

Supplemental Information

Health risk assessment of ambient volatile organic compounds in a border city in Canada

Taraneh Mihankhah¹, Yushan Su^{2*}, Tianchu Zhang¹, Jonathan Wang², James Gilmore³, Michael Noble², Anthony Munoz², Chris Charron², Xiaohong Xu^{1*}

¹ Department of Civil and Environmental Engineering, University of Windsor, Windsor, ON N9B 3P4, Canada

² Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment, Conservation and Parks, Toronto, ON M9P 3V6, Canada

³ Technical Assessment and Standards Development Branch, Ontario Ministry of the Environment, Conservation and Parks, Toronto, ON M4V 1M2, Canada

* Correspondance: yushan.su@ontario.ca, xxu@uwindsor.ca

4 pages, 3 tables

Table S1. Method detection limit (MDL), percentage of missing and flagged, below MDL, and equal to or above MDL concentrations for each of the 16 VOCs used in this study.

Compound	Missing and Flagged (%)	Below MDL (%)	Equal to or Above MDL (%)	MDL (ppb)
n-Nonane	9.36	41.69	48.94	0.0191
Benzene	9.36	11.83	78.81	0.0313
1,3,5-Trimethylbenzene	9.36	69.87	20.76	0.0204
1,2,4-Trimethylbenzene	9.36	46.51	44.12	0.0204
1,2,3-Trimethylbenzene	9.36	49.97	40.67	0.0204
m,p-Xylene	9.36	5.59	85.04	0.023
o-Xylene	9.36	46.01	44.63	0.023
Methylcyclohexane	9.36	61.83	28.81	0.0249
i-Propylbenzene	9.36	84.25	6.38	0.0204
n-Hexane	19.53	13.85	66.64	0.0284
Ethylbenzene	9.36	50.45	40.19	0.023
n-Propylbenzene	9.36	78.70	11.93	0.0204
Styrene	9.36	76.86	13.78	0.0235
Propene	10.44	19.44	70.12	0.0581
Toluene	9.36	0.94	89.70	0.0266
Cyclohexane	9.36	81.68	8.96	0.0291

Table S2. Toxicity values and target organs for each of the 16 VOCs.

Compound	RfC ($\mu\text{g}/\text{m}^3$)	Target Organs	Data Source
n-Nonane	20	N.A.	https://cfpub.epa.gov/ncea/pprtv/documents/Nonanen.pdf (2009)
Benzene	30	Hematologic & immune system	Benzene (CASRN 71-43-2) IRIS US EPA (2003)
1,3,5-Trimethylbenzene	60	Nervous system	Toxicological Review of Trimethylbenzenes: Executive Summary (epa.gov) (2016)
1,2,4-Trimethylbenzene	60	Nervous system	Toxicological Review of Trimethylbenzenes: Executive Summary (epa.gov) (2016)
1,2,3-Trimethylbenzene	60	Nervous system	Toxicological Review of Trimethylbenzenes: Executive Summary (epa.gov) (2016)
m,p-Xylene	100	Nervous system	Xylenes (CASRN 1330-20-7) IRIS US EPA (2003)
o-Xylene	100	Nervous system	Xylenes (CASRN 1330-20-7) IRIS US EPA (2003)
Methylcyclohexane	100	Liver/ kidney	https://cfpub.epa.gov/ncea/pprtv/documents/Methylcyclohexane.pdf (2023)
i-Propylbenzene	400	Endocrine & urinary system	Cumene (CASRN 98-82-8) IRIS US EPA (1997)
n-Hexane	700	Nervous system	n-Hexane IRIS US EPA (2005)
Ethylbenzene	1000	Developmental system	Ethylbenzene (CASRN 100-41-4) IRIS US EPA (1991)
n-Propylbenzene	1000	Developmental system	https://cfpub.epa.gov/ncea/pprtv/documents/Propylbenzenen.pdf (2009)
Styrene	1000	Nervous system	Styrene (CASRN 100-42-5) IRIS US EPA (1992)
Propene	3000	Respiratory system	OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary - OEHHA (ca.gov) (2023)
Toluene	5000	Nervous system	2,4-/2,6-Toluene diisocyanate mixture (TDI) (CASRN 26471-62-5) IRIS US EPA (2005)
Cyclohexane	6000	Developmental system	Cyclohexane (CASRN 110-82-7) IRIS US EPA (2003)

Table S3. Seasonal HQs for 16 VOCs in Windsor, Ontario, Canada (all significant at $p < 0.001$, i.e., not all four seasonal means are significantly the same).

Compound	Spring	Summer	Fall	Winter	Classification based on ANOVA and Tukey's test.
n-Nonane	0.01147 (A*)	0.00637 (C)	0.00834 (B)	0.00843 (B)	1, Spring high, summer low, other two seasons in between.
Benzene	0.01468 (C)	0.01056 (D)	0.01598 (B)	0.02052 (A)	1, Winter > fall > spring > summer.
1,3,5-Trimethylbenzene	0.00247 (C)	0.00267 (B)	0.00304 (A)	0.00218 (D)	2, Fall > summer > spring > winter.
1,2,4-Trimethylbenzene	0.00372 (C)	0.00521 (B)	0.00863 (A)	0.00298 (D)	2, Fall > summer > spring > winter.
1,2,3-Trimethylbenzene	0.00327 (B)	0.00564 (A)	0.00547 (A)	0.00287 (C)	2, Summer and fall high, winter low, spring in between.
m,p-Xylene	0.00526 (B)	0.00718 (A)	0.00763 (A)	0.00477 (B)	2, Summer and fall high, and spring and winter low.
o-Xylene	0.00122 (D)	0.00270 (B)	0.00327 (A)	0.00165 (C)	2, Fall > summer > winter > spring.
Methylcyclohexane	0.00136 (C)	0.00166 (B)	0.00176 (A)	0.00140 (C)	2, Fall high, spring and winter low, summer in between.
i-Propylbenzene	0.00031 (A)	0.00026 (C)	0.00028 (B)	0.00029 (B)	1, Spring high, summer low, other two seasons in between.
n-Hexane	0.00141 (B,C)	0.00215 (A)	0.00168 (B)	0.00126 (C)	2, Summer > fall & spring > winter.
Ethylbenzene	0.00017 (C)	0.00020 (B)	0.00023 (A)	0.00016 (C)	2, Fall high, spring and winter low, summer in between.
n-Propylbenzene	0.00011 (C)	0.00013 (B)	0.00017 (A)	0.00012 (B)	2, Fall high, spring low, other two seasons in between.
Styrene	0.00011 (B)	0.00012 (B)	0.00021 (A)	0.00012 (B)	3, fall high, other three low.
Propene	0.00005 (C)	0.00011 (A)	0.00012 (A)	0.00010 (B)	2, Summer and fall high, spring low, and winter in between.
Toluene	0.00018 (B)	0.00023 (A)	0.00025 (A)	0.00017 (B)	2, summer and fall high, and spring and winter low.
Cyclohexane	0.000022 (A)	0.000020 (B,C)	0.000021 (A,B)	0.000019 (C)	4, Spring high winter low, other two seasons in between.

*A, B, C, D are grouping information using the Tukey method and 95% confidence. Means that do not share a letter are significantly different.