Niagara River Biomonitoring Study 2012

Caged Mussels (*Elliptio complanata*) and

Semi Permeable Membrane Devices (SPMDs)

Lisa Richman
Ontario Ministry of Environment
Water Monitoring Section
Environmental Monitoring and Reporting Branch
November 2015

ADDENDUM: April 2022

Estimated 2012 water concentrations of contaminants using SPMD data provided in an earlier version of this report have been updated to reflect changes in the Performance Reference Compound (PRCs) values used for the calculations.

Table 4 has been replaced with the updated version of the table and text has been changed accordingly.

Estimated water concentrations have increased significantly for some parameters using the modified PRCs, however, the contaminant trends spatially (i.e., location of suspected sources) remain the same.

Table 4 (Updated April 2022): Mean estimated water concentrations (ng/L) using 2012 SPMD data and the USGS Water Concentration Estimator.

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font. U/S = upstream; D/S = downstream

	Agency	**Water Quality Criteria**	2 Mile Creek		**Exceedence Factor (EF)**	Pettit Flume[a] upstream	**EF**	Pettit Flume[a] outer	**EF**	Pettit Flume[a] Downstream	**EF**	Gratwick Riverside Park upstream		**EF**	Gratwick Riverside Park downstream		**EF**
			Mean	SD								Mean	SD		Mean	SD	
		ng/L	ng/L	ng/L		ng/L		ng/L		ng/L		ng/L	ng/L		ng/L	ng/L	
1,3-Dichlorobenzene	MECP	**2500**	3.2	0.35		0.42		24		6.1		1.11	0.12		1.5	0.21	
1,4-Dichlorobenzene	MECP	**4000**	9.3	0.61		3.7		72		12		5.2	0.49		10	2.0	
1,2-Dichlorobenzene	NYSDEC	**3000**	0.69	0.11		0.88		36		0.69		0.53	0.005		1.01	0.13	
1,3,5-Trichlorobenzene	MECP	**650**	0.42	0.03				1.5		0.36		0.03	0.003		0.02	0.003	
1,2,4-Trichlorobenzene	MECP	**500**	1.1	0.10		0.04		6.4		0.32		0.26	0.03		0.07	0.01	
1,2,3-Trichlorobenzene	MECP	**900**	0.08	0.01				3.2		0.05		0.03	0.004		0.02	0.004	
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			1.3	0.15		0.01		4.5		0.27		0.04	0.002		0.03	0.002	
1,2,3,4-Tetrachlorobenzene	MECP	**100**	1.8	0.20		0.01		8.2		0.14		0.02	0.004		0.02	0.003	
Hexachlorobutadiene	NYSDEC	**10**	0.03	0.003				0.03		0.06					0.00	0.001	
Pentachlorobenzene	MECP	**30**	2.5	0.32		0.02		5.5		1.05		0.08	0.01		0.07	0.01	
Hexachlorobenzene	NYSDEC	**0.03**	**0.57**	0.08	**19**	**0.05**	**2**	**4.5**	**151**	**4.0**	**133**	**0.18**	0.02	**6**	**0.12**	0.02	**4**
HCH, gamma (Lindane)	NYSDEC	**8**	1.0	0.05								0.12	0.11		0.07	0.07	
HCH, alpha	NYSDEC	**2**	**38**	0.39	**19**										0.08	0.14	
HCH, beta			12	1.6													
HCH, delta			1.0	0.26						0.01		0.003	0.01				
Aldrin	NYSDEC	**2**		0.01													
Octachlorostyrene	NYSDEC	**0.006**	**0.01**	0.002	**2**			**0.03**	**4.6**	**0.04**	**7.5**						
2,4'-DDE			0.03	0.001		0.02		0.02		0.02		0.02	0.002		0.01	0.01	
4,4'-DDE	NYSDEC	**0.007**	**0.21**	0.02	**30**	**0.08**	**11**	**0.18**	**26**	**0.08**	**12**	**0.07**	0.01	**10**	**0.04**	0.01	**6**
2,4'-DDD			0.10	0.02				0.22				0.00	0.01		0.01	0.01	
4,4'-DDD	NYSDEC	**0.08**	**0.44**	0.05	**6**	0.07		**0.71**	**9**	0.07		0.05	0.01		0.04	0.01	
2,4'-DDT			0.05	0.01		0.03		0.02		0.03		0.04	0.00		0.01	0.01	
4,4'-DDT	NYSDEC	**0.01**	**0.02**	0.01	**2**							0.003	0.01				
Mirex	NYSDEC	**0.001**	**0.11**	0.02	**105**			**0.06**	**63**								
Chlordane, alpha (cis)	NYSDEC		0.12	0.01		0.04		0.23		0.04		0.03	0.001		0.02	0.005	
Chlordane, gamma (trans)	NYSDEC		0.08	0.01		0.03		0.14		0.03		0.02	0.001		0.01	0.002	
Nonachlor, cis-			0.02	0.004				0.03		0.01		0.01	0.002		0.004	0.001	
Nonachlor, trans-			0.07	0.01		0.03		0.12		0.03		0.02	0.001		0.02	0.003	
Heptachlor	NYSDEC	**0.2**															
Heptachlor Epoxide	NYSDEC	**0.3**	0.03	0.003		0.03		0.05		0.02		0.02	0.003		0.02	0.002	
alpha-Endosulphan	MECP (proposed)	**3**	0.32	0.01				0.04		0.07		0.05	0.05		0.05	0.05	
beta-Endosulphan			0.68	0.05				0.19									
Endosulphan Sulphate			0.22	0.20		0.16		0.61		0.09							
Dieldrin	NYSDEC	**0.0006**	**0.10**	0.01	**165**	**0.13**	**218**	**0.14**	**233**	**0.12**	**200**	**0.08**	0.01	**141**	**0.07**	0.01	**121**
Endrin	NYSDEC	**2**															
Methoxychlor	NYSDEC	**30**	0.13	0.01								0.01	0.02				
Total PCB[c]	NYSDEC	**0.001**	**6.2**	0.74	**6152**	**8.8**	**8827**	**151**	**150582**	**10**	**10004**	**52**	4.5	**52233**	**15**	3.4	**14954**

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

Table 4 (updated April 2022): Continued

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font. U/S = upstream; D/S = downstream

	Agency	**Water Quality Criteria**	102nd Street Upstream		**EF**	Little Niagara River (near 102nd St)		**EF**	Cayuga Creek		**EF**	Little Niagara River (downstream Cayuga ck)		**EF**	Occidental Sewer[b]		**EF**	Gill Creek upstream (in creek)		**EF**	Gill Creek mouth		**EF**
			Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD	
		ng/L	ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L	
1,3-Dichlorobenzene	MECP	**2500**	1.1	0.12		4.6	0.68		9.1	7.9		1.2	0.18		3.0	0.50		3.0	0.46		13	1.6	
1,4-Dichlorobenzene	MECP	**4000**	2.8	0.11		15	0.84		86	16		9.7	0.72		4.4	0.75		24	7.7		42	1.7	
1,2-Dichlorobenzene	NYSDEC	**3000**	3.5	1.1		0.64	0.05		0.13	0.22		0.08	0.14		0.78	0.24		3.5	1.2		29	1.7	
1,3,5-Trichlorobenzene	MECP	**650**	0.003	0.01		0.65	0.04		0.03	0.001		0.12	0.01		0.12	0.11		0.14	0.08		0.03	0.01	
1,2,4-Trichlorobenzene	MECP	**500**	0.03	0.002		1.0	0.06		0.20	0.01		0.11	0.02		2.1	1.8		1.3	0.68		2.2	0.73	
1,2,3-Trichlorobenzene	MECP	**900**	0.005	0.01		0.13	0.01		0.04	0.03		0.03	0.01		0.41	0.33		0.11	0.04		0.51	0.17	
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			0.09	0.01		1.4	0.24		0.06	0.01		0.28	0.01		8.8	1.5		0.62	0.30		0.74	0.13	
1,2,3,4-Tetrachlorobenzene	MECP	**100**	0.03	0.004		1.9	0.23		0.06	0.01		0.37	0.02		11	15		0.37	0.15		0.36	0.07	
Hexachlorobutadiene	NYSDEC	**10**	0.01	0.001		0.01	0.01		0.001	0.002					0.20	0.07		0.02	0.02		**11**	2.8	**1.1**
Pentachlorobenzene	MECP	**30**	0.06	0.001		2.0	0.20		0.27	0.04		0.53	0.05		0.14	0.14		0.38	0.15		0.49	0.11	
Hexachlorobenzene	NYSDEC	**0.03**	**0.24**	0.004	**8**	**0.69**	0.10	**23**	**0.65**	0.11	**22**	**0.19**	0.02	**6**	0.02	0.01		**0.42**	0.18	**14**	**0.52**	0.13	**17**
HCH, gamma (Lindane)	NYSDEC	**8**	0.03	0.06								0.52	0.23		0.11	0.01		3.9	0.73		1.0	0.23	
HCH, alpha	NYSDEC	**2**				0.42	0.04					**2.7**	0.22	**1.3**	0.21	0.29		**68**	5.1	**34**	**26**	1.4	**13**
HCH, beta												1.3	0.24		0.12	0.16		18	0.64		6.0	0.65	
HCH, delta			0.01	0.004		0.03	0.00		0.04	0.02		0.21	0.05					1.3	0.34		0.14	0.01	
Aldrin	NYSDEC	**2**													0.67	0.65		0.02	0.02				
Octachlorostyrene	NYSDEC	**0.006**							**0.01**	0.01	**1.3**				**2.8**	3.92	**467**	**0.02**	0.03	**3**	**0.02**	0.01	**4**
2,4'-DDE			0.01	0.002		0.01	0.01		0.06	0.01		0.02	0.001		0.04	0.01		0.02	0.01			0.003	
4,4'-DDE	NYSDEC	**0.007**	**0.03**	0.001	**5**	**0.13**	0.02	**19**	**0.36**	0.04	**52**	**0.09**	0.02	**13**	**0.03**	0.02	**4**	**0.22**	0.08	**31**	**0.04**	0.01	**5**
2,4'-DDD			0.01			0.13	0.02		0.21	0.05		0.04	0.01					0.06	0.02		0.01	0.002	
4,4'-DDD	NYSDEC	**0.08**	0.03	0.002		**0.49**	0.05	**6**	**0.78**	0.17	**10**	**0.14**	0.02	**2**				**0.30**	0.13	**4**	0.04	0.01	
2,4'-DDT			0.01	0.002		0.04	0.004		0.10	0.02		0.03	0.01					0.04	0.01		0.01	0.002	
4,4'-DDT	NYSDEC	**0.01**	0.004	0.004					**0.06**	0.01	**5**	0.01	0.01										
Mirex	NYSDEC	**0.001**	**0.01**	0.01	**12**	**0.70**	0.12	**120**	**0.27**	0.05	**47**	**0.09**	0.03	**27**	**0.04**	0.05	**52**	**0.08**	0.04	**40**	**0.01**	0.01	**7**
Chlordane, alpha (cis)	NYSDEC		0.02	0.002		0.04	0.004		0.41	0.06		0.06	0.01		0.02	0.02		0.09	0.04		0.02	0.004	
Chlordane, gamma (trans)	NYSDEC		0.02	0.002		0.03	0.01		0.26	0.04		0.04	0.01		0.35	0.46		0.06	0.03		0.01	0.003	
Nonachlor, cis-			0.01	0.001		0.01	0.01		0.05	0.01		0.01	0.003		0.03	0.05		0.02	0.01		0.002	0.002	
Nonachlor, trans-			0.02	0.001		0.03	0.01		0.22	0.04		0.05	0.01		0.04	0.05		0.05	0.03		0.01	0.003	
Heptachlor	NYSDEC	**0.2**													**0.32**	0.41	**1.6**						
Heptachlor Epoxide	NYSDEC	**0.3**	0.01	0.002		0.01	0.002		0.15	0.02		0.01	0.01		0.03	0.004		0.01	0.01		0.01	0.002	
alpha-Endosulphan	MECP (proposed)	**3**	0.20	0.04		0.13	0.01		0.17	0.15		0.18	0.05		0.41	0.16		0.36	0.10		0.18	0.01	
beta-Endosulphan						0.19	0.01					0.21	0.25					0.19	0.08				
Endosulphan Sulphate			0.03	0.05		0.03	0.06		0.51	0.20		0.10	0.10					0.24	0.003		0.10	0.01	
Dieldrin	NYSDEC	**0.0006**	**0.07**	0.01	**115**	**0.07**	0.01	**118**	**0.44**	0.08	**736**	**0.05**	0.004	**91**	**0.09**	0.02	**154**	**0.20**	0.07	**341**	**0.08**	0.01	**138**
Endrin	NYSDEC	**2**																					
Methoxychlor	NYSDEC	**30**	0.002	0.003					0.30	0.05		0.02	0.04										
Total PCB[c]	NYSDEC	**0.001**	**7.9**	0.04	**7917**	**19**	2.6	**19480**	**54**	11	**53666**	**7.7**	1.0	**7721**	**237**	61.4	**236909**	**19**	8.0	**18621**	**12**	3.3	**11877**

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

Table 4 (updated April 2022): Continued

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font.   U/S = upstream; D/S = downstream

			Millers Creek			Boyers Ck			Chippawa Channel			Fort Erie[b]			NOTL			Balsam Lake		
	Agency	**Water Quality Criteria**			**EF**			**EF**			**EF**			**EF**			**EF**			**EF**
			Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD	
		ng/L	ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L	
1,3-Dichlorobenzene	MECP	**2500**	0.37	0.06		0.15	0.14		0.37	0.34					0.40	0.35				
1,4-Dichlorobenzene	MECP	**4000**	2.4	0.42		2.1	0.06		3.0	1.6		2.3	0.15		1.9	0.29		1.3	0.14	
1,2-Dichlorobenzene	NYSDEC	**3000**				0.09	0.15		1.5	2.7		2.2	1.6		3.0	0.27				
1,3,5-Trichlorobenzene	MECP	**650**	0.005	0.001																
1,2,4-Trichlorobenzene	MECP	**500**	0.01	0.001		0.004	0.01								0.05	0.01				
1,2,3-Trichlorobenzene	MECP	**900**				0.01	0.01		0.005	0.01					0.02	0.002				
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			0.01	0.001		0.00	0.004		0.001	0.002		0.002	0.003		0.04	0.01				
1,2,3,4-Tetrachlorobenzene	MECP	**100**	0.003			0.002	0.003		0.005	0.004		0.01	0.01		0.10	0.02				
Hexachlorobutadiene	NYSDEC	**10**				0.004	0.01		0.005	0.004		0.01			0.03	0.01		0.01	0.02	
Pentachlorobenzene	MECP	**30**	0.01	0.002		0.01	0.004		0.02	0.01		0.01	0.002		0.10	0.02				
Hexachlorobenzene	NYSDEC	**0.03**	0.01	0.002		0.01	0.01		**0.04**	0.02	**1.3**	0.02	0.001		**0.09**	0.01	**3**	**0.03**	0.02	**0.89**
HCH, gamma (Lindane)	NYSDEC	**8**				0.37	0.40		0.14	0.14		0.17	0.17		0.09	0.03				
HCH, alpha	NYSDEC	**2**													0.03	0.06				
HCH, beta																				
HCH, delta			0.001	0.001		0.01	0.01					0.01	0.001		0.01	0.01				
Aldrin	NYSDEC	**2**																		
Octachlorostyrene	NYSDEC	**0.006**													**0.01**	0.001	**2**			
2,4'-DDE									0.01	0.01					0.005	0.001				
4,4'-DDE	NYSDEC	**0.007**	**0.19**	0.04	**27**	**0.03**	0.01	**5**	**0.12**	0.09	**17**	**0.04**	0.001	**6**	**0.03**	0.003	**4**	**0.05**	0.03	**8**
2,4'-DDD			0.03	0.01					0.01	0.02		0.01	0.001		0.00	0.003				
4,4'-DDD	NYSDEC	**0.08**	**0.15**	0.02	**2**				0.07	0.08		0.03	0.004		0.02	0.004		0.02	0.01	
2,4'-DDT									0.05	0.09		0.002	0.003		0.01	0.001				
4,4'-DDT	NYSDEC	**0.01**		0.004					0.01	0.02		0.002	0.003		0.01	0.01				
Mirex	NYSDEC	**0.001**																		
Chlordane, alpha (cis)	NYSDEC		0.01	0.003		0.01	0.01		0.02	0.02		0.01			0.01	0.001				
Chlordane, gamma (trans)	NYSDEC		0.01	0.001		0.01	0.01		0.01	0.01		0.003	0.004		0.01					
Nonachlor, cis-			0.00	0.001					0.01	0.01		0.003								
Nonachlor, trans-			0.01	0.002		0.01	0.01		0.02	0.01		0.01	0.001		0.01	0.001		0.01	0.01	
Heptachlor	NYSDEC	**0.2**													0.003	0.01				
Heptachlor Epoxide	NYSDEC	**0.3**	0.003	0.003					0.03	0.03		0.01			0.01	0.001				
alpha-Endosulphan	MECP (proposed)	**3**	0.14	0.00		0.38	0.02		0.08	0.07		0.07	0.02		0.11	0.02		0.12	0.03	
beta-Endosulphan			0.07	0.06		0.25	0.01		0.27	0.28										
Endosulphan Sulphate			0.07	0.06		0.50	0.06		0.04	0.07		0.04	0.06		0.06	0.05		0.22	0.05	
Dieldrin	NYSDEC	**0.0006**	**0.03**	0.01	**44**	**0.04**	0.01	**63**	**0.13**	0.10	**218**	**0.06**	0.01	**105**	**0.06**	0.003	**98**	**0.06**	0.04	**106**
Endrin	NYSDEC	**2**																		
Methoxychlor	NYSDEC	**30**													0.002	0.003				
Total PCB[c]	NYSDEC	**0.001**	**0.47**	0.13	**474**	**0.70**	0.30	**696**	**0.79**	0.53	**789**	**0.27**	0.02	**267**	**0.99**	0.19	**993**	**0.13**	0.05	**127**

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

Acknowledgments

The author would like to acknowledge John Thibeau and Patrick Padovan of MOECC for the 2012 field work. The efforts of the MOECC Laboratory Services Branch organic contaminant analysis unit and dioxin unit are also acknowledged.

The author would also like to acknowledge and thank Duncan Boyd, Tanya Long, Cheriene Vieira and Rick Day for their review and comments on this report.

Executive Summary

The Niagara River is the interconnecting channel between Lake Erie and Lake Ontario. Numerous persistent toxic and bioaccumulative contaminants from waste disposal sites, industrial outfalls, municipal point sources and non point sources have been discharged to the Niagara River for decades. Since 1983 the Ontario Ministry of Environment and Climate Change (MOECC) has been committed to the biomonitoring of contaminants in the Niagara River using caged mussels (*Elliptio complanata*) as part of Ontario's commitment to the Niagara River Toxics Management Plan. These studies have provided information on suspected contaminant sources and source areas in the river between upstream Fort Erie and downstream Niagara-on-the-Lake.

This current report summarizes data from the 2012 survey which included the deployment of caged mussels, semi-permeable membrane devices (SPMDs) and polyethylene strips. A comparison of all three contaminant monitors was one of the objectives of this survey. However, data for the polyethylene strips are currently unavailable since they have not been analysed to date. Accordingly, this report only summarizes the caged mussel and SPMD data. SPMD data, reported as ng/SPMD were used to estimate mean water concentrations using the United States Geological Survey (USGS) SPMD Water Concentration Estimator. These values were compared with the most stringent of either the relevant New York State Department of Environmental Conservation (NYSDEC) guideline and/or MOECC Provincial Water Quality Criteria (WQC).

SPMDs and mussels have different uptake routes thereby providing different but complementary information on environmental contaminants. Due to their mechanisms of uptake, the SPMDs provided a more accurate determination of the presence of compounds in water compared with the caged mussels. However, they can underestimate the presence of contaminants and bioavailability of compounds that preferentially bind to sediment. If understanding and assessing contaminant bioavailability from sediment is also an objective of these surveys, then including biomonitors such as caged mussels for some parameters may be desirable.

The contaminant tissue data from the deployment of caged mussels at various sites on the Canadian side of the river were consistent with previous years of monitoring. Data suggested that only a few contaminants were bioavailable at trace concentrations; in particular, the metabolites of DDT which were likely related to legacy contamination in the area, and PCBs which were likely related to atmospheric sources. The SPMDs provided results that were consistent with the caged mussel data, however, they also identified the presence of legacy organochlorine pesticide use on the Canadian side of the river (e.g., alpha-endosulphan, beta-endosulphan, endosulphan sulphate, and dieldrin all detected at low concentrations). PCBs, Hexachlorobenzene (HCB), pentachlorobenzene and 1,2,3,4-tetrachlorobenzene were detected in SPMDs deployed at Niagara-on-the-Lake (NOTL) at higher concentrations than the other Canadian sites, but this was to be expected at the mouth of the river since contaminants discharged

from American sources were mixed with the Canadian water mass once the river passes over the falls.

Sources of organic contaminants identified on the US side were consistent with previous mussel monitoring surveys. Occidental Chemical Corp, Buffalo Avenue Sewer 003 (OCC Sewer 003) had the highest tissue concentrations of 1,2,3,4-tetrachlorobenzene, pentachlorobenzenes and HCB, and the Pettit Flume and Bloody Run Creek were also sources of pentachlorobenzene and HCB. This pattern was confirmed with SPMDs deployed at the Pettit Flume and OCC Sewer 003 (SPMDs were not deployed at Bloody Run Creek). SPMDs at Two Mile Creek showed high concentrations of tetra- and hexachlorobenzene relative to other sites. These contaminants have not been identified in previous mussel surveys. With the exception of the OCC Sewer 003, all stations on the US side of the river had estimated HCB water concentrations that were from 2 to 124 times greater than the NYSDEC WQC of 0.03 ng/L indicating sources of HCB throughout the Niagara River.

The highest concentrations of PCBs were present in mussels deployed at OCC Sewer 003, Cayuga Creek, Two Mile Creek and Gill Creek. PCB concentrations in SPMDs confirmed the unusually high bioavailability of PCBs at the Occidental site and Cayuga Creek. The mean estimated water concentration for OCC Sewer 003 was 142 ng/L which significantly exceeded the NYSDEC water quality criteria of 0.001 ng/L, and suggested that the discharge of PCBs from this site could be problematic if this occurred regularly. PCB data for SPMDs deployed at Gratwick Riverside Park suggested that contaminants may still be leaching from this waste site into the Niagara River in spite of remedial actions being completed, or alternatively, there is an additional source upstream of the Park. This possibility will be investigated in 2015 by deploying SPMDs at locations upstream of GRP. Estimated water concentrations for PCBs associated with the area were 24 ng/L. As well, the Pettit Flume had high concentrations of PCBs in the SPMDs (estimated water concentration: 57 ng/L). The homologue pattern showed that the total PCB concentration was represented by mono and dichlorobiphenyl which was not analysed in caged mussels, providing an explanation as to why PCBs had not been identified previously at this location.

The 2012 data confirm the previous survey data that showed the Pettit Flume and Bloody Run Creek to be sources of dioxins and furans. Data for sediment and mussels deployed downstream of the Pettit Flume at Fisherman’s Park showed that dioxin contaminated sediment from the Pettit Flume may have migrated off-site.

Although organochlorine pesticides were below the detection limits in mussels (with the exception of metabolites of DDT), they were detected at most stations in the SPMDs. Most noteworthy was dieldrin which exceeded the NYSDEC WQC (0.001 ng/L) at every station in the study (US and Canadian sites) by a factor of 23 to 309 times. The highest concentrations of dieldrin and α and γ chlordane were present in Cayuga Creek. The WQC was also exceeded at all stations for 4,4’-DDE (0.007 ng/L). Gill Creek had the highest concentrations of hexachlorobutadiene and metabolites of the pesticide lindane, consistent with previous mussel surveys. SPMDs deployed at sites downstream of the

102nd St. Hazardous Waste site all had mirex present and estimated water concentrations exceeded the NYSDEC WQC by 54 to 836 times. Mirex has been associated with these sites in past mussel and juvenile fish surveys and was present in mussels at the OCC Sewer 003 in 2012.

Table of Contents

INTRODUCTION AND BACKGROUND 1

OBJECTIVES 2

METHODS 3

Sample Locations 3

Collection Methods and Ambient Measurements 4
  Mussel Deployment/Retrieval and Sample Preparation 4
  Sediment 6
  Water Chemistry 6
  SPMD Deployment 6

Analytical Methods 7

Data Analysis 7

RESULTS 9

Balsam Lake Control Mussels, SPMDs and SPMD Field Blanks 10
  Balsam Lake 10
  Field Blanks 10

Caged Mussel and SPMD Data: Canadian Sites 11
  Polychlorinated Biphenyls (PCBs) at Canadian Sites 14

Caged Mussel and SPMD Data: American Sites 18
  Two Mile Creek 18
  Pettit Flume 21
  Fisherman's Park 24
  Gratwick Riverside Park (GRP) 26
  102nd Street Hazardous Waste Site, Little Niagara River (LNR), and Cayuga Creek 27
  Gill Creek 30
  Occidental Chemical Corporation (OCC), Buffalo Avenue Plant, Niagara Falls, New York 32
  Bloody Run Creek 32

Using SPMDs to Estimate Water Concentrations 35

SPMDs vs Caged Mussels 41

CONCLUSIONS & RECOMMENDATIONS 44

REFERENCES 45

APPENDICES 50

List of Tables

Table 1: Parameter List.

Table 2: Mussel sampling locations for the 2012 survey and contaminants identified at each station.

Table 3: Concentrations of total PCB (sum of 55 congeners) in caged mussels and surface sediment collected from the Niagara River and tributaries (2006-2012).

Table 4. Estimated mean water concentrations (ng/L) of organic compounds based on SPMD data and comparison with water quality guidelines.

List of Figures

Figure 1: Niagara River: Mussel biomonitoring sampling stations 2012.

Figure 2: PCB homologue distribution patterns in caged mussels and SPMDs deployed in Balsam Lake, and SPMD field blanks exposed to the air during deployment and retrieval, 2012. NOTE: Mussels were not analysed for Mono or Di-chlorinated biphenyls.

Figure 3: Chlorinated Benzenes in SPMDs (ng/SPMD) for the Niagara River, 2012
NOTE: on all figures stations are listed from upstream to downstream. Canadian sites begin at Fort Erie and extend to the end of the X axis.

Figure 4: DDT metabolites in SPMDs (ng/SPMD) for the Niagara River, 2012.

Figure 5: Organochlorine Pesticides in SPMDs (ng/SPMD) for the Niagara River, 2012.

Figure 6: Mean and standard deviation total PCB concentrations (sum of 55 congeners) (ng/g dry wt.) in caged mussels deployed at sites along the Niagara River.

Figure 7: Total PCB (sum of 209 congeners) data for SPMDs deployed in the Niagara River, 2012.

Figure 8: PCB homologue distribution patterns in SPMDs, Balsam Lake Control Mussels and caged mussels deployed at various Canadian locations in the Niagara River, 2012. **Note** that the x axis for the SPMDs includes mono and dichloro biphenyl.

Figure 9: Comparison of homologue concentrations (ng/SPMD) in SPMD field blanks with SPMDs deployed at selected Canadian sites.

Figure 10: PCB homologue distribution patterns in caged mussels and SPMDs deployed at the mouth of Two Mile Creek, 2012 and in Balsam Lake mussels.

Figure 11: Mean (bars) and standard deviation (whiskers) of total PCB concentrations (Aroclor analytical method (ng/g wet wt.) in caged mussels deployed at the mouth of Two Mile Creek through time (1987-2012).

Figure 12: Dichlorobenzene and trichlorobenzene concentrations (ng/SPMD) in SPMDs for the Niagara River, 2012.

Figure 13: OC pesticide concentrations in SPMDs (ng/SPMD) for the Niagara River, 2012.

Figure 14: Concentrations of organic compounds in caged mussels deployed at the Pettit Flume Cove through time (1987-2012).

Figure 15: Dioxin and furan congener patterns in sediment and mussels collected from the Pettit Flume and Fisherman's Park, 2012 and from SPMDs deployed at Pettit Flume. The Pettit Flume upstream sediment data is from 2009.

Figure 16: Mean PCB homologue concentrations (ng/SPMD) in SPMDs deployed at the upstream and downstream end of Gratwick Riverside Park and the mean field blank concentration.

Figure 17**:** Mirex and methoxychlor concentrations in SPMDs (ng/SPMD) for the Niagara River, 2012.

Figure 18: Total PCB concentrations in caged mussels (ng/g dry wt.) and SPMDs (ng/SPMD) deployed in the LNR and Cayuga Creek, 2012.

Figure 19: Chlordane and alpha-endosulphan concentrations in SPMDs (ng/SPMD) for the Niagara River, 2012.

Figure 20: Concentrations of chlorinated organic compounds in caged mussels deployed at the Occidental Chemical Corp. Sewer 003 through time (1983-2012).

Figure 21: Concentrations of organic compounds detected in caged mussels deployed at Bloody Run Creek (1987-2012).

Figure 22: Dioxin and furan isomer patterns in sediment and caged mussels deployed at the mouth of Bloody Run Creek, 2012.

Figure 23: PCB concentrations in SPMDs (ng/g triolein) and Caged Mussels (ng/g lipid; dry wt.) deployed in the Niagara River, 2012.

Figure 24: Contaminant concentrations in SPMDs (ng/g triolein) and Caged Mussels (ng/g lipid dry wt.) deployed in the Niagara River, 2013.

List of Appendices

Appendix A: Sampling Location Coordinates.

Appendix B1 &2: Water Temperature, Dissolved Oxygen and Conductivity Data.

Appendix C: 2012 Mussel Tissue Wet and Dry Weights.

Appendix D1: 2012 Caged Mussel Tissue Contaminant Data.

Appendix D2: 2012 Caged Mussel Congener Specific PCB Data.

Appendix D3: 2012 Dioxin and Furan Concentrations in Mussel Tissue and Sediment.

Appendix E: Dioxin and Furan Concentrations in Mussels and Sediment 1985-2012.

Appendix F1 – F3: SPMD Data.

Appendix G: PCB Homologue Patterns for Aroclor Technical Mixtures.

Appendix H: Station Map of LNR and 102nd St. Hazardous Waste Site

Introduction and Background

The Niagara River (64 km long), is the interconnecting channel between Lake Erie and Lake Ontario. Since 1983, the Ontario Ministry of Environment and Climate Change (MOECC) has been committed to both routine and specialized biomonitoring of contaminants in the river using caged mussels (*Elliptio complanata*) as part of Ontario's commitment to the Niagara River Toxic Management Plan (NRTMP). These studies have provided information on suspected contaminant sources and source areas on the American as well as the Canadian side of the river between upstream Fort Erie and downstream Niagara-on-the-Lake (Richman *et al*. 2011).

Numerous persistent, toxic and bioaccumulative contaminants from waste disposal sites, industry, municipal point sources and non-point sources have been discharged to the Niagara River for decades. The river was identified as an Area of Concern by the International Joint Commission in 1987. Currently, due to environmental improvements through government and local stakeholder/industry remedial actions, the Niagara River (Ontario) RAP (Remedial Action Plan) is moving towards delisting the Canadian side of the river as an AOC. Because of the large number of point and non-point sources of contaminants on the American side of the river and the need for extensive remedial actions at many sites, delisting of the US AOC is not expected for at least 15 more years and possibly longer (Ecology and Environment, Inc. 2011).

The biota in the river can accumulate contaminants from the water, sediment and the food chain. Biota may be the most sensitive indicators of contaminants since current technology cannot always detect the low concentrations in water. Accordingly, the use of caged mussels as a biomonitor has been an effective tool to measure the presence of contaminants in the river.

The 2012 Biomonitoring Survey using mussels (*Elliptio complanata*) was a follow up to surveys every two to three years since 1983. In 2009, passive samplers known as semi permeable membrane devices (SPMDs) were introduced at selective stations to assess their effectiveness at accumulating organic compounds. Geographic contaminant patterns matched well with the caged mussels, and additional compounds not previously detected in the mussels were accumulated by the passive samplers. Accordingly, in 2012, SPMDs and polyethylene strips (another type of passive sampler) were deployed at 18 stations (plus 1 at Balsam Lake) to further assess their effectiveness as contaminant monitors and obtain a more complete database of the stations routinely monitored with mussels. A comparison of all three contaminant monitors was one of the objectives of this survey. It was anticipated that the polyethylene strips could be a useful monitor and had the potential of being analysed at the Rexdale MOECC laboratory making them more cost effective than the SPMDs. Currently, data for the polyethylene strips are unavailable for comparison in this report because the analysis has not been completed. Accordingly, this report only summarizes the caged mussel and SPMD data from the 2012 survey.

Objectives

The biota in the river can accumulate contaminants from the water, sediment and the food chain. The principle behind the mussel biomonitoring program was to take mussels from a relatively uncontaminated site and place them in an environment that was known or suspected of being contaminated with persistent, bioaccumulative, toxic substances. Mussels are abundant, easily collected and transported, and sedentary, which means that their contaminant exposure is reflective of relatively local conditions. They are responsive to their surrounding environment so tissue concentrations can often reflect short-term fluctuations in contaminant concentrations which may not be detected by routine water quality monitoring (Kauss and Hamdy, 1991; Lobel *et al*., 1991; Metcalfe and Charlton, 1990; Muncaster *et al.,* 1989). *Elliptio complanata* is a filter feeder (feeding on plankton and organic detritus) and will accumulate contaminants directly from both the water column and particulate matter (Pennak, 1978). This makes it a good biomonitor since contaminants often partition between the dissolved and particulate phases.

SPMDs and other passive samplers efficiently sequester hydrophobic contaminants dissolved in the water and may be more reliable monitors than the caged mussels since the monitoring method is standardized among all stations. Biota don't always survive the exposure, or they may be stressed which can affect uptake and depuration leading to inaccurate measurements of ambient exposure concentrations. Additionally, there may be variability in the bioaccumulation due to their physical condition, sex or age (Lobel *et al*. 1991). Deployment of SPMDs between 14-30 days has been shown to be sufficient to accumulate most hydrophobic contaminants that are environmentally relevant, although studies have suggested that depending on the contaminant, they may require a longer deployment time to be in equilibrium with the environment (Huckins *et al.* 1996; Petty *et al.* 2000). While some studies have shown agreement in geographic contaminant trends between SPMDs and mussels (Prest *et al.* 1992; Prest *et al.* 1995; Herve *et al.* 1995; Peven *et al.* 1996), others did not find a good correlation (Richardson *et al.* 2001; Degger *et al.* 2011). One explanation was the variability in the performance of mussels had an effect on study outcomes, but these studies also highlighted the importance of the different contaminant uptake processes for SPMDs and mussels. Accordingly, it may be useful to use the two datasets in tandem to compare the relative patterns of contamination among the stations but not compare the actual concentrations between the monitors.

The objectives of the survey in 2012 were consistent with earlier surveys and are listed below:

- identify contaminant sources or source areas requiring more detailed follow-up investigations based on uptake of contaminants in selected biomonitors.

- compare results with ongoing long-term trace contaminant monitoring using indigenous species i.e., spottail shiners and identify spatial and temporal trends. Unfortunately, juvenile fish were not collected in 2012 by MOECC. This objective will be revisited in the 2015 survey.

- augment ongoing upstream/downstream Niagara River Toxics Management Plan programs by providing information on contaminants present in the river between Fort Erie and Niagara-on-the-Lake.

- assess effectiveness of SPMDs and polyethylene strips as a possible replacement for caged mussels.

Methods

Sample Locations

During the week of July 16th 2012, mussels were deployed at 29 sites on the Canadian and US side of the river (Figure 1; Appendix A provides site coordinates). On the Canadian side these included the routine monitoring at the head and mouth of the river: Fort Erie and Niagara-on-the-Lake (NOTL), in addition to tributaries to the Niagara River (e.g., Millers Creek, Bakers Creek and Boyers Creek), and a site in the river along the Chippawa Channel. Mussels deployed at Bakers Creek did not survive, likely due to low oxygen concentrations measured at the time of deployment (DO = 2.3 mg/L.

On the US side, mussels were deployed at stations with long-term monitoring datasets (e.g., the Occidental Chemical Corp. (Buffalo Ave facility) sewer 003, Gill Creek, Two Mile Creek, Gratwick Riverside Park (GRP), Cayuga Creek, Bloody Run Creek, 102nd St. Hazardous Waste Site (Little Niagara River–LNR), and the Pettit Flume), and at two locations in the Tonawanda Channel that had not been previously monitored (upstream and downstream of Fisherman’s Park). Deployment at Rattlesnake Creek, a small tributary in North Tonawanda that discharges to Two Mile Creek about 300 m above the mouth before it discharges to the Niagara River was cancelled while in the field since the creek was dry. Rattlesnake Creek was monitored using mussels in 2009. Cages deployed at the Bloody Run Creek upstream site were vandalized and therefore no 2012 mussel data are available for this site.

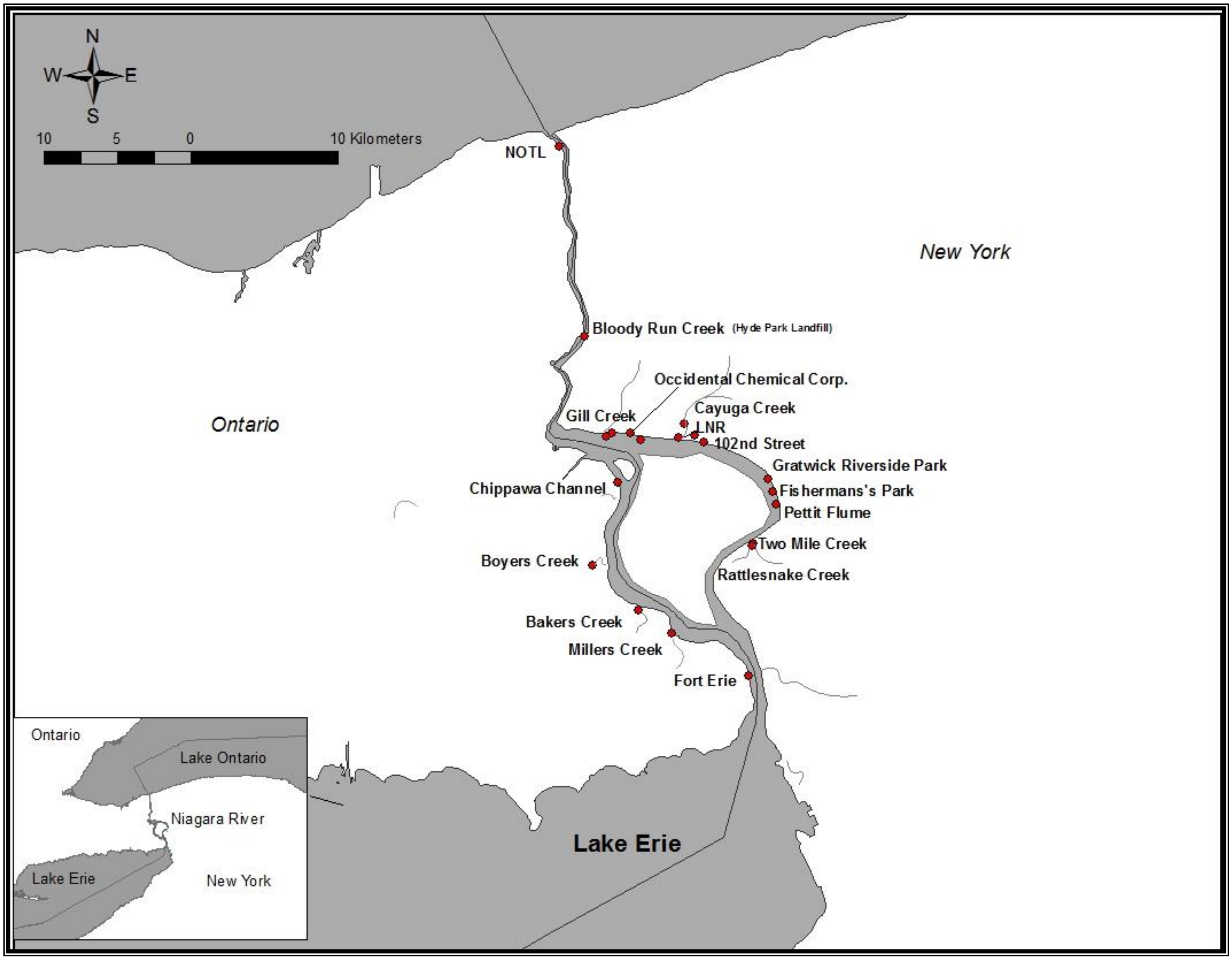


Figure 1: 2012 Niagara River caged mussel biomonitoring sites.

Collection Methods and Ambient Measurements

Mussel Deployment/Retrieval and Sample Preparation

Mussels were collected by divers from Balsam Lake, a relatively uncontaminated lake located in Victoria County, Ontario. Mussels of approximately the same size (6.5 to 7.2 cm) were selected to reduce variability due to tissue weight and mussel age. They were placed in buckets lined with clean bioassay (food-grade) polyethylene bags partially filled with lake water and then sealed with trapped air inside for transportation back to the laboratory. Rapid temperature fluctuations were avoided. Five, randomly selected mussels were submitted for analysis of contaminants described in Table 1 to determine initial tissue contaminant concentrations. These mussels are referred to as the “Balsam Lake control mussels”.

Table 1: Parameter List

Organochlorinated Pesticides, Industrial Chemicals and Chlorinated Benzenes	PCB congener number		Dioxins and Furans Dioxin-like PCBs
hexachloroethane	18	153	2378-tetrachlorofuran
1,3,5-trichlorobenzene	19	155	12378-pentachlorofuran
1,2,4-trichlorobenzene	22	158	23478-pentachlorofuran
1,2,3-trichlorobenzene	28	168	123478-hexachlorofuran
hexachlorobutadiene (HCBD)	33	170	123678-hexachlorofuran
2,4,5-trichlorotoluene	44	171	123789-hexachlorofuran
2,3,6-trichlorotoluene	49	177	234678-hexachlorofuran
1,2,3,5-tetrachlorobenzene	52	178	1234678-heptachlorofuran
1,2,4,5-tetrachlorobenzene	54	180	1234789-heptachlorofuran
1,2,3,4-tetrachlorobenzene (1,2,3,4-TetraCB)	70	183	Octachlorofuran
pentachlorobenzene (PentaCB)	74	187	2378-tetrachlorodioxin
hexachlorobenzene (HCB)	87	188	12378-pentachlorodioxin
heptachlor	95	191	123478-hexachlorodioxin
Aldrin	99	194	123678-hexachlorodioxin
p,p'-DDE	101	199	123789-hexachlorodioxin
α-BHC	104	201	1234678-heptachlorodioxin
β-BHC	110	202	Octachlorodioxin
γ-BHC (lindane)	119	205	PCB081
α-chlordane	128	206	PCB077
γ-chlordane	138	208	PCB123
oxychlordane	149	209	PCB118
cis chlordane	151		PCB114
trans chlordane			PCB105
o,p'-DDT			PCB126
p,p'-DDD			PCB167
p,p'-DDT			PCB156
Mirex			PCB157
Photo-Mirex			PCB169
PCB (total)			PCB189
Toxaphene			
octachlorostyrene			

A minimum of five clean mussels (and/or up to 28 mussels, depending on analytical requirements) were placed in clean, galvanized wire cages (about 30 cm x 36 cm x 10cm; 1 cage per station). These were anchored to the bottom using spikes or rope attached to a concrete block in water of at least 1 m depth. Three randomly selected mussels were retrieved after three weeks (21 days) and analysed individually for percent lipid and total PCBs (polychlorinated biphenyls), organochlorine pesticides, chlorinated benzenes and industrial chlorinated compounds at all stations (Table 1). At 16 stations, three replicates of 6 mussels each were composited and also submitted for congener-specific PCBs. Additionally, at 9 stations mussels (one composite of four mussels) were submitted for dioxins and furans. Balsam Lake control mussels were submitted for all parameters.

Upon retrieval, mussels were immediately shucked, excess water drained and the soft tissues weighed (Appendix C). Mussels were either wrapped individually in hexane-rinsed aluminum foil or packaged as composites, placed in plastic bags, and frozen until analysis. Mussels submitted for PCB congener-specific analysis were freeze-dried prior to analysis. In all cases, the mussels were not depurated prior to analysis.

Sediment

At 6 sites associated with Bloody Run Creek, the Pettit Flume and Fishermans Park, surficial sediment (top 3 cm) grab samples were collected with a hexane rinsed stainless steel spoon for PCDD/Fs analysis. All sediment samples were also analysed for total organic carbon and particle size.

Water Chemistry

Water temperature, DO and conductivity measurements were collected *in situ* during deployment and retrieval of mussels at all stations using a YSI sonde (Appendix Table B).

SPMD Deployment

SPMDs were obtained from Environmental Sampling Technologies (EST) who is the manufacturer of the SPMD equipment, media preparation and dialysis services. Analysis of the SPMDs for contaminants of interest was performed by AXYS Analytical Services Ltd. SPMDs were deployed along-side caged mussels at 18 stations to measure contaminant uptake from the dissolved water phase. Additionally, SPMDs were deployed in Balsam Lake for three weeks to compare uptake with the Balsam Lake Control mussels. Briefly, 91.4 cm x 2.5 cm low density polyethylene lay-flat tubing was filled with 1 mL of high purity triolein then heat-sealed and stored frozen in aluminum canisters for transportation to the Niagara River. EST also spiked the SPMDs with Performance Reference Compounds (PRC). These compounds are used to measure rates of loss, which allow adjustment of the SPMD data to reflect field sampling conditions. Each SPMD was spiked with 60 ng/SPMD of PCB 14, PCB 29 and PCB 50. At each site, three SPMDs were placed on a “spider carrier” within a galvanized metal shroud and deployed by placing them in the current on the sediment using site rocks or steel pegs to hold them in place. Four field blanks were opened and exposed to the air for the duration of the deployment and retrieval to assess the impact of atmospheric contamination on the SPMDs. Two sites were on the Canadian side and two sites were on the US side.

SPMDs were retrieved simultaneously with the caged mussels, placed in metal containers, and stored on ice until return to the laboratory where they were stored frozen until analysis by AXYS.

Analytical Methods

The mussel samples were analyzed for total-PCB and OC pesticides using the OMOE method E3136 (OMOE, 2008a; summarized in Richman and Somers, 2010). PCB congeners were analysed in biota using OMOE method E3411 (OMOE, 2008b) and the seventeen 2,3,7,8-substituted toxic PCDD/Fs and homologue totals were analysed in mussels and sediment using the OMOE method DFPCB-E3418 (OMOE, 2008c; Richman and Somers, 2005). Particle size and TOC in sediment were analyzed by OMOE methods E3328A and E3142A (OMOE, 2008d-e; described in Richman and Milani, 2010).

All mussel data are reported on a wet weight basis with the exception of the data for congener-specific PCBs. These mussels were freeze dried prior to analysis so concentrations are reported as dry weight. The total PCB concentration (sum of the 55 congeners) for these samples were also converted to wet weight by determining the ratio of wet to dry weight for each individual sample to facilitate a comparison with historical PCB data. The water content of the mussel tissue ranged from 84-91%. All sediment data are reported on a dry wt. basis.

SPMDs were analysed for PCBs, OC pesticides, chlorinated benzenes and dioxins and furans by AXYS with a combined gas chromatography/low resolution mass spectrometry (GC/LRMS) analysis (based on EPA Method 8270 OC/D, EPA Method 625, EPA Method 1613B respectively). Prior to the analysis, all parameters were co-extracted (AXYS in house method MLA-013 (fractionation only). Detailed descriptions of analytical methods can be provided upon request. All SPMD data are reported as ng/SPMD (equivalent to ng/mL triolein) unless otherwise noted.

The remaining PRC PCBs (14, 29 and 50) measured following retrieval were subtracted from the total PCB data and for the description of homologue patterns.

Data Analysis

For the caged mussel data, “W” represents the smallest amount of an analyte that can be reliably detected by the procedure used. Concentrations described as “trace” are flagged with a “<T”. Trace values ranged from greater than “W” to 10 times “W” for organic parameters. Data flagged as trace indicate that the presence of the analyte is

confirmed but the actual concentrations reported should be interpreted with caution. Basically, “T” indicates the limit of quantification. Both “W” and “T” are based on the precision of the method which is in turn based on replicate measurements for the same analyte. “W” is set at 2/3 of the standard deviation of the replicate measurements of low-level spiked blank matrix samples. Each sample run (generally 12 to 25 samples) is compared against a prepared standard and includes the determination of low level detection limits, method blanks and recovery checks using spikes. An independent control standard is used to monitor accuracy and stability, duplicate samples are used to test within run precision, and calibration standards are used for a drift check. Details on QA/QC expectations are provided in the method manuals listed above.

In the case of PCDD/Fs and dioxin-like PCBs, a run usually consisted of 10 samples. An analyte was considered to be above the detection limit when the result met standard peak definition (usually 3-5 times signal:noise ratio) or was greater than five times a corresponding positive result determined to be present in the method blank used within that specific sample set. “W” and “T” values do not apply to these analytical procedures. Data that do not meet peak definition and/or are less than five times the method blank are flagged as “<“.

Toxicity Equivalency Factors (TEFs) have been used to express the toxicity of different dioxins and furans and dioxin-like PCBs (DL-PCBs) on a common basis. The World Health Organization (WHO) TEFs for the protection of fish were used for the calculations for both sediment and mussels (van den Berg et al., 2006). Concentrations of individual isomers were converted to toxicity equivalents of 2,3,7,8-TCDD and then summed to yield a total toxic equivalent (TEQ). TEQs were calculated to facilitate comparisons of mussel tissue and sediment dioxin/furan concentrations among stations and through time.

Statistical analysis on the congener-specific PCB mussel data was performed using SigmaStat^{TM}. To compare total PCB concentrations (sum of 55 congeners) between stations, a one-way analysis of variance (ANOVA) was used on $\log_{10}$ transformed data. Transformation of the data resulted in assumptions for normality and equal variance being met. If significant differences were found, the Holm-Sidak test for multiple comparisons was used to determine which stations differed.

Results

A summary of the contaminants present/absent in mussels deployed at each station in the 2012 survey is provided in Table 2. All caged mussel and sediment data are provided in Appendix D and E. SPMD data are provided in Appendix F.

TABLE 2. Mussel sampling locations for the 2012 survey and presence (√√) of contaminants in mussel tissue.
NR - mussels deployed along the Niagara River shoreline; U/S and D/S refers to upstream and downstream.

HCH (α, β, and/or γ - lindane); chlordane (α and/or γ); HCBD: hexachlorobutadiene; HCB: hexachlorobenzene; CB: chlorobenzenes; TCT: trichlorotoluenes;
total PCBs = sum of the congener specific PCB analysis
NA: not analysed
(T): Trace concentrations

Sampling Station	pp'-DDE	total PCBs	HCH	chlordanes	mirex	OCS	HCBD	triCB	tetraCB	pentaCB	HCB	TCT	Dioxin/Furan
Balsam Lake Control Mussels	√ (T)	√ (T)									√ (T)		NA
Canadian Sites													NA
NR-Fort Erie @ Robertson St.		√ (T)									√ (T)		NA
Chippawa Channel	√ (T)	√ (T)									√ (T)		NA
Miller Creek	√ (T)	NA									√ (T)		NA
Baker Creek	Mussels did not survive												NA
Boyer's Creek	√ (T)	NA									√ (T)		NA
NR-Niagara-on-the-Lake (NOTL)		√ (T)									√ (T)		NA
American Sites													
Two Mile Creek (mouth)		√√									√ (T)		NA
Rattlesnake Creek	Deployment cancelled due to dry creekbed												
Pettit Flume (U/S)	√ (T)	NA											NA
Pettit Flume (site B)		NA						√ (T)	√ (T)	√ (T)	√√		√√
Pettit Flume (D/S)	√ (T)	NA									√ (T)		√√
Fisherman's Park (U/S inlet)	√ (T)	√ (T)									√ (T)		√√
Fisherman's Park (D/S inlet)		√ (T)									√ (T)		√√
Gratwick Riverside Park (U/S within park)		NA											NA
Gratwick Riverside Park (D/S within park)		√ (T)									√ (T)		NA
NR-102nd Street (U/S)	√ (T)	√√									√ (T)		NA
Little Niagara River (D/S 102nd St)		√ (T)									√ (T)		NA
Cayuga Creek (in the Ck)	√ (T)	√√						√ (T)		√ (T)	√ (T)		NA
Little Niagara River (D/S Cayuga Ck)	√ (T)	√√											NA
NR-U/S Occidental Chemical Corp.		√ (T)									√ (T)		NA
NR-Occidental 003	√ (T)	√√	√ (T)		√ (T)	√√	√ (T)	√ (T)	√√	√√	√√	√√	NA
NR-350 m U/S Gill Creek Mouth		√ (T)									√ (T)		NA
Gill Creek Mouth		√√	√ (T)				√√				√ (T)		NA
Gill Creek (U/S in the creek)	√ (T)	√ (T)	√ (T)								√ (T)		NA
NR-Bloody Run Creek (U/S)	Cages vandalized												NA
NR-Bloody Run Creek (3 deployment locations)	√ (T)	NA					√ (T)	√ (T)	√ (T)	√√	√√	√√	√√
NR-Bloody Run Creek (D/S)		NA								√√	√√	√√	√√

Balsam Lake Control Mussels, SPMDs and SPMD Field Blanks

Balsam Lake

Trace concentrations of congener specific PCBs (4 to 6 ng/g wet wt; (54-55 ng/g dry wt.) were present in the Balsam Lake control mussels consistent with 2006 and 2009 surveys where concentrations ranged from 0.6 to 3.4 ng/g wet. The corresponding PCB concentration in sediment collected in 2006 from the same area where the mussels were collected was 4 ng/g dry wt. (Richman *et al.* 2011) which suggested low contamination. The low tissue concentrations and high percentage (56%) of trichlorobiphenyls present in the Balsam Lake mussel samples relative to the other homologue groups suggested atmospheric deposition as the likely PCB source to the lake (Johnson *et al*., 2005; MacDonald and Metcalfe 1991) (Figure 2).

Organochlorine pesticides and chlorinated compounds were all below the detection limit with the exception of trace concentrations of p,p'-DDE (3 ng/g) in one mussel and trace concentrations of HCB (3-4 ng/g) in the three mussels (Appendix D1).

The SPMD data were consistent with the caged mussels, e.g., the detection of 4,4'-DDE and HCB at low concentrations (mean $\leq$ 2 ng/SPMD) (Appendix F). Additionally, 4,4'-DDD, hexachlorobutadiene (HCBD), trans-nonachlor (a component of the pesticide chlordane), endosulphan sulphate (all means < 1.5 ng/SPMD), and dieldrin (mean 2.3 ng/SPMD), were also detected suggesting their presence in the lake at low concentrations (Figures 3-5). The mean total PCB concentration in the SPMDs was 4.6 ng/SPMD (standard deviation (SD) 1.2 ng/SPMD). The homologue pattern was consistent with the profile for the caged mussels also suggesting atmospheric deposition as the sources, however, the percent contribution of the homologues vary since the SPMD analysis included mono and dichloro biphenyls whereas mussel analysis does not include these homologues (Figure 2).

Field Blanks

SPMD field blanks were exposed to the air at four stations for the duration of sample deployment and retrieval (Chippawa Channel, Millers Creek, Pettit Flume, Little Niagara River (LNR) (near 102nd St). The detection of contaminants represents the potential for the SPMDs to adsorb contaminants from the atmosphere. The field blanks had detectable, but low concentrations (< 1ng/SPMD) of some chlorinated benzenes, alpha- and gamma-chlordane and alpha-endosulphan and PCBs. Three blanks had total PCB concentrations ranging from 5.4 to 6.5 ng/SPMD while the blank opened at the Pettit Flume had a total PCB concentration of 59 ng/SPMD. This was due to relatively higher concentrations of trichlorobiphenyl (PCB congener 30 was 50 ng/SPMD). The reason for this discrepancy is unclear. The only compounds that were consistently elevated in the field blanks were 1,4 dichlorobenzene (mean 12.6 ng/SPMD; SD 6.1 ng/SPMD) and oxy-chlordane (mean 35.2 ng/SPMD; SD 2.6 ng/SPMD) (Appendix F).

The PCB homologue pattern in the blanks was similar to the Balsam Lake SPMD pattern (Figure 2). All four field blanks and Balsam Lake had the trichlorobiphenyls as the dominant homologue. Since the concentration of total PCBs in the SPMD field blanks was similar to the Balsam Lake SPMDs, it is possible the Balsam Lake samples represented exposure to the atmosphere during deployment/retrieval rather than available PCBs in the water. However, the source of PCBs to the water is likely atmospheric as well.

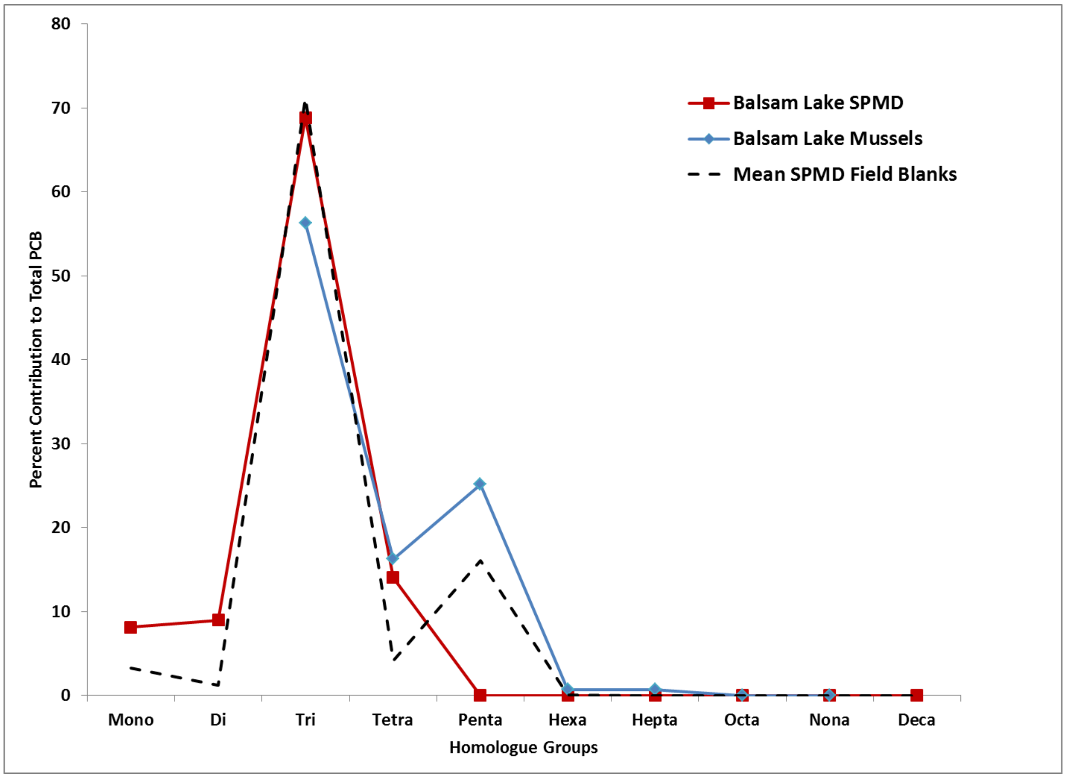


Figure 2: PCB homologue distribution patterns in caged mussels and SPMDs deployed in Balsam Lake, and SPMD field blanks exposed to the air during deployment and retrieval, 2012. NOTE: Mussels were not analysed for Mono or Di-chlorinated biphenyls.

Caged Mussel and SPMD Data: Canadian Sites

The results from the 2012 survey were consistent with historical data (Richman *et al.* 2011; Richman 2013). Trace concentrations of PCBs (4.9 - 7.6 ng/g wet wt.), HCB (2-4 ng/g) and p,p'- DDE (2-4 ng/g) were present in mussels deployed at Canadian sites. The presence of HCB could have been attributed to the initial concentrations in the Balsam Lake control mussels, however, the SPMDs also identified HCB as being present at all stations at low concentrations (means < 2.5 ng/SPMD). The exception was NOTL, where concentrations of HCB were relatively higher at 14 ng/SPMD (SD of 0.72 ng/SPMD). Additionally, SPMDs at NOTL also detected the presence of 1,2,3,4-tetrachlorobenzene (mean: 12 ng/SPMD; SD 2 ng/SPMD), and pentachlorobenzene (mean 15 ng/SPMD; SD 1.3 ng/SPMD) (Figure 3). This is not surprising given that contaminants detected only on the US side of the upper river will be mixed with the relatively cleaner water from the Canadian side as the water passes over the falls and then detected on the Canadian side at the mouth of the river. This is also consistent with the Environment Canada (EC) Upstream/Downstream Niagara River Monitoring Program water quality data where contaminants with sources within the Niagara River such as HCB and mirex, were detected only at the NOTL site and not at the upstream (Fort Erie) site (Hill and Klawunn 2009).

There were several OC pesticides not detected in mussels but present in SPMDs at similar concentrations to those detected on the US side of the river particularly in tributaries (e.g., 4,4'-DDE, 4,4' DDD, alpha-endosulphan, beta-endosulphan, endosulphan sulphate, and dieldrin), suggesting widespread historical use of these compounds in the Niagara watershed (Figures 4 & 5). Lake Erie has also been identified as a source of dieldrin and metabolites of DDT to the Niagara River in addition to sources within the Niagara River tributaries (Hill and Klawunn 2009).

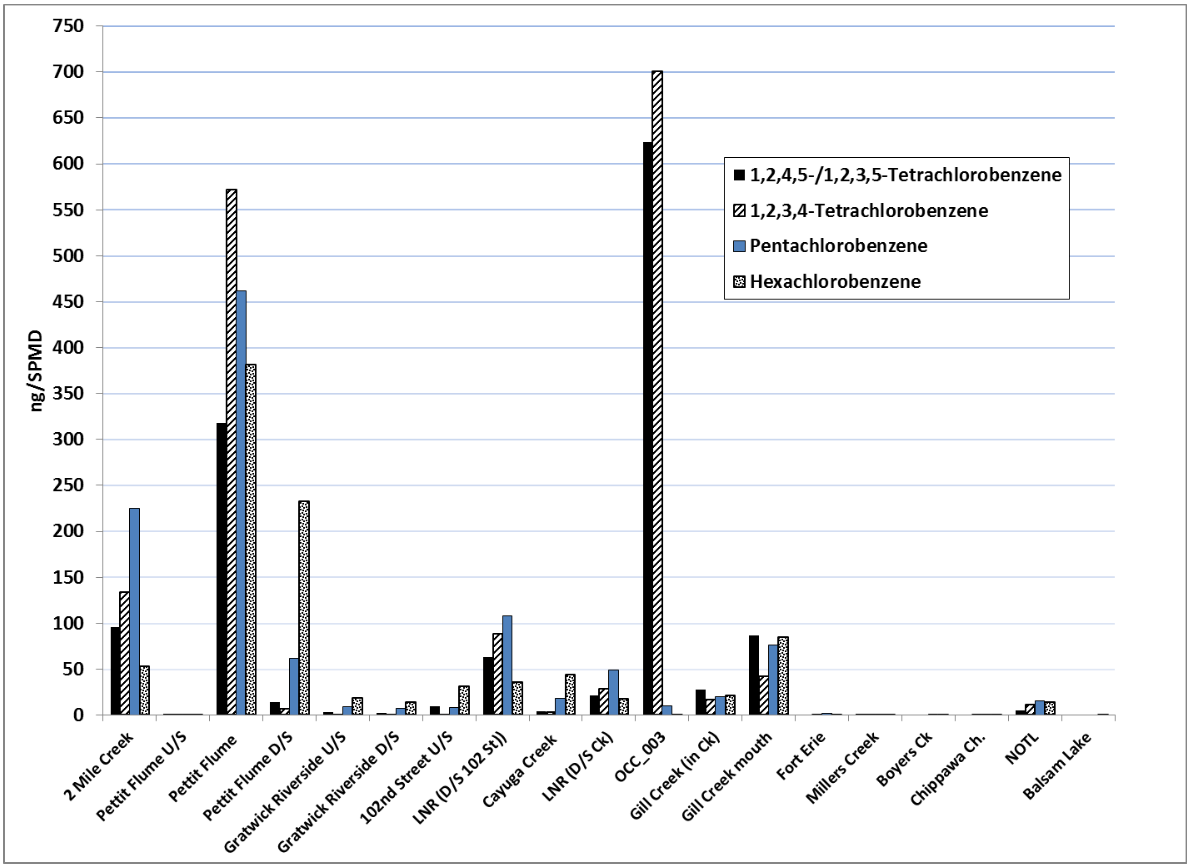


Figure 3: Chlorinated Benzenes in SPMDs (ng/SPMD) for the Niagara River, 2012
NOTE: on all figures stations are listed from upstream to downstream. Canadian sites begin at Fort Erie and extend to the end of the X axis.

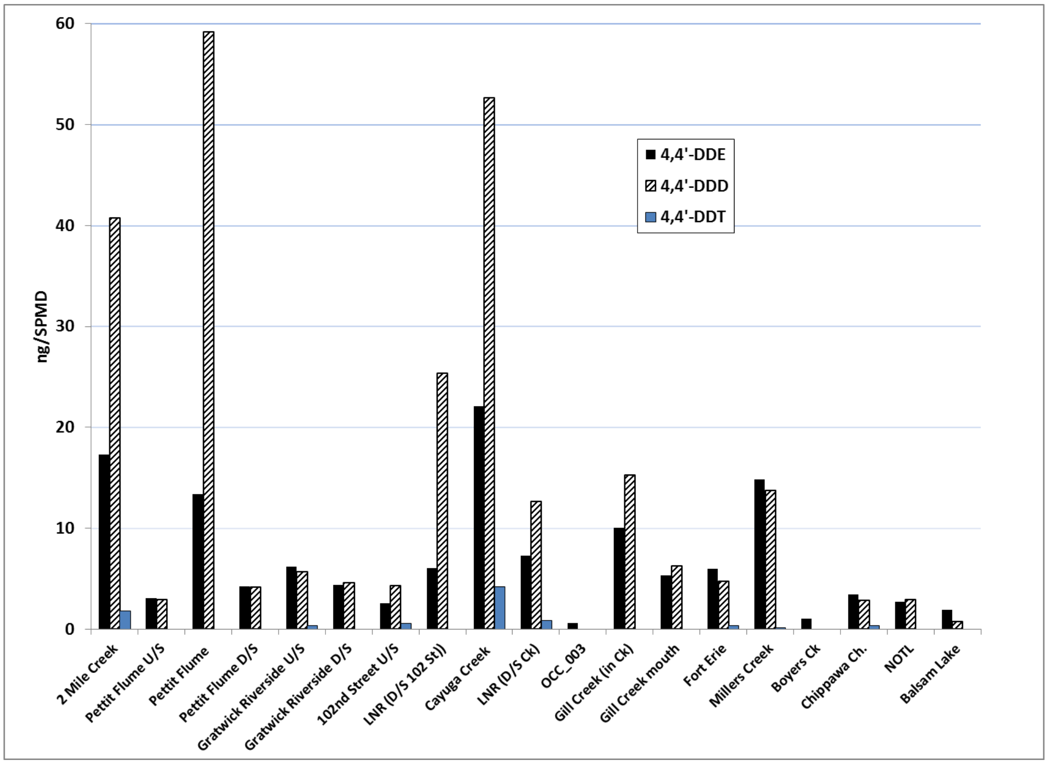


Figure 4: DDT metabolites in SPMDs (ng/SPMD) for the Niagara River, 2012

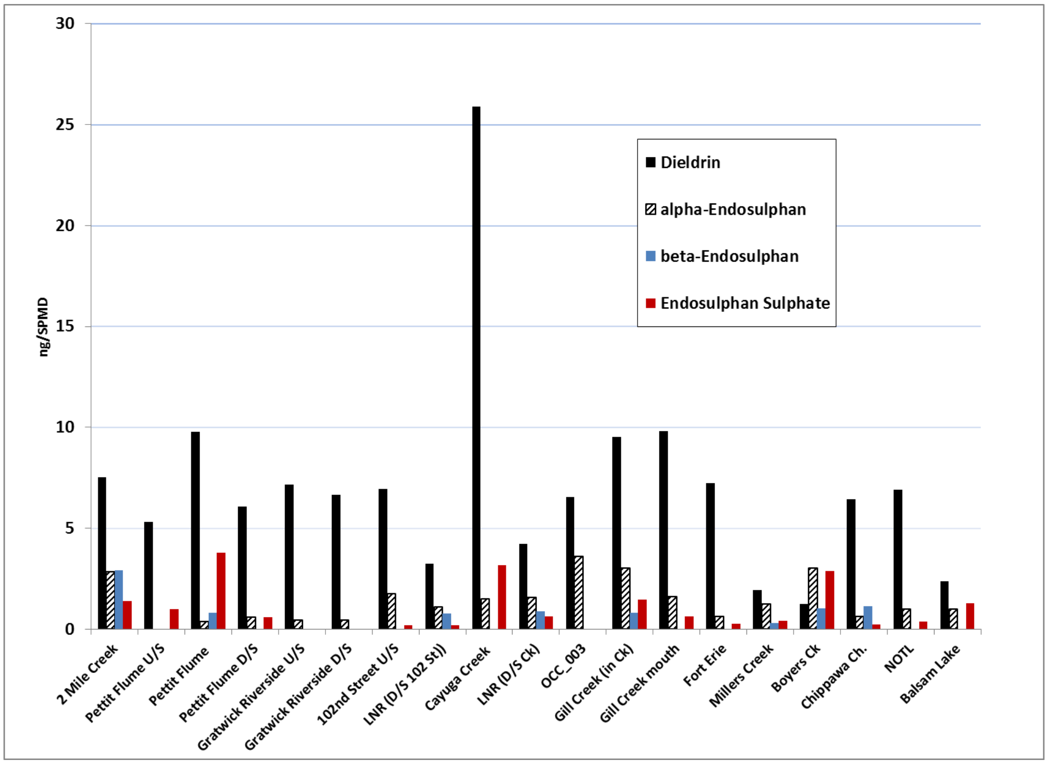


Figure 5: Organochlorine Pesticides in SPMDs (ng/SPMD) for the Niagara River, 2012

Polychlorinated Biphenyls (PCBs) at Canadian Sites

A summary of the 2012 congener specific PCB data in caged mussels, and for comparison, historical data (2006-2009) in mussels and sediment, is provided in Table 3. An ANOVA on all 2012 caged mussel data showed that there were significantly different concentrations of total PCBs among the stations (F=290; p<0.001) which involved comparisons among the US sites. The Holm-Sidak test for multiple comparisons showed that mussels deployed at all Canadian sites had total PCB (sum of 55 congeners) concentrations that were not significantly different from the Balsam Lake control mussels and that concentrations among the Canadian sites were also not significantly different (Figure 6). SPMD data provided results that were consistent with the caged mussel data whereby PCB concentrations were similar among all Canadian stations (Figure 7; Appendix F).

The homologue patterns in both mussels and SPMDs were relatively consistent among these two media. Patterns for all Canadian sites (with the exception of NOTL) were similar to the Balsam Lake control mussels and Balsam Lake SPMDs, with a high percent contribution from the lighter homologues suggesting atmospheric contributions as opposed to a direct discharge (Figure 8). Concentrations of total PCBs in caged mussels and SPMDs for these sites were low, ranging from 4.9 -7.6 ng/g (wet wt.) and 10-50 ng/SPMD respectively which was not suggestive of a PCB source, or significant contamination when compared to sites on the U.S. side with known PCB sources.

The higher PCB concentrations and different homologue pattern at NOTL was likely due to the contributions of PCBs from the US side as discussed earlier for HCB, tetra and pentachlorobenzene (Figure 9).

Table 3: Total PCB concentrations (sum of 55 congeners) in caged mussels and surface (0-3 cm) sediment collected from the Niagara River. Mussel data is the mean of 3 replicate samples +/- Standard Error (SE). Each replicate from the 2012 survey is a composite of 6 mussels. For comparison data from 2006 and 2009 were provided: composites consisted of 12 mussels Data for mussels reported as dry wt. and wet wt. Sediment data (n=1) is reported as dry wt.

	Mussels (2012)	**Mussels (2012)**	**Mussels (2009)**	**Mussels (2006)**		**Mussels**		**Sediment (2003)**	**TOC**	**Sediment (2006)**		**TOC**	**Sediment (2009)**		**TOC**
	Total PCB±SE	**Total PCB±SE**	**Total PCB±SE**	**Total PCB±SE**		**Total PCB±SE**	**% Lipid**	**Total PCB**		**Total PCB**			**Total PCB**		
	ng/g	**ng/g**	**ng/g**	**ng/g**		**ng/g**		**ng/g**	**mg/g**	**ng/g**		**mg/g**	**ng/g**		**mg/g**
	wet wt.	**dry wt.**	**dry wt.**	**dry wt.**		**wet wt.**		**dry wt.**	**dry wt.**	**dry wt.**		**dry wt.**	**dry wt.**		**dry wt.**
	n=3	**n=3**	**n=3**	**n=3**		**2006 & 2009**	**2006 & 2009**	**n=1**		**n=1**			**n=1**		
Canadian sites															
Balsam Lake (control)	**5.3 ± 0.6**	**45±4.1**	**ND**	**17±8.1**	**<T**	**2 ± 1**	**3.7±0.4**			**4**		**3 <T**			
Fort Erie @ Robertson Street	6.2 ± 0.8	51±2.9		27±5.1*	<T	3 ± 1	1±0.1			5	<=W	11			
Chippawa Channel	5.7 ± 0.1	46±1.5		33±9.3	<T	3 ± 2	1.1±0	19	7	190		6			
Niagara-on-the-Lake	6.2 ± 0.2	54±0.3		32±3.8	<T	4 ± 1	5.2±1	38	7	14	<T	9			
Millers Creek			54 ± 4			7 ± 0.4	7 ± 0.5						5	<=W	33
Bakers Creek			45 ± 4			6 ± 0.2	6.7 ± 0.2						5	<=W	94
Boyers Creek			45 ± 5			6 ± 0.3	7.2 ± 0.6						5	<=W	14
Lyons Creek			243 ± 18			28 ± 3	5.8 ± 0.7	87	28						
Welland R at Confluence with Lyons Creek			45 ± 0.6			5 ± 0.4	6.8 ± 0.3						10	<T	21
Lyons Creek U/S of Welland River			48 ± 3			5 ± 0.2	8.3 ± 0.7						16	<T	28
Welland River @ Welland canal			50 ± 3			6 ± 0.2	7.7 ± 0.2								
American sites															
Tonawanda Channel - U/S Two Mile Creek				129±18	<T	13±2	6±0.6								
Scajaquada Creek			257 ± 13			27±3	5.2±0.4						73		45
Rattlesnake Creek			697 ± 13			82±3	5.0±0.5						390		30
Tonawanda Channel - U/S Two Mile Creek			110 ± 6			12±1	6±0.5								
Two Mile Creek - Mouth	47±2.7	450 ± 5.8		580±17	<T	66±4	6.5±0.3	690	65	1200		34			
Two Mile Creek - U/S in Creek				103±9.1	<T	10±1	6.3±0.2								
Fisherman's Park (U/S inlet)	15±1.5	123±8.8													
Fisherman's Park (D/S inlet)	9.9±0.3	88±6.5													
Gratwick Riverside Park (D/S end of park)	27±2.9	220±23.1													
102 nd Street (U/S)	35±1.1	273±14.6													
Little Niagara River	24±1.2	190±10	243 ± 13			26±2	5.5±0.3						140		48
Cayuga Creek - in Creek	82±4.8	527+27.3	213 ± 3			22±0.5	4.5±0.0						570		65
Little Niagara River - D/S Cayuga Creek	44±2.6	343±16.7	190 ± 15			21±3	6.5±1						190		48
Niagara River @ Occidental Sewer 003								8800	8						
Occidental 003 (U/S)	23±0.1	170±0.0													
Occidental 003	81±6.5	690±15.3	187 ± 12			18±1	5.7±0.2								
Niagara River - U/S Gill Creek	7.8±0.3	61±2.3		43±21	<T	4±4	1±0.1								
Gill Creek - Mouth	47±2	367±12		227±15	<T	25±3	1.2±0.1	3400	7						
Gill Creek - U/S in Creek	28±1.8	227±6.7		230±12	<T	29±1	6.1±0.2	150	17	120		8			
Niagara River - U/S Bloody Run Creek				57±11	<T	6±2	6±0.1			220		12			
Niagara River - Bloody Run Creek				83±8.1	<T	9±2	5.6±0.2	7900	22	440		14			

* n=2

<W no measurable response

<T measurable trace amount

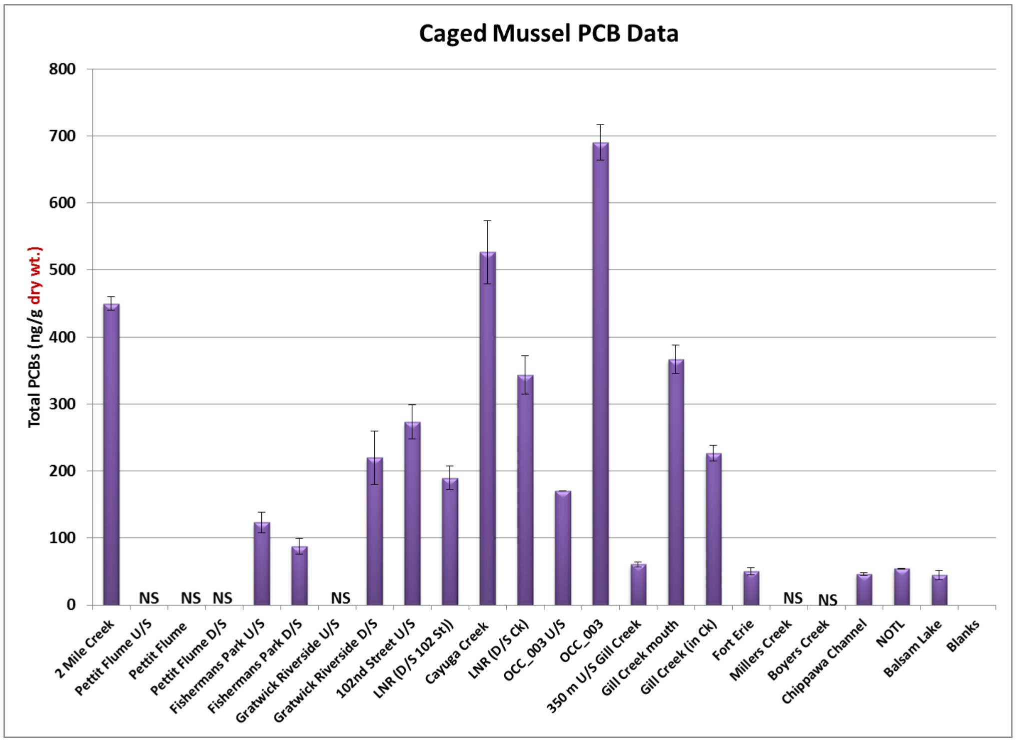


Figure 6: Mean (bars) and standard deviation (whiskers) of total PCB concentrations (sum of 55 congeners) (ng/g dry wt.) in caged mussels deployed at sites along the Niagara River in 2012. **NS** represents stations where samples were not analysed for congener specific PCBs.

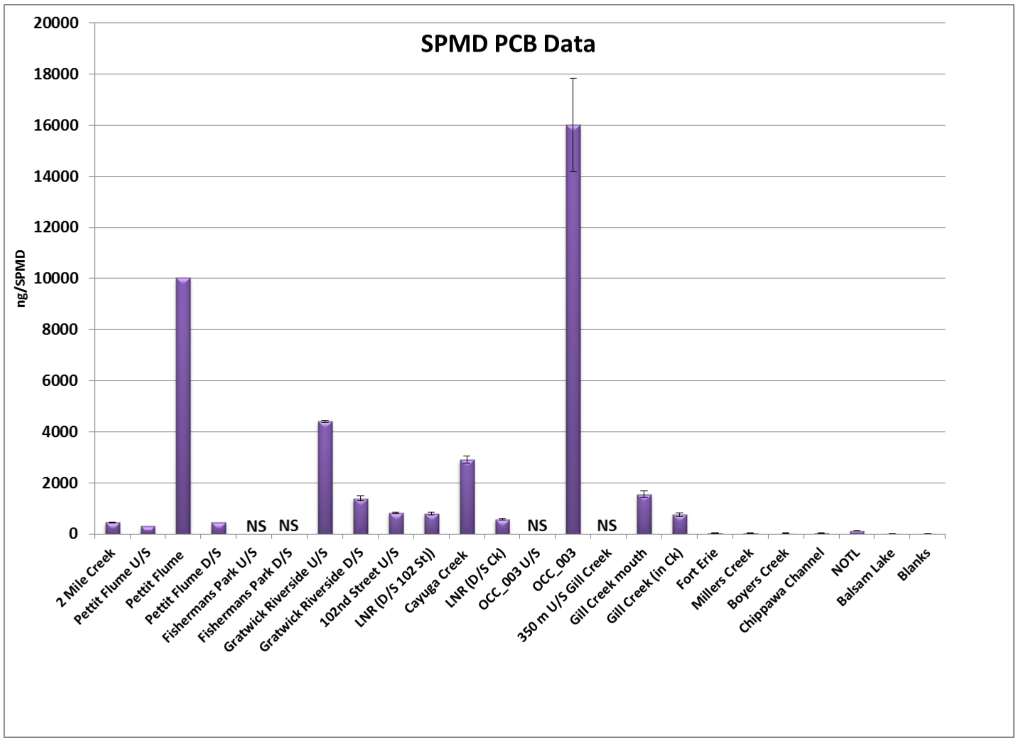


Figure 7: Mean and standard deviation, total PCBs (sum of 209 congeners) for SPMDs deployed in the Niagara River, 2012. **NS** represents stations where SPMDs were not deployed.

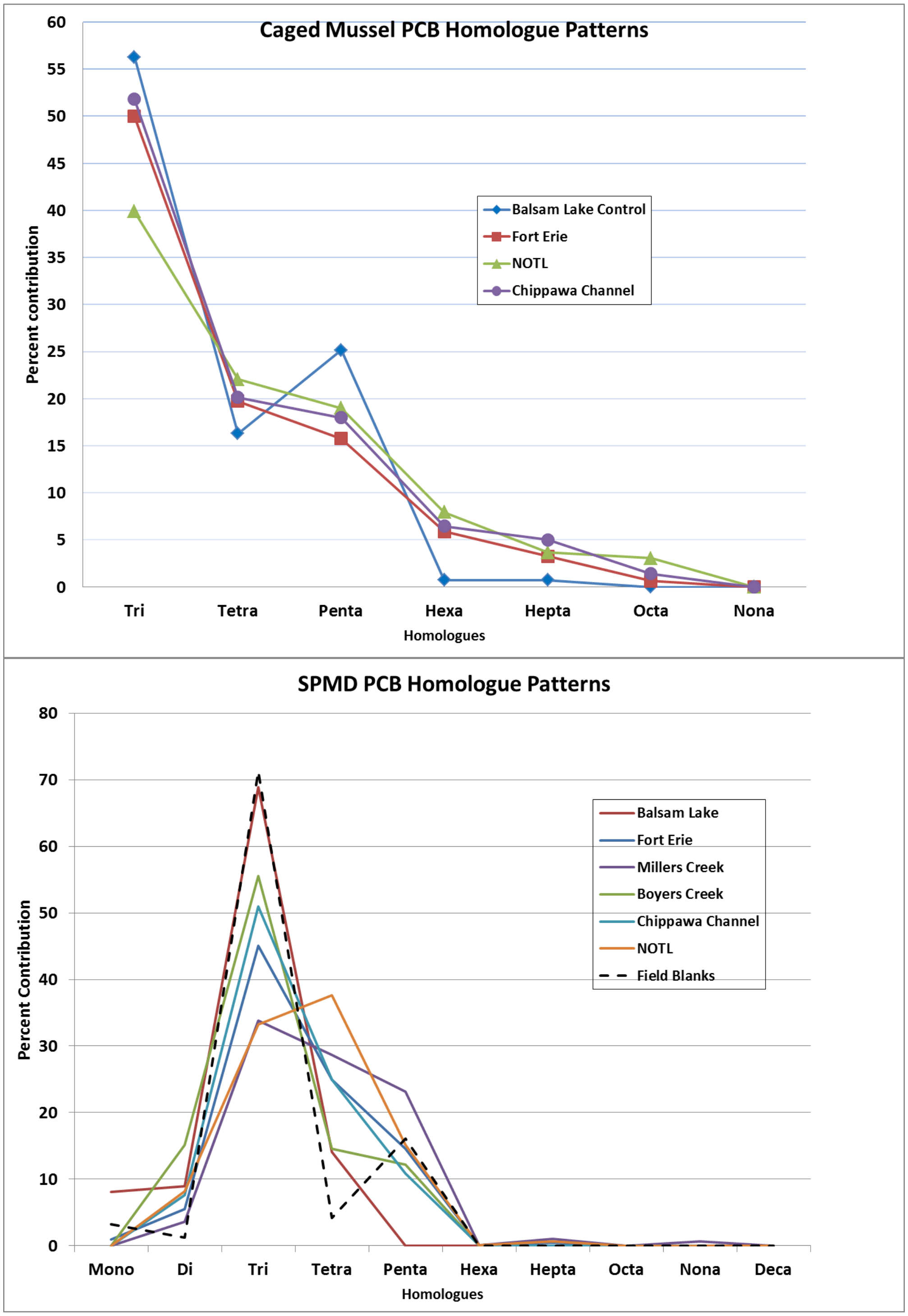


Figure 8: PCB homologue distribution patterns in SPMDs, and caged mussels deployed at various Canadian locations in the Niagara River, 2012. **Note** that the x axis for the SPMDs includes mono, di and deca-chlorinated homologues.

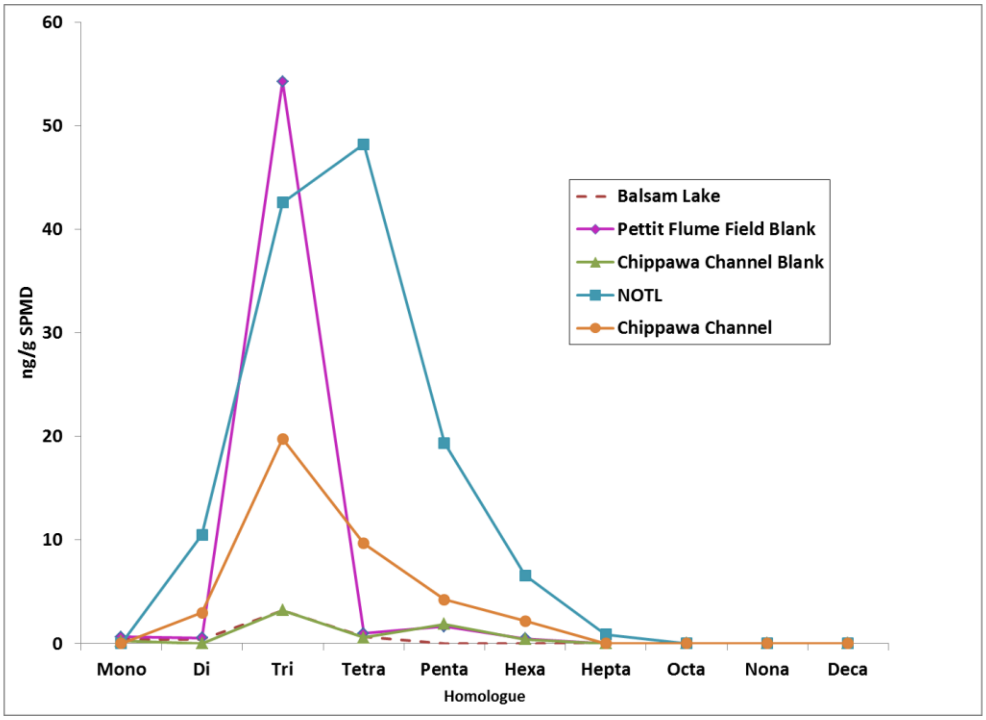


Figure 9: Comparison of homologue concentrations (ng/SPMD) in SPMD field blanks with SPMDs deployed at selected Canadian sites.

Caged Mussel and SPMD Data: American Sites

Two Mile Creek

The 2012 mussel tissue contaminant data for Two Mile Creek was consistent with earlier surveys; OC pesticides, chlorinated benzenes and industrial compounds were not detected in caged mussels. Two Mile Creek has been identified by NYSDEC as a PCB contaminated site due to historic and ongoing active sources (e.g., runoff from landfills, inactive hazardous waste sites, storm sewers, industries such as Spaulding Composites and the Bisonite Company located upstream) (Niagara River Secretariat 2002). PCB contaminated sediment and soil was removed in 2008 from an area associated with General Electric, however, PCB contaminated sediment at the mouth of the creek in the area where the mussels were deployed has not been remediated to date (J. Lehnen, personal communication, NYSDEC 2012). Caged mussel total PCB concentrations (sum of 55 congeners) ranged from 41 to 50 ng/g (wet wt.), and were similar to mean concentrations reported in 2009 (66 ± 4 ng/g) (Table 3) (Richman 2013). PCB concentrations were significantly higher than concentrations detected at all stations in the survey with the exception of mussels deployed at the Occidental sewer outfall which had the highest concentrations in the survey, and Gill Creek and Cayuga Creek which had concentrations that were not significantly different than Two Mile Creek (Figure 6). Homologue patterns in mussels in 2012 resembled Aroclor 1254 and were consistent with patterns reported in earlier studies (Figure 10). Appendix G provides examples of Aroclor patterns for comparison.

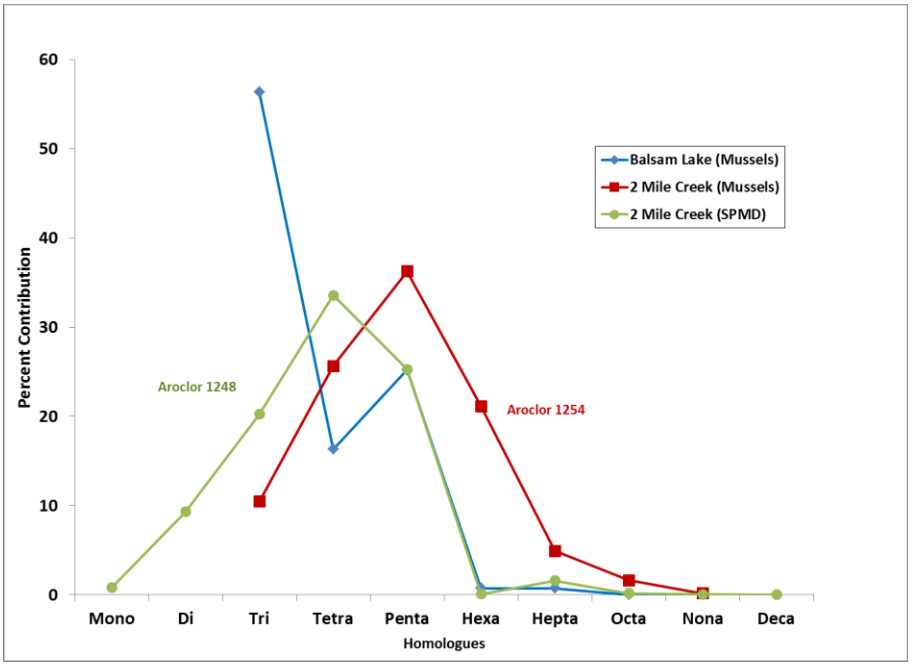


Figure 10: PCB homologue distribution patterns in caged mussels and SPMDs deployed at the mouth of Two Mile Creek, 2012 and in Balsam Lake mussels.

Concentrations of total PCB (Aroclor method) in mussels deployed in Two Mile Creek have been variable since 1987, and at times, variability among deployed mussels within a survey has been high (e.g. 1987; Figure 11). There has been no change through time in mussel tissue concentrations which is not unexpected since there has not been any remediation at the mouth of the creek.

The SPMD data identified several chlorinated benzene compounds, and OC pesticides in Two Mile Creek (Figures 3-5 and Figures 12 & 13) which had not been detected in mussels. Some of the compounds, namely 1,3,5- and 1,2,4 trichlorobenzene, 1,2,3,4 tetrachlorobenzene, pentachlorobenzene, 4,4’ DDD, α and β HCH (by-products of the pesticide lindane), and methoxychlor were present at high concentrations relative to other stations in the survey, suggesting that this creek was a source of these compounds to the Niagara River compared with other sites. SPMD PCB data showed a shift in homologue distribution from resembling Aroclor 1254 to Aroclor 1248 (Figure 10). Additionally, SPMD PCB concentrations in Two-Mile Creek were significantly less than concentrations in Cayuga Creek and Gill Creek as well other stations in the survey, which was inconsistent with the caged mussel data (Figures 6 & 7). The caged mussel tissue PCB concentrations likely reflected PCB contamination in both the sediment and water column due to their feeding behaviour while the SPMDs would only be reflecting PCBs in the dissolved-phase in water and hence the shift to the lower chlorinated homologues. In addition, since the mussels were not depurated prior to analysis, contaminated sediment particles would likely also be contributing to the total PCB concentration.

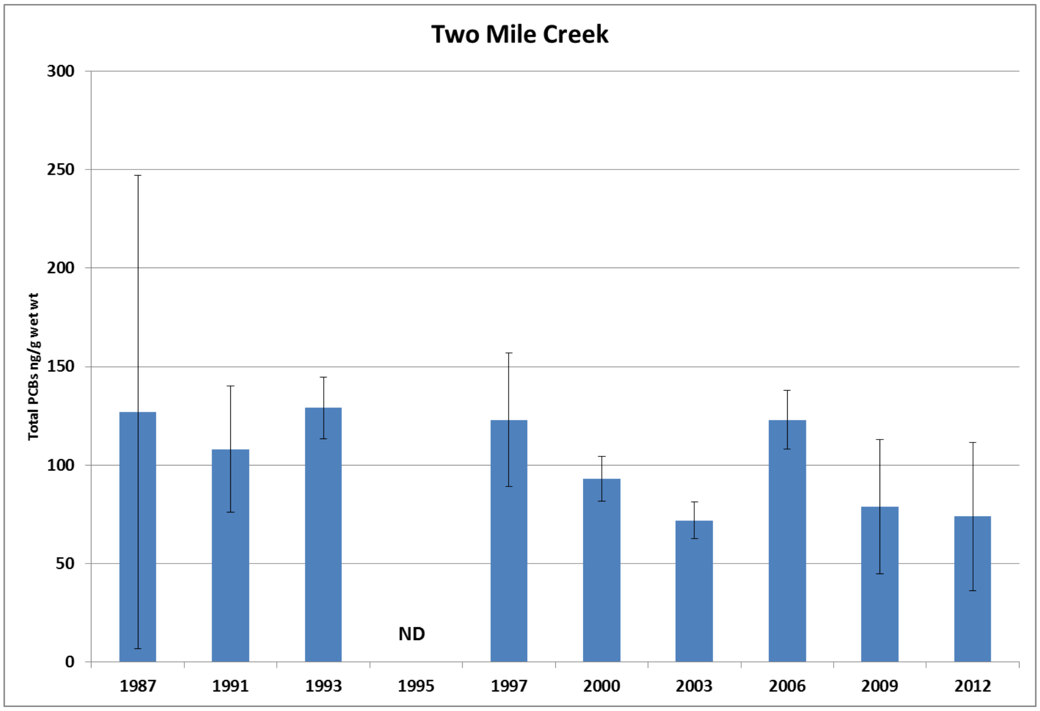


Figure 11: Mean (bars) and standard deviation (whiskers) of total PCB concentrations (Aroclor analytical method (ng/g wet wt.) in caged mussels deployed at the mouth of Two Mile Creek through time (1987-2012).

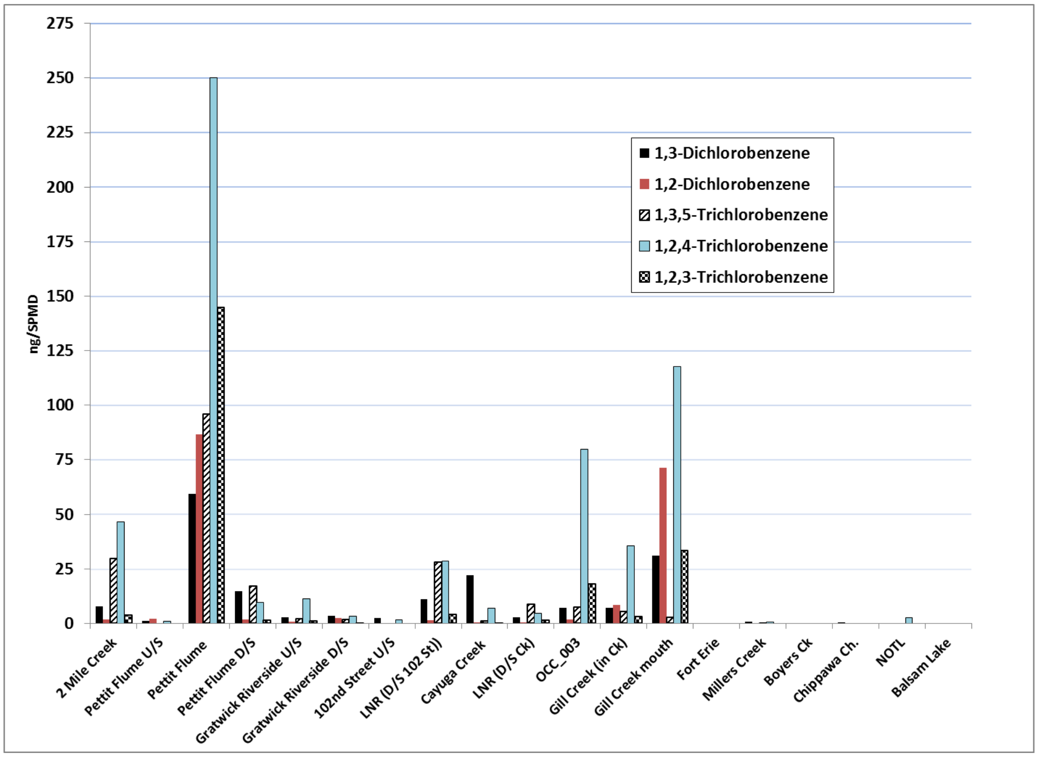


Figure 12: Dichlorobenzene and trichlorobenzene concentrations in SPMDs for the Niagara River, 2012.

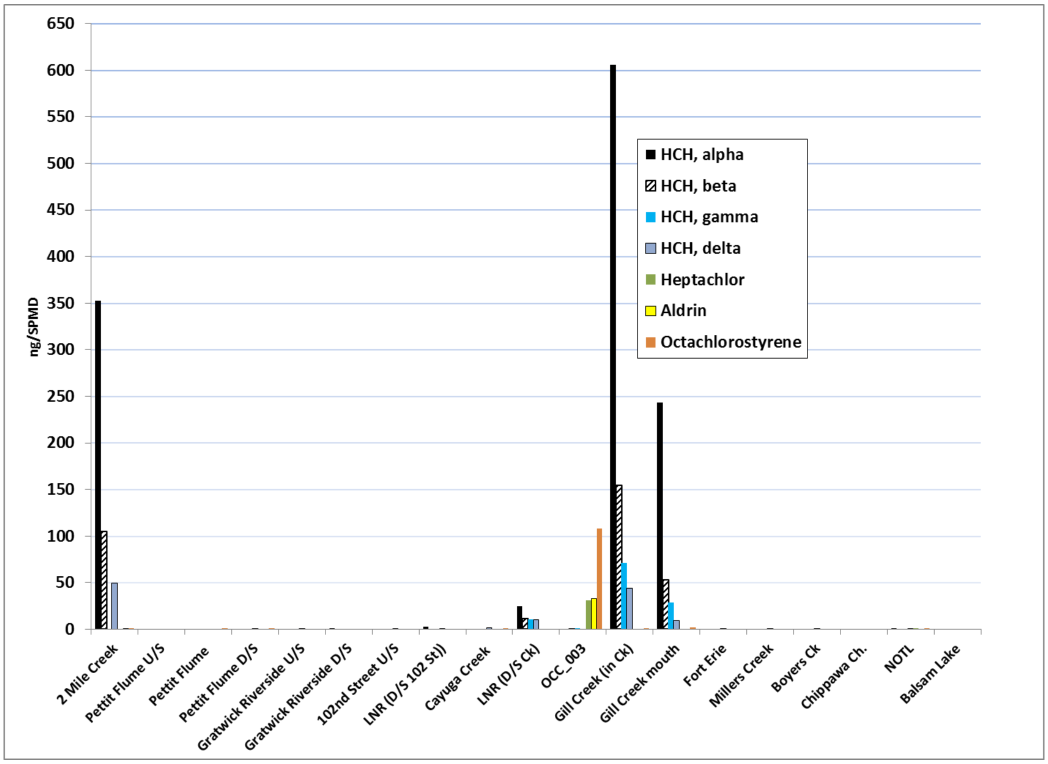


Figure 13: OC pesticide concentrations in SPMDs (ng/SPMD) for the Niagara River, 2012.

Pettit Flume

The Pettit Flume is a storm sewer in North Tonawanda that received waste water from the Occidental Chemical Corporation’s Durez Division and surrounding hazardous waste sites (Geologic Testing Consultants Ltd., 1984). Remediation of the site from 1990 to 1995 included on-site containment of contaminants, removal of contaminated sediment from sewer lines, and sediment removal from the cove. The sediments were contaminated with inorganic and organic wastes including chlorinated phenols, chlorotoluene, dioxins and furans and phenol tar containing chlorinated benzenes (Interagency Task Force on Hazardous Waste, 1979; US EPA and NYSDEC, 2004).

Organochlorine pesticides and PCBs have only been detected at trace concentrations in mussels in past surveys and were never considered contaminants of concern for this site. Prior to the remediation of the cove however, tetrachlorobenzene, pentachlorobenzene and HCB were detected at high concentrations in mussels. Results from 2012 showed trace concentrations of 1,2,4 trichlorobenzene (3 ng/g), 1,2,3,4 tetrachlorobenzene (4-5 ng/g), pentachlorobenzene (7-8 ng/g) and HCB (13-14 ng/g) in mussel tissue consistent with previous years post sediment remediation (Appendix D1) (Figure 14).

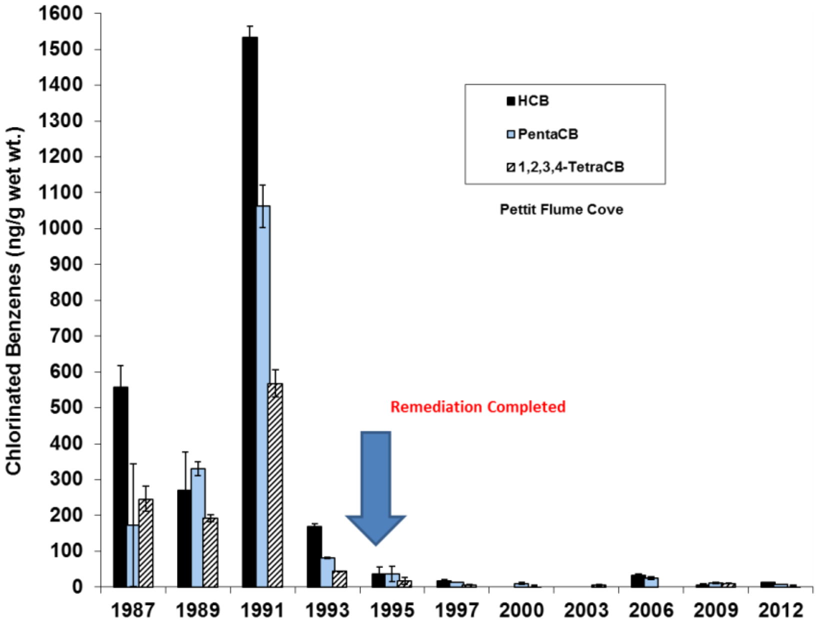


Figure 14: Mean (+/- SE) concentrations of organic compounds in caged mussels deployed at the Pettit Flume Cove through time (1987-2012).

Notwithstanding the decrease in chlorinated benzene concentrations in mussel tissue through time, the SPMDs still identified the Pettit Flume as a source of these compounds. The Pettit Flume had the highest concentrations of di-, tri-, tetra-, pentachlorobenzene and hexachlorobenzene compared with all the other stations in the study with the exception of tetrachlorobenzene at the Occidental 003 outfall (Figures 3 & 12). Concentrations of chlorinated benzenes were orders of magnitude higher at the Pettit Flume and its downstream site compared with other sites in the survey. In contrast to the mussel data, the SPMD data also suggested relatively high concentrations of 4,4' DDD and PCBs compared with the other sites (Figure 4 & 7). The PCB data are of particular interest since the homologue pattern was dominated by mono and dichlorobiphenyl (Appendix F). This pattern may reflect the presence of Aroclor 1221 or the dechlorination of historically deposited higher chlorinated PCBs. These homologues were not analysed in the caged mussels by the MOECC laboratory and so the high concentrations of PCBs were not measured in previous surveys. This assessment using SPMDs will be repeated in 2015 to confirm these findings.

In contrast to the reductions in chlorinated benzenes in mussels, high concentrations of dioxins and furans have been measured in sediment and mussels deployed in the cove consistently since 1993 suggesting the presence of a source that had eluded the remediation in the early 1990's and additional sediment remedial efforts in 2000 (Appendix E) (US EPA and NYSDEC 2002). The sediment collected in 2012 from the cove was highly contaminated with dioxins and furans with a TEQ of 25,494 pg/g (Appendix D3). This concentration was higher than in 2009 which was 3800 pg/g, and similar to concentrations reported in 1997 and 2000. Sediment collected in previous surveys (1993-2006) had total TEQ concentrations that ranged from 11,000 to 48,000 pg/g (Richman *et al.* 2011). The dioxin and furan isomer patterns in sediments from the cove were unique to the cove when compared to other sites in the Niagara River (i.e., concentration of octachlorodioxin was low relative to other isomers) (Figure 15). Additionally, sediment collected from a site immediately upstream of the cove in past surveys (1993-2009) had low dioxin/furan contamination (total TEQ ranged from 13 to 37 pg/g) and isomer patterns in the upstream sediment samples did not match the unique Pettit Flume profile, but was similar to patterns detected in sediment collected at other sites in the Niagara River representative of non-point sources (Richman 2013).

The continued presence of contaminants in the cove was likely due, in part, to residual contamination in the sewer system. Camera inspections (authorized by Occidental) of the sewer line in 2008 and 2009 identified sediment deposits throughout the sewer. Chemical analysis of the sediment detected contaminants associated with the waste deposited in the cove. A decision to manually vacuum the sediment deposits and line portions of the sewer with resin coated liner tubes to prevent further infiltration of contaminated water and sediment was announced by NYSDEC in October 2013 (NYSDEC Fact Sheet 2013). Some of this work was completed in 2014. Further remediation of the dioxin contaminated cove sediment has not been announced to date.

In contrast to the high sediment TEQ, the TEQ for caged mussels deployed in the cove in 2012 was low at 4.4 pg TEQ/g compared to concentrations observed for the site in past surveys (ranged from 42 -195 pg TEQ/g) since 1993. Mussels deployed immediately upstream of the cove had a TEQ of 0.1 pg/g. The higher dioxin/furan concentrations in mussels deployed in the cove suggested that these compounds were bioavailable and coming from the cove. However, it is unclear why the bioavailability of the dioxins and furans was lower in 2012 than in previous surveys, particularly given the high sediment concentrations. Isomer patterns were consistent with previous surveys, and TOC concentrations in sediment, which may influence bioavailability, were also similar to previous years. Mussel physiological factors may have influenced uptake rates although this is only speculation.

High concentrations of dioxins and furans and isomer patterns consistent with those observed in cove sediments were found in mussels (8.3 pg/g) and sediment collected from a station downstream of the cove (total TEQ 379 pg/g) (Figure 15). This indicated that contaminated sediment had migrated out of the cove into the Niagara River. This TEQ is lower than reported in 2009 (7200 pg/g), but a review of the data since 2000 showed considerable variability through time (Appendix E). These results suggested that the sediment in this area is either heterogeneous and/or transitory (i.e. subject to the variable movement and re-suspension of sediment from the cove and then re-suspension and transport further downstream). The SPMD chlorinated benzene data from this downstream site also had higher concentrations relative to the Pettit Flume upstream station which also provides evidence of migration of contaminants from the cove (Appendix F). Additional sediment transport studies from the cove would be required to confirm this theory. However, evidence of movement of contaminated sediment from the Pettit Flume Cove even further downstream is observed at

Fisherman’s Park located about 0.5 km downstream.

SPMDs deployed at the Pettit Flume Cove analysed for dioxins/furans showed the same congener patterns as the caged mussels (Figure 15), and also higher accumulation downstream from the cove compared with inside the cove (upstream: mean TEQ 0.57 pg/SPMD; SD 0.02 pg/SPMD; cove: mean TEQ 121 pg/SPMD; SD 16 pg/SPMD; downstream: mean 160 pg/SPMD; SD 66 pg/SPMD). The higher concentrations of dioxins/furans in the dissolved phase measured by the SPMDs at the downstream site compared to the site in the cove may suggest greater bioavailability at the downstream site and provide an explanation as to why the caged mussels accumulated higher concentrations of dioxins/furans at this site compared to the mussels deployed in the cove.

Fisherman’s Park

The Raymond J. Klimek Fishermen's Park was created in the 1970's along the shore of the River on a former dumpsite due to decades of operation of Tonawanda Iron Works (also known as Tonawanda Iron and Steel). The company was founded in 1873 and operated for 99 years until 1972 after having changed ownership on several occasions (City of North Tonawanda 1997). Fisherman’s Park is bounded on both sides by inlets which appear to receive Niagara River water. Two monitoring sites were established within the inlets: upstream and downstream of the park. The total TEQ for mussel tissue was 2.5 pg TEQ/g and 0.4 pg TEQ/g at the upstream and downstream site respectively which indicated bioavailability of PCDD/Fs. The total TEQ for dioxins and furans in sediment (333 pg TEQ/g and 210 pg TEQ/g upstream and downstream sites respectively) were high and isomer patterns matched the Pettit Flume signature (Figure 15). Concentrations at Fisherman’s Park were 10 to 15 times greater than the the Canadian Sediment Quality Guidelines (CSQG) probable effect level (PEL) of 21.5 pg TEQ/g (CCME 2001). This data suggested that dioxin and furan contamination of the site was likely influenced by the downstream movement of contaminated sediment from the Pettit Flume, however historically there was a storm sewer that discharged to the upstream inlet which is no longer operational but could have been the source of the dioxins as well.

With the exception of low concentrations of PCBs, organic contaminants (OC pesticides and chlorinated benzenes) were not detected in caged mussels deployed at either of the two Fisherman’s Park sites (Appendix D1). Congener specific PCB concentrations (sum of 55 congeners) ranged from 14-18 ng/g wet wt. (110 to 140 ng/g dry wt.) at the upstream site and from 9 -10 ng/g wet wt. (78 to 100 ng/g dry wt.) at the downstream site (Table 3; Appendix D2). Concentrations at the downstream site were not significantly different than the Balsam Lake Control mussels and homologue patterns at both sites suggested atmospheric sources of PCBs.

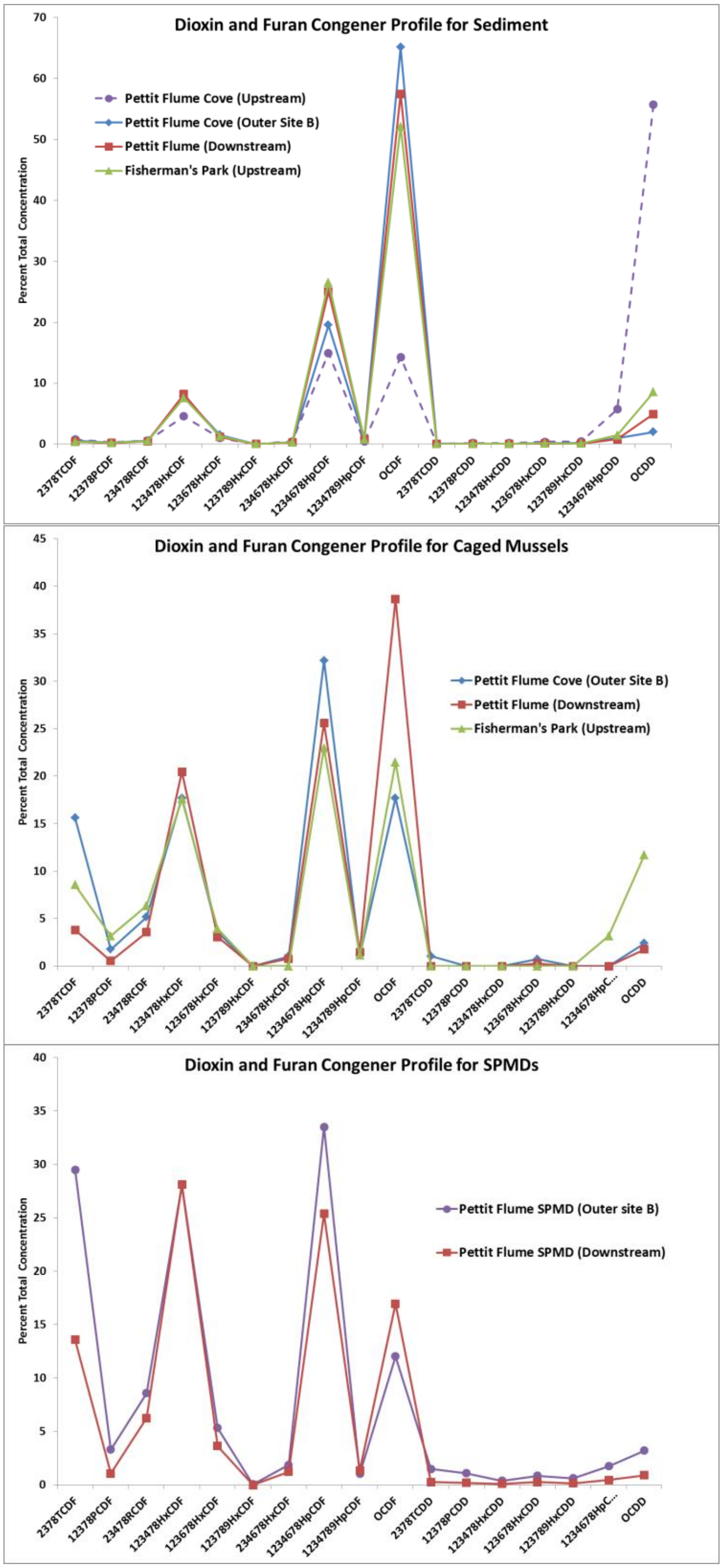


Figure 15: Dioxin and furan congener patterns in sediment and mussels collected from the Pettit Flume and Fisherman’s Park, 2012 and from SPMDs deployed at Pettit Flume. The Pettit Flume upstream sediment data is from 2009.

Gratwick Riverside Park (GRP)

The park is located along the shore of the Niagara River in the city of North Tonawanda. It is 53 acres and was used, prior to the 1970's, as a landfill that accepted municipal and industrial waste as well as metallurgical slag, and phenolic waste from the Occidental Durez site. It was identified as a State Superfund site and remedial actions began in 1999. The goal of the remediation was to provide shoreline protection, install a slurry wall between the site and the river to act as a hydraulic barrier and prevent the movement of contaminants to the river, cap the site so that it can be used as a park and collect and treat contaminated groundwater. Remediation of the site was completed by 2003 (USEPA and NYDEC 2003). This site has not been monitored using caged mussels since the 2003 post remediation monitoring because concentrations of most contaminants were below the detection limit in the mussels.

Since the former waste site is about 1.5 km in length two stations were established along the shoreline of GRP in an attempt to identify movement of contaminant from the site: one at the upstream end and one at the downstream end. Between 1987 and 2003 tetra, penta and hexachlorobenzene, and total PCBs were present in mussel tissue on occasion and concentrations were variable between years. A review of the 2012 SPMD results identified PCBs at the upper end of the Park as being significantly higher than most other sites in the river with the exception of the Pettit Flume and the Occidental outfall suggesting two possibilities: 1) PCBs were still leaching into the river from the former waste site; 2) there are additional sources of PCBs upstream of GRP (Figures 7 and 16). The homologue pattern suggested Aroclor 1248 as the PCB source.

The SPMDs did detect OC pesticides and chlorinated compounds at Gratwick Riverside Park stations, but the concentrations were typical of other Niagara River stations and likely reflected Niagara River nearshore concentrations. The caged mussel data did not provide any additional information with almost all parameters in 2012 below detection. Total PCB using the Aroclor method supported the SPMD data with higher concentrations at the upstream station compared with the downstream station (Appendix D1). The SPMD PCB results will be reassessed in 2015 with the inclusion of sites located further upstream of GRP to act as upstream reference sites when compared with GRP.

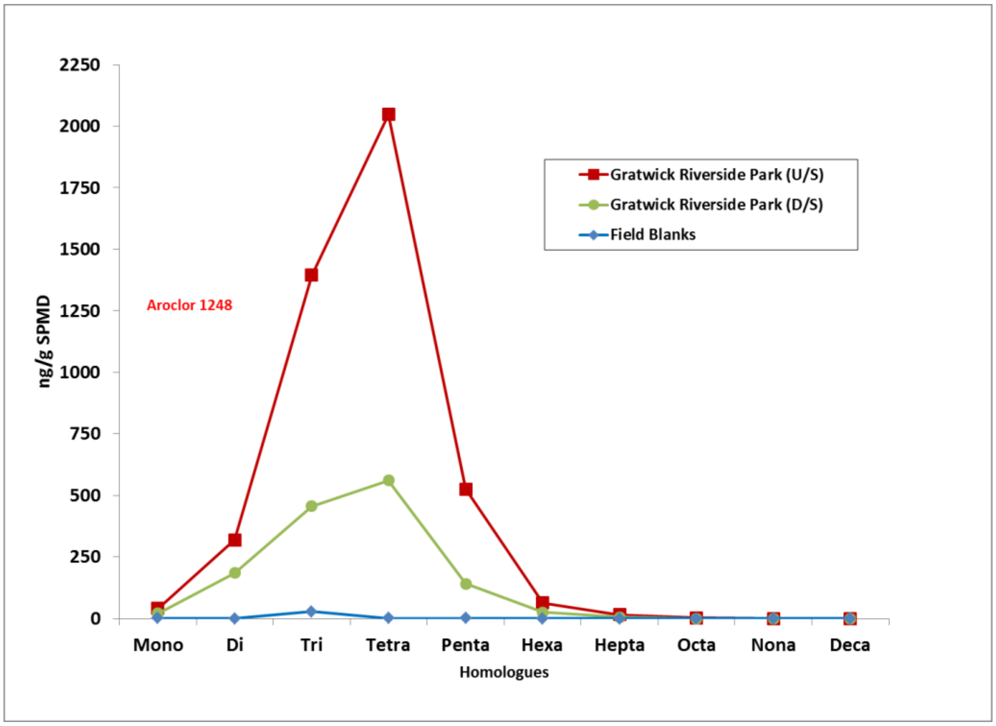


Figure 16: Mean PCB homologue concentrations (ng/SPMD) in SPMDs deployed at the upstream and downstream end of Gratwick Riverside Park and the mean field blank concentration.

102nd Street Hazardous Waste Site, Little Niagara River (LNR), and Cayuga Creek

The 102nd Street hazardous waste site located in the city of Niagara Falls on the bank of the Niagara River was used by Occidental and Olin Chemical Corporation between the early 1940s and 1971 for the disposal of an estimated 150,000 tons of hazardous waste (NRTC 1984; USEPA and NYSDEC, 2002). Remedial actions including the on-site containment of contaminants, implementing a program for the long-term pump and treatment of contaminated groundwater, and the removal of contaminated sediments from the Niagara River were completed in 1999. Details about the site and long-term mussel contaminant trends are provided in Richman *et al.* 2011. Post remediation mussel monitoring surveys showed a decrease in trichlorobenzenes, tetrachlorobenzene, pentachlorobenzene and hexachlorobenzene as well as dioxins and furans at the 102nd site following removal of highly contaminated sediment.

The LNR branches off from the Niagara River about 240 m downstream of the 102nd Street waste site. It travels a short distance around an island and downstream of the mouth of Cayuga Creek, and then rejoins the main river further downstream (Station location map: Appendix H).

In 2006 and 2009, the signature compounds reflective of the 102nd Street waste site (chlorinated benzenes and dioxins and furans) were present in caged mussels deployed in the LNR which suggested that contaminated sediment had migrated downstream prior to the remediation. In 2012, these organic compounds were not detected in mussels deployed in the same area. However, a comparison of the SPMD data upstream and downstream of the 102nd Street waste site did show higher concentrations of compounds representative of the chemicals from the hazardous waste site at the downstream location confirming the 2006 and 2009 mussels data (Figures 3-5 and Figure 12). The reason for the inconsistency between mussels and SPMDs in 2012 is unclear but may be related to lower detection limits in the SPMDS. These same compounds were present in SPMDs located further downstream in the LNR at albeit lower concentrations, but still reflective of contaminated sediment likely transported from the waste site.

The highest concentrations of mirex in SPMDs for the 2012 survey were present at the LNR site (range: 20 to 24 ng/SPMD) downstream of 102nd St. (Figure 17). The presence of mirex at this site was not surprising given that the 102nd Street waste site was used by Occidental and they were the sole producer of mirex until 1976 when its use was restricted by both Canadian and U.S. legislation (Apeti and Lauenstein, 2006; Interagency Task Force on Hazardous Waste, 1979). Mirex has been detected by MOE and NYSDEC in 2006 and 2009 respectively in juvenile fish collected from the LNR (MOE unpublished data: Biomonitoring Section, Environmental Monitoring and Reporting Branch; Preddice et al. 2011).

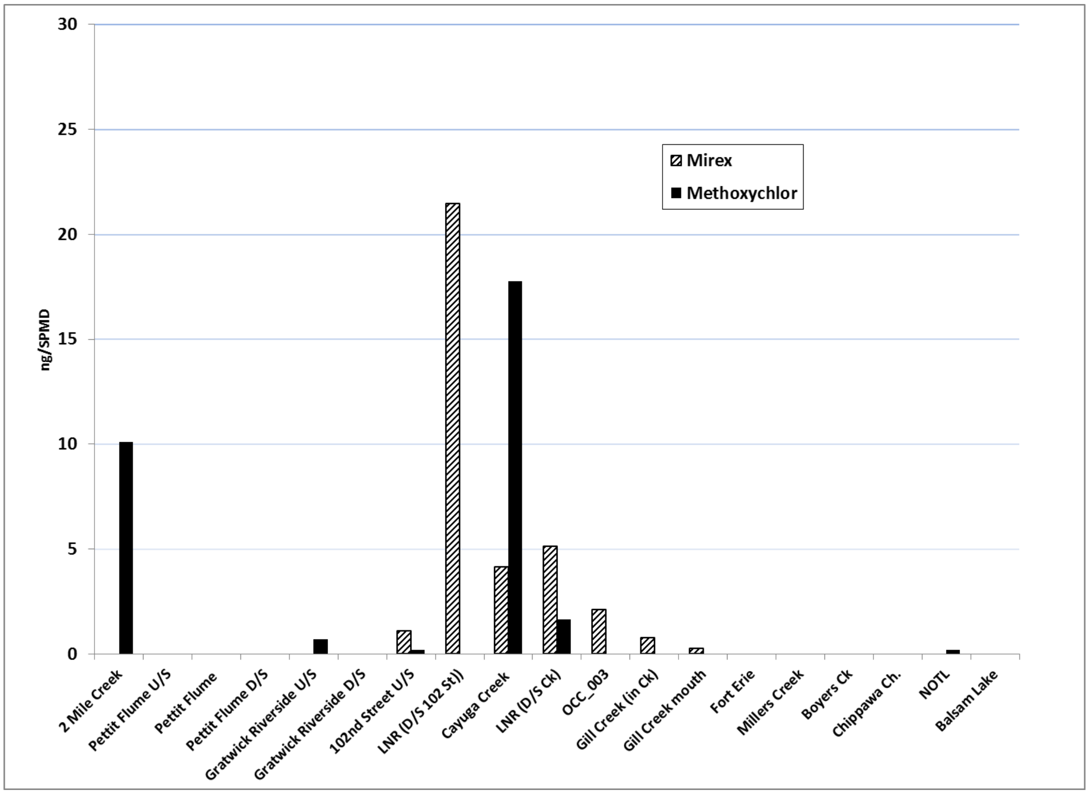
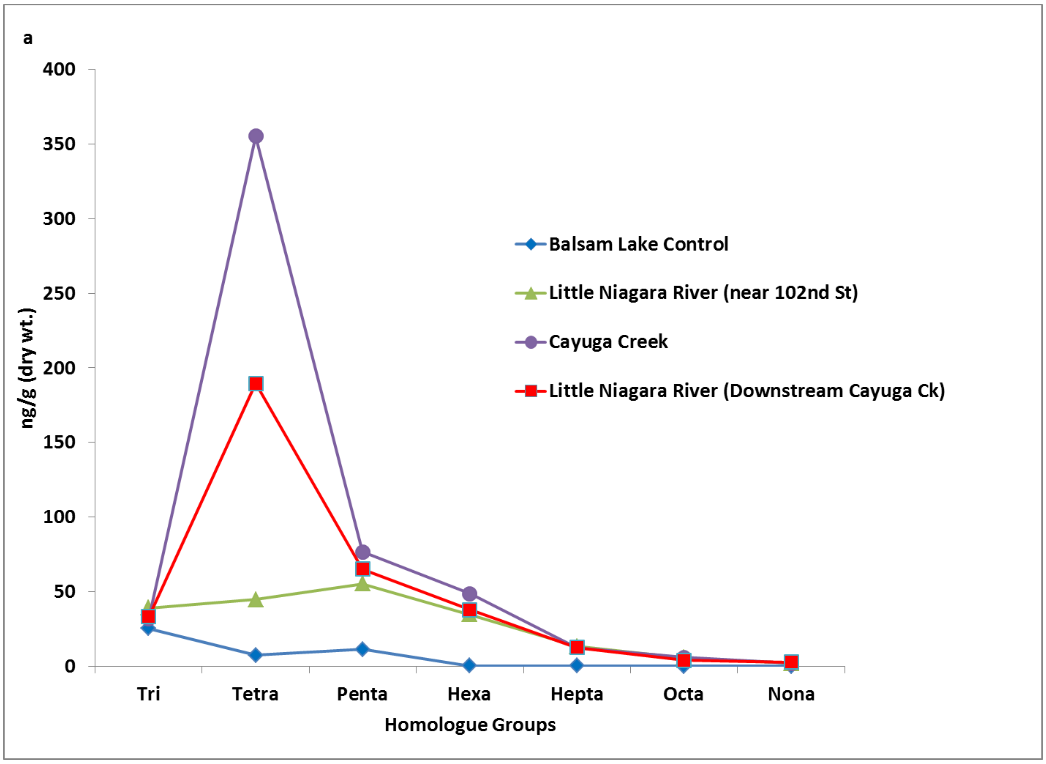


Figure 17: Mirex and methoxychlor concentrations in SPMDs (ng/SPMD) for the Niagara River, 2012

Sampling stations were also located within Cayuga Creek which discharges to the LNR. Based on caged mussel data from earlier surveys and from 2012, the creek is a source of PCBs to the LNR. Total PCBs (based on congener-specific analysis) were significantly higher ($p<0.001$) in caged mussels deployed in the creek than at all other stations in the 2012 survey with the exception of the Occidental outfall (Figure 6). High PCB concentrations were also present in mussels deployed at the LNR station downstream of Cayuga Creek. The PCBs in these mussels had similar homologue patterns (representative of Aroclor 1248), and were significantly higher ($t=9.0$; $p<0.001$) than mussels deployed at the LNR upstream station suggesting that Cayuga Creek was the source (Figure 6 and Figure 18a and Appendix H for site map). The SPMD PCB data supported the caged mussel data with SPMDs deployed in Cayuga Creek having higher concentrations compared with the remaining sites, with the exception of Occidental and the Gratwick Riverside Park upstream station (Figure 7; Figure 18 b). Total PCB concentrations in sediment collected from the three stations in 2009 ranged from140 ng/g to 570 ng/g, with the highest concentration in Cayuga Creek (Table 3).



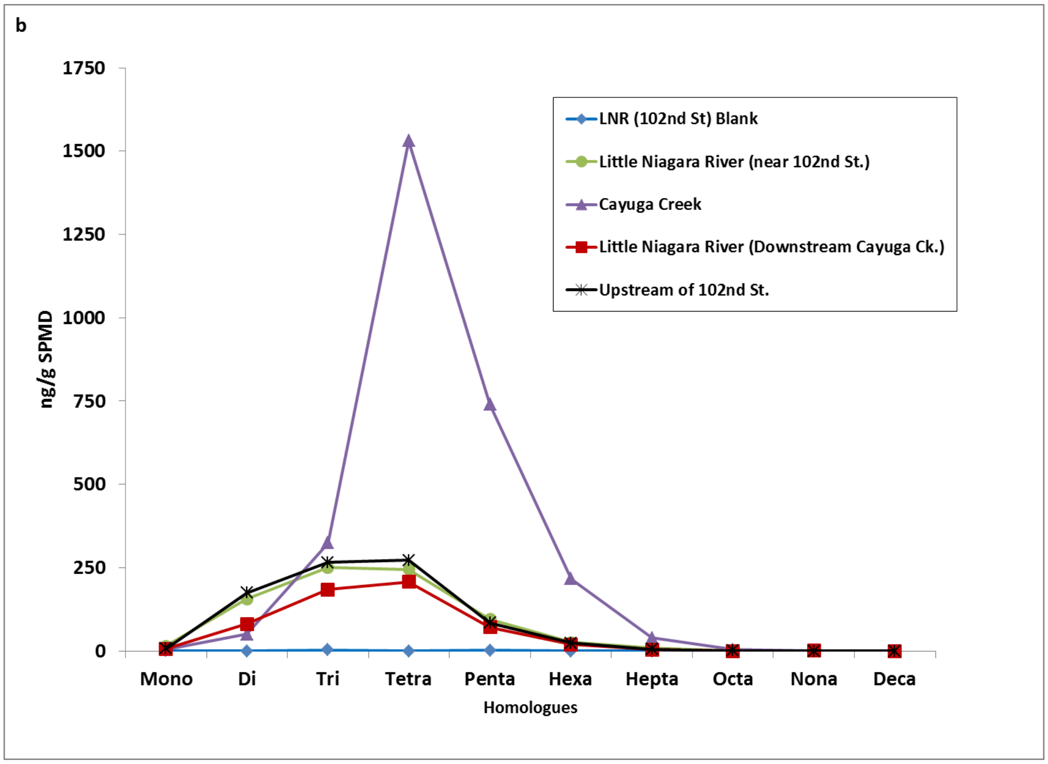


Figure 18: Total PCB concentrations in a) caged mussels (ng/g dry wt.) and b) SPMDs (ng/SPMD) deployed in the LNR and Cayuga Creek, 2012.

Only trace concentrations of p'p-DDE and pentachlorobenzene were present in mussels deployed in Cayuga Creek. However, the SPMDs provided additional information on the water quality including the presence of chlorinated benzenes, and historical use of legacy pesticides. This included high concentrations of 4,4'-DDD (Figure 4), dieldrin (Figure 5), methoxychlor (Figure 17), and α and γ chlordane relative to the other sites (Figure 19). Several sources of contaminants to Cayuga Creek were identified by NYSDEC and included Love Canal, 102nd Street waste site, Charles Gibson landfill and LNR backflow.

Gill Creek

Gill Creek discharges into the Niagara River just above Niagara Falls on the U.S. side. The creek received contaminants from the Olin Chemical Corporation (Buffalo Avenue Plant) and the E. I. Dupont Company upstream of the mouth. These two plants had three and six hazardous waste sites on their properties, respectively. Additionally, NYSDEC identified over 100 sources of contaminants within the watershed. Briefly, Gill creek was a major contributor of PCBs to the Niagara River; estimated to have contributed as much as 20% of the total PCB load (USEPA and NYSDEC, 1994). Remediation of PCB contaminated sediment in Gill Creek upstream of the mouth was completed in 1992. Additional sediment remediation was completed further upstream in 1998.

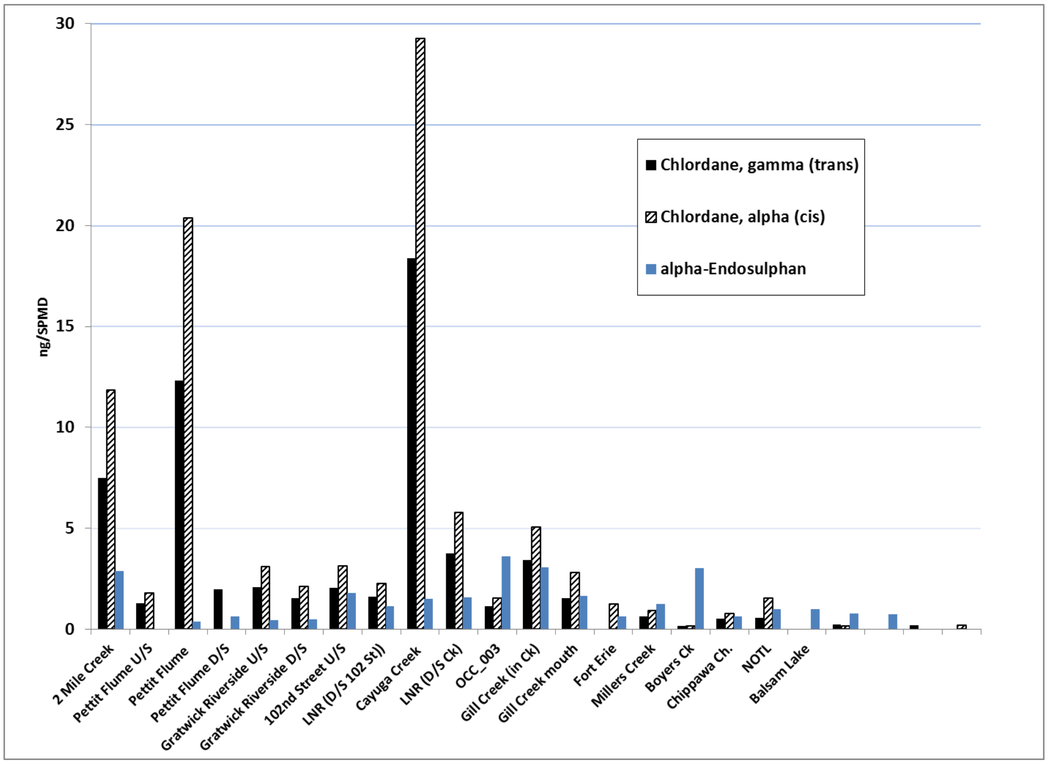


Figure 19: Chlordane and alpha-endosulphan in SPMDs (ng/SPMD) for the Niagara River, 2012.

Concentrations of total PCBs in caged mussels deployed at these two sites have decreased post remediation; however, some PCB contamination remains. Total PCB concentrations in mussels deployed in Gill Creek near the mouth (mean 47 ng/g +/- SE 2 ng/g wet wt.) and upstream within the creek (mean 28 ng/g +/- SE 1.8 ng/g wet wt.) were significantly higher than Balsam Lake control mussels (t= 19 and 11 respectively: $p<0.001$) and mussels deployed in the Niagara River upstream of the creek (t= 18 and 10 respectively; $p<0.001$) identifying the creek as a source of PCBs to the Niagara River.

Despite the remediation of PCB-contaminated creek sediments, other contaminants continue to be detected in caged mussels and SPMDs deployed at these sites. Compounds such as α-HCH and β-HCH (metabolites of the pesticide lindane), hexachlorobutadiene (HCBD), and chlorinated benzenes have been routinely detected in mussels, as well as in sediment and juvenile fish by NYSDEC (Preddice *et al.* 2011). HCBD, for example, was stored in waste sites which were known to be leaching contaminants into the Creek. With the exception of low concentrations measured in SPMDs at the Occidental outfall, Gill Creek was the only site in the 2012 survey where HCBD was present (mean: 1627 ng/SPMD; SD 188 ng/SPMD) identifying Gill Creek as a source. The SPMDs also detected the highest concentrations of α–HCH (mean 605 ng/SPMD; SD 18 ng/SPMD) in the survey and 1,2,4 trichlorobenzene and second highest concentration of 1,2 dichlorobenzene (Figures 12 and 13).

Occidental Chemical Corporation (OCC), Buffalo Avenue Plant, Niagara Falls, New York

OCC's Buffalo Avenue Plant is located adjacent to the Niagara River upstream of the Niagara River’s confluence with Gill Creek. Persistent, bioaccumulative contaminants have entered the Niagara River along the waterfront via sewers and contaminated groundwater (NRTC, 1984).

The facility has manufactured over 250 chemical products with direct discharges to the river. Additionally, there are at least 10 hazardous waste sites located on the property which have leached contaminants into the groundwater. Throughout the 1990s, there have been extensive remediation efforts at various locations on the property which may explain, in part, the decreases in concentrations of 1,2,3,4-tetrachlorobenzene, pentachlorobenzene and HCB observed in caged mussels deployed near the sewer outfalls along the OCC property between 1987 and 1997 (Figure 20). However, Sewer 003 is an active outfall servicing the Occidental facility and is clearly an ongoing source of contaminants based on continued high contaminant concentrations in caged mussels and SPMDs.

In 2012, total PCB concentrations measured in caged mussels and SPMDs were of particular note: both monitors identified Sewer 003 as having the highest concentration of PCBs (Figures 6 and 7). The homologue pattern in both datasets resembled Aroclor 1248 (see Appendix G). These data suggested that this outfall is a source of concern due to highly elevated concentrations of bioavailable PCBs.

Likewise, Sewer 003 had the highest concentrations of tetrachlorobenzes (> 600 ng/SPMD) and was the only site with detectable octachlorostyrene (Figures 3 and 13). In addition to Bloody Run Creek, Sewer 003 was also the only site where 2,3,6- and 2,4,5-trichlorotoluene were present in caged mussels which was consistent with previous years of data. Trichlorotoluene is a manmade chemical with several different isomers which are generally released in the manufacture of other chemicals. For example, 2,3,6-trichlorotoluene is a herbicide intermediate but also has uses as a solvent and dielectric fluid.

Bloody Run Creek

Hyde Park, a 6.1 hectare hazardous waste disposal site, was operated by the Hooker Chemical Co. (now Occidental Chemical Co.; OCC) from 1953 to 1975 (NRTC, 1984). Approximately 55,000 tons of halogenated wastes including chlorinated benzenes, toluenes and phenols were buried at this site (Interagency Task Force on Hazardous Waste, 1979). The 2,4,5-trichlorophenol wastes contained significant amounts of 2,3,7,8-TCDD. Bloody Run Creek (BRC), which runs adjacent to the waste site, drains storm water run-off and overburden leachate overflow from the site and discharges it into the lower Niagara River. Despite the remediation at the Hyde Park site and the upper section of the Creek, the lower section continues to be a source of contaminants to the Niagara River.

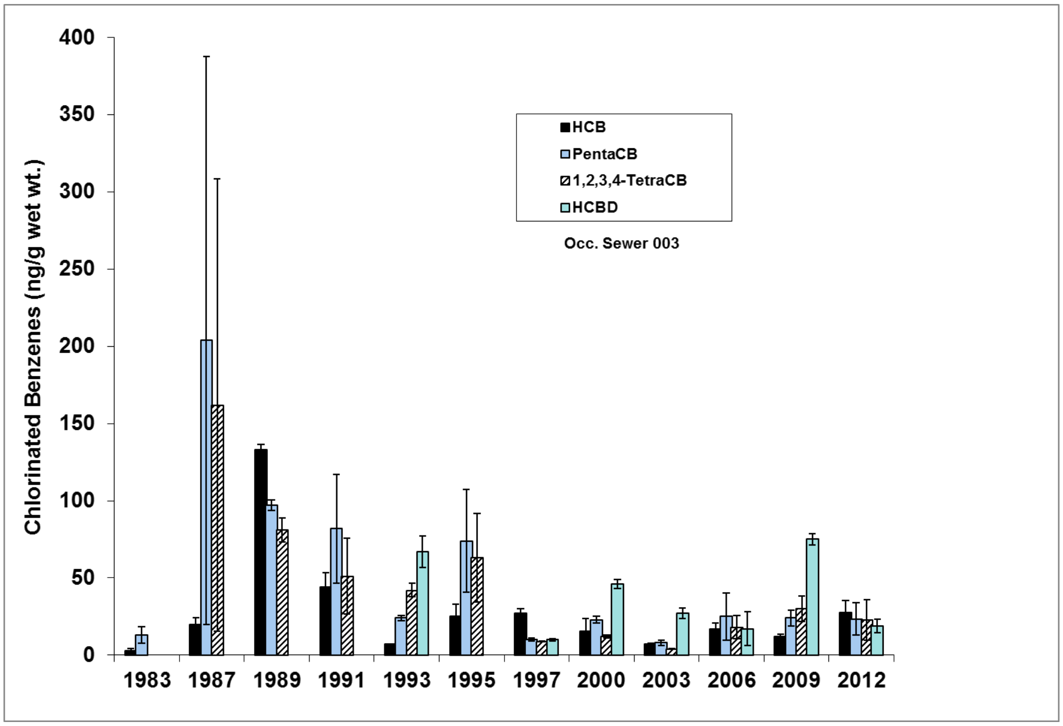


Figure 20: Concentrations of chlorinated organic compounds in caged mussels deployed at the Occidental Chemical Corp. Sewer 003 through time (1983-2012).

Contamination to the Niagara River was substantiated with relatively high concentrations of 1,2,3,4-tetrachlorobenzene, pentachlorobenzene and HCB in mussels collected from the BRC site since 1987 (Figure 21). There has been some variation in contaminant concentrations measured in mussels through time although the compounds present at this site have remained consistent. Variations in bioavailability could be linked to rainfall events experienced during the deployment. Particularly low rainfall could result in decreased surface run-off from the contaminated lower gorge which, in turn, would have decreased the off-site migration of contaminants. This could explain the relatively lower concentrations of contaminants present in 1997 and 2012. The cause of the significantly higher tissue concentrations in mussels in 1993 is unknown and cannot be completely explained by the increased rainfall that summer since greater accumulation of rain from 2004-2009 did not generate similarly elevated mussel tissue contaminant concentrations observed in 1993. The increase in concentrations measured in 1993 could be related to remedial activities at the Hyde Park waste site. Throughout the early 1990’s there was continuous construction at the waste site in order to implement remedial actions which included installation of extraction wells, purge wells and monitoring wells. It is possible that work at the site increase the movement of offsite contaminants in the short term until remedial actions to contain offsite migration were up and running (USEPA and NYSDEC 2002).

Sediment collected from the shoreline of the Niagara River in the vicinity of Bloody Run

Creek between 1993 and 2012 had consistently high concentrations of dioxins and furans although concentrations have increased and decreased in what appears to be a random fashion (Appendix E). This data suggested heterogeneous contamination with dioxins and furan along the shoreline and nearshore bed sediment. Given the original source of contamination and a massive rock slide in the lower gorge in 1994, this is not surprising. The dioxins and isomer patterns found in Bloody Run Creek sediments were distinct from those seen at other sites in the Niagara River with lower concentrations of octachlorodioxin relative to the 1,2,3,4,6,7,8-heptachlorodioxin. Furthermore, all the tetra dioxin was in the form of 2,3,7,8-TCDD, the most toxic form of dioxin (Figure 22). Earlier studies have shown that the contribution of DL-PCBs to the total TEQ was negligible. The unique congener pattern present in the sediment was also present in the caged mussels demonstrating bioavailability of the contamination.

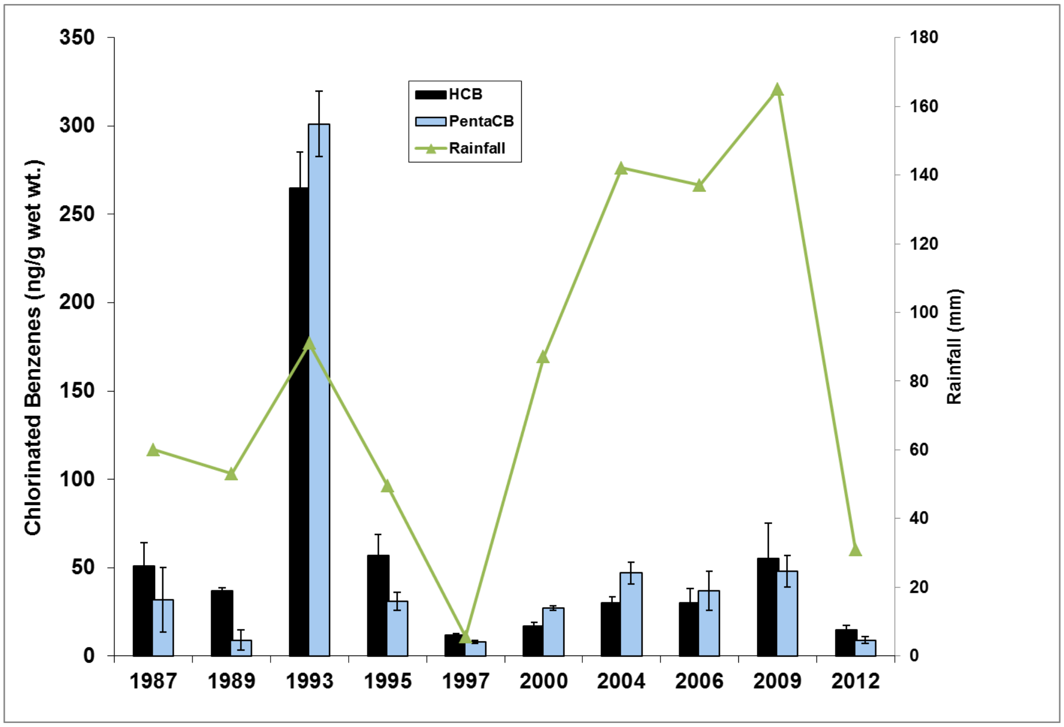


Figure 21: Concentrations of organic compounds detected in caged mussels deployed at Bloody Run Creek 1987-2012. Rainfall data was obtained from http://www.wunderground.com/history/airport/KIAG/2012/8/5/DailyHistory.html

Sediment collected from a shoreline station about 70 m upstream of the Creek had relatively low concentrations of dioxins and furans (346 pg/g) compared to the BRC site, but the 2012 concentration was greater than in past years (Appendix E), and the congener pattern was consistent with the BRC pattern and not the typical “upstream pattern” characteristic of this station. These data suggested that our sampling location was not consistent with previous surveys. Additional sampling in the 2015 survey, from multiple upstream locations will be required to confirm this theory.

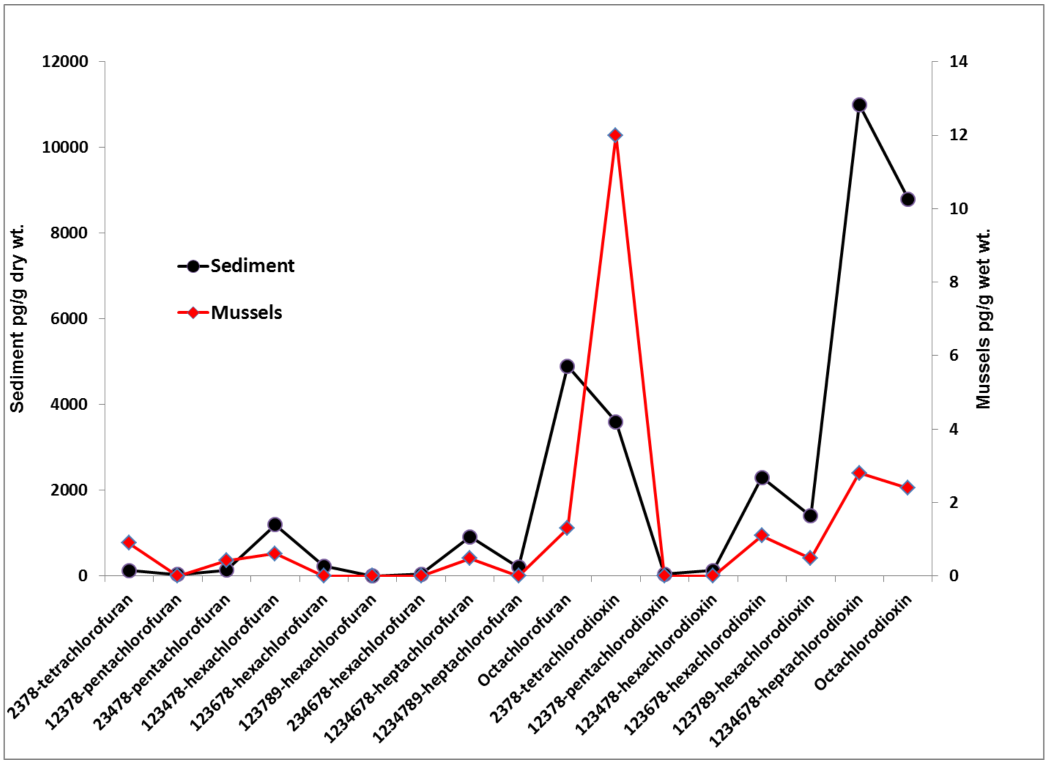


Figure 22: Dioxin and furan isomer patterns in sediment and caged mussels deployed at the mouth of Bloody Run Creek, 2012.

Using SPMDs to Estimate Water Concentrations

SPMD sampling rates are independent of water concentrations (Huckins *et al*. 1996). The amount of accumulated chemical in the SPMDs is proportional to the ambient concentrations of the dissolved phase of the chemical. However, temperature, bio-fouling and water current velocity have been shown to affect uptake rates (Huckins *et al.* 1996; Petty *et al.* 2000; Vrana and Schuurmann 2002; Booij *et al.* 2006; Wang *et al.* 2009). Huckins *et al.* (1996) showed that sampling rates increased with ambient temperature and hydrophobicity (up to about a log K_{OW} of 6). However, studies have also shown sampling rates to decrease for compounds that have a log K_{OW} of greater than 6 (Petty et al. 2000), and that temperature may not have a significant impact on uptake rates (Booij *et al.* 2003).

In the Niagara River survey, temperature was similar at all sites with the average temperature ranging from 21.8 to 27.3 ^{o}C (Appendix B) and there was minimal bio-fouling of the SPMDs at all sites. Although not measured, visual observations of the water currents at each station suggested that velocity likely did vary. Even if water current rates were available, the SPMDs were, at times, covered by large rocks as camouflage, which would alter the flow in the immediate vicinity of the SPMD. Differences in uptake rates due to these site by site variations in water current can affect the accurate estimates of water concentrations of the compounds of interest among the sites. However, large differences in contaminant concentrations among sites that would identify sources should not be affected by these site to site variations.

One method to account for these differences is to use Performance Reference Compounds (PRCs) which are standardized compounds added to the triolein (Huckins *et al.* 2002). The effects of environmental variables (e.g., temperature, water current) on the uptake rates of the compounds of interest can be approximated by the effects of these variables on the loss rates of the PRCs. PRCs for PCB congeners 14, 29 and 50 were added to the SPMDs and their concentrations were measured after deployment. This information was entered into the USGS SPMD Water Concentration Estimator.

Water concentrations estimated in this way were compared to NYSDEC or MOECC water quality criteria (which ever was most conservative) to determine if the presence of these compounds could be potentially problematic to biota (Table 4). Criteria for total PCBs, dieldrin, mirex, DDT metabolites and HCB were most frequently exceeded for the parameters analyzed. Concentrations for most parameters were typically higher on the US side compared to the Canadian side but overall, organochlorinated pesticides, and industrial organic compounds, were present at low concentrations throughout the Niagara River. The SPMD data allowed for the identification of source areas for these compounds, particularly highlighting the American tributaries (Two Mile Creek, Cayuga Creek, and LNR), but even in those cases the estimated water concentrations suggested that most parameters (with the exception of those that exceed the criteria) do not appear to be problematic to biota. However, many of the contaminants are hydrophobic and are likely bound to sediment, accordingly, impacts on the benthic community and food chain effects cannot be assessed from this monitoring tool. Additionally, Water Quality Criteria tend to be based on whole water concentrations which include both the dissolved phase and particulate phase concentrations, and so if the comparisons with the criteria use only the dissolved phase, actual contamination may be underestimated particularly for hydrophobic compounds like PCBs. Since the SPMDs are integrating exposure overtime and are therefore providing a mean concentration, episodic events likely have greater concentrations.

Water concentration estimates of PCBs were particularly interesting as they highlight the Occidental outfall as a problematic source of PCBs (237 ng/L), the area near Gratwick Riverside Park hazardous waste site (52 ng/L), and the 102nd Street Hazardous waste site and Cayuga Creek (19 ng/L and 54ng/L respectively). Additional monitoring of these sites, and the Pettit Flume cove (PCB: 151 ng/L) is recommended for 2015.

Environment Canada's Upstream/Downstream Water Monitoring Program was designed to collect 24 hr. time integrated dissolved and particulate samples every two weeks from FE and NOTL. Mean contaminant concentrations for the dissolved fraction of the samples encompassing the period of SPMD deployment were compared with the SPMD data from the two locations (Table 4). Note that the EC data is currently provisional since a report has not been produced (Great Lakes Water Quality Monitoring and Surveillance, Brad Hill: personal communication). Agreement between the two datasets was good for several parameters measured at NOTL (e.g., HCB, HCBD, pentachlorobenzene, α-HCH, metabolites of DDT, chlordane, dieldrin and PCBs), and PCBs and dieldrin at FE. Sampling location differences (nearshore for the SPMDs and off-shore for the EC samples) may contribute to some of the variability between datasets.

Table 4 (updated April 2022): Mean estimated water concentrations (ng/L) using 2012 SPMD data and the USGS Water Concentration Estimator.

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font. U/S = upstream; D/S = downstream

	Agency	Water Quality Criteria	2 Mile Creek		Exceedence Factor (EF)	Pettit Flume[a] upstream	EF	Pettit Flume[a] outer	EF	Pettit Flume[a] Downstream	EF	Gratwick Riverside Park upstream		EF	Gratwick Riverside Park downstream		EF
		ng/L	Mean ng/L	SD ng/L		ng/L		ng/L		ng/L		Mean ng/L	SD ng/L		Mean ng/L	SD ng/L	
1,3-Dichlorobenzene	MECP	2500	3.2	0.35		0.42		24		6.1		1.11	0.12		1.5	0.21	
1,4-Dichlorobenzene	MECP	4000	9.3	0.61		3.7		72		12		5.2	0.49		10	2.0	
1,2-Dichlorobenzene	NYSDEC	3000	0.69	0.11		0.88		36		0.69		0.53	0.005		1.01	0.13	
1,3,5-Trichlorobenzene	MECP	650	0.42	0.03				1.5		0.36		0.03	0.003		0.02	0.003	
1,2,4-Trichlorobenzene	MECP	500	1.1	0.10		0.04		6.4		0.32		0.26	0.03		0.07	0.01	
1,2,3-Trichlorobenzene	MECP	900	0.08	0.01				3.2		0.05		0.03	0.004		0.02	0.004	
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			1.3	0.15		0.01		4.5		0.27		0.04	0.002		0.03	0.002	
1,2,3,4-Tetrachlorobenzene	MECP	100	1.8	0.20		0.01		8.2		0.14		0.02	0.004		0.02	0.003	
Hexachlorobutadiene	NYSDEC	10	0.03	0.003				0.03		0.06					0.00	0.001	
Pentachlorobenzene	MECP	30	2.5	0.32		0.02		5.5		1.05		0.08	0.01		0.07	0.01	
Hexachlorobenzene	NYSDEC	0.03	0.57	0.08	19	0.05	2	4.5	151	4.0	133	0.18	0.02	6	0.12	0.02	4
HCH, gamma (Lindane)	NYSDEC	8	1.0	0.05								0.12	0.11		0.07	0.07	
HCH, alpha	NYSDEC	2	38	0.39	19										0.08	0.14	
HCH, beta			12	1.6													
HCH, delta			1.0	0.26						0.01		0.003	0.01				
Aldrin	NYSDEC	2		0.01													
Octachlorostyrene	NYSDEC	0.006	0.01	0.002	2			0.03	4.6	0.04	7.5						
2,4'-DDE			0.03	0.001		0.02		0.02		0.02		0.02	0.002		0.01	0.01	
4,4'-DDE	NYSDEC	0.007	0.21	0.02	30	0.08	11	0.18	26	0.08	12	0.07	0.01	10	0.04	0.01	6
2,4'-DDD			0.10	0.02				0.22				0.00	0.01		0.01	0.01	
4,4'-DDD	NYSDEC	0.08	0.44	0.05	6	0.07		0.71	9	0.07		0.05	0.01		0.04	0.01	
2,4'-DDT			0.05	0.01		0.03		0.02		0.03		0.04	0.00		0.01	0.01	
4,4'-DDT	NYSDEC	0.01	0.02	0.01	2							0.003	0.01				
Mirex	NYSDEC	0.001	0.11	0.02	105			0.06	63								
Chlordane, alpha (cis)	NYSDEC		0.12	0.01		0.04		0.23		0.04		0.03	0.001		0.02	0.005	
Chlordane, gamma (trans)	NYSDEC		0.08	0.01		0.03		0.14		0.03		0.02	0.001		0.01	0.002	
Nonachlor, cis-			0.02	0.004				0.03		0.01		0.01	0.002		0.004	0.001	
Nonachlor, trans-			0.07	0.01		0.03		0.12		0.03		0.02	0.001		0.02	0.003	
Heptachlor	NYSDEC	0.2															
Heptachlor Epoxide	NYSDEC	0.3	0.03	0.003		0.03		0.05		0.02		0.02	0.003		0.02	0.002	
alpha-Endosulphan	MECP (proposed)	3	0.32	0.01				0.04		0.07		0.05	0.05		0.05	0.05	
beta-Endosulphan			0.68	0.05				0.19									
Endosulphan Sulphate			0.22	0.20		0.16		0.61		0.09							
Dieldrin	NYSDEC	0.0006	0.10	0.01	165	0.13	218	0.14	233	0.12	200	0.08	0.01	141	0.07	0.01	121
Endrin	NYSDEC	2															
Methoxychlor	NYSDEC	30	0.13	0.01								0.01	0.02				
Total PCB[c]	NYSDEC	0.001	6.2	0.74	6152	8.8	8827	151	150582	10	10004	52	4.5	52233	15	3.4	14954

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

[d] Env. Canada upstream/downstream water quality monitoring program

data represent mean "dissolved" concentrations of 4 sampling event: July 5, July 19, August 2, and August 16 (NOTL), and July 4, July 18, August 1, August 15 (FE)

[e] data value not verified

Table 4 (updated April 2022): Continued

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font.   U/S = upstream; D/S = downstream

			102nd Street			Little Niagara River			Cayuga Creek			Little Niagara River			Occidental Sewer[b]			Gill Creek upstream			Gill Creek mouth		
	Agency	Water Quality	Upstream			(near 102nd St)						(downstream Cayuga ck)						(in creek)					
		Criteria			EF			EF			EF			EF			EF			EF			EF
			Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD		Mean	SD	
		ng/L	ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L		ng/L	ng/L	
1,3-Dichlorobenzene	MECP	2500	1.1	0.12		4.6	0.68		9.1	7.9		1.2	0.18		3.0	0.50		3.0	0.46		13	1.6	
1,4-Dichlorobenzene	MECP	4000	2.8	0.11		15	0.84		86	16		9.7	0.72		4.4	0.75		24	7.7		42	1.7	
1,2-Dichlorobenzene	NYSDEC	3000	3.5	1.1		0.64	0.05		0.13	0.22		0.08	0.14		0.78	0.24		3.5	1.2		29	1.7	
1,3,5-Trichlorobenzene	MECP	650	0.003	0.01		0.65	0.04		0.03	0.001		0.12	0.01		0.12	0.11		0.14	0.08		0.03	0.01	
1,2,4-Trichlorobenzene	MECP	500	0.03	0.002		1.0	0.06		0.20	0.01		0.11	0.02		2.1	1.8		1.3	0.68		2.2	0.73	
1,2,3-Trichlorobenzene	MECP	900	0.005	0.01		0.13	0.01		0.04	0.03		0.03	0.01		0.41	0.33		0.11	0.04		0.51	0.17	
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			0.09	0.01		1.4	0.24		0.06	0.01		0.28	0.01		8.8	1.5		0.62	0.30		0.74	0.13	
1,2,3,4-Tetrachlorobenzene	MECP	100	0.03	0.004		1.9	0.23		0.06	0.01		0.37	0.02		11	15		0.37	0.15		0.36	0.07	
Hexachlorobutadiene	NYSDEC	10	0.01	0.001		0.01	0.01		0.001	0.002					0.20	0.07		0.02	0.02		**11**	2.8	1.1
Pentachlorobenzene	MECP	30	0.06	0.001		2.0	0.20		0.27	0.04		0.53	0.05		0.14	0.14		0.38	0.15		0.49	0.11	
Hexachlorobenzene	NYSDEC	0.03	**0.24**	0.004	8	**0.69**	0.10	23	**0.65**	0.11	22	**0.19**	0.02	6	0.02	0.01		**0.42**	0.18	14	**0.52**	0.13	17
HCH, gamma (Lindane)	NYSDEC	8	0.03	0.06								0.52	0.23		0.11	0.01		3.9	0.73		1.0	0.23	
HCH, alpha	NYSDEC	2				0.42	0.04					**2.7**	0.22	1.3	0.21	0.29		**68**	5.1	34	**26**	1.4	13
HCH, beta												1.3	0.24		0.12	0.16		18	0.64		6.0	0.65	
HCH, delta			0.01	0.004		0.03	0.00		0.04	0.02		0.21	0.05					1.3	0.34		0.14	0.01	
Aldrin	NYSDEC	2													0.67	0.65		0.02	0.02				
Octachlorostyrene	NYSDEC	0.006							**0.01**	0.01	1.3				**2.8**	3.92	467	**0.02**	0.03	3	**0.02**	0.01	4
2,4'-DDE			0.01	0.002		0.01	0.01		0.06	0.01		0.02	0.001		0.04	0.01		0.02	0.01			0.003	
4,4'-DDE	NYSDEC	0.007	**0.03**	0.001	5	**0.13**	0.02	19	**0.36**	0.04	52	**0.09**	0.02	13	**0.03**	0.02	4	**0.22**	0.08	31	**0.04**	0.01	5
2,4'-DDD			0.01			0.13	0.02		0.21	0.05		0.04	0.01					0.06	0.02		0.01	0.002	
4,4'-DDD	NYSDEC	0.08	0.03	0.002		**0.49**	0.05	6	**0.78**	0.17	10	**0.14**	0.02	2				**0.30**	0.13	4	0.04	0.01	
2,4'-DDT			0.01	0.002		0.04	0.004		0.10	0.02		0.03	0.01					0.04	0.01		0.01	0.002	
4,4'-DDT	NYSDEC	0.01	0.004	0.004					**0.06**	0.01	5	0.01	0.01										
Mirex	NYSDEC	0.001	**0.01**	0.01	14	**0.70**	0.12	699	**0.27**	0.05	274	**0.09**	0.03	93	**0.04**	0.05	37	**0.08**	0.04	75	**0.01**	0.01	6
Chlordane, alpha (cis)	NYSDEC		0.02	0.002		0.04	0.004		0.41	0.06		0.06	0.01		0.02	0.02		0.09	0.04		0.02	0.004	
Chlordane, gamma (trans)	NYSDEC		0.02	0.002		0.03	0.01		0.26	0.04		0.04	0.01		0.35	0.46		0.06	0.03		0.01	0.003	
Nonachlor, cis-			0.01	0.001		0.01	0.01		0.05	0.01		0.01	0.003		0.03	0.05		0.02	0.01		0.002	0.002	
Nonachlor, trans-			0.02	0.001		0.03	0.01		0.22	0.04		0.05	0.01		0.04	0.05		0.05	0.03		0.01	0.003	
Heptachlor	NYSDEC	0.2													**0.32**	0.41	1.6						
Heptachlor Epoxide	NYSDEC	0.3	0.01	0.002		0.01	0.002		0.15	0.02		0.01	0.01		0.03	0.004		0.01	0.01		0.01	0.002	
alpha-Endosulphan	MECP (proposed)	3	0.20	0.04		0.13	0.01		0.17	0.15		0.18	0.05		0.41	0.16		0.36	0.10		0.18	0.01	
beta-Endosulphan						0.19	0.01					0.21	0.25					0.19	0.08				
Endosulphan Sulphate			0.03	0.05		0.03	0.06		0.51	0.20		0.10	0.10					0.24	0.003		0.10	0.01	
Dieldrin	NYSDEC	0.0006	**0.07**	0.01	115	**0.07**	0.01	118	**0.44**	0.08	736	**0.05**	0.004	91	**0.09**	0.02	154	**0.20**	0.07	341	**0.08**	0.01	138
Endrin	NYSDEC	2																					
Methoxychlor	NYSDEC	30	0.002	0.003					0.30	0.05		0.02	0.04										
Total PCB[c]	NYSDEC	0.001	**7.9**	0.04	7917	**19**	2.6	19480	**54**	11	53666	**7.7**	1.0	7721	**237**	61.4	236909	**19**	8.0	18621	**12**	3.3	11877

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

[d] Env. Canada upstream/downstream water quality monitoring program

data represent mean "dissolved" concentrations of 4 sampling event: July 5, July 19, August 2, and August 16 (NOTL), and July 4, July 18, August 1, August 15 (FE)

[e] data value not verified

Table 4 (updated April 2022): Continued

Concentrations were compared with Water Quality Criteria: Exceedence Fatcors (EF) represent the ratio of the water concentration estimate to the criteria.

Values that exceed the criteria were highlighted in **red** font. U/S = upstream; D/S = downstream

	Agency	Water Quality Criteria	Millers Creek		EF	Boyers Ck		EF	Chippawa Channel		EF	Fort Erie[b]		EF	Fort Erie[d] Env. Can. upstream/downstream Dissolved Phase	NOTL		EF	NOTL[d] Env. Can. upstream/downstream Dissolved Phase	Balsam Lake		EF
		ng/L	Mean ng/L	SD ng/L		Mean ng/L	SD ng/L		Mean ng/L	SD ng/L		Mean ng/L	SD ng/L		Mean ng/L	Mean ng/L	SD ng/L		Mean ng/L	Mean ng/L	SD ng/L	
1,3-Dichlorobenzene	MECP	**2500**	0.37	0.06		0.15	0.14		0.37	0.34					0.069	0.40	0.35		1.18			
1,4-Dichlorobenzene	MECP	**4000**	2.4	0.42		2.1	0.06		3.0	1.6		2.3	0.15		Q07[e]	1.9	0.29		1.88	1.3	0.14	
1,2-Dichlorobenzene	NYSDEC	**3000**				0.09	0.15		1.5	2.7		2.2	1.6		0.088	3.0	0.27		0.39			
1,3,5-Trichlorobenzene	MECP	**650**	0.005	0.001											0.005				0.15			
1,2,4-Trichlorobenzene	MECP	**500**	0.01	0.001		0.004	0.01								0.010	0.05	0.01		0.40			
1,2,3-Trichlorobenzene	MECP	**900**				0.01	0.01		0.005	0.01					0.004	0.02	0.002		0.10			
1,2,4,5-/1,2,3,5-Tetrachlorobenzene			0.01	0.001		0.00	0.004		0.001	0.002		0.002	0.003			0.04	0.01					
1,2,3,4-Tetrachlorobenzene	MECP	**100**	0.003			0.002	0.003		0.005	0.004		0.01	0.01		0.004	0.10	0.02		0.17			
Hexachlorobutadiene	NYSDEC	**10**				0.004	0.01		0.005	0.004		0.01			Q07	0.03	0.01		0.03	0.01	0.02	
Pentachlorobenzene	MECP	**30**	0.01	0.002		0.01	0.004		0.02	0.01		0.01	0.002		0.004	0.10	0.02		0.09			
Hexachlorobenzene	NYSDEC	**0.03**	0.01	0.002		0.01	0.01		**0.04**	0.02	**1.3**	0.02	0.001		0.011	**0.09**	0.01	**3**	0.04	**0.03**	0.02	**0.89**
HCH, gamma (Lindane)	NYSDEC	**8**				0.37	0.40		0.14	0.14		0.17	0.17		0.016	0.09	0.03		0.02			
HCH, alpha	NYSDEC	**2**													0.020	0.03	0.06		0.04			
HCH, beta																						
HCH, delta			0.001	0.001		0.01	0.01					0.01	0.001			0.01	0.01					
Aldrin	NYSDEC	**2**													0.007				0.01			
Octachlorostyrene	NYSDEC	**0.006**													0.005	**0.01**	0.001	**2**	0.001			
2,4'-DDE									0.01	0.01						0.005	0.001					
4,4'-DDE	NYSDEC	**0.007**	**0.19**	0.04	**27**	**0.03**	0.01	**5**	**0.12**	0.09	**17**	**0.04**	0.001	**6**	0.009 (particulate)	**0.03**	0.003	**4**	0.013 (particulate)	**0.05**	0.03	**7.62**
2,4'-DDD			0.03	0.01					0.01	0.02		0.01	0.001			0.00	0.003					
4,4'-DDD	NYSDEC	**0.08**	**0.15**	0.02	**2**				0.07	0.08		0.03	0.004		0.023	0.02	0.004		0.02	0.02	0.01	
2,4'-DDT									0.05	0.09		0.002	0.003		0.030	0.01	0.001		0.03			
4,4'-DDT	NYSDEC	**0.01**		0.004					0.01	0.02		0.002	0.003		0.024	0.01	0.01		0.02			
Mirex	NYSDEC	**0.001**													0.018				0.005			
Chlordane, alpha (cis)	NYSDEC		0.01	0.003		0.01	0.01		0.02	0.02		0.01			0.004	0.01	0.001		0.01			
Chlordane, gamma (trans)	NYSDEC		0.01	0.001		0.01	0.01		0.01	0.01		0.003	0.004		0.006	0.01			0.01			
Nonachlor, cis-			0.00	0.001					0.01	0.01		0.003			0.019				0.02			
Nonachlor, trans-			0.01	0.002		0.01	0.01		0.02	0.01		0.01	0.001		0.005	0.01	0.001		0.01	0.01	0.01	
Heptachlor	NYSDEC	**0.2**														0.003	0.01					
Heptachlor Epoxide	NYSDEC	**0.3**	0.003	0.003					0.03	0.03		0.01				0.01	0.001					
alpha-Endosulphan	MECP (proposed)	**3**	0.14	0.00		0.38	0.02		0.08	0.07		0.07	0.02		0.004	0.11	0.02		0.01	0.12	0.03	
beta-Endosulphan			0.07	0.06		0.25	0.01		0.27	0.28					0.011				0.01			
Endosulphan Sulphate			0.07	0.06		0.50	0.06		0.04	0.07		0.04	0.06			0.06	0.05			0.22	0.05	
Dieldrin	NYSDEC	**0.0006**	**0.03**	0.01	**44**	**0.04**	0.01	**63**	**0.13**	0.10	**218**	**0.06**	0.01	**105**	0.039	**0.06**	0.003	**98**	0.04	**0.06**	0.04	**105.77**
Endrin	NYSDEC	**2**													Q07				Q13			
Methoxychlor	NYSDEC	**30**													0.069	0.002	0.003		0.07			
Total PCB[c]	NYSDEC	**0.001**	**0.47**	0.13	**474**	**0.70**	0.30	**696**	**0.79**	0.53	**789**	**0.27**	0.02	**267**	0.357	**0.99**	0.19	**993**	0.41	**0.13**	0.05	**127.24**

[a] n=1

[b] n=2

[c] SPMD data were blank subtracted prior to estimating a water concentration

[d] Env. Canada upstream/downstream water quality monitoring program

data represent mean "dissolved" concentrations of 4 sampling event: July 5, July 19, August 2, and August 16 (NOTL), and July 4, July 18, August 1, August 15 (FE)

[e] data value not verified

SPMDs vs Caged Mussels

Regardless of whether contaminant data were generated by the deployment of caged mussels or SPMDs, with few exceptions (e.g., absence of HCB and pentachlorobenzene at OCC 003 in the SPMDs), the contaminant patterns among sites for the various compounds detected in both monitors were consistent. However, SPMDs had a greater sensitivity as a monitor by identifying more sites with low level contamination than the mussels: particularly for the organochlorine pesticides.

Important examples of consistency between the datasets and further enhancement by the SPMDs included HCBD and lindane. HCBD was not detected at any sites in the survey with the exception of Gill Creek and OCC 003 in both mussels and SPMDs, however, the SPMDs identified Gill Creek as having substantially higher concentrations than OCC, while the mussels showed similar concentrations between the two sites. For lindane, a chemical which was only detected at Gill Creek in the caged mussels, was identified at both Gill Creek and Two Mile Creek in the SPMDs, and the concentrations in Gill Creek were substantially higher than Two Mile Creek providing a clearer understanding of spatial trends where contaminant concentrations are near the limit of detection in the caged mussels. Likewise 1,2,3,4-tetrachlorobenzene was only detected at OCC in caged mussels, while the SPMDs detected this compound at several stations, but highlighted OCC with the highest concentrations.

For PCBs, patterns between sampling sites for the two media were consistent but SPMDs underestimated the concentrations in Two Mile Creek and the LNR downstream of Cayuga Creek relative to other stations when compared to the mussel data (Figures 6 and 7). This may be due to PCB contaminated sediment in the mussels contributing to the total PCB tissue concentration, and that mussel bioaccumulation of PCBs would be representative of both the dissolved and particulate phase which would not be measured in the SPMDs.

The SPMD and caged mussel datasets can also be compared by converting the mussel PCB data from ng/g (dry wt.) to ng/g lipid, and converting the SPMD data from ng/SPMD to ng/g triolein (Figure 23 and 24). With few exceptions the patterns of contamination among the stations were consistent with the non-converted data but there were a few interesting points to note. With the exception of the OCC 003 site, the mussels on a lipid-normalized basis have a greater potential for PCB accumulation than the SPMDs. This could be due to the addition of the contaminated sediment in their gut as mentioned above but could also reflect the possibility that the SPMDs were not in equilibrium upon retrieval and were still in the linear uptake phase. The SPMDs at OCC 003 had higher PCB concentrations on a lipid-normalized basis than the mussels possibly highlighting that this exposure was a direct effluent discharge of PCBs from an outfall rather than historically contaminated sediment as a primary source. Likewise, if the SPMDs were still in the linear phase of uptake, concentrations in the SPMDs at the OCC 003 site could have been even higher if the deployment was longer. A comparison of lipid-normalized SPMD and mussel data for other parameters showed that, with few exceptions (e.g., pentachlorobenzene at the Pettit Flume), the mussels had higher concentrations than the SPMDs (Figure 24).

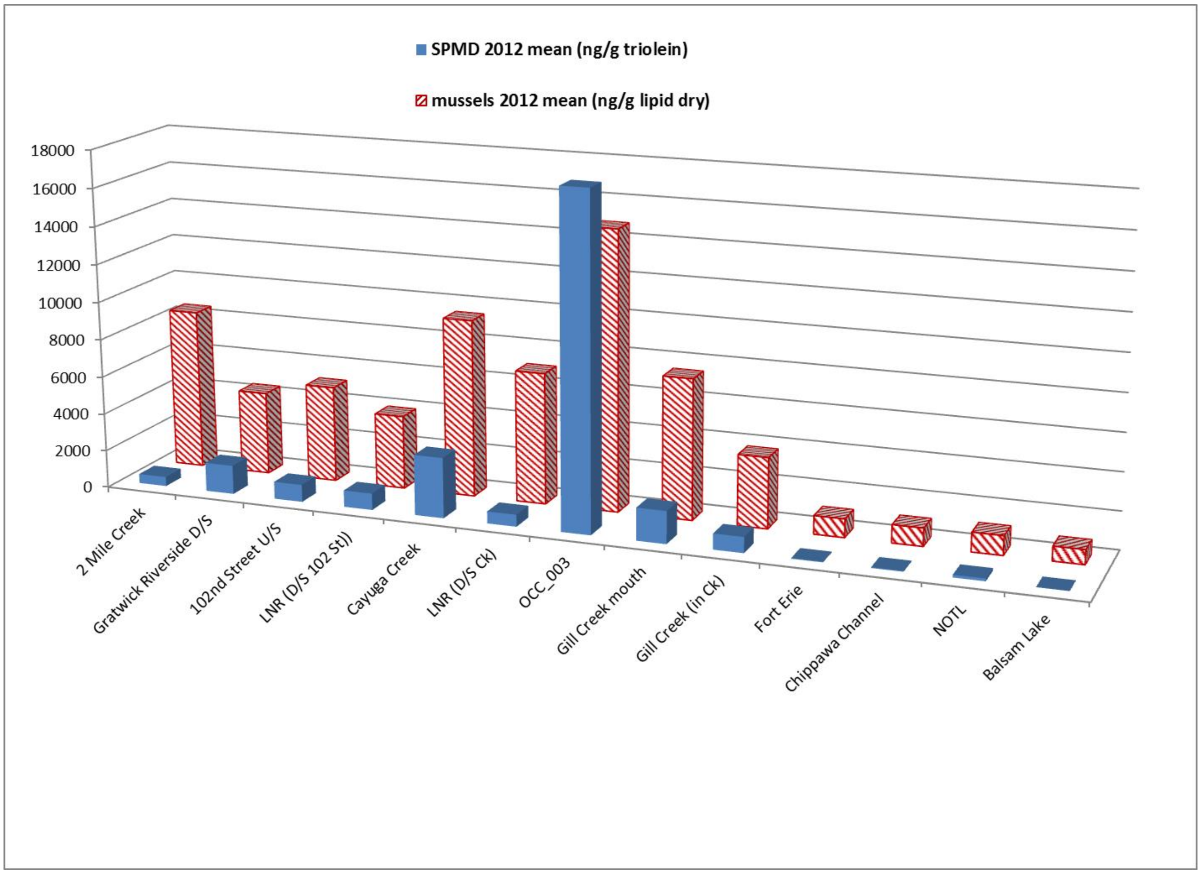


Figure 23: PCB concentrations in SPMDs (ng/g triolein) and Caged Mussels (ng/g lipid dry wt.) deployed in the Niagara River, 2013.

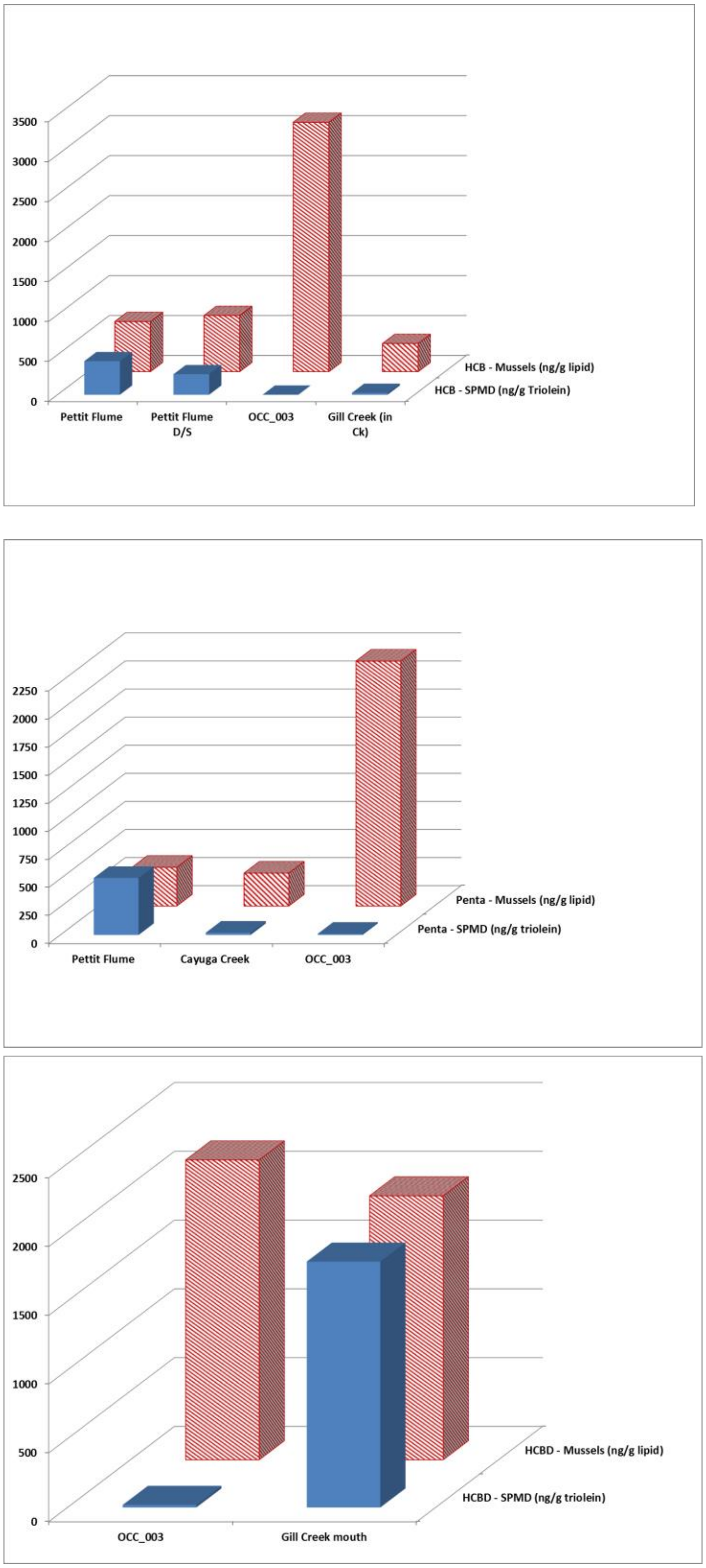


Figure 24: Contaminant concentrations in SPMDs (ng/g triolein) and Caged Mussels (ng/g lipid wet wt.) deployed in the Niagara River, 2012

Conclusions & Recommendations

- Contaminant data from the deployment of caged mussels and SPMDs have not identified sources of organic contaminants on the Canadian side of the Niagara River that require follow-up investigation.

- The 2012 mussel and SPMD contaminant data was consistent with previous surveys and has identified several sources of organic compounds to the Niagara River on the US side. These included:
    - Tributaries - Two Mile Creek (PCBs, lindane), Cayuga Creek (PCBs) and Gill Creek (PCBs, HCBD, lindane),
    - The Pettit Flume cove (1,2,3,4 – tetrachlorobenzene, pentachlorobenzene, HCB, and dioxins and furans) and
    - Bloody Run Creek (pentachlorobenzene, HCB, and dioxins and furans).
    - The Little Niagara River downstream of the 102nd St Hazardous Waste Site (PCBs, chlorinated benzene compounds).
    - Organochlorinated pesticides, in general were present throughout the study area on both sides of the river with the exception mirex which was present in SPMDs at sites associated with Occidental Chemical Corp.

- Overall, water concentration estimates for most compounds on both side of the river with a few exceptions (PCBs, dieldrin, metabolites of DDT, HCB, mirex) were below Water Quality Criteria. However, many of the contaminants are hydrophobic and are likely bound to sediment. Accordingly, impacts on the benthic community and food chain effects cannot be assessed from this monitoring tool, which, since it monitors only dissolved phase contaminants may underestimate contamination.

- High concentrations of PCBs in SPMDs at the OCC Sewer 003 (estimated at 237 ng/L) suggested that this outfall may be an important source of PCBs to the river. NYSDEC was notified, and it is recommended that the discharge history of this outfall be reviewed to investigate whether the SPMD data collected in 2012 reflect an intermittent, random occurrence, rather than ongoing, long-term PCB concentrations at the site.

- High PCB concentrations were present in SPMDs deployed at the upstream end of the Gratwick Riverside Park Hazardous Waste Site suggesting that there may be leakage from that site to the river, or there may be a source of PCBs located further upstream impacting the downstream water quality. Follow up sampling at Gratwick Riverside Park in 2015 is recommended with additional stations further upstream and downstream in the Niagara River to attempt to bracket the source area.

- Dioxin contaminated sediment samples collected from Fisherman's Park suggested movement and transport of contaminated sediment from the Pettit Flume cove.

- SPMD deployment in the Niagara River at Bloody Run Creek is recommended in 2015 to better assess contamination from that site and multiple sediment samples should be collected to assess the variability in dioxin contamination, particularly upstream of the creek mouth.

References

Apeti, D. A., Lauenstein, G.G., 2006. An assessment of mirex concentrations along the southern shorelines of the Great Lakes, USA. *Amer. J. Environ. Sci.* 2(3):95-103.

Booij, K., Hofmans, H.E., Fischer, C.V., and Van Weerlee, E.M. 2003. Temperature-dependent uptake rates of nonpolar organic compounds by semipermeable membrane devices and low-density polyethylene membranes. Environ. Sci, Technol. 37:361-366.

Booij, K., Smedes, F., Van Weerlee, E.M., and Honkoop, P. 2006. Environmental monitoring of hydrophobic organic contaminans:The case of mussels versus semipermeable membrane devices. Environ. Sci. Technol. 40:3893-3900.

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans (PCDD/Fs).

City of North Tonawanda Centennial Celebration book. 1997. http://www.nthistorymuseum.org/Collections/tonironsteel.html

Degger, N., Wepener, V., Richardson, B.J., and Wu, R.S.S. 2011. Brown mussels (*Perna perna*) and semi-permeable membrane devices (SPMDs) as indicators of organic pollutants in the South African marine environment. Marine Pollut. Bull. 63:91-97.

Ecology and Environment, Inc. 2011. Interim Niagara River Area of Concern (AOC) strategic plan for beneficial use impairment (BUI) delisting. Prepared for the United States Army Corps of Engineers. Buffalo District. Buffalo, New York. March 2011.

Geologic Testing Consultants Ltd., 1984. *Hydrogeologic evaluation of the Durez plant site.* Report to the Niagara River Steering Committee, Ontario Ministry of the Environment.

Herve, S., Prest, H.F., Heinonen, P., Hyotylainen, T., Koistinen, J., and Paasivirta, J.1995. Lipid-filled semipermeable membrane devices and mussels as samplers of organochlorine compounds in lake water. Environ. Sci. Pollut. Res. Int. 2:24-30.

Hill, B., Klawunn, P., 2009. Niagara River upstream/downstream monitoring program report: 2001-2002 to 2004-2005. Environment Canada (EC).

Huckins, J.N., Petty, J.D., Lebo, Orazio, C.E., Prest, H.F., Tillitt, D.E., Ellis, G.S., Johnson, B.T., and Manuweera, G.K. 1996. Semipermeable membrane devices

(SPMDs) for the concentration and assessment of bioavailable organic contaminants in aquatic environments. In Ostrander, G.K. (ed.) Techniques in aquatic toxicology. CRC Lewis Publishers. Chapter 34.

Huckins, J.N., Petty, J.D., Lebo, J.A., Almeida, F.A., Booij, K., Alverez, D., Cranor, W.L., Clark, R.C., Mogensen, B.B. 2002. Development of the permeability/performance reference compound approach for in situ calibration of semipermeable membrane devices. *Environ. Sci. Technol.* 36:85-91.

Interagency Task Force on Hazardous Waste, 1979. Draft report on hazardous waste disposal in Erie and Niagara counties, New York.

Johnson, G.W., Quensen III, J. F., Chiarenzelli, J.R., Hamilton, C., 2005. Polychlorinated biphenyls*.* In *Environmental forensics*. *eds.* R. Morrison and B. Murphy, pp-187-221. Academic Press.

Kauss, P.B. and Hamdy, Y.S.1991. Polycyclic aromatic hydrocarbons in surficial sediments and caged mussels of the St. Marys River, 1985. *Hydrobiologia.* 219:37-62.

Lobel, P.B., Bajdik, C.D., Belkhhode, S.P., Jackson, S.E., Longerich, H.P., 1991. Improved protocol for collecting Mussel Watch specimens taking into account sex, size, condition, shell shape and chronological age. *Arch. Environ. Contam. Toxicol*. 21(3):409-414.

Macdonald, C.R., Metcalfe, C.D., 1991. Concentration and distribution of PCB congeners in isolated Ontario lakes contaminated by atmospheric deposition. *Can. Fish. Aquat. Sci.* 48:371-381.

Metcalfe, J.L., Charlton, M.N., 1990. Freshwater mussels as biomonitors for organic industrial contaminants and pesticides in the St. Lawrence River. *Science of the Total Environment.* 97/98:595-615.

Muncaster, B.W., Innes, D.J., Hebert, P.D.N., Haffner, D.,1989. Patterns of organic contaminant accumulation by freshwater mussels in the St. Clair River, Ontario. *J. Great Lakes Res.*15(4):645-653.

NYSDEC Fact Sheet: State Superfund Program, Durez Update: Pettit Creek Flume (PCF) - Sewer Cleaning Activities October 2013.

Niagara River Secretariat, 2002?. *Niagara River Toxic Management Plan (NRTMP). Progress Report and Workplan.* October 2007.

NRTC, 1984. *Report of the Niagara River Toxics Committee.* Environment Canada, USEPA II, Ontario Ministry of the Envrionement and New York State Department of Environmental Conservation, October.

Ontario Ministry of the Environment_2008a. *The determination of polychlorinated biphenyls (PCB), organochlorines (OC) and chlorobenzenes (CB) in fish clams and mussels by gas liquid chromatography-electron capture detection* (GLC-ECD). PFAOC-E3136. Laboratory Services Branch, Etobicoke, Ontario.

___________2008b. *The determination of polychlorinated biphenyl congeners (PCBs) in fish clams and mussels by gas liquid chromatography-electron capture detection (GLC-ECD). PCBC-E3411.* Laboratory Services Branch, Etobicoke, Ontario.

___________2008c. *The Determination of Polychlorinated Dibenzo-P-Dioxins, Polychlorinated Dibenzofurans and Dioxin-Like Polychlorinated Biphenyls (DLPCBS) In Environmental Matrices by Gas Chromatography-High Resolution Mass Spectrometry (GC-MS).* (DFPCB-E3418) Laboratory Services Branch, Etobicoke, Ontario.

___________2008d. *The Determination of Particle Size Distribution on Sediments Particulate Matter and Liquids by Coulter Model LS230 Particle Size Analyzer,* LLPART-E3328A. Laboratory Services Branch, Quality Management Office. Etobicoke, Ontario.

___________2008e. *The determination of total carbon in soil and sediments by the thermal oxidation and infrared detection.* CARBONTC-E3142A. Laboratory Services Branch, Etobicoke, Ontario.

Pennak, R.W., 1978. *Fresh-water Invertebrates of the United States.* 2nd Edition. John Wiley & Sons, Inc.,Toronto, Ontario.

Petty, J.D., Orazio, C.E., Huckins, J.N., Gale, R.W., Lebo, J.A., Meadows, J.C., Echols, K.R., and Cranor, W.L. 2000. Considerations involved with the use of semipermeable membrane devices for monitoring environmental contaminants. J of Chromatography A. 879:83-95.

Peven, C.S., Uhler, A.D., and Querzoli, F.J. 1996. Caged mussels and semipermeable membrane devices as indicators of organic contaminant uptake in Dorchester and Duxbury Bays, Massachusetts. Environ. Toxicol. and Chem. 15:144-149.

Preddice, T.L., Skinner, L.C. and Gudlewski, A.J. 2011. PCBs and organochlorine pesticide residues in young-of-year fish from new and traditional near-shore sampling areas in the western portion of New York State's Great Lakes Basin, 2009. Division of Fish, Wildlife and Marine Resources. New York State Department of Environmental Conservation Albany, NY.

Prest, H.F., Jarman, W.M., Burns, S.A., Weismuller, T., Martin, M., and Huckins, J.N. 1992. Passive water sampling via semipermeable membrane devices (SPMDs) in concert with bivalves in the Sacramento/San Joaquin River Delta. Chemosphere 25:1811-1823.

Prest, H.F., Richardson, B.J., Jacobson, L.A., Vedder, J., and Martin, M. 1995. Monitoring organochlorines with semi-permeable membrane devices (SPMDs) and mussels (*Mytilus edulis*) in Corio Bay, Victoria, Australia. Marine Pollut. Bull. 30:543-554.

Richardson, B.J., Zhengm G.J., Tse, S.C., and Lam, P.K.S. 2001. A comparison of mussels (*Perna viridis*) and semi-permeable membrane devices (SPMDs) for monitoring chlorinated trace organic contaminants in Hong Kong coastal waters. Chemosphere 45:1201-1208.

Richman, L., Somers, K., 2005. Can we use zebra and quagga mussels for monitoring contaminants in the Niagara River? *Wat. Air and Soil Pollut.*167:155-178.

_________,Somers, K., 2010. Monitoring metal and organic contaminant trends through time using quagga mussels (*dreissena bugensis*) collected from the Niagara River. *J of Great Lake Res.* 36:28-36.

_________, Milani, D. 2010. Temporal trends in near-shore sediment contaminant concentrations in the St. Clair River and potential long-term implications for fish tissue concentrations. *J. Great Lakes Res.* 36:722-735.

_________, Hobson, G., Williams, D.J., and Reiner, E. 2011. The Niagara River mussel biomonitoring program (*elliptio complanata*): 1983-2009. Journal of Great Lakes Research 37:213-225.

Richman, L.A. 2013. Niagara River Biomonitoring Study 2006/2009 Caged Mussels (*Elliptio complanata*) and Semi Permeable Membrane Devices (SPMDs). Ontario Ministry of Environment, Water Monitoring Section, Environmental Monitoring and Reporting Branch, January 2013. PIBS 9416

US EPA/NYSDEC, 1994. *Reduction of Toxic Loadings to the Niagara River from Hazardous Waste Sites in the United States: A Progress Report.* United States Environmental Protection Agency and the New York State Department of Environmental Conservation.

USEPA/NYSDEC (United States Environmental Protection Agency and the New York State Department of Environmental Conservation). 2002. Reduction of toxic loadings to the Niagara River from hazardous waste sites in the United States: A progress report.

USEPA/NYSDEC (United States Environmental Protection Agency and the New York State Department of Environmental Conservation). 2003. Reduction of toxic loadings to the Niagara River from hazardous waste sites in the United States: June 2003.

USEPA/NYSDEC (United States Environmental Protection Agency and the New York State Department of Environmental Conservation). 2004. Reduction of toxic loadings to the Niagara River from hazardous waste sites in the United States: June 2004.

van den Berg, M., Bimbaum, L., Denison, M., De Vito, M., Farland, W., Feeley, M., Fiedler, H., Hakansson, H., Hanberg, A., Haws, L., Rose, M., Safe, S., Schrenk, D., Tohyama, C., Tritscher, A., Tuomisto, J., Tysklind, M., Walker, N., and Peterson., R., 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93(2): 223-241.

Vrana, B., and Schuurmann, G. 2002. Calibrating the uptake kinetics of semipermeable membrane devices in water:Impact of hydrodynamics. 2002. Environ. Sci. Technol. 36:290-296.

Wang, J., Yonghong, B., Phister, G., Henkelmann, B., Zhu, K., and Schramm, K. 2009. Determination of PAH, PCB, and OCP in water from the Three Gorges Reservoir accumulated by semipermeable membrane devices (SPMD). Chemosphere 75:1119-1127.

http://www.wunderground.com/history/airport/KIAG/2012/8/5/DailyHistory.html

Appendices

Appendix A: Station Location

Station Location	Station #	Northing	Easting
Canadian sites			
Balsam Lake (Control)	18 01 0001	4938157	674831
Fort Erie	05 02 203	4754908	670305
Millers Creek at Niagara Parks Department	05 15 41	4757774	665065
Bakers Creek at Schweigler Rd.	05 15 27	4759344	662860
Boyers Creek at Sherk Rd.	05 15 28	4762397	659697
Chippawa Channel	05 02 51	4768226	661232
NOTL	05 11 09	4790824	657471
American Sites			
Two Mile Creek	05 02 197	4764036	670595
Rattlesnake Creek	05 15 38	670555	4763739
Pettit Flume - U/S	05 02 185	4766739	672260
Pettit Flume - Site B	05 02 186	4766806	672236
Pettit Flume - D/S	05 02 187	4766795	672170
Fisherman's Park - U/S	05 02 01	4767294	671992
Fishermans's Park - D/S	05 02 02	4767371	671979
Gratwick Riverside Park - U/S	05 02 31	4768285	671655
Gratwick Riverside Park - D/S	05 02 199	4769277	670593
102nd Street Upstream site	05 02 93	4770760	667252
LNR (D/S 102nd St. waste site)	05 02 095	4771208	666639
Cayuga Creek	05 15 31	4771997	665978
LNR (D/S Cayuga Creek)	05 02 96	4771057	665523
U/S of Occidental Chem. Co.	05 02 97	4770936	662808
Occidental 003	05 02 42	4771074	662219
Niagara River - U/S Gill Creek	05 02 98	4771388	661048
Gill Creek - Mouth	05 02 37	4771395	660686
Gill Creek - U/S in Creek	05 15 22	4772103	660855
Bloody Run Creek - U/S	11 02 0018	4777914	659122
Bloody Run Creek	11 02 0017	4777974	659171
Bloody Run Creek	11 02 0131	4777962	659155
Bloody Run Creek	11 02 0132	4777965	659160
Bloody Run Creek - D/S	11 02 0025	4778024	659199

Appendix B: 2012 Niagara River Biomonitoring

Field Water Quality Measurements

Sonde = YSI 600 QS

Dissolved oxygen sensor calibrated before every measurement

Conductivity values are temperature compensated, except where noted

Station Name	Station #	Depth (m)	Date	Cond. (µs/cm)	Temp. (°C)	DO (%)	DO (mg/L)
Fisherman's Park U/S	05 02 0001	0.4	17 JUL 12	295	26.5	119	9.5
			07 AUG 12	303	24.7	131	10.9
Fisherman's Park D/S	05 02 0002	0.9	17 JUL 12	297	25.9	108	8.8
			07 AUG 12	302	24.5	94	7.9
2 Mile Creek	05 02 0197	0.6	17 JUL 12	1015	27.2	62	4.5
			07 AUG 12	*Not measured*			
Pettit Flume D/S	05 02 0187	1.0	18 JUL 12	293	25.9	96	7.8
			08 AUG 12	295	24.5	100	8.3
Pettit Flume (Outer Site B)	05 02 0186	0.9	18 JUL 12	379	23.6	80	6.7
			08 AUG 12	394	21.8	21	1.8
Pettit Flume U/S	05 02 0185	0.9	18 JUL 12	294	26.6	96	7.7
			08 AUG 12	296	25.1	104	8.6
U/S Gratwick Riverside Park	05 02 0031	0.5	18 JUL 12	297	26.5	102	18.2
			08 AUG 12	294	25.2	111	9.1
Gratwick Riverside Park	05 02 0199	0.8	18 JUL 12	290	26.3	123	9.9
			08 AUG 12	302	25.3	100	8.2
102nd Street (Upstream)	05 02 0093	0.6	18 JUL 12	293	26.8	129	10.3
			08 AUG 12	296	26.2	94	7.6
Little Niagara River (near 102nd St)	05 02 0095	0.5	18 JUL 12	292	26.6	30	2.4
			08 AUG 12	279	26.4	102	8.2
Cayuga Creek (within the creek)	05 15 0031	0.5	18 JUL 12	759	27.0	102	8.1
			08 AUG 12	623	26.4	83	6.7
Little Niagara River (D/S Cayuga Creek)	05 02 0096	0.6	18 JUL 12	297	27.3	123	9.7
			08 AUG 12	257	26.1	113	9.2
Bloody Run Creek U/S	11 02 0018		19 JUL 12	*Not measured. See station 11 02 0017.*			
			09 AUG 12	*Site vandalized. Empty cage found dry, up on rocks.*			
Bloody Run Creek	11 02 0017	0.5	19 JUL 12	290	24.7	112	9.5
			09 AUG 12	290	24.5	120	10.0
Bloody Run Creek	11 02 0131	0.6	19 JUL 12	*Not measured. See station 11 02 0017.*			
			09 AUG 12	290	24.4	119	9.9
Bloody Run Creek	11 02 0132	0.8	19 JUL 12	*Not measured. See station 11 02 0017.*			
			09 AUG 12	283	23.8	105	8.9
Bloody Run Creek D/S	11 02 0025	0.7	19 JUL 12	293	23.8	121	10.1
			09 AUG 12	290	24.3	115	9.7
Upstream of Occidental Facility	05 02 0097	0.4	19 JUL 12	295	25.4	91	7.5
			09 AUG 12	306	24.9	92	7.6
Occidental Sewer 003	05 02 0042	0.5	19 JUL 12	470	25.1	95	7.8
			09 AUG 12	390	24.7	96	7.9
350m U/S Gill Ck (in Niagara R)	05 02 0098	0.8	19 JUL 12	289	25.0	104	8.3
			09 AUG 12	289	24.4	96	8.0
Gill Creek Mouth	05 02 0037	1.0	19 JUL 12	314	25.3	96	7.9
			09 AUG 12	296	24.5	92	7.7
Upstream Gill Ck (in creek)	05 15 0022	0.5	19 JUL 12	297	26.0	104	8.5
			09 AUG 12	287	24.0	78	6.6

Appendix B continued: 2012 Niagara River Biomonitoring

Field Water Quality Measurements

Sonde = YSI 600 QS

Dissolved oxygen sensor calibrated before every measurement

Conductivity values are temperature compensated, except where noted

Station Name	Station #	Depth (m)	Date	Cond. (µs/cm)	Temp. (°C)	DO (%)	DO (mg/L)
Fort Erie at Robertson St	05 02 0203	0.7	20 JUL 12	291	23.3	79	6.8
			10 AUG 12	298	22.4	81	7.0
Millers Creek @ Niagara Parks Dept.	05 15 0041	0.4	20 JUL 12	303	20.9	57	4.9
			10 AUG 12	292	23.2	75	6.4
Bakers Creek	05 15 0027		20 JUL 12	384	19.0	25	2.3
			10 AUG 12	*Not measured. All mussels found dead.*			
Boyers Creek @ Sherk Rd	05 15 0028	0.3	20 JUL 12	619	19.4	65	6.0
			10 AUG 12	462	21.6	75	6.6
Chippewa Channel, Niagara River	05 02 0051	0.5	20 JUL 12	289	22.9	121	10.5
			10 AUG 12	289	24.2	113	9.5
Niagara On The Lake	11 02 0009	1.0	20 JUL 12	289	24.1	107	9.4
			10 AUG 12	289	24.5	100	8.3
Balsam Lake (control mussels)			16 JUL 12	153*	27.1	100	-----

* cond. value not temp. compensated

Appendix Table C: 2012 Niagara River Biomonitoring

Mussel Weights & Lab Submission Summary

Station Name	Station #	Deployed	Retrieved	Depth (m)	GL12xxxx	# Mussels	Wet Weight (g, tared)	Dry Weight (g, tared)	Submit	Test Codes
Fisherman's Park U/S	05 02 0001	17 JUL 12 @ 1258h	07 AUG 12 @ 1215h	0.4	3100	1	6.11		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3101	1	7.53		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3102	1	7.33		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3103	4	23.87		wet	DIOX3418, LIPID3136
					3104	6	40.33	5.27	dry	PCBC3411, LIPID3136
					3105	6	37.48	4.70	dry	PCBC3411, LIPID3136
					3106	6	42.50	4.94	dry	PCBC3411, LIPID3136
					3107 A	1	5.63		not	Archive
					3107 B	1	6.67		not	Archive
					3107 C	1	8.11		not	Archive
					3107 D	1	5.82		not	Archive
Fisherman's Park D/S	05 02 0002	17 JUL 12 @ 1323h	07 AUG 12 @ 1327h	0.9	3108	1	8.10		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3109	1	7.12		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3110	1	6.40		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3111	4	28.25		wet	DIOX3418, LIPID3136
					3112	6	35.27	4.22	dry	PCBC3411, LIPID3136
					3113	6	41.59	4.91	dry	PCBC3411, LIPID3136
					3114	6	37.17	3.81	dry	PCBC3411, LIPID3136
					3115 A	1	6.87		not	Archive
					3115 B	1	4.16		not	Archive
					3115 C	1	5.10		not	Archive
2 Mile Creek	05 02 0197	17 JUL 12 @ 1545h	07 AUG 12 @ 1550h	0.6	3116	1	5.80		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3117	1	6.11		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3118	1	7.12		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3119	6	36.14	3.40	dry	PCBC3411, LIPID3136
					3120	6	38.11	4.17	dry	PCBC3411, LIPID3136
					3121	6	34.80	3.77	dry	PCBC3411, LIPID3136
					3122 A	1	5.95		not	Archive
					3122 B	1	5.20		not	Archive
					3122 C	1	3.90		not	Archive
Pettit Flume D/S	05 02 0187	18 JUL 12 @ 0850h	08 AUG 12 @ 0809h	1.0	3123	1	5.94		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3124	1	7.00		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3125	1	5.47		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3126	4	27.97		wet	DIOX3418, LIPID3136
					3127 A	1	6.86		not	Archive
					3127 B	1	5.83		not	Archive
Pettit Flume (Outer Site B)	05 02 0186	18 JUL 12 @ 0929h	08 AUG 12 @ 0840h	0.9	3128	1	7.69		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3129	1	7.11		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3130	1	6.26		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3131	4	24.85		wet	DIOX3418, LIPID3136
Pettit Flume U/S	05 02 0185	18 JUL 12 @ 1002h	08 AUG 12 @ 0916h	0.9	3132	1	6.93		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3133	1	5.52		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3134	1	5.67		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3135	4	22.25		wet	DIOX3418, LIPID3136
					3136 A	1	7.43		not	Archive
					3136 B	1	5.52		not	Archive
U/S Gratwick Riverside Park	05 02 0031	18 JUL 12 @ 1050h	08 AUG 12 @ 1100h	0.5	3137	1	7.72		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3138	1	8.15		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3139	1	7.23		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3140 A	1	6.70		not	Archive
					3140 B	1	6.27		not	Archive
Gratwick Riverside Park	05 02 0199	18 JUL 12 @ 1145h	08 AUG 12 @ 1134h	0.8	3141	1	4.91		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3142	1	6.50		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3143	1	6.79		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3144	6	38.13	4.60	dry	PCBC3411, LIPID3136
					3145	6	35.77	4.27	dry	PCBC3411, LIPID3136
					3146	6	43.54	5.28	dry	PCBC3411, LIPID3136
					3147 A	1	8.01		not	Archive
					3147 B	1	5.95		not	Archive
					3147 C	1	5.85		not	Archive
					3147 D	1	6.76		not	Archive

Appendix Table C continued: 2012 Niagara River Biomonitoring

Mussel Weights & Lab Submission Summary

Station Name	Station #	Deployed	Retrieved	Depth (m)	GL12xxxx	# Mussels	Wet Weight (g, tared)	Dry Weight (g)	Submit	Test Codes
102nd Street (Upstream)	05 02 0093	18 JUL 12 @ 1315h	08 AUG 12 @ 1325h	0.6	3148	1	7.83		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3149	1	7.37		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3150	1	8.77		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3151	6	41.00	5.03	dry	PCBC3411, LIPID3136
					3152	6	47.74	5.86	dry	PCBC3411, LIPID3136
					3153	6	39.67	5.36	dry	PCBC3411, LIPID3136
					3154 A	1	6.21		not	Archive
					3154 B	1	6.77		not	Archive
					3154 C	1	5.80		not	Archive
					3154 D	1	8.08		not	Archive
Little Niagara River (near 102nd St)	05 02 0095	18 JUL 12 @ 1407h	08 AUG 12 @ 1419h	0.5	3155	1	8.15		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3156	1	7.55		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3157	1	6.03		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3158	6	38.94	5.02	dry	PCBC3411, LIPID3136
					3159	6	39.28	4.94	dry	PCBC3411, LIPID3136
					3160	6	36.77	4.64	dry	PCBC3411, LIPID3136
					3161 A	1	5.45		not	Archive
					3161 B	1	7.86		not	Archive
					3161 C	1	5.32		not	Archive
					3161 D	1	5.92		not	Archive
Cayuga Creek (within the creek)	05 15 0031	18 JUL 12 @ 1445h	08 AUG 12 @ 1511h	0.5	3162	1	9.20		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3163	1	8.12		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3164	1	8.77		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3165	6	54.88	8.64	dry	PCBC3411, LIPID3136
					3166	6	49.19	7.35	dry	PCBC3411, LIPID3136
					3167	6	51.25	8.12	dry	PCBC3411, LIPID3136
					3168 A	1	7.30		not	Archive
					3168 B	1	8.61		not	Archive
					3168 C	1	8.19		not	Archive
					3168 D	1	7.89		not	Archive
Little Niagara River (D/S Cayuga Creek)	05 02 0096	18 JUL 12 @ 1532h	08 AUG 12 @ 1554h	0.6	3169	1	6.36		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3170	1	6.46		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3171	1	6.96		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3172	6	40.64	5.24	dry	PCBC3411, LIPID3136
					3173	6	43.43	5.54	dry	PCBC3411, LIPID3136
					3174	6	42.05	5.22	dry	PCBC3411, LIPID3136
					3175 A	1	6.19		not	Archive
					3175 B	1	6.86		not	Archive
					3175 C	1	6.28		not	Archive
					3175 D	1	7.11		not	Archive
Bloody Run Creek U/S	11 02 0018	19 JUL 12 @ 0830h	N/A	Site vandalized. Empty cage found dry, up on rocks.						
Bloody Run Creek	11 02 0017	19 JUL 12 @ 0825h	09 AUG 12 @ 0741h	0.5	3176	1	5.19		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3177	1	5.60		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3178	1	6.07		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3179	4	26.21		wet	DIOX3418, LIPID3136
Bloody Run Creek	11 02 0131	19 JUL 12 @ 0825h	09 AUG 12 @ 0740h	0.6	3180	1	5.88		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3181	1	5.86		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3182	1	6.29		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3183	4	27.90		wet	DIOX3418, LIPID3136
					3184 A	1	7.41		not	Archive
					3184 B	1	5.36		not	Archive
Bloody Run Creek	11 02 0132	19 JUL 12 @ 0825h	09 AUG 12 @ 0802h	0.8	3185	1	5.77		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3186	1	6.32		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3187	1	5.29		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3188	4	25.18		wet	DIOX3418, LIPID3136
					3189 A	1	4.18		not	Archive
Bloody Run Creek	11 02 0025	19 JUL 12 @ 0839h	09 AUG 12 @ 0754h	0.7	3190	1	4.92		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3191	1	5.47		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3192	1	6.20		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3193	**3**	18.40		wet	DIOX3418, LIPID3136

Appendix Table C continued: 2012 Niagara River Biomonitoring

Mussel Weights & Lab Submission Summary

Station Name	Station #	Deployed	Retrieved	Depth (m)	GL12xxxx	# Mussels	Wet Weight (g, tared)	Dry Weight (g)	Submit	Test Codes
Upstream of Occidental Facility	05 02 0097	19 JUL 12 @ 1012h	09 AUG 12 @ 1038h	0.4	3194	1	6.05		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3195	1	8.22		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3196	1	5.04		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3197	6	42.09	5.70	dry	PCBC3411, LIPID3136
					3198	6	37.90	5.19	dry	PCBC3411, LIPID3136
					3199	6	34.18	4.62	dry	PCBC3411, LIPID3136
					3200 A	1	6.95		not	Archive
					3200 B	1	7.12		not	Archive
Occidental Sewer 003	05 02 0042	19 JUL 12 @ 1045h	09 AUG 12 @ 1120h	0.5	3201	1	7.20		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3202	1	6.39		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3203	1	5.83		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3204	6	37.44	3.87	dry	PCBC3411, LIPID3136
					3205	6	37.93	4.73	dry	PCBC3411, LIPID3136
					3206	6	34.20	4.24	dry	PCBC3411, LIPID3136
					3207 A	1	6.20		not	Archive
					3207 B	1	5.36		not	Archive
350m U/S Gill Ck (in Niagara R)	05 02 0098	19 JUL 12 @ 1135h	09 AUG 12 @ 1205h	0.8	3208	1	5.01		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3209	1	8.64		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3210	1	5.37		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3211	6	35.60	4.65	dry	PCBC3411, LIPID3136
					3212	6	36.00	4.50	dry	PCBC3411, LIPID3136
					3213	6	32.62	4.18	dry	PCBC3411, LIPID3136
					3214 A	1	5.75		not	Archive
					3214 B	1	6.50		not	Archive
					3214 C	1	4.36		not	Archive
Gill Creek Mouth	05 02 0037	19 JUL 12 @ 1236h	09 AUG 12 @ 1239h	1.0	3215	1	7.12		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3216	1	7.83		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3217	1	5.95		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3218	6	41.94	5.17	dry	PCBC3411, LIPID3136
					3219	6	43.24	5.27	dry	PCBC3411, LIPID3136
					3220	6	41.30	5.66	dry	PCBC3411, LIPID3136
					3221 A	1	8.02		not	Archive
					3221 B	1	6.60		not	Archive
					3221 C	1	6.33		not	Archive
Upstream Gill Ck (in creek)	05 15 0022	19 JUL 12 @ 1321h	09 AUG 12 @ 1335h	0.5	3222	1	6.58		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3223	1	8.01		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3224	1	9.26		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3225	6	47.81	5.72	dry	PCBC3411, LIPID3136
					3226	6	39.20	5.21	dry	PCBC3411, LIPID3136
					3227	6	45.40	5.52	dry	PCBC3411, LIPID3136
					3228 A	1	6.49		not	Archive
					3228 B	1	5.45		not	Archive
					3228 C	1	5.54		not	Archive
					3228 D	1	6.84		not	Archive
Fort Erie at Robertson St	05 02 0203	20 JUL 12 @ 0846h	10 AUG 12 @ 0818h	0.7	3229	1	8.23		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3230	1	5.75		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3231	1	6.79		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3232	6	42.84	4.53	dry	PCBC3411, LIPID3136
					3233	6	42.53	5.24	dry	PCBC3411, LIPID3136
					3234	6	39.69	5.36	dry	PCBC3411, LIPID3136
					3235 A	1	8.22		not	Archive
					3235 B	1	6.78		not	Archive
					3235 C	1	5.85		not	Archive
Millers Creek @ Niagara Parks Dept.	05 15 0041	20 JUL 12 @ 0939h	10 AUG 12 @ 0919h	0.4	3236	1	7.57		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3237	1	4.80		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3238	1	4.99		wet	PCBT3136, OC3136, CB3136, LIPID3136
Bakers Creek	05 15 0027	20 JUL 12 @ 1003h	N/A	All mussels found dead.						
Boyers Creek @ Sherk Rd	05 15 0028	20 JUL 12 @ 1033h	10 AUG 12 @ 1008h	0.3	3239	1	6.98		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3240	1	7.57		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3241	1	6.24		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3242 A	1	5.91		not	Archive
					3242 B	1	5.69		not	Archive
Chippewa Channel, Niagara River	05 02 0051	20 JUL 12 @ 1108h	10 AUG 12 @ 1038h	0.5	3243	1	7.94		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3244	1	6.62		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3245	1	6.50		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3246	6	38.27	4.73	dry	PCBC3411, LIPID3136
					3247	6	40.84	4.89	dry	PCBC3411, LIPID3136
					3248	6	37.50	4.59	dry	PCBC3411, LIPID3136
					3249 A	1	7.02		not	Archive
					3249 B	1	5.67		not	Archive
					3249 C	1	5.49		not	Archive
					3249 D	1	6.08		not	Archive
Niagara on the Lake	11 02 0009	20 JUL 12 @ 1242h	10 AUG 12 @ 1202h	1.0	3250	1	6.20		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3251	1	7.04		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3252	1	6.00		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3253	6	36.25	4.25	dry	PCBC3411, LIPID3136
					3254	6	36.81	4.45	dry	PCBC3411, LIPID3136
					3255	6	38.95	4.13	dry	PCBC3411, LIPID3136
					3256 A	1	7.27		not	Archive
					3256 B	1	6.52		not	Archive
					3256 C	1	5.65		not	Archive
					3256 D	1	4.92		not	Archive
Balsam Lake (control mussels)	18 01 0001	N/A	16 JUL 12 @ 1145h	2.0	3257	1	11.20		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3258	1	8.00		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3259	1	8.30		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3260	1	8.40		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3261	1	9.50		wet	PCBT3136, OC3136, CB3136, LIPID3136
					3262	6	47.10	5.63	dry	PCBC3411, LIPID3136
					3263	6	51.20	6.21	dry	PCBC3411, LIPID3136
					3264	6	49.70	5.36	dry	PCBC3411, LIPID3136

Appendix D1: 2012 Caged Mussel Tissue Contaminant Data.

Test Code	Description
LIPID	LIPIDS
P1ALDR	ALDRIN
P1BHCA	HEXACLOROCYCLOHEX,ALPHA-BHC
P1BHCB	HEXACLOROCYCLOHEX,BETA-BHC
P1BHCG	HEXACLOROCYCLOHEX,GAMMA-BHC
P1CHLA	CHLORDANE,ALPHA
P1CHLG	CHLORDANE,GAMMA
CISCHL	CIS-NONACHLOR
P1HEPT	HEPTACHLOR
P1MIRX	MIREX
P1OCHL	OXYCHLORDANE
DDTMET	DDT & METABOLITES
P1OPDT	OP-DDT
P1PCBT	PCB TOTAL
P1PMIR	PHOTO MIREX
P1PPDD	PP-DDD
P1PPDE	PP-DDE
P1PPDT	PP-DDT
P1TOX	TOXAPHENE
TOTTEC	TOTAL TECHNICAL CHLORDANE
TRACHL	TRANS-NONACHLOR
X1HCBD	HEXACHLOROBUTADIENE
X2123	TRICHLOROBENZENE 1,2,3
X21234	TETRACHLOROBENZENE 1,2,3,4
X21235	TETRACHLOROBENZENE 1,2,3,5
X2124	TRICHLOROBENZENE 1,2,4
X21245	TETRACHLOROBENZENE 1,2,4,5
X2135	TRICHLOROBENZENE 1,3,5
X2HCB	HEXACHLOROBENZENE
X2HCE	HEXACHLOROETHANE
X2OCST	OCTACHLOROSTYRENE
X2PNCB	PENTACHLOROBENZENE
X2T236	TRICHLOROTOLUENE 2,3,6
X2T245	TRICHLOROTOLUENE 2,4,5
X2T26A	TRICHLOROTOLUENE 2,6,A

Test Code	Description
P4D378	2378-T4-CDD
P4F378	2378-T4-CDF
P5D378	12378-P5-CDD
P5F378	12378-P5-CDF
P5F478	23478-P5-CDF
P6D478	123478-H6-CDD
P6D678	123678-H6-CDD
P6D789	123789-H6-CDD
P6F234	234678-H6-CDF
P6F478	123478-H6-CDF
P6F678	123678-H6-CDF
P6F789	123789-H6-CDF
P7D678	1234678-H7-CDD
P7F678	1234678-H7-CDF
P7F789	1234789-H7-CDF
P98CDD	OCTCHLORODIBENZPIOXIN
P98CDF	OCTCHLORODIBENZO FURAN

Test Code	Description
PNACNE	ACENAPHTHENE
PNACNY	ACENAPHTHYLENE
PNANTH	ANTHRACENE
PNBAA	BENZO(A)ANTHRACENE
PNBAP	BENZO(A)PYRENE
PNBBFA	BENZO (B) FLUORANTHENE
PNBKF	BENZO (K) FLUORANTHENE
PNCHRY	CHRYSENE
PNDAHA	DIBENZO(AH)ANTHRACENE
PNFLAN	FLUORANTHENE
PNFLUO	FLUORENE
PNGHIP	BENZO(G,H,I) PERYLENE
PNINP	INDENO(1,2,3-CD) PYRENE
PNNAPH	NAPHTHALENE
PNPHEN	PHENANTHRENE
PNPYR	PYRENE
D10PHE	D10-PHENANTHRENE
D12CHR	D12-CHRYSENE
D8NAPH	D8-NAPHTHALENE

Test Code	Description
PCB018	2,2',5-TRICHLOROBIPHENYL
PCB019	2,2',6-TRI(CL)BIPHENYL
PCB022	2,3,4'-TRICHLOROBIPHENYL
PCB028	2,4,4'-TRICHLOROBIPHENYL
PCB033	2',3,4-TRICHLOROBIPHENYL
PCB037	3,4,4'-TRICHLOROBIPHENYL
PCB044	2,2',3,5'-TETRACHLOROBIPHENYL
PCB049	2,2',4,5'-TETRACHLOROBIPHENYL
PCB052	2,2',5,5'-TETRACHLOROBIPHENYL
PCB054	2,2',6,6'-TETRA(CL)BIPHENYL
PCB070	2,3',4',5-TETRACHLOROBIPHENYL
PCB074	2,4,4',5-TETRACHLOROBIPHENYL
PCB077	3,3',4,4'-TETRACHLOROBIPHENYL
PCB081	3,4,4',5-TETRACHLOROBIPHENYL
PCB087	2,2'3,4,5'-PENTACHLOROBIPHENY
PCB095	2,2'3,5',6-PENTACHLOROBIPHENY
PCB099	2,2'4,4',5-PENTACHLOROBIPHENY
PCB101	2,2'4,5,5'-PENTACHLOROBIPHENY
PCB104	2,2'4,6,6'-PENTA(CL)BIPHENYL
PCB105	2,3,3'4,4'-PENTACHLOROBIPHENY
PCB110	2,3,3'4',6-PENTACHLOROBIPHENY
PCB114	2,2'3,4,5'-PENTACHLOROBIPHENY
PCB118	2,3'4,4',5-PENTACHLOROBIPHENY
PCB119	2,3'4,4',6-PENTACHLOROBIPHENY
PCB123	2'3,4,4',5-PENTA(CL)BIPHENYL
PCB126	3,3'4,4',5-PENTACHLOROBIPHENY
PCB128	22',33',44'-HEXA(CL)BIPHENYL
PCB138	2,2'3,44'5'-HEXACHLOROBIPHENY
PCB149	2,2'3,3'46'-HEXACHLOROBIPHENY
PCB151	2,2'3,5,5'6-HEXA(CL)BIPHENYL
PCB153	22',44',55'-HEXACHLOROBIPHENY
PCB155	22',44',66'-HEXA(CL)BIPHENYL
PCB156	2,3,3'4,4'5-HEXACHLOROBIPHENY
PCB157	2,3,3'44'5'-HEXACHLOROBIPHENY
PCB158	2,3,3'4,4'6-HEXACHLOROBIPHENY
PCB167	23',44',55'-HEXA(CL)BIPHENYL
PCB168	23',44',5'6-HEXA(CL)BIPHENYL
PCB169	3,3'4,4'55'-HEXACHLOROBIPHENY

Test Code	Description
PCB170	22'33'44'5-HEPTA(CL)BIPHENYL
PCB171	22'33'44'6-HEPTA(CL)BIPHENYL
PCB177	22'33'4'56-HEPTA(CL)BIPHENYL
PCB178	22'33'55'6-HEPTA(CL)BIPHENYL
PCB180	22'344'55'-HEPTACHLOROBIPHENY
PCB183	22'344'5'6-HEPTA(CL)BIPHENYL
PCB187	22'34'55'6-HEPTA(CL)BIPHENYL
PCB188	22'34'566'-HEPTA(CL)BIPHENYL
PCB189	233'44'55'-HEPTA(CL)BIPHENYL
PCB191	233'44'5'6-HEPTACHLOROBIPHENY
PCB194	22'33'44'55'-OCTACHLOBIPHENYL
PCB199	22'33'455'6'-OCTA(CL)BIPHENYL
PCB201	22'33'45'66'-OCTA(CL)BIPHENYL
PCB202	22'33'55'66'-OCTA(CL)BIPHENYL
PCB205	233'44'55'6-OCTACHLOBIPHENYL
PCB206	22'33'44'55'6-OCTACHLOBIPHENY
PCB208	22'33'455'66'NONA(CL)BIPHENYL
PCBTOT	PCB CONGENER TOTAL

<T - measurable trace amount

<W - no measurable response

MPC - Max possible concentration due to chromatographic overlap

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	Station No	Collect Date and Time	Field Sample	Water Depth(m)	LIPID %	CISCHL NG/G	VQF	P1ALDR NG/G	VQF	P1BHCA NG/G	VQF	P1BHCB NG/G	VQF	P1BHCG NG/G	VQF	P1CHLA NG/G	VQF	P1CHLG NG/G	VQF	P1HEPT NG/G	VQF	P1MIRX NG/G	VQF	P1OCHL NG/G	VQF
Balsam Lake	1800010001	07/16/2012 11:45	GL123257	2	0.88	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Balsam Lake	1800010001	07/16/2012 11:45	GL123258	2	0.52	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Balsam Lake	1800010001	07/16/2012 11:45	GL123259	2	0.53	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Balsam Lake	1800010001	07/16/2012 11:45	GL123260	2	0.59	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Balsam Lake	1800010001	07/16/2012 11:45	GL123261	2	0.55	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
American Sites																									
Two Mile Creek	500020197	08/07/2012 15:50	GL123116	0.6	0.64	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Two Mile Creek	500020197	08/07/2012 15:50	GL123117	0.6	0.49	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Two Mile Creek	500020197	08/07/2012 15:50	GL123118	0.6	0.81	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Downstream)	500020187	08/08/2012 8:09	GL123123	1	0.64	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Downstream)	500020187	08/08/2012 8:09	GL123124	1	0.59	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Downstream)	500020187	08/08/2012 8:09	GL123125	1	0.49	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Outer Site B)	500020186	08/08/2012 8:40	GL123128	0.9	1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Outer Site B)	500020186	08/08/2012 8:40	GL123129	0.9	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Outer Site B)	500020186	08/08/2012 8:40	GL123130	0.9	4.3	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Upstream)	500020185	08/08/2012 9:16	GL123132	0.9	0.86	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Upstream)	500020185	08/08/2012 9:16	GL123133	0.9	0.68	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Pettit Flume (Upstream)	500020185	08/08/2012 9:16	GL123134	0.9	0.6	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Upstream)	500020001	08/07/2012 12:15	GL123100	0.4	0.76	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Upstream)	500020001	08/07/2012 12:15	GL123101	0.4	0.93	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Upstream)	500020001	08/07/2012 12:15	GL123102	0.4	0.9	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Downstream)	500020002	08/07/2012 13:27	GL123108	0.9	0.99	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Downstream)	500020002	08/07/2012 13:27	GL123109	0.9	0.82	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fisherman's Park (Downstream)	500020002	08/07/2012 13:27	GL123110	0.9	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Upstream)	500020031	08/08/2012 11:00	GL123137	0.5	0.86	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Upstream)	500020031	08/08/2012 11:00	GL123138	0.5	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Upstream)	500020031	08/08/2012 11:00	GL123139	0.5	0.5	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Downstream)	500020199	08/08/2012 11:34	GL123141	0.8	1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Downstream)	500020199	08/08/2012 11:34	GL123142	0.8	0.79	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gratwick Riverside Park (Downstream)	500020199	08/08/2012 11:34	GL123143	0.8	0.91	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
102nd Street (Upstream)	500020093	08/08/2012 13:25	GL123148	0.6	0.88	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
102nd Street (Upstream)	500020093	08/08/2012 13:25	GL123149	0.6	0.54	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
102nd Street (Upstream)	500020093	08/08/2012 13:25	GL123150	0.6	0.38	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (near 102nd St)	500020095	08/08/2012 14:19	GL123155	0.5	0.12	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (near 102nd St)	500020095	08/08/2012 14:19	GL123156	0.5	0.63	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (near 102nd St)	500020095	08/08/2012 14:19	GL123157	0.5	0.6	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Cayuga Creek	500150031	08/08/2012 15:11	GL123162	0.5	1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Cayuga Creek	500150031	08/08/2012 15:11	GL123163	0.5	1.5	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Cayuga Creek	500150031	08/08/2012 15:11	GL123164	0.5	0.92	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (Downstream Cayuga Ck)	500020096	08/08/2012 15:54	GL123169	0.6	0.82	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (Downstream Cayuga Ck)	500020096	08/08/2012 15:54	GL123170	0.6	0.84	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Little Niagara River (Downstream Cayuga Ck)	500020096	08/08/2012 15:54	GL123171	0.6	0.65	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	Station No	Collect Date and Time	Field Sample	Water Depth(m)	LIPID %	CISCHL NG/G	VQF	P1ALDR NG/G	VQF	P1BHCA NG/G	VQF	P1BHCB NG/G	VQF	P1BHCG NG/G	VQF	P1CHLA NG/G	VQF	P1CHLG NG/G	VQF	P1HEPT NG/G	VQF	P1MIRX NG/G	VQF	P1OCHL NG/G	VQF
Upstream of Occidental	500020097	08/09/2012 10:38	GL123194	0.4	1.3	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Upstream of Occidental	500020097	08/09/2012 10:38	GL123195	0.4	0.98	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Upstream of Occidental	500020097	08/09/2012 10:38	GL123196	0.4	1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Occidental 003	500020042	08/09/2012 11:20	GL123201	0.5	1.1	2	<=W	1	<=W	1	<=W	**2**	**<T**	1	<=W	2	<=W	2	<=W	1	<=W	**16**	**<T**	2	<=W
Occidental 003	500020042	08/09/2012 11:20	GL123202	0.5	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	**10**	**<T**	2	<=W
Occidental 003	500020042	08/09/2012 11:20	GL123203	0.5	0.46	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	**16**	**<T**	2	<=W
350 m U/S Gill Creek (in NR)	500020098	08/09/2012 12:05	GL123208	0.8	0.44	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
350 m U/S Gill Creek (in NR)	500020098	08/09/2012 12:05	GL123209	0.8	0.7	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
350 m U/S Gill Creek (in NR)	500020098	08/09/2012 12:05	GL123210	0.8	0.26	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gill Creek (Mouth)	500020037	08/09/2012 12:39	GL123215	1	1.5	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gill Creek (Mouth)	500020037	08/09/2012 12:39	GL123216	1	1.3	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Gill Creek (Mouth)	500020037	08/09/2012 12:39	GL123217	1	0.9	2	<=W	1	<=W	1	<=W	**2**	**<T**	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
U/S Gill Creek (in creek)	500150022	08/09/2012 13:35	GL123222	0.5	0.98	2	<=W	1	<=W	1	<=W	**3**	**<T**	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
U/S Gill Creek (in creek)	500150022	08/09/2012 13:35	GL123223	0.5	1.1	2	<=W	1	<=W	1	<=W	**7**	**<T**	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
U/S Gill Creek (in creek)	500150022	08/09/2012 13:35	GL123224	0.5	1.3	2	<=W	1	<=W	1	<=W	**3**	**<T**	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek	1100020017	08/09/2012 7:41	GL123176	0.5	1.2	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek	1100020017	08/09/2012 7:41	GL123177	0.5	1.6	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek	1100020017	08/09/2012 7:41	GL123178	0.5	0.96	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 7th and 8th post)	1100020131	08/09/2012 7:40	GL123180	0.6	0.49	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 7th and 8th post)	1100020131	08/09/2012 7:40	GL123181	0.6	0.78	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 7th and 8th post)	1100020131	08/09/2012 7:40	GL123182	0.6	0.98	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 4th and 5th post)	1100020132	08/09/2012 8:02	GL123185	0.8	1.2	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 4th and 5th post)	1100020132	08/09/2012 8:02	GL123186	0.8	0.99	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (btwn 4th and 5th post)	1100020132	08/09/2012 8:02	GL123187	0.8	1.8	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (Downstream)	1100020025	08/09/2012 7:54	GL123190	0.7	1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (Downstream)	1100020025	08/09/2012 7:54	GL123191	0.7	0.83	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Bloody Run Creek (Downstream)	1100020025	08/09/2012 7:54	GL123192	0.7	0.86	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Canadian Sites																									
Fort Erie @ Robertson St.	500020203	08/10/2012 8:18	GL123229	0.7	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fort Erie @ Robertson St.	500020203	08/10/2012 8:18	GL123230	0.7	1.1	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Fort Erie @ Robertson St.	500020203	08/10/2012 8:18	GL123231	0.7	0.51	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Miller Creek	500150041	08/10/2012 9:19	GL123236	0.4	0.75	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Miller Creek	500150041	08/10/2012 9:19	GL123237	0.4	0.48	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Miller Creek	500150041	08/10/2012 9:19	GL123238	0.4	0.38	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Boyers Creek @ Sherk Rd.	500150028	08/10/2012 10:08	GL123239	0.3	0.45	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Boyers Creek @ Sherk Rd.	500150028	08/10/2012 10:08	GL123240	0.3	0.2	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Boyers Creek @ Sherk Rd.	500150028	08/10/2012 10:08	GL123241	0.3	0.41	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Chippawa Channel, NR	500020051	08/10/2012 10:38	GL123243	0.5	0.58	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Chippawa Channel, NR	500020051	08/10/2012 10:38	GL123244	0.5	0.23	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
Chippawa Channel, NR	500020051	08/10/2012 10:38	GL123245	0.5	0.55	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
NOTL	1100020009	08/10/2012 12:02	GL123250	1	0.3	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
NOTL	1100020009	08/10/2012 12:02	GL123251	1	0.6	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W
NOTL	1100020009	08/10/2012 12:02	GL123252	1	0.74	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	2	<=W	2	<=W	1	<=W	5	<=W	2	<=W

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	P1OPDT	VQF	P1PCBT	VQF	P1PMIR	VQF	P1PPDD	VQF	P1PPDE	VQF	P1PPDT	VQF	P1TOX	VQF	TOTTEC	VQF	TRACHL	VQF	X1HCBD	VQF
	NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G	
Balsam Lake	5	<=W	31	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Balsam Lake	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Balsam Lake	5	<=W	44	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Balsam Lake	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Balsam Lake	5	<=W	40	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
American Sites																				
Two Mile Creek	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Two Mile Creek	5	<=W	110	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Two Mile Creek	5	<=W	77	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Downstream)	5	<=W	95	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Downstream)	5	<=W	28	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Downstream)	5	<=W	37	P40	4	<=W	5	<=W	4	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Outer Site B)	5	<=W	38	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Outer Site B)	5	<=W	43	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Outer Site B)	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Upstream)	5	<=W	29	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Upstream)	5	<=W	43	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Pettit Flume (Upstream)	5	<=W	34	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Upstream)	5	<=W	42	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Upstream)	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Upstream)	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Downstream)	5	<=W	20	<=W	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Downstream)	5	<=W	29	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fisherman's Park (Downstream)	5	<=W	37	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Upstream)	5	<=W	110	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Upstream)	5	<=W	110	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Upstream)	5	<=W	87	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Downstream)	5	<=W	81	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Downstream)	5	<=W	75	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gratwick Riverside Park (Downstream)	5	<=W	52	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
102nd Street (Upstream)	5	<=W	53	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
102nd Street (Upstream)	5	<=W	46	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
102nd Street (Upstream)	5	<=W	35	P40	4	<=W	5	<=W	7	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (near 102nd St)	5	<=W	57	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (near 102nd St)	5	<=W	70	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (near 102nd St)	5	<=W	63	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Cayuga Creek	5	<=W	73	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Cayuga Creek	5	<=W	73	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Cayuga Creek	5	<=W	75	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	5	<=W	63	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	5	<=W	73	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	5	<=W	78	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	P1OPDT	VQF	P1PCBT	VQF	P1PMIR	VQF	P1PPDD	VQF	P1PPDE	VQF	P1PPDT	VQF	P1TOX	VQF	TOTTEC	VQF	TRACHL	VQF	X1HCBD	VQF
	NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G	
Upstream of Occidental	5	<=W	61	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Upstream of Occidental	5	<=W	52	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Upstream of Occidental	5	<=W	58	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Occidental 003	5	<=W	320	PS1	4	<=W	5	<=W	6	<T	5	<=W	50	<=W	2	<=W	2	<=W	28	
Occidental 003	5	<=W	200	PS1	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	15	
Occidental 003	5	<=W	250	PS1	4	<=W	5	<=W	5	<T	5	<=W	50	<=W	2	<=W	2	<=W	15	
350 m U/S Gill Creek (in NR)	5	<=W	34	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
350 m U/S Gill Creek (in NR)	5	<=W	21	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
350 m U/S Gill Creek (in NR)	5	<=W	25	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Gill Creek (Mouth)	5	<=W	82	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	22	
Gill Creek (Mouth)	5	<=W	110	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	29	
Gill Creek (Mouth)	5	<=W	76	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	20	
U/S Gill Creek (in creek)	5	<=W	87	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
U/S Gill Creek (in creek)	5	<=W	98	P40	4	<=W	5	<=W	4	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
U/S Gill Creek (in creek)	5	<=W	88	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek	5	<=W	59	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek	5	<=W	70	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek	5	<=W	58	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (btwn 7th and 8th post)	5	<=W	40	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (btwn 7th and 8th post)	5	<=W	52	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (btwn 7th and 8th post)	5	<=W	41	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (btwn 4th and 5th post)	5	<=W	83	P40	4	<=W	5	<=W	5	<T	5	<=W	50	<=W	2	<=W	2	<=W	6	<T
Bloody Run Creek (btwn 4th and 5th post)	5	<=W	57	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (btwn 4th and 5th post)	5	<=W	64	P40	4	<=W	5	<=W	3	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (Downstream)	5	<=W	40	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (Downstream)	5	<=W	36	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Bloody Run Creek (Downstream)	5	<=W	46	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Canadian Sites																				
Fort Erie @ Robertson St.	5	<=W	28	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fort Erie @ Robertson St.	5	<=W	29	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Fort Erie @ Robertson St.	5	<=W	26	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Miller Creek	5	<=W	38	P40	4	<=W	5	<=W	4	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Miller Creek	5	<=W	47	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Miller Creek	5	<=W	56	P40	4	<=W	5	<=W	2	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Boyers Creek @ Sherk Rd.	5	<=W	29	P40	4	<=W	5	<=W	4	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Boyers Creek @ Sherk Rd.	5	<=W	31	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Boyers Creek @ Sherk Rd.	5	<=W	40	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Chippawa Channel, NR	5	<=W	36	P40	4	<=W	5	<=W	4	<T	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Chippawa Channel, NR	5	<=W	34	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
Chippawa Channel, NR	5	<=W	35	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
NOTL	5	<=W	50	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
NOTL	5	<=W	47	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W
NOTL	5	<=W	50	P40	4	<=W	5	<=W	1	<=W	5	<=W	50	<=W	2	<=W	2	<=W	1	<=W

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	X2123	VQF	X21234	VQF	X21235	VQF	X2124	VQF	X21245	VQF	X2135	VQF	X2HCB	VQF	X2HCE	VQF	X2OCST	VQF	X2PNCB	VQF	X2T236	VQF	X2T245	VQF
	NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G	
Balsam Lake	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Balsam Lake	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Balsam Lake	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Balsam Lake	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Balsam Lake	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
American Sites																								
Two Mile Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Two Mile Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Two Mile Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**5**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Outer Site B)	2	<=W	**5**	**<T**	2	MPC	**3**	**<T**	2	MPC	2	<=W	**13**		1	<=W	1	<=W	**7**	**<T**	1	<=W	1	<=W
Pettit Flume (Outer Site B)	2	<=W	**5**	**<T**	2	MPC	**3**	**<T**	2	MPC	2	<=W	**13**		1	<=W	1	<=W	**7**	**<T**	1	<=W	1	<=W
Pettit Flume (Outer Site B)	2	<=W	**4**	**<T**	2	MPC	2	<=W	2	MPC	2	<=W	**14**		1	<=W	1	<=W	**8**	**<T**	1	<=W	1	<=W
Pettit Flume (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Pettit Flume (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fisherman's Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gratwick Riverside Park (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
102nd Street (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
102nd Street (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
102nd Street (Upstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Little Niagara River (near 102nd St)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Little Niagara River (near 102nd St)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Little Niagara River (near 102nd St)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Cayuga Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	**3**	**<T**	1	<=W	1	<=W
Cayuga Creek	2	<=W	**2**	**<T**	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	**4**	**<T**	1	<=W	1	<=W
Cayuga Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	**3**	**<T**	1	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Little Niagara River (Downstream Cayuga Ck)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W

Appendix D1: Tissue concentrations (ng/g wet wt.) of organic compounds in caged mussels, Niagara River, 2012. <W= no measurable response; <T= measurable trace amount

Station Description	X2123	VQF	X21234	VQF	X21235	VQF	X2124	VQF	X21245	VQF	X2135	VQF	X2HCB	VQF	X2HCE	VQF	X2OCST	VQF	X2PNCB	VQF	X2T236	VQF	X2T245	VQF
	NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G		NG/G	
Upstream of Occidental	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Upstream of Occidental	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Upstream of Occidental	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Occidental 003	2	<=W	**49**		2	MPC	**6**	**<T**	2	MPC	2	<=W	**42**		1	<=W	**3**	**<T**	**44**		**43**		**24**	
Occidental 003	2	<=W	**6**	**<T**	1	MPC	2	<=W	1	MPC	2	<=W	**17**		1	<=W	**2**	**<T**	**9**	**<T**	**7**	**<T**	**5**	**<T**
Occidental 003	2	<=W	**13**		1	MPC	2	<=W	1	MPC	2	<=W	**24**		1	<=W	**4**	**<T**	**17**		**14**		**8**	**<T**
350 m U/S Gill Creek (in NR)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
350 m U/S Gill Creek (in NR)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
350 m U/S Gill Creek (in NR)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gill Creek (Mouth)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gill Creek (Mouth)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Gill Creek (Mouth)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**5**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
U/S Gill Creek (in creek)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
U/S Gill Creek (in creek)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
U/S Gill Creek (in creek)	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	2	<T	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Bloody Run Creek	2	<=W	1	<=W	1	<=W	**3**	**<T**	1	<=W	2	<=W	**13**		1	<=W	1	<=W	**7**	**<T**	**5**	**<T**	**5**	**<T**
Bloody Run Creek	2	<=W	1	<=W	1	<=W	**8**	**<T**	1	<=W	2	<=W	**17**		1	<=W	1	<=W	**8**	**<T**	**8**	**<T**	**10**	
Bloody Run Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**9**	**<T**	1	<=W	1	<=W	**3**	**<T**	**2**	**<T**	**2**	**<T**
Bloody Run Creek (btwn 7th and 8th post)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**10**		1	<=W	1	<=W	**6**	**<T**	1	<=W	**3**	**<T**
Bloody Run Creek (btwn 7th and 8th post)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**11**		1	<=W	1	<=W	**7**	**<T**	1	<=W	**3**	**<T**
Bloody Run Creek (btwn 7th and 8th post)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**11**		1	<=W	1	<=W	**8**	**<T**	**6**	**<T**	**4**	**<T**
Bloody Run Creek (btwn 4th and 5th post)	2	<=W	**3**	**<T**	1	<=W	**4**	**<T**	1	<=W	2	<=W	**32**		1	<=W	1	<=W	**21**		**35**		**27**	
Bloody Run Creek (btwn 4th and 5th post)	2	<=W	**2**	**<T**	1	<=W	2	<=W	1	<=W	2	<=W	**18**		1	<=W	1	<=W	**14**		**12**		**8**	**<T**
Bloody Run Creek (btwn 4th and 5th post)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**11**		1	<=W	1	<=W	**5**	**<T**	**5**	**<T**	**5**	**<T**
Bloody Run Creek (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**6**	**<T**	1	<=W	1	<=W	**2**	**<T**	1	<=W	**3**	**<T**
Bloody Run Creek (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	**2**	**<T**
Bloody Run Creek (Downstream)	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**7**	**<T**	1	<=W	1	<=W	**3**	**<T**	1	<=W	**3**	**<T**
Canadian Sites																								
Fort Erie @ Robertson St.	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fort Erie @ Robertson St.	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Fort Erie @ Robertson St.	2	<=W	1	<=W	1	MPC	2	<=W	1	MPC	2	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Miller Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Miller Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Miller Creek	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Boyers Creek @ Sherk Rd.	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Boyers Creek @ Sherk Rd.	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Boyers Creek @ Sherk Rd.	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Chippawa Channel, NR	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Chippawa Channel, NR	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**2**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
Chippawa Channel, NR	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
NOTL	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
NOTL	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**3**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W
NOTL	2	<=W	1	<=W	1	<=W	2	<=W	1	<=W	2	<=W	**4**	**<T**	1	<=W	1	<=W	1	<=W	1	<=W	1	<=W

Appendix D2: Congener specific PCB tussue concentrations in caged mussels, 2012, Niagara River. <W = no measurable response; <T=measurable trace amount

Station Description	Station No	Field Sample No	LIPID	VQF	PCBTOT	VQF	PCB018	VQF	PCB019	VQF	PCB022	VQF	PCB028	VQF	PCB033	VQF	PCB037	VQF	PCB044	VQF	PCB049	VQF	PCB052	VQF	PCB054	VQF
			E3136A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A	
			%		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.	
Balsam Lake	1800010001	GL123262	5.6		48	<T	8	<T	2	<=W	3	<T	6		7		4	<T	1		2		3		1	<T
Balsam Lake	1800010001	GL123263	6.2		50	<T	6	<T	2	<=W	3	<T	6		6		4	<T	1		2		2		0.2	<=W
Balsam Lake	1800010001	GL123264	5.8		37	<T	7	<T	2	<=W	2	<T	5		5		4	<T	1		2		2		0.2	<=W
Two Mile Creek	500020197	GL123119	5.4		440		9	<T	2	<=W	4	<T	12		7		10		25		23		29		2	
Two Mile Creek	500020197	GL123120	5.4		450		10	<T	2	<=W	3	<T	12		10		15		27		20		32		3	
Two Mile Creek	500020197	GL123121	5.1		460		10	<T	2	<=W	3	<T	13		9		14		26		24		39		2	
Fisherman's Park (Upstream)	500020001	GL123104	5		140	<T	8	<T	2	<=W	3	<T	12		7		5	<T	8		8		10		3	
Fisherman's Park (Upstream)	500020001	GL123105	5.3		110	<T	7	<T	2	<=W	2	<T	7		5		4	<T	5		5		6		3	
Fisherman's Park (Upstream)	500020001	GL123106	5.4		120	<T	6	<T	2	<=W	2	<T	7		5		3	<T	6		6		8		2	
Fisherman's Park (Downstream)	500020002	GL123112	4.8		85	<T	8	<T	9	<T	2	<T	7		5		3	<T	4		4		5		1	<T
Fisherman's Park (Downstream)	500020002	GL123113	5		78	<T	7	<T	2	<=W	2	<T	6		5		3	<T	1		4		4		2	
Fisherman's Park (Downstream)	500020002	GL123114	4.9		100	<T	7	<T	2	<=W	2	<T	6		4	<T	3	<T	2		3		4		1	<T
Gratwick Riverside Park (Downstream)	500020199	GL123144	5.1		220	<T	11	<T	2	<=W	2	<T	13		7		5	<T	12		13		15		4	
Gratwick Riverside Park (Downstream)	500020199	GL123145	4.9		180	<T	10	<T	2	<=W	2	<T	10		6		5	<T	10		11		14		4	
Gratwick Riverside Park (Downstream)	500020199	GL123146	5		260		12	<T	3	<T	3	<T	10		7		6	<T	13		13		18		5	
102nd Street (Upstream)	500020093	GL123151	5.8		300		9	<T	2	<=W	2	<T	9		6		4	<T	9		7		10		3	
102nd Street (Upstream)	500020093	GL123152	5.1		270		9	<T	2	<=W	2	<T	8		6		3	<T	7		7		11		2	
102nd Street (Upstream)	500020093	GL123153	5.2		250		8	<T	2	<=W	2	<T	7		5		3	<T	7		7		10		2	
Little Niagara River (near 102nd St)	500020095	GL123158	4.9		180	<T	9	<T	2	<=W	3	<T	10		6		9	<T	9		6		11		2	
Little Niagara River (near 102nd St)	500020095	GL123159	4.7		180	<T	9	<T	3	<T	3	<T	8		5		7	<T	9		6		10		3	
Little Niagara River (near 102nd St)	500020095	GL123160	5		210	<T	11	<T	3	<T	4	<T	11		7		9	<T	9		7		13		3	
Cayuga Creek	500150031	GL123165	5.6		580		7	<T	7	<T	3	<T	9		4	<T	3	<T	7		8		14		1	<T
Cayuga Creek	500150031	GL123166	5.6		510		6	<T	5	<T	2	<T	8		4	<T	3	<T	7		8		13		1	<T
Cayuga Creek	500150031	GL123167	5.6		490		7	<T	7	<T	2	<T	10		6		3	<T	7		8		14		1	<T
Little Niagara River (Downstream Cayuga Ck)	500020096	GL123172	4.8		360		8	<T	4	<T	2	<T	11		5		3	<T	9		10		15		2	
Little Niagara River (Downstream Cayuga Ck)	500020096	GL123173	5.2		360		8	<T	5	<T	2	<T	12		5		4	<T	11		11		15		4	
Little Niagara River (Downstream Cayuga Ck)	500020096	GL123174	4.8		310		6	<T	4	<T	2	<T	10		5		4	<T	9		10		13		3	
Upstream of Occidental	500020097	GL123197	4.4		170	<T	7	<T	2	<=W	1	<T	8		5		3	<T	7		8		11		3	
Upstream of Occidental	500020097	GL123198	4.2		170	<T	6	<T	2	<=W	2	<T	10		5		3	<T	7		8		9		3	
Upstream of Occidental	500020097	GL123199	4.2		170	<T	8	<T	2	<=W	2	<T	10		5		3	<T	7		9		11		3	
Occidental 003	500020042	GL123204	5		660		29		2	<=W	8		28		17		25		72		39		59		4	
Occidental 003	500020042	GL123205	4.4		710		28		2	<=W	9		32		18		27		77		40		62		3	
Occidental 003	500020042	GL123206	4.6		700		29		4	<T	9		29		17		27		77		41		63		3	
350 m U/S Gill Creek (in NR)	500020098	GL123211	4.8		63	<T	6	<T	2	<=W	1	<T	7		4	<T	2	<T	2		2		3		1	<T
350 m U/S Gill Creek (in NR)	500020098	GL123212	4.8		63	<T	6	<T	2	<=W	2	<T	7		4	<T	2	<T	1		2		2		2	
350 m U/S Gill Creek (in NR)	500020098	GL123213	4.8		56	<T	4	<T	2	<=W	1	<T	6		4	<T	2	<T	1		1		1		1	<T
Gill Creek (Mouth)	500020037	GL123218	5		390		8	<T	2	<=W	2	<T	12		5		5	<T	16		18		24		4	
Gill Creek (Mouth)	500020037	GL123219	5.2		350		9	<T	2	<=W	2	<T	10		6		5	<T	15		17		24		4	
Gill Creek (Mouth)	500020037	GL123220	4.6		360		9	<T	2	<=W	2	<T	12		6		5	<T	15		17		22		4	
U/S Gill Creek (in creek)	500150022	GL123225	6		220	<T	9	<T	2	<=W	2	<T	11		7		9	<T	11		15		18		6	
U/S Gill Creek (in creek)	500150022	GL123226	6.2		240	<T	9	<T	2	<=W	2	<T	9		9		9	<T	12		17		21		8	
U/S Gill Creek (in creek)	500150022	GL123227	6		220	<T	11	<T	2	<=W	3	<T	11		9		11		11		15		22		7	
Fort Erie @ Robertson St.	500020203	GL123232	5.2		46	<T	6	<T	2	<=W	2	<T	5		6		4	<T	2		2		3		1	<T
Fort Erie @ Robertson St.	500020203	GL123233	5		50	<T	8	<T	2	<=W	2	<T	6		5		4	<T	2		2		3		1	<T
Fort Erie @ Robertson St.	500020203	GL123234	5.4		56	<T	8	<T	2	<=W	3	<T	6		7		4	<T	2		2		3		1	<T
Chippawa Channel, NR	500020051	GL123246	4.8		44	<T	6	<T	2	<=W	2	<T	5		6		3	<T	2		2		2		1	<T
Chippawa Channel, NR	500020051	GL123247	5		49	<T	7	<T	2	<=W	2	<T	6		7		4	<T	2		2		2		1	<T
Chippawa Channel, NR	500020051	GL123248	4.8		46	<T	7	<T	2	<=W	2	<T	6		6		3	<T	2		2		3		1	<T
NOTL	1100020009	GL123253	5		54	<T	5	<T	2	<=W	2	<T	5		4	<T	3	<T	2		2		3		0.2	<=W
NOTL	1100020009	GL123254	5.8		54	<T	6	<T	2	<=W	2	<T	5		5		2	<T	2		2		2		0.2	<=W
NOTL	1100020009	GL123255	5.2		55	<T	8	<T	2	<=W	2	<T	6		6		4	<T	2		3		3		1	<T

Appendix D2: Congener specific PCB tussue concentrations in caged mussels, 2012, Niagara River. <W = no measurable response; <T=measurable trace amount

Station Description	PCB070	VQF	PCB074	VQF	PCB077	VQF	PCB081	VQF	PCB087	VQF	PCB095	VQF	PCB099	VQF	PCB101	VQF	PCB104	VQF	PCB105	VQF	PCB110	VQF	PCB114	VQF	PCB118	VQF	PCB119	VQF	PCB123	VQF
	E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A	
	ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.	
Balsam Lake	2		0.1	<=W	0.2	<=W	0.5	<=W	4		2		1		0.1	<=W	0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Balsam Lake	2		0.1	<=W	0.2	<=W	0.5	<=W	11		2		1		1		0.1	<=W	2		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Balsam Lake	1		0.1	<=W	0.2	<=W	0.5	<=W	5		2		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Two Mile Creek	16		0.1	<=W	12		1	<T	20		55		16		28		0.1	<=W	8		7		1		17		8		1	MPC
Two Mile Creek	16		0.1	<=W	13		2	<T	26		57		14		28		0.1	<=W	8		7		1		16		0.1	<=W	1	MPC
Two Mile Creek	17		0.1	<=W	13		4	<T	21		58		15		29		0.1	<=W	8		7		2		17		6		1	MPC
Fisherman's Park (Upstream)	6		4		0.2	<=W	0.5	<=W	8		12		3		6		0.1	<=W	2		1		0.1	<=W	4		0.1	<=W	0.2	<=W
Fisherman's Park (Upstream)	5		2		0.2	<=W	0.5	<=W	7		8		2		5		0.1	<=W	2		1		0.1	<=W	4		0.1	<=W	0.2	<=W
Fisherman's Park (Upstream)	5		1		0.2	<=W	1	<T	10		9		3		6		0.1	<=W	2		1		0.1	<=W	4		0.1	<=W	0.2	<=W
Fisherman's Park (Downstream)	3		0.1	<=W	4		2	<T	3		6		1		2		0.1	<=W	1		1		1		1		1		0.2	<=W
Fisherman's Park (Downstream)	4		0.1	<=W	4		1	<T	5		6		1		3		0.1	<=W	2		0.1	<=W	1		1		0.1	<=W	0.2	<=W
Fisherman's Park (Downstream)	0.1	<=W	39		2		1	<T	4		6		1		3		0.1	<=W	2		1		1		1		0.1	<=W	0.2	<=W
Gratwick Riverside Park (Downstream)	13		0.1	<=W	1	<T	1	<T	9		21		7		11		0.1	<=W	4		2		0.1	<=W	9		0.1	<=W	0.2	<=W
Gratwick Riverside Park (Downstream)	11		0.1	<=W	0.2	<=W	2	<T	6		18		5		9		0.1	<=W	4		2		0.1	<=W	7		0.1	<=W	0.2	<=W
Gratwick Riverside Park (Downstream)	0.1	<=W	53		0.2	<=W	2	<T	8		22		7		11		0.1	<=W	4		2		0.1	<=W	9		0.1	<=W	0.2	<=W
102nd Street (Upstream)	0.1	<=W	140		0.2	<=W	1	<T	9		13		4		9		0.1	<=W	3		2		0.1	<=W	5		1		0.2	<=W
102nd Street (Upstream)	0.1	<=W	130		0.2	<=W	1	<T	10		10		3		7		0.1	<=W	3		2		1		5		1		0.2	<=W
102nd Street (Upstream)	0.1	<=W	110		0.2	<=W	1	<T	10		12		3		8		0.1	<=W	3		1		0.1	<=W	5		0.1	<=W	0.2	<=W
Little Niagara River (near 102nd St)	8		0.1	<=W	3		2	<T	8		12		3		9		0.1	<=W	3		3		0.1	<=W	8		1		0.2	<=W
Little Niagara River (near 102nd St)	8		0.1	<=W	3		2	<T	13		12		3		9		0.1	<=W	4		2		1		8		0.1	<=W	0.2	<=W
Little Niagara River (near 102nd St)	8		7		3		2	<T	9		14		3		11		0.1	<=W	4		3		0.1	<=W	9		1		0.2	<=W
Cayuga Creek	0.1	<=W	370		1	<T	2	<T	17		18		6		18		0.1	<=W	4		3		1		9		0.1	<=W	0.2	<=W
Cayuga Creek	0.1	<=W	310		0.2	<=W	2	<T	18		17		5		17		0.1	<=W	4		3		1		9		0.1	<=W	0.2	<=W
Cayuga Creek	0.1	<=W	290		0.2	<=W	2	<T	17		18		6		18		0.1	<=W	4		3		1		9		0.1	<=W	0.2	<=W
Little Niagara River (Downstream Cayuga Ck)	0.1	<=W	180		0.2	<=W	2	<T	12		15		4		12		0.1	<=W	3		2		1		8		0.1	<=W	0.2	<=W
Little Niagara River (Downstream Cayuga Ck)	0.1	<=W	140		0.2	<=W	3	<T	15		22		6		15		0.1	<=W	4		3		1		9		0.1	<=W	0.2	<=W
Little Niagara River (Downstream Cayuga Ck)	0.1	<=W	130		0.2	<=W	2	<T	9		18		5		13		0.1	<=W	3		2		1		8		0.1	<=W	0.2	<=W
Upstream of Occidental	0.1	<=W	40		0.2	<=W	0.5	<=W	9		12		3		7		0.1	<=W	3		1		1		5		0.1	<=W	0.2	<=W
Upstream of Occidental	0.1	<=W	35		0.2	<=W	0.5	<=W	5		12		4		9		0.1	<=W	3		2		1		6		0.1	<=W	0.2	<=W
Upstream of Occidental	0.1	<=W	26		0.2	<=W	0.5	<=W	5		13		4		8		0.1	<=W	3		2		0.1	<=W	5		0.1	<=W	0.2	<=W
Occidental 003	58		32		12		6		18		81		14		27		0.1	<=W	16		0.1	<=W	2		22		8		1	MPC
Occidental 003	60		35		15		10		19		84		15		28		3		16		1		2		24		13		1	MPC
Occidental 003	57		33		15		8		19		82		14		27		2		15		1		2		22		12		1	MPC
350 m U/S Gill Creek (in NR)	0.1	<=W	7		0.2	<=W	0.5	<=W	4		3		0.1	<=W	2		0.1	<=W	2		1		0.1	<=W	1		1		0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	8		0.2	<=W	0.5	<=W	5		2		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	9		0.2	<=W	0.5	<=W	8		2		1		1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Gill Creek (Mouth)	0.1	<=W	160		0.2	<=W	0.5	<=W	13		28		9		15		0.1	<=W	4		3		1		10		0.1	<=W	0.2	<=W
Gill Creek (Mouth)	0.1	<=W	120		0.2	<=W	2	<T	8		28		8		15		0.1	<=W	5		2		1		11		0.1	<=W	0.2	<=W
Gill Creek (Mouth)	0.1	<=W	130		0.2	<=W	2	<T	12		27		7		14		0.1	<=W	4		2		1		10		0.1	<=W	0.2	<=W
U/S Gill Creek (in creek)	9		2		3		1	<T	14		18		5		11		0.1	<=W	3		2		1		7		0.1	<=W	1	MPC
U/S Gill Creek (in creek)	10		1		0.2	<=W	2	<T	12		21		6		12		0.1	<=W	4		3		1		8		0.1	<=W	1	MPC
U/S Gill Creek (in creek)	9		3		0.2	<=W	1	<T	9		20		5		10		0.1	<=W	3		2		1		7		0.1	<=W	1	MPC
Fort Erie @ Robertson St.	2		0.1	<=W	0.2	<=W	0.5	<=W	3		2		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Fort Erie @ Robertson St.	2		0.1	<=W	0.2	<=W	0.5	<=W	2		3		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Fort Erie @ Robertson St.	2		0.1	<=W	0.2	<=W	0.5	<=W	3		2		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Chippawa Channel, NR	2		0.1	<=W	0.2	<=W	0.5	<=W	4		2		0.1	<=W	1		0.1	<=W	2		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Chippawa Channel, NR	2		0.1	<=W	0.2	<=W	0.5	<=W	3		2		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
Chippawa Channel, NR	2		0.1	<=W	0.2	<=W	0.5	<=W	2		2		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
NOTL	2		3		1	<T	0.5	<=W	3		3		0.1	<=W	2		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
NOTL	2		1		1	<T	0.5	<=W	9		3		0.1	<=W	1		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W
NOTL	2		1		1	<T	0.5	<=W	2		3		0.1	<=W	2		0.1	<=W	1		0.1	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W

Appendix D2: Congener specific PCB tussue concentrations in caged mussels, 2012, Niagara River. <W = no measurable response; <T=measurable trace amount

Station Description	PCB126	VQF	PCB128	VQF	PCB138	VQF	PCB149	VQF	PCB151	VQF	PCB153	VQF	PCB155	VQF	PCB156	VQF	PCB157	VQF	PCB158	VQF	PCB167	VQF	PCB168	VQF	PCB169	VQF	PCB170	VQF	PCB171	VQF
	E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A	
	ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.	
Balsam Lake	1		0.2	<=W	0.2	<=W	0.2	<=W	1		0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	0		0.1	<=W	0.2	<=W	0.2	<=W
Balsam Lake	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W
Balsam Lake	1		0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W
Two Mile Creek	2		3		21		23		12		18		1		0.2	<=W	0.2	<=W	2		1	<T	14	MPC	0.1	<=W	5		0.2	<=W
Two Mile Creek	2		4		21		23		12		15		1		3		0.2	<=W	2		1	<T	13	MPC	0.1	<=W	5		2	
Two Mile Creek	2		3		20		23		13		15		1		3		0.2	<=W	2		1	<T	14	MPC	0.1	<=W	5		2	
Fisherman's Park (Upstream)	2		1	<T	6		4		2		4		0.1	<=W	0.2	<=W	0.2	<=W	1		0.2	<=W	2	MPC	0.1	<=W	1	<T	0.2	<=W
Fisherman's Park (Upstream)	2		1	<T	4		3		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	0.1	<=W	1	<T	0.2	<=W
Fisherman's Park (Upstream)	2		1	<T	5		4		2		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	0.1	<=W	1	<T	1	<T
Fisherman's Park (Downstream)	0.1	<=W	0.2	<=W	2		1	<T	0.1	<=W	2		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W
Fisherman's Park (Downstream)	2		0.2	<=W	4		1	<T	0.1	<=W	3		0.1	<=W	0.2	<=W	0.2	<=W	1		0.2	<=W	0.1	<=W	0.1	<=W	1	<T	0.2	<=W
Fisherman's Park (Downstream)	0.1	<=W	0.2	<=W	2		1	<T	1		2		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	1	<T	0.2	<=W
Gratwick Riverside Park (Downstream)	2		0.2	<=W	8		8		2		7		0.1	<=W	2		0.2	<=W	0.1	<=W	0.2	<=W	4	MPC	0.1	<=W	2		2	
Gratwick Riverside Park (Downstream)	2		0.2	<=W	6		6		2		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	3	MPC	0.1	<=W	1	<T	1	<T
Gratwick Riverside Park (Downstream)	2		0.2	<=W	8		8		2		7		0.1	<=W	2		0.2	<=W	1		0.2	<=W	4	MPC	0.1	<=W	2		1	<T
102nd Street (Upstream)	3		0.2	<=W	6		6		2		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	3	MPC	0.1	<=W	2		1	<T
102nd Street (Upstream)	1		0.2	<=W	6		5		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	0.1	<=W	2		1	<T
102nd Street (Upstream)	6		0.2	<=W	6		5		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	3	MPC	0.1	<=W	2		1	<T
Little Niagara River (near 102nd St)	4		0.2	<=W	8		6		4		8		0.1	<=W	3		0.2	<=W	0.1	<=W	0.2	<=W	4	MPC	2		3		2	
Little Niagara River (near 102nd St)	3		2		7		6		3		7		1		3		0.2	<=W	0.1	<=W	0.2	<=W	3	MPC	1		2		2	
Little Niagara River (near 102nd St)	6		2		7		6		3		7		1		3		0.2	<=W	0.1	<=W	0.2	<=W	5	MPC	2		3		2	
Cayuga Creek	2		1	<T	11		11		4		10		1		3		0.2	<=W	1		1	<T	7	MPC	0.1	<=W	4		2	
Cayuga Creek	2		1	<T	11		10		4		10		1		2		0.2	<=W	1		0.2	<=W	7	MPC	0.1	<=W	4		2	
Cayuga Creek	0.1	<=W	1	<T	11		11		5		10		0.1	<=W	3		0.2	<=W	1		0.2	<=W	7	MPC	0.1	<=W	4		0.2	<=W
Little Niagara River (Downstream Cayuga Ck)	2		1	<T	8		8		4		7		0.1	<=W	2		0.2	<=W	1		0.2	<=W	4	MPC	1		3		1	<T
Little Niagara River (Downstream Cayuga Ck)	2		1	<T	10		9		5		9		0.1	<=W	2		0.2	<=W	1		1	<T	6	MPC	1		3		2	
Little Niagara River (Downstream Cayuga Ck)	0.1	<=W	1	<T	8		7		3		7		0.1	<=W	2		0.2	<=W	1		0.2	<=W	4	MPC	0.1	<=W	4		2	
Upstream of Occidental	0.1	<=W	1	<T	6		4		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	1		2		0.2	<=W
Upstream of Occidental	0.1	<=W	1	<T	6		5		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	0.1	<=W	3		0.2	<=W
Upstream of Occidental	0.1	<=W	1	<T	6		5		3		5		0.1	<=W	2		0.2	<=W	1		0.2	<=W	2	MPC	1		2		0.2	<=W
Occidental 003	7		3		10		14		13		8		1		3		0.2	<=W	2		0.2	<=W	1	MPC	0.1	<=W	2		3	
Occidental 003	8		4		10		15		12		8		2		2		0.2	<=W	2		0.2	<=W	1	MPC	0.1	<=W	2		3	
Occidental 003	7		4		10		14		12		7		2		2		0.2	<=W	2		0.2	<=W	1	MPC	0.1	<=W	1	<T	3	
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	2		1	<T	1		2		0.1	<=W	3		0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	2		1	<T	1		2		0.1	<=W	3		0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	2		1	<T
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	2		1	<T	1		1		0.1	<=W	3		0.2	<=W	0.1	<=W	0.2	<=W	0.1	<=W	0.1	<=W	2		0.2	<=W
Gill Creek (Mouth)	0.1	<=W	1	<T	9		9		6		8		0.1	<=W	2		1	<T	1		0.2	<=W	5	MPC	1		3		0.2	<=W
Gill Creek (Mouth)	0.1	<=W	2		9		9		6		8		0.1	<=W	2		0.2	<=W	1		0.2	<=W	5	MPC	0.1	<=W	4		0.2	<=W
Gill Creek (Mouth)	0.1	<=W	1	<T	8		9		5		7		0.1	<=W	2		0.2	<=W	1		0.2	<=W	4	MPC	0.1	<=W	4		0.2	<=W
U/S Gill Creek (in creek)	2		0.2	<=W	9		8		5		8		0.1	<=W	1	<T	0.2	<=W	1		1	<T	5	MPC	0.1	<=W	3		1	<T
U/S Gill Creek (in creek)	1		0.2	<=W	10		9		6		8		0.1	<=W	1	<T	0.2	<=W	1		0.2	<=W	6	MPC	1		3		0.2	<=W
U/S Gill Creek (in creek)	1		1	<T	8		8		4		7		0.1	<=W	1	<T	0.2	<=W	1		1	<T	5	MPC	0.1	<=W	2		0.2	<=W
Fort Erie @ Robertson St.	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	0.2	<=W	0.2	<=W
Fort Erie @ Robertson St.	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	0.2	<=W	0.2	<=W
Fort Erie @ Robertson St.	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	1	<T	0.2	<=W
Chippawa Channel, NR	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	1	<T	0.2	<=W
Chippawa Channel, NR	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	0.2	<=W	0.2	<=W
Chippawa Channel, NR	1		0.2	<=W	1	<T	0.2	<=W	0.1	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	1	<T	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	1	<T	1	<T	1		1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	1	<T	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	1	<T	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		1		0.1	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.2	<=W	1	MPC	0.1	<=W	0.2	<=W	0.2	<=W

Appendix D2: Congener specific PCB tussue concentrations in caged mussels, 2012, Niagara River. <W = no measurable response; <T=measurable trace amount

Station Description	PCB177	VQF	PCB178	VQF	PCB180	VQF	PCB183	VQF	PCB187	VQF	PCB188	VQF	PCB189	VQF	PCB191	VQF	PCB194	VQF	PCB199	VQF	PCB201	VQF	PCB202	VQF	PCB205	VQF	PCB206	VQF	PCB208	VQF
	E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A		E3411A	
	ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.		ng/g dry wt.	
Balsam Lake	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Balsam Lake	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Balsam Lake	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Two Mile Creek	1		0.2	<=W	6		1	<T	4		3		0.2	<=W	0.2	<=W	0.2	<=W	2		5		0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Two Mile Creek	2		0.2	<=W	6		1	<T	4		4		0.2	<=W	0.2	<=W	1	<T	1	<T	5		0.2	<=W	1	<T	1	<T	0.2	<=W
Two Mile Creek	2		0.2	<=W	6		1	<T	3		3		0.2	<=W	0.2	<=W	1	<T	1	<T	5		0.2	<=W	0.2	<=W	1	<T	0.2	<=W
Fisherman's Park (Upstream)	1		0.2	<=W	0.2	<=W	0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		0.2	<=W	0.2	<=W	1	<T	1	<T
Fisherman's Park (Upstream)	0.1	<=W	0.2	<=W	2		0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		0.2	<=W	0.2	<=W	1	<T	2	
Fisherman's Park (Upstream)	1		0.2	<=W	3		0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		0.2	<=W	0.2	<=W	1	<T	1	<T
Fisherman's Park (Downstream)	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	1	<T	0.2	<=W	0.2	<=W
Fisherman's Park (Downstream)	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	0.2	<=W	1	<T	2		0.2	<=W
Fisherman's Park (Downstream)	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Gratwick Riverside Park (Downstream)	1		0.2	<=W	5		0.2	<=W	2		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	4		1	<T	0.2	<=W	2		1	<T
Gratwick Riverside Park (Downstream)	1		0.2	<=W	3		0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	3		0.2	<=W	0.2	<=W	1	<T	1	<T
Gratwick Riverside Park (Downstream)	1		0.2	<=W	5		0.2	<=W	3		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	4		0.2	<=W	0.2	<=W	1	<T	2	
102nd Street (Upstream)	1		0.2	<=W	3		0.2	<=W	2		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	3		1	<T	0.2	<=W	1	<T	1	<T
102nd Street (Upstream)	1		0.2	<=W	3		0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	3		0.2	<=W	0.2	<=W	1	<T	1	<T
102nd Street (Upstream)	1		0.2	<=W	3		0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	3		0.2	<=W	0.2	<=W	1	<T	1	<T
Little Niagara River (near 102nd St)	1		0.2	<=W	4		0.2	<=W	3		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	2		1	<T	0.2	<=W	1	<T	1	<T	1	<T
Little Niagara River (near 102nd St)	1		0.2	<=W	4		1	<T	2		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	2		1	<T	0.2	<=W	1	<T	1	<T	1	<T
Little Niagara River (near 102nd St)	0.1	<=W	0.2	<=W	4		2		4		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	2		1	<T	2		1	<T	1	<T	1	<T
Cayuga Creek	1		0.2	<=W	4		1	<T	2		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	4		0.2	<=W	0.2	<=W	1	<T	1	<T
Cayuga Creek	1		0.2	<=W	3		0.2	<=W	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	3		0.2	<=W	2		1	<T	1	<T
Cayuga Creek	1		0.2	<=W	3		1	<T	2		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	3		0.2	<=W	1	<T	1	<T	1	<T
Little Niagara River (Downstream Cayuga Ck)	1		0.2	<=W	3		0.2	<=W	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	1	<T	0.2	<=W	0.2	<=W	1	<T	1	<T
Little Niagara River (Downstream Cayuga Ck)	1		0.2	<=W	4		0.2	<=W	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	1	<T	0.2	<=W	0.2	<=W	1	<T	2	
Little Niagara River (Downstream Cayuga Ck)	1		0.2	<=W	4		0.2	<=W	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	4		0.2	<=W	0.2	<=W	1	<T	2	
Upstream of Occidental	0.1	<=W	0.2	<=W	2		0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		0.2	<=W	1	<T	1	<T	1	<T
Upstream of Occidental	0.1	<=W	0.2	<=W	2		0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	0.2	<=W	1	<T	2		0.2	<=W	0.2	<=W	1	<T	1	<T
Upstream of Occidental	0.1	<=W	0.2	<=W	2		0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	2		0.2	<=W	6		1	<T	0.2	<=W
Occidental 003	0.1	<=W	0.2	<=W	2		0.2	<=W	0.1	<=W	10		0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	1	<T
Occidental 003	0.1	<=W	0.2	<=W	0.2	<=W	1	<T	3		9		0.2	<=W	0.2	<=W	1	<T	0.2	<=W	1	<T	2		0.2	<=W	2		0.2	<=W
Occidental 003	0.1	<=W	0.2	<=W	0.2	<=W	1	<T	2		9		1	<T	0.2	<=W	2		0.2	<=W	1	<T	2		0.2	<=W	3		0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	2		0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	1	<T	2		0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	2		0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
350 m U/S Gill Creek (in NR)	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	1	<T	0.2	<=W	0.2	<=W
Gill Creek (Mouth)	1		0.2	<=W	1	<T	0.2	<=W	1		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	3		0.2	<=W	0.2	<=W	1	<T	1	<T
Gill Creek (Mouth)	1		0.2	<=W	4		1	<T	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		1	<T	0.2	<=W	1	<T	1	<T
Gill Creek (Mouth)	1		0.2	<=W	3		0.2	<=W	2		0.1	<=W	1	<T	0.2	<=W	1	<T	1	<T	2		0.2	<=W	0.2	<=W	1	<T	1	<T
U/S Gill Creek (in creek)	0.1	<=W	0.2	<=W	4		1	<T	3		2		0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	2		0.2	<=W	1	<T	0.2	<=W	0.2	<=W
U/S Gill Creek (in creek)	1		0.2	<=W	4		0.2	<=W	3		2		0.2	<=W	0.2	<=W	0.2	<=W	1	<T	2		0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
U/S Gill Creek (in creek)	1		0.2	<=W	4		0.2	<=W	3		1		0.2	<=W	0.2	<=W	0.2	<=W	1	<T	2		0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Fort Erie @ Robertson St.	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Fort Erie @ Robertson St.	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Fort Erie @ Robertson St.	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Chippawa Channel, NR	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W
Chippawa Channel, NR	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
Chippawa Channel, NR	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	1	<T	0.2	<=W	0.1	<=W	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1	<T	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W
NOTL	0.1	<=W	0.2	<=W	0.2	<=W	0.2	<=W	1		0.1	<=W	0.2	<=W	0.2	<=W	1	<T	0.2	<=W	1	<T	0.2	<=W	0.2	<=W	0.2	<=W	0.2	<=W

Appendix D3: Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in caged mussels (pg/g wet wt.) deployed in the Niagara River, and sediment (ng/g dry wt), 2012. n=1 composite of four mussels. Values less than the detection limit (<) are replaced with a 0 when calculating TEQs.

Station Description		Fisherman's Park (Upstream)		Fisherman's Park (Downstream)		Pettit Flume (Downstream)		Pettit Flume (Outer Site B)		Pettit Flume (Upstream)		Bloody Run Creek		Bloody Run Creek (btwn 7th and 8th post)		Bloody Run Creek (btwn 4th and 5th post)		Bloody Run Creek (Downstream)	
Station No		500020001		500020002		500020187		500020186		500020185		1100020017		1100020131		1100020132		1100020025	
Collect Date		08/07/2012 12:15		08/07/2012 13:27		08/08/2012 8:09		08/08/2012 8:40		08/08/2012 9:16		08/09/2012 7:41		08/09/2012 7:40		08/09/2012 8:02		08/09/2012 7:54	
Field Sample No		GL123103		GL123111		GL123126		GL123131		GL123135		GL123179		GL123183		GL123188		GL123193	
Water Depth		0.4		0.9		1		0.9		0.9		0.5		0.6		0.8		0.7	
LIPID	%	0.52		0.65		0.71		1.1		0.58		0.42		0.4		0.97		0.88	
2378-tetrachlorofuran	pg/g wet wt	3.5		1.1		6.7		9.7		0.32	<	0.9		0.46		0.74		0.28	<
12378-pentachlorofuran	pg/g wet wt	1.3		0.22	<	0.95		1.1		0.15	<	0.19	<	0.18	<	0.26	<	0.17	<
23478-pentachlorofuran	pg/g wet wt	2.6		0.46		6.3		3.2		0.18	<	0.42		0.31	<	0.34	<	0.17	<
123478-hexachlorofuran	pg/g wet wt	7.2		0.98		36		11		0.27	<	0.61		0.37	<	0.63		0.23	<
123678-hexachlorofuran	pg/g wet wt	1.6		0.29	<	5.4		2.2		0.22	<	0.3	<	0.21	<	0.29	<	0.23	<
123789-hexachlorofuran	pg/g wet wt	0.31	<	0.22	<	0.32	<	0.25	<	0.26	<	0.21	<	0.27	<	0.26	<	0.28	<
234678-hexachlorofuran	pg/g wet wt	0.66	<	0.18	<	1.4		0.63		0.22	<	0.18	<	0.22	<	0.21	<	0.24	<
1234678-heptachlorofuran	pg/g wet wt	9.4		1.1		45		20		0.14	<	0.48		0.32	<	0.38		0.16	<
1234789-heptachlorofuran	pg/g wet wt	0.46		0.22	<	2.6		0.7		0.21	<	0.2	<	0.24	<	0.22	<	0.24	<
Octachlorofuran	pg/g wet wt	8.8		0.88	<	68		11		0.41	<	1.3		0.97	<	1.1		0.33	<
2378-tetrachlorodioxin	pg/g wet wt	0.22	<	0.17	<	0.25	<	0.66		0.19	<	12		5.2		9.5		0.8	
12378-pentachlorodioxin	pg/g wet wt	0.42	<	0.23	<	0.25	<	0.51	<	0.23	<	0.17	<	0.22	<	0.34	<	0.2	<
123478-hexachlorodioxin	pg/g wet wt	0.24	<	0.18	<	0.27	<	0.18	<	0.16		0.21	<	0.18	<	0.27	<	0.22	<
123678-hexachlorodioxin	pg/g wet wt	0.36	<	0.18	<	0.48		0.45		0.19	<	1.1		0.7	<	0.82		0.23	<
123789-hexachlorodioxin	pg/g wet wt	0.25	<	0.18	<	0.2	<	0.29	<	0.19	<	0.48		0.3	<	0.38	<	0.24	<
1234678-heptachlorodioxin	pg/g wet wt	1.3		0.31	<	1.1	<	0.86	<	0.41	<	2.8		1.1	<	1.8		0.32	<
Octachlorodioxin	pg/g wet wt	4.8		0.47	<	3.1		1.5		1.5		2.4		1.3		2		0.8	<
mammals	**Total TEQ**	**2.2**		**0.4**		**7.4**		**4.3**		**0.02**		**12**		**5.2**		**9.7**		**0.8**	
fish	**Total TEQ**	**2.5**		**0.4**		**8.3**		**4.4**		**0.08**		**12**		**5.2**		**9.6**		**0.8**	
birds	**Total TEQ**	**7.2**		**1.7**		**18**		**15**		**0.01**		**13**		**5.7**		**10**		**0.8**	

Appendix D3: Dioxin and furan concentrations in sediment collected from the Niagara River, 2013

		Fisherman's Park (Upstream)	Fisherman's Park (Downstream)	Pettit Flume (Downstream)	Pettit Flume (Outer Site B)	Bloody Run Creek (Upstream)	Bloody Run Creek
Station No		500020001	500020002	500020187	500020186	1100020018	1100020017
Collect Date		08/07/2012 14:20	08/07/2012 14:30	08/08/2012 9:45	08/08/2012 10:10	08/09/2012 7:30	08/09/2012 7:42
Field Sample No		GL123053	GL123054	GL123055	GL123056	GL123058	GL123059
Water Depth		0.4	0.4	1	0.9	0.4	0.4
TOC	mg/g	37	41	26	83	10	5
2378-tetrachlorofuran	pg/g dry	84	64	100	8900	9.4	130
12378-pentachlorofuran	pg/g dry	43	41	41	3500	3.9	37
23478-pentachlorofuran	pg/g dry	110	68	110	8800	10	140
123478-hexachlorofuran	pg/g dry	1600	1000	2000	120000	130	1200
123678-hexachlorofuran	pg/g dry	270	180	290	23000	22	230
123789-hexachlorofuran	pg/g dry	2.2	2.6	1.9	140	0.64	5.6
234678-hexachlorofuran	pg/g dry	68	46	61	4900	4.5	46
1234678-heptachlorofuran	pg/g dry	5600	3400	6100	300000	86	920
1234789-heptachlorofuran	pg/g dry	160	100	200	13000	20	210
Octachlorofuran	pg/g dry	11000	7600	14000	1000000	220	4900
2378-tetrachlorodioxin	pg/g dry	4.6	< 2.8	< 6	< 580	310	3600
12378-pentachlorodioxin	pg/g dry	12	7.7	11	1300	3.6	49
123478-hexachlorodioxin	pg/g dry	12	7.7	12	1000	9.8	130
123678-hexachlorodioxin	pg/g dry	26	16	24	2400	210	2300
123789-hexachlorodioxin	pg/g dry	24	6.6	20	2100	130	1400
1234678-heptachlorodioxin	pg/g dry	310	140	200	15000	1600	11000
Octachlorodioxin	pg/g dry	1800	570	1200	31000	1400	8800
mammals	**Total TEQ**	**319**	**200**	**366**	**24458**	**386**	4362
fish	**Total TEQ**	**333**	**210**	**379**	**25494**	**346**	4000
birds	**Total TEQ**	**467**	**304**	**528**	**38266**	**368**	4264
SUM2 (silt)	% VOLUME	66.6	59.1	72.1	65.5	76.2	75.7
SUM4 (sand)	% VOLUME	22.6	30.2	7.4	21.6	1.8	3.4
SUM5 (Clay)	% VOLUME	10.8	10.7	20.5	12.9	22	20.9

Appendix E. Total TEQ pg/g and TEQ for Dioxin-Like (DL) PCBs(pg/g)** in caged mussels (wet wt.) and sediment (dry wt.) collected from the Niagara River (1987-2012).*

NR-Niagara River; ND-below the detection limit

		Mussels		**Sediment**		
STATION	**YEAR**	**Total TEQ**	**DL-PCB TEQ**	**Total TEQ**	**DL-PCB TEQ**	**TOC (mg/g)**
Canadian Sites						
NR - Fort Erie	1995	ND		0.9		
	1997			10		20
	2000	0.01	0.01	2	0.01	9
NR - Chippawa Channel	2000	ND	ND	0.01	0.01	5
Niagara-on-the-Lake	1993	ND		13		
	1995	ND		14		
	1997	ND				
	2000	0.01	0.01			
	2003			8	0.05	7
American Sites						
Tonawanda Channel (U/S Two Mile Ck.)	2009	0.01				
Scajaquada Creek	2009	0.03		13		45
Rattlesnake Creek	2009	0.11		13		30
Two Mile Creek	2000			30	3.3	39
	2003			52	1.4	65
Exalon (upstream) in Erie Canal	2003	0.04	0.04	77	0.2	33
NR - Gratwick /Riverside Park	1991	15				
NR - Wheatfield	1987	ND				
Little Niagara River (downstream 102nd St.)	2006	16		300	2.1	43
Cayuga Creek	1995	18		18		
	2003	0.16	0.05	59	0.3	82
Little Niagara River (downstream Cayuga Ck.)	2006	8		140	0.6	110
Occidental Sewer 003	1991	ND				
Gill Creek (upstream in Creek)	2000			71	0.8	14
	2003	0.44	0.08	88	1.0	17
	2006	1		28	0.3	8
NR - 102nd Street	1991	70				
	1993	96		230		
	1995	130		500		
	1997	1		ND		ND
Pettit Flume (upstream)	1991	5				
	1993	ND		26		
	2000	ND	0.05	13	0.3	23
	2003	ND	ND	37	0.3	34
	2006	0.03		15		
	2009	0.010		21		44
	2012	0.10				
Pettit Flume Cove (site A)	1991	960				
	1993	200		48000		
Pettit Flume Cove (site B)	1997	46		20000		110
	2000	74	ND	30000	2.6	120
	2003	60	0.05	11000	1.4	120
	2006	190		15000		
	2009	46		3800		71
	2012	4		25500		83
Pettit Flume (downstream)	2000	3	0.03	490	0.2	33
	2003	0.36	0.01	2000	0.3	20
	2006	5		680		
	2009	1		7200		47
	2012	8		379		26
Fisherman's Park (upstream inlet)	2012	3		333		37
Fisherman's Park (downstream inlet)	2012	0.4		210		41
NR - Bloody Run Creek (upstream)	2000	ND	ND	43	0.3	5
	2003			180	0.4	5
	2004	0.01	0.01			
	2006	2		36		12
	2009	ND		44		9
	2012			346		10
NR- Bloody Run Creek	1993	270		120000		
	1994	56				
	1995	120		61000		
	1997	84		52000		29
	2000	23	0.04	3300		7
	2003			110000	6.2	22
	2004	46	0.06			
	2006	45		4200		14
	2009	18		48000		16
	2012	9		4000		5
Bloody Run Creek (downstream)	2004	9	0.02			
	2006	6		220		7
	2009	6		2200		22
	2012	1				

*Dioxin, furan and dioxin-like PCB concentrations were multiplied by the WHO Toxicity *Equivalency Factors (TEF) for protection of fish to express their respective toxicity* on a common basis and then summed to yield a total toxic equivalent (TEQ).

** Analysis for dioxin-like PCBs was not available prior to 2000

Appendix F: SPMD data for US deployments - concentrations represent ng/SPMD

	2 Mile Creek		2 Mile Creek		2 Mile Creek		Pettit Flume^1		Pettit Flume		Pettit Flume		Gratwick Riverside Park		Gratwick Riverside Park		Gratwick Riverside Park	
	-1		-2		-3		upstream-3		outer-3		Downstream-3		upstream-1		upstream-2		upstream-3	
1,3-Dichlorobenzene	8.35		8.24		6.82		1.02	J	59.2		14.8		2.36	J	2.89	J	2.85	J
1,4-Dichlorobenzene	21.9		24.4		21.8		9.06		175		30.1		11.5		13.9		12.7	
1,2-Dichlorobenzene	1.98	J	1.6	J	1.44	J	2.13	J	86.7		1.68	J	1.27	J	1.29	J	1.27	NDR J
1,3,5-Trichlorobenzene	30.8		29.8		28.8			ND	96.2		17.3		2.06	J	2.49	J	2.12	J
1,2,4-Trichlorobenzene	45.4		46.4		47.8		1.13	J	250		9.68		10.7		11.2		12.4	
1,2,3-Trichlorobenzene	3.8		4.27		4.02			ND	145		1.72	J	1.22	J	1.53	J	1.48	J
1,2,4,5-/1,2,3,5-Tetrachlorobenzene	95.7		93.2		98.6		0.499	J	318		13.7		3.02	J	3.13	J	3.05	J
1,2,3,4-Tetrachlorobenzene	135		131		137		0.345	J	572		7.34		1.77	J	1.98	J	2.16	J
Hexachlorobutadiene	2.55	J	2.68	J	2.66	J		ND	2.67	J	3.29	J		ND		ND		ND
Pentachlorobenzene	230		214		231		0.849	J	462		61.9		8.8		8.67		8.75	
Hexachlorobenzene	55.3		50		54.2		2.14	J	382		233		18.7		18.7		19.8	
HCH, alpha	352		350		356			ND		NQ		ND		ND		ND		ND
HCH, beta	108		90.1		118			ND		ND		ND		ND		ND		ND
HCH, gamma	25.6	NDR	24.2	NDR	25	NDR		ND		NQ		ND	5.47	NDR J		ND	3.68	NDR J
Heptachlor		ND		ND		ND		ND		ND		ND		ND		ND		ND
Aldrin		ND	0.955	J		ND		ND		ND		ND		ND		ND		ND
Chlordane, gamma (trans)	7.99		6.92		7.57		1.27	J	12.3		1.98	J	2.25	J	1.98	J	1.99	J
Chlordane, alpha (cis)	12.7		11.1		11.8		1.8	J	20.4		2.36	NDR J	3.47	J	2.97	J	2.85	J
Octachlorostyrene	0.545	J	0.426	J	0.353	J		ND	0.934	J	1.04	J		ND		ND		ND
Chlordane, oxy-	42.1	NDR	35.1	NDR	38.7	NDR	38	NDR	24.8	NDR	23.9	NDR	11.1	NDR J	21.3	NDR	16.6	NDR
Nonachlor, trans-	5.67	J	4.68	J	4.99	J	1.03	J	7.8	J	1.32	J	1.51	J	1.57	J	1.43	J
Nonachlor, cis-	1.49	J	1.34	J	1.6	J		ND	1.89	J	0.477	J	0.463	J	0.477	J	0.664	J
Mirex	6.39	NDR	5.07	NDR	5.96	NDR		ND	3.16	NDR J		ND		ND		ND		ND
2,4'-DDE	3.05	NDR	2.92	NDR	2.62	NDR J	0.753	NDR J	1.97	NDR J	0.954	NDR J	1.58	NDR J	1.84	NDR J	1.73	NDR J
4,4'-DDE	17.9		16.9		17.2		3.11	J	13.4		4.28	J	5.69	J	6.46		6.49	
2,4'-DDD	7.78	D	9	D	8.88	D		ND	16.3			ND		ND		ND	1.11	J
4,4'-DDD	40.3	D	40.8	D	41.3	D	2.98	J	59.2		4.19	J	5.46	J	5.92	J	5.84	J
2,4'-DDT	4.94	NDR D J	4.31	NDR D J	4.67	NDR D J	1.17	NDR J	2.11	NDR J	2	NDR J	4.16	NDR J	4.43	NDR J	4.36	NDR J
4,4'-DDT	2.06	D J	1.35	D J	2.12	D J		ND		ND		ND		ND	1.15	J		ND
HCH, delta	42.8	D	45.5	D	59.5	D		ND		ND	0.49	D J Q		ND D	0.504	D J Q		ND D
Heptachlor Epoxide	2.31	D J Q	2.05	D J Q	2.21	D J Q	0.967	J Q	3.13	J Q	1.14	D J Q	1.36	D J Q	1.75	D J Q	1.35	D J Q
Dieldrin	7.93	D J	7.21	D J	7.46	D J	5.31	J	9.78		6.07	D J	7.11	D J	7.3	D J	7.06	D J
Endrin		ND D		ND D		ND D		ND		ND		ND D		ND D		ND D		ND D
Endrin Aldehyde		ND D		ND D		ND D		ND		ND		ND D		ND D		ND D		ND D
Endrin Ketone		ND D		ND D		ND D		ND		ND		ND D		ND D	1.3	D J	0.314	D J Q
Methoxychlor	10.1	D Q	10.1	D Q	10.1	D Q		ND		ND		ND D		ND D		ND D	2.14	D J
alpha-Endosulphan	2.93	D J Q	2.75	D J Q	2.95	D J		ND	0.383	J	0.622	D J	0.874	D J	0.539	D J		ND D
beta-Endosulphan	2.93	D J	2.71	D J	3.1	D J		ND	0.811	J Q		ND D		ND D		ND D		ND D
Endosulphan Sulphate	1.98	D J Q	2.21	D J Q		ND D	0.991	J Q	3.78	J Q	0.585	D J Q		ND D		ND D		ND D

J = concentration less than lowest calibration equivalent.

NDR=Peak detected but did not reach quantification criteria, results reported represents maximum possible value. Censored data

D= Sample diluted

ND= not detected at reporting level

Q= Contract defined limit

Pettit Flume^1 = the three Pettit Flume sites each have only 1 replicate (rep -1 and rep-2 were used for dioxin/furan analysis)

Occidental Sewer-2^2 = There are only 2 reps for this site

Appendix F: SPMD data for US deployments - concentrations represent ng/SPMD

	Gratwick Riverside Park downstream-1		Gratwick Riverside Park downstream-2		Gratwick Riverside Park downstream-3		102nd Street Upstream-1		102nd Street Upstream-2		102nd Street Upstream-3		Little Niagara River (near 102nd St)-1		Little Niagara River (near 102nd St)-2		Little Niagara River (near 102nd St)-3	
1,3-Dichlorobenzene	3.85	J	3.85	J	2.95	J	2.27	J	2.86	J	2.58	J	9.59		11		12.9	
1,4-Dichlorobenzene	31.1		22.6		22.4		6.47		7		6.87		36.7		35.5		39.5	
1,2-Dichlorobenzene	2.53	J	2.73	J	2.12	J	6.8	NDR	7.38	NDR	11.7	NDR	1.44	J	1.57	J	1.69	J
1,3,5-Trichlorobenzene	2.32	J	1.99	J	1.87	J		ND		ND	0.898	NDR J	27		27.9		29.9	
1,2,4-Trichlorobenzene	3.26	J	3.55	J	2.82	J	1.56	J	1.6	J	1.71	J	27.4		27.9		30.2	
1,2,3-Trichlorobenzene	0.8	J	1.02	J	0.853	J		ND		ND	0.863	NDR J	4.26	J	4.08	J	4.65	J
1,2,4,5-/1,2,3,5-Tetrachlorobenzene	2.5	J	2.29	J	2.5	J	8.82	J	10.4	J	9.26	J	68		68.4		53.1	
1,2,3,4-Tetrachlorobenzene	1.87	J	2.01	J	1.94	J	2.2	J	2.65	J	2.88	J	93.1		88.4		84.6	
Hexachlorobutadiene	0.261	J		ND		ND	0.776	NDR J	0.944	NDR J	0.819	NDR J	0.775	NDR J		ND		ND
Pentachlorobenzene	7.64		7.68		7.47		8.54		7.92		8.05		110		110		104	
Hexachlorobenzene	14.3		14.5		14		33.1		30.5		31.1		38.5		36.3		32.9	
HCH, alpha		ND	2.23	J		ND		ND		ND		ND	3.94	J	4.02	NDR J	3.33	J
HCH, beta		ND		ND		ND		ND		ND		ND		ND		ND		ND
HCH, gamma		ND	1.81	NDR J	3.57	NDR J		ND	2.64	NDR J		ND		ND		ND		ND
Heptachlor		ND		ND		ND		ND		ND		ND		ND		ND		ND
Aldrin		ND		ND		ND		ND		ND		ND		ND		ND		ND
Chlordane, gamma (trans)	1.66	J	1.46	J	1.47	J	2.21	J	2.13	J	1.76	J	1.85	J	1.69	J	1.35	J
Chlordane, alpha (cis)	2.88	J	1.84	J	1.64	J	3.52	J	3.07	J	2.89	J	2.32	J	2.35	J	2.14	J
Octachlorostyrene		ND		ND		ND		ND		ND		ND		ND		ND		ND
Chlordane, oxy-	23.7	NDR	27.3	NDR	31.9	NDR	20.3	NDR	31.5	NDR	31.9	NDR	16.7	NDR	24.9	NDR	12.3	NDR
Nonachlor, trans-	1.45	J	1.56	J	1.56	J	1.99	J	1.72	J	1.73	J	1.51	J	1.59	J	1.19	J
Nonachlor, cis-	0.448	J	0.252	NDR J	0.479	J	0.735	J	0.68	J	0.522	J	0.378	J	0.461	J		ND
Mirex		ND		ND		ND	1.6	J	1.72	J		ND	23.5		21.3		19.6	
2,4'-DDE	1.34	NDR J	1.51	NDR J		ND	0.791	NDR J	1.14	NDR J	1.12	NDR J		ND	0.937	NDR J		ND
4,4'-DDE	3.26	J	4.84	J	5.17	J	3.95	J	3.89	NDR J	3.78	J	6.23		6.32		5.59	J
2,4'-DDD	1.08	J	1	NDR J		ND	1.03	J	0.934	J	0.966	NDR J	6.47		6.32		5.95	J
4,4'-DDD	4.52	J	4.7	J	4.66	J	4.3	J	4.57	J	4.12	J	26.1		26.1		23.9	
2,4'-DDT	2.37	NDR J	2.51	NDR J		ND	1.77	NDR J	1.08	NDR J	1.39	NDR J	1.86	NDR J	2.46	NDR J	1.9	NDR J
4,4'-DDT		ND		ND		ND		ND	0.965	J	0.819	J		ND		ND		ND
HCH, delta		ND		ND		ND	0.634	J Q	0.931	J Q	0.447	J Q	0.988	D J	0.873	D J	1.1	D J
Heptachlor Epoxide	1.27	J Q	1.31	J Q	1.32	J Q	1.29	J Q	1.14	J Q	0.868	J Q	0.649	D J Q	0.548	D J Q	0.636	D J Q
Dieldrin	6.8	J	6.56	J	6.61	J	7.48	J	7.1	J	6.24	J	3.53	D J	3.2	D J	3.02	D J
Endrin		ND		ND		ND		ND		ND		ND		ND D		ND D		ND D
Endrin Aldehyde		ND		ND		ND		ND		ND		ND		ND D		ND D		ND D
Endrin Ketone		ND		ND		ND	0.632	J Q	0.575	J Q	0.771	J Q		ND D		ND D		ND D
Methoxychlor		ND		ND		ND		ND		ND	0.579	J Q		ND D		ND D		ND D
alpha-Endosulphan		ND	0.697	J	0.746	J	2.15	J	1.68	J	1.53	J	1.05	D J Q	1.17	D J	1.17	D J
beta-Endosulphan		ND		ND		ND		ND		ND		ND	0.849	D J	0.771	D J	0.747	D J
Endosulphan Sulphate		ND		ND		ND		ND	0.576	J Q		ND		ND D		ND D	0.63	D J Q

J = concentration less than lowest calibration equivalent.

NDR=Peak detected but did not reach quantification criteria, results reported represents maximum possible value. Censored data

D= Sample diluted

ND= not detected at reporting level

Q= Contract defined limit

Pettit Flume[1] = the three Pettit Flume sites each have only 1 replicate (rep -1 and rep-2 were used for dioxin/furan analysis)

Occidental Sewer-2[2] = There are only 2 reps for this site

Appendix F: SPMD data for US deployments - concentrations represent ng/SPMD

	Cayuga Creek -1		Cayuga Creek -2		Cayuga Creek -3		Little Niagara River (D/S Cayuga ck)-1		Little Niagara River (D/S Cayuga ck)-2		Little Niagara River (D/S Cayuga ck)-3		Occidental Sewer-21		Occidental Sewer-3		Gill Creek (in creek)-1		Gill Creek (in creek)-2		Gill Creek (in creek)-3		Gill Creek mouth-1		Gill Creek mouth-2		Gill Creek mouth-3	
1,3-Dichlorobenzene		ND D	34.8	D	31.5	D	2.44	J	3.31	J	2.83	J	8.14		6.43		8.44		6.71		6.41		30.7		35		27.4	
1,4-Dichlorobenzene	239	D	224	D	166	D	21.6		24.6		24.7		9.31		11.9		79.7		46		49.5		99.3		107		101	
1,2-Dichlorobenzene		ND D		ND D	0.914	D J	0.581	J		ND		ND	1.49	J	2.31	J	9.12		11.2		5.49	J	69.2		76.1		68.4	
1,3,5-Trichlorobenzene	2.25	NDR D J	1.87	D J	1.59	D J	8.21		9.68		8.53		3.05	J	11.8		7.32		4.36	J	5.5	J	2.47	J	3.68	J	2.3	J
1,2,4-Trichlorobenzene	7.95	D J	7.8	D J	5.67	D J	3.77	J	5.55	J	4.44	J	33.8		126		44.7		28.3		33.3		105		159		89.7	
1,2,3-Trichlorobenzene		ND D	1.94	D J	2.09	NDR D J	1.32	J	1.27	J	1.99	J	8.62		28.1		3.62	J	3.58	J	2.79	J	29.2		45		26.4	
1,2,4,5-/1,2,3,5-Tetrachlorobenzene	4.09	J	4.13	D J	3.26	D J	20.4		21.4		22		602		646		32		25		26.7		82.2		92.1		85.1	
1,2,3,4-Tetrachlorobenzene	3.62		3.65	D J	3.02	D J	27		28.7		30		12	J	1390		17.9		16.4		16.8		40		44.3		43	
Hexachlorobutadiene	0.295	J		ND D		ND D		ND		ND		ND	22.6		11.3	J	1.78	J	0.67	NDR J	1.08	J	1460		1830		1590	
Pentachlorobenzene	19.8		18.8	D	17.1	D	48.7		48.7		49.2		3.82	NDR J	19.2		20.1		21.2		18.4		71.5		77.7		78	
Hexachlorobenzene	48.3		44.1	D	41.6	D	18.4		18.3		18.1		1.97	NDR J	2.19	J	22.2		23.1		20.3		79.8		86.6		87.6	
HCH, alpha		ND D		ND D		ND D	24.7		23.3		27.4			ND	3.88	NDR J	623		587		606		229		246		254	
HCH, beta		ND		ND D		ND D	10.8	J	10.5	J	14.4		2.07	J		ND	143		155		167		59.1		53.3		47.6	
HCH, gamma		ND D		ND D		ND D	16.6		14.4		6.53	NDR J	2.8	J	2.22	NDR J	68.2		69.7		75.9		28		22.6		34.6	
Heptachlor		ND		ND D		ND D		ND		ND		ND	59.5		2.48	J		ND		ND		ND		ND		ND		ND
Aldrin		ND		ND D		ND D		ND		ND		ND	15	NDR	65.5			ND	1.47	NDR J	1.04	NDR J		ND		ND		ND
Chlordane, gamma (trans)	20.1	D J	17.7	D	17.3	D J	3.91	J	3.74	J	3.64	J	2.31	J	54.4	NDR	3.65	J	3.25	J	3.42	J	1.26	J	1.71	J	1.62	J
Chlordane, alpha (cis)	33	D	27.7	D	27.1	D	6.13	J	5.54	J	5.69	J	0.739	J	2.38	J	5.14	J	5.54	J	4.5	J	2.75	J	2.85	J	2.86	J
Octachlorostyrene		ND D	0.689	D J		ND D		ND		ND		ND	216		0.825	J	0.767	J		ND		ND	1.38	J	2.03	J	1.5	J
Chlordane, oxy-	32.1	NDR D	36.7	NDR D	33	NDR D	14.5	NDR	10.6	NDR J	18.4	NDR		ND	234		46.3	NDR	41.3	NDR	40.6	NDR	16.7	NDR	22.7	NDR	17.9	NDR
Nonachlor, trans-	12.7		11.8	D J	11.2	D J	3.78	J	3.65	J	3.21	J	5.52	J		ND	2.22	J	2.35	J	1.71	J	1.59	J	1.73	J	1.78	J
Nonachlor, cis-	3.33	J	2.9	D J	2.79	D J	1.23	J	1	J	1.14	J		ND	4.59	J	0.843	NDR J	1.05	J	0.888	J	0.492	NDR J	0.501	J		ND
Mirex	12.5	D J	10.7	NDR D	10.5	NDR D	6.25		4.59	J	4.65	J	4.25	J		ND	2.61	NDR J	1.89	NDR J	2.32	J	0.848	J	1.21	NDR J		ND
2,4'-DDE	5.36	NDR	3.3	NDR D J	3.47	NDR D J	1.57	NDR J	1.58	NDR J	1.68	NDR J	2.75	NDR J	3.84	J	0.985	NDR J	1.55	NDR J	0.999	NDR J		ND	0.796	NDR J	0.441	NDR J
4,4'-DDE	25.6		21.1	D	19.6	D	8.26		7.81		5.79	J	1.3	J	2.66	NDR J	9.33		10.9		9.86		4.79	J	5.77	J	5.53	J
2,4'-DDD	13.3	D J	12.5	D	12.6	D	3.28	J	3.29	J	2.85	J				ND	2.71	J	2.51	J	2.61	J	1.21	J	1.08	J	1.41	J
4,4'-DDD	54	D	52.2	D	51.8	D	13.5		12.1		12.4						15.5		16		14.5		6.11	J	6.58		6.31	J
2,4'-DDT	7.28	NDR D J	7.37	NDR D J	7.22	NDR D J	3.48	NDR J	3.24	NDR J	3.02	NDR J					1.9	NDR J	2.02	NDR J	1.92	NDR J	1.72	NDR J	1.55	NDR J	1.74	NDR J
4,4'-DDT	4.87	D J	3.5	D J	4.19	D J	1.31	J	1.3	J		ND						ND		ND		ND		ND		ND		ND
HCH, delta	1.4	D J T Q	1.32	D J T Q	1.91	D J T	12.5	D	8.46	D J	10.3	D J		ND		ND	41.7		42.4		48.5		9.56	J	9.73	J	8.87	J
Heptachlor Epoxide	10.1	D T	7.81	D J T	7.87	D J T	1.04	D J Q	1.25	D J Q		ND D	2.67	J Q	1.9	J Q	0.559	J Q	0.545	J Q		ND	1.44	J Q	1.65	J Q	1.37	J Q
Dieldrin	27.3	D	25.2	D	25.2	D	3.8	D J	4.09	D J	4.75	D J	6.22	J Q	6.88	J Q	9	J	9.96		9.6	J	10		9.75		9.69	J
Endrin		ND D		ND D		ND D		ND D		ND D		ND D		ND		ND		ND		ND		ND		ND		ND		ND
Endrin Aldehyde		ND D		ND D		ND D	2.21	D J Q		ND D		ND D		ND		ND		ND		ND		ND		ND		ND		ND
Endrin Ketone		ND D		ND D		ND D	5.29	D J Q		ND D		ND D	3.22	J	2.42	J Q		ND		ND		ND		ND		ND		ND
Methoxychlor	19	D Q	17.2	D Q	17.1	D Q	4.97	D J Q		ND D		ND D		ND		ND		ND		ND		ND		ND		ND		ND
alpha-Endosulphan		ND D T	2.34	D J T	2.2	D J T Q	1.24	D J	1.42	D J	2.08	D J	4.63	J	2.59	J	3.2	J	3.76	J	2.19	J Q	1.49	J	1.74	J	1.69	J
beta-Endosulphan		ND D		ND D		ND D	2.11	D J Q	0.609	D J		ND D		ND		ND	0.739	J Q	1.17	J	0.545	J Q		ND		ND		ND
Endosulphan Sulphate	1.79	D J Q	3.85	D J Q	3.9	D J Q	1.19	D J Q	0.752	D J		ND D		ND		ND	1.41	J Q	1.47	J Q	1.51	J Q	0.695	J Q	0.687	J Q	0.554	J Q

J = concentration less than lowest calibration equivalent.

NDR=Peak detected but did not reach quantification criteria, results reported represents maximum possible value. Censored data

D= Sample diluted

ND= not detected at reporting level

Q= Contract defined limit

Pettit Flume[1] = the three Pettit Flume sites each have only 1 replicate (rep -1 and rep-2 were used for dioxin/furan analysis)

Occidental Sewer-2[2] = There are only 2 reps for this site

Appendix F: SPMD data for Canadian deployments - concentrations represent ng/SPMD

	Balsam Lake-1		Balsam Lake-2		Balsam Lake-3		Fort Erie -2[1]		Fort Erie-3		Millers Creek-1		Millers Creek-2		Millers Creek-3	
1,3-Dichlorobenzene		ND		ND		ND		ND		ND	0.813	J	0.849	J	1.07	J
1,4-Dichlorobenzene	3.32	J	3.42	J	2.8	J	5.74	J	5.22	J	4.67		6.15		6.64	
1,2-Dichlorobenzene		ND		ND		ND	8.12	NDR	2.52	NDR J		ND		ND		ND
1,3,5-Trichlorobenzene		ND		ND		ND		ND		ND	0.343	J	0.391	J	0.277	J
1,2,4-Trichlorobenzene		ND		ND		ND		ND		ND	0.563	J	0.609	J	0.605	J
1,2,3-Trichlorobenzene		ND		ND		ND		ND		ND		ND		ND		ND
1,2,4,5-/1,2,3,5-Tetrachlorobenzene		ND		ND		ND	0.514	NDR J		ND	0.605	J	0.613	J	0.578	J
1,2,3,4-Tetrachlorobenzene		ND		ND		ND	1.92	J	0.997	J	0.208	J	0.246	J	0.22	NDR J
Hexachlorobutadiene	0.873	J		ND		ND	1.06	NDR J	1.03	NDR J		ND		ND		ND
Pentachlorobenzene		ND		ND		ND	1.87	J	1.34	J	0.839	J	0.746	J	0.873	J
Hexachlorobenzene	1.24	J	1.04	J	1.04	J	2.6	J	2.29	J	1	J	0.955	J	0.964	J
HCH, alpha		ND		ND		ND		ND		ND		ND		ND		ND
HCH, beta		ND		ND		ND		ND		ND		ND		ND		ND
HCH, gamma		ND		ND		ND	1.33	NDR J	7.89	NDR J		ND		ND		ND
Heptachlor		ND		ND		ND		ND		ND		ND		ND		ND
Aldrin		ND		ND		ND		ND		ND		ND		ND		ND
Chlordane, gamma (trans)		ND		ND		ND		ND	0.824	NDR J	0.683	J	0.654	J	0.618	J
Chlordane, alpha (cis)		ND		ND		ND	1.28	J	1.27	J	0.985	J	0.813	J	0.974	J
Octachlorostyrene		ND		ND		ND		ND		ND		ND		ND		ND
Chlordane, oxy-	34.7	NDR	35	NDR	30.4	NDR	30.3	NDR	30.1	NDR	17.2	NDR	21.4	NDR	19.5	NDR
Nonachlor, trans-	0.412	J		ND		ND	0.728	NDR J	0.92	J	0.553	J	0.518	J	0.504	J
Nonachlor, cis-		ND		ND		ND	0.33	J	0.407	J	0.242	J	0.243	J	0.238	NDR J
Mirex		ND		ND		ND		ND		ND		ND		ND		ND
2,4'-DDE		ND		ND		ND		ND		ND	0.402	J	0.454	J	0.465	NDR J
4,4'-DDE	2.13	J	1.85	J	1.86	J	6	J	5.97	J	**15.4**		**14.8**		**14.4**	
2,4'-DDD		ND		ND		ND	0.727	J	0.803	J	2.41	D J	2.1	D J	2.21	D J
4,4'-DDD	0.813	J	0.743	J	0.71	J	4.45	J	5.15	J	13.5	D	13.6	D	14.2	D
2,4'-DDT		ND		ND		ND		ND	0.663	NDR J		ND D		ND D		ND D
4,4'-DDT		ND		ND		ND		ND	0.725	J	0.486	D J		ND D		ND D
HCH, delta		ND		ND		ND	0.456	J Q	0.548	J Q		ND D		ND D	0.098	D J Q
Heptachlor Epoxide		ND		ND		ND	1.33	J Q	1.3	J Q		ND D	0.415	D J Q	0.344	D J Q
Dieldrin	2.78	J	1.84	J	2.48	J	6.72	J	7.76	J	2.1	D J	1.84	D J	1.93	D J
Endrin		ND		ND		ND		ND		ND		ND D		ND D		ND D
Endrin Aldehyde		ND		ND		ND		ND		ND		ND D		ND D		ND D
Endrin Ketone		ND		ND		ND	0.201	J Q	0.08	J Q		ND D		ND D		ND D
Methoxychlor		ND		ND		ND		ND		ND		ND D		ND D		ND D
alpha-Endosulphan	1.12	J	0.998	J	0.889	J	0.542	J	0.756	J	1.22	D J	1.25	D J	1.3	D J
beta-Endosulphan		ND		ND		ND		ND		ND	0.496	D J Q		ND D	0.426	D J
Endosulphan Sulphate	1.53	J Q	1.15	J Q	1.19	J Q		ND	0.537	J Q	0.599	D J Q	0.625	D J Q		ND D

J = concentration less than lowest calibration equivalent.

NDR=Peak detected but did not reach quantification criteria, results reported represents maximum possible value. Censored data

D= Sample diluted

ND= not detected at reporting level

Q= Contract defined limit

Fort Erie[1] = There are only 2 reps for this site

Appendix F: SPMD data for Canadian deployments - concentrations represent ng/SPMD

	Boyers Ck -1		Boyers Ck -2		Boyers Ck -3		Chippawa Channel-1		Chippawa Channel-2		Chippawa Channel-3		NOTL-1		NOTL-2		NOTL-3	
1,3-Dichlorobenzene		ND D	0.471	NDR J	0.642	NDR J	1.01	NDR J		ND	1.63	J	1.23	NDR J		ND	1.66	NDR J
1,4-Dichlorobenzene	5.18	D J	5.06	J	5.07	J	5.46	NDR J	4.6	J	11.6		5.37	J	3.98	NDR J	4.39	J
1,2-Dichlorobenzene		ND D	0.623	NDR J		ND	11.2	NDR		ND		ND	8.04	NDR	6.73	NDR	7.38	NDR
1,3,5-Trichlorobenzene		ND D		ND		ND		ND		ND		ND		ND		ND		ND
1,2,4-Trichlorobenzene		ND D	0.343	NDR J		ND		ND		ND		ND	2.88	J	2.76	J	1.9	J
1,2,3-Trichlorobenzene		ND D	0.449	NDR J		ND		ND	0.732	NDR J		ND	1.4	NDR J	1.62	NDR J	1.25	NDR J
1,2,4,5-/1,2,3,5-Tetrachlorobenzene		ND D	0.29	NDR J		ND	0.31	NDR J		ND		ND	5.88	J	5.01	J	4.11	J
1,2,3,4-Tetrachlorobenzene		ND D	0.19	NDR J		ND	0.717	J	0.522	J		ND	13.7		11.2		9.94	
Hexachlorobutadiene		ND D	0.553	NDR J		ND	0.691	NDR J	0.762	NDR J		ND	4.5	J	3.9	J	3.1	J
Pentachlorobenzene	0.469	D J	0.608	NDR J	0.543	NDR J	1.53	J	1.19	J	0.815	J	**16.5**		**14.5**		**14.1**	
Hexachlorobenzene	0.501	D J	0.562	NDR J	0.421	J	4.04	J	2.03	J	1.87	J	**15.2**		**13.8**		**14.2**	
HCH, alpha		ND D		ND		ND		ND		ND		ND		ND		ND	0.954	J
HCH, beta		ND D		ND		ND		ND		ND		ND		ND		ND		ND
HCH, gamma		ND D	13.4	NDR	5.88	NDR J	1.16	NDR J	1.55	NDR J	3.74	NDR J	3.46	NDR J	1.91	NDR J	1.98	NDR J
Heptachlor		ND D		ND		ND		ND		ND		ND		ND	1.75	J		ND
Aldrin		ND D		ND		ND		ND		ND		ND		ND		ND		ND
Chlordane, gamma (trans)	0.505	D J		ND		ND	0.738	J		ND	0.834	J	0.891	J	1.1	NDR J	0.834	J
Chlordane, alpha (cis)	0.559	D J		ND		ND	1.19	J	1.02	NDR J	1.15	J	1.53	J	1.62	J	1.51	J
Octachlorostyrene		ND D		ND		ND		ND		ND		ND	0.674	J	0.762	J	0.663	J
Chlordane, oxy-	42.6	NDR D	25.5	NDR	24.1	NDR	29.1	NDR	28.4	NDR	28	NDR	35.8	NDR	31.6	NDR	28.6	NDR
Nonachlor, trans-	0.356	D J	0.306	NDR J		ND	0.84	J	0.922	J	0.793	J	1.17	J	1.12	J	0.961	J
Nonachlor, cis-		ND D		ND		ND	0.251	NDR J	0.344	NDR J	0.43	J	0.392	NDR J	0.494	NDR J	0.353	J
Mirex		ND D		ND		ND		ND		ND		ND		ND		ND		ND
2,4'-DDE		ND D		ND		ND		ND	2.04	NDR J		ND	0.809	NDR J	0.983	NDR J	0.519	NDR J
4,4'-DDE	1.05	D J	1.01	J	1.1	J	4.7	J	8.67	NDR	5.74	J	4.41	J	4.67	NDR J	3.83	J
2,4'-DDD		ND D		ND		ND	0.577	J		ND	0.823	J		ND	0.973	NDR J		ND
4,4'-DDD		ND D		ND		ND	3.88	J		ND	4.71	J	3.34	J	2.98	J	2.63	J
2,4'-DDT		ND D		ND		ND	0.587	NDR J	16.7	NDR		ND	1.63	NDR J	1.8	NDR J	1.46	NDR J
4,4'-DDT		ND D		ND		ND	0.881	NDR J		ND	1.11	J	2.27	NDR J	1.24	NDR J		ND
HCH, delta		ND D	0.595	D J Q	0.484	D J		ND		ND		ND		ND	0.592	J	0.893	J
Heptachlor Epoxide		ND D		ND D		ND D	1.32	J Q	0.943	J Q	1.5	J Q	1.32	J Q	1.42	J Q	1.45	J Q
Dieldrin	1.28	D J	1.33	D J	1.19	D J	6.24	J	6.48	J	6.64	J	6.14	J	7.77	J	6.78	J
Endrin		ND D		ND D		ND D		ND		ND		ND		ND		ND		ND
Endrin Aldehyde		ND D		ND D		ND D		ND		ND		ND		ND		ND		ND
Endrin Ketone		ND D		ND D		ND D		ND	4.22	J Q		ND	0.444	J Q		ND	0.295	J Q
Methoxychlor		ND D		ND D		ND D		ND		ND		ND	0.578	J		ND		ND
alpha-Endosulphan	2.72	D J	3.38	D J	3.01	D J	0.852	J Q		ND	1.1	J Q	1.26	J	0.859	J	0.909	J
beta-Endosulphan	0.946	D J	1.06	D J	1.05	D J	1.01	J Q	2.39	J Q		ND		ND		ND		ND
Endosulphan Sulphate	3.01	D J	2.97	D J	2.7	D J		ND		ND	0.708	J Q	0.564	J Q	0.582	J Q		ND

J = concentration less than lowest calibration equivalent.

NDR=Peak detected but did not reach quantification criteria, results reported represents maximum possible value. Censored data

D= Sample diluted

ND= not detected at reporting level

Q= Contract defined limit

Fort Erie[1] = There are only 2 reps for this site

Appendix F: SPMD data for Travel Blanks, Lab Blank and Spiked Matrix - concentrations represent ng/SPMD unless noted otherwise.

	Millers Creek Field Blank		Chippawa Channel Field Blank		Pettit Flume Outer Field Blank		Little Niagara River (near 102nd St) Field Blank		Lab Blank	Lab Blank		Spiked Matrix	Spiked Matrix	
1,3-Dichlorobenzene	0.846	NDR J	0.918	J	1.3	J	1.85	NDR J			ND	100		% Recovery
1,4-Dichlorobenzene	14.8		5.89		9.72		20.2		2.17		J	98.7		% Recovery
1,2-Dichlorobenzene	0.702	J	0.524	J	0.765	J	18.1		0.506		J	93.2		% Recovery
1,3,5-Trichlorobenzene		ND		ND		ND		ND			ND	97.3		% Recovery
1,2,4-Trichlorobenzene	0.39	J	0.569	J	0.565	J	0.569	J			ND	99.4		% Recovery
1,2,3-Trichlorobenzene		ND		ND	0.136	NDR J		ND			ND	99.1		% Recovery
1,2,4,5-/1,2,3,5-Tetrachlorobenzene		ND		ND		ND		ND			ND	198		% Recovery
1,2,3,4-Tetrachlorobenzene		ND	0.188	J	0.118	J		ND			ND	101		% Recovery
Hexachlorobutadiene		ND		ND		ND		ND			ND	96.8		% Recovery
Pentachlorobenzene		ND	0.227	NDR J		ND		ND			ND	99.2		% Recovery
Hexachlorobenzene		ND	0.177	NDR J		ND		ND			ND	90.5		% Recovery
HCH, alpha		ND		ND		ND		ND			ND	97.9		% Recovery
HCH, beta		ND		ND		ND		ND			ND	97.5		% Recovery
HCH, gamma		ND		ND		ND		ND			ND	94.3		% Recovery
Heptachlor		ND		ND		ND		ND			ND	95.7		% Recovery
Aldrin		ND		ND		ND		ND			ND	99.9		% Recovery
Chlordane, gamma (trans)	0.218	J		ND	0.211	J	0.207	NDR J			ND	103		% Recovery
Chlordane, alpha (cis)	0.177	J		ND		ND	0.211	J			ND	90.8		% Recovery
Octachlorostyrene		ND		ND		ND		ND			ND	99.1		% Recovery
Chlordane, oxy-	33.3	NDR	33.8	NDR	34.9	NDR	39	NDR			ND	97		% Recovery
Nonachlor, trans-	0.136	NDR J		ND	0.085	NDR J		ND			ND	110		% Recovery
Nonachlor, cis-		ND		ND		ND		ND			ND	107		% Recovery
Mirex		ND		ND		ND		ND			ND	97.2		% Recovery
2,4'-DDE		ND		ND		ND		ND			ND	96.6		% Recovery
4,4'-DDE	0.435	NDR J		ND	0.54	NDR J	0.473	NDR J	0.325		NDR J	91.9		% Recovery
2,4'-DDD		ND		ND		ND		ND			ND	96.1		% Recovery
4,4'-DDD		ND		ND		ND		ND			ND	97.1		% Recovery
2,4'-DDT		ND		ND		ND		ND			ND	97.8		% Recovery
4,4'-DDT		ND		ND		ND		ND			ND	24.4		% Recovery
HCH, delta		ND D		ND D		ND D		ND D			ND D	95.1	100	% Recovery
Heptachlor Epoxide		ND D		ND D		ND D		ND D	0.088	1.13	D J	94.7	102	% Recovery
Dieldrin		ND D		ND D		ND D		ND D			ND D	92.4	100	% Recovery
Endrin		ND D		ND D		ND D		ND D			ND D	105	110	% Recovery
Endrin Aldehyde		ND D		ND D		ND D		ND D			ND D	61.8	64.2	% Recovery
Endrin Ketone		ND D		ND D		ND D		ND D			ND D	103	107	% Recovery
Methoxychlor		ND D		ND D		ND D		ND D	ND D	0.231	D J	120	122	% Recovery
alpha-Endosulphan	0.771	D J	0.742	D J		ND D		ND D	ND D	0.301	D J	102	104	% Recovery
beta-Endosulphan		ND D		ND D		ND D		ND D	0.328	0.301	D J	95.7	102	% Recovery
Endosulphan Sulphate		ND D		ND D		ND D		ND D	ND D	1.58	D J	102	119	% Recovery
Total PCBs	157		155		150		154							
Total PCBs with PRC subtracted	6		6		59		5							

Appendix F: SPMD Homologue data, ng/SPMD. Individual congener data can be obtained on request

Little Niagara River (LNR)

Gratwick Riverside Park (GRP)

		2 Mile Creek		2 Mile Creek		2 Mile Creek		Pettit Flume[1]		Pettit Flume		Pettit Flume		GRP		GRP		GRP	
COMPOUND	UNIT	-1		-2		-3		upstream-3		outer-3		Downstream-3		upstream-1		upstream-2		upstream-3	
Total Monochloro Biphenyls	ng/sample	2.75		3.70		4.41		6.1		7830		34.5		44.2		38.1		40.3	
Total Dichloro Biphenyls	ng/sample	42.8		41.3		42.5		49.1		2025		78.9		331.63		312		315	
Total Trichloro Biphenyls	ng/sample	106		81.1		88.1		115		36.5		148		1448		1414		1323	
Total Tetrachloro Biphenyls	ng/sample	153		148		154		101		34.1		138		2019		2009		2116	
Total Pentachloro Biphenyls	ng/sample	117		112		114		32.9		53.1		44.2		515		506		555	
Total Hexachloro Biphenyls	ng/sample	43.6		38.4		40.6		9.45		44.7		12.6		61.1		59.5		67.1	
Total Heptachloro Biphenyls	ng/sample	7.53		6.41		7.57		2.01		10.7		1.80		15.3		13.8		16.9	
Total Octachloro Biphenyls	ng/sample	0.79		0.71		0.68			ND		ND		ND	2.46		2.08		2.52	ND
Total Nonachloro Biphenyls	ng/sample		ND		ND	0.63			ND		ND		ND	0.99			ND		ND
Decachloro Biphenyl	ng/sample		ND		ND	0.00			ND		ND		ND		ND		ND		ND
TOTAL PCBs	ng/sample	**473**		**432**		**453**		**315**		**10034**		**458**		**4437**		**4354**		**4436**	

		GRP		GRP		GRP		102nd Street		102nd Street		102nd Street		LNR		LNR		LNR	
COMPOUND	UNIT	downstream-1		downstream-2		downstream-3		Upstream-1		Upstream-2		Upstream-3		D/S 102nd St-1		D/S 102nd St-2		D/S 102nd St-3	
Total Monochloro Biphenyls	ng/sample	20.7		19.6		20.5		8.02		5.80		8.45		15.4		16.3		13.9	
Total Dichloro Biphenyls	ng/sample	193		189		172		183		172		167		162		163		144	
Total Trichloro Biphenyls	ng/sample	462		496		409		271		260		266		273		258		227	
Total Tetrachloro Biphenyls	ng/sample	570		599		511		286		267		265		251		262		222	
Total Pentachloro Biphenyls	ng/sample	135		150		136		88.2		84.1		79.6		99.4		99.2		88.0	
Total Hexachloro Biphenyls	ng/sample	22.7		26.7		27.5		24.5		25.5		22.8		27.3		28.2		23.1	
Total Heptachloro Biphenyls	ng/sample	4.38		6.20		5.65		5.30		5.66		5.07		9.38		11.37		7.17	
Total Octachloro Biphenyls	ng/sample		ND		ND	0.89			ND	0.76		0.29			ND		ND		ND
Total Nonachloro Biphenyls	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND		ND
TOTAL PCBs	**ng/sample**	**1408**		**1487**		**1283**		**866**		**822**		**814**		**838**		**838**		**725**	

		Cayuga		Cayuga		Cayuga		LNR		LNR		LNR		Occidental		Occidental		Gill Creek	
COMPOUND	UNIT	Creek -1		Creek -2		Creek -3		(D/S Cayuga ck)-1		(D/S Cayuga ck)-2		(D/S Cayuga ck)-3		Sewer-2		Sewer-3		(in creek)-1	
Total Monochloro Biphenyls	ng/sample	2.05		7.58		5.26		5.17		4.90		8.69		8.20		11.4		5.65	
Total Dichloro Biphenyls	ng/sample	54.2		47.8		48.1		79.8		79.9		82.6		244		279		35.1	
Total Trichloro Biphenyls	ng/sample	337		325		311		179		193		179		4290		5230		210	
Total Tetrachloro Biphenyls	ng/sample	1618		1510		1464		223		205		196		8113		9494		333	
Total Pentachloro Biphenyls	ng/sample	774		734		711		75.0		70.6		67.5		1937		2149		130	
Total Hexachloro Biphenyls	ng/sample	226		210		213		20.9		19.8		17.6		123		131		38.0	
Total Heptachloro Biphenyls	ng/sample	41.2		38.3		39.2		4.35		3.96		3.41		10.9		10.3		8.79	
Total Octachloro Biphenyls	ng/sample	5.11		3.88		4.63			ND		ND		ND	1.53		0.61		0.59	
Total Nonachloro Biphenyls	ng/sample		ND	0.79			ND	2.21		0.82		1.21			ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND		ND		ND	0.46		0.74			ND
TOTAL PCBs	**ng/sample**	**3057**		**2877**		**2796**		**590**		**579**		**556**		**14729**		**17306**		**760**	

		Gill Creek		Gill Creek		Gill Creek		Gill Creek		Gill Creek	
COMPOUND	UNIT	(in creek)-2		(in creek)-3		mouth-1		mouth-2		mouth-3	
Total Monochloro Biphenyls	ng/sample	5.43		5.31		3.63		4.44		4.07	
Total Dichloro Biphenyls	ng/sample	36.3		33.2		42.8		47.0		47.0	
Total Trichloro Biphenyls	ng/sample	240		185		407		448		436	
Total Tetrachloro Biphenyls	ng/sample	354		300		738		868		849	
Total Pentachloro Biphenyls	ng/sample	140		116		200		232		232	
Total Hexachloro Biphenyls	ng/sample	43.3		35.3		30.8		35.7		38.1	
Total Heptachloro Biphenyls	ng/sample	8.69		8.12		5.41		6.68		5.83	
Total Octachloro Biphenyls	ng/sample	0.95			ND		ND		ND	0.80	
Total Nonachloro Biphenyls	ng/sample		ND		ND		ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND		ND
TOTAL PCBs	**ng/sample**	**829**		**684**		**1428**		**1642**		**1614**	

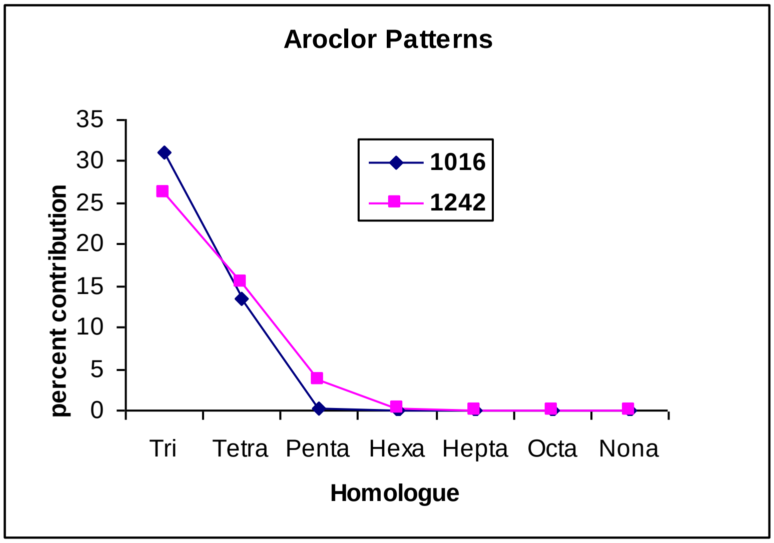
Appendix F: SPMD Homologue data, ng/SPMD. Individual congener data can be obtained on request

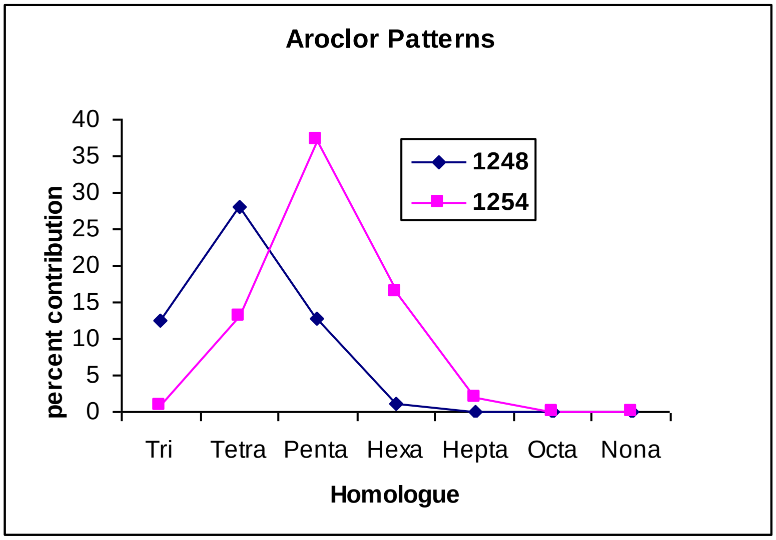
COMPOUND	UNIT	Fort Erie -2[1]		Fort Erie-3		Millers Creek-1		Millers Creek-2		Millers Creek-3		Boyers Ck -1		Boyers Ck -2		Boyers Ck -3	
Total Monochloro Biphenyls	ng/sample		ND	0.67	ND		ND		ND		ND		ND		ND		ND
Total Dichloro Biphenyls	ng/sample	1.65		2.08		1.14		1.27		1.25			ND	6.10		4.34	
Total Trichloro Biphenyls	ng/sample	17.48		13.27		14.10		9.68		10.28		5.24		19.03		14.04	
Total Tetrachloro Biphenyls	ng/sample	9.86		7.15		10.17		9.40		9.31		1.79		7.42		0.86	
Total Pentachloro Biphenyls	ng/sample	5.01		4.93		8.02		8.02		7.28		2.10		3.92		2.39	
Total Hexachloro Biphenyls	ng/sample	3.04		2.80		3.01		2.97		3.23		0.57		0.66		0.52	
Total Heptachloro Biphenyls	ng/sample		ND	0.31		0.36		0.34		0.36			ND		ND		ND
Total Octachloro Biphenyls	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND
Total Nonachloro Biphenyls	ng/sample		ND		ND		ND		ND	0.68			ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND
TOTAL PCBs	ng/sample	**37**		**31**		**37**		**32**		**32**		**10**		**37**		**22**	

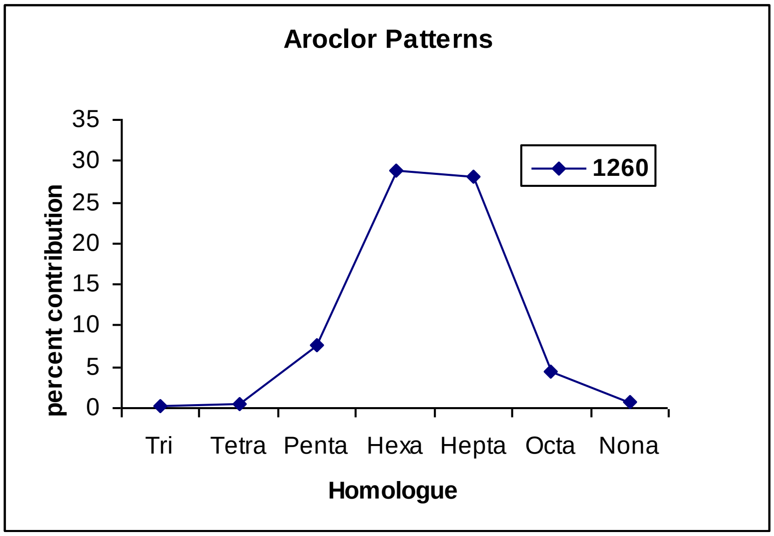
COMPOUND	UNIT	Chippawa Channel-1		Chippawa Channel-2		Chippawa Channel-3		NOTL-1		NOTL-2		NOTL-3		Balsam Lake-1		Balsam Lake-2		Balsam Lake-3	
Total Monochloro Biphenyls	ng/sample		ND		ND		ND		ND		ND		ND	1.13			ND		ND
Total Dichloro Biphenyls	ng/sample	3.45		2.78		2.68		9.86		10.29		11.34			ND		ND	1.25	
Total Trichloro Biphenyls	ng/sample	29.79		12.46		17.06		48.12		41.16		38.50		2.33		3.92		3.33	
Total Tetrachloro Biphenyls	ng/sample	9.46		12.73		6.85		54.11		45.70		44.93		0.48			ND	1.47	
Total Pentachloro Biphenyls	ng/sample	5.08		4.15		3.46		21.85		18.04		18.25			ND		ND		ND
Total Hexachloro Biphenyls	ng/sample	1.86		2.37		2.27		6.54		6.31		6.85			ND		ND		ND
Total Heptachloro Biphenyls	ng/sample		ND		ND		ND	1.20		0.53		0.85			ND		ND		ND
Total Octachloro Biphenyls	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND		ND
Total Nonachloro Biphenyls	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND		ND		ND		ND		ND		ND
TOTAL PCBs	ng/sample	**50**		**34**		**32**		**142**		**122**		**121**		**4**		**4**		**6**	

COMPOUND	UNIT	Millers Creek Field Blank		Chippawa Channel Field Blank		Pettit Flume Outer Field Blank		LNR (near 102nd St) Field Blank	
Total Monochloro Biphenyls	ng/sample	0.13		0.24		0.63		0.62	
Total Dichloro Biphenyls	ng/sample		ND		ND	0.55		0.29	
Total Trichloro Biphenyls	ng/sample	3.21		3.22		54.3		2.76	
Total Tetrachloro Biphenyls	ng/sample	0.65		0.59		0.96			ND
Total Pentachloro Biphenyls	ng/sample	1.99		1.88		1.65		1.48	
Total Hexachloro Biphenyls	ng/sample	0.49		0.41		0.47		0.30	
Total Heptachloro Biphenyls	ng/sample		ND		ND		ND		ND
Total Octachloro Biphenyls	ng/sample		ND		ND		ND		ND
Total Nonachloro Biphenyls	ng/sample		ND		ND		ND		ND
Decachloro Biphenyl	ng/sample		ND		ND		ND		ND
TOTAL PCBs	ng/sample	**6**		**6**		**59**		**5**	

Appendix G: Homologue Patterns for Aroclor Technical Mixtures using PCB congeners analysed by the MOECC for comparison to homologue patterns present in caged mussel data and SPMDs







Appendix H: Station Locations for Little Niagara River (LNR) and 102nd St. Hazardous Waste Site.