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Exploring applications of the Ontario Toxics Reduction Act for exposure surveillance

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May 2018

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Towards a cancer-free workplace

Executive Summary

Exposures to toxic substances in the workplace contribute significantly to the global disease burden and are increasingly being recognized as an important disease risk factor. In Ontario, the reduction of workplace exposures to toxic substances including cancer-causing agents could help prevent many occupational diseases in the province. An effective exposure surveillance system can serve as a tool to inform workers of potential hazardous substances they may be exposed to in their workplace and also aid policy makers in setting priorities for occupational exposure monitoring and enforcement activities.

Data from exposure surveillance databases can be used to establish priorities for disease prevention among particular types of toxic substances, or in particular industrial sectors or regions where these substances are used. Fortunately, a legislated database that collects annual data on the industrial use of various toxic chemicals already exists in the Province of Ontario. The Toxics Reduction Act (TRA), Ontario Regulation 455/09, requires industrial facilities in four major manufacturing and mineral processing sectors to track and report their use and emission of toxic substances to the Ontario Ministry of Environment and Climate Change. The TRA is the only program of its kind in Canada and provides a unique opportunity to leverage this type of data for an exposure surveillance system in occupational health. This report explores the potential application of the TRA Program as an exposure surveillance tool by examining current trends in toxic substance use by industry sector, by region and by substance type.

In this report we used TRA data to identify particular sectors such as the chemical manufacturing sector as well as the primary metal manufacturing sector that would benefit from an exposure surveillance system. We also used the data to identify certain regions where the use of cancer-causing substances was highest such as in Lambton County and the City of Sudbury. The report’s findings suggest that targeted toxic substance use reductions in key sectors and regions could minimize potential occupational exposures among workers that work with the particular substances identified in this report to lower overall occupational disease risk.

This report demonstrates how the TRA could be leveraged as an exposure surveillance tool to assess potential exposures to toxic substances using a sector, regional and substance-specific approach. The applications of the TRA data described in this report could help set priorities for disease prevention by directing future policies towards workers that are employed in certain industrial sectors or in specific regions. Therefore, the TRA Program can help to fill an important gap in occupational exposure surveillance in Ontario using facility-level data to highlight trends occurring at the industry sector or regional scale.

Exploring applications of the Ontario Toxics Reduction Act for exposure surveillance

Background

Cancer and other chronic diseases have been linked to many different factors, and exposures to toxic substances in the workplace are increasingly being recognized as one important risk factor. For example, globally, it has been estimated that between two to 10 percent of all newly diagnosed cancer cases are attributable to occupational exposures (2). In Ontario, an estimated 1,600 cancers could be prevented annually by reducing workplace exposures to carcinogens commonly found in many industrial and manufacturing facilities (e.g. nickel, benzene, formaldehyde etc.) (2). Unfortunately, similar estimates of the burden for other occupational diseases are not available. These estimates demonstrate the need to reduce the use and emission of cancer-causing substances, and other toxic pollutants, in industries in Ontario to help address the burden of occupational cancer and other diseases in this province.

Surveillance systems that collect data on occupational exposures can provide important information on population-level trends in occupational diseases that support primary prevention efforts (3). Surveillance is defined broadly as the systemic and continuous collection and analysis of data to inform decision-making on health practices, going beyond any episodic inspection or monitoring activities in place (4). Occupational surveillance systems can provide a way to help predict work-related health issues before they arise (5).

Exposure surveillance consists of the ongoing assessment and monitoring of chemical use and worker exposures in industries (5). It can serve as a tool to inform workers of potential carcinogens they may be exposed to in their workplace and also aid policy makers in setting priorities for occupational exposure monitoring and enforcement activities. One approach to exposure surveillance includes the use of surveys to collect data on workplace exposures (3), which can include questionnaires and observational facility walkthroughs at workplaces (6). Exposure surveillance can also be conducted with routine inspections and enforcement.

Data from exposure surveillance systems can be used to establish priorities for disease prevention strategies among particular groups of substances, or in particular industrial sectors where these substances are used. These databases can also help researchers conduct ongoing monitoring of the use and emission of particular chemicals in the workplace. Despite progress in the work of surveillance programs like CAREX, a national carcinogen exposure surveillance program, and some provincial exposure registries, not all hazardous occupational exposures are captured and there exist many data gaps. For example, while CAREX provides an opportunity to assess potential exposures in particular industry sectors or occupations, it does not provide data at the facility level and is focused exclusively on carcinogens (7).

The TRA Program

The Toxics Reduction Act (TRA), Ontario Regulation 455/09, requires industrial facilities in four major manufacturing and mineral processing sectors, which report emissions to Canada's National Pollutant Release Inventory (NPRI) (8), to additionally track and report their use of toxic substances (i.e. amount entering the facility, amount created and amount contained in product) on an annual basis to the Ontario Ministry of Environment and Climate Change (MOECC) (9).

The goal of toxics use reduction regulations and policies is to reduce, substitute or eliminate the use and release of hazardous industrial pollutants by altering industry production processes, redesigning products and systems and rewarding innovative industries for using less hazardous chemicals (10). Ontario's TRA was implemented in 2010 and modelled after the Massachusetts Toxic Use Reduction Act of 1989 (TURA) as a primary prevention intervention intended to reduce population exposures to toxic substances. Massachusetts evaluated its TURA program and reported significant declines in carcinogen releases, reductions in toxic chemical use, economic benefits and technological advances in manufacturing, utilities and other sectors (11).

Ontario's TRA program has two main objectives:
1. To encourage regulated industrial facilities to reduce their use and creation of toxic substances prescribed under the legislation.
2. To provide public access to the information and data reported by facilities to the program.

The TRA applies to industrial facilities from the manufacturing and mineral processing sectors, (sectors with codes 31-33 and 212 from the North American Industry Classification System (NAICS)) that also report to the federal NPRI program. A list of industry sectors covered is provided in Appendix Table 1. Both the TRA and NPRI require reporting from facilities where employees work a total of more than 20,000 hours (equivalent to about 10 full-time employees) and facilities that use or release one or more of the prescribed substances in quantities above the legislated thresholds (8). A list of prescribed substances covered under the TRA is summarized in Appendix Table 2. Approximately 1040 facilities reported data for a total of 233 different toxic substances to the TRA in 2015, the most recent year for which data was available at the time of study (12).

The TRA requires facilities to submit annual reports to the MOECC that describe all of the toxic substances they create and use and requires facilities to make certain parts of the report available to the public (9). The MOECC then publishes annual datasets summarizing the use and emission of toxic substances from all facilities on its website (9). In addition, facilities must also plan to reduce their use and creation of each prescribed substance in their facility and review these toxics reduction plans every five years (9).

Applications of TRA data for occupational exposure surveillance

When facilities effectively plan for the reduction in use of toxic chemicals, hazardous worker exposures are likely to be reduced. In this report we will describe several methods for using TRA data for occupational exposure surveillance in Ontario. We used the five most recent years of data from the TRA Program to examine the use of cancer-causing substances (carcinogens) by sector, by region and by substance type and to demonstrate potential applications of the TRA data for exposure surveillance.

An industry sector approach

No research has been done in Canada taking an industry sector approach to examine trends in the use of toxic substances by facilities. In Ontario, very little is known about the presence of specific carcinogens in particular industry sectors. Therefore analyzing TRA data by industry sector was identified as key to filling a large knowledge gap in our understanding of worker exposures in specific industry sectors in Ontario. A forthcoming paper examining sector and regional trends in carcinogen use will be published (doi: 10.17269/s41997-018-0075-0) and some examples are highlighted in this report.

Using a sector approach, it is possible to examine which toxic chemicals are used in each industry sector and the approximate the volumes used. For example, using TRA data from 2011 to 2015 we determined that facilities in the chemical manufacturing sector ranked first among all sectors for reported carcinogen use, using more than 10 million tonnes in the five year period analysed (**Table 1**). In addition, the chemical manufacturing sector and primary metal manufacturing sector, which ranked second in carcinogen use, together accounted for 84% of all carcinogen use across all sectors, making these two sectors particularly large users. Using this data it was also found that carcinogens such as lead, nickel and benzene were among the most used by volume by facilities in all sectors. These results suggest exposure surveillance could be prioritized in certain sectors, including the chemical and primary metal manufacturing sectors, to track levels of hazardous exposures in specific industrial facilities that use large amounts of particularly toxic chemicals. Using employee data from the TRA program, we also examined which sectors employed the largest number of workers at facilities that use toxic substances. For example, the largest number of workers were employed on average in the primary metal manufacturing sector (n=132,401) and the transportation equipment manufacturing sector (n=42,223) (**Table 1**). From a surveillance standpoint, knowing which sectors contain the largest number of potentially exposed workers presents an opportunity to reduce occupational exposures where the impacts are likely to be largest. Prioritizing exposure reduction in these sectors can help to reduce the occupational disease burden by limiting the contact workers have to hazardous substances in sectors where the number of workers using and handling toxic substances is highest.

Table 1. Total estimated use* of carcinogens and top carcinogens† used by industrial sector, ranked by use in tonnes, TRA Program 2011-2015.

Total industrial carcinogen use 2011-2015			
Sectors using carcinogens	**Mean employees**	**Total estimated use (tonnes)**	**Top carcinogens used**
Chemical manufacturing	12,819	10,468,540	Benzene; Vinyl chloride; 1,3-Butadiene
Primary metal manufacturing	132,401	4,749,630	Nickel; Benzene; Lead
Petroleum and coal products manufacturing	14,891	1,977,480	Benzene; 1,3-Butadiene; Nickel
Mining (except oil and gas)	28,461	658,310	Nickel; Lead; Arsenic
Transportation equipment manufacturing	42,223	205,020	Nickel; Hexavalent chromium; Lead
Paper manufacturing	18,307	28,530	Formaldehyde; Lead; Arsenic
Fabricated metal product manufacturing	10,676	25,140	Nickel; Hexavalent chromium; Lead
Wood product manufacturing	4,102	9,770	Formaldehyde; Arsenic; Benzene
Machinery manufacturing	1,523	7,650	Nickel; Lead
Plastics and rubber products manufacturing	3,891	6,370	Lead; Hexavalent chromium; 1,3-Butadiene

*Values for estimates of use were rounded to the nearest 10th.

† Top carcinogens used represent the three carcinogens reportedly used in the largest quantities, listed in decreasing order.

A geographic perspective

Analysing TRA data geospatially could help set regional prevention priorities for reducing hazardous exposures in the workplace and could serve as another key component of a potential occupational exposure surveillance system. Working populations in one region may face different health risks compared to populations in other regions based on differences in industrial sectors and chemical use in those sectors, therefore, it is important to identify the disproportionate hazards and risks borne by populations in various geographic areas.

We used the TRA data to examine the distribution of Ontario's industrial sectors by health region and to identify which regions use the most industrial carcinogens. We used public health units (PHUs) as geographic study areas, which are used by the public health system in Ontario, however other geographic boundaries could be used in a surveillance system. There are 36 PHUs in all of Ontario (13).

After mapping all of the 326 industrial facilities reporting the use of carcinogens in 2015, we found that the City of Toronto and Peel Region contained the largest number of industrial facilities that reported the use of carcinogens, with each containing 34 facilities (**Figure 1**). Other PHUs in the Golden Horseshoe Region contained between 12 and 24 facilities reporting carcinogen use, with fewer facilities located in Northern and Southern Ontario (**Figure 1**). These results would suggest that a large number of facilities are concentrated in central Ontario, particularly in the Greater Toronto Area, and exposure prevention measures may benefit workers there employed in a large number of facilities.

We examined carcinogen use by PHU and a full list summarizing results for all 36 PHUs is located in Appendix Table 3. We found that use was highest in Lambton Health Unit from 2011 to 2015, representing nearly half of the total carcinogen use for all regions in Ontario (**Figure 2**). The chemical manufacturing and petroleum and coal products manufacturing sectors are prominent industries in Lambton County, particularly in the City of Sarnia, and were responsible for most of the carcinogen use observed in that region. We also found that industrial facilities located in the Sudbury District Health Unit and Niagara Regional Area Health Unit also used large volumes of carcinogens, representing 21% and 17% of total carcinogen use in the province, respectively (**Figure 2**).

Such findings demonstrate the utility of approaching toxic substance use from a geographic standpoint to examine which regions are likely to contain workers experiencing hazardous workplace exposures compared to areas where fewer industrial facilities are located or where facilities use smaller volumes of toxic substances. These findings could be used to target exposure reduction and occupational disease prevention in particular regions or to direct exposure monitoring and enforcement activities in certain geographic areas. For example, in Sudbury and other health units in Northern Ontario where mining industries are concentrated, the industrial use of nickel and other carcinogenic metals is likely. Such regions could benefit from exposure reduction strategies targeted towards particular industries and carcinogens that workers are likely to be in contact with.

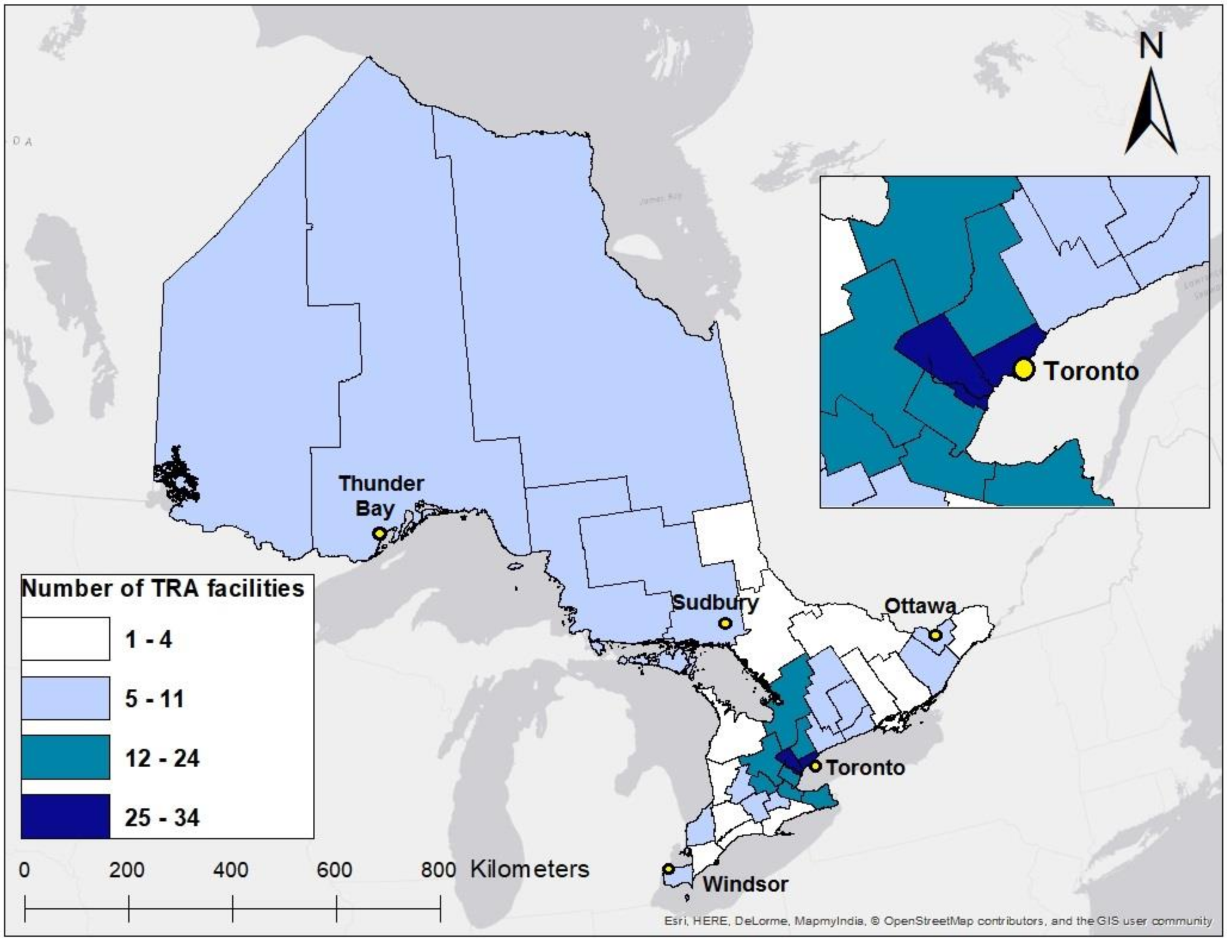

Figure 1. The number of industrial facilities reporting the use of carcinogens in Ontario, by Public Health Unit. TRA Program, 2015.

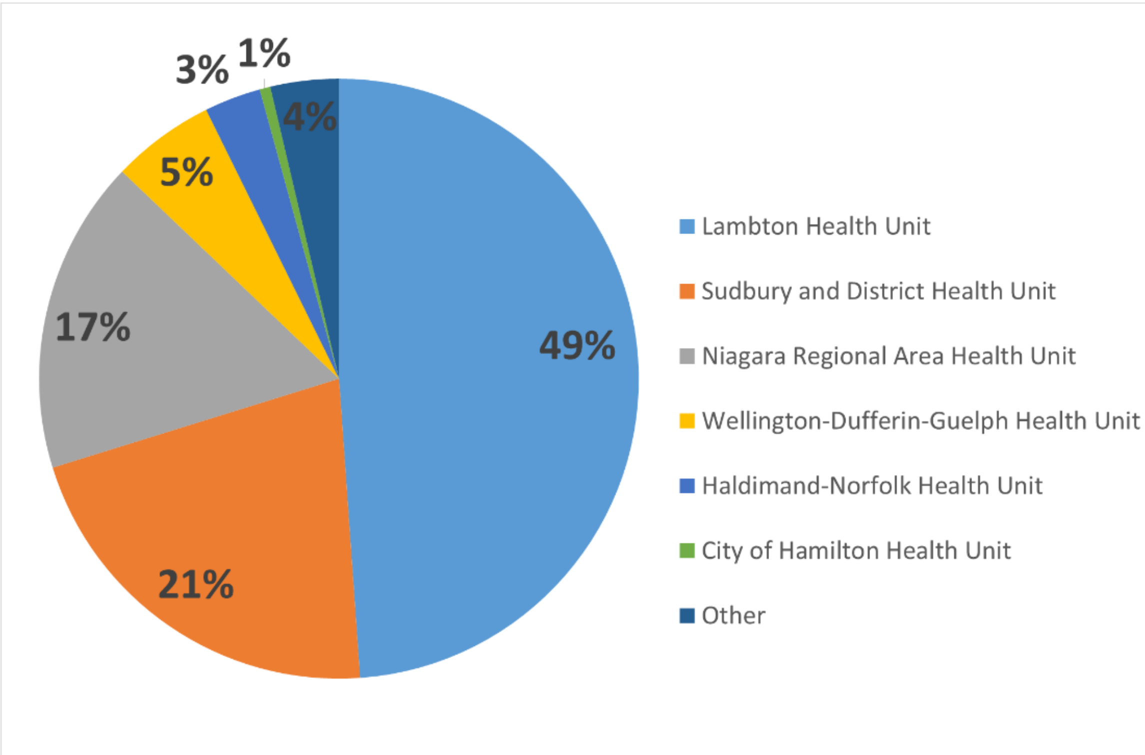

Figure 2. The percentage of summed total carcinogen use by industrial facilities located in the top 6 PHUs ranked by use. The 'other' category represents summed carcinogen use for the remaining 30 PHUs in Ontario. TRA Program, 2011-2015.

Identifying toxic substances of concern

Another application of the TRA data would be to examine the use of particular toxic substances and carcinogens in order to understand which substances are likely to pose a hazard in particular sectors or regions. Since exposures to different substances will lead to different health effects at different exposure levels, examining these substances individually or grouping them by health effect can be useful. We used the TRA data to examine patterns of industrial use by carcinogen type.

In all, we estimated that over 19 million tonnes of known and suspected carcinogens were used between 2011 and 2015. When grouped by carcinogen type, we found that carcinogens used by industrial facilities in the largest volumes were associated with specific cancers like lung (e.g. nickel, arsenic, hexavalent chromium), leukemia and lymphomas (e.g. benzene, 1,3-butadiene, formaldehyde). Facilities reported the use of more than 10 million tonnes of carcinogens associated with each of these three cancer types.

Another toxic substance of concern that was identified was lead, which was used the most frequently by industrial facilities in various sectors in Ontario, by an average 152 facilities each year. Exposure to lead has been associated with numerous health impacts including neurological, cardiovascular and reproductive effects (14) and has been classified as a suspected bladder carcinogen (15). Another substance of concern that was identified was trichloroethylene, which saw a large increase in use over time from approximately 110 tonnes in 2011 to 605 tonnes in 2015. Trichloroethylene is a suspected carcinogen linked to cancers such as kidney, liver, non-Hodgkin lymphoma, breast and prostate (16).

Identifying particular toxic substances of concern used by industries in Ontario can be useful for identifying which substances could be prioritized in an occupational surveillance system. For example, based on our findings, a reduction in exposures to substances associated with various cancers such as benzene, nickel, 1,3-butadiene and lead would be particularly effective at reducing the occupational disease burden in Ontario. Several industry sectors, including the chemical manufacturing and primary metal manufacturing sectors, reported using large quantities of the toxic substances identified above.

Conclusions

Databases like Ontario's TRA Program can be used for surveillance to provide estimates of industrial toxic substance use where detailed exposure assessments and routine environmental monitoring are not feasible. The three examples of applications described in this report have highlighted the feasibility of applying data from the TRA to establish an exposure surveillance system. Using annual datasets from the TRA Program, we examined the industrial use of toxic substances across various sectors and regions in the province.

Leveraging data from Ontario's TRA Program to establish an occupational exposure surveillance system can help reduce the occupational disease burden by directing exposure reduction strategies where they would be most impactful. We have highlighted particular sectors and regions where hazardous exposures are likely to take place. The continuous monitoring of workplace exposures is an important part of an exposure surveillance system and should be prioritized in specific workplace settings that may contribute to a large occupational disease burden. Based on the findings outlined in this report, some general policy recommendations are listed below.

Targeted exposure surveillance in priority sectors:

- Continue monitoring substance use trends in industrial sectors where use is highest e.g. chemical and primary metal manufacturing sectors.
- Conduct routine inspections of workplaces in these sectors to ensure adequate worker exposure protections are in place.

Targeted exposure reductions in priority regions:

- Continue monitoring toxic substance use trends in regions where the number of industrial facilities reporting the use of toxic substances is highest e.g. City of Toronto and Peel Region.
- Prioritize inspections of workplaces in regions where the volume of toxic substance use is high e.g. Lambton County, Sudbury and Niagara Regions.
- Link carcinogen use data from the TRA to data from the cancer registry and prioritize exposure surveillance in regions with a double burden of large industry presence and higher cancer rates.

Targeted exposure reductions of particular toxic substances:

- Continue monitoring use trends for specific toxic substances used by facilities in large volumes e.g. benzene and nickel.
- Help facilitate the substitution and elimination of toxic substances in workplaces with safer alternatives by encouraging more facilities to plan and implement chemical use reduction. For example, one option to control exposure to benzene is to use other solvents when practicable (17) such as toluene or alcohols.
- Expand the list of substances covered under the TRA Program to contain more occupational and environmental pollutants that are used in Ontario, which contribute to the occupational disease burden (e.g. diesel engine exhaust), and substances with emerging health concerns to improve exposure surveillance.

This report has demonstrated that the TRA could be leveraged as an exposure surveillance tool to assess potential exposures to toxic substances using a sector, regional and substance-specific approach. The applications of the TRA data in this report could help set priorities for occupational disease prevention to direct future policies towards the regulation of certain toxic substances. In addition, the data could be used to highlight practices in industrial sectors using particularly large volumes of toxic substances in specific regions. Reductions in the use of toxic substances in the workplace could minimize potential occupational exposures among workers that work with the particular substances identified in this study. The TRA can fill an important gap in occupational exposure surveillance in Ontario using facility-level data to highlight trends occurring at the industry sector or regional scale. Toxics reduction programs can therefore play a unique role in supporting disease prevention initiatives by serving as an effective pollution prevention policy and by supporting occupational exposure surveillance activities.

One limitation of applying data from the TRA Program to an exposure surveillance tool is that the amount of toxic substances used by facilities is self-reported, though some consistency between volumes of self-reported pollutant data by industrial facilities and verified pollution monitoring data have previously been found (18). Due to the nature of self-reported data, there may be cases where reported substance use do not reflect true use by the facilities. In addition, there are limitations in the program's reporting requirements as the TRA Program allows for the reporting of use quantities by industrial facilities as ranges as opposed to absolute quantities, which limits the analysis to estimates. Another limitation of most environmental reporting programs is the fact that only larger industrial facilities meeting specific use and release thresholds are required to report (19), potentially leaving out a significant source of toxic substance use from smaller facilities. Therefore, it is likely that the use of toxic substances by industries in the province is actually much higher than what is indicated by the TRA. However, the TRA Program provides an indication of toxic substance use among facilities in the manufacturing and mineral processing sectors in Ontario and potential workplace exposures.

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APPENDICES

Appendix Table 1. Industry sectors that report substance use and emission data to the TRA program according to their North American Industry Classification System (NAICS) code.

NAICS code	Industry sector
212	Mining and quarrying (except oil and gas)
311	Food manufacturing
312	Beverage and tobacco product manufacturing
313	Textile mills
314	Textile product mills
315	Clothing manufacturing
316	Leather and allied product manufacturing
321	Wood product manufacturing
322	Paper manufacturing
323	Printing and related support activities
324	Petroleum and coal product manufacturing
325	Chemical manufacturing
326	Plastics and rubber products manufacturing
327	Non-metallic mineral product manufacturing
331	Primary metal manufacturing
332	Fabricated metal product manufacturing
333	Machinery manufacturing
334	Computer and electronic product manufacturing
335	Electrical equipment, appliance and component manufacturing
336	Transportation equipment manufacturing
337	Furniture and related product manufacturing
339	Miscellaneous manufacturing

Appendix Table 2. Toxic substances legislated under the TRA program

Name/nom	CAS number
Acenaphthene	83-32-9
Acenaphthylene	208-96-8
Acetaldehyde	75-07-0
Acetone	67-64-1
Acetonitrile	75-05-8
Acetophenone	98-86-2
Acetylene	74-86-2
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylic acid (and its salts)	79-10-7
Acrylonitrile	107-13-1
Adipic acid	124-04-9

Alkanes, C_{10-13}, chloro	85535-84-8
Alkanes, C_{6-18}, chloro	68920-70-7
Allyl alcohol	107-18-6
Aluminum (fume or dust only)	7429-90-5
Aluminum oxide (fibrous forms only)	1344-28-1
Ammonia (total)	NA
Aniline (and its salts)	62-53-3
Anthracene	120-12-7
Anthraquinone (all isomers)	NA
Antimony (and its compounds)	NA
Arsenic (and its compounds)	NA
Asbestos (friable form only)	1332-21-4
Benzene	71-43-2
Benzo(a)anthracene	56-55-3
Benzo(a)phenanthrene	218-01-9
Benzo(a)pyrene	50-32-8
Benzo(b)fluoranthene	205-99-2
Benzo(e)pyrene	192-97-2
Benzo(g,h,i)perylene	191-24-2
Benzo(j)fluoranthene	205-82-3
Benzo(k)fluoranthene	207-08-9
Benzoyl chloride	98-88-4
Benzoyl peroxide	94-36-0
Benzyl chloride	100-44-7
Biphenyl	92-52-4
Bis(2-ethylhexyl) adipate	103-23-1
Bis(2-ethylhexyl) phthalate	117-81-7
Bisphenol A	80-05-7
Boron trifluoride	7637-07-2
Bromine	7726-95-6
Bromomethane	74-83-9
1,3-Butadiene	106-99-0
Butane (all isomers)	NA
Butene (all isomers)	25167-67-3
2-Butoxyethanol	111-76-2
n-Butyl acetate	123-86-4
Butyl acrylate	141-32-2
n-Butyl alcohol	71-36-3
tert-Butyl alcohol	75-65-0
i-Butyl alcohol	78-83-1
sec-Butyl alcohol	78-92-2
Butyl benzyl phthalate	85-68-7

1,2-Butylene oxide	106-88-7
Butyraldehyde	123-72-8
C.I. Basic Green 4	569-64-2
C.I. Disperse Yellow 3	2832-40-8
C.I. Solvent Yellow 14	842-07-9
Cadmium (and its compounds)	NA
Calcium fluoride	7789-75-5
Carbon disulphide	75-15-0
Carbon monoxide	630-08-0
Carbon tetrachloride	56-23-5
Carbonyl sulphide	463-58-1
Catechol	120-80-9
CFC-11	75-69-4
CFC-114	76-14-2
CFC-115	76-15-3
CFC-12	75-71-8
CFC-13	75-72-9
Chlorine	7782-50-5
Chlorine dioxide	10049-04-4
Chloroacetic acid (and its salts)	79-11-8
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
3-Chloropropionitrile	542-76-7
Chromium (and its compounds)	NA
Cobalt (and its compounds)	NA
Copper (and its compounds)	NA
Creosote	8001-58-9
Cresol (all isomers, and their salts)	1319-77-3
Crotonaldehyde	4170-30-3
Cumene	98-82-8
Cumene hydroperoxide	80-15-9
Cyanides (ionic)	NA
Cycloheptane	NA
Cyclohexane	110-82-7
Cyclohexanol	108-93-0
Cyclohexene	NA
Cyclooctane	NA
Decabromodiphenyl oxide	1163-19-5
Decane (all isomers)	NA
2,4-Diaminotoluene (and its salts)	95-80-7
Dibenzo(a,e)fluoranthene	5385-75-1

Dibenzo(a,e)pyrene	192-65-4
Dibenzo(a,h)acridine	226-36-8
Dibenzo(a,h)anthracene	53-70-3
Dibenzo(a,h)pyrene	189-64-0
Dibenzo(a,i)pyrene	189-55-9
Dibenzo(a,j)acridine	224-42-0
Dibenzo(a,l)pyrene	191-30-0
7H-Dibenzo(c,g)carbazole	194-59-2
Dibutyl phthalate	84-74-2
p-Dichlorobenzene	106-46-7
o-Dichlorobenzene	95-50-1
3,3'-Dichlorobenzidine dihydrochloride	612-83-9
1,2-Dichloroethane	107-06-2
Dichloromethane	75-09-2
2,4-Dichlorophenol (and its salts)	120-83-2
1,2-Dichloropropane	78-87-5
Dicyclopentadiene	77-73-6
Diethanolamine (and its salts)	111-42-2
Diethyl phthalate	84-66-2
Diethyl sulphate	64-67-5
Diethylene glycol butyl ether	112-34-5
Diethylene glycol ethyl ether acetate	112-15-2
Dihydronapthalene (all isomers)	NA
Dimethyl phthalate	131-11-3
Dimethyl sulphate	77-78-1
Dimethylamine	124-40-3
N,N-Dimethylaniline (and its salts)	121-69-7
7,12-Dimethylbenz(a)anthracene	57-97-6
Dimethylether	115-10-6
N,N-Dimethylformamide	68-12-2
4,6-Dinitro-*o*-cresol (and its salts)	534-52-1
2,4-Dinitrotoluene	121-14-2
Di-*n*-octyl phthalate	117-84-0
1,4-Dioxane	123-91-1
Diphenylamine	122-39-4
2,6-Di-*t*-butyl-4-methylphenol	128-37-0
Dodecane (all isomers)	NA
Epichlorohydrin	106-89-8
2-Ethoxyethanol	110-80-5
2-Ethoxyethyl acetate	111-15-9
Ethyl acetate	141-78-6

Ethyl acrylate	140-88-5
Ethyl alcohol	64-17-5
Ethylbenzene	100-41-4
Ethylene	74-85-1
Ethylene glycol	107-21-1
Ethylene glycol butyl ether acetate	112-07-2
Ethylene glycol hexyl ether	112-25-4
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Fluoranthene	206-44-0
Fluorene	86-73-7
Fluorine	7782-41-4
Formaldehyde	50-00-0
Formic acid	64-18-6
Furfuryl alcohol	98-00-0
Halon 1211	353-59-3
Halon 1301	75-63-8
HCFC-122 (all isomers)	41834-16-6
HCFC-123 (all isomers)	34077-87-7
HCFC-124 (all isomers)	63938-10-3
HCFC-141b	1717-00-6
HCFC-142b	75-68-3
HCFC-22	75-45-6
Heavy alkylate naphtha	64741-65-7
Heavy aromatic solvent naphtha	64742-94-5
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	35822-46-9
Heptane (all isomers)	NA
Hexachlorobenzene	118-74-1
Hexachlorocyclopentadiene	77-47-4
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	19408-74-3
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	39227-28-6
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	57653-85-7

Hexachlorophene	70-30-4
n-Hexane	110-54-3
Hexane	NA
Hexavalent chromium (and its compounds)	NA
Hexene (all isomers)	25264-93-1
Hydrazine (and its salts)	302-01-2
Hydrochloric acid	7647-01-0
Hydrogen cyanide	74-90-8
Hydrogen fluoride	7664-39-3
Hydrogen sulphide	7783-06-4
Hydroquinone (and its salts)	123-31-9
Hydrotreated heavy naphtha	64742-48-9
Hydrotreated light distillate	64742-47-8
Indeno(1,2,3-c,d)pyrene	193-39-5
Iron pentacarbonyl	13463-40-6
Isobutyraldehyde	78-84-2
Isophorone diisocyanate	4098-71-9
Isoprene	78-79-5
Isopropyl alcohol	67-63-0
Lead (and its compounds)	NA
Light aromatic solvent naphtha	64742-95-6
D-Limonene	5989-27-5
Lithium carbonate	554-13-2
Maleic anhydride	108-31-6
Manganese (and its compounds)	NA
2-Mercaptobenzothiazole	149-30-4
Mercury (and its compounds)	NA
Methanol	67-56-1
2-Methoxyethanol	109-86-4
2-(2-Methoxyethoxy)ethanol	111-77-3
2-Methoxyethyl acetate	110-49-6
Methyl acrylate	96-33-3
Methyl ethyl ketone	78-93-3
Methyl iodide	74-88-4
Methyl isobutyl ketone	108-10-1
Methyl methacrylate	80-62-6
Methyl *tert*-butyl ether	1634-04-4
N-Methyl-2-pyrrolidone	872-50-4
2-Methyl-3-hexanone	7379-12-6
3-Methylcholanthrene	56-49-5
5-Methylchrysene	3697-24-3
p,p'-Methylene*bis*(2-chloroaniline)	101-14-4

1,1-Methylene*bis*(4-isocyanatocyclohexane)	5124-30-1
Methylene*bis*(phenylisocyanate)	101-68-8
p,p'-Methylenedianiline	101-77-9
Methylindan (all isomers)	27133-93-3
N-Methylolacrylamide	924-42-5
2-Methylpyridine	109-06-8
Michler's ketone (and its salts)	90-94-8
Mineral spirits	64475-85-0
Molybdenum trioxide	1313-27-5
Myrcene	123-35-3
Naphtha	8030-30-6
Naphthalene	91-20-3
Nickel (and its compounds)	NA
Nitrate ion	NA
Nitric acid	7697-37-2
Nitrilotriacetic acid (and its salts)	139-13-9
p-Nitroaniline	100-01-6
Nitrobenzene	98-95-3
Nitrogen oxides (expressed as nitrogen dioxide)	11104-93-1
Nitroglycerin	55-63-0
2-Nitropropane	79-46-9
1-Nitropyrene	5522-43-0
N-Nitrosodiphenylamine	86-30-6
Nonane (all isomers)	NA
Nonylphenol and its ethoxylates	NA
Octachlorodibenzofuran	39001-02-0
Octachlorodibenzo-*p*-dioxin	3268-87-9
Octane (all isomers)	NA
Octylphenol and its ethoxylates	NA
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	40321-76-4
Pentane (all isomers)	NA
Pentene (all isomers)	NA
Peracetic acid (and its salts)	79-21-0
Perylene	198-55-0
beta-Phellandrene	555-10-2
Phenanthrene	85-01-8
Phenol (and its salts)	108-95-2
Phenyl isocyanate	103-71-9

p-Phenylenediamine (and its salts)	106-50-3
Phosgene	75-44-5
Phosphorus (total)	NA
Phosphorus (yellow or white only)	7723-14-0
Phthalic anhydride	85-44-9
beta-Pinene	127-91-3
alpha-Pinene	80-56-8
PM_{10}	NA
$PM_{2.5}$	NA
Polymeric diphenylmethane diisocyanate	9016-87-9
Potassium bromate	7758-01-2
Propane	74-98-6
Propionaldehyde	123-38-6
Propylene	115-07-1
Propylene glycol butyl ether	5131-66-8
Propylene glycol methyl ether acetate	108-65-6
Propylene oxide	75-56-9
Pyrene	129-00-0
Pyridine (and its salts)	110-86-1
Quinoline	91-22-5
Selenium (and its compounds)	NA
Silver (and its compounds)	NA
Sodium fluoride	7681-49-4
Sodium nitrite	7632-00-0
Solvent naphtha light aliphatic	64742-89-8
Solvent naphtha medium aliphatic	64742-88-7
Stoddard solvent	8052-41-3
Styrene	100-42-5
Sulphur dioxide	7446-09-5
Sulphuric acid	7664-93-9
Terpenes (all isomers)	68956-56-9
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	1746-01-6
1,1,2,2-Tetrachloroethane	79-34-5
1,1,1,2-Tetrachloroethane	630-20-6
Tetrachloroethylene	127-18-4
Tetraethyl lead	78-00-2
Tetrahydrofuran	109-99-9
Thallium (and its compounds)	NA
Thiourea	62-56-6
Thorium dioxide	1314-20-1

Titanium tetrachloride	7550-45-0
Toluene	108-88-3
Toluene-2,4-diisocyanate	584-84-9
Toluene-2,6-diisocyanate	91-08-7
Toluenediisocyanate (mixed isomers)	26471-62-5
Total particulate matter	NA
Total reduced sulphur (expressed as hydrogen sulphide)	NA
1,2,4-Trichlorobenzene	120-82-1
1,1,2-Trichloroethane	79-00-5
Trichloroethylene	79-01-6
Triethylamine	121-44-8
1,2,4-Trimethylbenzene	95-63-6
Trimethylbenzene	25551-13-7
Trimethylfluorosilane	420-56-4
2,4,4-Trimethylhexamethylene diisocyanate	15646-96-5
2,2,4-Trimethylhexamethylene diisocyanate	16938-22-0
Vanadium (and its compounds)	7440-62-2
Vinyl acetate	108-05-4
Vinyl chloride	75-01-4
VM & P naphtha	8032-32-4
White mineral oil	8042-47-5
Xylene (all isomers)	1330-20-7
Zinc (and its compounds)	NA

Appendix Table 3. Total estimated use* of carcinogens for all years summed from 2011 to 2015 and the number of facilities that reported use in 2015 by PHU, ranked by use in tonnes, TRA Program 2011-2015.

PHU	Number of facilities reporting carcinogen use	Total estimated carcinogen use (in tonnes)
Lambton Health Unit	11	8,870,610
Sudbury and District Health Unit	7	3,870,660
Niagara Regional Area Health Unit	17	3,071,310
Wellington-Dufferin-Guelph Health Unit	20	1,009,490
Haldimand-Norfolk Health Unit	2	553,050
City of Hamilton Health Unit	18	104,620
Waterloo Health Unit	19	74,730
Durham Regional Health Unit	6	71,230
York Regional Health Unit	23	70,080

Peel Regional Health Unit	34	58,600
Porcupine Health Unit	6	58,130
Perth District Health Unit	6	57,980
North Bay Parry Sound District Health Unit	1	57,590
Simcoe Muskoka District Health Unit	15	57,190
Leeds Grenville and Lanark District Health Unit	8	33,330
Haliburton Kawartha Pine Ridge District Heath Unit	6	29,200
Thunder Bay District Health Unit	6	27,300
Halton Regional Health Unit	16	16,820
Northwestern Health Unit	7	10,140
City of Toronto Health Unit	34	9,440
Brant County Health Unit	6	5,340
Timiskaming Health Unit	4	5,310
Oxford County Health Unit	7	4,650
The District of Algoma Health Unit	6	4,600
Grey Bruce Health Unit	4	3,030
City of Ottawa Health Unit	7	2,810
Renfrew County and District Health Unit	2	2,760
Windsor-Essex County Health Unit	6	2,600
Middlesex-London Health Unit	5	2,570
Elgin-St. Thomas Health Unit	3	900
The Eastern Ontario Health Unit	4	530
Kingston Frontenac and Lennox and Addington Health Unit	2	500
Chatham-Kent Health Unit	1	400
Peterborough County-City Health Unit	5	380
Hastings and Prince Edward Counties Health Unit	2	240
Huron County Health Unit	-	-
Total	326	18,148,120

* Values for estimates of use were rounded to the nearest 10th.