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## **2021 Lyons Creek East (Niagara River Area of Concern) Sediment Pore Water Survey**

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Ontario Region

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Great Lakes Areas of Concern Section  
Sediment Remediation Unit  
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## Executive Summary

In 2021, a data gap investigation was conducted by Environment and Climate Change Canada (ECCC). The purpose of the investigation was to measure the concentration and spatial extent of polychlorinated biphenyls (PCBs) sediment in sediment pore water in Zones 1 to 4 of Lyons Creek East (LCE) in the Niagara River Area of Concern. Up until now pore water concentrations could only be estimated using the equilibrium partitioning method which uses site specific bulk sediment PCB and total organic carbon concentrations along with literature based soil-water partitioning coefficients. This method is known to be conservative.

This work generally found the pore water concentrations were of similar concentrations in the 0–5 cm increments as the 0–10 cm. The pore water concentration also generally follows the contamination trends that are known to exist at this site (highest near the canal and lower as you progress downstream). Apart from an elevated PCB pore water concentration in at location EC4B, the trends followed suite.

Pore water concentrations were found to be elevated in relation to surface water guidelines however, well below a final chronic value derived by Fuschman et al. (2006) which was specific to toxicity from PCBs. Guidelines specific to pore water do not exist.

Estimated (modeled) PCB pore water concentrations were found to be very conservative being consistently much higher than measured and there was a poor relationship between measured and estimated values. This prevented using estimated concentrations to replace vandalized samples. Estimating pore water concentrations from partitioning coefficients (EqP Theory) tends to overestimate results, especially for PCBs. Therefore, comparison of measured and estimated shows the importance of tools such as passive samplers to enhance accuracy of site characteristics. In a study on PAHs, field deployed passive samplers and estimate values showed a large difference and passive samplers provided better accuracy (Conder, 2021).

It was possible to loosely examine the general trend between tissue data collected in 2019 and pore water collected in this present study (2021) for Zones 1 and 2. The examination shows that pore water is higher near the canal and decreases towards Zone 2 while the tissue concentrations showed an increasing trend to Zone 2. This case of opposing trends was not expected however, these data sets are 2 years apart.

Additional planned pore water and tissue samples from the same time period (2022) should help clarify and understand the trends. This work will also cover Zones 1 to 4 and measurement of total PCBs by congeners instead of Aroclors will be considered.

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# 1. Background

Lyons Creek East (LCE) is a 17-km long tributary of the Welland River in Ontario. The original creek was bisected by the Welland Canal into West and East sections in 1971. Flow to the east section of the creek is now artificially provided by water pumped directly from the canal. LCE was historically included in the Niagara River Area of Concern (AOC) due to the presence of polychlorinated biphenyl (PCB) contamination in the sediment and resulting risks to creek biota and wildlife.

PCBs are classified by the United States Environmental Protection Agency (USEPA) as probable human carcinogens, and have been shown to cause cancer and reproductive defects in animals. The chlorine substituents of PCBs mean that they are difficult to degrade under natural conditions, and therefore persist in the environment and bioaccumulate in the tissues of organisms. They then biomagnify as they move up the food chain. Sources of contamination to LCE include historical storm water overflow from the nearby city of Welland, several oil spills in the creek itself, and treated effluent from a steel mill pipe discharging into the creek. The mill was subsequently closed in 2003. The construction of the Welland Canal is assumed to have removed upstream sources of contamination to LCE.

According to a 2008 report by Golder Associates, risks to wildlife receptors in LCE are low but persistent, and will remain so for 10–40 years. Additionally, most of LCE is identified as a Provincially Significant Wetland and minimal disturbance of the sensitive habitat was desirable. A Human Health Risk Assessment conducted by Dillon in 2007 identified no expected risks to human health from direct exposure to sediments. Therefore, Monitored Natural Recovery (MoNR) was selected in 2008 as the preferred remediation strategy for LCE. It should be noted that natural recovery for LCE relies upon the deposition of cleaner sediments slowly burying the contamination. The bisection of LCE in 1971 reduced the natural sedimentation rate in the areas of the creek close to the canal, which has since been estimated as between 1–10 mm/yr (Golder 2008, Golder 2011).

In order to assess the progress of MoNR a long-term monitoring plan was established and the benthic conditions in the creek, surveys of sediment, benthic invertebrates and young of the year (YOY) fish in LCE were conducted by Environment and Climate Change Canada (ECCC) and the Ontario Ministry of Environment, Conservation, and Parks (MECP) in 2002-03, 2010, 2015 and 2019. Invertebrates serve as prey to many fish and other aquatic species and can be an important exposure pathway representative of local conditions.

The 2015 survey (Richman, 2018) data showed that total PCB concentrations in surficial sediment (defined as  $\leq 10$  cm) were elevated above the Probable Effect Level (PEL) of 0.277  $\mu\text{g/g}$  in Zones 1–5 (out of seven Zones assessed, Figure 1). Zones 1–5 cover the area of the creek from the headwaters to 3.6

km downstream. Out of these, Zones 1 and 2, comprising the farthest upstream (1.3 km), had the highest concentrations of PCBs at the sediment surface and at depth. Concentrations of total PCB congeners ranged up to 340 µg/g at depth, and from 0.03–93 µg/g in surface sediments in 2015. For reference, the maximum surface concentration observed at reference sites was 0.04 µg/g and hazardous PCB waste is defined by the MECP as 50 µg/g. The reference sites identify background PCB levels for the region.

A similar spatial distribution was observed for benthic tissue concentrations of total PCBs, where concentrations were elevated above reference levels in Zones 1–5, ranging from 0.2–5.1 µg/g-dw (Milani and Grapentine 2017). The maximum reference tissue concentration observed was 0.9 µg/g-dw. Remedial action targets to protect the mink and kingfisher were exceeded and contamination within these zones was higher than expected when compared to baseline (2005) data. Although PCB contamination in the surface sediment in the zones farther downstream was lower than in Zones 1 and 2, concentrations have not decreased through time, and remain above the target to protect the mink. Additionally, PCB concentrations in YOY fish are high (up to 3000 ng/g) and exceed targets for fish eating birds and mammals presented in the ERA.

As a result of all this, a detailed sediment survey within Zones 1 and 2 was required in 2019 to better delineate the spatial extent of high PCB concentrations in the surface sediment and at depth.

Forty sediment coring locations were selected by the MECP based on historical (2015) sampling stations and results (hotspots). To establish collocated sediment and tissue samples, a subset of 10 of the coring stations were selected by ECCC for amphipod sampling. The MECP sediment samples showed a sharp decrease in sediment concentration of total PCBs from the canal (upstream) to the other downstream sites. The ECCC amphipod tissue concentrations, however, generally increased downstream with a spike at the end of Zone 1 (EC5). Tissue results for dioxin-like PCBs were converted to Toxic Equivalents (TEQs) and all 2019 samples exceeded the avian and mammalian reference values. Biota-sediment accumulation factors (BSAFs) for total PCBs were calculated using the amphipod tissue concentrations (normalized to lipids) and the sediment concentrations provided by the MECP from the 0–3 cm and 0–10 cm layers of sediment. Both depths show a spike around the end of Zone 1 (EC5) and then an increasing / variable trend towards downstream (EC1).

The results of this work were somewhat surprising in the general trends lack of correlation between sediment and tissue and the location of the highest tissue concentration. Sediment PCB concentrations are highest closest to the canal with a decreased but varying trend as you move downstream. Sediment concentrations also showed a slight downstream increase around EC3 and EC2 in Zone 2. Tissue PCB concentrations, in contrast, were lower towards the canal, elevated at location EC5 and then stable downstream of EC5 but higher in these downstream samples than those located upstream of EC5. Generally, the situation is that elevated tissue concentrations do not match with the

areas of elevated sediment concentrations. When accounting for lipids and organic carbon, this results in no statistically significant relationship between sediment and tissue concentrations for Zones 1 and 2 for 2019. Location EC5 (at the end of Zone 1), with the highest tissue concentrations is surprising as this location was the least vegetated and appeared more scoured. By observation, it did not appear to be as suitable a habitat for amphipods as other locations. This observation, as well as negative relationship trends between sediment and tissue, raise questions over the mobility and transport of the PCB contaminated sediment. In general, this 2019 work found that tissue concentrations in amphipods are elevated. In the limited areas where some loose comparison can be made, they are higher than those reported from previous years.

The 2019 work generally confirmed that PCB concentrations remain high in these zones and the need to reassess the monitored natural recovery as the remedial option for the site. Prior to making any final decisions, additional data is required and in 2021, a few additional studies were undertaken. One of the studies was the acquisition of sediment pore water concentrations in Zones 1–4 and this is reported herein.



**Figure 1:** Assessment zones for Lyons Creek East benthic and sediment survey

## 2. Objective

Natural recovery of the contaminated sediments at Lyons Creek East is progressing at a very slow rate and some form of active management, may be required to meet objectives in a reasonable timeframe. In order to further characterize the contamination as well as to prepare for potential active management, some key data gaps exist that should be filled. These gaps will specifically allow for better understanding how the contaminants are available to receptors as well as provide key site data that will facilitate any future modeling and other calculations used in assessing and designing active management options.

Contaminant concentrations in the pore water is the main driver of toxicity to benthos and is the main concern if any capping options are required in the future. It is important to obtain some actual pore water measurements from the site to understand the concentrations, general trend between Zones 1–4, and relate these to observed tissue concentrations. This data is helpful for understanding the current concentration levels in fish and invertebrates. With the previous data available, pore water concentrations could only be estimated by equilibrium partitioning methods using site specific bulk chemistry and total organic carbon (TOC) concentrations as well as literature based soil-water partitioning coefficients. This method is generally considered to be conservative.

## 3. Scope of Work

1. Measure the freely dissolved concentrations of PCBs in sediment using in situ polyethylene-based passive samplers
2. Collection of corresponding sediment cores
3. Measure bulk total PCB concentrations and total organic carbon in sediment from the cores



## 4. Methods

### 4.1. Field Collection

Sampling consisted of deploying 17 SP3™ polyethylene-based passive samplers in 25 locations shown in Table 1 and Figure 2. Samplers consisted of regular (5 cm) and larger (10 cm) polyethylene strips encased in a protective mesh. The large samplers were cut in half on retrieval to allow for measurement of the top 5 cm as well as the 5–10 cm increment. The larger samplers were located in areas that had previously high concentrations as well as spread out to give coverage over the four zones. The budget limited the number to only seven. Upon retrieval of the samplers (29 day deployment), co-located hand driven cores were advanced by hand to allow for analysis of total PCBs and total organic carbon at each location. The sediment was extruded from the cores using water pressure and 0–5 cm was jarred for regular sized samplers, 0–5 cm, and 5–10 cm increments were jarred for the larger samplers.

Table 1. Proposed Sample Locations and details

Zone	Station	Northing	Easting	Position specifics	Type of sampler
1	LC01-mid*	4759470.72	645089.27	1 Passive sampler	Larger
1	EC 9	4759533.00	645140.00	1 Passive sampler	Larger
1	EC-6	4759614.00	645199.00	1 passive sampler, North bank	Regular
1	EC5 (Trans)	4759632.00	645214.00	3 Passive samplers in a transect	Larger on NW bank
2	EC3	4759765.00	645386.00	1 Passive Sampler, near north bank	Larger
2	MECP71	4759765.47	645546.23	1 Passive Sampler between middle and N bank	Regular
2	MECP75	4759771.29	645638.21	1 Passive Sampler near south bank	Regular
2	EC1	4759774.00	645713.00	1 Passive Sampler, deploy near south bank	Larger
2	EC4b	4759887.15	645924.86	1 Passive Sampler between middle and N bank	Regular
3	T7A	4759862	646192	1 Passive Sampler deploy at will	Larger
3	T7C	4760063	646279	1 Passive Sampler deploy at will	Regular
3	T7D	4760160	646288	1 Passive Sampler deploy at will	Regular
4	T8	4760373.16	646501.596	1 Passive Sampler deploy at will	Regular
4	T8A	4760466.516	646587.382	1 Passive Sampler deploy at will	Larger
4	T8B	4760563.657	646664.337	1 Passive Sampler deploy at will	Regular

#### Notes:

*Regular = 0–5 cm sample / Larger = longer sampler where will cut into 0–5cm and 5–10 cm*

*\*LC01-mid was moved to 4759509 N, 645119 E during deployment*

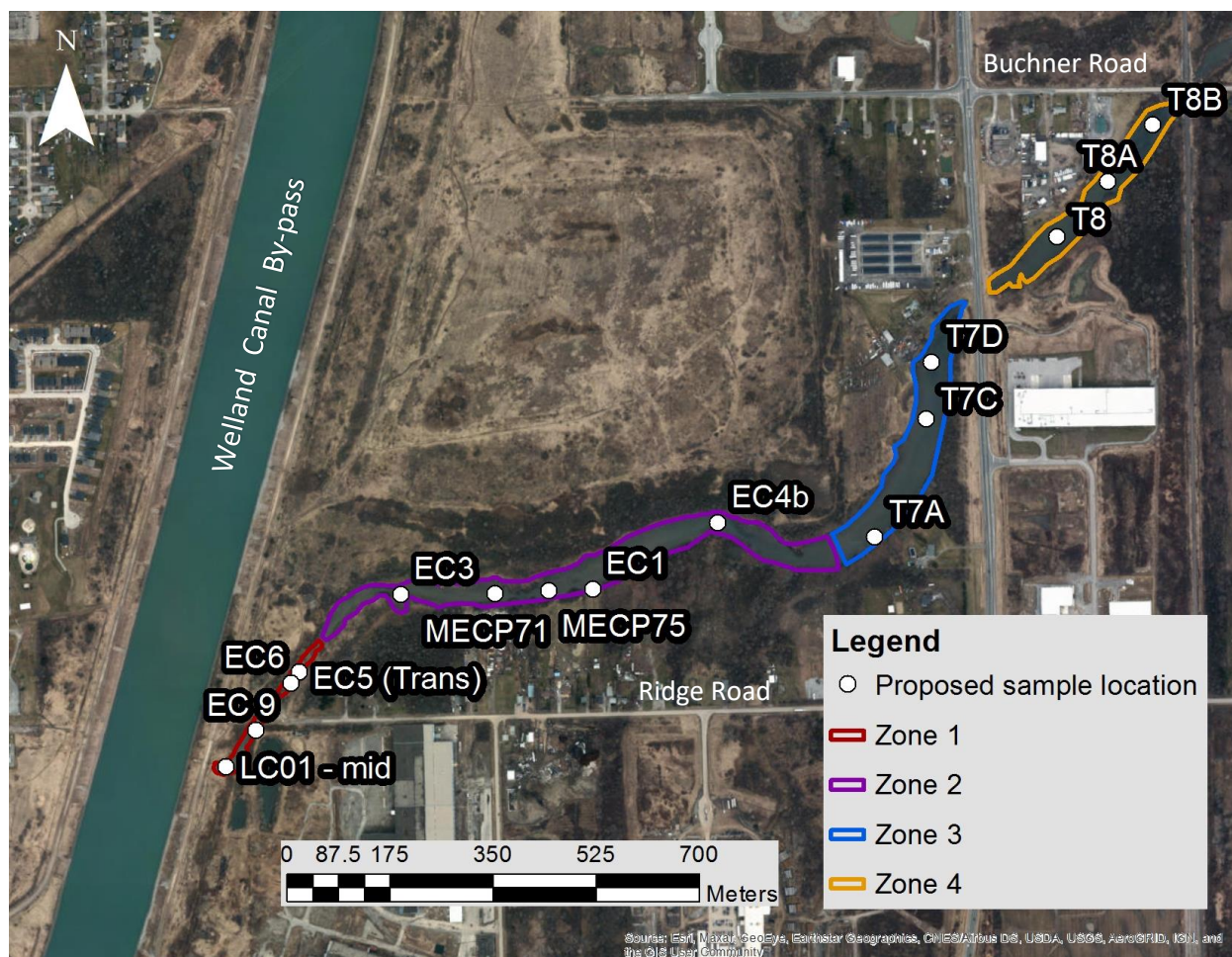


Figure 2. Proposed Sample Locations. Sample location labels are generally on the upper right, unless there is overlap.

#### 4.2. Laboratory (Passive samplers)

The SP3™ is a comprehensive polyethylene-based passive sampler and interpretation service for the quantification of hydrophobic organic compounds including polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), and dioxins and furans in pore water. The SP3™ samplers for this application were used to quantify the freely dissolved concentrations ( $C_{\text{free}}$ ) of PCB Aroclors in sediment.

Each SP3™ sampler (Figure 3) contained 1 polyethylene strip spiked with performance reference compounds (PRCs) to be used for equilibrium calculations and one polyethylene strip without PRCs for PCB Aroclor analysis. The standard SP3™ sampler consists of a 5 cm × 8 cm polyethylene sheet housed in a steel-mesh envelope attached to two 8 cm × 18 cm × 0.1 cm stainless steel support plates. Larger samplers (for capturing deeper pore water) consist of 10 cm × 8 cm polyethylene sheets also house in

steel mesh. Ten (10) standard SP3TM double samplers were utilized for the 0–5 cm depth interval and seven (7) larger samplers for the 0–5 cm and 5–10 cm depth intervals.



*Figure 3.* Passive sampler used at Lyons Creek East. PRC sampler is on the opposite side.

Samplers were deployed for 29 days (August 25 to September 23, 2021). The sampler uses a standard list of 10 PCB congeners rarely found in the environment as PRCs:

PCB-14, PCB-36, PCB-78, PCB-104, PCB-121, PCB-142, PCB-155, PCB-184, PCB-192, and PCB-204.

These 10 PCBs are rarely found in sediment and biological tissue and are used to evaluate the sampling kinetics of the sampler during the exposure period. These are not readily quantified by the standard EPA method for PCB aroclors, therefore a separate sampler is required for PRC only determination and ultimate  $C_{\text{free}}$  calculation.

PCB Aroclor analysis on the passive samplers was conducted using EPA method 8082 by Eurofins Environmental Testing America. PCB and TOC analysis on sediment were conducted using EPA Method

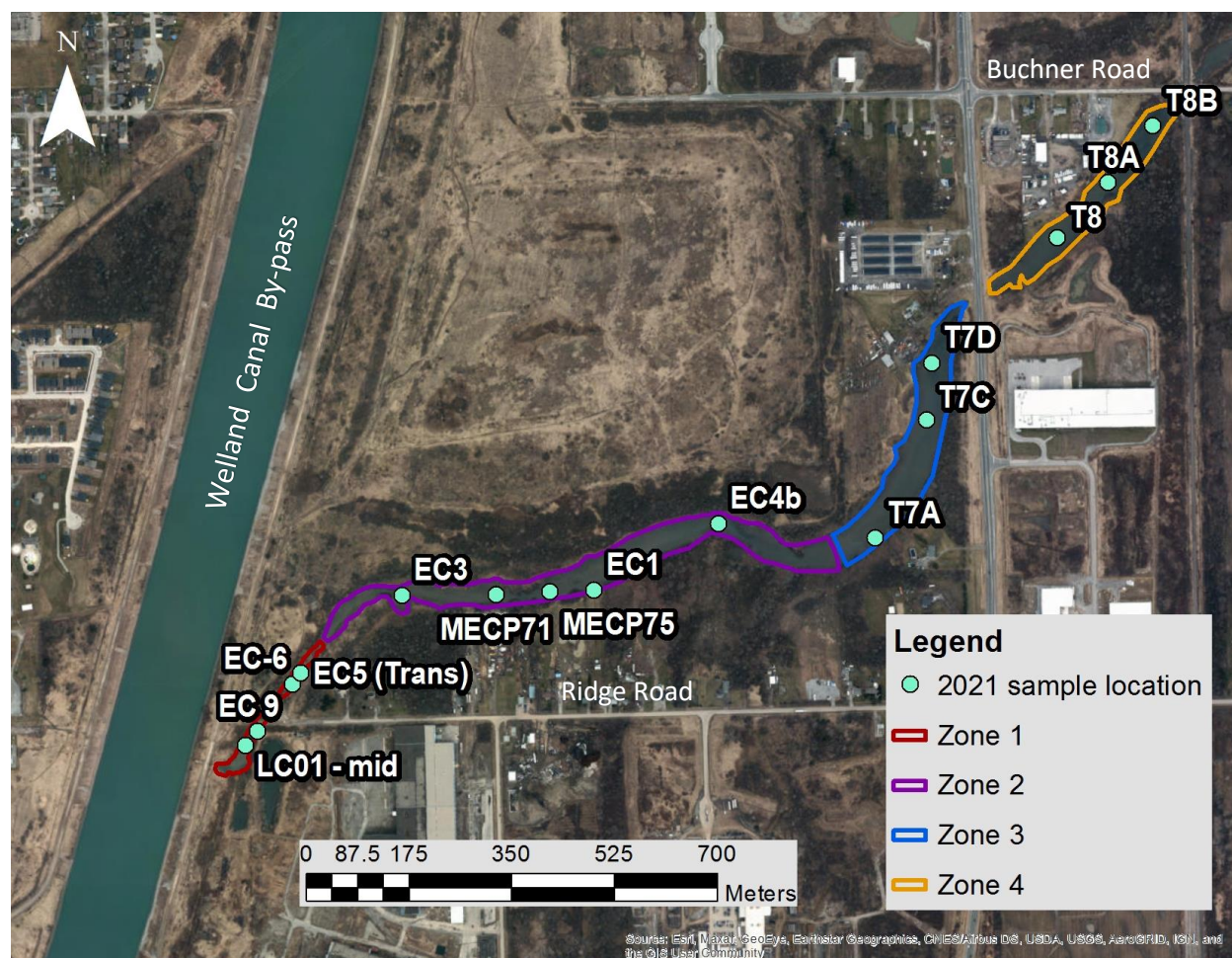
8082A and the Lloyd Khan method respectively also by Eurofins Environmental Testing America. The PCB Aroclor method was selected as an economical approach to measuring total PCBs. This method allowed for a larger scope of work, despite a slight addition of uncertainty associated with not measuring all 209 specific PCB congeners.

Three PCR trip blanks were also utilized as part of the field QA/QC program to assess equilibrium condition of the samplers. The trip blanks were exposed to the site ambient conditions for approximately 5 minutes and then packaged for shipping in the same manner as the deployed samplers. As an example of the use, if 100 ng/g of a PRC is present in a trip blank and 50 ng/g of the same PRC is present in a deployed sampler upon retrieval, the PRC is at 50% of its equilibrium concentration. With several different PRC depletion values a predicative model can be assembled to estimate the primary target compound fractional equilibrium using an average polyethylene-water partition coefficient for the Aroclor composition.



## 5. Results & Discussion

Figure 4 presents the locations of the pore water samples from 2021 as well the aerial extent of Zones 1 to 4.



*Figure 4.* Final sample locations from 2021. LC01-mid was moved to 4759509 N, 645119 E from the locations. Sample location labels are generally placed on the upper right, with the exception of overlapping labels.

It should be noted that the sediment samples were past the holding times recommended by the lab for total organic carbon (14 days) due to complications with ECCC obtaining access to process the cores during the Covid pandemic. PCB holding times are 1 year. The samples were stored upright in the core tubes with overlying water in a walk-in cooler for 28 days and then in jars in a cooler for an additional 5 days. This extra holding time is not expected to have had much of an effect on the results. The lab indicated the samples were received within temperature specifications.

All passive sampler data indicated the PCBs detected in pore water samples was only the Aroclor 1248 mixture. This pattern was observed consistently across all pore water samples. A potential reason for certain Aroclor mixtures being more pronounced, such as Aroclor 1248 in pore water, is that these compounds are present in the water phase more than other Aroclor mixtures which may be more abundant in the sorbed phase, i.e., sorbed to organic matter (B. Pautler, personal communication, January 21, 2022). All other Aroclor mixtures were below detection limits (ND). Sediment samples were also ND for all but three Aroclor mixtures: PCB-1248, PCB-1254, and PCB-1260. These three Aroclor mixtures were detected in nearly all sediment samples. Table 2 presents the total PCB and total organic carbon concentrations of all the measured pore water and sediment samples. A complete laboratory report on results can be found in the Appendix.

Table 2. Pore water and sediment sample results

	Pore Water	Sediment			
Sample ID	tPCB (µg/L)	tPCBs (ng/g)	tPCBs (µg/g)	TOC (%)	Notes
LCO1-MID (0 TO 5)	0.036	17700	17.7	19	
LCO1-MID (5 TO 10)	0.043	30000	30	23	
EC9 (0 TO 5)		9890	9.89	7.2	Samples Vandalized
EC9 (5 TO 10)		92	0.092	0.62	Samples Vandalized
EC6	0.031	268	0.268	7.1	
EC5-SE Bank	0.025	16790	16.79	6.5	
EC5 (0 TO 5)	0.006	1190	1.19	7.8	
EC5 (5 TO 10)					Mislabeled sampled
EC5-NW BANK-BOTTOM	0.011	493	0.493	8.6	
EC5-NW BANK-TOP	0.0092	648	0.648	8.4	
EC3 (0 TO 5)	0.021	280	0.28	14	
EC3 (5 TO 10)	0.023	409	0.409	10	
MECP71	0.023	2090	2.09	20	
MECP75	0.019	342	0.342	10	
EC1 (0 TO 5)	0.018	467	0.467	6.9	
EC1 (5 TO 10)	0.017	509	0.509	6.5	
EC4B	0.059	220	0.22	8.9	
T7A (0 TO 5)	0.022	402	0.402	8.6	
T7A (5 TO 10)	0.024	469	0.469	9.8	
T7C	0.019	178	0.178	7.5	
T7D	0.012	109	0.109	12	
T8	0.015	479	0.479	10	Highly suspect vandalized
T8A (0 TO 5)	0.012	402	0.402	8.5	possibly vandalized
T8A (5 TO 10)	0.011	1188	1.188	6.6	possibly vandalized
T8B	0.01	361	0.361	8.6	possibly vandalized

While there is no specific guideline for pore water, the Provincial Water Quality Objectives (PWQO) for Ontario surface water for total PCBs is 0.001 µg/L. The province of Ontario also has aquatic protection values (APV) that are designed to be used for situations where contaminated groundwater discharges to surface water bodies. The APV is 0.014 µg/L. With respect to benthic toxicity, Fuschman et al. (2006) addresses the toxicity between PCBs and benthic invertebrates. Using available data for Aroclor 1254 and 1242, with a greater availability of Aroclor 1254 data, it was found that they exhibit similar toxicity. This conclusion was based on comparisons of the most sensitive species and overall distributions of toxicity values. Lower (Aroclors 1221 and 1232) and higher (Aroclors 1260, 1262 and 1268) chlorine content (although more limited in data availability) suggests these formulations are less toxic than Aroclors 1242 and 1254. Therefore, a final chronic value (FCV) of 0.54 µg/L was presented as a reasonable estimate of toxicity for sensitive invertebrates (Fuschman et al., 2006). *Table 3* presents the measured pore water concentrations along with the PWQO, APV, and FCV values. This comparison indicates that the pore water concentrations measured in 2021 are elevated in terms of comparisons to surface water guidelines but not in comparison to the FCV derived by Fuschman et al., 2006).

*Table 3. Pore water versus surface water guidelines. Note: “y” indicates a guideline exceedance.*

	Pore water	PWQO	APVs (ON)	FCV
<b>Sample ID</b>	<b>tPCB (µg/L)</b>	<b>0.001 µg/L</b>	<b>0.014 µg/L</b>	<b>0.54 µg/L</b>
LCO1-MID (0 TO 5)	0.036	y	y	n
EC6	0.031	y	y	n
EC5-SE Bank	0.025	y	y	n
EC5 (0 TO 5)	0.006	y	n	n
EC5-NW BANK-TOP	0.0092	y	n	n
EC3 (0 TO 5)	0.021	y	y	n
MECP71	0.023	y	y	n
MECP75	0.019	y	y	n
EC1 (0 TO 5)	0.018	y	y	n
EC4B	0.059	y	y	n
T7A (0 TO 5)	0.022	y	y	n
T7C	0.019	y	y	n
T7D	0.012	y	n	n
T8	0.015	y	y	n
T8A (0 TO 5)	0.012	y	n	n
T8B	0.01	y	n	n
LCO1-MID (5 TO 10)	0.043	y	y	n
EC5-NW BANK-BOTTOM	0.011	y	n	n
EC3 (5 TO 10)	0.023	y	y	n
EC1 (5 TO 10)	0.017	y	y	n
T7A (5 TO 10)	0.024	y	y	n
T8A (5 TO 10)	0.011	y	n	n

Figure 5 presents a relative depiction of the PCB pore water concentrations for each zone and the general trends. Dark blue represents sampling results from deeper (5–10 cm) sediment. Shallow sediment samples (0–5 cm) are shown in light blue. Figure 6 to Figure 9 show magnified views of the PCBs in pore water for each zone.

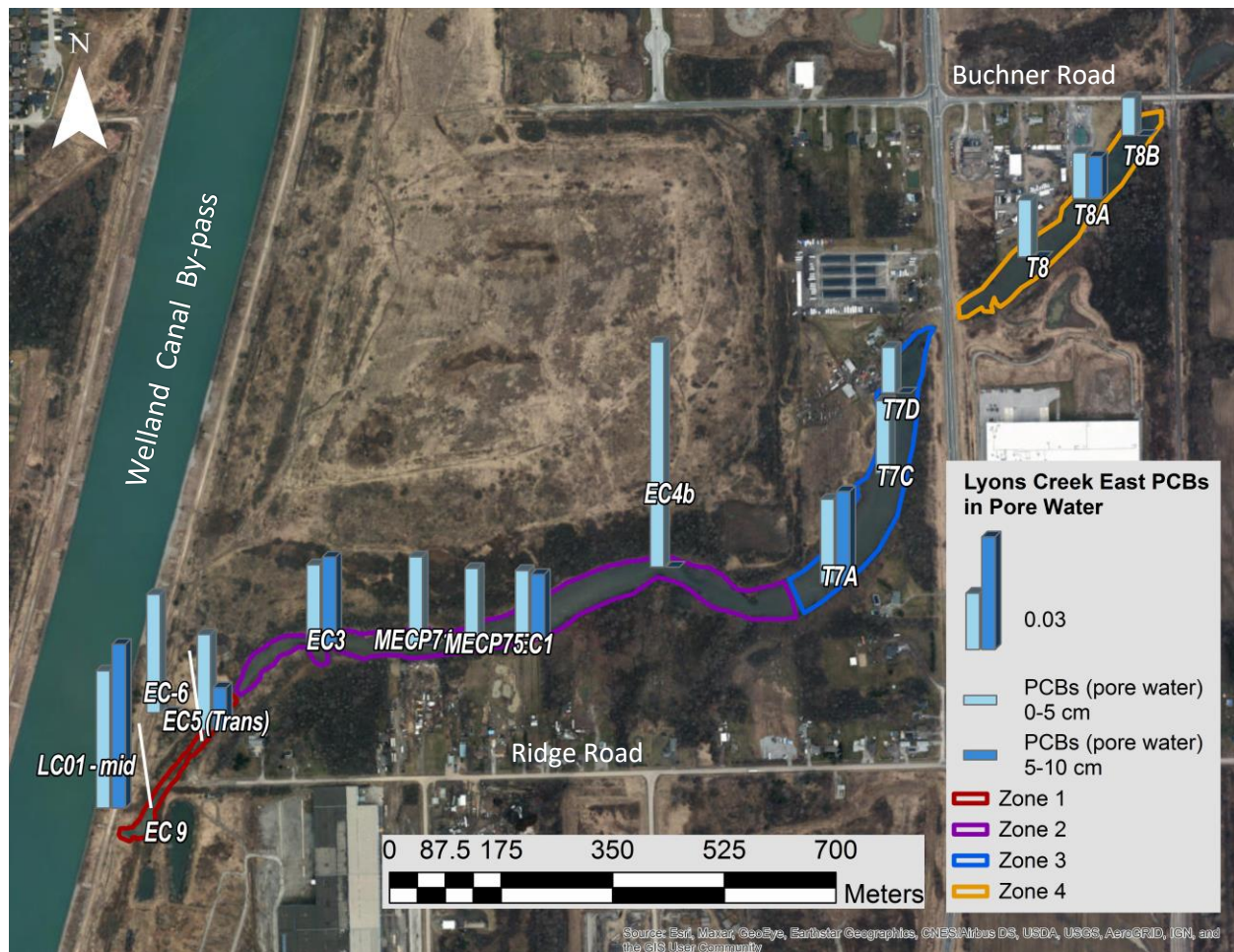


Figure 5. Relative total PCB pore water distribution by zone.



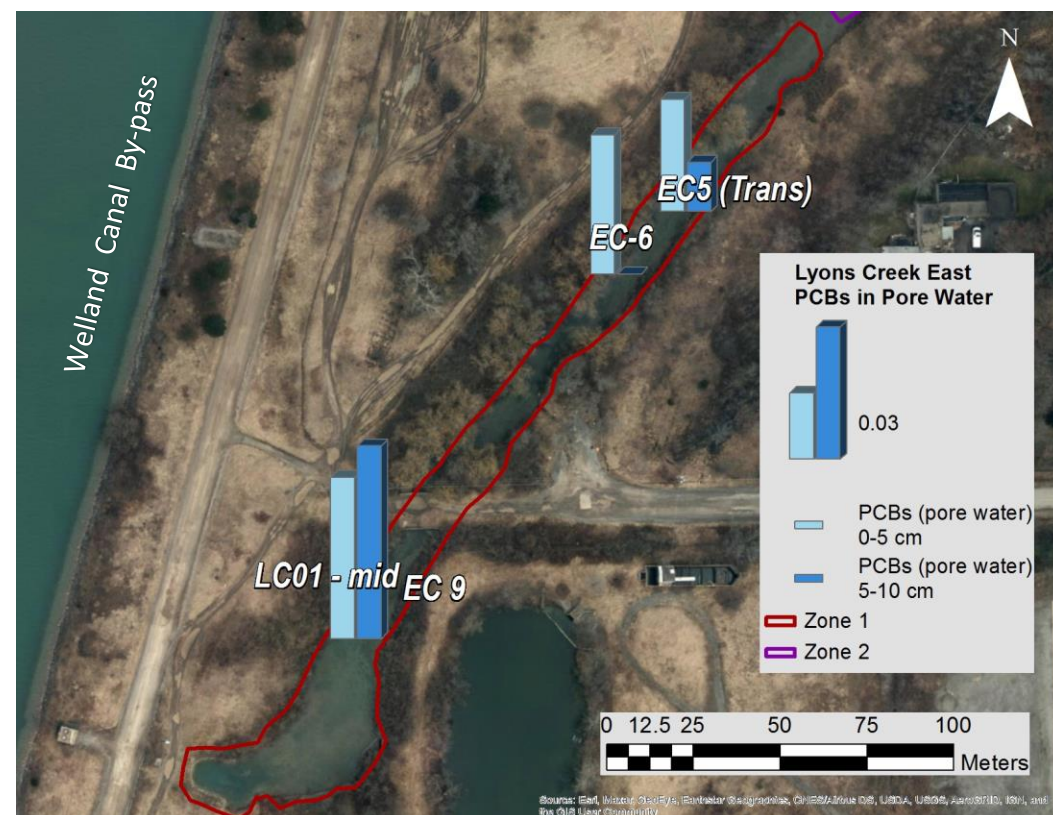


Figure 6. Enlarged view of Zone 1 showing PCB concentrations in pore water. Samplers from location EC 9 were vandalized therefore no data was reported.

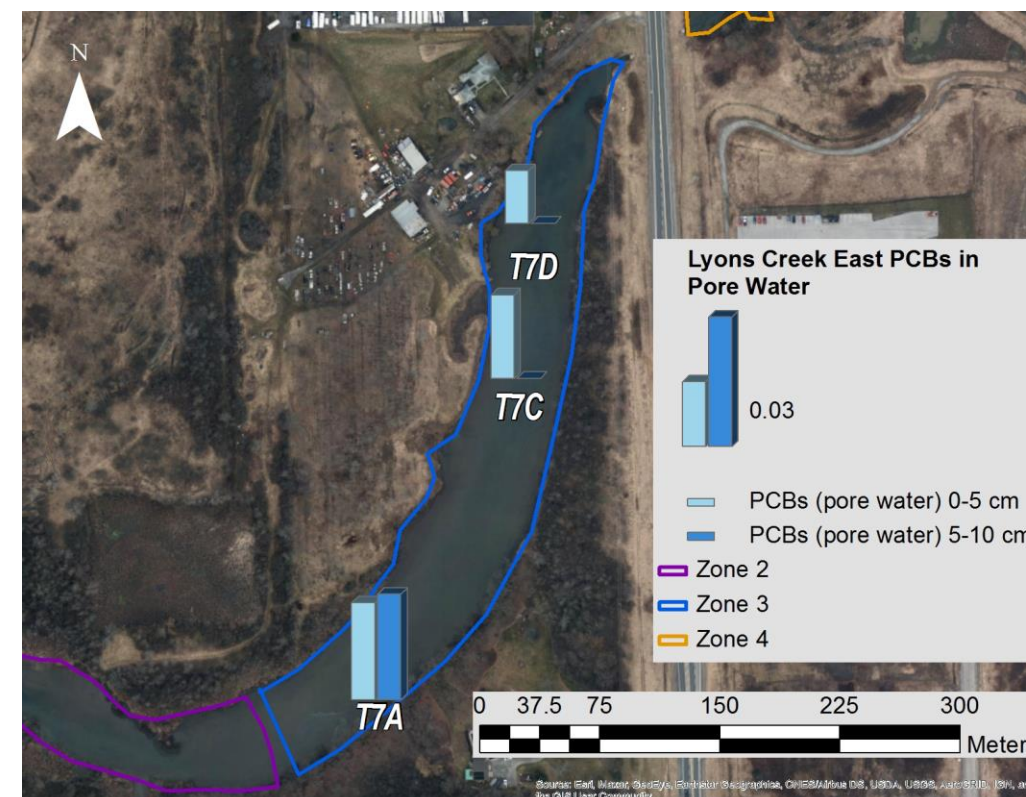


Figure 8. Enlarged view of Zone 3 showing PCB concentrations in pore water.

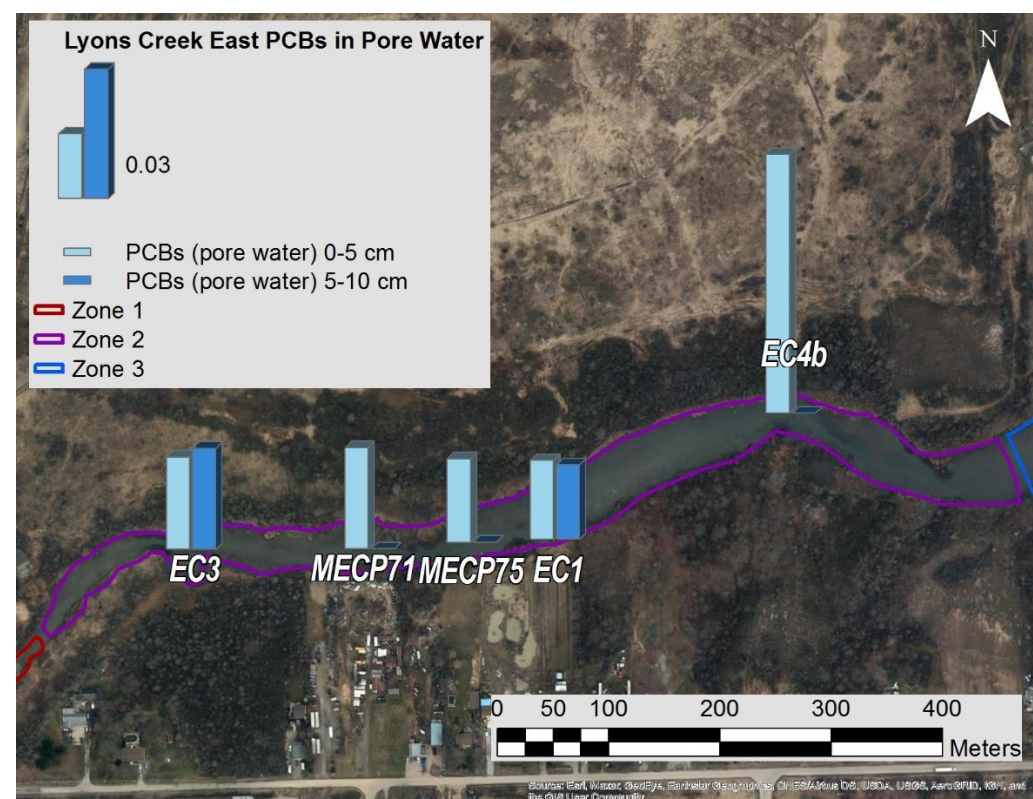


Figure 7. Enlarged view of Zone 2 showing PCB concentrations in pore water.

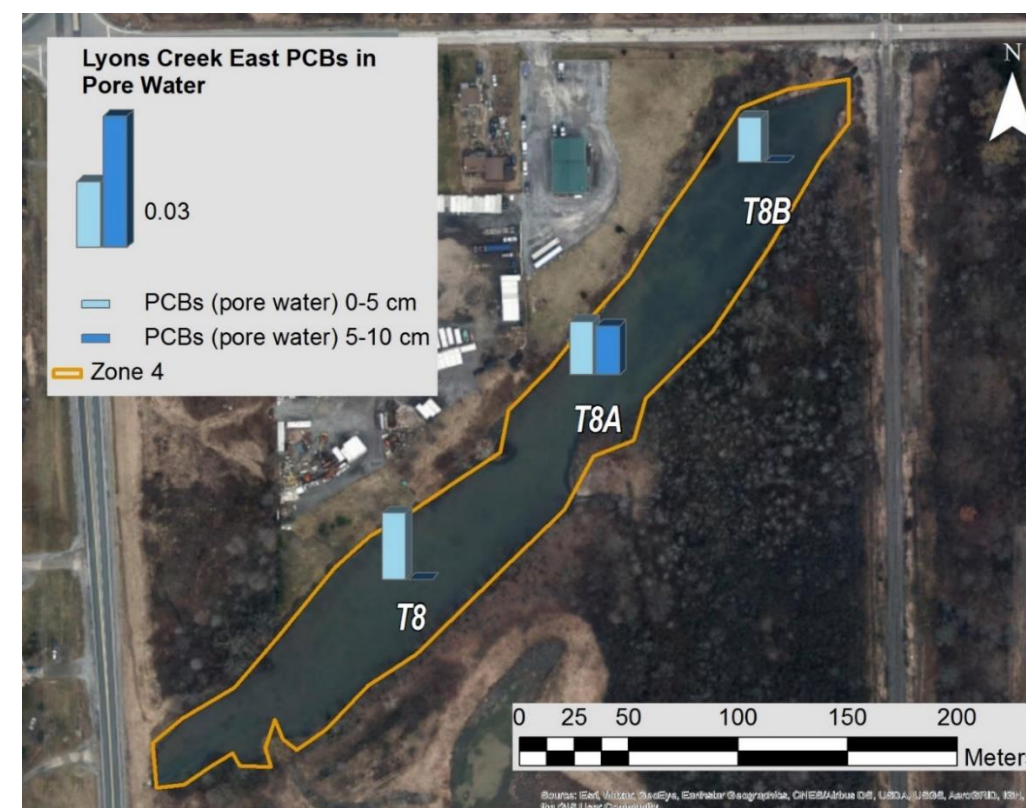


Figure 9. Enlarged view of Zone 4 showing PCB concentrations in pore water.



Figure 10 shows box plots of the PCB pore water concentration distributions. The box plots provide an overview of PCB distribution at the 0–5 cm and 5–10 cm depths.

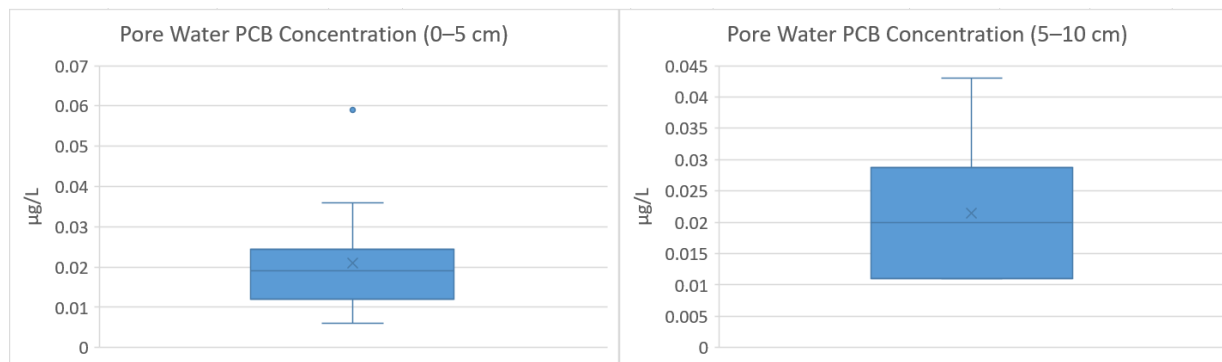


Figure 10. Box plots of total PCB pore water concentrations at 0–5 cm and 5–10 cm showing the range of concentrations. The mean is represented by “x”, percentiles by the lines, maximum and minimum by the whiskers and potential outliers by the circles.

Figure 11 presents a relative depiction of the PCB concentrations in sediment for each zone and the general trend. Figure 12 to Figure 15 provide magnified views of each zone.

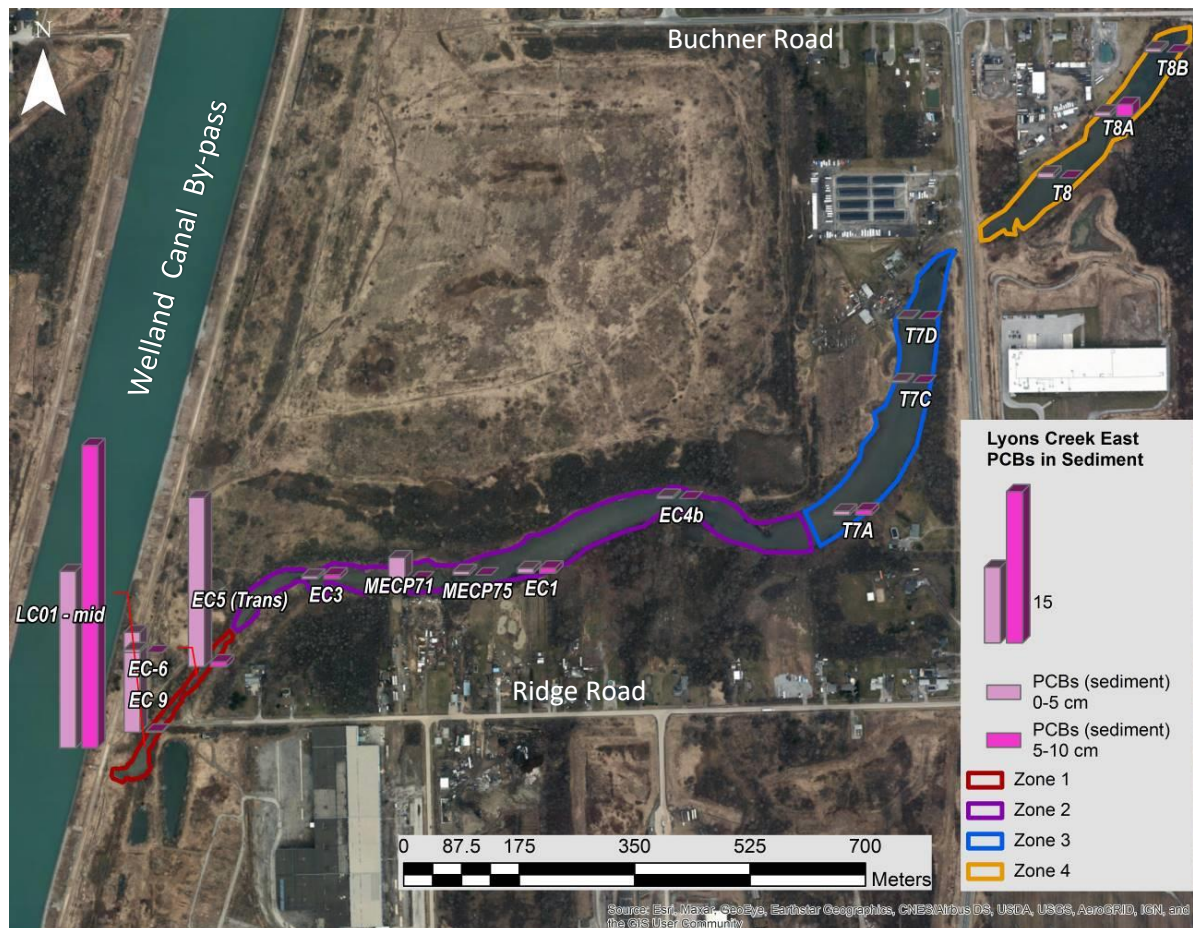


Figure 11. Total PCBs in sediment, by zone.



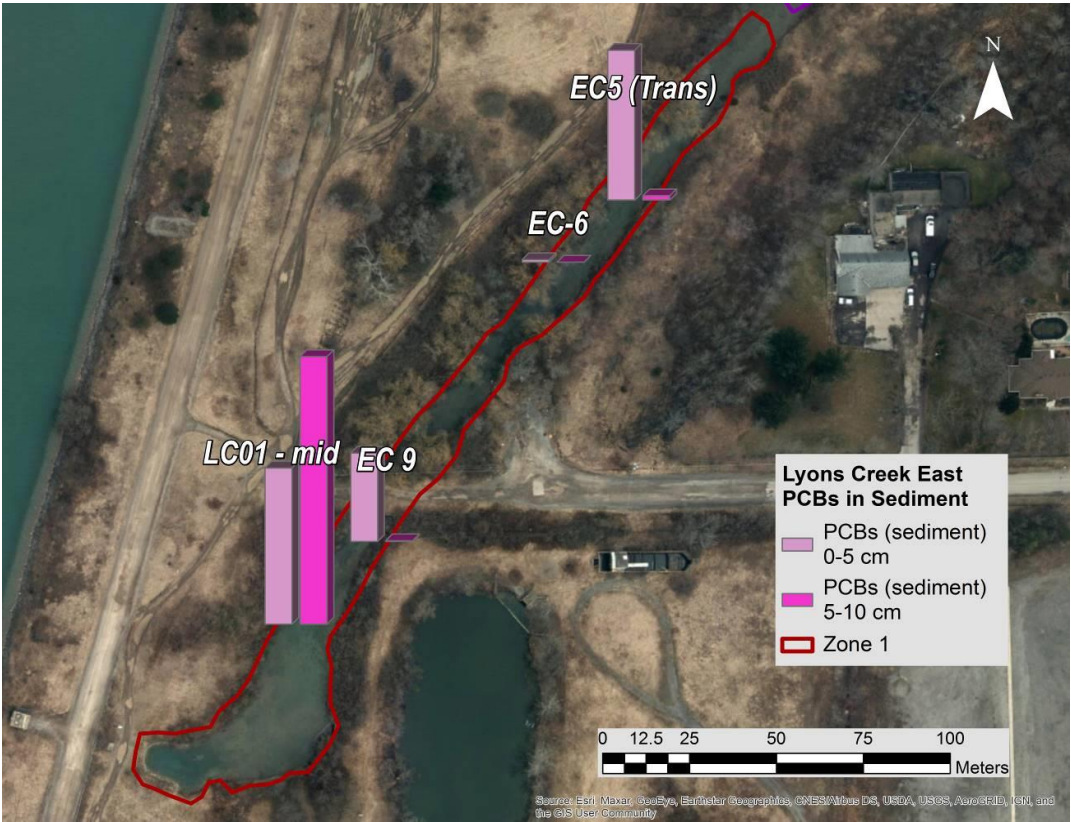


Figure 12. Enlarged view of Zone 1 showing PCBs in sediment.

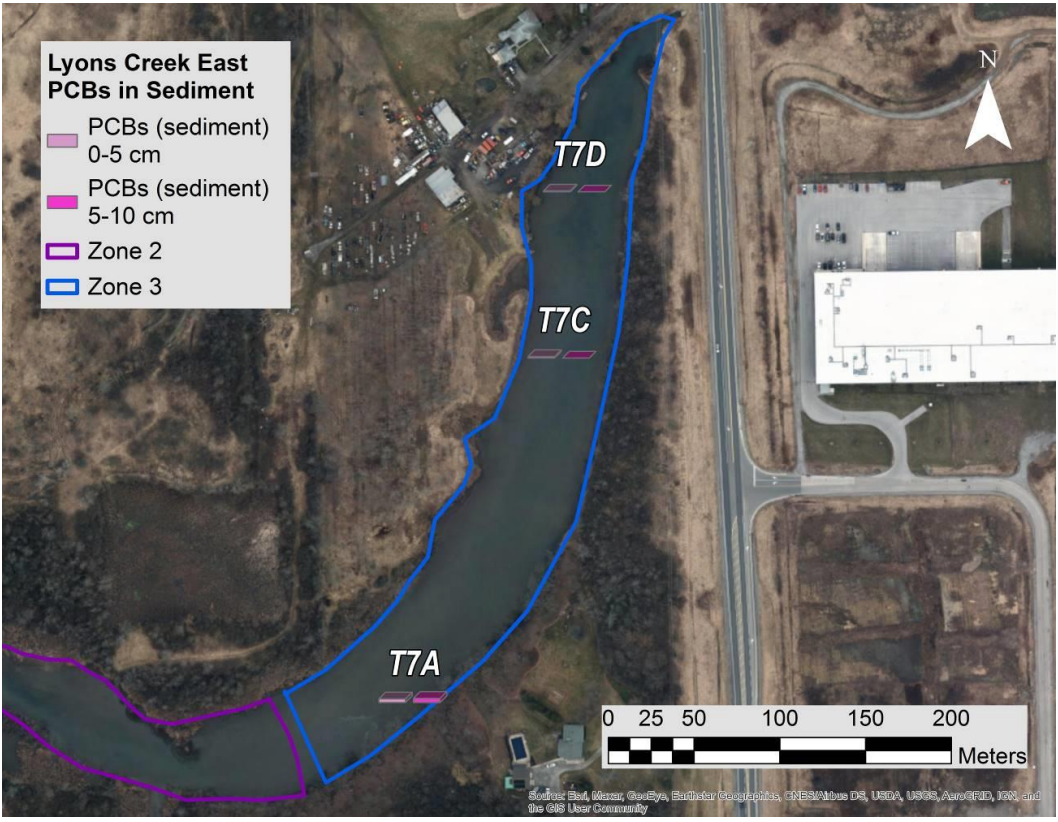


Figure 14. Enlarged view of Zone 3 showing PCBs in sediment.

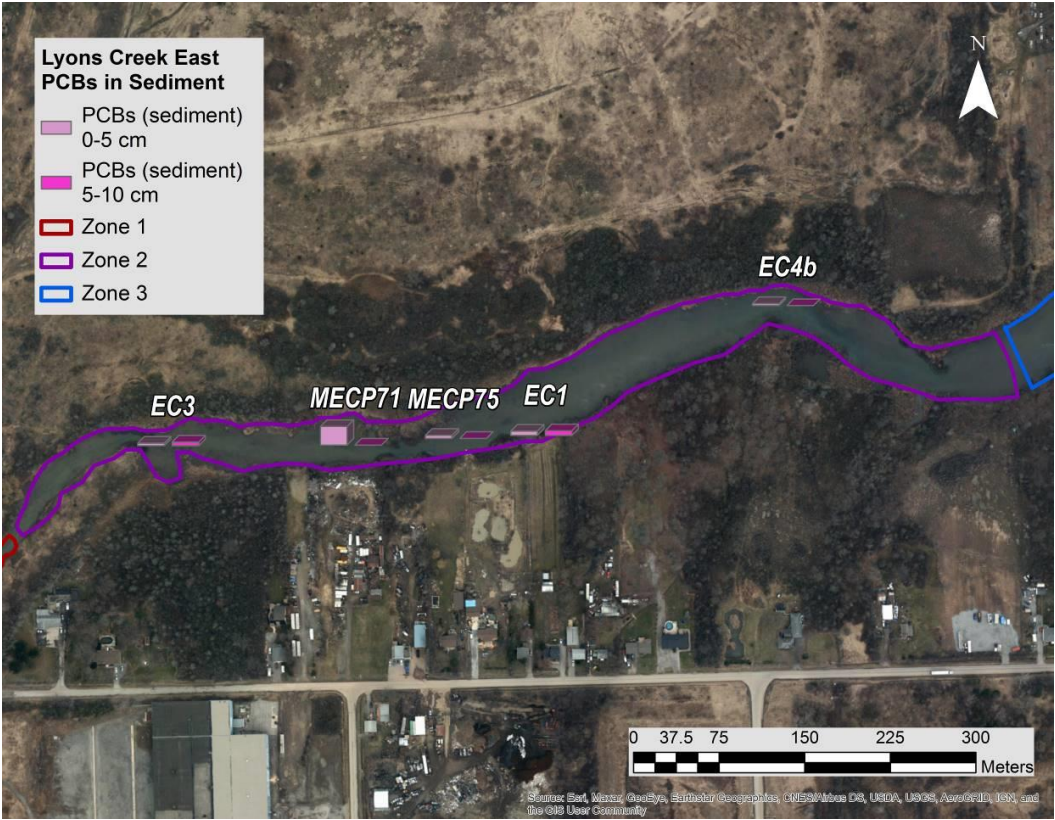


Figure 13. Enlarged view of Zone 2 showing PCBs in sediment.

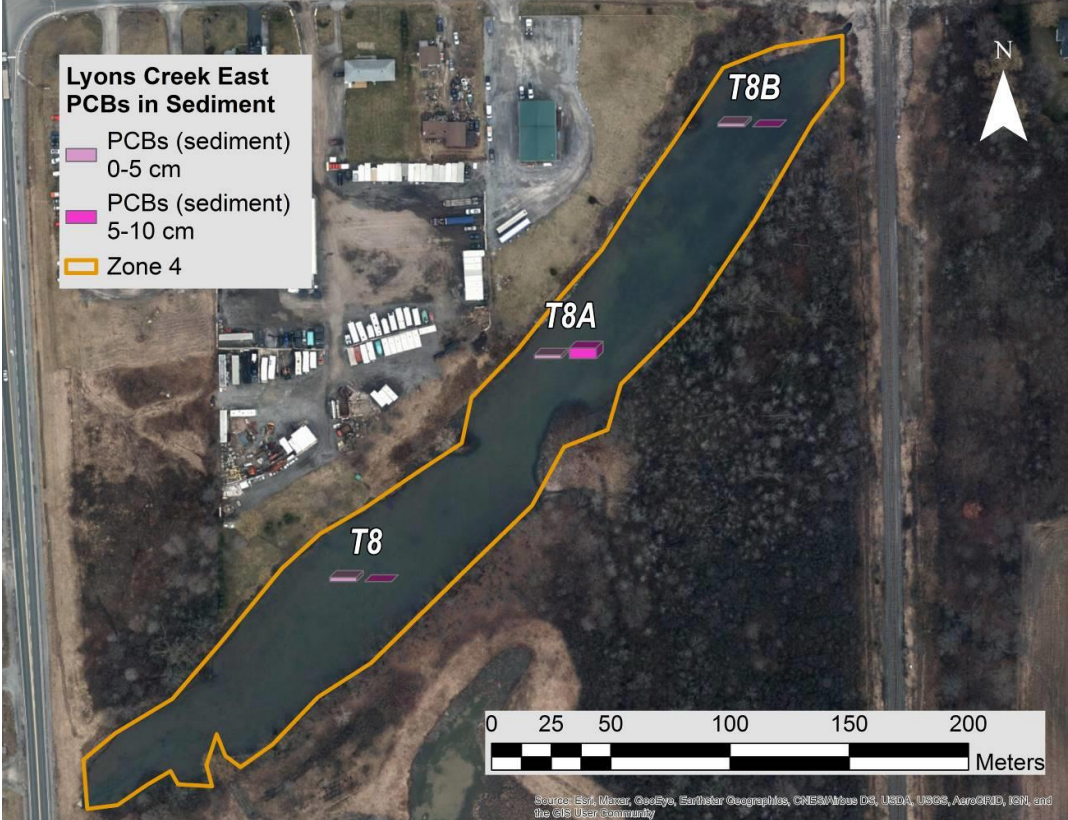


Figure 15. Enlarged view of Zone 4 showing PCBs in sediment.



Figure 16a and b present the pore water data along with the sediment bulk chemistry. They indicate that apart from the spike in pore water PCB at EC4B, the general trend of pore water and sediment PCB concentrations is elevated near the canal and then lowered but steady after EC6.

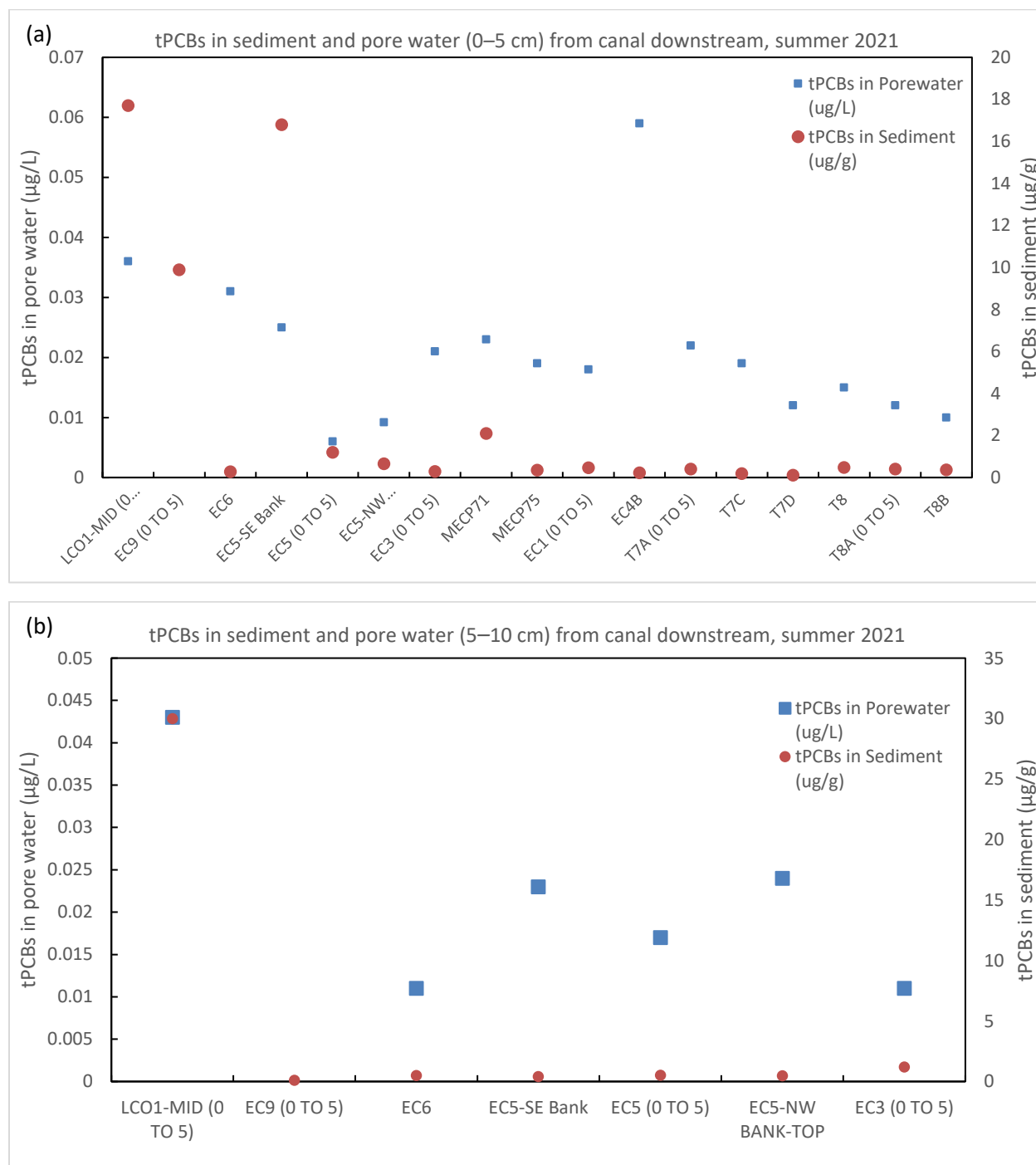
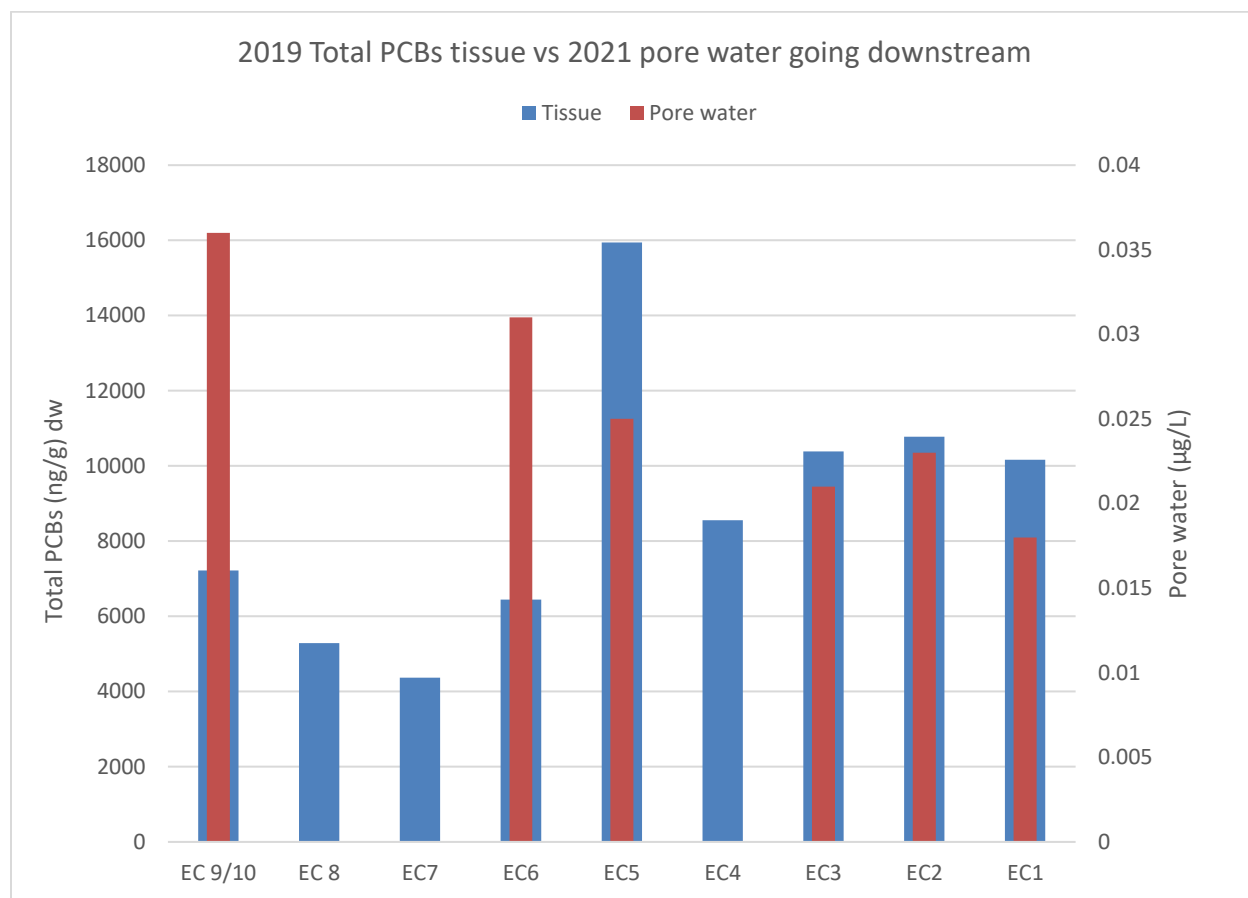


Figure 16. Total PCBs in sediment and pore water from the Welland Canal travelling downstream to the end of Zone 4 at the a) 0–5 cm depth and b) 5–10 cm depth.

Figure 17 presents a comparison of the general trend between tissue data collected in 2019 and pore water collected in this present study (2021) for similar locations in Zones 1 and 2. Pore water is represented in red, as the narrower bars. The examination shows pore water is higher near the canal and decreases towards Zone 2 while the tissue concentrations showed an increasing trend to Zone 2. This case of opposing trends was not expected however, these data sets were 2 years apart and as such affects the ability to truly compare.



*Figure 17.* Total PCBs in tissue (2019) vs total PCBs in pore water (2021) for comparable sites in Zones 1 and 2. Note EC2 (2019) is compared to MECP71 (2021) for this figure and tissue results are only available for zones 1 and 2 from 2019.

As shown previously in Table 2, a number of samplers were either vandalized (EC9) or potentially vandalized (T8 samples). Potentially vandalized is used to describe samples that felt like they had been disturbed upon removal resulting in very low “felt” resistance to being extracted from the sediment. As a result there is both missing and uncertainty associated with some samples. Since we have a reasonable set of measured pore water samples along with corresponding sediment data it is possible to estimate pore water concentrations using the equilibrium partitioning (Equation 1).

$$C_{pw} = \frac{C_s}{K_{oc} \times f_{oc}} \quad (1)$$

Where  $C_s$  = concentration in the solid phase  
 $K_{oc}$  = chemical specific partition coefficient  
 $f_{oc}$  = mass fraction of organic carbon

The chemical specific partition coefficient ( $K_{oc}$ ) differs with the structure of PCBs which have 209 possible congeners. Total PCBs in this project were analyzed by the Aroclor method and as such congener specific information is not available. Waid (1986) provides generic  $K_{oc}$  values for Aroclor mixes and these were used along with the Aroclor concentrations and total organic carbon to estimate the pore water concentrations (Table 4).

*Table 4.*  $K_{oc}$  values from Waid (1986) for estimating pore water concentrations

	$K_{oc}$ (L/kg)	$K_{oc}$ (L/g)
PCB-1016	17684	17.684
PCB-1221	4123	4.123
PCB-1232	7092	7.092
PCB-1242	12400	12.4
PCB-1248	54626	54.626
PCB-1254	63914	63.914
PCB-1260	349462	349.462

If a reasonable relationship between the estimated pore water concentrations and the actual measured pore water concentrations exists, the locations where data was missing or uncertain, could be approximated. Therefore, as an additional task, Equation 1 was used to estimate the pore water concentrations for all locations and the data plotted along with the measured concentrations to examine the relationship (Figure 18 and Figure 19). Figure 19 and the corresponding  $R^2$  indicates that there is a poor relationship and as such this method was not useful for this work. The estimated PCB pore water concentrations are consistently much higher than measured (Figure 18). This may be partially explained by the use of Aroclors in determining the total PCB bulk chemistry concentrations as well as the  $K_{oc}$  values which are specific to Aroclor mixtures and not individual PCB congeners. The estimation method was expected to be conservative but not necessary by this magnitude.

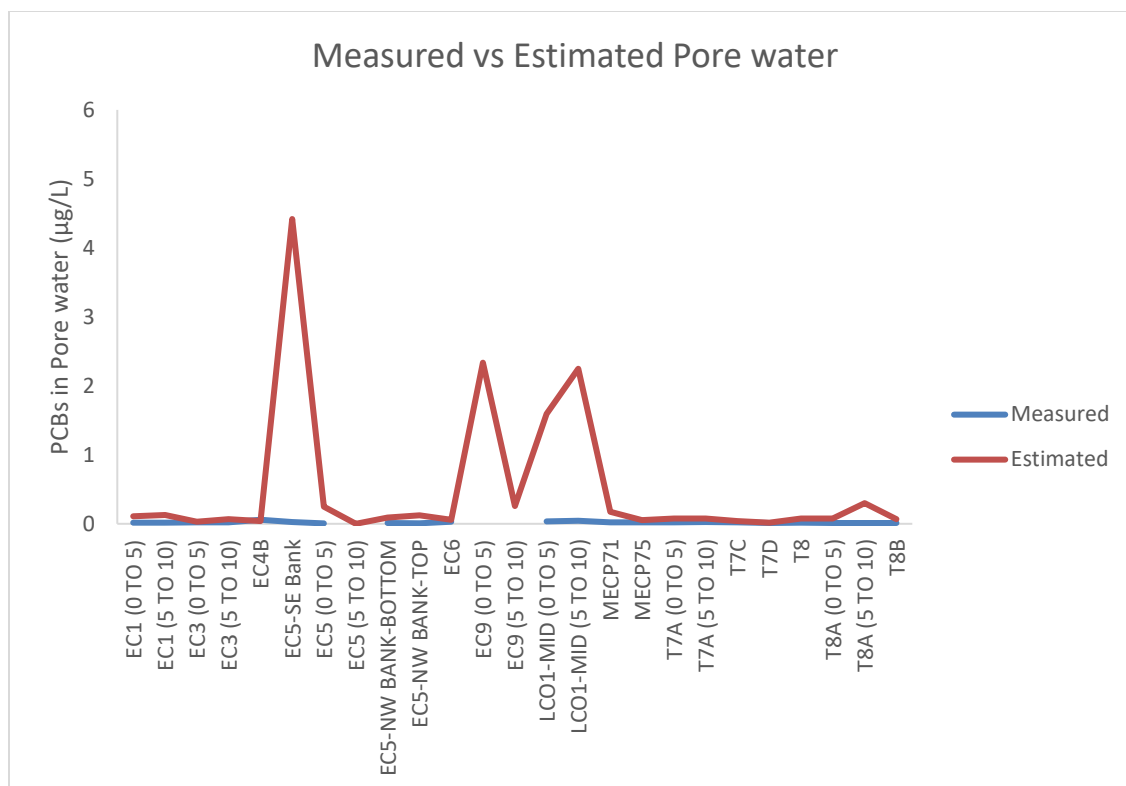


Figure 18. Measured total PCBs in pore water and estimated total PCBs in pore water

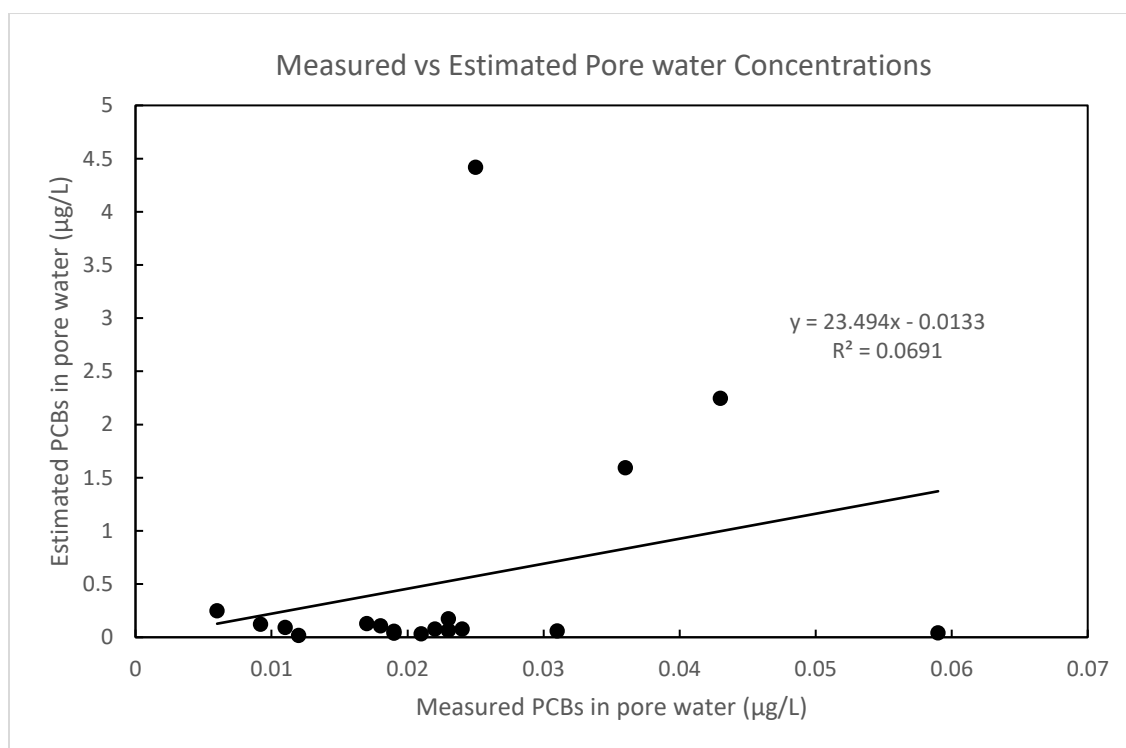


Figure 19. Measured total PCBs in pore water versus estimated total PCBs in pore water

## 5.1. Future Directions

An improvement for future field work is to use a more accurate analysis approach. The total PCB / Aroclor analysis approach was used for analyzing 2021 pore water samples mostly due to budgetary reasons but for future sampling the congener-specific analysis method should be considered. Although it is more costly, it is more accurate and has lower detection limits (Prignano et al., 2007).

Weathering of Aroclors implies there is a higher chance of samples being reported as ND or for very low concentrations to be reported. This is a possibility as to why many ND values were reported for samples. To determine if weathering has taken place, congener or homolog concentrations can be compared to Aroclor concentrations. PCBs that have not undergone weathering will display consistent concentrations for both congener and Aroclor approaches (Wischkaemper et al., 2013).

## 5.2. Sources of Error

With respect to Equation 1, there is added uncertainty to the estimated pore water concentration value due to the  $K_{oc}$  input value.  $K_{oc}$  variability from site to site is normal, due to environmental factors such as the size of particles, grain-size distribution, mineral composition, pH, organic matter, and cation exchange capacity. Accurate pore water concentrations are obtained by obtaining field-specific  $K_{oc}$  values instead of calculating them indirectly from sediment concentrations (Martin, 2019).

The inability of ECCC to be present during field work due to COVID restrictions increased uncertainty in the results. MECP reported some samplers were distinctly subject to vandalism, and others were “potentially” vandalized based on personal observations.

Uncertainty related to the pore water calculation could have also decreased accuracy of estimates. Each sediment and pore water data pair included ND values, which leads to uncertainty in the resulting pore water calculation (Parsons Corporation & Anchor QEA, 2012).

The total PCB / Aroclor analysis approach was used for analyzing 2021 pore water samples as a result of the need for total PCBs within a fixed budget. There are two dominant sampling approaches for PCBs and the Aroclor method chosen for this round of sampling is less specific. According to the US EPA (2021) depending on which Aroclor peaks are selected as being representative, this can yield different compositions of Aroclors and thus different concentrations. Also when PCBs are weathered, Aroclor mixtures do not match the samples actual pattern and so accurate assignment of their representative Aroclors can be challenging.



## 6. Conclusions

1. Pore water total PCB concentrations are similar for the 0–5 and 5–10 cm increments.
2. Pore water total PCB concentrations are elevated at location EC4B. Sediment total PCB concentrations are low at this location, however while sediment cores were collected nearby, it is precisely the same sediment to which the passive sampler was deployed into.
3. Pore water concentrations are elevated in relation to available surface water guidelines, however, well below the final chronic value derived by Fuschman et al. (2006) which was specific to toxicity from PCBs.
4. An assessment of groundwater vertical gradients should be undertaken in the near future.
5. Apart from the elevated PCB concentration in pore water at EC4B, the general trend of pore water and sediment PCB concentrations is elevated near the canal and then lowered but steady concentrations after EC6.
6. Estimated PCB pore water concentrations (using the equilibrium partitioning approach) are very conservative being consistently much higher than measured.
7. There is a poor relationship between measured and estimated and combined with the fact that the equilibrium partitioning approach is very conservative, means estimating pore water concentrations at this site using the data at hand would be very inaccurate.
8. The general trend between tissue (2019) and pore water (2021) (from the canal to EC1) is that pore water concentrations are higher near the canal and decrease to EC1 while the tissue concentrations showed an increasing trend to EC1. These data sets, however, are 2 years apart.
9. Additional pore water, tissue and sediment samples from the same 2022 should help clarify and understand the trends. The measurement of total PCBs by congeners will be considered for future work.

## 7. Acknowledgements

The Authors would like to thank Lisa Richman, Ryan Motosune and Ben Keen of the Ministry of Environment, Conservation and Parks for assistance with obtaining the sediment cores and passive sampler retrieval; Ryan Kitchen of the Niagara Peninsula Conservation Authority for assistance with the passive sampler deployment; and Hans Biberhofer and Jennifer Unsworth of Environment and Climate Change Canada for assistance with processing of the sediment cores.

## 8. References

- Conder, J., Jalalizadeh, M., Luo, H., Bess, A., Sande, S., Healey, M., & Unger, M. A. (2021). Evaluation of a rapid biosensor tool for measuring PAH availability in petroleum-impacted sediment. *Environmental Advances*, 3, 100032.
- Conder, J., Wang, A., Arblaster, J., Magar, V., Nelis, L., Heavner, G. ... Bahnick, K. (2021, November 14-18). *Sediment passive sampling data accurately predicts concentrations in benthic invertebrate tissue* [Presentation]. Society of Environmental Toxicology and Chemistry (SETAC) North America Annual Meeting.
- Fuchsman, P. C., Barber, T. R., Lawton, J. C., & Leigh, K. B. (2006). An evaluation of cause-effect relationships between polychlorinated biphenyl concentrations and sediment toxicity to benthic invertebrates. *Environmental Toxicology and Chemistry*, 25(10), 2601-2612.
- Golder Associates. (2008). Niagara River AOC Phase IV: Sediment Management Options for Lyon's Creek East and West. Welland: Niagara Peninsula Conservation Authority.
- Golder Associates. (2011). Niagara River AOC: Lyons Creek East Sediment Transport Study. Welland: Niagara Peninsula Conservation Authority.
- Martin, G. (2019). Pore water concentration measurement in boreholes in low permeability cohesive geological media for depth discrete high resolution concentration profiles (Doctoral dissertation, University of Guelph, Guelph, Canada). Retrieved from <https://atrium.lib.uoguelph.ca/xmlui/handle/10214/16863>
- Milani, D. and L. Grapentine. 2017. Lyons Creek East (Niagara River, Ontario) Area of Concern: Benthic Conditions in 2015 and temporal trends from 2002 to 2015.
- Parsons Corporation & Anchor QUE (2012, March). Onondaga Lake capping, dredging, habitat and profundal zone (SMU 8) final design appendix B – cap modeling [PDF]. *New York State Department of Environment and Conservation*. <https://www.dec.ny.gov/chemical/83049.html>
- Prignano, A.L., Narquis, C.T., & Hyatt, J.E. (2007). *Generating the right PCB data: determination of Aroclors versus PCB congeners*. [https://clu-in.org/contaminantfocus/default.focus/sec/Polychlorinated Biphenyls \(PCBs\)/cat/Detection and Site Characterization/](https://clu-in.org/contaminantfocus/default.focus/sec/Polychlorinated+Biphenyls+(PCBs)/cat/Detection+and+Site+Characterization/)
- Pautler, Brent 2022. Laboratory Manager, SIREM. (supplier of the passive samplers)
- Richman, L. (2018). Lyons Creek East Long Term Monitoring Plan to Assess Monitored Natural Recovery as an Effective Remediation Strategy: 2015 Survey. Ministry of Environment, Conservation and Parks, Technical Memorandum.

US EPA (Environmental Protection Agency). 2021. Update on the benefits of PCB congener-specific Analysis. Centre for Environmental Solutions and Emergency Response. Ecological Risk Assessment Support Centre. Cincinnati, OH. EPA/600/R-21/237.

Waid, R.S. (ed.) 1986. PCBs and Environment, Volume 1. CRC Press, Boca Rotan.

Whittemore, R.C (ed.) 2002. Handbook on Sediment Quality. Water Environment Federation, 2002.

Wischkaemper, H. K., Beliveau, A. F., & Henderson, R. W. (2013). *U.S. EPA region 4 technical services section issue paper for polychlorinated biphenyl characterization at region 4 superfund and RCRA sites*. <https://www.epa.gov/risk/regional-issues-paper-pcb-characterization>.

## 9. Appendix

This appendix includes an excerpt from the SiREM laboratory (Guelph, Ontario) Certificate of Analysis report. This report includes the original data presented in the body of the report. The full SiREM report is under a separate cover and can be obtained by contacting the author.

**Certificate of Analysis**  
**Concentrations of Freely Dissolved Analytes**  
**Measured via SP3™ Passive Samplers**

**Customer:** Environment & Climate Change  
Canada

**SiREM Reference:** Si-4970-032321

**Site Sampling Date:**  
August 25, 2021 to September 23, 2021

**Report Issued:**  
December 15, 2021

**Introduction**

This report represents the results from *in situ* deployment of SP3™ passive samplers for the Lyons Creek site in Welland ("The Site"). The data from passive samplers (23 sediment-deployed and 4 trip blanks) were analyzed to determine the freely dissolved concentrations ( $C_{free}$ ) of polychlorinated biphenyl (PCB) aroclors in sediment pore water. Each sampler consisted of 2 polyethylene (PE) sheets, one spiked and analyzed for PCB Performance Reference Compounds (PRCs), which are used in the determination of  $C_{free}$  and the second free of PRCs for PCB aroclor analyses. The data from each sampler are combined as a single sample for  $C_{free}$  calculation and reporting. The sample containing PRCs was used to infer sample kinetics for the A and B samples. The samplers were deployed on August 25, 2021 and retrieved on September 23, 2021. Details of the data analysis procedure are provided in Attachment A and the Eurofins Environment Testing America analytical reports are provided in Attachment B.

Bulk Sediment Samples at each location were also collected and analyzed for PCB aroclors and total organic carbon.

**SP3™ Sample Summary**

Client Sample ID	Sampler Deployment Date	Sampler Retrieval Date	Sample Type	Analysis
EC1 (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC1 (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC3 (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC3 (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC4B PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC5 (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC5 (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC5-NW BANK-BOTTOM PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC5-NW BANK-TOP PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC6 PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
EC9 (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
LCO1-MID (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs

Client Sample ID	Sampler Deployment Date	Sampler Retrieval Date	Sample Type	Analysis
LCO1-MID (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
MECP71 PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
MECP75 PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T7A (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T7A (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T7C PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T7D PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T8 PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T8A (0 TO 5) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T8A (5 TO 10) PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
T8B PRCs	8/25/2021	9/23/2021	PRC Sample	PCB PRCs
TRIP BLANK 1 PRCs	-	-	PRC Blank	PCB PRCs
TRIP BLANK 2 PRCs	-	-	PRC Blank	PCB PRCs
TRIP BLANK 3 PRCs	-	-	PRC Blank	PCB PRCs
EC1 (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC1 (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC3 (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC3 (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC4B	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC5 (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC5 (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC5-NW BANK-BOTTOM	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC5-NW BANK-TOP	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC6	8/25/2021	9/23/2021	Sample	PCB Aroclors
EC9 (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
LCO1-MID (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
LCO1-MID (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
MECP71	8/25/2021	9/23/2021	Sample	PCB Aroclors
MECP75	8/25/2021	9/23/2021	Sample	PCB Aroclors
T7A (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
T7A (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
T7C	8/25/2021	9/23/2021	Sample	PCB Aroclors
T7D	8/25/2021	9/23/2021	Sample	PCB Aroclors
T8	8/25/2021	9/23/2021	Sample	PCB Aroclors
T8A (0 TO 5)	8/25/2021	9/23/2021	Sample	PCB Aroclors
T8A (5 TO 10)	8/25/2021	9/23/2021	Sample	PCB Aroclors
T8B	8/25/2021	9/23/2021	Sample	PCB Aroclors
TRIP BLANKS - AROCLORS	-	-	Aroclor Blank	PCB Aroclors

## Sediment Sample Summary

Client Sample ID	Sample Type	Analysis
EC1 (0-5)	Sediment	PCB Aroclors & TOC
EC1 (5-10)	Sediment	PCB Aroclors & TOC
EC3 (0-5)	Sediment	PCB Aroclors & TOC
EC3 (5-10)	Sediment	PCB Aroclors & TOC
EC4B	Sediment	PCB Aroclors & TOC
EC5-MID (0-5)	Sediment	PCB Aroclors & TOC
EC5-NORTHWEST (0-5)	Sediment	PCB Aroclors & TOC
EC5-NORTHWEST (5-10)	Sediment	PCB Aroclors & TOC
EC5-SE BANK (0-5)	Sediment	PCB Aroclors & TOC
EC6	Sediment	PCB Aroclors & TOC
EC9 (0-5)	Sediment	PCB Aroclors & TOC
EC9 (5-10)	Sediment	PCB Aroclors & TOC
LC01-MID (0-5)	Sediment	PCB Aroclors & TOC
LC01-MID (5-10)	Sediment	PCB Aroclors & TOC
MECP71	Sediment	PCB Aroclors & TOC
MECP75	Sediment	PCB Aroclors & TOC
T7A (0-5)	Sediment	PCB Aroclors & TOC
T7A (5-10)	Sediment	PCB Aroclors & TOC
T7C	Sediment	PCB Aroclors & TOC
T7D	Sediment	PCB Aroclors & TOC
T8	Sediment	PCB Aroclors & TOC
T8A (0-5)	Sediment	PCB Aroclors & TOC
T8A (5-10)	Sediment	PCB Aroclors & TOC
T8B	Sediment	PCB Aroclors & TOC

## Sampler Design, Deployment, and Chemical Analysis

This deployment used a SP3™ double sampler design and a larger double SP3™ sampler design for PCB aroclors and PCB PRCs. Each SP3™ double sampler will contain 1 sampler spiked with PRCs (to be used for equilibrium calculations) and one without PRCs for PCB aroclors analysis. The standard SP3™ double sampler consists of a 5 cm × 8 cm polyethylene sheet housed in a steel-mesh envelope attached to two 8 cm × 18 cm × 0.1 cm stainless steel support plates. Ten (10) standard SP3™ double samplers were prepared for 10 locations sampling the 0 – 5 cm depth interval. The larger SP3™ double sampler consists a 10 cm × 8 cm polyethylene sheet housed in a steel-mesh envelope attached to two 8 cm × 18 cm × 0.1 cm stainless steel support plates. Seven (7) large SP3™ double samplers were prepared for 7 locations sampling the 0 – 5 cm and 5 – 10 cm depth intervals. For the designated PE for PRC analysis, the PE was spiked with PRCs that are not present in any aroclor mixture are assumed to: 1) not be present in the media sampled or 2) present at concentrations so low as to be inconsequential, not affect calculations involving PRCs, and insignificant compared to the concentration of other freely-dissolved PCBs in the media sampled. The PRCs used for this project were: PCB-14, PCB-36, PCB-78, PCB-104, PCB-

121, PCB-142, PCB-155, PCB-184, PCB-192, and PCB-204<sup>1</sup>. The PE used for PCB aroclor analysis was not spiked with the PRC compounds.

The deployed SP3™ samplers were deployed on August 25, 2021 and retrieved on September 23, 2021. The deployment time for the samplers was 29 days. Upon retrieval, the larger SP3™ samplers were cut in half using solvent-rinsed scissors, generating a sample representing the 0 – 5 cm interval and a sample representing the 5 – 10 cm interval. The divided larger samplers and the standard SP3™ samplers were then wrapped in aluminum foil and placed in an opaque re-sealable bag. The samplers were then placed in an additional re-sealable plastic bag and packaged in a cooler with ice packs for overnight shipment to Eurofins Environment Testing America in Knoxville, TN. Note that one sampler was damaged at some point during deployment and was not included in the final study. Sediment samples were also collected on September 23, 2021, handled and processed by ECCC at their facility, were subsampled and overnight shipment to Eurofins Environment Testing America in Knoxville, TN.

During the deployment stage the 3 PRC trip blanks (labelled as TRIP BLANK 1, TRIP BLANK 2 and TRIP BLANK 3) and an aroclor trip blank (labelled as AROCLOR TRIP BLANKS) remained in their original packaging under cold storage (approximately 4 degrees Celsius [ $^{\circ}\text{C}$ ]) with the exception of a period on August 25, 2021 in which the trip blanks were removed from the packaging by field personnel, exposed to ambient field conditions for approximately 5 minutes, and packaged for shipment in the same manner as the deployed samplers. The trip blanks were sent to the laboratory and stored under cold storage conditions during the deployment stage. The trip blanks were processed by the laboratory along with the retrieved field samplers.

Processing of the samplers by Eurofins Environment Testing America included removal of the PE from the stainless-steel mesh envelope, wiping any visible sediment from the PE using a moist tissue, and determination of the concentrations of PCBs in PE. The analytical report provided by Eurofins Environment Testing America is attached to this report (Attachment B).

## Results

$C_{\text{free}}$  values for PCB Aroclors are reported in Table 1. Bulk sediment analyses are reported in Table S1 and S2.

As detailed in Attachment B, concentrations of PRCs in the exposed samplers and trip blanks were used to estimate a compound-specific mass transport rate for each sampler. For example, if 100 ng/g of a PRC is present in a trip blank and 50 ng/g of the same PRC is present in a sampler following retrieval, the data indicate that the PRC is at 50% of its equilibrium concentration upon retrieval. With several different PRC depletion values, a predictive model can be constructed to estimate primary target compound fractional equilibrium, as described in greater detail in Attachment B. An average PE-water partition coefficient for the Aroclor composition is used in the  $C_{\text{free}}$  Aroclor model calculations.

The results from the *in-situ* tests suggest that the following PRC may have been present in the sediment and partitioned into the sampler during deployment: PCB-121. This phenomenon is unexpected and extremely rare, as these (and other PRCs) are not present in standard PCB

<sup>1</sup> PCB shorthand nomenclature used in this report follows the Chemical Abstract Service (CAS) nomenclature used by USEPA (2003): United States Environmental Protection Agency (USEPA). 2003. Table of PCB Species by Congener Number.



aroclor mixtures and are rarely detected in high enough concentrations in the environment to elicit detectable concentrations in passive samplers. Concentrations of this PRC across all samplers were much higher than expected both in relation to the PRC equilibration mode curves and in comparison to respective trip blank concentrations. Data from this PRC was excluded from calculations as anomalies. Note that both PCB-36 and PCB-182 had slightly higher detectable PRCs concentrations in 7 samplers and 1 sampler, respectively, suggesting a negative PRC depletion rate, a highly unlikely phenomenon. These anomalies were likely the result of analytical chemistry error and were thus excluded from calculations for those respective samplers.

Following exclusion of outliers as discussed above, robust PRC correction curves were developed with the remaining PRC data points in each sampler. The overall  $R^2$  and P value of the curves were robust, thus reducing the uncertainty involved in the PRC calculations.

TABLE 1

Table 1. Concentration of Freely-Dissolved (Cfree) Analytes  
ECCC Lyons Creek, ON

Client ID	EC1 (0 TO 5)			EC1 (5 TO 10)			EC3 (0 TO 5)			EC3 (5 TO 10)			EC4B			EC5 (0 TO 5)		
Analyte	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)
PCB-1016	ND		690	ND		710	ND		640	ND		620	ND		570	ND		1900
PCB-1221	ND		8000	ND		8000	ND		7900	ND		7800	ND		6800	ND		22000
PCB-1232	ND		2900	ND		2900	ND		2800	ND		2700	ND		2400	ND		11000
PCB-1242	ND		250	ND		260	ND		230	ND		230	ND		210	ND		1600
PCB-1248	18000		170	17000		160	21000		150	23000		140	59000		130	25000		590
PCB-1254	ND		91	ND		80	ND		77	ND		74	ND		61	ND		230
PCB-1260	ND		35	ND		26	ND		29	ND		27	ND		20	ND		83
PCB-1262	ND		42	ND		31	ND		35	ND		34	ND		24	ND		83
PCB-1268	ND		16	ND		13	ND		13	ND		13	ND		9.2	ND		83
Total PCBs	18000			17000			21000			23000			59000			25000		

Notes

- B: Compound was found in the blank and sample  
CI: The peak identified by the data system exhibited chromatographic interference that could not be resolved. There is reason to suspect there may be a high bias  
J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value

Table 1. Concentration of Freely-Dissolved (Cfree) Analytes  
ECCC Lyons Creek, ON

Client ID	EC5 (5 TO 10)			EC5-NW BANK-BOTTOM			EC5-NW BANK-TOP			EC6			EC9 (5 TO 10)			LCO1-MID (0 TO 5)		
Analyte	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)
PCB-1016	ND		410	ND		460	ND		740.0	ND		620	ND		620	ND		420
PCB-1221	ND		5200	ND		5900	ND		9500.0	ND		7300	ND		7500	ND		5200
PCB-1232	ND		1800	ND		2000	ND		3300.0	ND		2500	ND		2700	ND		1800
PCB-1242	ND		160	ND		170	ND		280.0	ND		230	ND		230	ND		160
PCB-1248	6000		120	11000.0		110	9200.0		190.0	31000		150	9100		130	36000		99
PCB-1254	ND		88	ND		58	ND		110.0	ND		83	ND		57	ND		51
PCB-1260	ND		51	ND		23	ND		49.0	ND		32	ND		16	ND		18
PCB-1262	ND		62	ND		28	ND		61.0	ND		39	ND		20	ND		22
PCB-1268	ND		24	ND		11	ND		23.0	ND		15	ND		7.6	ND		8.4
Total PCBs	6000			11000			9200			31000			9100			36000		

Table 1. Concentration of Freely-Dissolved (Cfree) Analytes  
ECCC Lyons Creek, ON

Client ID	LCO1-MID (5 TO 10)			MECP71			MECP75			T7A (0 TO 5)			T7A (5 TO 10)			T7C		
Analyte	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)
PCB-1016	ND		470	ND		620	ND		590	ND		560	ND		520	ND		560
PCB-1221	ND		5800	ND		7700	ND		7100	ND		7500	ND		6900	ND		7100
PCB-1232	ND		2000	ND		2700	ND		2500	ND		2600	ND		2400	ND		2500
PCB-1242	ND		170	ND		230	ND		220	ND		210	ND		190	ND		210
PCB-1248	43000		110	23000		160	19000		140	22000.0		140	24000		130	19000		150
PCB-1254	ND		64	ND		97	ND		71	ND		96	ND		89	ND		110
PCB-1260	ND		26	ND		45	ND		25	ND		53	ND		50	ND		58
PCB-1262	ND		32	ND		56	ND		31	ND		66	ND		63	ND		72
PCB-1268	ND		12	ND		21	ND		12	ND		25	ND		24	ND		28
Total PCBs	43000			23000			19000			22000			24000			19000		

Table 1. Concentration of Freely-Dissolved (Cfree) Analytes  
ECCC Lyons Creek, ON

Client ID	T7D			T8			T8A (0 TO 5)			T8A (5 TO 10)			T8B		
Analyte	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)	(pg/L)		(pg/L)
PCB-1016	ND		660	ND		660	ND		560	ND		650	ND		550
PCB-1221	ND		8700	ND		8700	ND		7300	ND		7900	ND		7200
PCB-1232	ND		2900	ND		2900	ND		2500	ND		2800	ND		2500
PCB-1242	ND		240	ND		250	ND		210	ND		250	ND		210
PCB-1248	12000		160	15000		150	12000		130	11000		170	10000		160
PCB-1254	ND		87	ND		79	ND		76	ND		94	ND		120
PCB-1260	ND		35	ND		29	ND		33	ND		40	ND		81
PCB-1262	ND		42	ND		38	ND		40	ND		49	ND		100
PCB-1268	ND		17	ND		14	ND		16	ND		19	ND		38
Total PCBs	12000			15000			12000			11000			10000		

TABLE S1

Table S1. Concentration of analytes in Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	EC1 (0-5)			EC1 (5-10)			EC3 (0-5)			EC3 (5-10)			EC4B			EC5-MID (0-5)			EC5-NORTHWEST (0-5)		
	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)
PCB-1016	ND	H H3	5.4	ND	H H3	4.8	ND	H H3	6.8	ND	H H3	5.8	ND	H H3	6.4	ND	H H3	5.3	ND	H H3	5.0
PCB-1221	ND	H H3	5.9	ND	H H3	5.3	ND	H H3	7.5	ND	H H3	6.4	ND	H H3	7.0	ND	H H3	5.8	ND	H H3	5.5
PCB-1232	ND	H H3	4.1	ND	H H3	3.6	ND	H H3	5.1	ND	H H3	4.4	ND	H H3	4.8	ND	H H3	4.0	ND	H H3	3.8
PCB-1242	ND	H H3	2.4	ND	H H3	2.2	ND	H H3	3.1	ND	H H3	2.6	ND	H H3	2.9	ND	H H3	2.4	ND	H H3	2.3
PCB-1248	270	H H3	4.0	320	H H3	3.6	160	H H3	5.1	240	H H3	4.4	130	H H3	4.8	750	H H3	4.0	410	H H3	3.8
PCB-1254	150	H H3	5.0	150	H H3	4.5	91	H H3	6.3	130	H H3	5.4	72	H H3	5.9	340	H H3	4.9	170	H H3	4.7
PCB-1260	47	H H3	4.7	39	H H3	4.3	29	H H3	6.0	39	H H3	5.1	18	J H H3	5.7	100	H H3	4.7	68	H H3	4.4
Total Aroclors	467			509			280			409			220			1190			648		

**Notes**  
ND: Non-detect  
H: Sample was prepped or analyzed beyond the specified holding time  
H3: Sample was received and analyzed past holding time  
F1: MS and/or MSD recovery exceed control limits  
F2: MS/MSD RPD exceeds control limits  
B: Compound was found in blank and sample  
J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value



Table S1. Concentration of analytes in Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	EC5-NORTHWEST (5-10)			EC5-SE BANK (0-5)			EC6			EC9 (0-5)			EC9 (5-10)			LC01-MID (0-5)		
	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)
PCB-1016	ND	H H3	3.3	ND	H H3	22.0	ND	H H3	5.0	ND	H H3	29	ND	H H3	2.1	ND	H F1 H3	71.0
PCB-1221	ND	H H3	3.7	ND	H H3	24.0	ND	H H3	5.5	ND	H H3	31	ND	H H3	2.3	ND	H H3	78.0
PCB-1232	ND	H H3	2.5	ND	H H3	17.0	ND	H H3	3.8	ND	H H3	22	ND	H H3	1.6	ND	H H3	54.0
PCB-1242	ND	H H3	1.5	ND	H H3	10.0	ND	H H3	2.3	ND	H H3	13	ND	H H3	1.0	ND	H H3	32.0
PCB-1248	310	H H3	2.5	13000	H H3	17.0	160	H H3	3.8	7400	H H3	21	61	H H3	1.6	13000	H H3	53.0
PCB-1254	130	H H3	3.1	3000	H H3	20.0	75	H H3	4.6	2000	H H3	27	31	H H3	1.9	4000	H H3	66.0
PCB-1260	53	H H3	2.9	790	H H3	19.0	33	H H3	4.4	490	H H3	25	ND	H H3	1.8	700	H F1 H3	63.0
Total Aroclors	493			16790			268			9890			92			17700		

Table S1. Concentration of analytes in Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	LC01-MID (5-10)			MECP71			MECP75			T7A (0-5)			T7A (5-10)			T7C			T7D		
	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)
PCB-1016	ND	H H3	64.0	ND	H H3	7.6	ND	H H3	5.7	ND	H H3	6.7	ND	H H3	6.6	ND	H H3	5.8	ND	H H3	7.8
PCB-1221	ND	H H3	70.0	ND	H H3	8.3	ND	H H3	6.3	ND	H H3	7.3	ND	H H3	7.2	ND	H H3	6.4	ND	H H3	8.6
PCB-1232	ND	H H3	48.0	ND	H H3	5.7	ND	H H3	4.3	ND	H H3	5.1	ND	H H3	5.0	ND	H H3	4.4	ND	H H3	5.9
PCB-1242	ND	H H3	29.0	ND	H H3	3.4	ND	H H3	2.6	ND	H H3	3.0	ND	H H3	3.0	ND	H H3	2.6	ND	H H3	3.5
PCB-1248	24000	H H3	48.0	1400	H H3	5.7	200	H H3	4.3	240	H H3	5.0	280	H H3	4.9	110	H H3	4.3	72	H H3	5.9
PCB-1254	4700	H H3	59.0	530	H H3	7.0	110	H H3	5.3	130	H H3	6.2	150	H H3	6.1	55	H H3	5.4	37	H H3	7.3
PCB-1260	1300	H H3	56.0	160	H H3	6.7	32	H H3	5.0	32	H H3	5.9	39	H H3	5.8	13	J H H3	5.1	ND	H H3	6.9
Total Aroclors	30000			2090			342						469			178			109		

Table S1. Concentration of analytes in Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	T8			T8A (0-5)			T8A (5-10)			T8B		
	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)
PCB-1016	ND	H H3 F1 F2	7.2	ND	H H3	6.7	ND	H H3	6.5	ND	H H3	7.1
PCB-1221	ND	H H3	7.9	ND	H H3	7.4	ND	H H3	7.1	ND	H H3	7.8
PCB-1232	ND	H H3	5.4	ND	H H3	5.1	ND	H H3	4.9	ND	H H3	5.4
PCB-1242	ND	H H3	3.2	ND	H H3	3.0	ND	H H3	2.9	ND	H H3	3.2
PCB-1248	330	H H3	5.4	270	H H3	5.0	810	H H3	4.9	240	H H3	5.3
PCB-1254	110	H H3	6.6	100	H H3	6.2	290	H H3	6.0	92	H H3	6.6
PCB-1260	39	H H3 F1 F2	6.3	32	H H3	5.9	88	H H3	5.7	29	H H3	6.3
Total Aroclors	479			402			1188			361		

**TABLE S2**

Table S2. % Moisture and Total Organic Carbon of Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	EC1 (0-5)			EC1 (5-10)			EC3 (0-5)			EC3 (5-10)			EC4B			EC5-MID (0-5)		
	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)
Percent Moisture	74.9		0.1	72.0		0.1	80.3		0.1	77.1		0.1	79.0		0.1	74.5		0.1
Total Organic Carbon - Duplicates	69000	H H3	3000	65000	H H3	2700	140000	H H3	3800	100000	H H3	3300	89000	H H3	3500	78000	H H3	2900

**Notes**  
TOC result provided on a dry weight basis i.e. mg TOC/kg sediment, dry wt  
ND: Non-detect  
H: Sample was prepped or analyzed beyond the specified holding time  
H3: Sample was received and analyzed past holding time  
F1: MS and/or MSD recovery exceed control limits  
F2: MS/MSD RPD exceeds control limits  
B: Compound was found in blank and sample  
J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value

Table S2. % Moisture and Total Organic Carbon of Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	EC5-NORTHWEST (0-5)			EC5-NORTHWEST (5-10)			EC5-SE BANK (0-5)			EC6			EC9 (0-5)			EC9 (5-10)		
	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)
Percent Moisture	73.3		0.1	59.6		0.1	39.4		0.1	73.4		0.1	53.3		0.1	35.7		0.1
Total Organic Carbon - Duplicates	84000	H H3 F1 F2	2800	86000	H H3 B	1800	65000	H H3	1200	71000	H H3	2800.000	72000	H H3	1600	6200	H H3	1200



Table S2. % Moisture and Total Organic Carbon of Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	LC01-MID (0-5)			LC01-MID (5-10)			MECP71			MECP75			T7A (0-5)			T7A (5-10)		
	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)		(mg/kg)
Percent Moisture	81.0		0.1	79.2		0.1	82.5		0.1	76.4		0.1	80.0		0.1	79.6		0.1
Total Organic Carbon - Duplicates	190000	H H3	3900	230000	H H3	3600	200000	H H3	4300	100000	H H3	3200	86000	H H3	3700	98000	H H3	3700

Table S2. % Moisture and Total Organic Carbon of Bulk Sediment Samples  
ECCC Lyons Creek, ON

Client ID	T7C			T7D			T8			T8A (0-5)			T8A (5-10)			T8B		
	Result (mg/kg)	Qualifier	MDL (mg/kg)	Result (mg/kg)	Qualifier	MDL (mg/kg)	Result (mg/kg)	Qualifier	MDL (mg/kg)	Result (mg/kg)	Qualifier	MDL (mg/kg)	Result (mg/kg)	Qualifier	MDL (mg/kg)	Result (mg/kg)	Qualifier	MDL (mg/kg)
Percent Moisture	76.8		0.1	82.8		0.1	81.4		0.1	80.1		0.1	79.3		0.1	81.3		0.1
Total Organic Carbon - Duplicates	75000	H H3	3200	120000	H H3	4300	100000	H H3	4000	85000	H H3	3700	66000	H H3	3600	86000	H H3	4000

**ATTACHMENT A:**  
**DATA ANALYSIS METHODS**

## Attachment A:

### **Data Analysis Methods Concentrations of Freely Dissolved Analytes Measured via SP3™ Passive Samplers**

The concentration of analyte aroclors (Table A1) in PE obtained from the information provided in the analytical report (Attachment B) are used in a multi-step data process to calculate  $C_{\text{free}}$  analytes as described below.

#### Step 1:

The concentrations of the PRCs in PE [ $PE_i$ ] were used to calculate the elimination rate ( $k_e$ ) values for the PRCs in each deployed sampler using the following equation (Lohmann, 2012):

$$PRC\ k_e = \ln \left( \frac{[PE_{t=0}]}{PE_{t=final}} \right) \div t_{final}$$

where:

$PE_{t=0}$	= the average concentration of the PRC present in the PE at the beginning of the deployment (obtained from an average measurement of the PRC control blanks)
$PE_{t=final}$	= the concentration of the PRC in the PE after the deployment (obtained from each deployed PE sampler)
$t_{final}$	= the deployment time (in days)
$k_e$	= the elimination rate (in days <sup>-1</sup> )

PRC  $k_e$  values for the PRCs in each sampler are shown in Table A2. The values are also expressed as a percentage of steady state (concentration at equilibrium). Several PRC  $k_e$  values were not calculated and were treated as outliers because  $PE_{t=final}$  values were equal to or greater than  $PE_{t=0}$  values.

Step 2:

The second step was to estimate  $k_e$  values for the non-PRC primary analytes (non-PRC PCB) in each of the deployed samplers. This was accomplished by developing a linear regression model using PRC  $k_e$  values (dependent variable, from Table A2) and PE-water partition coefficients ( $K_{PE}$ ) for each PRC PCB (independent variable, Smedes et al., 2009). Note that regression models were specific to each sampler (i.e. not global to the whole deployment) as local geologic and hydrodynamic conditions can vary greatly within a site.

Values were  $\log_{10}$ -transformed per Tomaszewski and Luthy (2008). By entering the analyte-specific  $K_{PE}$  into the linear regression model developed for each sampler,  $k_e$  values for each of the primary analytes for each sampler were calculated.

$\log_{10} K_{PE}$  values for the aroclors are provided in the inset table below.

Analyte	$\log_{10} K_{PE}$ (L/kg PE) <sup>[1]</sup>
Aroclor 1016	5.20
Aroclor 1221	4.10
Aroclor 1232	4.40
Aroclor 1242	5.30
Aroclor 1248	5.80
Aroclor 1254	6.30
Aroclor 1260	6.90
Aroclor 1262 <sup>[2]</sup>	6.90
Aroclor 1268 <sup>[2]</sup>	6.90

Notes

- 1:  $\log_{10} K_{PE}$  values for Aroclors calculated with Aroclor-specific  $\log_{10}$  octanol-water partition coefficients ( $\log_{10} K_{OW}$ ; Fuchsman et al., 2006) and a  $\log_{10} K_{OW}/\log_{10} K_{PE}$  regression model for PCBs from Smedes et al. (2009).
- 2:  $\log_{10} K_{PE}$  values for Aroclor 1262 and 1268 assumed to be equal to the value calculated for Aroclor 1260.

Step 3:

Concentrations of some non-PRC PCBs (Table A1-a and A1-b) in PE were corrected for trace levels of non-PRC PCBs present in the PRC control blanks (due to trace levels present in the PRC spiking solutions). Using the sample specific  $k_e$  values, the expected amount of these trace primary analyte PCBs present in the sample at the end of deployment ( $\text{Trace PCB}_{t=final}$ ) was calculated via the following equation:

$$[\text{Trace PCB}_{t=final}] = \frac{[\text{Trace PCB}_{t=0}]}{e^{k_e \times t_{final}}}$$

where:

$\text{Trace PCB}_{t=final}$  = the concentration of trace PCBs remaining in the sample at the end of the deployment

$Trace\ PCB_{t=0}$	= the average concentration of the trace PCB in the PE at the beginning of the deployment (obtained from an average measurement of the trace PCBs in the PRC control blanks)
$k_e$	= the elimination rate value predicted by the sampler-specific regression model (in days <sup>-1</sup> )
$t_{final}$	= the deployment time (in days)

Concentrations of  $Trace\ PCB_{t=final}$  values were then subtracted from the measured concentrations of non-PRC PCBs and pesticides in PE (Table A1).

#### Step 4:

This step describes the calculation of sampling rate correction factors ( $CF$ s) for each primary analyte in each sampler. The following equation is used, as adapted from Lohmann (2012):

$$CF = \frac{1}{1 - e^{-k_e \times t_{final}}}$$

where:

$k_e$	= the elimination rate value predicted by the sampler-specific regression model (in days <sup>-1</sup> )
$t_{final}$	= the deployment time (in days).

#### Step 5:

The concentration of primary analyte in the PE of each sampler (obtained from Table A1) were multiplied by the  $CF$  values to calculate the steady-state concentration of primary analytes.

#### Step 6:

In the final step, the steady-state concentrations are divided by  $K_{PE}$  values (Smedes et al. 2009) to obtain the concentrations of  $C_{free}$  for the primary analytes. These are reported in Table 1.  $C_{free}$  Method Detection Limits (MDLs) were calculated in the approach described above using the estimated MDL concentration in PE, as reported the analytical laboratory and shown in Table A1.

For samples in which the percentage of steady state was indicated to be less than 10% for a primary analyte,  $C_{free}$  was calculated and given an “L” qualifier in Table 1. Estimates associated with L-qualified values should be evaluated with caution due to the higher level of uncertainty associated with high  $CF$  values (i.e., higher than 10)

## References Cited

- Fuchsman, P.C., Barber, T.R., Lawton, J.C., and K.B. Leigh. 2006. An evaluation of cause-effect relationships between polychlorinated biphenyl concentrations and sediment toxicity to benthic invertebrates. *Environ. Toxicol. Chem.* 25: 2601-2612.
- Lohmann, R. 2012. Critical review of low-density polyethylene's partitioning and diffusion coefficients for trace organic contaminants and implications for its use as a passive sampler. *Environ. Sci. Technol.*: 46:606-618.
- Smedes, P., Geerstma, R. W., van der Zande, T., and Booij, K. 2009. Polymer-water partition coefficients of hydrophobic compounds for passive sampling: Application of cosolvent models for validation. *Environ. Sci. Technol.* 43:7047-7054.
- Tomaszewski, J.E., and Luthy, R.G. 2008. Field deployment of polyethylene devices to measure PCB concentrations in pore water of contaminated sediment. *Environ. Sci. Technol.* 42:6086-6091.
- United States Environmental Protection Agency (USEPA). 2003. Table of PCB Species by Congener Number.

**TABLE A1**



Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			TRIP BLANK 1 PRCs			TRIP BLANK 2 PRCs			TRIP BLANK 3 PRCs			EC1 (0 TO 5)			EC1 (5 TO 10)			EC3 (0 TO 5)		
	Homolog Group	PRC	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
			(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)
PCB-1016			--	--	--	--	--	--	--	--	--	ND		94.0	ND		96.0	ND		92.0
PCB-1221			--	--	--	--	--	--	--	--	--	ND		100.0	ND		100.0	ND		100.0
PCB-1232			--	--	--	--	--	--	--	--	--	ND		71.0	ND		72.0	ND		69.0
PCB-1242			--	--	--	--	--	--	--	--	--	ND		42.0	ND		43.0	ND		41.0
PCB-1248			--	--	--	--	--	--	--	--	--	7700		70.0	7400		72.0	10000		69.0
PCB-1254			--	--	--	--	--	--	--	--	--	ND		87.0	ND		89.0	ND		85.0
PCB-1260			--	--	--	--	--	--	--	--	--	ND		83.0	ND		84.0	ND		81.0
PCB-1262			--	--	--	--	--	--	--	--	--	ND		100.0	ND		100.0	ND		100.0
PCB-1268			--	--	--	--	--	--	--	--	--	ND		39.0	ND		40.0	ND		38.0
PCB-14	Di	PRC	660		2.0	780		2.2	690		2.0	100	J B	1.8	97	J B	1.9	42	J B	2.1
PCB-36	Tri	PRC	890	B	2.0	1100	B	2.2	810	B	2.0	270	B	1.8	290	B	1.9	210	B	2.1
PCB-78	Tetra	PRC	680		2.0	770		2.2	610		2.0	280		1.8	240		1.9	250		2.1
PCB-104	Penta	PRC	1100		2.0	1200		2.2	900		2.0	370		1.8	270		1.9	300		2.1
PCB-121	Penta	PRC	460		2.0	520		2.2	430		2.0	360		1.8	320		1.9	330		2.1
PCB-142	Hexa	PRC	260		2.0	290		2.2	240		2.0	170	J B	1.8	140	J B	1.9	160	J B	2.1
PCB-155	Hexa	PRC	430		2.0	470		2.2	380		2.0	270		1.8	230		1.9	250		2.1
PCB-184	Hepta	PRC	790		2.0	880		2.2	730		2.0	600		1.8	520		1.9	570		2.1
PCB-192	Hepta	PRC	960		2.0	1100		2.2	910		2.0	780		1.8	720		1.9	740		2.1
PCB-204	Octa	PRC	1900		2.0	2100		2.2	1800		2.0	1700		1.8	1500		1.9	1600		2.1
Total Aroclors			#N/A			#N/A			#N/A			7700			7400			10000		

Notes

B: Compound was found in the blank and sample

CI: The peak identified by the data system exhibited chromatographic interference that could not be resolved. There is reason to suspect there may be a high bias

J: Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value

Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			EC3 (5 TO 10)			EC4B			EC5 (0 TO 5)			EC5 (5 TO 10)			EC5-NW BANK-BOTTOM		
	Homolog Group	PRC	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)
PCB-1016			ND		90.0	ND		78.0	ND		280.0	ND		59.0	ND		67.0
PCB-1221			ND		98.0	ND		85.0	ND		280.0	ND		65.0	ND		74.0
PCB-1232			ND		68.0	ND		59.0	ND		280.0	ND		45.0	ND		51.0
PCB-1242			ND		41.0	ND		35.0	ND		280.0	ND		27.0	ND		30.0
PCB-1248			11000		67.0	27000		58.0	12000		280.0	2200		44.0	5000		50.0
PCB-1254			ND		83.0	ND		72.0	ND		280.0	ND		55.0	ND		62.0
PCB-1260			ND		79.0	ND		69.0	ND		280.0	ND		52.0	ND		59.0
PCB-1262			ND		98.0	ND		85.0	ND		280.0	ND		64.0	ND		73.0
PCB-1268			ND		37.0	ND		32.0	ND		280.0	ND		25.0	ND		28.0
PCB-14	Di	PRC	56	J B	2.0	77	J B	2.2	74	J B	250.0	98	J B	2.3	78	J	1.9
PCB-36	Tri	PRC	190	J B	2.0	260	B	2.2	170	J B	250.0	350	B	2.3	1800	B CI	1.9
PCB-78	Tetra	PRC	240		2.0	260		2.2	240	J	250.0	330		2.3	260		1.9
PCB-104	Penta	PRC	280		2.0	250		2.2	210	J	250.0	480		2.3	270		1.9
PCB-121	Penta	PRC	330		2.0	390		2.2	350		250.0	450		2.3	510		1.9
PCB-142	Hexa	PRC	150	J B	2.0	130	J B	2.2	150	J B	250.0	220	J B	2.3	150	J	1.9
PCB-155	Hexa	PRC	240		2.0	210	J	2.2	200	J	250.0	330		2.3	250		1.9
PCB-184	Hepta	PRC	560		2.0	490		2.2	500		250.0	720		2.3	570		1.9
PCB-192	Hepta	PRC	740		2.0	690		2.2	690		250.0	900		2.3	800		1.9
PCB-204	Octa	PRC	1600		2.0	1400		2.2	1500		250.0	1900		2.3	1700		1.9
Total Aroclors			11000			27000			0			2200			0		

Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			EC5-NW BANK-TOP			EC6			EC9 (5 TO 10)			LCO1-MID (0 TO 5)			LCO1-MID (5 TO 10)		
	Homolog Group	PRC	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)	Result (ng/g)	Qualifier	MDL (ng/g)
PCB-1016			ND		110.0	ND		84.0	ND		82.0	ND		59.0	ND		67.000
PCB-1221			ND		120.0	ND		92.0	ND		90.0	ND		65.0	ND		73.000
PCB-1232			ND		83.0	ND		63.0	ND		62.0	ND		44.0	ND		51.000
PCB-1242			ND		50.0	ND		38.0	ND		37.0	ND		27.0	ND		30.000
PCB-1248			4100		83.0	13000		63.0	4300		62.0	16000		44.0	19000		50.000
PCB-1254			ND		100.0	ND		78.0	ND		76.0	ND		55.0	ND		62.000
PCB-1260			ND		97.0	ND		74.0	ND		73.0	ND		52.0	ND		59.000
PCB-1262			ND		120.0	ND		91.0	ND		90.0	ND		64.0	ND		73.000
PCB-1268			ND		46.0	ND		35.0	ND		34.0	ND		24.0	ND		28.000
PCB-14	Di	PRC	54	J	3.0	110	J B	1.9	26	J B	2.3	56	J B	2.4	60	J B	2.300
PCB-36	Tri	PRC	230	J B	3.0	260	B	1.9	740	B	2.3	200	J B	2.4	210	J B	2.300
PCB-78	Tetra	PRC	260	J	3.0	280		1.9	140	J	2.3	310		2.4	290		2.300
PCB-104	Penta	PRC	300		3.0	370		1.9	34	J	2.3	300		2.4	330		2.300
PCB-121	Penta	PRC	420		3.0	520		1.9	210	J	2.3	510		2.4	560		2.300
PCB-142	Hexa	PRC	180	J	3.0	180	J B	1.9	100	J B	2.3	170	J B	2.4	180	J B	2.300
PCB-155	Hexa	PRC	280	J	3.0	270		1.9	100	J	2.3	250		2.4	280		2.300
PCB-184	Hepta	PRC	640		3.0	610		1.9	410		2.3	590		2.4	640		2.300
PCB-192	Hepta	PRC	850		3.0	790		1.9	580		2.3	730		2.4	790		2.300
PCB-204	Octa	PRC	1800		3.0	1700		1.9	1200		2.3	1500		2.4	1700		2.300
Total Aroclors			4100			13000			4300			16000			19000		

Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			MECP71			MECP75			T7A (0 TO 5)			T7A (5 TO 10)			T7C		
	Homolog Group	PRC	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
			(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)
PCB-1016			ND		89.0	ND		81.0	ND		85.0	ND		80.0	ND		82.0
PCB-1221			ND		97.0	ND		89.0	ND		94.0	ND		87.0	ND		90.0
PCB-1232			ND		67.0	ND		61.0	ND		65.0	ND		60.0	ND		62.0
PCB-1242			ND		40.0	ND		37.0	ND		39.0	ND		36.0	ND		37.0
PCB-1248			9800		66.0	8200		61.0	10000		64.0	11000		60.0	7500		61.0
PCB-1254			ND		82.0	ND		75.0	ND		79.0	ND		74.0	ND		76.0
PCB-1260			ND		78.0	ND		72.0	ND		75.0	ND		70.0	ND		72.0
PCB-1262			ND		97.0	ND		89.0	ND		93.0	ND		87.0	ND		89.0
PCB-1268			ND		37.0	ND		34.0	ND		35.0	ND		33.0	ND		34.0
PCB-14	Di	PRC	80	J B	1.9	95	J B	2.0	88	J	2.4	94	J	2.1	110	J	1.9
PCB-36	Tri	PRC	260	B	1.9	280	B	2.0	1800	B CI	2.4	4100	B CI	2.1	370	B	1.9
PCB-78	Tetra	PRC	310		1.9	270		2.0	300		2.4	260		2.1	310		1.9
PCB-104	Penta	PRC	330		1.9	280		2.0	340		2.4	330		2.1	350		1.9
PCB-121	Penta	PRC	430		1.9	340		2.0	410		2.4	420		2.1	380		1.9
PCB-142	Hexa	PRC	180	J B	1.9	140	J B	2.0	170	J	2.4	170	J	2.1	180	J	1.9
PCB-155	Hexa	PRC	290		1.9	240		2.0	290		2.4	280		2.1	290		1.9
PCB-184	Hepta	PRC	670		1.9	550		2.0	660		2.4	660		2.1	680		1.9
PCB-192	Hepta	PRC	890		1.9	780		2.0	890		2.4	910		2.1	920		1.9
PCB-204	Octa	PRC	1800		1.9	1600		2.0	1900		2.4	1900		2.1	1900		1.9
Total Aroclors			9800			8200			10000			11000			7500		

Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			T7D			T8			T8A (0 TO 5)			T8A (5 TO 10)			T8B		
	Homolog Group	PRC	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL	Result	Qualifier	MDL
			(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)	(ng/g)		(ng/g)
PCB-1016			ND		96.0	ND		96.0	ND		84.0	ND		92.0	ND		83.0
PCB-1221			ND		110.0	ND		110.0	ND		92.0	ND		100.0	ND		91.0
PCB-1232			ND		73.0	ND		73.0	ND		63.0	ND		70.0	ND		63.0
PCB-1242			ND		43.0	ND		44.0	ND		38.0	ND		42.0	ND		38.0
PCB-1248			5300		72.0	7000		72.0	5800		63.0	4700		69.0	4000		62.0
PCB-1254			ND		89.0	ND		89.0	ND		78.0	ND		85.0	ND		77.0
PCB-1260			ND		85.0	ND		85.0	ND		74.0	ND		81.0	ND		73.0
PCB-1262			ND		100.0	ND		110.0	ND		91.0	ND		100.0	ND		91.0
PCB-1268			ND		40.0	ND		40.0	ND		35.0	ND		38.0	ND		34.0
PCB-14	Di	PRC	69	J	2.1	70	J	2.1	83	J	2.0	100	J	2.3	96	J	2.1
PCB-36	Tri	PRC	2500	B CI	2.1	1200	B CI	2.1	1700	B CI	2.0	360	B	2.3	2600	B CI	2.1
PCB-78	Tetra	PRC	250		2.1	260		2.1	240		2.0	260		2.3	370		2.1
PCB-104	Penta	PRC	320		2.1	260		2.1	270		2.0	330		2.3	400		2.1
PCB-121	Penta	PRC	320		2.1	340		2.1	320		2.0	330		2.3	390		2.1
PCB-142	Hexa	PRC	150	J	2.1	140	J	2.1	140	J	2.0	160	J	2.3	200	J	2.1
PCB-155	Hexa	PRC	270		2.1	230		2.1	250		2.0	270		2.3	320		2.1
PCB-184	Hepta	PRC	620		2.1	560		2.1	590		2.0	610		2.3	730		2.1
PCB-192	Hepta	PRC	820		2.1	780		2.1	850		2.0	850		2.3	970		2.1
PCB-204	Octa	PRC	1700		2.1	1600		2.1	1800		2.0	1800		2.3	2000		2.1
Total Aroclors			5300			7000			5800			4700			4000		

Table A1. Concentration of analytes in polyethylene  
ECCC, Lyons Creek

Client ID			TRIP BLANKS - AROCLORS		
	Homolog Group	PRC	Result	Qualifier	MDL
			(ng/g)		(ng/g)
PCB-1016			ND		45.0
PCB-1221			ND		49.0
PCB-1232			ND		34.0
PCB-1242			ND		20.0
PCB-1248			ND		33.0
PCB-1254			ND		41.0
PCB-1260			ND		39.0
PCB-1262			ND		49.0
PCB-1268			ND		19.0
PCB-14	Di	PRC	--		--
PCB-36	Tri	PRC	--		--
PCB-78	Tetra	PRC	--		--
PCB-104	Penta	PRC	--		--
PCB-121	Penta	PRC	--		--
PCB-142	Hexa	PRC	--		--
PCB-155	Hexa	PRC	--		--
PCB-184	Hepta	PRC	--		--
PCB-192	Hepta	PRC	--		--
PCB-204	Octa	PRC	--		--
Total Aroclors			0		

**TABLE A2**

Table A2. Elimination Rates (ke) and Percentage to Steady State Reached by Performance Reference Compounds (PRCs) During Deployment  
ECCC, Lyons Creek, ON

Client ID		EC1 (0 TO 5)		EC1 (5 TO 10)		EC3 (0 TO 5)		EC3 (5 TO 10)		EC4B		EC5 (0 TO 5)		EC5 (5 TO 10)		EC5-NW BANK-BOTTOM		EC5-NW BANK-TOP	
PRC	Homolog Group	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State
		(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%
PCB-14	Di	0.0676	86%	0.0686	86%	0.0975	94%	0.0876	92%	0.0766	89%	0.0780	90%	0.0683	86%	0.0762	89%	0.0888	92%
PCB-36	Tri	0.0428	71%	0.0403	69%	0.0514	78%	0.0549	80%	0.0441	72%	0.0587	82%	0.0338	63%	OUTLIER		0.0483	75%
PCB-78	Tetra	0.0309	59%	0.0362	65%	0.0348	64%	0.0362	65%	0.0335	62%	0.0362	65%	0.0253	52%	0.0335	62%	0.0335	62%
PCB-104	Penta	0.0365	65%	0.0474	75%	0.0437	72%	0.0461	74%	0.0500	77%	0.0560	80%	0.0275	55%	0.0474	75%	0.0437	72%
PCB-121	Penta	OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER	
PCB-142	Hexa	0.0151	35%	0.0218	47%	0.0172	39%	0.0194	43%	0.0243	51%	0.0194	43%	0.0062	16%	0.0194	43%	0.0131	32%
PCB-155	Hexa	0.0158	37%	0.0213	46%	0.0184	41%	0.0198	44%	0.0244	51%	0.0261	53%	0.0089	23%	0.0184	41%	0.0145	34%
PCB-184	Hepta	0.0099	25%	0.0149	35%	0.0117	29%	0.0123	30%	0.0169	39%	0.0162	38%	0.0036	10%	0.0117	29%	0.0077	20%
PCB-192	Hepta	0.0082	21%	0.0110	27%	0.0100	25%	0.0100	25%	0.0124	30%	0.0124	30%	0.0033	9%	0.0073	19%	0.0053	14%
PCB-204	Octa	0.0044	12%	0.0088	22%	0.0065	17%	0.0065	17%	0.0111	28%	0.0088	22%	0.0006	2%	0.0044	12%	0.0025	7%

%: percent  
PRC: Performance Reference Compound  
Note: PCB-122 was excluded from calculation as concentrations in all samplers were much higher than expected. See report for additional details.



Table A2. Elimination Rates (ke) and Percentage to Steady State Reached by Performance Reference Compounds (PRCs) During Deployment  
ECCC, Lyons Creek, ON

Client ID		EC6		EC9 (5 TO 10)		LCO1-MID (0 TO 5)		LCO1-MID (5 TO 10)		MECP71		MECP75		T7A (0 TO 5)		T7A (5 TO 10)		T7C		T7D	
PRC	Homolog Group	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State	k <sub>e</sub>	Steady State
		(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%
PCB-14	Di	0.0643	85%	0.1140	96%	0.0876	92%	0.0852	92%	0.0753	89%	0.0694	87%	0.0720	88%	0.0697	87%	0.0643	85%	0.0804	90%
PCB-36	Tri	0.0441	72%	0.0080	21%	0.0531	79%	0.0514	78%	0.0441	72%	0.0415	70%	OUTLIER		OUTLIER		0.0319	60%	OUTLIER	
PCB-78	Tetra	0.0309	59%	0.0548	80%	0.0274	55%	0.0297	58%	0.0274	55%	0.0322	61%	0.0286	56%	0.0335	62%	0.0274	55%	0.0348	64%
PCB-104	Penta	0.0365	65%	0.1188	97%	0.0437	72%	0.0405	69%	0.0405	69%	0.0461	74%	0.0394	68%	0.0405	69%	0.0384	67%	0.0415	70%
PCB-121	Penta	OUTLIER		Outlier	55%	OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER	
PCB-142	Hexa	0.0131	32%	0.0334	62%	0.0151	35%	0.0131	32%	0.0131	32%	0.0218	47%	0.0151	35%	0.0151	35%	0.0131	32%	0.0194	43%
PCB-155	Hexa	0.0158	37%	0.0500	77%	0.0184	41%	0.0145	34%	0.0133	32%	0.0198	44%	0.0133	32%	0.0145	34%	0.0133	32%	0.0158	37%
PCB-184	Hepta	0.0094	24%	0.0231	49%	0.0105	26%	0.0077	20%	0.0061	16%	0.0129	31%	0.0066	18%	0.0066	18%	0.0056	15%	0.0088	23%
PCB-192	Hepta	0.0078	20%	0.0184	41%	0.0105	26%	0.0078	20%	0.0037	10%	0.0082	21%	0.0037	10%	0.0029	8%	0.0025	7%	0.0065	17%
PCB-204	Octa	0.0044	12%	0.0164	38%	0.0088	22%	0.0044	12%	0.0025	7%	0.0065	17%	0.0006	2%	0.0006	2%	0.0006	2%	0.0044	12%

Table A2. Elimination Rates (ke) and Percentage to Steady State Reached by Performance Reference Compounds (PRCs) During Deployment  
ECCC, Lyons Creek, ON

Client ID		T8		T8A (0 TO 5)		T8A (5 TO 10)		T8B	
PRC	Homolog Group	ke	Steady State	ke	Steady State	ke	Steady State	ke	Steady State
		(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%	(d <sup>-1</sup> )	%
PCB-14	Di	0.0799	90%	0.0740	88%	0.0676	86%	0.0690	86%
PCB-36	Tri	OUTLIER		OUTLIER		0.0329	61%	OUTLIER	
PCB-78	Tetra	0.0335	62%	0.0362	65%	0.0335	62%	0.0213	46%
PCB-104	Penta	0.0487	76%	0.0474	75%	0.0405	69%	0.0338	63%
PCB-121	Penta	OUTLIER		OUTLIER		OUTLIER		OUTLIER	
PCB-142	Hexa	0.0218	47%	0.0218	47%	0.0172	39%	0.0095	24%
PCB-155	Hexa	0.0213	46%	0.0184	41%	0.0158	37%	0.0099	25%
PCB-184	Hepta	0.0123	30%	0.0105	26%	0.0094	24%	0.0032	9%
PCB-192	Hepta	0.0082	21%	0.0053	14%	0.0053	14%	0.0007	2%
PCB-204	Octa	0.0065	17%	0.0025	7%	0.0025	7%	OUTLIER	