Where required, multiple devices are installed to collect samples destined for different analyses. For example, samples are collected separately for metals, perfluorinated compounds and flame retardants. To minimize sample contamination and ensure sample stability, precipitation sampling methods (bottle types; volume required; preservative; storage) vary for each parameter measured. Some analyses are conducted within Environment Canada, while others are contracted out to private laboratories with demonstrated skill in that particular analysis.

Data Management: Air and precipitation data are stored within Environment Canada's NAtChem online database www.ec.gc.ca/natchem.

Water

Stations: A fundamental component of the CMP is the need for accurate and timely water quality monitoring information. The water component builds on existing water quality monitoring and surveillance programs; supplementary stations have been added to evaluate CMP substances of concern on a national basis. Water samples are collected from all regions across Canada on a monthly basis. Stations are selected and modified by taking into account the nature of the target analytes. Water samples are also collected annually at a limited number of fish sampling stations to compare the levels of chemical substances in fish versus those in the surrounding water.

Sampling and Analytical Methods: To minimize sample contamination and ensure sample stability, water sampling methods (bottle types; volume required; preservative; storage) vary for each parameter measured. Similarly, some analyses are conducted within Environment Canada, in collaboration with the Research Divisions, while others are contracted out to private laboratories with demonstrated skill in that particular analysis.

Photo: © Melissa Gledhill
Water sampling

Data Management: Water data are stored within Environment Canada's ENVIRODAT database.

Sediment

Stations: The sediment component of the CMP Environmental M&S Program is important for providing information not only on the current state, but also the historical condition of contaminants in the environment.

The sediment component of the CMP M&S Program builds on the Great Lakes Sediment Program, which measures sediment concentrations of harmful chemicals on a spatially intensive basis in each of the Great Lakes on an annual rotating basis. The program has expanded to include sites across the country. In addition, sediment cores are also collected at selected stations and archived for potential future analysis of target analytes.

Sampling and Analytical Methods: Surficial sediment samples, which are drawn from a depth of 0–1 cm or 0–3 cm, are collected in the sedimentary basin of either a lake or river with grab samplers (e.g., Ponar) and/or corers (e.g., box corer). Sampling frequency for open-lake areas is 5–10 years based on typical response times for sediments relative to changes in contaminant loadings. The stations selected for monitoring are chosen, in part, because of their relation to prospective contamination sources, and include reference areas representative of ambient loadings. Once gathered, samples are placed into high-density bottles and frozen before being transported to the laboratory for analysis. Chemical analyses are conducted according to certified protocols. Sediment samples are typically air dried and extracted using pressurized liquid extraction. Extracts are subjected to open-column clean-ups and then analyzed by state-of-the-art high-resolution gas chromatographic/mass spectrometric or high-performance liquid chromatographic/mass spectrometric techniques.

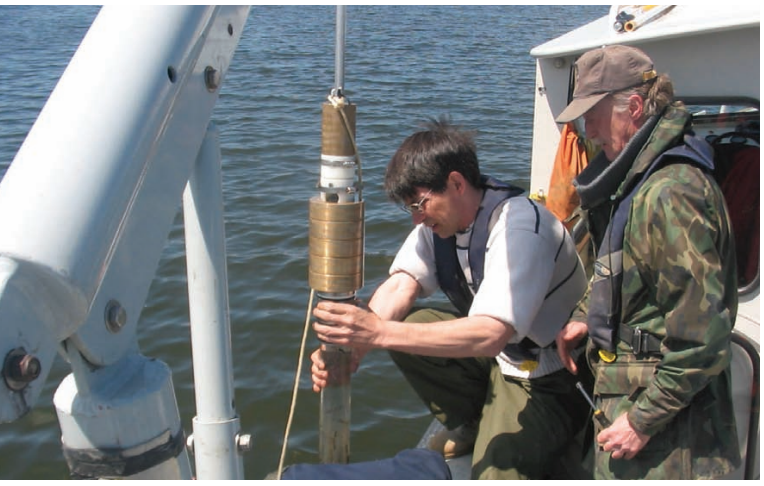

Photo: © Michel Arseneau
Open-water sediment collection

Data Management: Sediment data are stored within Environment Canada's ENVIRODAT database.

Aquatic Biota (Fish)

Stations: The monitoring of aquatic biota for the CMP was based on the Great Lakes Fish Contaminants Surveillance Program, which was initiated more than 30 years ago, and expanded to include stations in freshwater ecosystems across Canada. The stations cover major North American drainage basins, or watersheds, which drain into the Atlantic Ocean, Hudson Bay, the Arctic Ocean, and the Pacific Ocean. They include the Pacific Seaboard, Yukon, Columbia, Mackenzie, Hudson Bay Seaboard, Nelson, St. Lawrence, and Atlantic Seaboard watersheds. This allows the examination of priority contaminants such as PBDEs and PFCs in top predator fish on a national scale in areas of federal interest.

Sampling and Analytical Methods: Sampling at the 19 stations consists of collecting 10 to 20 top predator fish per location, usually working in collaboration with partners and local organizations. Top predator fish (such as Lake Trout and Walleye) are collected annually from most lakes during late summer/fall, except for northern stations, which are sampled during the onset of winter. In lakes, fish are collected using gill nets, which are essentially walls of multi-strand nylon or monofilament webbing, maintained vertically in the

Photo: © Photos.com – 2011
Fish sampling in the North

water column by several weights and floats. Once the fish are retrieved, they are sorted and identified in accordance with their collection date and location, and placed into contaminant-free, clear polyethylene bags and frozen prior to transportation to the lab. Once in the lab, fish length and weight are recorded and, prior to processing, aging structures are removed and dorsal muscle samples taken for stable isotope analysis (C/N) to confirm trophic status. Specimens are then processed, subsampled, inventoried and submitted for analysis; subsamples are archived in the National Aquatic Biological Specimen Bank at the Canada Centre for Inland Waters (CCIW) in Burlington, Ontario. Sample numbers vary depending on availability; 3–20 individuals of a single top predator are analyzed per lake.

Data Management: Data collected under this project are maintained within a secure relational database at Environment Canada's CCIW. All specimens received and/or collected are registered and assigned successive and unique identification numbers. The database maintains all biological data (length, age, etc.) and metadata (sampling location, collection methods, archival information) associated with each specimen, as well as results of all chemical analyses that have been performed on the specimen.

Biota (Wildlife)

Stations: There are two elements to the wildlife monitoring component designed to assess both aquatic and terrestrial environments. The first element builds on a monitoring program that involves the collection of colonial waterbird eggs from sites in the Great Lakes Basin (the Great Lakes Herring Gull Egg Program).

This monitoring program has been in operation for nearly 40 years. Collections throughout the Great Lakes region will continue, while new CMP-funded sites have been initiated in Quebec, Manitoba, Alberta, British Columbia and the Atlantic region.

The second element, developed specifically for the CMP, involves collecting terrestrial songbird eggs from urban locations. In 2008, starling nesting boxes were constructed and installed in order to begin monitoring during their breeding season in 2009. Twenty nest boxes per trail were developed in association with five metropolitan areas, namely Halifax, Montreal, Hamilton, Edmonton and Vancouver. In each given location, there is one trail within the urban/industrial centre itself, which will further be compared to trails 10 km and 40 km outside of the city centre. Additionally, trails have been constructed in close proximity to landfill sites for each metropolitan area, and in Ontario, to wastewater treatment plants (WWTP) in order to correlate bird and landfill/ WWTP monitoring results.

Sampling and Analytical Methods: Colonial waterbird egg collections consist largely of Herring Gull eggs (although similar species may be examined) where eggs from each of two colonies per region are acquired. Colonies were chosen so that one is closer to human habitation and one is more remote. A total of ten eggs are collected from each colony.

Starling eggs from first clutches are collected during April/May where a total of five pools of eggs per trail are collected, totalling 100 pools nationwide.

Photo: © Photos.com – 2011
Herring Gulls

A small number of plasma samples are collected from nestlings in order to provide a substrate for the analysis of BPA.

All egg samples are transported to the National Wildlife Research Centre (NWRC) in Ottawa for homogenization, archiving and analysis.

Data Management: Wildlife data are stored in Environment Canada's Laboratory Information Management System (LIMS) online database.

Waste

Stations: Landfills are emerging as an important component for monitoring and surveillance under the CMP since a considerable number of priority substances are contained in consumer products that routinely end up in landfills at the end of their lifecycle. Landfills have been flagged as a significant potential release source for some CMP substances, but much of this information is based on empirical or modeled data which may not adequately represent the complex release profile of substances contained in products.

In order to monitor the potential release of these substances from landfills in Canada, a nation-wide monitoring program has been initiated. Ten engineered landfill sites with operating leachate collection and landfill gas collection and combustion systems from across Canada have participated in this initiative since 2008.

Sampling and Analytical Methods: Initial sampling of landfill gas (LFG) and leachate were completed by a consulting firm in the fall of 2008. Additional sampling will be completed on a semi-annual basis, during the late summer/early fall and late winter/early spring, to reflect a diversity of climatic conditions.

Leachate samples were analyzed by a private-sector laboratory as well as Environment Canada's laboratories at CCIW; landfill gas samples were processed by the private laboratory. Additional substances will be added to future sample collections as warranted. This will be determined in accordance with the CMP Environmental M&S Program's priority-setting process.

Photo: © Photos.com – 2011
Landfill leachate

Data Management: The monitoring of CMP substances in landfills is the first of its kind. No data management system has been established for the waste results to date because the program is in its early stages.

Wastewater

Stations: The potential release of priority substances from wastewater effluents into the Canadian environment has led to the need for a nation-wide wastewater treatment plant (WWTP) monitoring and surveillance program in support of the CMP. This monitoring program will provide vital information for modeling the ability of diverse types of WWTPs to remove priority compounds.

Photo: © Shirley Anne Smyth

Model of a wastewater treatment plant

Environment Canada has developed partnerships with 20 municipalities throughout Canada to conduct a CMP Environmental M&S Program that represents a cross-section of WWTP types (including primary, secondary and lagoon treatment) and geographic regions (mountain, prairie, coastal). Table 1 provides a summary of the different types of WWTPs being sampled.

Sampling and Analytical Methods: Wastewater samples are collected on a semi-annual basis: once in the late summer/early fall to capture the warmest water temperatures, and once in the late winter/early spring to capture the coldest temperatures.

Table 1 Different types of WWTPs sampled across Canada

Treatment type	Solids treatment type (digestion, dewatering, final destination)
Lagoon, facultative, Arctic (2)	
Lagoon, aerated, Arctic	
Lagoon, aerated (2)	
Lagoon, facultative (3)	
Primary, chemical assist	Dewatering, alkaline stabilization
Primary, chemical assist	Rotary press dewatering, incineration
Primary, chemical assist	Mesophilic anaerobic digestion, centrifuge dewatering, forest fertilization
Secondary, activated sludge	Biopasteurization, mesophilic anaerobic digestion, centrifuge dewatering
Secondary, activated sludge	Dewatering, potassium permanganate, alkaline stabilization
Secondary, activated sludge	Mesophilic anaerobic digestion, plate-and-frame dewatering, incineration
Secondary, activated sludge	Aerobic digestion, land application
Secondary, biological aerated filter	Centrifuge dewatering, sludge to landfill
Secondary, enhanced trickling filter	Thermophilic digestion, centrifuge dewatering, mine reclamation
Secondary, HPO-activated sludge	Mesophilic anaerobic digestion, centrifuge dewatering, land application
Secondary, lagoon	Mesophilic anaerobic digestion (primary sludge only), filter press dewatering, composted
Advanced, biological nutrient removal	Mesophilic anaerobic digestion, lagoon settling, land application

At each station, equal-volume 24-hour composite samples of raw influent, primary effluent, and final effluent are collected; grab samples of primary sludge, waste-activated sludge and treated biosolids are also collected. These samples are collected by trained Environment Canada personnel, with the support of temporary staff.

Once collected, wastewater samples are analyzed for conventional parameters such as phosphorus, nitrogen species, and oxygen demand, along with other compounds. Sludge and biosolids are analyzed for total and volatile solids (TS/TV). These wastewater and solids measurements are crucial to providing context for interpreting concentrations and removals of priority compounds within wastewater and sludge treatment systems.

Wastewater and sludge samples are analyzed for a number of CMP priority substances. A suite of metals (cobalt, mercury, etc.), BPA and siloxanes are analyzed at Environment Canada's metals and organic laboratories at CCIW. The analysis of PFCs and PBDEs in wastewater is performed by a private laboratory through contractual agreements with Environment Canada.

www.**ec.gc.ca**

Additional information can be obtained at:

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