1,3-Butadiene

Environmental estimates (circa 2011): Supplemental data

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1. Data for lifetime excess cancer risk estimates

Overview

The summary data used to calculate lifetime excess cancer risk and the results for 1,3-butadiene are provided in the tables below. For more detailed information on supporting data and sources, see below for each exposure pathway.

i. Environmental Concentrations

Exposure pathway	Units	Average	Maximum	Notes
Outdoor air	µg/m³	0.073	1.2	
Indoor air	µg/m³	0.2	4.2	No wood burning present, could be higher in homes with wood burning appliances
Drinking water	µg/L	Insufficient data		
Foods and beverages		Insufficient data		

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.0000017	0.000028
Indoor air	0.000065	0.001364
Drinking water	Insufficient data	
Foods and beverages	Insufficient data	

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	--	0.105	0.6
Ingestion	--	--	3.4

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	--	0.177	1.01	16.66
Indoor air	--	6.82	38.98	818.67
Drinking water	Insufficient data			
Foods and beverages	Insufficient data			

[1]Lifetime excess cancer risk based on average intake x cancer potency factor from each agency
[2]Lifetime excess cancer risk based on maximum intake x highest cancer potency factor
[3]California 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	0.012	1.2	0.073	1.0

DF = Detection frequency

We assume 1,3-butadiene 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;
4. 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:	Health Canada (2012)					Location:	Halifax, NS			
Samples (n)	**DF***	**DL****	**Sample Date**	**Units**	**Sample Duration**	**Min**	**Max**	**Mean (AM)**	**Med**	**Geomean (GM)**	**Percentile**
331	0.834	0.022	2009 summer	µg/m³	24hr	<DL	0.808	0.063	0.040	0.044	25th 0.028 75th 0.064 90th 0.104 95th 0.160
312	0.984		winter			<DL	7.293	0.183	0.070	0.088	25th 0.047 75th 0.130 90th 0.263 95th 0.393

*DF = Detection frequency
**DL = Detection limit

Rank: 1	Author:	Health Canada (2010)					Location:	Regina, SK			
Samples (n)	**DF***	**DL****	**Sample Date**	**Units**	**Sample Duration**	**Min**	**Max**	**Mean (AM)**	**Med**	**Geomean (GM)**	**Percentile**
105	0.686	0.050	2007 Summer	µg/m³	24hr	0.025	9.177	0.285	0.070	0.083	25th 0.025 75th 0.137 90th 0.405 95th 1.190
101	0.812				5 day	0.025	9.003	0.353	0.077	0.101	25th 0.053 75th 0.155 90th 0.445 95th 1.877
105	0.971		winter		24hr	0.025	5.787	0.453	0.163	0.212	25th 0.097 75th 0.437 90th 0.947 95th 1.750
89	1.0				5 day	0.053	4.477	0.477	0.177	0.229	25th 0.100 75th 0.393 90th 1.317 95th 2.143

*DF = Detection frequency
**DL = Detection limit

Rank: 1 Author: Health Canada (2010) Location: Windsor, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
217	0.917	0.055	2005 summer	µg/m^3	24hr	0.027	0.900	0.136	0.105	0.108	25th 0.075 75th 0.155 90th 0.263 95th 0.325
232	0.935		winter			0.027	2.833	0.168	0.120	0.125	25th 0.080 75th 0.180 90th 0.280 95th 0.340
211	0.929	0.043	2006 summer		24hr	0.021	0.893	0.119	0.087	0.092	25th 0.063 75th 0.140 90th 0.217 95th 0.310
224	0.933		winter			0.021	1.033	0.103	0.177	0.102	25th 0.070 75th 0.140 90th 0.213 95th 0.320

*DF = Detection frequency
**DL = Detection limit

Rank: 1 Author: Stocco (2008) Location: Windsor, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
48		0.006	2005	µg/m^3	5 days					0.13	
48										0.11	

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

Rank: 1 Author: Zhu (2005) Location: Ottawa, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
75		0.32	2002-2003	µg/m^3	1 day	0.16	3.65	0.5			50th 0.16 75th 0.47 90th 1.64

*DF = Detection frequency
**DL = Detection limit

Rank: 1 | **Author:** Health Canada (2010) | **Location:** Windsor, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
217	0.917	0.055	2005 summer	$\mu g/m^3$	24hr	0.027	0.900	0.136	0.105	0.108	25^{th} 0.075 75^{th} 0.155 90^{th} 0.263 95^{th} 0.325
232	0.935		winter			0.027	2.833	0.168	0.120	0.125	25^{th} 0.080 75^{th} 0.180 90^{th} 0.280 95^{th} 0.340
211	0.929	0.043	2006 summer		24hr	0.021	0.893	0.119	0.087	0.092	25^{th} 0.063 75^{th} 0.140 90^{th} 0.217 95^{th} 0.310
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Rank: 1 | **Author:** Stocco (2008) | **Location:** Windsor, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
48		0.006	2005	$\mu g/m^3$	5 days					0.13	
48										0.11	

Notes: Values listed in the following order: Winter, Summer
*DF = Detection frequency
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Rank: 1 | **Author:** Zhu (2005) | **Location:** Ottawa, ON

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
75		0.32	2002-2003	$\mu g/m^3$	1 day	0.16	3.65	0.5			50th 0.16 75th 0.47 90th 1.64

*DF = Detection frequency
**DL = Detection limit

Rank: 2 | **Author:** Johnson (2010) | **Location:** Detroit, MI

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
28		0.2	2006-2007	µg/m³	7 days	<0.1	3.3	0.4			25th 0.1 50th 0.3 75th 0.5 95th 1.1

*DF = Detection frequency
**DL = Detection limit

Rank: 2 | **Author:** Weisel (2008) | **Location:** New Jersey, NY

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
100		1.1 (48) 0.44 (52)	2003-2006	µg/m³	24h	<0.44		4.4			25th <1.1 50th <1.1 75th <1.1 90th<1.1 95th 1.30

*DF = Detection frequency
**DL = Detection limit

Rank: 3 | **Author:** Gustafson (2007) | **Location:** Hagfors, Sweden

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
14			Feb-	µg/m³	24-h			0.33	0.18		95th 0.12-0.54
13			March		24-h			0.38	0.2		95th 0.08-0.48
11			2003		7 days			0.31	0.23		95th 0.10-0.072
10					24-h			0.14	0.12		95th 0.06-0.23
10					24-h			0.11	0.1		95th 0.05-0.14
10					7 days			0.11	0.11		95th 0.06-0.17

Notes: Values listed in the following order: 1st 3 are wood burning homes, 2nd three are non-wood burning homes
*DF = Detection frequency
**DL = Detection limit

Rank: 4 | **Author:** Kim (2001) | **Location:** Birmingham, UK

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
6			1999-2000	µg/m³	8 hrs/day x3 days (32 samples)	0.3	10.8	1.7	0.7		
6						0.1	1.1	0.5	0.4		

Notes: Values listed in the following order: smoking homes, non-smoking homes
*DF = Detection frequency
**DL = Detection limit

Rank: 4	Author:	Sax (2006)					Location:	Los Angeles, New York			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
40		0.8	2000	$\mu g/m^3$	48h	ND	1.89	0.47	0.3		
40		0.068					1.47	0.41	0.34		
41		0.61	1999				5.25	0.97	0.75		
41		0.065					9.02	1.01	0.5		

Notes: Values listed in the following order: LA personal, LA inside home, NY personal, NY inside home
*DF = Detection frequency
**DL = Detection limit

Rank: 5	Author:	Graham (2004)					Location:	Ottawa, ON			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
11			Winters	$\mu g/m^3$	2 days	0.21	0.68	0.51	0.36		
17			1997			0.38	28.6	5.76	2.69		
17			&1998			21.8	166	82.8	84.7		
12						0.18	0.78	0.41	0.37		
10						0.51	1.16	0.73	0.75		
13						0.79	3.2	1.58	1.42		

Notes: Values listed in the following order: homes w/attached garages Cold-start pre-test, homes w/attached garages Cold-start house, homes w/attached garages Cold-start garage, homes w/attached garages Hot-soak pre-test, homes w/attached garages Hot-soak house, homes w/attached garages Hot-soak garage
*DF = Detection frequency
**DL = Detection limit

Rank: 5	Author:	Serrano-Trespalacios (2004)					Location:	Mexico City			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
30			1998-1999	$\mu g/m^3$	24-h		8.3	2.5	2	2	90th 4.7

*DF = Detection frequency
**DL = Detection limit

Rank: 5	Author:	Vainiotalo (2008)					Location:	Helsinki, Finland			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
10			2005-2006	$\mu g/m^3$	4-days x 5h	0.06	11.1	2.7		1.2	

Notes: restaurants – smoking & non-smoking areas
*DF = Detection frequency
**DL = Detection limit

Sources for indoor air data:

- Graham, L. A., Noseworthy, L, Fugler, D, O'Leary, K, Karman, D, and Grande, C, 1-5-2004. Contribution of Vehicle Emissions from an Attached Garage to Residential Indoor Air Pollution Levels. Air & Waste Management Association 54: 563-584.
- 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. Available online at http://www.healthcanada.gc.ca.
- Health Canada. 2010. Regina Indoor Air Quality Study (2007) : Data Summary for Volatile Organic Compound Sampling. Available online at http://www.healthcanada.gc.ca.
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- 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.
- 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.
- Serrano-Trespalacios PI, Ryan L, Spengler JD. 2004. Ambient, indoor and personal exposure relationships of volatile organic compounds in Mexico City Metropolitan Area. Journal of Exposure Analysis and Environmental Epidemiology 14: S118-S132.
- 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.
- Vainiotalo S, Vaananen V, Vaaranrinta R. 2008. Measurement of 16 volatile organic compounds in restaurant air contaminated with environmental tobacco smoke. Environmental Research 108: 280-288.
- Weisel CP, Alimokhtari S, Sanders PF. 2008. Indoor Air VOC Concentrations in Suburban and Rural New Jersey. Environmental Science & Technology 42: 8231-8238.
- 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

1,3-butadiene is not expected to be present in indoor dust in significant amounts.

iv. Drinking water

No recent data or studies were identified.

v. Food and Beverages

No recent data or studies were identified.

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	• 1,3-butadiene is regularly measured in outdoor air at 53 monitoring stations across Canada using accepted protocols.
Indoor air	Medium	• Recent studies were available for three locations in Canada (Halifax NS, Windsor ON, and Regina SK). Mean value represents an average of means reported in the Canadian studies. The annual mean concentration in Regina (0.39) is similar to levels measured in Detroit, MI and in wood burning homes in Sweden. Annual means in Halifax and Windsor (0.12 and 0.13) are similar to levels reported in non-wood burning homes in Sweden (2003).
Drinking water	Gap	• 1,3-butadiene was not measured in Ontario drinking water in 2011. No recent Canadian studies were identified.
Foods and beverages	Gap	• No Canadian or US data on concentrations of 1,3-butadiene in foods or beverages were identified.

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 1,3-butadiene 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 1,3-butadiene concentrations by province based on data at the health region level. The median concentration of 1,3-butadiene measured in outdoor air in 2011 at the health region level was 0.066 µg/m^3, while the mean concentration was 0.071 µg/m^3. Concentrations of 1,3-butadiene can be higher or lower than average in many locations.

i. Provincial averages of predicted 1,3-butadiene concentrations (µg/m^3) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	0.082	0.088
AB	0.066	0.067
SK	0.051	0.054
MB	0.053	0.062
ON	0.065	0.072
QC	0.075	0.079
NB	0.058	0.061
PE	0.062	0.062
NS	0.071	0.078
NL	0.046	0.045
YK	0.055	0.055
NT	0.040	0.040
NU	0.152	0.152
Canada	**0.066**	**0.071**

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 1,3-butadiene in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m³)	Less than 0.02	0.02 to 0.03	0.03 to 0.04	0.04 to 0.05	0.05 to 0.7	0.7 to 0.11	0.11 to 0.15	0.15 to 0.18	0.18 to 0.22	More than 0.22
Compared to national average (0.7 µg/m³)*	> 3x lower	2.5 to 3x lower	2 to 2.5x lower	1.5 to 2x lower	1 to 1.5x lower	1 to 1.5x higher	1.5 to 2x higher	2 to 2.5x higher	2.5 to 3x higher	> 3.0x higher
				Below Average		Above Average				
BC	672,422 (15.3%)	5,421 (0.1%)	8,462 (0.2%)	265,814 (6.0%)	1,053,320 (23.9%)	1,387,614 (31.5%)	285,378 (6.5%)	120,608 (2.7%)	67,195 (1.5%)	533,823 (12.1%)
AB	687,026 (18.8%)	3,941 (0.1%)	4,615 (0.1%)	6,140 (0.2%)	311,378 (8.5%)	2,220,035 (60.9%)	80,073 (2.2%)	65,170 (1.8%)	53,919 (1.5%)	212,960 (5.8%)
SK	380,121 (36.8%)	2,852 (0.3%)	5,284 (0.5%)	5,649 (0.5%)	125,665 (12.2%)	352,073 (34.1%)	56,083 (5.4%)	39,011 (3.8%)	21,246 (2.1%)	45,397 (4.4%)
MB	315,832 (26.1%)	1,692 (0.1%)	3,527 (0.3%)	2,030 (0.2%)	661,624 (54.8%)	109,889 (9.1%)	13,291 (1.1%)	29,047 (2.4%)	15,285 (1.3%)	56,051 (4.6%)
ON	1,793,925 (14.0%)	656,866 (5.1%)	481,832 (3.7%)	2,446,511 (19.0%)	4,557,453 (35.5%)	1,691,373 (13.2%)	282,952 (2.2%)	266,487 (2.1%)	143,249 (1.1%)	531,173 (4.1%)
QC	1,986,440 (25.1%)	20,421 (0.3%)	33,476 (0.4%)	1,402,397 (17.7%)	1,365,669 (17.3%)	1,517,410 (19.2%)	119,260 (1.5%)	1,130,969 (14.3%)	52,215 (0.7%)	274,744 (3.5%)
NB	270,563 (36.0%)	2,140 (0.3%)	44,963 (6.0%)	11,009 (1.5%)	84,229 (11.2%)	280,925 (37.4%)	17,056 (2.3%)	10,416 (1.4%)	9,902 (1.3%)	19,968 (2.7%)
NS	336,305 (36.5%)	1,879 (0.2%)	3,832 (0.4%)	5,813 (0.6%)	380,497 (41.3%)	166,976 (18.1%)	11,213 (1.2%)	5,216 (0.6%)	3,641 (0.4%)	6,355 (0.7%)
PE	56,774 (40.5%)	373 (0.3%)	420 (0.3%)	935 (0.7%)	727 (0.5%)	50,210 (35.8%)	15,539 (11.1%)	5,865 (4.2%)	2,805 (2.0%)	6,556 (4.7%)
NL	200,144 (38.9%)	1,959 (0.4%)	5,145 (1.0%)	12,978 (2.5%)	200,940 (39.1%)	54,387 (10.6%)	8,186 (1.6%)	8,293 (1..6%)	3,605 (0.7%)	18,899 (3.7%)
NU	23,292 (73.0%)	--	0 (<0.1%)	17 (0.1%)	358 (1.1%)	1,434 (4.5%)	2,379 (7.5%)	628 (2.0%)	807 (2.5%)	2,991 (9.4%)
NT	17,468 (42.1%)	244 (0.6%)	115 (15.4%)	318 (0.8%)	456 (1.1%)	961 (2.3%)	3,763 (9.1%)	7,964 (19.2%)	3,862 (9.3%)	6,311 (15.2%)
YT	7,664 (22.6%)	25 (0.1%)	48 (0.3%)	92 (0.3%)	40 (0.1%)	9,361 (27.6%)	1,355 (4.0%)	4,622 (13.6%)	3,417 (10.1%)	7,273 (21.5%)
CANADA	6,747,976	697,813	591,719	4,159,703	8,742,356	7,842,648	896,528	1,694,296	381,148	1,722,501
% of pop.	(20.2%)	(2.1%)	(1.8%)	(12.4%)	(26.1%)	(23.4%)	(26.8%)	(5.1%)	(1.1%)	(5.1%)

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

Health Canada CPF: No CPF										
California OEHHA CPF: 0.6	< 0.3	0.3 to < 0.4	0.4 to < 0.5	0.5 to < 0.7	0.7 to < 1.01	1.01 to < 1.51	1.51 to < 2.02	2.02 to < 2.53	2.53 to < 3.03	> 3.03
US EPA CPF: 0.1	< 0.06	0.06 to < 0.07	0.07 to < 0.09	0.09 to < 0.12	0.12 to < 0.18	0.18 to < 0.27	0.27 to < 0.35	0.35 to < 0.44	0.44 to < 0..53	> 0.53

* measured at National Air Pollution Surveillance (NAPS) monitors in 2011

CPF: Cancer Potency Factor