Surveillance of environmental & occupational exposures for cancer prevention

2009/2010 PROGRESS REPORT
Prepared for the Canadian Partnership Against Cancer
April, 2010
Executive Summary
This report presents a summary of the progress made by the CAREX Canada project during its second full year of operation. During this year we have made substantial progress in terms of developing estimates of environmental and workplace exposures, as well as in terms of communications and developing partnerships across the country.

The environmental team has continued to identify and gain access to new data resources, including provincial databases. We have established several new scientific advisory committees for different environmental media and received extremely useful input from these and our National Advisory Committee. We have made progress in developing indicators for outdoor air, and for indoor air, drinking water, and food as well, via our new tool (CAREX-eRisk) for integrating exposure information from multiple sources and expressing their relative importance in terms of cancer risk. In addition, several new projects have been initiated which will focus on vulnerable populations, including First Nations communities and people with low socioeconomic status.

The occupational team has greatly increased the number of prevalence estimates and there will soon be over 30 on the web in both official languages. Further enhancements have been made to the electronic platform that allow its more effective use in developing estimates and storing data in a usable format, including the Canadian Workplace Exposure Database (CWED). Progress is being made acquiring, cleaning, coding and reformatting national, provincial, and literature-derived exposure data for CWED and a grant application is currently under consideration that would allow CAREX Canada to assist in the creation of new provincially-based databases that would enhance prevention locally as well as contribute to a national resource.

Progress is also being made in knowledge translation and exchange. Substantially more information is now available on the website, providing an excellent resource centre for information on occupational and environmental carcinogens. We are working with our advisory and scientific committees to improve the usefulness of our profiles, exposure estimates, and national and provincial reports. We have also launched a quarterly e-bulletin. We are in the midst of a knowledge translation needs assessment survey. We have also been conducting literature reviews to identify the best practices in communicating environmental and occupational exposure and risk information.

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Environmental Exposure Surveillance Project

As part of CAREX Canada, the key objective of the Environmental Exposure Surveillance Project is to identify and implement methods to estimate Canadians’ potential exposure to various environmental carcinogens (known or suspected). In particular, our goal is to generate estimates of exposures that take into account geographic variations in carcinogen concentrations or population sub-groups across all environmental media, including indoor and outdoor air, dust and soil, drinking water, food and beverages and consumer products. Exposures to extremely low frequency magnetic fields and radon are also of interest.

Key activities in Year 1 included:

- detailed reviews of Group A (priority) substances;
- acquisition and formatting of available national datasets;
- systematic citation retrievals from 4 major databases (PubMed, ToxLine, Web of Science, and GeoBase) in search of published measured data in Canada; and,
- development of preliminary indicators of exposure for 17 substances, primarily for exposure via outdoor air.

This report provides details on key activities in Year 2, including:

- establishing advisory groups (see knowledge translation and exchange section);
- refining approaches for developing exposure estimates;
- acquiring additional existing data, including provincial holdings; and,
- developing Phase II estimates, including vulnerable populations.

Environmental exposure: approach

While our general approach for surveillance of environmental exposures has been clear since the inception of CAREX Canada, we continue to refine the operational aspects as we gain a better understanding of the available data and explore how they can best be used to support our goals. We are committed to developing comprehensive indicators of exposure that incorporate variation across environmental media, geographic locations, and populations of interest. In Year 1, we focused on looking for data for specific media (outdoor air, indoor air and dust, drinking water, food, outdoor soil and water, and consumer products), and developing approaches for using these data for national indicators of exposure. In Year 2, we have also focused on exploring useful methods for producing more integrated indicators, primarily through the use of a comprehensive risk assessment approach in conjunction with a spatial approach.

In Year 2, we have developed a pilot tool (the CAREX e-risk tool) that calculates excess lifetime cancer risk for different exposure routes. The calculation uses data on concentration levels and the frequency of detection*, typical body weights, breathing and consumption rates, and time spent indoor and outdoor for five life-stages (see Figure 1). As a preliminary step, we’ve added data from the National Air Pollution Surveillance network, Canadian Food Inspection Agency reports, US Food and Drug Administration Total Diet Study reports, the 2006 Statistics Canada Food Statistics report, California Office of Environmental Health Hazard Assessment cancer potency values, and peer-reviewed literature. The CAREX e-risk tool is the first of its kind, to our knowledge, given the wide range of substances and factors considered. Even more importantly, we are the first to link this kind of information with spatial data, enabling a detailed map view of estimated excess risk for all of Canada (see the exposure estimates section, below).

In Year 3, we will review the CAREX e-risk tool with our advisory groups, incorporate their feedback, and develop an online database with a graphic interface that allows users to adjust and document any/all of the parameters described above. Given this planned flexibility, users can input maximum, average or minimum values to understand the potential range of excess cancer risk, focus on specific pathways, foods, or populations, or investigate the sensitivity of the excess risk estimate to changes in parameters.

* In some cases, a substance is detected only in a few of the tested samples. When this occurs, using the average of the detected levels may overstate average exposure. We have including the option for weighting the concentration by its frequency of detection.

Figure 1. Diagram of the CAREX e-risk tool - Lifetime excess cancer risk calculation tool

Models of Carcinogens in Outdoor Air

We created national models for PM$_{2.5}$, benzene, ethylbenzene, butadiene and NO$_2$ (indicator of traffic-related carcinogens) concentrations that capture both between and within city variation across Canada. This approach is an improvement on our existing exposure estimates using fixed site monitors as we now have exposure estimates for all Canadians, not just for those living near air quality monitors.
Models were developed using national air pollution surveillance (NAPS) data and provincial fixed site air pollution monitors operating during 2006. Background levels were determined from satellite data when available (PM$_{2.5}$, NO$_{2}$) and local variation from geographical predictor variables (i.e., NPRI emitters within 5km, length of major roads within 10km, etc.). We also developed proximity factors to capture micro-scale pollution variation from specific sources that are not fully captured by fixed site pollution monitors. Proximity factors were created based on a comprehensive review of the literature. Table 1 includes the proximity factors for PM$_{2.5}$, benzene, ethylbenzene, butadiene, and NO$_{2}$, illustrating that localized pollution sources.

**Table 1. PM$_{2.5}$, Benzene, Ethylbenzene, Butadiene and NO$_{2}$ proximity factors determined from the literature to account for localized pollution sources.**

<table>
<thead>
<tr>
<th>SUBSTANCE</th>
<th>SOURCE</th>
<th>ELEVATED CONCENTRATION AT SOURCE (above background levels)</th>
<th>DISTANCE TO DECAY (to background levels)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM$_{2.5}$</td>
<td>Highway</td>
<td>25%</td>
<td>75m</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>Residential urban street</td>
<td>10%</td>
<td>75m</td>
</tr>
<tr>
<td>Benzene</td>
<td>Gas stations</td>
<td>65%</td>
<td>100m</td>
</tr>
<tr>
<td>Benzene</td>
<td>Major road and highway</td>
<td>325%</td>
<td>500m</td>
</tr>
<tr>
<td>Benzene</td>
<td>Local urban road</td>
<td>50%</td>
<td>50m</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Highway</td>
<td>370%</td>
<td>300m</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Major road</td>
<td>220%</td>
<td>300m</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Local road</td>
<td>40%</td>
<td>300m</td>
</tr>
<tr>
<td>Butadiene</td>
<td>Highway</td>
<td>400%</td>
<td>75m</td>
</tr>
<tr>
<td>NO$_{2}$</td>
<td>Highway</td>
<td>65%</td>
<td>300m</td>
</tr>
<tr>
<td>NO$_{2}$</td>
<td>Major roads</td>
<td>20%</td>
<td>100m</td>
</tr>
</tbody>
</table>

**Data resources**

In Year 2, we acquired additional data to support the development of spatial models for benzene, ethylbenzene, 1,3-butadiene and PM$_{2.5}$ in outdoor air. A model for nitrogen dioxide (NO$_{2}$) was also developed to indicate traffic-related pollution and as an input to other models. In addition, comprehensive literature reviews were completed to identify proximity factors.

- **Satellite-based NO$_{2}$**: Satellite-based NO$_{2}$ data were provided by the Department of Physics and Atmospheric Chemistry at Dalhousie University with funding from Health Canada. These data are a composite measure for 2005-2006 at a 0.1x0.1 degree resolution and are derived from the OMI platform. Satellite data estimates of NO$_{2}$ concentrations are available for all of Canada and provide good estimates of regional air pollutant concentrations.

- **Provincial air quality data**: Air quality data for 2006 were obtained for the province of Alberta (1), British Columbia (2), Quebec (3), and the city of Montreal (4). Monitored levels of PM$_{2.5}$ were downloaded from the Clean Air Strategic Alliance (CAS) for Alberta, the Ministry of Environment for British Columbia, and le Réseau de surveillance de la qualité de l’air for the city of Montreal. Monitored levels of PM$_{2.5}$ and NO$_{2}$ for the province of Quebec were obtained from the Ministère du Développement durable, Environnement et Parcs du Québec. The data were combined with the National Air Pollution Surveillance (NAPS).

- **US roads and rails**: The road and rail networks of US were downloaded (5) to augment the development of geographic variables for air quality monitoring stations near the Canadian border. The network was divided to fit the Canadian network for highways, major roads and railways. Both networks were combined and the variables derived from them.

- **US population**: The 2000 US census tracts were downloaded from the US Census Bureau web site (6) in shapefile format. The files were combined with the Canadian Block Points.

- **US National Emissions Inventory**: The 2005 Point Facility Summary file was downloaded from the US Environmental Protection Agency (EPA) web site (7), for NO$_{2}$, PM$_{2.5}$, and VOCs.

- **Mining**: Mining site locations and spatial data were downloaded from each Canadian province or territory’s Mining & Energy website, Natural Resources Canada’s website indicating mineral type; active or non-active production; years of production; etc.

- **Soil data**: Background concentration levels of metals (arsenic, cadmium, chromium, lead, and nickel) in soils for the province of British Columbia were downloaded from the Ministry of Environment website (8). Sample dates are circa 1996.

- **Outdoor water**: Concentrations of nickel, arsenic, cadmium, chromium, cobalt, copper, and lead in surface water were obtained from Environment Canada. Sample dates range from 1996 to 2008.

- **Identified online sources for provincial drinking water quality data and reports**: Average concentrations of Chloroform, Dichloromethane, 2,4-D, MCPA, MCPP, Pentachlorophenol, PAH, Trichloroethylene, N-Nitosodi-n-propylamine, N-Nitrosomethylamine, Acrylamide, Cobalt and Cobalt compounds, DDT, Hexachlorobenzene, and Toxaphene in 2006 were calculated based in data from the Drinking Water Information Management System (DWIMS), an online database that manages the water quality data collected by the Ontario Drinking Water Surveillance Program (DWSIP).

- **CFIA & USDA data on food residues**: Chemical residues in the normal food supply in Canada were downloaded from the Canadian Food Inspection Agency’s website (9). Additional data on residue concentrations were downloaded using the USDA’s Dietary Exposure Potential Model (DEPM) where 800 exposure core foods and 6500 common food items are evaluated from several diet study and residue databases (10). Additional data on residue concentrations were downloaded using the USDA’s Dietary Exposure Potential Model (DEPM) where 800 exposure core foods and 6500 common food items are evaluated from several diet study and residue databases (10).

- **Statistics Canada Data - food consumption**: Food consumption statistics and indicators were downloaded from a Statistics Canada database (Canada Food Stats) designed to provide information on per capita food availability for consumption and food prices, nutrition, supply and demand (11).
Environmental exposure estimates

We have used the CAREX e-risk tool to develop preliminary average lifetime excess risk estimates (selected examples are provided in Figure 2), based on current concentration levels. Each exposure route is represented separately for any given substance, as different types of cancer may be associated with ingestion via food or water versus inhalation via air. This approach also makes it easy to identify priorities for exposure reduction activities. Whenever appropriate, we will be linking these average estimates with spatial data to identify the geographic variation in excess risk. As Figure 3 clearly shows, while the average excess risk for benzene in outdoor air is estimated to be 1:150,000, there are ‘hot spots’ where excess risk is much higher.

Figure 2. Preliminary average lifetime excess risk estimates

![Chart showing various substances and their corresponding lifetime excess risk for different exposure routes.]

Figure 3. Lifetime Excess Cancer Risk - Inhalation of Benzene in Outdoor Air, 2006

![Map of Canada showing lifetime excess cancer risk for inhalation of benzene in outdoor air.]

Data Sources:
- CAREX ambient benzene model
- CAREX estimated lifetime average daily intake model
- Statistics Canada Block Point Population 2006.
Vulnerable populations

Socio-economic status and environmental exposures

Research indicates that populations of lower socioeconomic status (SES) may live in areas with higher pollution levels. We used our national models for PM$_{2.5}$, benzene, ethylbenzene, butadiene and NO$_2$ to examine associations with SES indicators derived from the Census. As an example, Table 2 summarizes benzene concentrations by the proportion of households in a dissemination area (DA) under the Statistics Canada low income cut-off for all Canadian census metropolitan areas (CMAs) and separately for the three largest urban centers in Canada. For all CMAs, mean benzene concentrations for individuals living in DAs with no households below the low income cut-off was 1.17 µg/m$^3$ compared to 1.50 µg/m$^3$ for individuals living in DAs within the highest 90th percentile of proportion of low income households (>21.9%). The magnitude of benzene exposure disparities by the proportion of low income households varied between cities; however, the gradient of benzene exposure increasing with increasing proportions of low income households is consistent.

An additional analysis illustrates that the relationship between SES and benzene exposure is not the same everywhere. Figure 4 maps, by city, the correlations between benzene exposure and the proportion of households in an area that are under the Statistics Canada low income cut-off. Large symbols indicate where the relationship was relatively strong, and smaller symbols indicate where the relationship was weak or even not present. This spatial information adds an important level of detail that can help focus exposure reduction activities and outreach efforts.

Environmental exposures among First Nations

In Year 2, we were successful in obtaining a Tri Council Knowledge Synthesis grant, in partnership with researchers at the University of Victoria, University of British Columbia, and the First Nations Environmental Health Innovation Network (FNEHIN). Over the course of the next year, we will be developing a geographic information system to synthesize existing environmental data and the inherent spatial information by producing indicators of exposure for all First Nations communities in Canada. The results will be made available as a comprehensive report as well as via an online mapping application, hosted by the FNEHIN and CAREX Canada.

Table 2. Benzene exposures by the proportion of households in a DA under the Statistics Canada low income cut-off for all of Canada and separately for Vancouver, Toronto and Montreal.

| Proportion of households in a DA under the Statistics Canada low income cut-off | BENZENE EXPOSURE (µg/m$^3$) |
|---|---|---|---|
| | Mean | Median | SD | 90th Percentile |
| **CANADA** | | | | |
| 10th Percentile (0% low income households) | 1.11 | 1.17 | 0.49 | 1.72 |
| 50th Percentile (<6.8% low income households) | 1.12 | 1.19 | 0.49 | 1.73 |
| 90th Percentile (>21.9% low income households) | 1.50 | 1.54 | 0.48 | 2.00 |
| **VANCOUVER** | | | | |
| 10th Percentile (0% low income households) | 1.48 | 1.47 | 0.30 | 1.79 |
| 50th Percentile (<10.5% low income households) | 1.50 | 1.48 | 0.29 | 1.80 |
| 90th Percentile (>26.8% low income households) | 1.59 | 1.53 | 0.30 | 1.87 |
| **TORONTO** | | | | |
| 10th Percentile (0% low income households) | 1.40 | 1.51 | 0.43 | 1.82 |
| 50th Percentile (<8% low income households) | 1.42 | 1.52 | 0.41 | 1.81 |
| 90th Percentile (>23.3% low income households) | 1.63 | 1.56 | 0.33 | 1.95 |
| **MONTREAL** | | | | |
| 10th Percentile (0% low income households) | 1.41 | 1.42 | 0.45 | 1.93 |
| 50th Percentile (<8.3% low income households) | 1.40 | 1.42 | 0.46 | 1.94 |
| 90th Percentile (>28.9% low income households) | 1.84 | 1.80 | 0.35 | 2.25 |
Figure 4. Correlations between modeled benzene exposures and the proportion of households in a DA under the Statistics Canada low income cut-off.

Future Work
In the near term, we plan to meet with the CAREX advisory group members in June to demonstrate the CAREX e-risk tool. We will use feedback and suggestion to refine the tool, and plan to develop a graphic interface as well as a dynamic connection to a mapping application that will incorporate spatial variability and support visualization of the data.

We will also be developing watershed-based inventories of carcinogen sources to support the development of exposure profiles. The initial focus will be on First Nations communities (see details provided previously for the CAREX and FNEHIN partnership), but plans are to extend this to all of Canada.

There are not enough air quality monitoring data to allow for comprehensive spatial modeling for carcinogens other than benzene, ethylbenzene, 1,3-butadiene and PM$_{2.5}$; there is value, however, in developing proximity factors wherever possible. These will be based on measured concentrations near sources and at background locations, as identified by comprehensive literature reviews. This approach will be applied not only to outdoor air, but also to locally grown and harvested food, indoor air, and drinking water from private wells, and incorporated into the CAREX e-risk tool.

Graduate students at the University of Victoria will be working on developing land user regression models for soil pollutants, with a focus on metals. Finally, we hope to gain access to data recently collected by Statistics Canada on drinking water quality across Canada, particularly for disinfection byproducts.
**SOURCES**

2. http://a100.gov.bc.ca/pub/aqis/station_info.go?cookie=LGHCNGJBJC
3. via personal request
Workplace Exposure Surveillance Project

As part of CAREX Canada, the key objective of the Workplace Exposure Surveillance Project is to identify and implement methods to estimate Canadians’ potential exposures to the most common workplace carcinogens. In particular, our goal is to generate estimates of the numbers of workers exposed by industry, occupation, province and sex. Where data are available to do so for substances, we will also create estimates of the levels of exposure expected in Canadian workplaces.

Key activities in Year 1 included:

- Identification of priority known, probable, and possible carcinogens (as identified by the International Agency for Research on Cancer);
- Identification of key resources, including the CAREX Canada pilot projects, updated labour force data, national and provincial exposure databases, other published literature, and environmental and business-related databases;
- Development of the basic design elements of the CAREX Canada Electronic Platform, a specialized system to house the Canadian Workplace Exposure Database (CWED), all exposure estimates, reference materials, and historical information on other CAREX systems; and,
- Development of estimates for 12 high priority substances or workplace characteristics for Canada.

This report provides details on key activities in Year 2, including:

- Acquisition, cleaning, coding and reformatting of national, provincial, and literature-derived exposure data sources, and creation of provincial partnerships and seeking out new funding opportunities within these partnerships to create electronic databases;
- Major infrastructure development and refinement of the CAREX Canada Electronic Platform;
- Development of systematic as well as substance-specific specialized approaches for estimate generation; and
- Generation of Phase 1 estimates of exposed populations for 21 new known or suspected carcinogens or groups (e.g., antineoplastics and PAHs).

Data resources & funding/partnerships

A major new resource being developed for this project is the Canadian Workplace Exposure Database (CWED). It will facilitate estimating the overall prevalence as well as levels of exposure. To date, we have gained access to 4 Canadian databases and one database of exposure data collected from the published literature (received from the National Institute forOccupational Safety and Health (NIOSH, United States). These databases are described below.

1. MESU database (Ontario Ministry of Labour): The MESU database contains data on over 300,000 samples taken by occupational hygienists in Ontario workplaces between 1981 and 1996 (when funding for the program was discontinued). Approximately 70,000 of the samples were for substances of interest to CAREX Canada (i.e. known or suspected carcinogens).

2. LIMS database (WorkSafeBC): The LIMS (Laboratory Information Management System) database from WorkSafeBC contains data that is similar to MESU (i.e. samples collected by workers’ compensation system hygienists). LIMS contains data from 1981 until 2004 (when funding for the program was also discontinued).

3. National Dose Registry (Radiation Protection Division, Health Canada): Through our partnership with the Radiation Protection Division of Health Canada, we have received data from the National Dose Registry (NDR) on worker exposure to radiation across all industries in Canada for 2004 to 2008 (by radiation type, province, industry, occupation, and sex).

4. Quebec: Through our partnership with colleagues at the Université du Montréal, we have been given access to two Quebec-based databases containing data on samples collected in workplaces from 1984 to 2004 for one database (called SMEST) and from 1976 to 1992 for the other (called HYGIENE).

5. Literature database: Through our partnership with the National Institute for Occupational Safety and Health (NIOSH) and the National Cancer Institute (NCI) in the US, we have been granted access to a literature database they created for benzene, which contains exposure measurement data that was extracted from the published literature as well as unpublished reports (i.e. Health Hazard Evaluations). We are in discussions with NIOSH and the NCI to gain access to other, similar databases. We also intend to use their methodology to guide our own extractions of exposure data from the literature for selected priority substances where we lack Canadian data.

Partnerships and funding opportunities

Over Years 1 and 2, our activities related to seeking out exposure data proved to be more difficult than originally expected. It was discovered that exposure data held by the majority of provincial and territorial agencies are often in unwieldy formats, such as hard copy files or singular electronic reports. Because the abstraction of such data is considerably more challenging, we applied for funding to support the transfer of occupational exposure data from the following priority collaborators into practical electronic databases: 1) The BC Ministry of Energy, Mines, and Petroleum Resources, 2) The Yukon Workers’ Compensation Health & Safety Board, and 3) The Saskatchewan Ministry of Labour. The overall objective of the work is to acquire the data, undertake basic characterization of exposure levels and trends in Canada and provide new exposure data capabilities to all collaborators. Our grant proposal (entitled ‘Capacity Development for a Canadian Workplace Exposure Database’) was submitted to WorkSafe BC’s Research at Work competition in January 2010.
**Infrastructure development (CAREX Canada Electronic Platform)**

For the current CAREX Canada Workplace Exposure Surveillance Project we have created a greatly enhanced relational database using Microsoft® SQL 2005. The CAREX Canada Electronic Platform (CCEP) is a server-based system that allows multiple users at the same time and access via the Internet with the look and feel of Microsoft® Access but the flexibility of a Microsoft SQL back end.

In the past year, the CCEP has undergone extensive development, and is now fully operational for internal use. It consists of a variety of functions required for producing estimates of occupational exposure, and houses all of our relevant data, including labour force data for all of Canada, historical data from the European CAREX system, and all of our actual estimates. The CWED will actually be housed within the CCEP as well; the technical details to create the CWED environment are currently underway. The CCEP is a cohesive and comprehensive resource for data on occupational exposure to carcinogens in Canada.

Figure 1 shows the main screen of the CCEP and the options available to users. A new feature that has proven to be very useful is the ‘Exposure estimates – staging’ area, which is where all data for producing estimates of the number of Canadians exposed to all our priority substances is entered. Figure 2 shows what the staging table looks like for styrene as an example.

The CCEP is in constant development as we find new ways to make it more user-friendly and functional. In a future stage of development a user-friendly, web-based data query interface will be developed that will allow CAREX Canada collaborators and others to generate reports.

**Approaches for generation of occupational estimates**

In Year 1, we produced exposure estimates for 12 substances that were evaluated by the CAREX Canada Pilot Projects. Year 2 saw the development of many new exposure estimates (for which no protocol existed) for the remaining high priority substances. We followed a general approach to ensure transparency, ease of interpretation, and comparability between substances. The approach is very flexible, however, and can be adjusted for substances with unique data sources or particular challenges with respect to uncertainty.

**General approach**

1. Literature review and consultation of our carcinogen profiles for current information on the Canadian uses of a substance, potential industries and occupations where exposure may occur, and exposure circumstances.
2. Consult CWED exposure databases to look for industries and occupations where exposure has been measured. This allows us both to confirm that industries we flagged during our literature review are important in the Canadian context of workplace exposure, and also to flag new industries that we had not considered.
3. Use National Pollutant Release Inventory of Environment Canada (which tracks releases of many of our CAREX priority chemicals) to flag industries where exposure may occur for particular substances.

4. In cases where a chemical is produced by a small number of companies, Industry Canada entries in the Canadian Company Capabilities database and web searches are used to find numbers of employees for those companies to guide how we assign proportions of workers exposed.

5. For jobs that do not differ significantly by industry (i.e. electricians, welders), assign exposure estimates for the total workforce. For ones that do differ, use the staging area of the CCEP to assess the occupation for each industry.

**Specialized approach example: Antineoplastic pharmaceuticals**

1. Data is available on how many pharmacists and technicians work in Canadian hospital pharmacy departments where the preparation and mixing of antineoplastics occurs. There is also readily available data on how many nurses specialize in oncology. These 3 jobs had the highest potential for exposure to antineoplastic drugs.

2. For other occupations, such as nurses in general, we sought external sources of information to estimate the number that are potentially exposed to antineoplastics. A comprehensive study in British Columbia containing data on how many nurses were likely to be exposed was used to estimate the proportion with the potential for exposure Canada-wide.

**New Phase I estimates**

To date, the occupational team of CAREX Canada has produced reports on exposure for 33 high priority known and suspected carcinogens. Seventeen of these have been outlined in previous reports (including our 2008/2009 Progress Report and our December 2009 Update Report). We have also developed estimates for 16 new substances, and for three others, we have updated our original estimates. We include in this report detailed information for three high profile substances (arsenic, asbestos and trichloroethylene). In addition, our website has been updated with reports on all other estimates completed to date.

Table 1 shows the estimated number of Canadians exposed to all of the CAREX Canada priority carcinogens. When interpreting the information conveyed in the table, it is important to note that each known/suspected carcinogen listed was considered alone, such that overlap of workers exposed in the totals is inevitable. In other words, the workers exposed to asbestos may also be counted in the totals for solar radiation or chromium (as an example). In addition, these estimates were developed with a low threshold for what we consider exposure. This threshold is described in each individual report, but in general, includes the known use of that substance in the industry/occupation intersection, and exposure levels above what could be considered “background.”

**Table 1: Workplace exposure to known and suspected carcinogens in Canada**

<table>
<thead>
<tr>
<th>KNOWN OR SUSPECTED CARCINOGEN</th>
<th>NUMBER OF CANADIANS EXPOSED AT WORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylamide*</td>
<td>9,000</td>
</tr>
<tr>
<td>Acrylonitrile*</td>
<td>5,900</td>
</tr>
<tr>
<td>Antimony trioxide</td>
<td>9,700</td>
</tr>
<tr>
<td>Antineoplastic drugs</td>
<td>17,000</td>
</tr>
<tr>
<td>Arsenic*</td>
<td>25,000</td>
</tr>
<tr>
<td>Asbestos*</td>
<td>152,000</td>
</tr>
<tr>
<td>Benzene</td>
<td>297,000</td>
</tr>
<tr>
<td>Beryllium</td>
<td>3,900</td>
</tr>
<tr>
<td>Cadmium*</td>
<td>32,000</td>
</tr>
<tr>
<td>Chromium (hexavalent)</td>
<td>83,000</td>
</tr>
<tr>
<td>Cobalt*</td>
<td>26,000</td>
</tr>
<tr>
<td>Creosotes*</td>
<td>1,200</td>
</tr>
<tr>
<td>Dichloromethane*</td>
<td>20,000</td>
</tr>
<tr>
<td>Diesel engine exhaust</td>
<td>804,000</td>
</tr>
<tr>
<td>Ethylene oxide*</td>
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</tr>
<tr>
<td>Formaldehyde</td>
<td>42,000</td>
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<tr>
<td>Lead</td>
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<tr>
<td>Naphthalene*</td>
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<td>Pentachlorophenol*</td>
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<td>Polychlorinated biphenyls (PCBs)*</td>
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<td>Polycyclic aromatic hydrocarbons (PAHs)</td>
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<td>Refractory ceramic fibers (RCF)*</td>
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<td>Shift work with potential for circadian disruption</td>
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<td>Silica (crystalline)</td>
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<tr>
<td>Solar radiation*</td>
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</tr>
<tr>
<td>Styrene*</td>
<td>41,000</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>14,000</td>
</tr>
<tr>
<td>Toluene diisocyanates (TDI)</td>
<td>24,000</td>
</tr>
<tr>
<td>Trichloroethylene*</td>
<td>13,000</td>
</tr>
<tr>
<td>UV radiation (artificial sources)*</td>
<td>207,000</td>
</tr>
<tr>
<td>Vanadium pentoxide</td>
<td>7,200</td>
</tr>
<tr>
<td>Wood dust</td>
<td>293,000</td>
</tr>
</tbody>
</table>

*New estimates (not included in any previous report)
Note: Italicized substances are included in this report; other substances flagged as new are available online (www.carexcanada.ca).
Example Estimates

Arсенic and its compounds

Arsenic compounds are found in complex minerals containing copper, lead, iron, nickel, and cobalt, and are encountered in the mining, processing and use of products containing these metals (1). The most common use for arsenic in Canada has been for chromated copper arsenate (CCA), a widely used wood preservative that contains hexavalent chromium and arsenic. Arsenic also has important uses in the metallurgical industry (hardening copper and lead-antimony alloys), glassmaking (bubble dispersant or colouring agent), the semi-conductor industry (solar cells, light emitting diodes, lasers, and integrated circuits), and battery and ammunition manufacturing (2).

Wood preservation and arsenic

Wood and wood products are vulnerable to the effects of insects and fungi, so these materials are often treated with pesticides to protect their aesthetics and structural integrity (3). Depending on the end-use of the wood, different preservatives are permitted for use. In Canada, 4 types of heavy-duty wood preservatives dominate (pentachlorophenol, creosotes, and 2 arsenic-based formulations); all 4 are considered priorities by CAREX Canada and information can be found on pentachlorophenol and creosotes at www.carexcanada.ca. The 2 arsenic-based formulations are chromated copper arsenate (CCA) and ammoniacal copper zinc arsenate (ACZA). ACZA is usually used on large wood products, such as those used for pilings and bridges, while CCA is currently used in a variety of applications, including utility poles, fence posts, shingles and shakes, and plywood (3). Since ACZA is only used at one treating plant and production data were not available, CCA hereafter refers to both CCA and ACZA. Until 2003, CCA was used for both industrial and non-industrial applications in Canada, when producers voluntarily stopped applying it to wood intended for non-industrial uses such as play structures, desks, fencing and boardwalks due to concerns regarding leaching of arsenic and chromium into surrounding soils (4).

A review done in 1999 of heavy-duty (5) wood preservation facilities in Canada found that of the 66 plants, CCA was used in 63 of them (95%) (Table 2) (5). Indeed, at 76% of the plants, CCA was used exclusively. In 1999, most of the CCA was used for lumber, timber and plywood (80%) with the remainder used for treating posts (14%), and poles and pilings (6%) (6).

Table 2. Wood preservation plants using arsenic-based treatments in Canada (modified from Stephens et al.)(5)

<table>
<thead>
<tr>
<th>PLANT TYPE</th>
<th># OF PLANTS</th>
<th>PROVINCES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BC</td>
<td>AB</td>
</tr>
<tr>
<td>CCA</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>CCA + PCP</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>CCA + PCPt</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CCA + PCP + PCPt</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CCA + CREO + PCP</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>CCA + ACZA + CREO + PCP</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

CCA: Chromated copper arsenate
CREO: Creosotes
PCP: Pentachlorophenol (applied using pressure-treating)
PCPt: Pentachlorophenol (applied thermally without pressure-treating)
ACZA: Ammoniacal copper zinc arsenate

Note: There are no wood preservation facilities in the territories.

Exposure to arsenic in wood preservation is defined as the potential for inhalation or dermal contact with arsenic-based wood preservatives (CCA and ACZA) at work. This includes direct contact with the preservatives (i.e. during application at wood preservation facilities, where exposure is potentially high), in addition to exposure to other workers who may handle or process (i.e. sawing) CCA-treated wood. Initial results show that 12,500 Canadians are currently exposed at work to arsenic via its use in CCA wood preservatives. Table 3 shows the number of people exposed to CCA by industry.

Table 3. Number of people exposed to CCA by industry

<table>
<thead>
<tr>
<th>INDUSTRY GROUP</th>
<th>NUMBER OF CANADIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawmill and wood preservation</td>
<td>2,900</td>
</tr>
<tr>
<td>Foundation, structure and building exterior contractors</td>
<td>2,800</td>
</tr>
<tr>
<td>Non-residential building construction</td>
<td>2,700</td>
</tr>
<tr>
<td>Farms</td>
<td>2,100</td>
</tr>
<tr>
<td>Residential building construction</td>
<td>1,000</td>
</tr>
<tr>
<td>Highway, street and building construction</td>
<td>750</td>
</tr>
<tr>
<td>All others</td>
<td>350</td>
</tr>
<tr>
<td>Total</td>
<td>12,500</td>
</tr>
</tbody>
</table>
Other sources of occupational arsenic exposure

While the main use of arsenic is for CCA wood preservatives, there are several other uses of arsenic in Canada. It is used in the metallurgical industry to harden copper and lead-antimony alloys for use in ammunition, solders, battery posts, bearings and lead shot (7). Arsenic is also used as a bubble dispersant and colouring agent in the glassmaking industry (8), and in the semiconductor industry in specialized applications (9). Occupational exposure to arsenic may occur during the smelting of arsenic-containing ores in non-ferrous metal production, or in iron ore processing, scrap iron reclamation or steel mills. Arsenic is also a by-product of coal combustion and is encountered in oil and gas extraction and coal generating power stations.

Exposure to arsenic from sources other than wood preservation using CCA is defined as inhalation or dermal exposure at work expected to exceed non-occupational exposure via these routes (i.e. does not include exposure via ingestion of food or drinking water). Initial results show that an additional 12,500 Canadians are currently exposed at work to arsenic in industries other than wood preservation (Table 4). The largest industrial group is non-ferrous metal production and processing, followed by iron and steel mills, where arsenic is produced as a by-product of the processing of other metals.

For occupation, the largest groups of workers exposed to arsenic are machinists and machining tool workers (2,600 workers exposed), industrial mechanics (1,000 exposed), glaziers (800 exposed), and welders (500 exposed). These occupational groups are also primarily responsible for the large number of workers included under ‘all others’ in Table 4. Other important occupational groups include sandblasters, boilermakers, and auto-body workers.

Table 4. Number of people exposed to arsenic by industry (not including CCA wood preservative use)

<table>
<thead>
<tr>
<th>INDUSTRY GROUP</th>
<th>NUMBER OF CANADIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-ferrous metal (except aluminium) production and processing</td>
<td>1,000</td>
</tr>
<tr>
<td>Iron and steel mills and ferroalloy manufacturing</td>
<td>900</td>
</tr>
<tr>
<td>Oil and gas extraction</td>
<td>800</td>
</tr>
<tr>
<td>Metal ore mining</td>
<td>800</td>
</tr>
<tr>
<td>Water, sewage and other systems</td>
<td>600</td>
</tr>
<tr>
<td>Glass and glass product manufacturing</td>
<td>500</td>
</tr>
<tr>
<td>Semiconductor and other electronic component</td>
<td>500</td>
</tr>
<tr>
<td>Basic chemical manufacturing</td>
<td>400</td>
</tr>
<tr>
<td>Other fabricated metal products manufacturing</td>
<td>250</td>
</tr>
<tr>
<td>All others</td>
<td>6,800</td>
</tr>
<tr>
<td>Total</td>
<td>12,500</td>
</tr>
</tbody>
</table>

Summary of occupational arsenic exposure

Combining results for arsenic exposure occurring via its use in producing and using treated wood products and all other industries, our initial results show that a total of approximately 25,000 Canadians are exposed to arsenic in their workplaces, 90% are male. Table 5 shows the number of workers exposed by province. Larger numbers are seen in British Columbia and Quebec due to the large wood and wood product industries in these provinces.

Table 5. Number of people exposed to arsenic by province

<table>
<thead>
<tr>
<th>PROVINCE/REGION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>25,000</td>
</tr>
<tr>
<td>British Columbia</td>
<td>3,800</td>
</tr>
<tr>
<td>Alberta</td>
<td>3,400</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>1,000</td>
</tr>
<tr>
<td>Manitoba</td>
<td>900</td>
</tr>
<tr>
<td>Ontario</td>
<td>8,100</td>
</tr>
<tr>
<td>Quebec</td>
<td>6,000</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>400</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>100</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>700</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>600</td>
</tr>
<tr>
<td>Yukon, Northwest Territories, Nunavut</td>
<td>80</td>
</tr>
</tbody>
</table>

Trichloroethylene

Trichloroethylene (TCE) is an industrial chlorinated solvent and metal degreaser that has been produced commercially since the 1920s (10). It is also used to make other chemicals and resin-based products, and as a laboratory reagent/solvent (11). It was used extensively in the past as a dry-cleaning agent.

TCE is no longer produced in Canada; it is imported mainly from the United States and the United Kingdom (12). The Canadian Environmental Protection Act (CEPA) regulations passed in 2003 required the metal degreasing industry to decrease consumption of TCE by 65% by 2007 (12). Trade data show that TCE imports were reduced by approximately 50% between 2006 to 2007 (13). Close to 90% of TCE in Canada has been used in vapour degreasing and cold cleaning of fabricated metal parts (13), where workers are often highly exposed (11). Results of a study commissioned by Environment Canada (14) in 1995 made a rough estimate of about 1,000-1,500 degreasing machines used in Canada. Table 6 shows the distribution of degreasing machines in Canada by province.

Table 6: Estimated geographical Distribution of degreasing machines in Canada (14)

<table>
<thead>
<tr>
<th>PROVINCE</th>
<th>DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic Canada</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>Quebec</td>
<td>30-40%</td>
</tr>
<tr>
<td>Ontario</td>
<td>40-50%</td>
</tr>
<tr>
<td>Manitoba/Saskatchewan</td>
<td>&lt; 10%</td>
</tr>
<tr>
<td>Alberta</td>
<td>&lt; 5%</td>
</tr>
<tr>
<td>British Columbia</td>
<td>&lt; 10%</td>
</tr>
</tbody>
</table>
Other uses include the production of adhesives and copolymers, the cleaning of electronic components, petroleum industry processes involving refining catalysts, paint removers, coatings and vinyl resins, and in laboratory reagent/solvent applications (13). TCE was also used as a spot treatment in the textile industry into the 1990s at least (15).

Exposure to TCE is broadly defined as inhalation or dermal exposure at work to levels likely to exceed non-occupational exposure from urban air or due to the use of household products that contain TCE (i.e. hobby adhesives, cleaners, and sealants). Initial results show that 13,000 Canadians are exposed to TCE in their workplaces; 69% are male. Table 7 shows the number of workers exposed by province. Table 8 shows the number of workers exposed by industry. The largest industrial groups are metal manufacturing, printing and related support activities, textile finishing mills, and other textile product mills. Of note, TCE is no longer a common solvent used in dry cleaning (although it is possibly still used as an occasional spot treatment), with estimates of only 200 exposed workers.

Table 7. Number of people exposed to trichloroethylene by province

<table>
<thead>
<tr>
<th>PROVINCE/REGION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>13,000</td>
</tr>
<tr>
<td>British Columbia</td>
<td>1000</td>
</tr>
<tr>
<td>Alberta</td>
<td>800</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>200</td>
</tr>
<tr>
<td>Manitoba</td>
<td>400</td>
</tr>
<tr>
<td>Ontario</td>
<td>5,500</td>
</tr>
<tr>
<td>Quebec</td>
<td>4,300</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>100</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>20</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>200</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>300</td>
</tr>
<tr>
<td>Yukon, Northwest Territories, Nunavut</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 8. Number of people exposed to trichloroethylene by industry

<table>
<thead>
<tr>
<th>INDUSTRY GROUP</th>
<th>NUMBER OF CANADIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal manufacturing (NAICS 331, 332, 333, 336)</td>
<td>2,500</td>
</tr>
<tr>
<td>Printing and related support activities</td>
<td>1,300</td>
</tr>
<tr>
<td>Textile furnishings mills</td>
<td>1,000</td>
</tr>
<tr>
<td>Other textile product mills</td>
<td>900</td>
</tr>
<tr>
<td>Plastic product manufacturing</td>
<td>800</td>
</tr>
<tr>
<td>Footwear manufacturing</td>
<td>700</td>
</tr>
<tr>
<td>Other chemical product manufacturing</td>
<td>700</td>
</tr>
<tr>
<td>Paint, coating and adhesive manufacturing</td>
<td>700</td>
</tr>
<tr>
<td>Fabric mills</td>
<td>600</td>
</tr>
<tr>
<td>Others</td>
<td>5,500</td>
</tr>
</tbody>
</table>

The largest occupational group (broadly defined) perform metal degreasing as part of their job (metal products and metalworking machine operators, plating and metal spraying occupations, and labourers in metal fabrication), with 2,900 workers exposed. Other important occupational groups include labourers in textile processing (1,600 workers exposed), and printing press operators (800 workers exposed). In addition, exposure to TCE is expected to occur among printing machine operators and textile dyeing and finishing machine operators.

Many measurements of airborne TCE taken in the workplace were available from Ontario (n=1,300 in the MESU database) and this data was prominently used in identifying exposed jobs and industries. The amount of TCE used has drastically declined due to the recent CEPA regulations and our estimates may not reflect these changes, yet. For example, in 1986, Germany introduced legislation to decrease the use of trichloroethylene and tetrachloroethylene in metal degreasing and this resulted in an 85% reduction in use by 1999. It was estimated that 10,830 workers were exposed to TCE in 1985 and this decreased to only 391 by 1999. This was achieved mainly due to technological advances (from using open top degreasing machines to totally enclosed machines without exhaust air into the environment). The reduction of degreasing machines in use dropped from 3,280 to 1,351 over the same time period, and some companies reduced their operational need for TCE by replacement it with non-chlorinated solvents (16). The regulation in Canada is still quite new and it remains to be seen how companies will cope with the lower allowable amounts of TCE consumption.

Asbestos

Asbestos is the commercial term for six naturally occurring fibrous minerals (17). The most abundant variety (worldwide and in Canada) is chrysotile, which is a type of serpentine mineral; the other 5 types of asbestos are slightly different minerals collectively referred to as amphiboles, and include amosite, crocidolite, actinolite, tremolite, and anthophyllite (17). From the early 1900s to circa 1970, asbestos was commonly added to products to provide durability, tensile strength, insulating properties, friction properties, and resistance to heat.
Occupational exposure to asbestos in Canada: Past and present

In Canada, the use of asbestos in products and construction has, for the most part, been phased out. There is still one mine producing asbestos, mostly for export, and a few manufacturers using small quantities of asbestos for the manufacture of gaskets, friction products, industrial textiles, and safety clothing.

Asbestos is an interesting and challenging substance to assess for exposure. Current asbestos-related disease is associated with exposures that occurred 10 to 40 years ago, and the exposure sources were very different at that time than they are now. Exposure from more widespread mining and milling, in addition to primary use of asbestos in manufactured products and buildings, was most important. In contrast, the vast majority of exposure that occurs today is due to contact with older asbestos-containing products, and doing renovation work on buildings and in industrial plants. These exposures can be considered as a kind of secondary exposure from contact with those products and building materials that were made or put in place more than 35 years ago. Indeed many of the workers currently expected to be exposed work in the construction sector, where exposure occurs from poor exposure control during repair, renovation, and refurbishing of old buildings. In addition, exposure may commonly occur among maintenance workers in industries where substantial amounts of asbestos were used in the past (such as smelting, petroleum refining and pulp and paper), in addition to automotive brake repair workers, and people that repair and maintain ships.

In some cases, we expect to see exposure today in the same or similar occupational groups as we did in the 1970s (i.e. construction workers, plumbers and pipefitters), albeit at lower exposure levels. In other cases, such as in mining, exposure has been almost completely phased out. However, the abatement and asbestos remediation industry is an entire category of business with potential for exposure to asbestos that did not exist as a separate profession until the early 1980s (18).

Using an approach that considered historical uses of exposure in Canada to guide exposure assessments for the present day, our initial estimate is that approximately 152,000 Canadians are currently exposed to asbestos in their workplaces, and are primarily male. This estimate includes people with the potential for exposure at work to any form of asbestos likely to exceed the non-occupational background level in dwellings or urban air (usually below 0.001 f/cm²). Table 9 shows the number of workers exposed by province. Table 10 shows the number of workers exposed by industry; the largest industrial groups exposed by far are construction-related (specialty trades and building construction contribute about 88% of all exposed workers). Other important industries are automotive repair and maintenance, ship and boat building, and remediation work (which is captured under remediation & waste management, and also under scientific and consulting services, for a total of 2,300 workers).

The largest occupational group exposed is carpenters and cabinetmakers (exposed during renovations; 34,000 workers exposed). Construction trades helpers and labourers are the second largest group (28,000 workers). Other important job groups which may be exposed are electricians, plumbers, plaster and drywall installers, and auto mechanics.

### Table 9. Number of people exposed to asbestos by province

<table>
<thead>
<tr>
<th>PROVINCE/REGION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>152,000</td>
</tr>
<tr>
<td>British Columbia</td>
<td>26,000</td>
</tr>
<tr>
<td>Alberta</td>
<td>22,000</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>4,200</td>
</tr>
<tr>
<td>Manitoba</td>
<td>4,800</td>
</tr>
<tr>
<td>Ontario</td>
<td>52,000</td>
</tr>
<tr>
<td>Quebec</td>
<td>28,000</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>3,200</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>800</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>3,800</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>5,400</td>
</tr>
<tr>
<td>Yukon</td>
<td>200</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>240</td>
</tr>
<tr>
<td>Nunavut</td>
<td>120</td>
</tr>
</tbody>
</table>

### Table 10. Number of people exposed to asbestos by industry

<table>
<thead>
<tr>
<th>INDUSTRY GROUP</th>
<th>NUMBER OF CANADIANS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialty trade contractors</td>
<td>82,000</td>
</tr>
<tr>
<td>Building construction</td>
<td>52,000</td>
</tr>
<tr>
<td>Automotive repair and maintenance</td>
<td>4,300</td>
</tr>
<tr>
<td>Ship and boat building</td>
<td>4,200</td>
</tr>
<tr>
<td>Remediation &amp; other waste management</td>
<td>1,700</td>
</tr>
<tr>
<td>Architectural, engineering &amp; related services</td>
<td>1,100</td>
</tr>
<tr>
<td>Pulp, paper &amp; paperboard mills</td>
<td>1,000</td>
</tr>
<tr>
<td>Management, scientific &amp; consulting services</td>
<td>600</td>
</tr>
<tr>
<td>Deep sea, coastal, great lakes water transport</td>
<td>500</td>
</tr>
<tr>
<td>All others</td>
<td>4,600</td>
</tr>
</tbody>
</table>

Environmental exposure to asbestos in Canada

Efforts to identify environmental exposure to asbestos are ongoing. Historical and current non-occupational exposures to asbestos occur in various circumstances: family members of workers exposed to asbestos may be exposed when contaminated dusts or fibres are brought home on work clothes, residents of homes insulated with Zonolite, vermiculite mined in Libby, Montana that was heavily contaminated with tremolite, may be exposed if the insulation is disturbed, and people living near asbestos mines or industrial sites (active or historical) and naturally-occurring deposits may be exposed to asbestos in air and dust, especially if waste piles or deposits are disturbed.

Studies have identified an increased risk of asbestos-related disease among family members of asbestos workers based on past exposure. We are conducting a literature review to identify measurements of past and current exposure to Canadian families. However, given
reductions in asbestos production and increases in exposure control for workers, family members’ exposures are likely low now.

Approximately 3 million paper records exist as part of the Canadian Home Insulation Program (CHIP), and may contain information on a residence-by-residence basis on the products purchased under the grant to upgrade home insulation. This program was active during the 1970s and 1980s, when contaminated Zonolite was available. These paper records could be searched and the information gained would indicate potential exposure in homes that were insulated with Zonolite, but would not reflect those that have since been remediated. Also, not all homes insulated with contaminated Zonolite would be included in the records – only those that applied for a grant during the program’s duration. Finally, the records also document residences containing other types of insulation, and thus not all records would be relevant to asbestos exposure. The feasibility of searching these records is uncertain, and our scientific advisors have questioned the utility of this approach.

Locations of asbestos mines and processing facilities in Canada that received contaminated vermiculite from Libby, Montana have been identified via a review of mining activity reports and Zonolite-related stories published in the media, and are shown on Figure 3. We are requesting the help of the United States Environmental Protection Agency to identify the amount of Zonolite shipped to each of these facilities. Also shown are areas of ultramafic rock, indicating potential deposits of natural asbestos. Estimates of the number of people living near mines and deposits, as of 2006, are included in

Tables 11 and 12 respectively. We have also begun to identify current and former asbestos product manufacturing sites. This summer we will review alternative risk assessment models for the potential health impact of these mines and facilities. At this time only figures for proximity to sites are identified.

### Table 11: Population living near historical and existing asbestos mines

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>WITHIN 5KM</th>
<th>WITHIN 10KM</th>
<th>WITHIN 25KM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newfoundland &amp; Labrador</td>
<td>821</td>
<td>1,286</td>
<td>11,553</td>
</tr>
<tr>
<td>Quebec</td>
<td>16,379</td>
<td>39,729</td>
<td>125,673</td>
</tr>
<tr>
<td>Ontario</td>
<td>1,640</td>
<td>23,119</td>
<td>79,455</td>
</tr>
<tr>
<td>British Columbia</td>
<td>3,687</td>
<td>10,251</td>
<td>69,739</td>
</tr>
<tr>
<td>Yukon</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>22,527</strong></td>
<td><strong>74,385</strong></td>
<td><strong>286,435</strong></td>
</tr>
</tbody>
</table>

| % of Total Population | 0.07 | 0.24 | 0.91 |

---

**Figure 3: Asbestos mines, processing facilities, and naturally occurring asbestos locations in Canada**
Future work

The WESP is generally divided into 3 phases: Phase I) Identification of data sources and infrastructure development; Phase II) Produce prevalence of exposure estimates; and Phase III) Produce estimates of the levels of exposure. These Phases are not sequential and they do not occur in isolation; for example, data acquisition is a part of Phase I, but we will pursue data sources for the entire life of the project. In general, our main goals for Year 3 are as follows:

- Complete Phase II estimates (prevalence based) for the remaining high priority substances (n=7);
- Where data allows, begin producing Phase III estimates for high priority substances. Phase III estimates will include information on exposure levels in the workplace;
- Review and enhance all Phase II prevalence estimates produced to date using the CWED databases and external input from our Occupational Exposures Advisory Group;
- Review lists of lower priority substances and consider producing Phase II estimates for ones of particular public interest, or where more information has become available;
- Continue to obtain and process regulatory data for entry into the CWED;
- Complete development phase of the CAREX Canada Electronic Platform (CCEP);
- Move to refining the functionality and user-friendliness of the CCEP; and
- Develop exposure databases from the published/grey literature for substances with sparse Canadian data sources.

Table 12: Population living near naturally occurring asbestos deposits (ultramafic rock)

<table>
<thead>
<tr>
<th>PROVINCE/TERRITORY</th>
<th>WITHIN 5KM</th>
<th>WITHIN 10KM</th>
<th>WITHIN 25KM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newfoundland &amp; Labrador</td>
<td>2,852</td>
<td>19,457</td>
<td>65,165</td>
</tr>
<tr>
<td>Quebec</td>
<td>6,473</td>
<td>9,847</td>
<td>33,178</td>
</tr>
<tr>
<td>Ontario</td>
<td>74,667</td>
<td>150,874</td>
<td>486,710</td>
</tr>
<tr>
<td>British Columbia</td>
<td>1,108</td>
<td>3,812</td>
<td>26,823</td>
</tr>
<tr>
<td>Yukon</td>
<td>73</td>
<td>167</td>
<td>307</td>
</tr>
<tr>
<td>Total</td>
<td>22,527</td>
<td>74,385</td>
<td>286,435</td>
</tr>
<tr>
<td>% of Total Population</td>
<td>0.27</td>
<td>0.58</td>
<td>1.94</td>
</tr>
</tbody>
</table>

SOURCES

5. Does not include anti-sapstain treatments, or chemicals used to treat finished products.
12. TradeMap (Canadian international trade data, free subscription required) http://www.trademap.org/canada/index.aspx
15. Bakke, Stewart, & Waters. 2007 ‘Uses of and exposure to trichloroethylene in US industry: A systematic literature review.’ JOEH; 4;375-390

Photos by Riverspirit, from the Flickr Creative Commons Pool, and the USGS Denver Microbeam Laboratory.
Pesticides

The agriculture and golf course industries are among the most extensive users of pesticides in Canada, and such use contributes to exposure in both environmental and occupational settings. The following report describes the surveillance methods that have been developed and applied to determine regional pesticide use and estimate the number of Canadians at risk of exposure to specific pesticides, as a result of their application in these two industries.

**Agricultural Pesticides**

Among the CAREX Canada priority pesticides, 11 are used for agriculture; they are all classified as IARC “possible” human carcinogens (Group 2B) and include: 5 herbicides (MCPA, MCPP, 2,4-D, 2,4-DP and 2,4,5-T), 1 fungicide (Chlorothalonil), and 5 insecticides (DDT, HCB, Lindane, Dichlorvos and 1,3-D). Our primary goals are to determine levels of pesticide use, and the corresponding number of Canadians at risk of environmental and occupational exposure. These data can be used for future research and surveillance to quantify the potential health effects of these pesticides.

### Quantify levels of pesticide use

A province-specific approach is used to estimate levels of use for each of the 11 agricultural pesticides. With the integration of an agriculture data source called the Interpolated Census of Agriculture to Soil Landscapes, Ecological Frameworks, and Drainage Areas of Canada (1), levels of use are now being quantified at a higher geographic resolution, the eco-district subdivision level. The following (Figure 1) summarizes this province-specific approach.

**Figure 1. The following steps are being applied for each province and pesticide active ingredient to quantify regional levels of use**

1. **Compile crop use and application information for all pesticide products that contain the active ingredient**
   - Source(s): Provincial guidelines, and Pest Management Regulatory Agency

2. **Import Excel file into statistical program, SAS v 9.1:**
   - Determine crop-specific intensity weights for each crop type (Tonnes/hectare per year)
   - Combine with provincial farm data at eco-district subdivision level
     - Source(s): Interpolated Census of Agriculture to Soil Landscapes, Ecological Frameworks, and Drainage Areas of Canada (AAFC, Stats Can)

3. **Combine Data Files in SAS v 9.1:**
   - Estimate total agricultural use:
     - Multiply crop-specific intensity weights (tonnes/hectare per year) by area of production (hectares per year) for each eco-district subdivision
     - (Tonnes per year)

4. **Determine exposure groups:**
   - Total use estimates are used to classify eco-districts as ‘no use’ (0 tonnes/year) or ‘any use’ of pesticides (>0 tonnes/year).

---

The following map (Figure 2) of Alberta provides an example of total agricultural use (tonnes per year) estimates for herbicide 2,4-D, by level of use, at the eco-district subdivision level.

**Figure 2. Estimated annual 2,4-D use for agriculture by Alberta eco-district subdivisions**
Estimate the number of Canadians at risk of environmental & occupational pesticide exposure

Environmental pesticide exposure: Geographic Information System (GIS) techniques are used to correlate pesticide use information with population data (Census of Population, 2006), in order to provide information about the potential for environmental exposure by geographic region. Table 1 provides an example of this for Alberta and the estimated agricultural use of the herbicide 2,4-D, by estimated levels of pesticide use. (*Note: these estimates do not imply that all individuals are exposed; rather, they provide a profile of how many people reside in these regions.)

Based on Table 1 estimates, approximately 3.3 million people in Alberta reside in areas where 2,4-D is used for agriculture at some level. Among the Alberta population that lives in regions where 2,4-D is likely to be applied, approximately 84% (2.8 million) reside in regions where the highest annual levels of 2,4-D are estimated to be used, although the great majority reside in urban areas where pesticide exposure is expected to be minimal. Future estimates will exclude urbanized areas that are not in close proximity to agriculture.

Occupational pesticide exposure: Despite the limited data on agricultural workers, we have developed a method to estimate the number of farm operators potentially exposed to each agricultural pesticide on a province-wide scale. An example is provided in Table 2 for Alberta farm operators and the herbicide 2,4-D. We have used an average of 1.5 full time farm operators per farm to derive occupational exposure estimates. This average was calculated using Alberta-specific data from the Census of Agriculture (2006) (2). Based on Table 2 estimates, the greatest percentage (36%) of farm operators potentially exposed to 2,4-D work on farms producing tame or seeded pasture (such as rangeland and pasture). Farm operators who work on farms that produce the following commodities may experience the highest intensity of 2,4-D exposure: tame or seeded pasture, forage seed and nursery products.

### Table 1. Alberta population (n), by estimated annual use of 2,4-D for agriculture

<table>
<thead>
<tr>
<th>REGIONAL USE OF 2,4-D (estimated annual tonnes)</th>
<th>AB POPULATION (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No use (0)</td>
<td>103,704</td>
</tr>
<tr>
<td>Low use (&gt;0-41)</td>
<td>150,563</td>
</tr>
<tr>
<td>Low-medium use (&gt;41-85)</td>
<td>61,384</td>
</tr>
<tr>
<td>Medium-high use (&gt;85-186)</td>
<td>262,344</td>
</tr>
<tr>
<td>High use (&gt;186)*</td>
<td>2,819,563</td>
</tr>
</tbody>
</table>

*High use regions include the cities of Edmonton and Calgary

### Table 2. Estimated number of Alberta farm operators (n) potentially exposed to 2,4-D by crop type and crop-related information

<table>
<thead>
<tr>
<th>CROP TYPE</th>
<th>TOTAL PRODUCTION (hectares)</th>
<th>ANNUAL DENSITY OF 2,4-D USE (grams 2,4-D/ha)</th>
<th>ESTIMATED NUMBER OF EXPOSED FARM OPERATORS (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tame/seeded pasture</td>
<td>2,560,387</td>
<td>3,807</td>
<td>36,240</td>
</tr>
<tr>
<td>Grains &amp; cereals</td>
<td>1,477,992</td>
<td>297</td>
<td>21,225</td>
</tr>
<tr>
<td>Spring wheat</td>
<td>2,735,697</td>
<td>440</td>
<td>19,950</td>
</tr>
<tr>
<td>Tame hay &amp; fodder</td>
<td>830,485</td>
<td>875</td>
<td>19,050</td>
</tr>
<tr>
<td>Fall rye &amp; winter wheat</td>
<td>64,057</td>
<td>474</td>
<td>2,205</td>
</tr>
<tr>
<td>Forage seed</td>
<td>81,005</td>
<td>1,011</td>
<td>1,635</td>
</tr>
<tr>
<td>Corn for silage</td>
<td>19,668</td>
<td>537</td>
<td>900</td>
</tr>
<tr>
<td>Nursery products</td>
<td>2,991</td>
<td>1,179</td>
<td>474</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1,244</td>
<td>114</td>
<td>273</td>
</tr>
<tr>
<td>Corn for grain</td>
<td>162</td>
<td>537</td>
<td>90</td>
</tr>
</tbody>
</table>

*Assumes 1.5 farm operators per farm (Census of Agriculture, 2006)

**Estimated number of unexposed farm operators in Alberta associated with all other crop production, n=152,850

Future work

The procedures described above are being conducted for all 10 provinces to generate exposure information for the 11 CAREX Canada agricultural pesticides. Attention will then be focused on gathering data to generate occupational estimates to represent other agricultural job titles for which exposure is known to occur (e.g. pesticide applicators, labourers, harvesters, etc).
Golf Course Pesticides
Although regulations to reduce cosmetic pesticide use are being enacted in many Canadian jurisdictions, golf courses often remain exempt. We are developing methods to estimate the number of Canadians who may be occupationally or environmentally exposed to certain pesticides used on golf courses.

Identifying Golf Courses and Pesticide Practices
A golf course database has been compiled in a Geographic Information System (GIS) using information from a range of geographic and commercial data sources (3-6). Information pertaining to pesticide practices was obtained from government and professional associations, such as the Canadian Golf Superintendents’ Association (7-9).

Preliminary estimates identify 2339 golf courses Canada-wide, with most in Ontario, Quebec, British Columbia and Alberta, and the majority of courses located in populated areas (Figure 3). We have identified three pesticides listed as IARC Group 2B (possible) carcinogens used on golf courses in Canada: 2,4-D and MCPP (phenoxy herbicides) and chlorothalonil (fungicide). Due to data limitations, preliminary estimates of annual application amounts (kg) will be developed in the future to represent an “average” Canadian golf course using the methodology in Figure 4.

Figure 3. Distribution of golf courses in Canada

*Ecupop (or “Population Ecumene”) is a term used to describe inhabited land. These areas on the map, identified by the light green colour, are the areas where the main Canadian population lives.

Environmental Pesticide Exposure
Pesticides applied to golf turf may experience different fates upon entering the environment, such as transport by air (drift), deposition onto vegetation or soil surfaces, or infiltration into water sources. Using GIS techniques, we will conduct exploratory analyses to assess the potential risk of environmental exposures to pesticides to populations living in areas where golf courses are present.

For example, preliminary analyses have examined the number of people living in close proximity to golf courses who may be affected by drift. Table 4 displays the number of residents living within a range of distances from golf courses in BC, Ontario and Quebec. A review of the literature on pesticide drift and application methods will be conducted to determine at what distance, if any, a potential environmental risk should be considered. Additional factors to be taken into account include application practices (type of equipment used, meteorological conditions, time of day), as well as vegetative buffers between golf course property and residential dwellings.

Occupational Pesticide Exposure
Occupational exposure estimates will be developed based on information from the CGSA BMP survey. Preliminary estimates have been developed at the provincial level by applying the mean number of pesticide applicators to all golf courses in the database. Results are presented in Table 5, and represent an estimate of the average number of pesticide applicators by province.
Future Work
Due to data limitations, this project has had to rely on information representing an “average” Canadian golf course (size, number of applicators, amounts applied) when developing estimates. Whether future refinement of estimates is possible will depend on the availability of more detailed data at the individual or provincial level. Ongoing analysis will focus on developing estimates of exposure levels of identified pesticides both occupationally and environmentally.

Table 4. Canadians living in proximity to golf courses in BC, Ontario and Quebec

<table>
<thead>
<tr>
<th>PROXIMITY DISTANCE</th>
<th>BC</th>
<th>ON</th>
<th>QC</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;50 m</td>
<td>2,190</td>
<td>3,843</td>
<td>2,799</td>
</tr>
<tr>
<td>50-100 m</td>
<td>3,591</td>
<td>21,672</td>
<td>4,194</td>
</tr>
<tr>
<td>100-150 m</td>
<td>4,174</td>
<td>20,136</td>
<td>7,519</td>
</tr>
<tr>
<td>150-200 m</td>
<td>12,403</td>
<td>23,910</td>
<td>9,289</td>
</tr>
<tr>
<td>200-250 m</td>
<td>9,548</td>
<td>29,005</td>
<td>11,315</td>
</tr>
<tr>
<td>Total (&lt;250 m)</td>
<td>31,906</td>
<td>95,566</td>
<td>35,116</td>
</tr>
</tbody>
</table>

Table 5. Number of pesticide applicators by province

<table>
<thead>
<tr>
<th>PROVINCE</th>
<th>PESTICIDE APPLICATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>British Columbia</td>
<td>1,056</td>
</tr>
<tr>
<td>Alberta</td>
<td>999</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>426</td>
</tr>
<tr>
<td>Manitoba</td>
<td>399</td>
</tr>
<tr>
<td>Ontario</td>
<td>2,493</td>
</tr>
<tr>
<td>Quebec</td>
<td>1,083</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>174</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>222</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>84</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>66</td>
</tr>
<tr>
<td>Yukon</td>
<td>6</td>
</tr>
<tr>
<td>Northwest Territories</td>
<td>9</td>
</tr>
<tr>
<td>Nunavut</td>
<td>0</td>
</tr>
<tr>
<td>CANADA</td>
<td>7,017</td>
</tr>
</tbody>
</table>

SOURCES

Photos by Wolfgang Schlegl and Jamie Scearce, from the Flickr Creative Commons Pool
Communications activities

CAREX Canada’s primary goal is to generate estimates of the number of Canadians exposed to known and suspected environmental and occupational carcinogens as well as how and where they are exposed and at what level. However, an essential secondary goal is to ensure that these data are used for prevention, surveillance, and research through effective knowledge transfer and exchange (KTE). KTE is built into CAREX Canada’s structure and its data collection/dissemination activities. A core piece of our KTE strategy is to develop partnerships and collaborations for both developing and using the exposure data generated by the project. In addition, the CAREX Canada website has been developed both as a passive means to distribute information and as a platform from which we can share information with our partners and collaborators.

Key activities in Year 1 included:

• the initiation of a knowledge translation network of collaborators and partners;
• the development of a National Advisory Committee;
• the launch and development of a public-facing website and Carcinogen Resource Centre; and,
• researching best practices for communicating with stakeholders.

This report provides details on key activities in Year 2, including:

• progress made with key partners and collaborators;
• the creation of scientific advisory committees;
• the expansion of the website and Carcinogen Resource Centre, and launch of an e-bulletin; and,
• results of knowledge translation and exchange literature reviews, and the launch of a communication needs assessment survey.

Partnerships and Collaborations

CAREX Canada is actively involved in seeking and creating collaborations with other agencies across the country to share resources and expand our data-gathering capacity. The CAREX team has been developing a network through which information can be shared and further disseminated. Groups included in this network to date are the National Collaborating Centre on Environmental Health, Alberta Health Services, Cancer Care Ontario, the Canadian Centre for Health and Safety in Agriculture, and the Atlantic Networks for Prevention Research.

In addition, a formal partnership has been established with Alberta Health Services with training and collaborative sessions between CAREX and Alberta Health Services starting in April 2009. Alberta Health Services is now developing Alberta-specific reports using CAREX Canada methods.

A second formal partnership has been established with the CHUM Research Centre at the University of Montreal. This collaboration, which started in February 2009, has been established primarily for sharing occupational health exposure information with Quebec. Other organizations that we have partnered with in the past year include:

• The Environmental Health Atlas project (PI Kate Bassil), a SSHRC-funded project based at Simon Fraser University that aims to make scholarly findings on health and environment accessible to a broader audience. We will be providing this project with some of our environmental data.
• Population Data BC, a multi-university, nationally active and recognised data and education resource facilitating interdisciplinary research and teaching on the determinants of human health, well-being and development. We will be providing exposure data to PopDataBC so that it can be used in other research projects.
• The R. Samuel McLaughlin Centre for Population Health Risk Assessment, based at the Institute of Population Health at the University of Ottawa. The Centre’s Scientific Director, Prof. Daniel Krewski, joined our advisory committee this year, and we are collaborating with the Centre to host a spring workshop that will raise awareness of CAREX Canada’s work among researchers and policy makers from federal ministries.
• The Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSSST), a non-profit agency dedicated to researching occupational health issues.

Efforts to identify existing data sources have also proven to be a good opportunity to develop collaborations and partnerships.

Advisory Groups

A series of advisory committees provides important feedback on the progress of the CAREX Canada project. Our National Advisory Committee is a pan-Canadian group of experts representing industry, government, non-governmental, and academic organizations. Through periodic teleconferences, this group provides high-level direction and oversight on the direction of the CAREX project. Because of their diversity and geographic spread, the National Advisory Committee also serves as a conduit for our research results to reach diverse stakeholders in all parts of the country. They can provide strategic advice on how to best package and direct our findings for maximum impact on cancer prevention.

National Advisory Committee

• Andy King, United Steel Workers Union, National Health, Safety and Environment Coordinator
• Corey Parker, Alberta Cancer Board
• Daniel Krewski, McLaughlin Centre for Population Health Risk Assessment
• France Labrèche, Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSSST)
• John Gordon, Canadian Centre for Occupational Health and Safety in Agriculture
• Larry Stoffman, Former Chair, National Committee on
Environmental & Occupational Exposures
• Laurie Chan, BC Leadership Chair in Aboriginal health, UNBC
• Loraine Marrett, Cancer Care Ontario
• Ray Copes, Ontario Agency for Health Protection and Promotion
• Robert Whiting, Canadian Centre for Occupational Health and Safety
• Roland Hosein, Environment, Health and Safety, GE Canada
• Stephen Bornstein, Atlantic Networks for Prevention Research & Memorial University

Our Occupational and Environmental Exposures Scientific Advisory Committees have been chosen based on their demonstrated expertise and experience in exposure measurement. They provide scientific feedback regularly throughout the year on our methodologies and results, and supply advice about available exposure data. Ultimately, these Advisory Committees also function as peer review committees for CAREX Canada’s reports and publications.

Occupational Exposures Scientific Advisory Committee
• John Oudyk, Occupational Health Clinics for Ontario Workers (OHCOW), McMaster University
• Judy Guernsey, Dalhousie University
• Hugh Davies, University of British Columbia
• Jérôme Lavoué, University of Montreal (CHUM)
• Jim Purdham, University of Toronto, Professor emeritus
• Melissa Friesen, National Cancer Institute, National Institutes of Health

Environmental Exposures Scientific Advisory Committees

Indoor air/dust
• Deborah Schoen, Indoor Air Contaminants Assessment, Health Canada
• Don Fulger, Canadian Mortgage and Housing Corporation, Sustainable Housing
• Marie-Eve Héroux, Indoor Air Contaminants Assessment, Health Canada
• Amanda Wheeler, Exposure Assessment Division, Health Canada
• Miriam Diamond, University of Toronto
• Pat Rasmussen, Health Canada, Metals Lab and University of Ottawa
• Tim Takaro, Simon Fraser University

Drinking water
• Michele Giddings, Water Quality Science Division, Health Canada
• Veronique Morisset, Water Quality Science Division, Health Canada
• Jaymie Meliker, Stony Brook University Medical Center
• Manuel Rodriguez-Pinzon, Laval University
• Will King, Queens University

Outdoor Air
• Barry Jessiman, Air Quality Assessment, Health Canada
• Jeff Brook, Environment Canada, Processes Research Division
• Michael Brauer, University of British Columbia
• Michael Jerret, Berkeley University
• Ilan Levy, Hebrew University of Jerusalem
• Paul Villeneuve, Health Canada, Air Health Effects Research
• Ryan Allen, Simon Fraser University

Website development and e-bulletin
In the past year, the CAREX Canada website and Carcinogen Resource Centre has grown significantly. Our online carcinogen database has grown exponentially, and now contains carcinogen profiles for more than 60 substances classified as known, probable, and possible carcinogens. The profiles contain basic information on chemical identity, health effects, and occupational and environmental exposure limits (where they exist). More detailed information on uses for each substance, particularly in Canada, as well as the potential for exposure in the workplace and also for the general population, are also included. The profiles are a valuable resource and are particularly unique in the Canadian context because most information available online for carcinogens and other chemicals is European- or American-based. For metals, information on the locations of Canadian mines and smelters as well as natural deposits of minerals is also included. The profiles are downloadable PDF documents and are a useful knowledge translation product for policy makers, researchers, and the general public.

In addition, we have uploaded the first phase of occupational and environmental exposure estimates for many of these substances. The exposure estimates present, in table and map form, the estimated number of Canadians exposed to carcinogens in workplace and community environments.

The website receives, on average, more than 300 visits every month. Our carcinogen profiles and exposure estimates are the most popular sections of the site, and keyword statistics suggest that visitors seek us out for Canadian-specific information on carcinogens.

We have also developed an e-bulletin to raise awareness about the CAREX project, and to keep partners appraised of our activities and progress. The e-bulletin, which is delivered quarterly to a broad range of stakeholders across Canada and beyond, has been successful in achieving our communications goals: of those who viewed the e-bulletin, 65% clicked through to our website, indicating that the bulletin was useful to them.

Best practices for communicating with stakeholders
In 2009, the knowledge translation and communications team reviewed the scientific literature on how to communicate information regarding carcinogen exposure and cancer risk to various stakeholders, including workers, employers, policy makers, and the general public. We investigated literature pertaining to a range of carcinogenic substances, including radon, asbestos, and wood preservatives.

In general, we were able to find very little research that evaluated efforts to communicate carcinogen risks to various populations. The one exception was radon, for which many studies exist. This body of literature, which focuses primarily on raising awareness about exposure and remediation among homeowners in areas of high radon concentration, has found that attempts to promote remediation have not been very successful. It is difficult to effect behaviour change among homeowners, even when faced with risk from a known carcinogen.

Based on the relative scarcity of published studies on how to effectively communicate carcinogen information to stakeholders, the team has recently embarked upon a needs assessment survey, to help us ensure that our research results are relevant and useful.
for all of our stakeholders. The survey, which gathers information about the demographics, information habits, and research needs of respondents, will be delivered via phone by trained interviewers. It has been approved by the UBC Behavioural Ethics Board, and has been piloted with a number of initial respondents. Based on the pilot surveys, we are now revising the survey and sending out invitations to a broad network of potential respondents across Canada.

Presentations
In the past year, the CAREX Canada team has been actively sharing the results of our research projects with colleagues and collaborators at national and international conferences. We have attended meetings such as the American Industrial Hygiene Conference and Expo, the International Society for Environmental Epidemiology Conference, the 6th International Conference on Innovations in Exposure Assessment, and the Canadian Association for Research on Work and Health Conference. A full list of our publications is available on our website: http://www.carexcanada.ca/en/publications/