

Appendix G: Ontario Toxic Emissions Inventory

BACKGROUND

The province of Ontario, Canada, has prepared an air toxic emissions inventory on the target compounds for the Great Lakes Regional Air Toxic Emissions Inventory for the 2002 calendar year. This 2002 air toxics emissions inventory includes point, area and mobile sources. Ontario followed the Air Toxic Emissions Inventory Protocol and the emissions source methodologies agreed upon by the inventory's Technical Steering Committee in developing the regional inventory, where applicable.

Emissions related source information was collected from regulated domestic emissions inventories for point sources, statistical organizations (i.e., Statistics Canada) for area sources and the Ontario Ministry of Transportation for mobile sources. Ontario's point, area and mobile source emissions information was compiled using the Regional Air Pollution Inventory Development System (RAPIDS Version 2.4.1) which applies reference tables and air toxic emission factors from the Factor Information Retrieval System (FIRE 6.24). In addition to using FIRE 6.24, MOBILE 6.2C model, NONROAD2004 model and the toxic profiles in the 2002 National Emission Inventory (NEI) documentation were used to estimate the emissions from on-road and non-road mobile sources.

MERCURY

As part of the effort to improve the estimates of mercury emissions for the 2002 inventory, Ontario identified major emission source categories of mercury and updated various emission factors based on recent mercury research and industry source test results. Ontario was also involved in the stakeholder workgroup which recommended revisions to the mercury reporting requirements for Canada's National Pollution Release Inventory (NPRI). This reporting requirement has improved the coverage of mercury emission sources by the inventory.

DATA SOURCES

Point Sources

The point source emissions inventory contains industrial air releases information provided by regulated reporting programs, such as Ontario's "Airborne Contaminant Discharge - Monitoring and Reporting" regulation (O.Reg.127/01) and the federal "National Pollutant Release Inventory" (NPRI). The point source sector profile includes emissions data for 105 of the 211 toxic substances targeted by the Great Lakes Commission (GLC).

Area Sources

The area source emissions inventory represents smaller emission sources. These include wide-spread sources and various industrial sources that cannot be included in the point source inventory due to a lack of facility and/or process specific information. The area source emissions

are based on available statistical information, including energy demand statistics, census data, housing data, industrial production statistics, and employment information. The recent studies undertaken by the joint federal/provincial Emissions and Projection Working Group (EPWG) on the “VOC Emissions from the Use of Solvent” provided significant updates on VOC emissions from solvent related sectors and resulted in change in the speciated toxic pollutants emissions.

The area source emissions were adjusted against the point source emissions in the corresponding sectors to avoid double counting. The 2002 Ontario area source inventory includes 12 source sectors. The area source sector profile includes emissions data for 107 of the 211 toxic substances targeted by the GLC.

Architectural Surface Coating

VOC emissions from architectural surface coating were obtained from the abovementioned “VOC Emissions from the Use of Solvent” studies. The VOC emissions were speciated into specific targeted air toxics.

Commercial and Consumer Solvent Use

Emissions from commercial and consumer solvent use were estimated by applying per capita based emission factors, provided by the GLC protocol, to the population in Ontario. The provincial total was apportioned by county using population statistics.

Dry Cleaning

A tetrachloroethylene (perchloroethylene) emission factor of 0.172 lb/person/year was developed using provincial emissions from the “VOC Emissions from the Use of Solvent” studies. The provincial total was apportioned by county using population statistics.

Fuel Marketing

Emissions for fuel marketing were estimated using VOC speciation and GLC toxic specific emission factors and were applied to county level fuel sale statistics. Emissions were estimated for Trucks in Transit Losses, Stage I Losses (Gasoline Retail Operations - Balanced Submerged Filling), and Stage II Losses (Filling Vehicle Gas Tanks - Vapour Loss and Liquid Spill Loss w/o Control).

Graphic Arts

The VOC emissions from the graphic arts sector were obtained from the “VOC Emissions from the Use of Solvent” studies. The toxic pollutant emission profile from the industrial point source inventory was used to derive an Ontario specific toxic speciation profile which was then applied to the area sources VOC emissions to estimate toxic pollutant emissions. The total provincial emissions were apportioned by county using population statistics.

Human Cremation

The number of human body cremated was estimated using death rate and cremation statistics. The default body weight (150 lb/body) and the GLC toxic emissions profile for cremation was used in the estimation of emissions from this sector.

Industrial Surface Coating

The VOC emissions for the following industrial surface coating sub-sectors were obtained from the “VOC Emissions from the Use of Solvent” studies:

Sub-sector	Corresponding Canadian NAICS	VOC Speciation Profile
Sub-sectors using employee based emission factors		
Factory Finished Wood	321211, 321215, 321911, 321919, 321920, 321992, 337100	2404
Wood Furniture	337x minus 337100	2405
Metal Cans	33243	2408
Miscellaneous Finished Metal	33122, 332619, 332720	2409
Machinery and Equipment	333x	2412
Large Appliance	3352x	2411
Electronic and other Electrical	335311, 33592	2410
New Motor Vehicles	33611, 33612, 336211	2413
Other Transportation	336x minus “New Motor Vehicles” & “Marine Coating”	2414
Marine Coating	33661	2415
Sub-sectors using population based emission factors		
Miscellaneous Manufacturing	Population	2417
Industrial Maintenance	Population	2418
Other Special Purpose	Population	2419

The VOC emissions from the point source inventory were separated out from the area source emissions. All sub-sectors of VOC emissions were speciated into the GLC targeted air toxics using the corresponding VOC speciation profiles listed in the above table.

Publicly Owned Treatment Works (POTW)

POTW emissions were estimated using effluent flow information from POTWs in Ontario and emission factors from the GLC protocol.

Residential Wood Combustion

The 2002 fuel wood consumption was estimated from the energy use statistics from Natural Resources Canada. GLC toxic emission factors were used in estimating the toxic pollutants emissions for the three wood burning stove types used in Ontario: conventional, catalytic, and non-catalytic. Total provincial wood burning stove emissions were apportioned by county according to regional wood use statistics and rural dwelling statistics taken from an Ontario Ministry of Natural Resources wood use study and Statistics Canada respectively.

Residential Fuel Combustion

Residential Fuel Combustion emissions were estimated using residential fuel consumption data from Statistics Canada and emission factors from the GLC protocol. The fuel types for which

targeted toxic emissions were estimated are fuel oils, liquid petroleum gas and natural gas. Fuel use was apportioned by county according to population statistics.

Traffic Markings

The VOC emission from the traffic markings was obtained from the “VOC Emissions from the Use of Solvent” studies. The toxic speciation profiles from the GLC protocol were used to estimate the toxic pollutants emissions.

Mobile Sources:

The mobile source inventory included 2 major categories, on-road sources and non-road sources. The 2002 Ontario mobile source inventory included 13 source sectors (7 in the on-road category and 6 in the non-road category). The mobile source sector profile includes emissions data for 40 of the 211 toxic substances targeted by the Great Lakes Commission (GLC).

On-road Mobile Sources

The on-road mobile sources included the expanded vehicle categories as defined by the U.S. transportation model MOBILE 6. These vehicle categories can be grouped as light-duty gasoline vehicles (LDGV), light-duty gasoline trucks (LDGT), heavy-duty gasoline vehicles (HDGV), light-duty diesel vehicles (LDDV), light-duty diesel trucks (LDDT), heavy-duty diesel vehicles (HDDV) and motorcycles (MC).

The Canadian version of the MOBILE model (MOBILE 6.2C) was used to estimate the evaporative and exhaust related VOC, PM emissions as well as 6 air toxic species. The toxic speciation profiles for additional air toxic species were estimated using estimated VOC and PM emissions and the 2002 NEI documentation for the on-road sources.

Non-road Mobile Sources

Non-road mobile sources include the following categories: i) aviation and ii) locomotives, iii) marine engines, iv) off-road gasoline engines/equipment; v) off-road diesel engines/equipment; and vi) other off-road equipment. The following sections provide details on the emission estimation methodologies associated with non-road mobile sources. The VOC and PM emissions were estimated using corresponding emission factors. The toxic speciation profiles provided by Environment Canada and the 2002 NONROAD NEI documentation and the National Mobile Inventory Model (NMIM) for the non-road sources were used to estimate the toxic emissions.

Aviation

The aircraft movement statistics for each airport were obtained from Transport Canada to estimate VOC and PM emissions. Then the toxic emission values were calculated from VOC and PM emissions based on toxic substance speciation profiles from 2002 NEI document.

Locomotives

The fuel consumption of locomotives, obtained from provincial statistics, was used to estimate VOC and PM emissions. Corresponding toxic substance speciation profiles from 2002 NEI documentation were applied to the VOC and PM emissions to obtain the toxic emission values.

Marine Engines

The fuel consumption and the operating statistics (i.e., movement) of marine engines (i.e., vessels) was obtained from provincial statistics. This information was used to estimate VOC and PM emissions. Corresponding FIRE emission factors/toxic substance speciation profiles were then applied to the VOC and PM emissions to obtain the toxic emission values.

It should be noted that the emissions from pleasure watercrafts (e.g. inboards, outboards) were estimated using the NONROAD2004 model and were inventoried under the off-road engines/equipment categories.

Off-road Diesel Engines/Vehicles

US NONROAD2004 model was used to estimate the VOC and PM emissions from the diesel engines/vehicles. Corresponding toxic substance speciation profiles from Environment Canada and 2002 NONROAD NEI documentation were applied to the VOC and PM emissions to obtain the toxic emission values.

Off-road Gasoline Engines/Vehicles

US NONROAD2004 model was used to estimate the VOC and PM emissions from the gasoline engines/vehicles. Corresponding toxic substance speciation profiles from Environment Canada, 2002 NONROAD NEI documentation and NMIM were applied to the VOC and PM emissions to obtain the toxic emission values.

Other Off-road Equipment

US NONROAD2004 model was used to estimate the VOC and PM emissions from the other engines/equipment that are powered by fuel other than gasoline and diesel (e.g. natural gas, propane). Corresponding toxic substance speciation profiles from Environment Canada, 2002 NONROAD NEI documentation and NMIM were applied to the VOC and PM emissions to obtain the toxic emission values.

QUALITY CHECK ACTIVITIES

During the development of this air toxics inventory, quality check activities, such as technical reviews and accuracy checks, were performed to ensure that the most appropriate emission profiles were used for each source.

UNCERTAINTIES

The emission estimates in this air toxic emissions inventory were based on the best available source information and source emission profiles. The use of O.Reg.127/01 and NPRI data in the point source sector profile is limited primarily to larger sources.

Uncertainties exist when using emission factor tables, which vary in terms of data quality. In preparing this emission inventory, Ontario has further updated some of the RAPIDS emission factor tables with the most recent information from FIRE, AP-42, and EIIP.

INFORMATION

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Ontario - Province Wide Summary of 2002 Emissions (lb/yr)

Pollutant Name (CAS)	Area Source Emissions	Non-road Emissions	On-road Emissions	Point Source Emissions	Total Emissions
Acenaphthene (83-32-9)	9145	2761	1408	7870	21,180
Acenaphthylene (208-96-8)	183,800	4337	7797	1559	197,500
Acetaldehyde (75-07-0)	14,230	3,055,000	1,238,000	389,700	4,697,000
Acetamide (60-35-5)	1,467				1,467
Acetonitrile (75-05-8)	1640			16,280	17,920
Acetophenone (98-86-2)	103.2				103.2
Acrolein (107-02-8)	15,080	566,000	154,800	25,670	761,500
Acrylamide (79-06-1)				207.3	207.3
Acrylic acid (79-10-7)	0.04371			427.8	427.8
Acrylonitrile (107-13-1)	1836			15,260	17,090
Allyl chloride (107-05-1)	91.99				91.99
Aniline (62-53-3)				577.7	577.7
Anthracene (120-12-7)	12,570	687.7	1694	9812	24,770
Antimony (7440-36-0)	36.62			1083	1119
Arsenic (7440-38-2)	187.8		986.6	148,100	149,200
Benz(a)anthracene (56-55-3)	18,140	203.6	317.8	6209	24,870
Benzo(g,h,i)perylene (191-24-2)	4327	493.8	510	270.9	5602
Benzene (71-43-2)	2,114,000	4,100,000	8,454,000	1,182,000	15,850,000
Benzo(a)pyrene (50-32-8)	3853	149.4	233.4	6162	10,400
Benzo(b)fluoranthene (205-99-2)	5417	120	273.5	5703	11,510
Benzo(k)fluoranthene (207-08-9)	1818	108.1	273.5	3623	5823
Benzyl chloride (100-44-7)	38.83			8.82	47.65
Beryllium (7440-41-7)	89.63	55.54		377.1	522.2
Biphenyl (92-52-4)	1300			21,470	22,770
Methyl bromide (74-83-9)	2,685,000			2.205	2,685,000
1,3-Butadiene (106-99-0)	12,780	844,200	1,099,000	138,900	2,095,000
Cadmium (7440-43-9)	459.2	70.57		17,550	18,080
Carbon disulfide (75-15-0)	20,560			115,800	136,300
Carbon tetrachloride (56-23-5)	6928				6928
Chlorine (7782-50-5)			1508	502,400	503,900
Chlorobenzene (108-90-7)	868,700			851.1	869,500
Chloroethane (75-00-3)	89,930				89,930
Chloroform (67-66-3)	42,600			8688	51,290
2-Chloro-1,3-butadiene (126-99-8)	113.2				113.2
Chromium (7440-47-3)	537.6	87.17	1497	99,140	101,300

Pollutant Name (CAS)	Area Source Emissions	Non-road Emissions	On-road Emissions	Point Source Emissions	Total Emissions
Chromium VI (18540-29-9)	1.73	32.07	303.6	2924	3262
Chrysene (218-01-9)	11,190	171.5	218.7	7593	19,180
Cobalt (7440-48-4)	68.68			36,820	36,890
Copper (7440-50-8)	468		496.7	761,900	762,900
Cresol (mixed isomers) (1319-77-3)	7.897			47,370	47,380
Cumene (98-82-8)	226.1			5713	5939
Cyanide (57-12-5)				970.2	970.2
Dibenz(a,h)anthracene (53-70-3)	250.6	3.458	0.6352	6300	6554
Dibenzofuran (132-64-9)	89.52				89.52
Di-N-butyl phthalate (84-74-2)				8035	8035
1,2-Dichloroethane (107-06-2)	49.5			4.41	53.91
1,4-Dichlorobenzene (106-46-7)	942,900			235.9	943,100
1,1-Dichloroethane (75-34-3)				11,160	11,160
1,3-Dichloropropene (542-75-6)	1,935,000				1,935,000
Diethanolamine (111-42-2)				11,160	11,160
Diethylhexyl phthalate (117-81-7)				3438	3438
Dimethyl phthalate (131-11-3)				4.41	4.41
Dimethyl sulfate (77-78-1)	5.902				5.902
N,N-Dimethylformamide (68-12-2)	127,400			213.9	127,600
Dimethylaniline (121-69-7)	1531				1531
2,4-Dinitrotoluene (121-14-2)	228.8				228.8
Di-N-octyl phthalate (117-84-0)				275.6	275.6
1,4-Dioxane (123-91-1)	206.4			1019	1225
Epichlorohydrin (106-89-8)	21.7				21.7
Ethyl acrylate (140-88-5)	8.548			105.8	114.4
Ethyl benzene (100-41-4)	1,318,000	2,330,000	3,269,000	1,485,000	8,401,000
Ethylene glycol (107-21-1)	851,300			282,500	1,134,000
Ethylene oxide (75-21-8)	183,700			16,740	200,500
Fluoranthene (206-44-0)	17,990	1750	1867	13,690	35,300
Fluorene (86-73-7)	21,500	3984	2975	1321	29,780
Formaldehyde (50-00-0)	132,200	6,954,000	3,083,000	1,001,000	11,170,000
Glycol ethers	1,333,000			5,232,000	6,565,000
Hydrochloric acid (7647-01-0)	2266			16,700,000	16,700,000
Hexachlorocyclopentadiene (77-47-4)	2.63				2.63
Hexamethylene-1,6-diisocyanate (822-06-0)				447.6	447.6
Hexane (110-54-3)	6,898,000	1,631,000	3,054,000	3,581,000	15,160,000

Pollutant Name (CAS)	Area Source Emissions	Non-road Emissions	On-road Emissions	Point Source Emissions	Total Emissions
Hexachloro-1,3-butadiene (87-68-3)	3.289				3.289
Hexachlorobenzene (118-74-1)				7.722	7.722
Hydrogen fluoride (7664-39-3)	156.2			1,462,000	1,462,000
Hydrazine (302-01-2)				224.9	224.9
Hydrogen cyanide (74-90-8)				78,490	78,490
Hydrogen sulfide (7783-06-4)				3,585,000	3,585,000
Indeno(1,2,3-c,d)pyrene (193-39-5)	1015	152	153	2198	3517
Isophorone (78-59-1)	11,460				11,460
Lead (7439-92-1)	448.4	243.5	101.4	340,900	341,600
Alkylated lead				22.05	22.05
Maleic anhydride (108-31-6)				209.5	209.5
Manganese (7439-96-5)	471.6	174.1	1756	383,500	385,900
Mercury (7439-97-6)	181.4		993.1	3018	4192
Methyl ethyl ketone (78-93-3)	6,529,000			7,959,000	14,490,000
Methyl isobutyl ketone (108-10-1)	2,417,000			1,539,000	3,956,000
Methyl methacrylate (80-62-6)	6367			45,330	51,700
Methyl tert-butyl ether (1634-04-4)	562.3			6573	7135
Methanol (67-56-1)	7,975,000			13,420,000	21,400,000
4,4'-Methylenediphenyl diisocyanate (101-68-8)				319,000	319,000
Methyl chloride (74-87-3)	78,940			1,542,000	1,621,000
Methylene chloride (dichloromethane) (75-09-2)	1,297,000			1,127,000	2,424,000
Naphthalene (91-20-3)	1,049,000	73,020	197,700	161,500	1,481,000
Nickel (7440-02-0)	1356	4440	1157	444,700	451,700
Nitrobenzene (98-95-3)	30.94				30.94
2-Nitropropane (79-46-9)	24.83				24.83
Polychlorinated biphenyls (PCBs) (1336-36-3)				4.41	4.41
Polychlorinated dibenzodioxins, total	0.000733			0.0506	0.05133
Polychlorinated dibenzofurans, total	0.001102				0.001102
Pentachlorophenol (87-86-5)				46.31	46.31
Tetrachloroethylene (Perc) (127-18-4)	2,429,000			44,090	2,473,000
Phenanthrene (85-01-8)	90,520	8775	5055	27,870	132,200
Phenol (108-95-2)	42.81			262,600	262,600
P-Phenylenediamine (106-50-3)				24.26	24.26
Phosphorus (7723-14-0)	65.98			725.4	791.4
Phthalic anhydride (85-44-9)				366	366
Propionaldehyde (123-38-6)	16.44	514,000	158,800		672,800

Pollutant Name (CAS)	Area Source Emissions	Non-road Emissions	On-road Emissions	Point Source Emissions	Total Emissions
Propylene dichloride (78-87-5)	54.54				54.54
Propylene oxide (75-56-9)	14,780			11,380	26,160
Pyrene (129-00-0)	21,090	1742	2559	11,720	37,110
Quinoline (91-22-5)				597.6	597.6
Selenium (7782-49-2)	440.3	28.33	24.48	87,020	87,510
Styrene (100-42-5)	42,630	187,000	633,300	744,100	1,607,000
2,3,7,8-Tetrachlorodibenzo-p-dioxin (1746-01-6)	6.25E-05	0.000506	0.009662	0.000454	0.01069
2,3,7,8-Tetrachlorodibenzofuran (51207-31-9)		0.001281		0.002362	0.003643
1,1,1-Trichloroethane (71-55-6)	4,846,000			6.615	4,846,000
1,1,2,2-Tetrachloroethane (79-34-5)	8.548				8.548
Toluene (108-88-3)	16,190,000	13,520,000	22,080,000	9,689,000	61,480,000
Toluene-2,4-diisocyanate (584-84-9)				26.46	26.46
O-Toluidine (95-53-4)	8.548				8.548
Trichloroethylene (79-01-6)	6949			1,408,000	1,415,000
1,2,4-Trichlorobenzene (120-82-1)	411.1			4897	5308
1,1,2-Trichloroethane (79-00-5)	5.251			1103	1108
Triethylamine (121-44-8)	10,150			59,850	70,000
2,2,4-Trimethylpentane (540-84-1)	105,600	4,990,000	9,016,000		14,110,000
Vinylidene chloride (75-35-4)	2011				2011
Vinyl acetate (108-05-4)	364.5			5521	5886
Vinyl chloride (75-01-4)	31.59			17,130	17,160
M-Xylene (108-38-3)	196,500				196,500
O-Xylene (95-47-6)	254,700				254,700
P-Xylene (106-42-3)	76,020				76,020
Xylene (mixed isomers) (1330-20-7)	9,940,000	9,239,000	12,390,000	10,520,000	42,080,000

Glycol ethers (misc.) emissions in point sources comprised of the emissions of the following substances: diethylene glycol butyl ether; diethylene glycol butyl ether acetate; diethylene glycol ethyl ether; diethylene glycol ethyl ether acetate; diethylene glycol methyl ether; dipropylene glycol methyl ether; ethylene glycol butyl ether (2-butoxyethanol); ethylene glycol butyl ether acetate; ethylene glycol hexyl ether; ethylene glycol phenyl ether; ethylene glycol propyl ether; 1-methoxy-2-propanol; 2-methoxy-1-propanol; propylene glycol butyl ether; propylene glycol ethyl ether; propylene glycol methyl ether acetate; and propylene glycol propyl ether (pgpe).

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