

Benzene Environmental estimates (circa 2011): Supplemental data



Table of Contents

ata for lifetime excess cancer risk estimates	2
view	2
Environmental Concentrations	2
Calculated Lifetime Daily Intake	2
Cancer Potency Factors	2
Lifetime Excess Cancer Risk (per million people)	3
orting data by exposure pathway	3
Food and Beverages	15
ata quality for lifetime excess cancer risk estimates	. 18
ata for mapping concentrations	
nates by health region	19
nates by census block	19
	view Environmental Concentrations Calculated Lifetime Daily Intake Cancer Potency Factors Lifetime Excess Cancer Risk (per million people) orting data by exposure pathway Outdoor air Indoor air Dust Dust Drinking water Food and Beverages ata quality for lifetime excess cancer risk estimates ata for mapping concentrations hates by health region



1. Data for lifetime excess cancer risk estimates

Overview

The summary data used to calculate lifetime excess cancer risk and the results for benzene are provided in the tables below. For more detailed information on supporting data and sources, see below for each exposure pathway.

i. Environment	al Concentration	ons		
Exposure pathway	Units	Average	Maximum	Notes
Outdoor air	µg/m³	0.84	12.09	
Indoor air	µg/m³	2.0	87	
Drinking water	μg/L	0.05	0.15	
Foods and beverages		See detailed data	Not estimated	

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.000019	0.00028
Indoor air	0.00065	0.0283
Drinking water	0.000013	0.000039
Foods and beverages	0.000023	Not estimated

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	0.0145	0.0273	0.1
Ingestion	0.0834	0.055	

Sources for Cancer Potency Factors:

- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment. Version 2.0.
- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors. Version 2.0.
- United States Environmental Protection Agency Integrated Risk Information System
- California Office of Environmental Health Hazard Assessment, 2009. Air Toxics Hot Spots Risk Assessment Guidelines Part II: Technical Support Document for Cancer Potency Factors, Appendix A. (Updated 2011)



iv. Lifetime Excess Cancer Risk (per million people)

		Average ¹		Maximum ²
Exposure pathway	Health Canada	US EPA	CA OEHHA ³	
Outdoor air	0.28	0.531	1.94	27.97
Indoor air	9.42	17.738	64.97	2826.37
Drinking water	0.108	0.0714		0.325
Foods and beverages	1.91	1.26		Not estimated

¹Lifetime excess cancer risk based on average intake x cancer potency factor from each agency

²Lifetime excess cancer risk based on maximum intake x highest cancer potency factor

³California Office of Environmental Health Hazard Assessment

Supporting data by exposure pathway

i. Outdoor air

Outdoor air concentrations are from the National Air Pollution Surveillance monitoring network operated by Environment Canada, for the year 2010.

Source	Stations (n)	Min	Max	Mean	DF
NAPS 2010 (µg/m³)	53	0.13	12.09	0.84	1.0

DF = Detection frequency

We assume benzene is present at these levels in all outdoor air, although concentrations may vary from one location to another.

ii. Indoor air

Indoor air concentrations are based on data published in peer-reviewed literature since 2000. A ranking system was used to select data most representative of Canadian conditions circa 2011:

- 1. Canadian data collected in 2000 or more recently, sample duration of 24 hours or longer;
- 2. US studies of similar currency and sample duration;
- 3. Studies from northern European countries of similar currency and sample duration;
- Canadian, US or European studies with data collected prior to 2000 and similar sample duration; and
- 5. Studies with sample duration of less than 24 hours regardless of country or collection date, or studies from countries not comparable to Canada.



Rank: 1	Author:	Whee	ler (2013)				Location:	Canada Nat	ional		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
3857	0.73	0.70	2009- 2011	µg/m³	7 days			1.95	0.90	1.07	25 th 0.51 75 th 2.07 90 th 4.25 95 th 7.42

*DF = Detection frequency **DL = Detection limit

Rank: 1	Author	: Heal	th Canada (20	012)			Location:	Halifax, NS			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
331	1.0	0.024	2009 summer	µg/m³	24hr	0.0148	85.17	2.435	0.520	0.751	25 th 0.328 75 th 1.408 90 th 4.980 95 th 9.020
312	1.0		winter			0.307	89.69	3.219	0.830	1.174	25 th 0.599 75 th 1.795 90 th 3.357 95 th 8.173

**DL = Detection limit

Rank: 1	Autho	r: Heal	lth Canada (20	010)			Location:	Regina, SK			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
105	1.0	0.044	2007 Summer	µg/m³	24hr 5 day	0.180	32.325	2.723	0.997	1.275	25th 0.540 75th 2.265 90th 6.485 95th 13.313 25th 0.680
											75 th 2.890 90 th 10.365 95 th 14.330
105	1.0		winter		24hr	0.533	17.873	2.062	1.150	1.438	25 th 0.823 75 th 1.967 90 th 3.617 95 th 5.513
89	1.0				5 day	0.487	13.127	1.931	1.167	1.388	25 th 0.790 75 th 2.120 90 th 3.890 95 th 6.277

*DF = Detection frequency **DL = Detection limit



	Author:	Hérou	ix (2010)				Location:	Canada, Re	gina		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
105 105 91 84			2007	µg/m³	1 week	0.18 0.53 0.18 0.53	32.33 17.87 32.33 17.87	2.72 2.06 2.66 0.85		1.25 1.44 1.19 1.31	
					. Nee see li						

Notes: Values listed in the following order: Summer, Winter, Non-smoking Summer, Non-smoking winter *DF = Detection frequency **DL = Detection limit

Rank: 1	Author:	Hérou	ix (2008)		Location: Canada, Quebec						
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
96	0.94	0.2	2005	µg/m³	7 days	0.1	22.37		1.18	1.22	
*DF = Dete	ction frequ	ency									

**DL = Detection limit

Rank: 1	Author	: Heal	th Canada (20	010)			Location:	Windsor, ON			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
217	1.0	0.100	2005 summer	µg/m³	24hr	0.525	16.485	3.076	1.475	1.958	25 th 1.025 75 th 2.870 90 th 8.705 95 th 11.070
232	1.0	0.038	winter 2006			0.596	513.936	2.094	1.541	1.682	25 th 1.068 75 th 2.360 90 th 3.752 95 th 5.260
211	1.0	0.036	summer		24hr	0.450	50.107	3.765	1.353	1.824	25 th 1.000 75 th 2.343 90 th 10.497 95 th 21.010
224	1.0		,			0.497	0.497	1.594	1.190	1.324	25 th 0.975 75 th 1.517 90 th 2.937 95 th 3.646

*DF = Detection frequency **DL = Detection limit



Rank: 1	Author:	Stocco	o (2008)				Location:	Canada, Wi	ndsor		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
48 48	1.0 1.0	0.014	2005	µg/m³	5 days					1.95 1.68	
Notes: Non	-smoking h	nomes valu	es listed for s	ummer and	winter respect	ivelv					

g homes, values listed for summer and winter respectively : Non-smo

*DF = Detection frequency

**DL = Detection limit

Rank: 1	Author	WBEA	(2008)				Location:	Canada, Alb	erta		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
35 24	0.95	0.42	2006	µg/m³	4 weeks				1.9 2.5		95th 18.9 95th 15.0

Notes: Values listed in the following order: Fort MacKay, Fort McMurray *DF = Detection frequency **DL = Detection limit

Location: USA, Minnesota	
Max Mean Med Geomean (AM) (GM)	Percentile
2.2	10th 0.8 90 th 6.2
2.1	10 th 0.6 90th 7.2
	Max Mean Med Geomean (AM) (GM) 2.2

Notes: Values presented in the following order: Winter, Spring *DF = Detection frequency **DL = Detection limit

-

Rank: 2	Author:	Batter	man (2007)				Location:	USA, Michi	gan		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
15	1.0	0.024	April – July, 2005	µg/m³	4 days		7.6	2			

Notes: Single family dwelling with attached garages

*DF = Detection frequency



Rank: 2	Author:	Jia (20	008)				Location:	USA, Michi	igan (Ann Ai	rbor, Ypsilanti, l	Dearborn)
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
252	1.0		2004/	µg/m³	3-4 days		47.35	2.84	1.17	252	
46			2005					3.15	0.94	46	
50								2.77	1.06	50	
30								4.06	1.05	30	
29								1.98	1.15	29	
45								2.05	1.25	45	
52								3.09	1.83	52	

Notes: Values listed in the following order: ALL, Suburban Summer 2004, Suburban Winter 2005, Urban Summer 2004, Urban Winter 2005, Industrial Spring 2005, Industrial Fall 2004 *DF = Detection frequency **DL = Detection limit

	Author:	Johns	on (2010)				Location:	USA, Michig	gan		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
41	1.0	0.4	2006 (winter)	µg/m³	7day or 24/48 hr	0.8	37.6	3			25th 1.1 50th 1.5 75th 2.7 95th 5.8

*DF = Detection frequency **DL = Detection limit

	Author:	Payne	-Sturges (20	04)			Location:	USA, Baltir	nore		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
33			2000 – 2001	µg/m³	3 day			3.7	2.45		10th 1.03 90th 8.34

*DF = Detection frequency

**DL = Detection limit

Rank: 2	Author:	Weise	1 (2008)				Location:	USA, New J	ersey		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
100	0.76	1.6 or 0.64	2003 - 2006	µg/m³	24 hr	Less than DL <0.64	42	4.07			25th <1.6 50th 1.80 75th 3.28 90th 10.0 95th 13.1
*DF = Dete	ction frequ	encv									



Rank: 3	Author:	Gusta	fson (2007)				Location:	Sweden, Ha	gfors		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
24		0.03,	Feb 10-	µg/m³	24hr,						
14		0.04	Mar 12		7day			3.9	2.6		
14			2003					5.7	3.0		
10								2.0	1.7		
10								2.5	1.5		

Notes: Values listed in the following order: All, Wood burning 24-hr, Wood burning 7 day, Non-wood burning 24-hr, Non-wood burning 7 day *DF = Detection frequency **DL = Detection limit

(n) Date Duration (AM) (GM) 601 2004- μg/m³ 4 weeks 22 2.03 46th 1.02 2005 2005 50th 1.55 54th 2.18 95th 4.77		Author:	Schlin	nk (2010)				Location:	Germany, I	Leipzig	
2005 50th 1.55 54th 2.18 95th 4.77		DF*	DL**		Units		Min	Max		Med	Percentile
560110.00	601				µg/m³	4 weeks		22	2.03		46th 1.02 50th 1.55 54th 2.18 95th 4.77 98th 10.00

*DF = Detection frequency **DL = Detection limit

Rank: 4	Author:	Hippe	lein (2004)				Location:	Germany			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
63		1	2000 – 2001	µg/m³	2 L sample		13	2.9	2.4	2.1	90th 5.4

*DF = Detection frequency **DL = Detection limit

Rank: 4	Author:	Kim (2	001)				Location:	England, Bi	rmingham		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
128		0.26	1999 -	µg/m³	8 hrs	3.4	63.7	13.9	9.2		
32			2000			4.2	63.7	16.3	11.4		
32						3.1	51.7	11.5	6.6		
2								3.5			
2								12.6			
2								6.1			
2								9.2			

Notes: Values listed in the following order: All, Smoking (6), Non-smoking (6), Before Solvent Cleaning, After Solvent Cleaning, Before Painting, After Painting *DF = Detection frequency



	Author:	Ohura	(2006)				Location:	Japan, Shim	izu		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
25			2000 2001	µg/m³	24 hr					0.99	10th 0.59 90 th 1.48
21										2.69	10 th 0.89 90 th 5.84

Notes: Values listed in the following order: Industrial city, Summer 2000, Winter 2001

*DF = Detection frequency

**DL = Detection limit

Rank: 4	Author:	Schlink	(2004)				Location:	Germany			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
			1994-								95th 8.6
2103			2001	µg/m³	4 weeks		3.3	3.2	2.3		98th 12.0
Notes: (Leip *DF = Detec											

**DL = Detection limit

Rank: 5	Author:	Esplu	gues (2010)				Location:	Spain, Vale	ncia		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
352	0.64	1.04	2006- 2007	µg/m³	15 days	0.52	88.7	2.7		1.4	25th 0.5 50th 1.5 75th 2.4

Notes: March 2006 - February 2007, Living rooms

*DF = Detection frequency **DL = Detection limit

Rank: 5	Author:	Fonde	lli (2008)				Location:	Italy, Floren	ice		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
11		0.01	2001- 2002	µg/m³	4 day	3.3 1.7	9.6 6.0	5.9 3.3	5.7 3.1		
						2.9 1.6	8.7 6.2	5.1 2.7	4.7 2.5		

Notes: Dec. 10-13, 2001 (winter) June 3-6, 2002 (spring),

Values listed in the following order: Rooms close to street (W) Rooms close to street (S) Rooms farther from street (W) Rooms farther from street (S)

*DF = Detection frequency



Rank: 5	Author:	Galleg	go (2010)				Location:	Spain, Barc	elona (Urba	n) Catalan (Rura	al)
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
48		0.5	2000	µg/m³	21 days	0.5	36.0	4.3			5th 1.1 50th 3.69 95th 8.5
13			2001			0.2	70.6	5.8			5 th 0.5 50 th 2.2 95 th 19.5

Notes: Values listed in the following order: samples taken in 2000-, samples taken in 2001

*DF = Detection frequency **DL = Detection limit

Rank: 5 Aut	hor: Hinw	ood (2006)				Location:	W Australia	, Perth		
Samples DF* (n)	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
27	<.01	2000	ppb	12 hrs		2.7 2.2 0.7 0.3 0.2 bdl				

Notes: Values listed in the following order: Open Fireplace Heating, Pot-bellied Stove Heating, With Garage, Indoor (daytime,) New Furnishings, Gas Heater *DF = Detection frequency **DL = Detection limit

Rank: 5	Author:	Kinne	y (2002)				Location:	New York C	ity, Los Ang	geles	
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
36			1999	µg/m³	48 hrs			0.00597			
41								0.00175			

Notes: Values listed in the following order: Winter, Summer

*DF = Detection frequency **DL = Detection limit

-

Rank: 5	Author:	Masso	lo (2009)				Location:	Argentine,	La Plata		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
		.0105	2000-	µg/m³	4 weeks						
26			2002				59.54	19.07	18.0		
24							12.74	3.58	3.20		
23							13.17	4.69	3.14		
14							10.5	3.69	3.10		

Notes: Values listed in the following order: Industry, Urban, Semi-Rural, Residential

*DF = Detection frequency



Rank: 5	Author:	Raw (2	2004)				Location:	England			
amples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
796		0.1	1997 -	µg/m³	4 weeks	< 0.1	93.5			3	10th 1.0
			1999								50th 3.3
											75th 5.8
											95th 14.6
DF = Dete	onal Survey ction freque ection limit	ency									
ank: 5	Author:	Sax (2	006)				Location:	New York C	ity, Los Ang	geles	
amples	DF*	DL**	Sample	Units	Sample	Min	Max	Mean	Med	Geomean	Percentil
(n)			Date		Duration			(AM)		(GM)	
79	0.83		1999-	µg/m³	48 hr		20.7	3.64	2.75		
			2000								
DF = Dete	1.0 es listed in ction freque ection limit	ency	2000 ing order: Ne	w York City,	Los Angeles.		11.4	3.87	3.30		
lotes: Valu DF = Dete *DL = Det	es listed in ction freque	ency		w York City,	Los Angeles.		11.4 Location:	3.87 USA, Minn			
lotes: Valu DF = Dete *DL = Det ank: 5	es listed in ction freque ection limit Author:	ency Sextor	ing order: Ne n (2004)			Min	Location:	USA, Minn	esota	Geomean	Parcantil
otes: Valu DF = Dete *DL = Det ank: 5	es listed in ction freque ection limit	ency	ing order: Ne	w York City, Units	Los Angeles. Sample Duration	Min				Geomean (GM)	Percentil
lotes: Valu DF = Dete *DL = Det lank: 5 amples	es listed in ction freque ection limit Author:	ency Sextor	ing order: Net n (2004) Sample		Sample	Min	Location:	USA, Minn Mean	esota		10th 0.8
Notes: Valu PDF = Dete **DL = Dete **DL = Dete Rank: 5 Gamples (n) 292 Notes: ALL: *DF = Dete	es listed in ction freque ection limit Author: DF* 1.0	Sextor DL**	ing order: Net n (2004) Sample Date	Units µg/m³	Sample Duration	Min	Location:	USA, Minn Mean (AM)	esota Med		Percentil 10th 0.8 90th 15.3
lotes: Valu DF = Dete *DL = Dete ank: 5 amples (n) 292 lotes: ALL: DF = Dete	es listed in ction freque ection limit Author: DF* 1.0 Spring, Sur ction freque	Sextor DL**	ing order: Net n (2004) Sample Date 1999 Non-Smoking	Units µg/m³	Sample Duration	Min	Location:	USA, Minn Mean (AM)	esota Med 1.9		10th 0.8
otes: Valu DF = Dete *DL = Det ank: 5 amples (n) 292 otes: ALL: DF = Dete *DL = Det ank: 5	es listed in ction freque ection limit Author: DF* 1.0 Spring, Sur ction freque ection limit	Sextor DL** mmer, Fall ency	ing order: Net n (2004) Sample Date 1999 Non-Smoking	Units µg/m³	Sample Duration	Min	Location: Max	USA, Minn Mean (AM) 5.8	esota Med 1.9		10th 0.8
otes: Valu DF = Dete *DL = Det ank: 5 amples (n) 292 otes: ALL: DF = Dete *DL = Det ank: 5 amples	es listed in ction freque ection limit Author: DF* 1.0 Spring, Sur ction freque ection limit Author:	Sextor DL** mmer, Fall ency Zhu (2	ing order: Ner n (2004) Sample Date 1999 Non-Smoking 2005) Sample	Units µg/m³	Sample Duration 2 day Sample		Location: Max Location:	USA, Minn Mean (AM) 5.8 Canada, Ott	esota Med 1.9 tawa	(GM) Geomean	10th 0.8 90th 15.3
otes: Valu DF = Dete *DL = Det ank: 5 amples (n) 292 otes: ALL: DF = Dete *DL = Det ank: 5 amples (n)	es listed in ction freque ection limit Author: DF* 1.0 Spring, Sur ction freque ection limit Author: DF*	Sextor DL** mmer, Fall ency Zhu (2 DL**	ing order: Net n (2004) Sample Date 1999 Non-Smoking 2005) Sample Date	Units µg/m ³	Sample Duration 2 day Sample Duration	Min	Location: Max Location: Max	USA, Minn Mean (AM) 5.8 Canada, Ott Mean (AM)	esota Med 1.9 tawa	(GM) Geomean	10th 0.8 90th 15. Percentil

**DL = Detection limit

Sources for indoor air data:

- Adgate JL, Church TR, Ryan AD, Ramachandran G, Frederickson AL, Stock TH, et al. 2004. Outdoor, indoor, and personal exposure to VOCs in children. Environmental Health Perspectives 112: 1386-1392.
- Batterman S, Jia CR, Hatzivasilis G. 2007. Migration of volatile organic compounds from attached garages to residences: A major exposure source. Environmental Research 104: 224-240.
- Esplugues A, Ballester F, Estarlich M, Llop S, Fuentes-Leonarte V, Mantilla E, et al. 2010. Indoor and outdoor air concentrations of BTEX and determinants in a cohort of one-year old children in Valencia, Spain. Science of the Total Environment In Press.



- Fondelli MC, Bavazzano P, Grechi D, Gorini G, Miliga L, Marchese G, et al. 2008. Benzene exposure in a sample of population residing in a district of Florence, Italy. Science of the Total Environment 392: 41-49.
- Gallego E, Roca FX, Guardino X, Rosell MG. 2010. Indoor and outdoor BTX levels in Barcelona City metropolitan area and Catalan rural areas. Journal of Environmental Sciences 20: 1063-1069.
- Gustafson P, Barregard L, Strandberg B, Sallsten G. 2007. The impact of domestic wood burning on personal, indoor and outdoor levels of 1,3-butadiene, benzene, formaldehyde and acetaldehyde. Journal of Environmental Monitoring 9: 23-32.
- Health Canada. 2012. Halifax Indoor Air Quality Study (2009) Volitile Organic Compounds (VOC) Data Summary.
- Health Canada. 2010. Regina Indoor Air Quality Study (2007): Data Summary for Volatile Organic Compound Sampling.
- Health Canada. 2010. Windsor Exposure Assessment Study (2005-2006): Data Summary for Volatile Organic Compound Sampling. Available online at: http://www.healthcanada.gc.ca.
- Héroux ME, Clark N, Van Ryswyk K, Mallick R, Gilbert NL, Harrison I, et al. 2010. Predictors of Indoor Air Concentrations in Smoking and Non-Smoking Residences. International Journal of Environmental Research and Public Health 7: 3080-3099.
- Héroux ME, Gauvin D, Gilbert NL, Guay M, Dupuis G, Legris M, et al. 2008. Housing characteristics and indoor concentrations of selected volatile organic compounds (VOCs) in Quebec City, Canada. Indoor and Built Environment 17: 128-137.
- Hinwood AL, Berko HN, Farrar D, Galbally IE, Weeks IA. 2006. Volatile organic compounds in selected micro-environments. Chemosphere 63: 421-429.
- Hippelein M. 2004. Background concentrations of individual and total volatile organic compounds in residential indoor air of Schleswig-Holstein, Germany. Journal of Environmental Monitoring 6: 745-752.
- Jia C, Batterman S, Godwin C. 2008. VOCs in industrial, urban and suburban neighborhoods, Part 1: Indoor and outdoor concentrations, variation, and risk drivers. Atmospheric Environment 42: 2083-2100.
- Johnson MM, Williams R, Fan Z, Lin L, Hudgens E, Gallagher J, et al. 2010. Participant-based monitoring of indoor and outdoor nitrogen dioxide, volatile organic compounds, and polycyclic aromatic hydrocarbons among MICA-Air households. Atmospheric Environment in Press: 1-10.
- Kim YM, Harrad S, Harrison RM. 2001. Concentrations and sources of VOCs in urban domestic and public microenvironments. Environmental Science & Technology 35: 997-1004.
- Kinney PL, Chillrud SN, Ramstrom S, Ross J, Spengler JD. 2002. Exposures to multiple air toxics in New York City. Environmental Health Perspectives 110: 539-546.
- Massolo L, Rehwagen M, Porta A, Ronco A, Herbarth O, Mueller A. 2010. Indoor-outdoor distribution and risk assessment of volatile organic compounds in the atmosphere of industrial and urban areas. Environmental Toxicology 25(4): 339-349.
- Ohura T, Amagai T, Senga Y, Fusaya M. 2006. Organic air pollutants inside and outside residences in Shimizu, Japan: Levels, sources and risks. Science of the Total Environment 366: 485-499.
- Payne-Sturges DC, Burke TA, Breyesse P, Diener-West M, Campbell S. 2004. Personal exposure meets risk assessment: a comparison of measured and modeled exposures and risks in an urban community. Environmental Health Perspectives 112: 589-598.
- Raw GJ, Coward SKD, Brown VM, Crump DR. 2004. Exposure to air pollutants in English homes. Journal of Exposure Analysis and Environmental Epidemiology 14: S85-S94.



- Sax SN, Bennett DH, Chillrud SN, Ross J, Kinney PL, Spengler JD. 2006. A cancer risk assessment of inner-city teenagers living in New York City and Los Angeles. Environmental Health Perspectives 114: 1558-1566.
- Schlink U, Rehwagen M, Damm M, Richter M, Borte M, Herbarth O. 2004. Seasonal cycle of indoor-VOCs: comparison of apartments and cities. Atmospheric Environment 38: 1181-1190.
- Schlink U, Thiem A, Kohajda T, Richter M, Strebel K. 2010. Quantile regression of indoor air concentrations of volatile organic compounds (VOC). Science of the Total Environment 408: 3840-3851.
- Sexton K, Adgate JL, Ramachandran G, Pratt GC, Mongin SJ, Stock TH, et al. 2004. Comparison of personal, indoor, and outdoor exposures to hazardous air pollutants in three urban communities. Environmental Science and Technology 38: 423-430.
- Stocco C, MacNeill M, Wang D, Xu X, Guay M, Brook J, et al. 2008. Predicting personal exposure of Windsor, Ontario residents to volatile organic compounds using indoor measurements and survey data. Atmospheric Environment 42: 5905-5912.
- Weisel CP, Alimokhtari S, Sanders PF. 2008. Indoor Air VOC Concentrations in Suburban and Rural New Jersey. Environmental Science & Technology 42: 8231-8238.
- Wheeler AJ, Wong S L, Khoury C, Zhu J. 2013. Predictors of indoor BTEX concentrations in Canadian residences. Component of Statistics Canada Catalogue no. 82-003-X Health Reports.
- Wood Buffalo Environmental Association. 2008. Wood Buffalo Environmental Association Human Exposure Monitoring Program - 2006 Monitoring Year Results. Alberta, Canada.
- Zhu JP, Newhook R, Marro L, Chan CC. 2005. Selected volatile organic compounds in residential air in the city of Ottawa, Canada. Environmental Science & Technology 39: 3964-3971.

iii. Dust

Benzene is not expected to be present in indoor dust in significant amounts.

iv. Drinking water

Drinking water data are from the Ontario Drinking Water Surveillance Program (DWSP) for 2011. A review of published reports was also conducted in order to compare how well the Ontario data represented other regions in Canada.



Source	Units	DL							
Ontario DWSP 2011	(µg/L)	0.05							
Sample Type	Parameter	Mean	SD	Min	25 th	50 th	75 th	Max	Ν
Distribution		0.05	0.005	0.05	0.05	0.05	0.05	0.15	342

DL = Detection limit

SD = Standard Deviation

Rank: 1	Author:	Health	Canada (200	09)			Location:	Canada			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
1000	0.05		1998 -	μg/L		0.01	4.92	0.28			96 th 1.0
1000	0.05		2003			0.01	0.23	0.01			
30		0.0005	1995 -			< 0.2	< 1.0	0.25			
34		to 1.0	2005			0.1		0.71			
12						0.1	1.0	0.46			
		1.0	1995 - 2005				<1.0				
2277		0.05	2002 - 2008			< 0.05	0.2				
2388	0.01	0.03 to 2.0	2001 - 2005			0.03	3.6	0.35			
104		0.5 to 1.0	2001 - 2005				<0.5 or 1.0				

Notes: Data presented in the following order: Alberta municipal treated surface water; Alberta municipal treated ground water; Saskatchewan municipal treated surface water; Saskatchewan municipal treated ground water; Saskatchewan municipal treated surface and ground water mix; Newfoundland raw, or municipal treated surface or ground water; Ontario municipal drinking water systems using surface or ground water; Quebec municipal treated drinking water; Nova Scotia municipal treated surface or groundwater

*DF = Detection frequency

**DL = Detection limit

Sources for drinking water:

• Health Canada. 2009. Guidelines for Canadian Drinking Water Quality: Guideline Technical Document - Benzene. Ottawa, Ontario, Canada: Water Quality and Health Bureau, Healthy Environments and Consumer Safety Branch, Health Canada.'



v. Food and Beverages

Food consumption data are from the Statistics Canada Food Survey (2006) - Food available, adjusted for losses tables, and from the Nutrition Canada Survey (1970-1972).

Food concentration data are primarily from the US-FDA Total Diet Study (2003-2004), with additional data on metals and several PAHs from the Canadian Food Inspection Agency (CFIA) - National Chemical Residue Monitoring Program: 2009-2010 Annual Report and the US-FDA (TDS Statistics on Element Results - 2008).

In order to better represent actual intake, we incorporated data for cooked and/or processed foods, as in some cases, this can either add to or diminish the amount measured in raw food.

Concentration data were obtained for 75% of total meat consumed, 46% of total seafood consumed, 41% of total fruit consumed, 20% of total vegetables consumed, 52% of total dairy and eggs consumed, 57% of total grains consumed, and 26% of total beverages consumed.



leef 0.01500 0.5820 Peakesfresh 0.02700 0.02273 Offal 0.0220 Pears canned 0.01800 0.02273 Offal 0.0020 0.02270 Pears fresh 0.01800 0.02273 Offal 0.0020 0.02500 Pineapples canned 0.01800 0.02273 Shortening and shortening oils 0.00177 0.04550 Quinces fresh 0.01300 0.02564 Shortening and shortening oils Stawberries canned Unices fresh 0.0105 0.13954 Stewing hen Stawberries frozen Stawberries frozen Image fresh 0.00105 0.13954 Fish fresh and frozen seafish 0.00875 1.0000 Honey Image fresh <	Food or Beverage	Concentration (µg/g)	DF	Food or Beverage	Concentration (µg/g)	DF
Mutton and lambPears fresh0.018000.02273OffalOlis and fats0.002507.5000Pineapples renned0.013000.02564Pork0.001770.04550Piums total fresh0.013000.02564Salad olisStawberries fresh0.01050.13954VielStortening and shortening olisStrawberries frozenStrawberries frozen1Stewing henStrawberries frozenStrawberries frozen1Turkey0.034000.0273Strawberries frozen1Fish fresh and frozen seafishSugar refined11Fish fresh and frozen seafish0.008751.0000Apples frozen1Apples driedApples driedAppargus fresh0.002330.52273Apples driedApples driedAvacados fresh0.008230.52273Apples fresh0.002450.2773Beans green and wax freshBeans green and wax freshBananas fresh0.033680.5901Beans green and wax fresh1Blueberries frozenBeats green and wax frozen11Cherries fresh0.016000.02272Caulifover fresh1Closust fresh0.010000.02273Beats green and wax frozen1Blueberries frozenCarrots fresh111Cherries fresh0.010000.02273Calbage fresh11Closust fresh0.013000.02273Calbage fresh11Claus theresh0.013000.02273Ca	Beef	0.01550	0.56820	Peaches fresh	0.02700	0.02273
Offal Pineapples canned Pineapples canned Olis and fats 0.00250 0.7500 Pineapples fresh Pineapples fresh Shartening and shortening oils Salad oils Raspberries frozen Staraberries canned Turkey 0.03400 0.02270 Strawberries canned Staraberries frozen Turkey 0.03400 0.02270 Strawberries canned Staraberries frozen Fish fresh and frozen seafish Sugar maple Strawberries frozen Staraberries frozen Fish fresh and frozen seafish 0.00875 1.00000 Asparagus fresh Sugar maple Apple se filling Asparagus fresh 0.00245 0.27273 Beans green and was tresh 0.00232 0.52273 Apples fresh 0.00245 0.27273 Beans green and was tresh Staraberries canned	Chicken	0.03600	0.02270	Pears canned		
Oils and fats 0.00250 0.75000 Pineapples fresh 0.01300 0.02564 Pork 0.00177 0.04550 Plums total fresh 0.01300 0.02564 Shortening and shortening oils Strawberries frozen Tite strawberies frozen Tite strawberries frozen<	Mutton and lamb			Pears fresh	0.01800	0.02273
Pork 0.00279 0.04550 Plums total fresh 0.02564 Salad oils Quinces fresh Quinces fresh 0.02105 Shorttening and shortening oils Strawberries frozen Strawberries fresh 0.00105 Stewing hen Strawberries fresh 0.00105 0.13954 Turkey 0.030400 0.02270 Strawberries fresh 0.00105 0.13954 Fish fresh and frozen seafish Strawberries fresh 0.00105 0.13954 Fish freshwater Sugar refined Sugar refined Image Image <td< td=""><td>Offal</td><td></td><td></td><td>Pineapples canned</td><td></td><td></td></td<>	Offal			Pineapples canned		
Salad oilsOutputO	Oils and fats	0.00250	0.75000	Pineapples fresh		
Shortening and shortening oils Raspberries frozen Stewing hen Strawberries frozen Turkey 0.03400 0.02270 Strawberries frozen Strawberries frozen Fish fresh and frozen seafish Sugar refined Sugar refined Fish processed seafish 0.00875 1.00000 Apple sance Apples dried Asparagus canned Apples dried Asparagus fresh 0.00823 0.52273 Banana frozen Beans dry Image fresh 0.00823 0.52273 Bananas fresh 0.00368 0.5901 Beans green and wax canned Image fresh Bananas fresh 0.03368 0.5901 Beans green and wax frozen Image fresh Blueberries fresh Beans green and wax frozen Image fresh Image fresh Image fresh Blueberries fresh Distop 0.02941 Brussels sprouts frozen Image fresh Image fresh Cherries fresh 0.01000 0.02272 Cabbage fresh Image fresh Image fresh Cranberries fresh 0.01000 0.02272 Cauliflower frozen Image fresh Image fresh Cranberries fresh <td>Pork</td> <td>0.00177</td> <td>0.04550</td> <td>Plums total fresh</td> <td>0.01300</td> <td>0.02564</td>	Pork	0.00177	0.04550	Plums total fresh	0.01300	0.02564
Stewing hen Strawberries canned Turkey 0.03400 0.02270 Strawberries fresh 0.00105 0.13954 Fish fresh and frozen seafish Sugar maple Sugar refined Sugar refined Sugar maple <	Salad oils			Quinces fresh		
Turkey0.034000.02270Strawberries fresh0.01050.13954VealFish fresh and frozen seafishSugar mapleStrawberries frozenSugar mapleIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	Shortening and shortening oils	s		Raspberries frozen		
Turkey 0.03400 0.02270 Strawberries fresh 0.00105 0.13954 Veal Strawberries frozen Artichokes fresh Asparagus fresh Asparagus fresh Strawberries frozen Asparagus fresh Strawberries frozen Asparagus fresh Strawberries fresh <td>Stewing hen</td> <td></td> <td></td> <td>Strawberries canned</td> <td></td> <td></td>	Stewing hen			Strawberries canned		
Veal Strawberries frozen Fish fresh and frozen seafish Sugar maple Fish processed seafish 0.00875 1.0000 Apple pip filling Artichokes fresh Attichokes fresh Apples canned Asparagus canned Asparagus fresh Apples dried 0.00245 0.27273 Beans dry Beans dry 0.00232 0.52273 Apples fresh 0.00245 0.27273 Beans dry 0.00232 0.52273 Apples frozen Beans green and wax canned Beans green and wax fresh 0.00232 0.52273 Banans fresh 0.03368 0.5901 Beans green and wax fresh 0.00231 0.20241 Blueberries fresh Beans green and wax fresh Image fresh	Turkey	0.03400	0.02270	Strawberries fresh	0.00105	0.13954
Fish freshwaterSugar refinedFish processed seafish0.008751.00000Apple pic fillingArtichokes freshApple sameApples areeAsparagus cannedAsparagus freshApples driedAvocados fresh0.00823Apples driedAvocados fresh0.00823Apples driedBeans baked and cannedBeans green and wax cannedApricots fresh0.033680.5901Bananas fresh0.033680.5901Berries other freshBeans green and wax freshBeans green and wax freshBlueberries frozenBects freshBeats freshBlueberries frozenBroccoll frozenFreshBlueberries frozenBroccoll freshCabbage Chinese freshCherries fresh0.016000.02941Brussels sprouts freshCherries freshCarrots freshCarrots freshCoconut freshCarrots freshCarrots freshCherries fresh0.010000.02272Grapes fresh0.010000.02273Grapes freshCorn freshCorn freshCuiting other freshCorn frozenImage freshGrapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn freshCorn freshLiemons fresh0.013000.02273Melons musk, cantaloupe freshCorn freshCorn freshMelons watermelons freshCorn freshCorn freshMelons watermelons freshCorn freshCarlot freshMelons watermelons freshLeuke freshC	Veal			Strawberries frozen		
Fish freshwater Sugar refined Image in the set of	Fish fresh and frozen seafish			Sugar maple		
Fish processed seafish 0.00875 1.00000 Apple pie filling Artichokes fresh Apples sauce Asparagus canned Apples aned Asparagus fresh 0.00825 0.22273 Beans green and wax canned Avocados fresh 0.00823 0.52273 Apples fresh 0.00245 0.27273 Beans baked and canned Beans green and wax canned Apricots canned Beans green and wax fresh Beans green and wax fresh Image: Stresh Bueberries canned Beans green and wax fresh Image: Stresh Image: Stresh Blueberries fresh 0.01600 0.02941 Brussels sprouts fresh Image: Stresh Cherries frozen Image: Stresh	Fish freshwater					
Apple pie fillingArtichokes freshApple sauceAsparagus cannedApples cannedAsparagus freshApples fresh0.00245Apples fresh0.00245Apples fresh0.00245Apples fresh0.00245Apples fresh0.00368Apricots cannedBeans green and wax cannedApricots freshBeans green and wax freshBananas fresh0.03368Blueberries cannedBeets freshBlueberries frozenBeets freshBlueberries frozenBroccoli freshBlueberries frozenBroccoli freshCherries fresh0.01600Blueberries frozenBrussels sprouts freshCherries freshCarbage freshCoranberries freshCarots freshFigs fresh0.01000Pruit dried0.01000Carots freshCarots freshGrapes freshConlowen freshCummer freshCorn forzenGrapes freshConlowen freshLimes freshConlowen freshLimes fresh0.01300Melons musk, cantaloupe freshCorn freshMelons watermelons freshCumbers freshMelons, winter melons freshLeeks freshMelons watermelons freshLeeks freshMelons watermelons freshLeeks freshMelons watermelons fre		0.00875	1 00000	-		
Apple sarceAsparagus cannedApples driedAsparagus fresh0.008230.52273Beans fresh0.002450.27273Beans davd and anned0.008230.52273Apples fresh0.002450.27273Beans dry0.008230.52273Apples freshDeans green and wax freshDeans green and wax fresh0.008230.52273Apricots cannedBeans green and wax freshDeans green and wax fresh0.008230.52273Bananas fresh0.033680.59091Beans green and wax freshDeets canned0.008230.52273Blueberries freshDeets cannedDeets canned <td< td=""><td></td><td>0.00875</td><td>1.00000</td><td></td><td></td><td></td></td<>		0.00875	1.00000			
Apples canned Asparagus fresh 0.00823 0.52273 Apples fresh 0.00245 0.27273 Beans baked and canned Deams dry Apples fresh 0.00245 0.27273 Beans dry Deams dry Deams dry Apricots canned Beans green and wax canned Beans green and wax fresh Deams fresh Deams green and wax fresh						
Apples driedAvocados fresh0.008230.52273Apples frozenBeans dryBeans dryBeans dryBeans dryApricots rannedBeans green and wax cannedBeans green and wax freshImage and wax freshImage and wax freshBananas fresh0.033680.59091Beans green and wax frozenImage and wax freshImage and wax freshBueberries charnedBilueberries freshBeets green and wax frozenImage and wax frozenImage and wax frozenBlueberries freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenBlueberries fresh0.016000.02941Brussels sprouts frozenImage and wax frozenImage and wax frozenCherries fresh0.016000.02941Brussels sprouts frozenImage and wax frozenImage and wax frozenCorout freshImage and wax freshImage and wax frozenImage and wax frozenImage and wax frozenCranberries freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenCranberries freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenGrapes freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenGrapes freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenGrapes freshImage and wax frozenImage and wax frozenImage and wax frozenImage and wax frozenGrapes freshImage						
Apples fresh0.002450.27273Beans baked and cannedApples frozenBeans green and wax cannedApricots cannedBeans green and wax cannedApricots freshBeans green and wax freshBananas fresh0.033680.59091Berries other freshBeans green and wax freshBlueberries frozenBeans green and wax freshBlueberries frozenBroccoli freshBlueberries fresh0.016000.02941Brussels sprouts freshBroccoli freshCherries fresh0.016000.02941Cherries freshCabbage Chinese freshCoront freshCarrots cannedCoront freshCarrots cannedFigs freshCarrots freshFruit dried0.010000.02273Grapes freshCorn flour and mealKiwi freshCorn flour and mealLimes freshCorn freshKiwi freshCorn freshMelons watermelons freshCurumbers freshMelons watermelons freshEgglant freshMelons, winter melons freshLeeks freshMelons, winter melons freshLeeks freshMelons, winter melons freshLeets freshPapayas fresh0.00134Oranges freshLima beans frozenMandarins freshLeiture fresh<					0.00000	0.50070
Apples frozenBeans dryApricots cannedBeans green and wax cannedApricots freshBeans green and wax freshBanans fresh0.03368Banans fresh0.03368Banans freshBeans green and wax frozenBarries other freshBeens green and wax frozenBlueberries cannedBeets cannedBlueberries freshBotto 0.02941Blueberries freshBroccoli freshBlueberries fresh0.01600Cherries fresh0.01600Cherries fresh0.01600Cherries fresh0.01600Cherries freshCalbage Chinese freshCoconut freshCabbage Chinese freshCoranberries freshCarrots cannedCarots freshCarrots freshCranberries freshCarrots freshCranberries freshCauliflower freshCarrots freshCauliflower freshGrape freshCorn frozenGrape freshCorn frozenGuava and mangoes freshCorn frozenKiwi freshCorn frozenLimes fresh0.01300Lemons freshCucumbers freshMelons wak, cantaloupe fresh0.01300Melons wakter melons freshLettuce freshMelons water melons freshLettuce freshMelons, winter melons freshLettuce freshMelons, wint		0.000.45	0.07070		0.00823	0.52273
Apricots cannedBeans green and wax cannedApricots freshBeans green and wax freshBanaas fresh0.033680.59091Berries other freshBeets GranedBlueberries cannedBeets freshBlueberries fresh0.016000.02941Brussels sprouts freshBrussels sprouts freshCherries frozenBrussels sprouts freshCherries fresh0.016000.02941Brussels sprouts freshCabbage Chinese freshCoconut freshCabbage freshCarnots freshCarrots cannedDates freshCarrots freshFruit dried0.001610.22727Grapes freshCalliflower frozenKiwi freshCorn flour and mealLimes freshCorn freshLimes freshCorn freshLimes fresh0.013000.02273Melons wak, cantaloupe freshCorn freshLimes freshCorn freshLimes fresh0.013000.02273Melons wak, cantaloupe freshCorn freshMelons waker melons freshLeeks freshMelons, winter melons freshLeeks freshMelons,		0.00245	0.27273			
Apricots freshBeans green and wax freshBananas fresh0.033680.59091Beans green and wax frozenBerries other freshBeets cannedBeets cannedBlueberries freshBroccoli freshBroccoli frozenCherries fresh0.016000.02941Brussels sprouts freshCherries fresh0.016000.02941Brussels sprouts frozenCherries fresh0.016000.02941Brussels sprouts freshCherries fresh0.016000.02941Brussels sprouts frozenCitrus other freshCabbage Chinese freshCarots cannedCocoutt freshCarots cannedCarots frozenFreish freshCarrots frozenCarots frozenFreish freshCarots frozenCauliflower freshGrapes fresh0.010000.22727Cauliflower freshGuava and mangoes freshCorn four and mealCorn freshLimes freshCorn freshCorn freshLimes freshCorn freshCorn freshLimes fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Melons water melons freshKohrabi freshGarlic freshMelons, winter melons freshLeeks freshCarlots freshMelons, winter melons freshLeeks freshLeets freshOranges fresh0.013400.13636Lima beans frozenMelons, winter melons freshLeets freshLeets freshPapayas fresh0.001340.13636Lima beans frozen						
Bananas fresh0.033680.59091Beans green and wax frozenBerries other freshBeets cannedBeets cannedBlueberries frozenBroccoli freshBroccoli freshBlueberries frozenBroccoli freshBroccoli frozenCherries frozenBrossels sprouts freshCabbage Chinese freshCitrus other freshCabbage Chinese freshCarots cannedCoconut freshCarrots cannedCarrots freshCarberries freshCarrots freshCarots freshFigs freshCarrots freshCarlots freshFigs freshCarrots freshCarlots freshGrapes fresh0.010000.02273Grapes freshCorn flower freshCorn flower freshLimes freshCorn frozenCorn flower freshLimes freshCorn frozenCorn frozenMadarins fresh0.013000.02273Melons water melons freshO.013000.02273Melons water melons freshLeeks freshCorn freshMelons, winter melons freshLeeks freshCarlot freshMelons, winter melons freshLeeks freshLeeks freshMelons, winter melo				-	,	
Berries other freshBeets cannedBlueberries cannedBeets freshBlueberries frozenBroccoli freshBlueberries frozenBroccoli frozenCherries frozenBrussels sprouts freshCherries frozenBrussels sprouts freshCitrus other fresh0.01600Coconut freshCabbage Chinese freshCoconut freshCabbage freshCoranberries freshCarrots cannedDates freshCarrots freshFruit dried0.010000.02273Califlower freshGrapes fresh0.01000Grapes freshCon cannedGrapes fresh0.01000Guava and mangoes freshCorn four and mealLimes freshCorn freshLimes freshCorn freshLimes fresh0.01300Melons wakr, cantaloupe freshColo2273Melons wakr melons freshKohlrabi freshMelons watermelons freshLettuce freshNectarines fresh0.00134Oranges freshLima beans frozenMelons, winter melons freshMandarins freshMelons, winter melons freshLettuce freshMetors, winter melons freshManioc freshMetors, winter melons freshManio freshMetors, winter melons freshLettuce freshMetors, freshLettuce fresh<				-		
Blueberries canned Beets fresh Blueberries fresh Broccoli fresh Blueberries frozen Broccoli frozen Cherries frozen Brussels sprouts fresh Cherries frozen Brussels sprouts frozen Citrus other fresh Cabbage Chinese fresh Cocoutt fresh Cabbage Chinese fresh Cocout fresh Cabbage Chinese fresh Corout fresh Carrots canned Dates fresh Carrots frozen Frig fresh Carrots frozen Fruit dried 0.00461 0.22727 Grape fresh Couliflower fresh Guava and mangoes fresh Corn canned Kiwi fresh Corn frozen Limes fresh Corn fresh Limes fresh 0.01300 0.02273 Melons musk, cantaloupe fresh 0.01300 0.02273 Melons watermelons fresh Corn fresh Cucumbers fresh Nectarines fresh 0.01300 0.02273 Begplant fresh Corn fresh Eets fresh Melons, winter melons fresh Kohlrabi fresh Corn fresh Nectarines fresh 0.00134 0.13636		0.03368	0.59091	-		
Blueberries freshBroccoli freshBlueberries frozenBroccoli frozenCherries frozenBrussels sprouts freshCherries frozenBrussels sprouts freshCitrus other freshCabbage Chinese freshCoconut freshCabbage freshCoconut freshCarrots cannedDates freshCarrots frozenFrigs freshCarrots frozenFruit dried0.004610.22727Calliflower freshGrapes fresh0.01000Guava and mangoes freshCorn cannedKiwi freshCorn frozenLimes freshCorn freshLimes freshCorn freshLimes freshCorn freshLimes fresh0.01300Melons watermelons fresh0.01300Melons watermelons freshKohlabi freshMelons watermelons freshCancis freshMelons watermelons freshLeetuce freshNectarines fresh0.00134Oranges freshLittue freshPapayas fresh0.00134Manioc freshLittue freshManioc freshLittue freshManioc freshLittue fresh						
Blueberries frozen Broccoli frozen Cherries frozen Brussels sprouts fresh Citrus other fresh Cabbage Chinese fresh Coconut fresh Cabbage fresh Cornberries fresh Carrots canned Dates fresh Carrots fresh Frigs fresh Carrots fresh Frigs fresh Carrots fresh Grapefruit fresh Califlower fresh Grapes fresh 0.01000 Grapes fresh 0.01000 Kiwi fresh Corn canned Limes fresh Corn frozen Kiwi fresh Corn frozen Limes fresh Corn frozen Madarins fresh Col1300 Melons musk, cantaloupe fresh 0.01300 Melons watermelons fresh Corna fresh Melons, winter melons fresh Leeks fresh Nectarines fresh 0.00134 Oranges fresh 0.00134 Oranges fresh Corna forzen Melons, winter melons fresh Leeks fresh Melons, winter melons fresh Leeks fresh Nectarines fresh 0.00134 Oranges fresh 0.00134 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
Cherries fresh0.016000.02941Brussels sprouts freshCherries frozenBrussels sprouts frozenCitrus other freshCabbage Chinese freshCoconut freshCabbage freshCabbage freshCranberries freshCarrots cannedCarrots freshDates freshCarrots frozenCarrots frozenFruit dried0.004610.22727Cauliflower freshGrapefruit freshCarrots frozenCarrots freshGrapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn flour and mealCorn flour and mealLimes freshCorn frozenCucumbers freshLimes freshCucumbers fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Eggplant freshMelons watermelons freshCucumbers freshCucumbers freshMelons, winter melons freshLeeks freshLeeks freshNectarines fresh0.001340.13636Lima beans frozenPapayas fresh0.001340.13636Lima beans frozen						
Cherries frozenBrussels sprouts frozenCitrus other freshCabbage Chinese freshCoconut freshCabbage freshCranberries freshCarrots cannedDates freshCarrots frozenFigs freshCarrots frozenFruit dried0.00461Option freshCauliflower freshGrape fresh0.01000Grapes fresh0.01000Guava and mangoes freshCorn cannedKiwi freshCorn flour and mealLemons freshCorn frozenLimes fresh0.01300Mandarins fresh0.01300Melons watermelons fresh0.01300Melons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.00134Mandor freshLeettuce freshMelons, winter melons freshLeettuce freshMelons, winter melons freshManica freshMelons, winter melons freshManica freshMelons freshManica fresh </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
Citrus other freshCabbage Chinese freshCoconut freshCahbage freshCranberries freshCarrots cannedDates freshCarrots freshFigs freshCarrots frozenFruit dried0.004610.22727Cauliflower freshGrape fruit fresh0.01000Grapes fresh0.01000Guava and mangoes freshCorn cannedKiwi freshCorn flour and mealLemons freshCorn frozenMandarins fresh0.01300Melons watermelons fresh0.01300Melons, winter melons freshCon0134Nectarines fresh0.00134Oranges fresh0.00134Manioc freshLima beans frozenManioc freshManioc freshManioc freshManioc fresh		0.01600	0.02941			
Coconut freshCabbage freshCranberries freshCarots cannedDates freshCarrots cannedPreshCarrots freshFigs freshCarrots freshFruit dried0.004610.22727Cauliflower freshGrapefruit fresh0.01000Grapes fresh0.01000Guava and mangoes freshCorn cannedLimes freshCorn flour and mealLemons freshCorn freshLimes fresh0.01300Mandarins fresh0.01300Melons watermelons freshCorn freshMelons, winter melons freshCorn SireshMelons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.00134Mandari freshLeettice freshMelons, winter melons freshLeettice freshMelons, winter melons freshLeettice freshMelons, winter melons freshManioc freshMelons freshManioc fresh						
Cranberries freshCarrots cannedDates freshCarrots cannedFigs freshCarrots freshFruit dried0.004610.22727Cauliflower freshGrapefruit freshCauliflower frozenGrapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn cannedKiwi freshCorn flour and mealLemons freshCorn freshLimes fresh0.01300Mandarins fresh0.01300Melons watermelons freshCorn300Melons, winter melons freshCarlit freshMelons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.01306Diagnational freshLeeks freshMelons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.013636Papayas freshManioc fresh						
Dates freshCarrots freshFigs fresh0.004610.22727Grapefruit fresh0.004610.22727Grapefruit fresh0.010000.02273Grapes fresh0.010000.02273Guava and mangoes fresh0.010000.02273Guava and mangoes freshCorn cannedImage freshKiwi freshCorn flour and mealImage freshLemons freshCorn freshCorn frozenMandarins fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Melons watermelons fresh0.013000.02273Melons, winter melons freshLeeks freshImage freshNectarines fresh0.001340.13636Papayas fresh0.001340.13636Papayas freshManioc freshImage fresh				Cabbage fresh		
Figs freshCarrots frozenFruit dried0.004610.22727Cauliflower freshGrapefruit freshCauliflower frozenCauliflower frozenGrapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn cannedCorn cannedKiwi freshCorn flour and mealCorn freshLemons freshCorn frozenCorn frozenMandarins fresh0.013000.02273Eggplant freshMelons musk, cantaloupe fresh0.013000.02273Eggplant freshMelons watermelons freshKohlrabi freshCorn freshMelons, winter melons freshLeeks freshLeeks freshNectarines fresh0.001340.13636Lima beans frozenPapayas freshManioc freshManioc fresh	Cranberries fresh			Carrots canned		
Fruit dried0.004610.22727Cauliflower freshGrapefruit fresh0.010000.02273Celery freshGuava and mangoes fresh0.010000.02273Celery freshGuava and mangoes freshCorn cannedCorn flour and mealLemons freshCorn freshCorn freshLimes fresh0.013000.02273Mandarins fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Melons watermelons freshCorn freshGarlic freshMelons, winter melons freshLettuce freshLettuce freshNectarines fresh0.001340.13636Papayas freshManioc freshLima beans frozen						
Grapefruit freshCauliflower frozenGrapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn cannedCorn cannedKiwi freshCorn flour and mealCorn freshLemons freshCorn frozenCorn frozenMandarins freshCorn frozenCucumbers freshMelons musk, cantaloupe fresh0.013000.02273Melons watermelons freshCorn freshCucumbers freshMelons, winter melons freshCorn freshCucumbers freshNectarines fresh0.001340.13636Papayas freshManioc freshLima beans frozen	Figs fresh			Carrots frozen		
Grapes fresh0.010000.02273Celery freshGuava and mangoes freshCorn cannedKiwi freshCorn flour and mealLemons freshCorn freshLimes freshCorn frozenMandarins fresh0.01300Melons musk, cantaloupe fresh0.01300Melons other fresh0.01300Melons, winter melons freshEggplant freshMelons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.00134Manioc freshManioc fresh	Fruit dried	0.00461	0.22727	Cauliflower fresh		
Guava and mangoes freshCorn cannedKiwi freshCorn flour and mealLemons freshCorn freshLimes freshCorn frozenMandarins freshCucumbers freshMelons musk, cantaloupe fresh0.01300Melons other fresh0.01300Melons watermelons freshGarlic freshMelons, winter melons freshLettuce freshNectarines fresh0.00134Oranges fresh0.00134Mandarins freshManioc fresh	Grapefruit fresh			Cauliflower frozen		
Kiwi freshCorn flour and mealLemons freshCorn freshLimes freshCorn frozenMandarins freshCucumbers fresh0.01300Melons musk, cantaloupe fresh0.013000.02273Melons other fresh0.013000.02273Melons watermelons freshGarlic freshImabeMelons, winter melons freshLettuce freshImabeNectarines fresh0.001340.13636Lima beans frozenPapayas freshManioc freshManioc fresh	Grapes fresh	0.01000	0.02273	Celery fresh		
Lemons freshCorn freshLimes freshCorn frozenMandarins freshCucumbers fresh0.01300Melons musk, cantaloupe fresh0.013000.02273Melons other fresh0.013000.02273Melons watermelons freshGarlic freshMelons, winter melons freshLeeks freshNectarines fresh0.00134Oranges fresh0.00134Papayas freshManioc fresh	Guava and mangoes fresh			Corn canned		
Limes freshCorn frozenMandarins fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Melons other fresh0.013000.02273Melons watermelons freshGarlic freshMelons, winter melons freshKohlrabi freshNectarines fresh0.00134Oranges fresh0.00134Oranges freshManioc fresh	Kiwi fresh			Corn flour and meal		
Mandarins freshCucumbers fresh0.013000.02273Melons musk, cantaloupe fresh0.013000.02273Eggplant freshMelons other freshGarlic freshGarlic freshMelons, winter melons freshKohlrabi freshMetarines freshLeeks freshOranges fresh0.00134Onages freshManioc fresh	Lemons fresh			Corn fresh		
Melons musk, cantaloupe fresh 0.01300 0.02273 Eggplant fresh Melons other fresh Garlic fresh Garlic fresh Melons, water melons fresh Kohlrabi fresh Leeks fresh Nectarines fresh 0.00134 0.13636 Lima beans frozen Oranges fresh 0.00134 0.13636 Lima beans frozen	Limes fresh			Corn frozen		
Melons other freshGarlic freshMelons watermelons freshKohlrabi freshMelons, winter melons freshLeeks freshNectarines freshLettuce freshOranges fresh0.00134Onages freshManioc fresh	Mandarins fresh			Cucumbers fresh	0.01300	0.02273
Melons watermelons fresh Kohlrabi fresh Melons, winter melons fresh Leeks fresh Nectarines fresh Lettuce fresh Oranges fresh 0.00134 0.13636 Papayas fresh Manioc fresh	Melons musk, cantaloupe fres	h 0.01300	0.02273	Eggplant fresh		
Melons, winter melons fresh Leeks fresh Nectarines fresh Lettuce fresh Oranges fresh 0.00134 0.13636 Papayas fresh Manioc fresh	Melons other fresh			Garlic fresh		
Nectarines fresh Lettuce fresh Oranges fresh 0.00134 0.13636 Papayas fresh Manioc fresh	Melons watermelons fresh			Kohlrabi fresh		
Oranges fresh 0.00134 0.13636 Lima beans frozen Papayas fresh Manioc fresh	Melons, winter melons fresh			Leeks fresh		
Papayas fresh Manioc fresh	Nectarines fresh			Lettuce fresh		
Papayas fresh Manioc fresh	Oranges fresh	0.00134	0.13636	Lima beans frozen		
Peaches canned Mushrooms canned	Papayas fresh			Manioc fresh		
	Peaches canned			Mushrooms canned		



Food or Beverage Con	centration (μg/g)	DF	Food or Beverage	Concentration (µg/g)	DF
Mushrooms fresh			Milk buttermilk		
Okra fresh			Milk chocolate drink		
Olives fresh			Milk concentrated skim		
Onions and shallots fresh			Milk concentrated whole		
Parsley fresh			Milk other whole milk produ	ucts	
Parsnips fresh			Milk partly skimmed 2%		
Peas canned			Milk skim		
Peas dry			Milk standard	0.00027	0.09091
Peas fresh			Milk sweetened concentrate	d skim	
Peas frozen			Milkshake		
Peppers fresh			Powder buttermilk		
Potatoes chips	0.00216	0.34091	Powder skim milk		
Potatoes frozen			Powder whey		
Potatoes other processed			Sherbet		
Potatoes sweet fresh			Yogurt		
Potatoes white fresh	0.01400	0.02273	Cereal products	0.00027	0.02273
Potatoes white fresh and			Oatmeal and rolled oats		
processed			Peanuts	0.00252	0.36364
Pumpkins and squash fresh	0.01400	0.02273	Pot and pearl barley	0.00252	0.0000
Radishes fresh	0.02300	0.02500	Pulses and nuts		
Rappini fresh			Rice		
Rutabagas and turnip fresh			Rye flour		
Spinach fresh			Tree nuts		
Spinach frozen			Wheat flour		
Tomatoes canned			Ale, beer, stout and porter		
Tomatoes fresh	0.00389	0.29546	Beverages alcoholic		
Tomatoes pulp, paste and puree			Coffee		
Vegetables other edible root fresh			Distilled spirits		
Vegetables other leguminous fresh	1		Juice apple	0.0160	0.02273
Vegetables unspecified canned			Juice grape	0.0100	0.02270
Vegetables unspecified fresh			Juice tomato		
Vegetables unspecified frozen			Juice fruit	0.00525	0.50000
Butter	0.00320	0.36364	Juice grapefruit	0.01900	0.02273
Cheese cheddar	0.00250	0.20455	Juice lemon	0.01500	0.02270
Cheese cottage			Juice orange	0.00170	0.22727
Cheese processed	0.00073	0.15909	Juice pineapple	0.00170	V.LE/ E/
Cheese variety	0.00218	0.29546	Juice vegetable		
Cream cereal 10%			Soft drinks	0.00536	0.25000
Cream sour	0.00157	0.18182	Tea	0.00530	0.25000
Cream table 18%			Water bottled	0.00275	0.50000
Cream whipping 32% or 35%			Wines	0.00275	0.50000
Eggs			Сосоа		
lce cream	0.00118	0.18182			
Ice cream Ice milk	0.00118	0.18182			



2. Data quality for lifetime excess cancer risk estimates

Only publicly available data were used to calculate these indicators. Data that are not publicly available may produce different results.

No systematic method for measuring data quality was possible, so we provide the following assessments of how well the data used may represent the actual Canadian average levels. Quality is rated higher when there are data from a number of Canadian monitors, or from Canadian studies that show results similar to other comparable studies. Quality is rated lower when data from few monitors or studies were available, and lowest when estimates are based on non-Canadian data. Others may rate data quality differently.

Exposure Pathway	Data Quality	Notes
Outdoor air	High	 Benzene is regularly measured in outdoor air at 53 monitoring stations across Canada using accepted protocols.
Indoor air	High	 The 2009-2011 Canadian Health Measures Survey provides a nationally representative sample of benzene in indoor air across Canada. The mean level reported is lower than those of three other Canadian studies identified (Halifax NS, Regina SK, and Windsor ON).
Drinking water	Moderate	 Trace amounts of benzene were detected in 2 of 342 samples from the Ontario Drinking Water Surveillance Program in 2011, given a detection limit of 0.05 μg/L. A national review of drinking water data by Health Canada reported infrequent detection of higher levels. Potential lifetime excess cancer risk could be much higher if source water is contaminated from leaking fuel storage tanks.
Foods and beverages	Very Low	 No Canadian data on concentration of benzene in foods and beverages were identified. Data from the US-FDA (TDS-2003-2004) were used for this estimate. The potential lifetime excess cancer risk is above 1 per million due to older data showing benzene in some soft drinks containing benzoate. Many soft drinks no longer contain benzoate.



3. Data for mapping concentrations

The maps use geographic coordinates at the census block level to represent residential locations. Concentration estimates are mapped at the health region level, which are created with aggregated census block data.

We used a model to predict annual average concentrations of benzene in outdoor air at residential locations for 2011. These are predicted using levels measured from the National Air Pollution Surveillance (NAPS) monitors and estimated concentrations from known emitters. For more information on how these estimates were created, please see the Mapping Methods document on the Environmental Approach section of our website.

Estimates by health region

The table below shows predicted benzene concentrations by province based on data at the health region level. The median concentration of benzene measured in outdoor air in 2011 at the health region level was 0.608 μ g/m³, while the mean concentration was 0.742 μ g/m³. Concentrations of benzene can be higher or lower than average in many locations.

i. Provincial averages of predicted benzene concentrations ($\mu g/m^3$) in outdoor air in 2011 based on health regions

Province	Median	Mean
ВС	0.630	0.864
AB	0.574	0.838
SK	0.423	0.476
MB	0.481	0.673
ON	0.714	0.826
QC	0.678	0.800
NB	0.493	0.571
PE	0.583	0.583
NS	0.603	0.705
NL	0.681	0.697
ҮК	0.412	0.412
NT	0.477	0.477
NU	0.560	0.560
Canada	0.608	0.742

Estimates by census block

The table below shows provincial populations by concentration levels (either annual average or number of times above/below the national average) based on the census block data and the associated potential lifetime excess risk given different cancer potency factors.



i. Provincial population distribution by estimated average concentration (µg/m³) of benzene in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m ³)	Less than 0.28	0.28 to 0.34	0.34 to 0.42	0.42 to 0.56	0.56 to 0.84	0.84 to 1.26	1.26 to 1.68	1.68 to 2.10	2.10 to 2.52	More than 2.52
Compared to national average (0.84 µg/m ³)*	>3x lower	2.5 to 3x lower	2 to 2.5x lower	1.5 to 2x lower Below A	1 to 1.5x Iower verage	1 to 1.5x higher <u>Above A</u>	1.5 to 2x higher verage	2 to 2.5x higher	2.5 to 3x higher	> 3.0x higher
BC	225.775	392.834	115,398	808,588	1,238,014	920,991	346,144	50,856	149,941	151,516
50	(5.1%)	(8.9%)	(2.6%)	(18.4%)	(28.1%)	(20.9%)	(7.9%)	(1.2%)	(3.4%)	(0.3%)
AB		458,044 (12.6%)	165,975 (4.6%)	70,101 (1.9%)	1,013,503 (27.8%)	1,184,894 (32.5%)	580,795 (15.9%)	120,381 (3.3%)	24,568 (0.7%)	26,996 (0.7%)
SK	2,577 (0.2%)	231,131 (22.4%)	98,342 (9.5%)	60,151 (5.8%)	114,210 (11.1%)	356,865 (34.5%)	151,358 (14.6%)	14,565 (1.4%)	1,997 (0.2%)	2,185 (0.2%)
MB		230,030 (19.0%)	66,560 (5.5%)	258,640 (21.4%)	493,903 (40.9%)	117,745 (9.7%)	37,518 (3.1%)	2,639 (0.2%)	741 (0.1%)	492 (<0.1%)
ON	238,584 (1.9%)	1,060,711 (8.2%)	614,640 (4.8%)	2,676,711 (20.8%)	3,837,757 (29.9%)	3,280,694 (25.5%)	890,817 (6.9%)	174,597 (1.4%)	46,619 (0.4%)	30,691 (0.2%)
QC	375,566 (4.8%)	904,378 (11.4%)	488,257 (6.2%)	807,073 (10.2%)	1,738,659 (22.0%)	1,904,902 (24.1%)	1,235,596 (15.6%)	218,977 (2.8%)	141,499 (1.8%)	88,094 (1.1%)
NB	14,348 (1.9%)	225,190 (30.0%)	31,476 (4.2%)	13,473 (1.8%)	3,142 (0.4%)	293,932 (39.1%)	103,739 (13.8%)	27,800 (3.7%)	21,537 (2.9%)	16,534 (2.2%)
NS	24,597 (2.7%)	267,564 (29.0%)	42,468 (4.6%)	10,969 (1.2%)	368,968 (40.0%)	166,878 (18.1%)	35,979 (3.9%)	2,920 (0.3%)	481 (<0.1%)	903 (0.1%)
PE		51,742 (36.9%)	5,221 (3.7%)	1,441 (1.0%)	668 (0.5%)	50,908 (36.3%)	28,728 (20.5%)	705 (0.5%)	416 (0.3%)	375 (0.3%)
NL		162,864 (31.7%)	46,301 (9.0%)	135,806 (26.4%)	108,649 (21.1%)	39,928 (7.8%)	19,380 (3.8%)	576 (0.1%)	671 (0.1%)	361 (<0.1%)
NU	0 (<0.1%)	11,495 (3.6%)	12,779 (40.1%)	4,728 (14.8%)	2,820 (8.8%)	74 (0.2%)	10 (<0.1%)			
NT		12,056 (29.1%)	5,243 (12.6%)	2,564 (6.2%)	2,099 (5.1%)	9,580 (23.1%)	8,141 (19.6%)	1,779 (4.3%)	0 (<0.1%)	0 (<0.1%)
YT		6,162 (18.1%)	1,223 (3.6%)	439 (1.3%)	20 (0.1%)	14,383 (42.4%)	9,583 (28.3%)	1920 (5.7%)	122 (0.4%)	45 (0.1%)
CANADA	881,447	4,014,201	1,693,883	4,850,684	8,922,412	8,341,774	3,477,788	617,715	388,592	318,192
% of pop.	(2.6%)	(12.0%)	(5.1%)	(14.5%)	(26.7%)	(24.9%)	(103%)	(1.8%)	(1.2%)	(1.0%)

ASSOCIATED LIFETIME EXCESS CANCER RISK (per million people): RED = POTENTIAL LIFETIME EXCESS RISK IS GREATER THAN 1 PER MILLION PEOPLE

Health Canada CPF: 0.0145	< 0.09	0.09 to < 0.11	0.11 to < 0.14	0.14 to < 0.19	0.19 to < 0.28	0.28 to < 0.42	0.42 to < 0.56	0.56 to < 0.7	0.7 to < 0.84	> 0.84
California OEHHA CPF: 0.1	< 0.65	0.65 to < 0.78	0.78 to < 0.97	0.97 to < 1.29	1.29 to < 1.94	1.94 to < 2.91	2.91 to < 3.88	3.88 to < 4.85	4.85 to < 5.82	> 5.82
US EPA CPF: 0.0273	< 0.18	0.18 to < 0.21	0.21 to < 0.27	0.27 to < 0.35	0.35 to < 0.53	0.53 to < 0.80	0.80 to < 1.06	1.06 to < 1.33	1.33 to < 1.59	> 1.59

* measured at National Air Pollution Surveillance (NAPS) monitors in 2011 CPF: Cancer Potency Factor