Lyons Creek East Long-Term Monitoring Plan to Assess Monitored Natural Recovery as an Effective Remediation Strategy: 2015 Survey

Technical Memorandum

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Background

Monitored Natural Recovery (MoNR) with administrative controls to minimize sediment disruption and mobilization was selected as the most appropriate management option for PCB contaminated sediment in Lyons Creek East following the application of the 2007 Canada-Ontario Agreement (COA) Sediment Assessment Framework, and completion of an Ecological Risk Assessment (ERA), and a human health risk assessment (HHRA).

The ERA described marginal risk to three wildlife receptors as a result of consumption of PCB contaminated prey: eastern belted kingfisher, great blue heron, and mink (Golder Associates 2008). Laboratory tests showed that the sediment was toxic to benthic invertebrates (as measured by survival and growth in laboratory bioassays), at some stations within the creek, but toxicity could only be partially explained by PCB contamination (Milani and Grapentine 2006). Notwithstanding the lab toxicity results, the sediment contamination did not alter benthic species composition or density. A community survey and field observations for the HHRA concluded that fish consumption was not occurring in Lyons Creek between the Welland Canal Bypass and the CN railway crossing (i.e., the area with highest PCB sediment contamination) (Dillon Consulting LTD. 2007). However, even if fish were being eaten from this section of the creek, there would be no risk to humans if fish consumption advisories, as provided in the *Guide to Eating Ontario Sport Fish*, were followed.

Given the low to marginal ecological risks, the absence of any ongoing PCB source, and the potential for greater environmental damage if more active sediment management options were employed (e.g., dredging and damage to a Provincially Significant Wetland within the Lyons Creek East watershed), MoNR was identified as the preferred option for this site. Provincial and Federal legislation, Ontario's Endangered Species Act and the Canadian Species at Risk Act, state that habitat should not be disrupted if a species at risk are identified in the area. With 19 species with some form of protected status in the Lyons Creek wetland, more active remediation options could not be considered. Furthermore, disruption of the creek during active remediation would expose receptors to higher concentrations of PCBs in the short term since PCB contamination increases with sediment depth; the highest PCB concentrations are at about 20-40 cm depth based on historical data (Golder Associates 2008) and the current survey. However, given the principles of adaptive management, if MoNR is found to result in limited success, other sediment management options (e.g., *in situ* sorbent amendments) may need to be considered in the future for specific segments of the creek.

Introduction

A commitment to long term monitoring is required as part of any sediment management strategy in order to confirm the success of the selected remedial option at protecting or restoring the environment and protecting human and ecological receptors. Generally, long term monitoring commitments for MoNR differ from other management options in that they also include quantification and evaluation of recovery rates for the contaminants of concern (PCBs in Lyons Creek) in sediment and biota to ensure that management concentration targets and timetables are achieved. For Lyons Creek East however, MoNR was selected with the knowledge that recovery rates would be very slow (Golder 2011), and accordingly, a specific recovery rate for sediment and biota was not identified.

Progress towards reaching the Remedial Action Objective for MoNR in Lyons Creek East: i.e. to reduce PCB exposure to biota, will be measured by achieving target concentrations of PCB in sediment that were based on the outcome of the ERA. In the ERA, the eastern belted kingfisher was identified as the most sensitive receptor, followed by the mink and heron. The ERA estimated that a sediment total PCB concentration protective of the kingfisher was 3.4 *u*g/g. However, following the completion of the ERA, new scientific analysis on the effect of PCBs to mink (Fuchsman et al. 2008), suggested that the toxicity reference value used for mink in the ERA may not have been fully protective of this receptor. Based on this new information, mink were identified as the most sensitive receptor to PCB contamination and the long-term remediation target was updated to protect mink in Lyons Creek East based on a total PCBs concentration of < 1.0 *u*g/g (Welsh 2008; Long Term Monitoring Plan (*in prep.* 2016). This is also the clean-up target set by US EPA for many PCB remediation projects in the United States and was also used locally in the Beaverdams Creek remediation near Thorold, Ontario.

The sediment data from this survey was used to assess whether the Remedial Action Objective and targets of MoNR for Lyons Creek East were being met.

The creek was sub-divided into seven zones based on existing habitat types and/or historical PCB contamination of sediment (Appendix Figure 1). These zones also corresponded with the home range sizes of most of the receptors of interest (i.e. kingfisher, mink, young of the year (YOY) fish). Recovery will be assessed in a step-wise fashion that includes short and long-term targets. The short-term targets refer to intermediate goals to show MoNR is working and long-term targets refer to the final desired state. To determine if targets have been met, the monitoring plan was designed to answer the following hypotheses:

Short-term Sediment Targets:

*(1) Area average total PCB concentrations in surface (**0-3 cm and 0-10 cm**) sediment collected from Zones 1-5 remain the same, or are lower than, mean baseline concentrations identified in the ERA (Zone 1: 4.3 ug/g; Zone 2: 4.0 ug/g; Zone 3: 3.9 ug/g; Zone 4: 2.0 ug/g; Zone 5: 2.2 ug/g).*

*(2) Area average total PCB concentrations in surface (**0-3 cm**) sediment collected from Zones 1-5 are ≦3.4 ug/g to protect the kingfisher.*

With sedimentation of newer cleaner sediment, it is expected that mean PCB concentrations in the surface sediment will decrease through time. In the short term, this may be difficult to observe if only 0-10 cm depth profiles are examined since the expected sedimentation rate is relatively low at approximately 1 cm/year (Golder 2011). PCB concentrations measured between 0-3 cm and 3-6 cm are expected to be lower than PCB concentrations measured from 6-10 cm depth if cleaner sediment is depositing on existing sediment and mixing/bioturbation rates are low. Over time, the PCB concentration in the 0-6 cm and the 6-10 cm profiles should decrease.

Long-term Sediment Targets:

*(1) Area average total PCB concentrations in surface (**0-10 cm**) sediment collected from each of Zones 1-5 decreased so that concentrations in each zone are ≦ 3.4* ug/g *to protect the kingfisher. The top 10 cm are typically identified as the bioturbation layer and mixing can potentially occur throughout this depth. Accordingly, the long-term target should use this depth as an assessment endpoint.*

*(2) Area average total PCB concentrations in surface (**0-3 cm**) sediment collected from each of Zones 1-5 decreased so that concentrations in each zone are ≦1.0 ug/g to protect mink from total PCBs and kingfisher from dioxin-like PCBs.*

*(3) Area average total PCB concentrations in surface (**0-10 cm**) sediment collected from each of Zones 1-5 decreased so that concentrations in each zone are ≦ 1.0 ug/g to protect mink from total PCBs and kingfisher from dioxin-like PCBs.*

Field and Laboratory Methods

Sediment Sampling

Sediment cores were collected October 15th – 21st, 2015 from 32 transects: 29 in Lyons Creek East and 1 transect in each of 3 reference creeks (Tee Creek, Beaver Creek and Ushers Creek) (Appendix Table 1; Appendix Figures 1-1j). At each of the transects

three 10 cm core samples were collected (i.e. 3 stations per transect located at equal distances from bank to bank along the transect). Each of the 3 cores was sectioned into 3 segments: 0-3 cm, 3-6 cm and 6-10 cm. Within each of Zones 1, 3, 4 and 5, one or two transects were selected where one of the cores was sectioned in 10 cm interval for the remaining length of the core. All sediment samples were submitted for analysis of PCB congeners, and total organic carbon (TOC). Particle size was analysed for sediment collected from the station located in the centre of each transect.

The cores were collected either from a boat or by wading, using a hexane-rinsed core tube. Once extruded, each sediment segment was homogenized using a hexane rinse aluminium spoon and bowl and placed in appropriate sample containers for analysis. Samples were kept in the dark and refrigerated/frozen prior to sample submission. All samples were submitted to the MECP Rexdale Laboratory for analysis.

Fish Collection

Young of the year fish were collected in November 2015 by the EMRB Biomonitoring Section. Target fish species were bluntnose minnows and golden shiners based on previous years collections. Depending on the availability of fish, 2 to 6 YOY fish replicates (each a composite of 5-10 fish within the size range of 4.6-8.6 cm) were collected from each of six stations with historical YOY data in Lyons Creek East and one reference station (Tee Creek) representative of a regional creek that was not contaminated with PCBs. All YOY fish samples were submitted for analysis of total PCBs congeners and total lipids in addition to organochlorinated pesticides as part of the routine survey analysis so that data were compatible with other YOY fish projects.

Fish were collected using a 0.60 cm mesh sized seine net, up to 18 m in length with a 2 m collection bag. Smaller sized nets were sometimes used for space restricted areas, and smaller mesh nets were used to follow the bag to shore to catch “swim-throughs” when fish sizes were smaller than usual. Fish were collected by wading into the creek. Length of hauls varied depending on fish quantity, obstacles and macrophyte growth.

Captured fish were placed in hexane-rinsed foil/sterile Whirl-pac bags or amber 5P jars and kept on ice until processed. Immediately after collection, each fish (to a maximum of 15) in each replicate was measured (tip to compressed tail), and each composite was weighed to ensure the quantity requirement for each test parameter was met. Sample bags from the same site were tied together and frozen immediately on dry ice. Longer term storage was at - 40 ^{o}C.

Laboratory Analysis

PCB congeners were analysed in sediment by two-dimensional gas chromatography with electron capture detection (GCxGC-ECD) using OMOE method E3487 (OMOE, 2017). A total of 76 peaks were quantified equating to a total of 79 quantified PCB

congeners (with coelutions). Detection limits ranged from 1 to 5 ng per peak. Particle size and TOC in sediment were analyzed by OMOE methods E3328A and E3142A, respectively (OMOE, 2008ab; described in Richman and Milani, 2010).

The YOY fish samples were analyzed for total-PCB (Aroclor method) using the OMOE method E3136 (OMOE, 2008c; summarized in Richman and Somers, 2010).

Data Analysis

Concentrations of total PCBs representing the top 0-10 cm of the core were calculated by using the data from the 0-3 cm, 3-6 cm and 6-10 cm segments as follows:

$\sum$ [0-3 cm PCB] * 0.3 + [3-6 cm PCB] * 0.3 + [6-10 cm PCB]*0.4

A one-way analysis of variance (ANOVA) was used to compare 2015 mean total PCB concentrations (sum of 55 congeners) between Zones (for sediment and young of the year (YOY) fish), using SigmaPlot™. Sediment data analysis was performed using both $\log_{10}$ transformed data and data corrected for TOC. PCB concentrations were not lipid-normalized prior to the statistical analysis for YOY since the method for determining lipid concentrations is not considered reliable for small-bodied fishes (Awad et al 2012). This is consistent with the approach taken in past studies (Fletcher and Petro, 2005; Milani and Fletcher, 2005).

The mean sediment PCB concentration within a zone was calculated using all samples collected along transects as individual sampling locations (i.e., transect data was not averaged). The mean PCB concentration for YOY within a Zone was based on multiple composite fish samples collected for each Zone. If significant differences were found between Zones, the Holm-Sidak test for multiple comparisons was used to determine which Zones differed. If data failed the Shapiro-Wilk Normality Test or were shown to have significantly different variances (Brown-Forsythe Equal Variance Test), then the Kruskal-Wallis One Way Analysis of Variance on Ranks was performed in place of the ANOVA and a pairwise comparison procedure using Dunn's method was used to determine which Zones differed. The same analytical methods were used to compare YOY total body length and lipid concentrations between Zones and between years and YOY PCB concentrations between years from 2002-2015.

Results and Discussion:

The sediment data collected from the 2015 study was compared with the short and long-term targets described in the Introduction as benchmarks to assess the success of MoNR. In addition to the numerical target for sediment to protect the kingfisher and mink, another more general long-term target is that conditions in the creek do not deteriorate, i.e., PCB concentrations in sediment and biota do not increase through time. To assess this endpoint the 2015 sediment data was compared with the historical

baseline data used in the ERA. However, the average baseline PCB concentration for each contaminated zone reported in the ERA was based on a combination of surface sediment data from three different depths: 0-5 cm, 0-10 cm and 0-25 cm, and hence could have resulted in an over estimation of the surface sediment PCB contamination in 2005 due to the inclusion of deeper sediment. Additionally, there was a lot of variability in total PCB concentrations within each zone in the 2005 dataset resulting in uncertainty associated with mean PCB concentrations. The historical data may not have adequately characterized the spatial heterogeneity of the PCB contamination so total PCB concentrations for some zones may have been underestimated. This makes the comparison between the datasets difficult, and hence the comparison of the 2015 data within a core among the 3 segments analysed will be a better indication of change through time than the comparison between 2015 and 2005 data.

Throughout all 7 zones within Lyons Creek East mean concentrations of total PCBs (regardless of whether it was the top 3 cm or top 10 cm), were greater than total PCBs measured at the 3 reference locations (Tee Creek, Ushers Creek and Beavers Creek), where concentrations were all less than the method detection limit (< 10 ng/g) (Appendix Table 2). For comparison, Milani and Grapentine (2017) reported total PCB concentrations for these three creeks as 42.2 ng/g, 2.1 ng/g and 10.7 ng/g respectively.

Sediment Total PCB Concentrations and Comparisons with Remedial Action Targets

The 2015 data are presented in Appendix Table 2 and summarized in Figures 1-4. A comparison of the mean total PCB concentrations within each zone with the short and long-term remedial action targets is presented in Table 1.

Based on the historical data, the ERA concluded that the distribution of PCBs both longitudinally and with sediment depth indicated that the upstream area, Zones 1-3 (upstream of Highway 140), was the only identified source of PCBs to the downstream areas (Golder Associates 2008). The 2015 data (surface 0-3 cm and 0-10 cm) supported these earlier conclusions with the highest mean concentrations of total PCB present in Zones 1 and 2 (Figures 1 and 2). Total PCB data and TOC corrected data for the 0-3 cm and 0-10 cm depths failed the normality test and the equal variance test ($p>0.05$). Accordingly, the Kruskal-Wallis One Way Analysis of Variance on Ranks was performed followed by pairwise comparisons using Dunn's test. For the total PCB dataset, the Kruskal-Wallis rank test concluded that there was a significant difference between all 7 zones ($p<0.001$); however, the Dunn's test did not identify any zones that were different. Although mean total PCB concentrations decreased with increasing distance downstream, the large variability in PCB concentrations within a zone (Figures 3 and 4) was the likely reason that the pairwise comparison test did not find significant differences among the zones. When the data were corrected for TOC the statistical analysis provided similar results as non-corrected data; however, the Dunn's test did identify significantly higher concentrations for both the 0-3 cm and 0-10 cm segments in Zones 1, 2 and 4 compared to Zone 6. There was a poor relationship between TOC and

PCB concentrations in the sediment for each core segment (r^2 for 0-3 cm, 3-6 cm and 6-10 cm were all <0.19) (Appendix Figure 2) indicating that high PCB contamination was due to a historical source and unrelated to the presence of TOC. In general, TOC as well as particle size distribution was consistent among all stations and depths with little variability (Appendix Table 2). There was no significant difference among stations for TOC for both the 0-3 cm and 0-10 cm depth (ANOVA: F 1.1, p=0.39; F 1.5, p=0.18 respectively). The mean percent silt, sand and clay for the 0-3 cm segment was 64% (SD 5.7%), 11% (SD 10 %) and 26% (SD 5.5%), respectively. The particle size for the top 10 cm was similar to the top 3 cm segment for silt, sand and clay at 64% (SD 4.1%), 9% (SD 7.5 %) and 27% (SD 4.9%), respectively. There was no significant difference in particle size between zones for the 0-3 cm and 0-10 cm segments (p>0.05 in all cases).

Table 1: Status of Zones 1 -7 in Lyons Creek East Concerning Remedial Action Targets

Remedial Action Targets	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Short Term Targets							
*(1) Current mean total PCB concentrations in surface (**0-10 cm**) sediment collected from Zones 1-5 are not greater than mean concentrations identified in the ERA (Zone 1: 4.3 ug/g; Zone 2: 4.0 ug/g; Zone 3: 3.9 ug/g; Zone 4: 2.0 u/g; Zone 5: 2.2 ug/g). (i.e suggests conditions have not deteriorated since the ERA, however if concentrations are greater than historical (e.g. Zone 1 & 2) then it could mean that the zones were not adequately characterized in 2005*	X	X	√	√	√		
*(2) Current mean total PCB concentrations in surface (**0-3 cm**) sediment collected from Zones 1-5 are lower than mean concentrations identified in the ERA (Zone 1: 4.3 ug/g; Zone 2: 4.0 ug/g; Zone 3: 3.9 ug/g; Zone 4: 2.0 u/g; Zone 5: 2.2 ug/g). (i.e. suggests conditions have improved through time.)*	√	√	√	√	√		
*(3) Current mean total PCB concentrations in surface sediment (**0-3 cm**) within zones 1-5 are ≤3.4 ug/g to protect the kingfisher*	X	√	√	√	√		
Long-Term Targets							
*(1) Current mean total PCB concentrations in surface (**0-10 cm**) sediment collected from each of Zones 1-5 are ≤ 3.4 u*g/g *to protect the kingfisher.*	X	X	√	√	√	√	√
*(2) Current mean total PCB concentrations in surface sediment (**0-3 cm**) within zones 1-5 are < 1.0 ug/g to protect the mink.*	X	X	X	X	X	√	√
*(3) Current mean total PCB concentrations in surface sediment (**0-10 cm**) within zones 1-5 are < 1.0 ug/g to protect the mink.*	X	X	X	X	X	√	√

Mean total PCB concentrations in **Zone 1** exceeded most short and long-term remedial action targets: i.e., protection of the kingfisher and subsequently protection of mink for both 0-3 cm and 0-10 cm segments (Table 1; Figures 1 and 2). Additionally, concentrations within the top 10 cm were higher than 2005 baseline concentrations (2015 mean: 10 *u*g/g (SD 12.4 *u*g/g) vs baseline: 4.3 *u*g/g). Since there are no known sources of PCBs to this area, this data suggested that the 2005 baseline assessment did not adequately characterize the contamination in this Zone. Awad et al. (2013) and Milani and Grapentine (2017) also reported higher PCB concentrations in Zone 1 compared with the 2005 assessment. The poor characterization was likely due to the high variability in concentrations within the Zone. Total PCB concentrations ranged from 1.2 *u*g/g to 18 *u*g/g within the top 3 cm, while concentrations were as high as 98 *u*g/g within the top 10 cm (Figures 3-5). Sediment collected from a deeper core had even higher PCB contamination at the 10-20 cm segment and 20-30 cm segment (210 *u*g/g and 340 *u*g/g, respectively) (Figure 6).

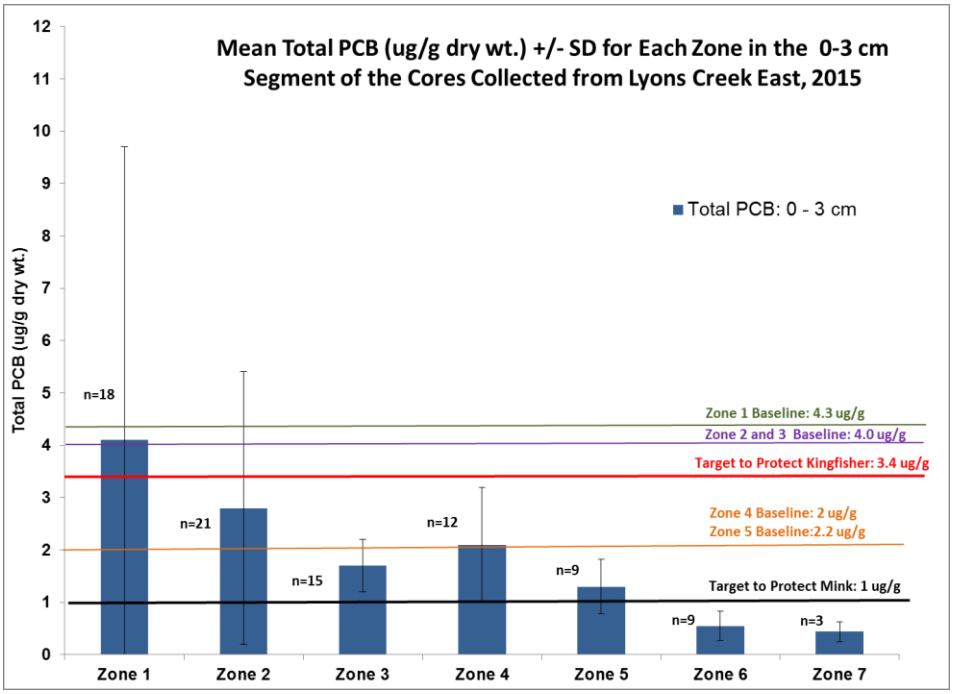


Figure 1: Mean (+/- SD) Total PCBs (ug/g dry wt.) from Zones 1-7 in the 0-3 cm Core Segment, 2015.

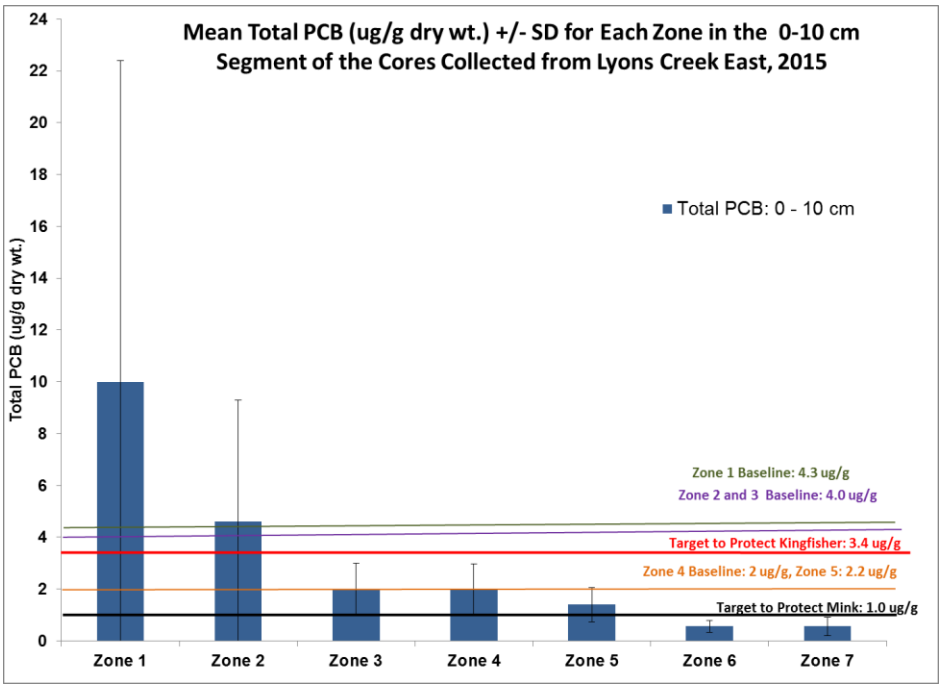


Figure 2: Mean (+/- SD) Total PCBs (ug/g dry wt.) from Zones 1-7 in the 0-10 cm Core Segment, 2015.

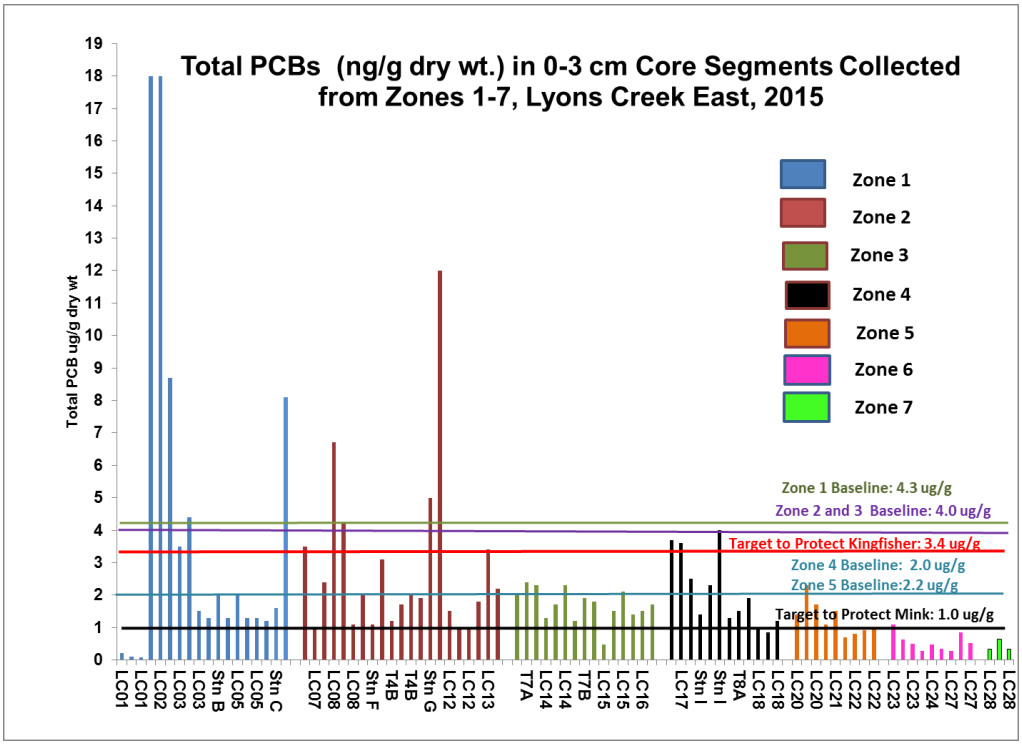


Figure 3: Total PCBs (*ug*/g dry wt.) in 0-3 cm Core Segments Collected from Individual Stations in Zones 1-7, Lyons Creek East, 2015.

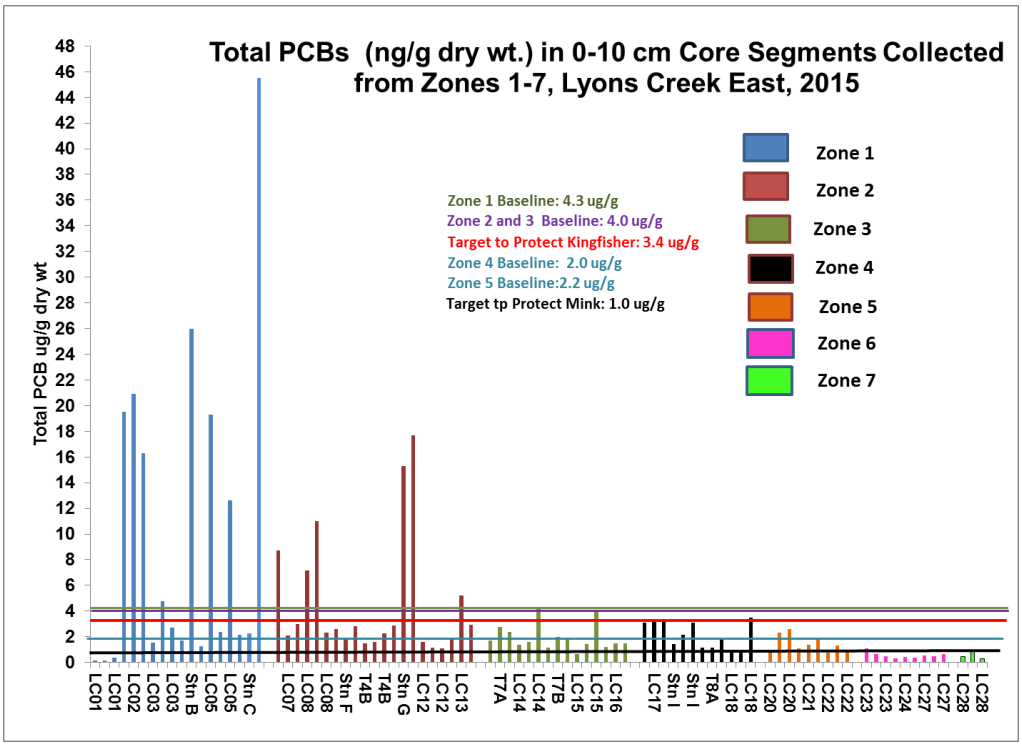


Figure 4: Total PCBs (*ug*/g dry wt.) in 0-10 cm Core Segments Collected from Individual Stations in Zones 1-7, Lyons Creek East, 2015.

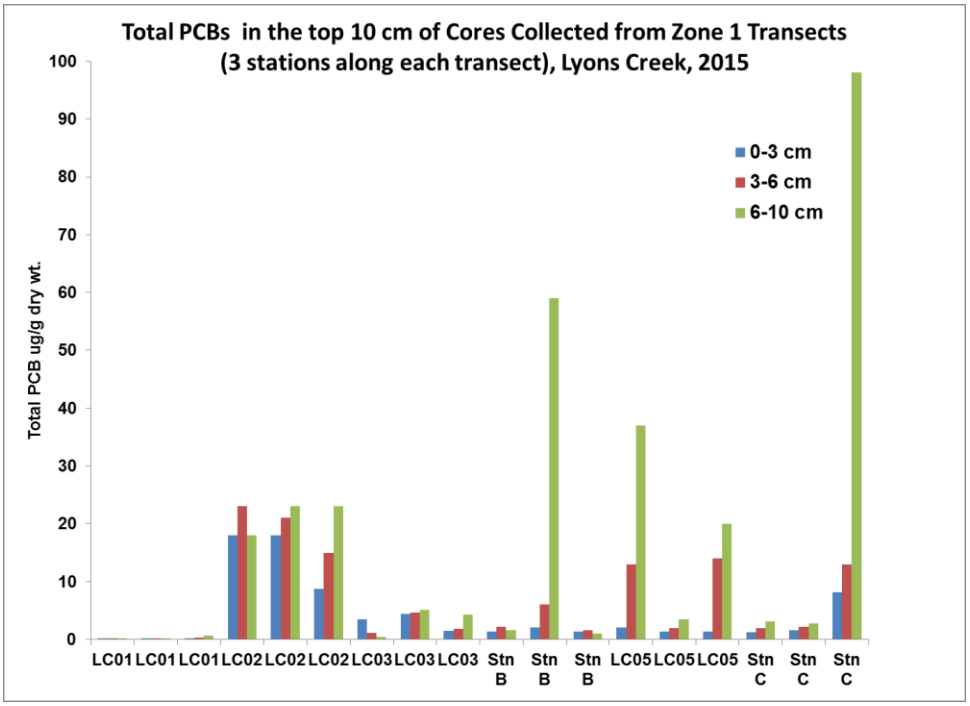


Figure 5: Zone 1 - Total PCB Concentrations (*ug*/g dry wt.) within the 10 cm Core Segments.

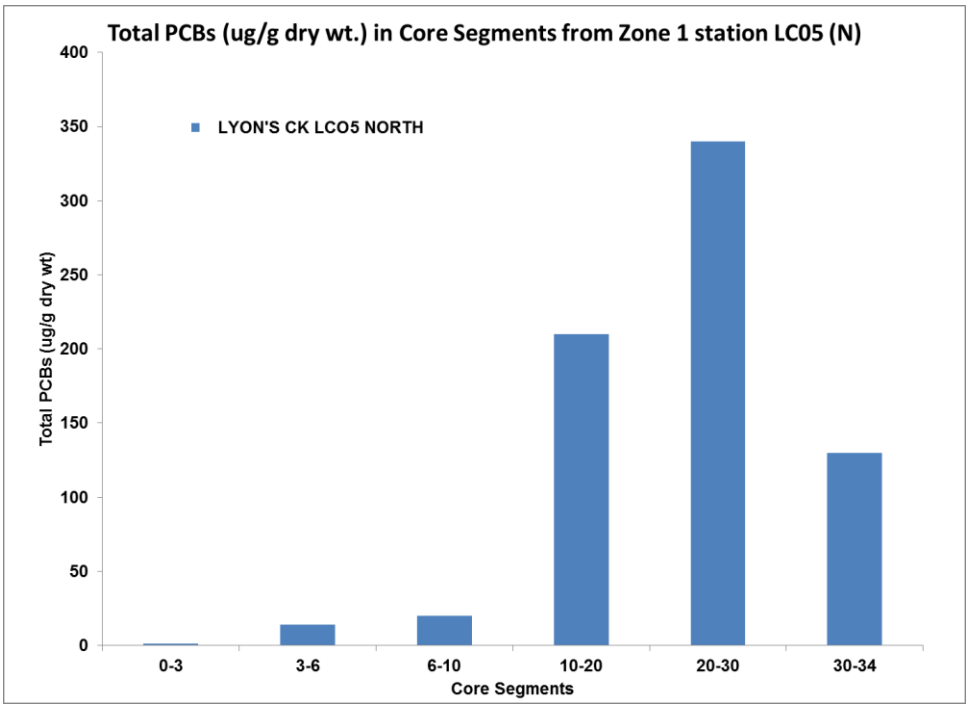


Figure 6: Zone 1 Station LC05 - Total PCB Concentrations (*u*g/g dry wt.) within the Core Segments.

Zone 2 mean total PCB concentrations within the top 10 cm exceeded all short term and long-term targets; concentrations were > the 2005 baseline concentration and the kingfisher and mink targets (Figure 2) with concentrations as high as 18 *u*g/g (Figure 4). This data was consistent with PCB concentrations measured in this zone in 2015 by Milani and Grapentine (2017). The mean surface sediment concentration within the top 3 cm was below the short-term kingfisher target (2.8 *u*g/g vs 3.4 *u*g/g, respectively), indicating signs of natural recovery, although concentrations as high as 12 ug/g were measured in the 0-3 cm sediment at one site in this zone (Figure 3), and as high as 21 *u*g/g in the 6-10 cm segments (Figure 7). In 2010, Awad et al. (2013) reported PCB concentrations as high as 120 *u*g/g in Zone 2 at 10 cm depth.

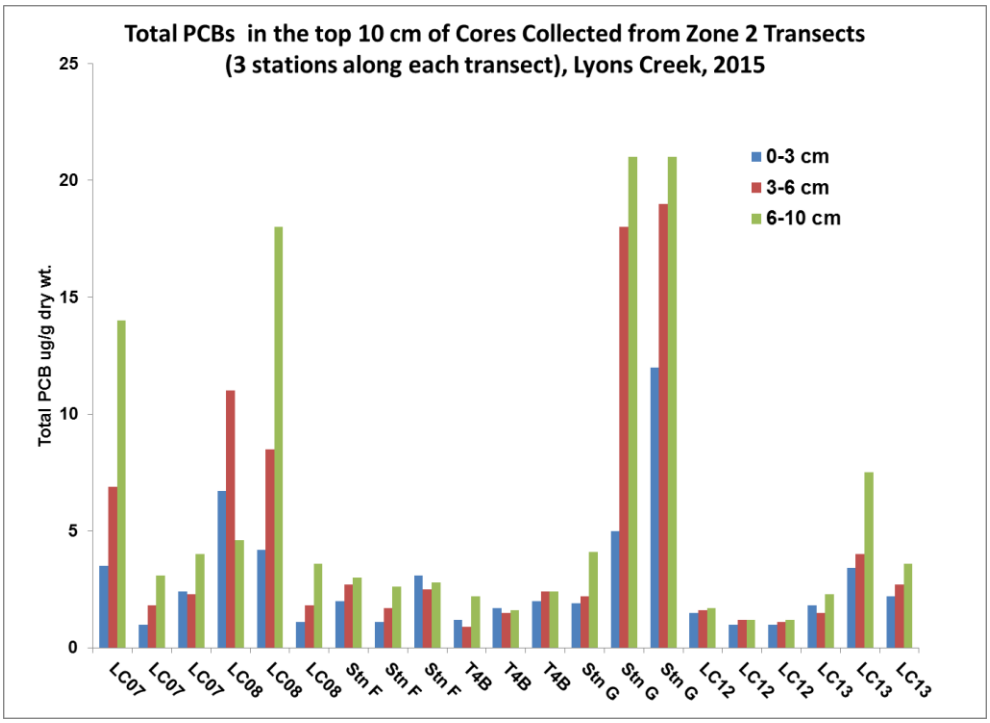


Figure 7: Zone 2 - Total PCB Concentrations (*u*g/g dry wt.) within the 10 cm Core Segments.

For **Zones 3 and 4,** with the exception of a few stations, total PCB concentrations in the 0-3 cm and 0-10 cm segments were below the kingfisher target but did exceed the target for protection of mink (Figures 3 and 4). Mean PCB concentrations for both sediment segments in Zone 3 were also below the 2005 baseline concentration, and for Zone 4, mean concentrations were similar to the 2005 baseline concentration (Figures 1 and 2). For **Zone 5,** total PCB concentrations were below all short- and long-term targets at all stations with the exception of the target for protection of mink (Figures 1-4). Surface sediment total PCB concentrations in **Zones 6 and 7** were below all short and long-term remediation targets (Figures 1-4). Although concentrations were lower than the upstream zones, an impact from the historical contamination is evident when comparing surface concentrations in Zones 6 and 7 with the reference sites which had PCB concentrations that were about 60 times lower (< 0.01 *u*g/g; Appendix Table 2).

Change in PCB Concentrations through Time and Evidence of Effective MoNR

Total PCB concentrations in deeper sediment (3-6 cm and 6-10 cm) were typically, (but not always), higher than at the surface 0-3 cm for Zones 1 and 2 where the highest concentrations of PCBs were present for the study area (Figures 5 - 7). This is evidence of effective MoNR where the more contaminated sediment is being covered by cleaner newly deposited sediment. This is particularly evident at LC05 (a site where the core sectioned past 10 cm) when you compare PCB concentrations at 6-10 cm (20 *u*g/g) to those in the deeper core at 10-20 cm (210 *u*g/g) and 20-30 cm (340 *u*g/g) (Figure 6).

However, Zones 3 and 4 showed little evidence of burial of contaminated sediment within the top 10 cm. With a few exceptions, sediment within the top 10 cm in Zone 3 showed no gradation in PCB concentrations, and within Zone 4 the surface 0-6 cm sediment for most sites (LC18 exception) had higher PCB concentrations than sediment at 6-10 cm (Figures 8 and 9). For Zone 5 only one station along each transect showed less contaminated sediment within the top 3 cm compared with the 6-10 cm segment. When data were corrected for TOC the same patterns remained with only small variations. This data suggested two possible scenarios: first, contaminated sediment from Zones 1 and 2 may be moving downstream and reducing the speed of recovery as evidenced in Zones 3-5 (Figure 10) by the higher PCB concentrations within the top 0-6 cm compared with the 6-10 cm; second, within Zones 3-5, re-suspended sediment is being deposited at specific locations along a transect likely due to creek morphology where obvious burial of contaminated sediment is present, but suspended sediment is also in transition (e.g., where sediment is temporary deposited and then likely eroded) at other sites along the transect where there is no change in PCB concentration at the surface (Figure 10). Interestingly, at selected stations from Zones 3-5 where the cores were sectioned at greater depths (up to 70 cm), the data showed that historical contamination was considerably greater than recent contamination with the highest concentrations buried between 20-40 cm (Figures 11 and 12). However, natural recovery has slowed near the surface at most locations in these three zones; 72% of the samples had either higher PCB concentrations within the 0-6 cm segment compared with the 6-10 cm segment, or there was no change in concentration throughout the top 10 cm.

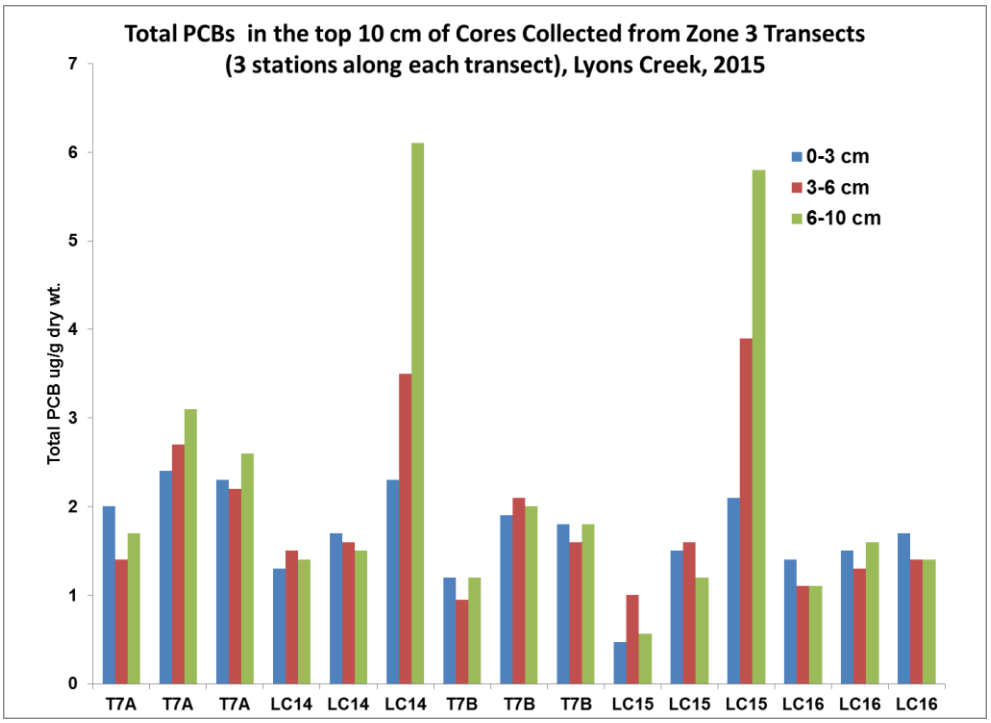


Figure 8: Zone 3 - Total PCB Concentrations (*u*g/g dry wt.) within the 10 cm Core Segments.

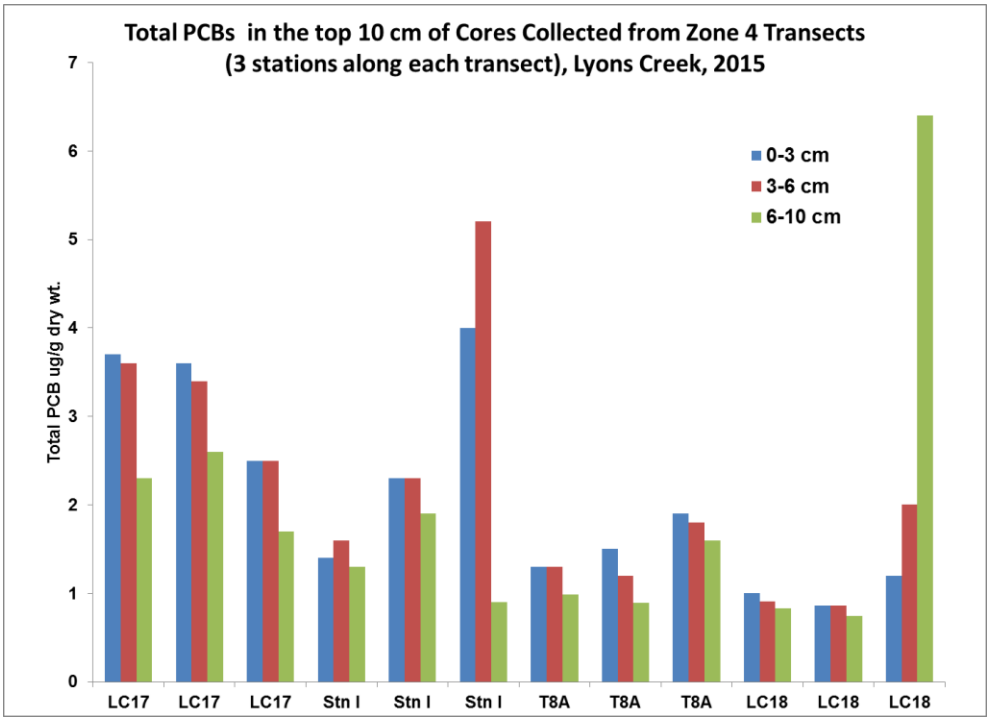


Figure 9: Zone 4 - Total PCB Concentrations (*u*g/g dry wt.) within the 10 cm Core Segments.

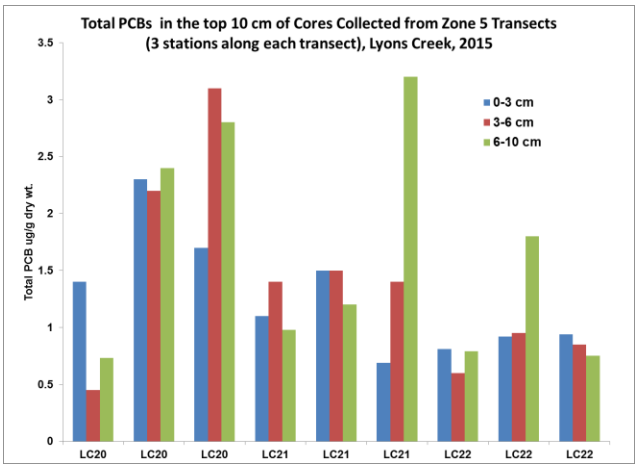


Figure 10: Zone 5 - Total PCB Concentrations (*u*g/g dry wt.) within the 10 cm Core Segments.

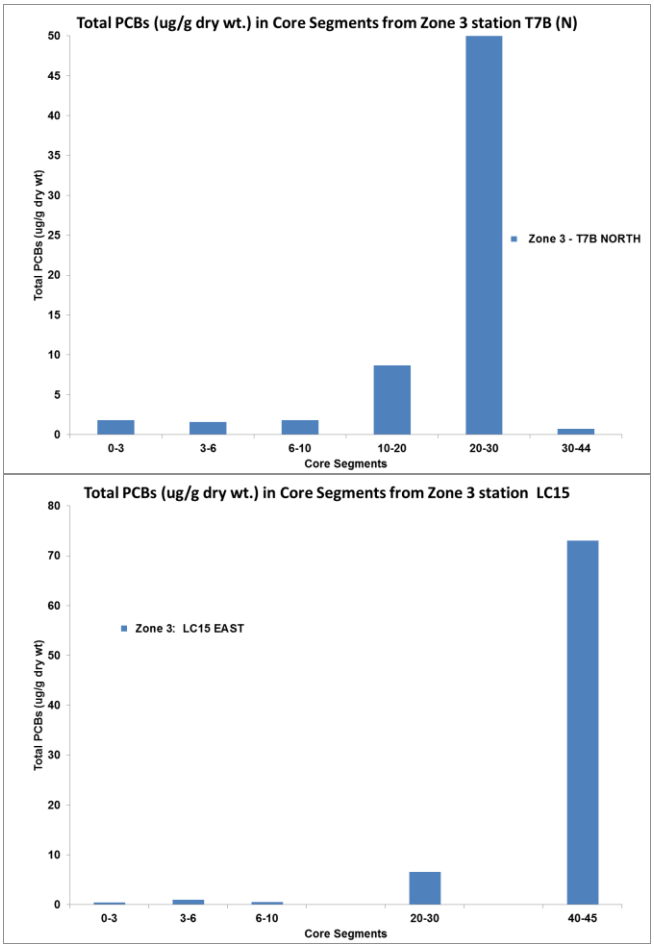


Figure 11: Zone 3 Stations T7B (N) and LC15 - Total PCB Concentrations (*u*g/g dry wt.) within the Core Segments.

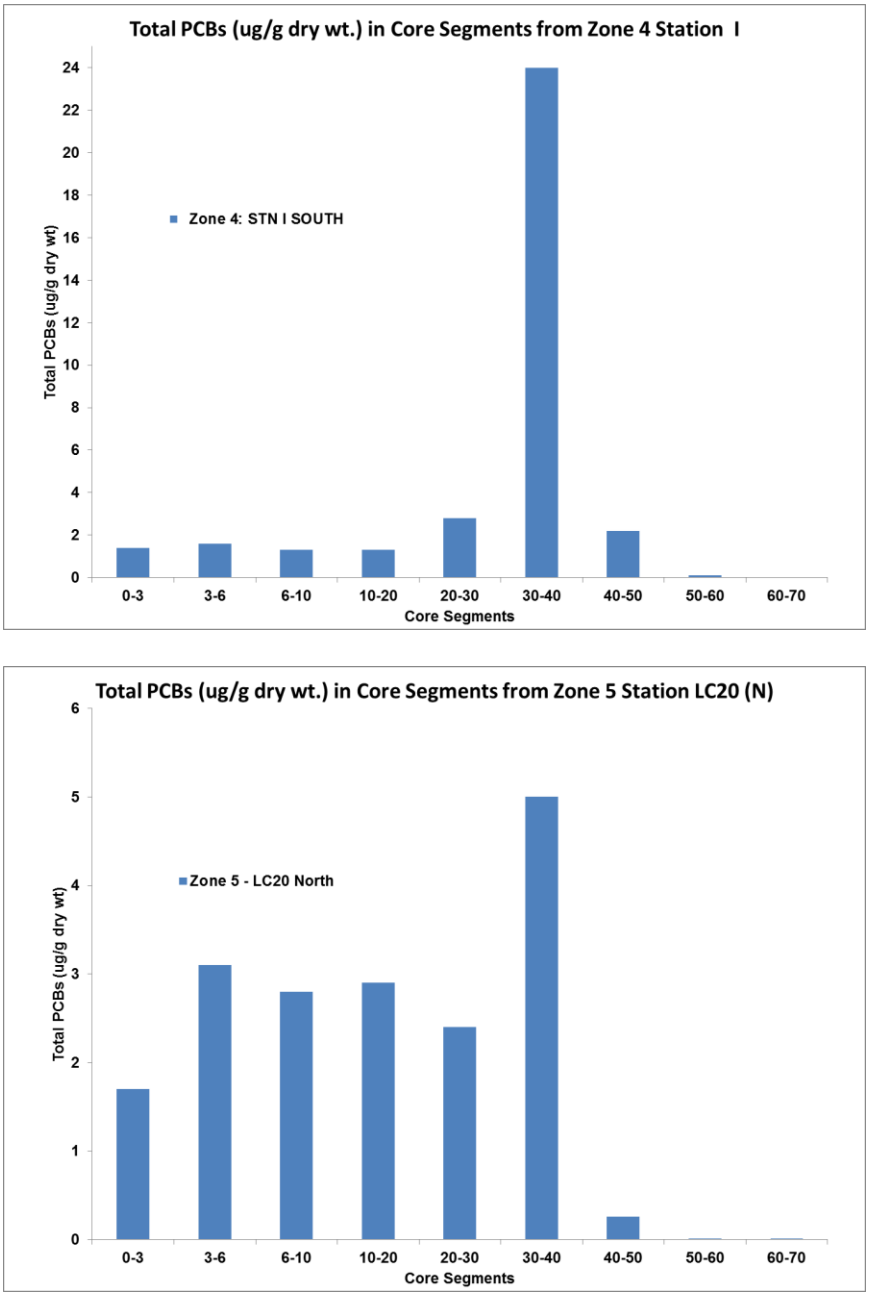
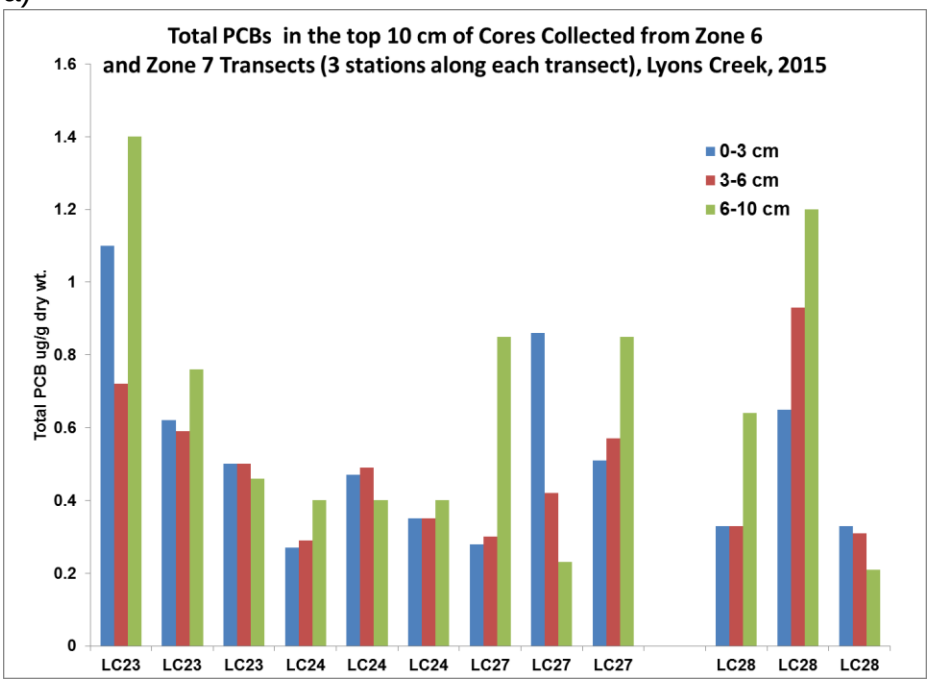


Figure 12: Zone 4: Station I (S) (top panel) and Zone 5 Station LC20 (N) (bottom panel) - Total PCB Concentrations (*u*g/g dry wt.) within the Core Segments.

With a few exceptions, cores collected from Zones 6 and 7 showed higher concentrations of PCBs in the 6-10 cm segment compared with the 0-3 cm surface sediment (Figure 13a) suggesting some impact from historical upstream contamination and subsequent recovery, although concentrations were lower than in Zones 1-5 in general. When the data were corrected for TOC the patterns of contamination were consistent with the non-corrected data (Figure 13b).

a)



b)

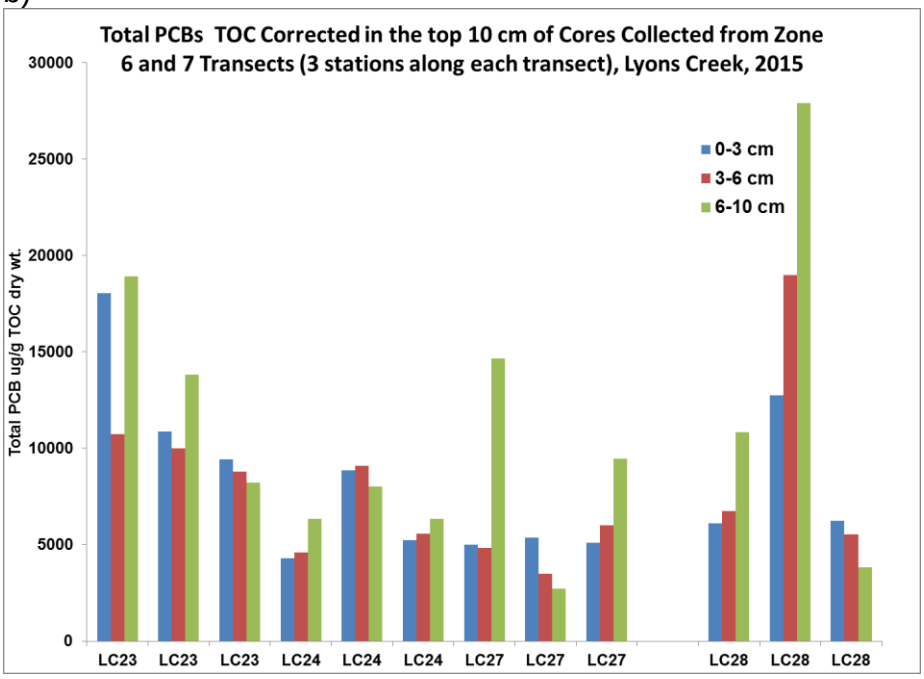


Figure 13: Zones 6 and 7 – a) Total PCB Concentrations within the 10 cm Core Segments; b) Total PCB corrected for TOC.

Sediment Deposition Rates, Recovery and Potential Impacts on Biota PCB Tissue Concentrations.

The construction of the Welland Canal By-pass began in 1967 and was completed by 1971. The By-pass resulted in the severing of Lyons Creek West from Lyons Creek East which resulted in the elimination of the PCB source to Lyons Creek East. Accordingly, using 1970 as the baseline year, maximum PCB contamination would be at least 45 years before the 2015 sediment survey and possibly earlier.

Although this has not been directly measured through sediment transport studies, there appears to be greater sediment deposition within Zones 3-5 than Zone 1 based on the examination of PCB data from the deeper cores and the location of the maximum PCB concentrations within the cores. These cores showed maximum total PCB concentrations in Zone 1 (LC05) at 20-30 cm (Figure 6) while in Zones 3-5 (LC15 (E), T7B (N), Stn I (S) and LC20 (N)), maximum PCB concentrations were present, depending on the core, from 20-45 cm depth (Figures 11 and 12). The recovery of Zone 1 and possibly Zone 2 (data for a deep core is not available) may be slower due to lower deposition rates (or possibly greater erosion before the Welland Canal By-pass was constructed), and higher initial total PCB contamination than the downstream areas. These two factors are likely contributing to the limited decrease in PCB concentrations within the top 10 cm of Zones 3-5 at most stations (despite suspected higher deposition rates downstream).

Golder (2008) estimated deposition rates to be about 1 cm/year, although, as discussed above, this may not be consistent throughout the creek. Assuming the Golder estimate to be correct, the top 10 cm of the cores, which is reflective of the bioturbation layer, represents about 10 years of time. The lack of significant change in PCB sediment concentrations over this time may explain the relatively high PCB concentrations measured in amphipods, chironomids, and oligochaetes collected from Zones 2-5 compared with reference sites in 2015, and lack of change and/or increase in tissue concentrations, dependant on the stations, since 2002 (Milani and Grapentine 2017). In fact, the long cores collected in Zones 4 and 5 showed minimal changes in sediment PCB concentrations throughout the top 20 cm and 30 cm respectively, which could represent the last 20-30 years.

The 2015 YOY Bluntnose Minnow total PCB concentrations were significantly higher in Zones 1-4 (range 1000 – 3000 ng/g) compared to Zones 6 and 7 and the Tee Creek reference station (range 110-380 ng/g) (ANOVA, $p < 0.01$) (Figure 14). YOY PCB concentrations in Zone 6 were also significantly greater than the reference site but were not significantly different than Zone 7. Mean total PCBs in Zone 7 were not significantly different than the mean concentrations in YOY from the reference station ($p=0.17$) using the Dunn's multiple comparison test, although it is noteworthy that the concentrations in Zone 7 (mean 365 ng/g SD 21 ng/g) were, nevertheless, higher than the reference site (mean 146 ng/g; SD 41 ng/g), likely reflecting the higher PCB concentrations in Zone 7 sediment. It is unclear, however, why bluntnose minnow within Zone 1 had significantly

lower tissue PCB concentrations compared with the fish collected from Zones 3 and 4, in spite of the higher sediment mean PCB concentrations within Zone 1. One possible explanation could be that the bluntnose minnow were spending a greater percentage of their time feeding at the west end of Zone 1 which receives inflow from the Welland Canal and where station LC01 has low PCB sediment concentrations.

PCB concentrations in fish from Zones 1-4 were up to 30 times greater than the IJC guideline (100 ng/g) for the protection of fish-eating wildlife. Since fish length among sites were not statistically different (p=0.86), size did not influence PCB tissue concentrations.

For Golden Shiner, the YOY collected from Zone 1 had significantly higher total PCB concentrations (1350 ng/g) than fish collected from the reference creek (20 ng/g; T-test: t=11.9 p< 0.001). Golden Shiners were not collected from the other zones in 2015.

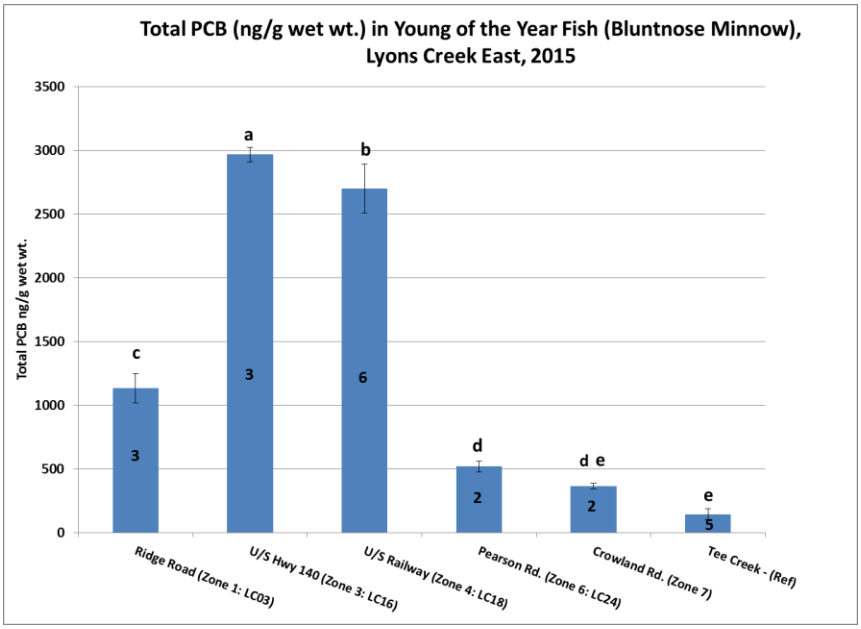


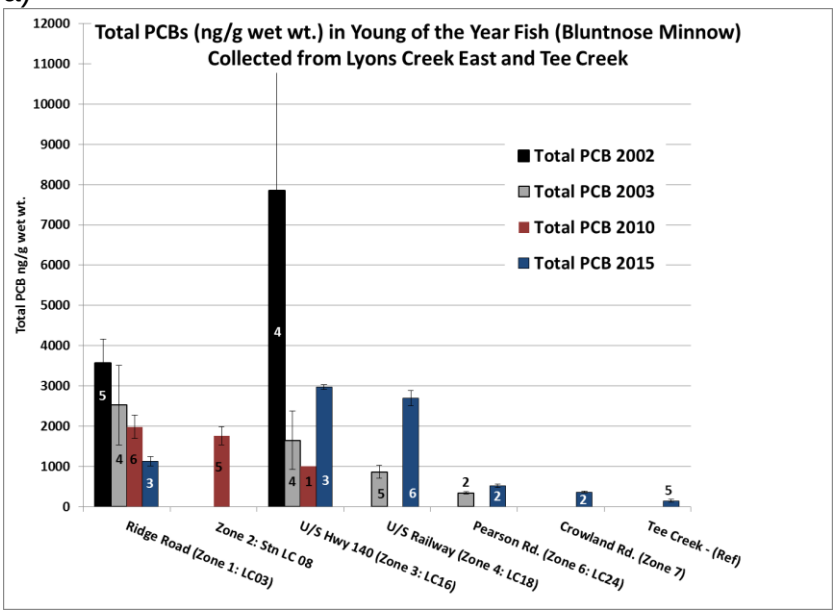
Figure 14: Total PCB (mean ± SD; ng/g wet wt.) in Bluntnose Minnow Collected from Lyons Creek East, 2015. Sample sizes are shown in the bars. Letters above the bars indicate statistical differences among the stations.

With the exception of Zone 1, YOY fish data showed limited improvement in PCB tissue concentrations through time (Figure 15a). Tissue PCB concentrations in bluntnose minnow were consistently lower through time in Zone 1 from 2002 to 2015 which may reflect the lower sediment concentrations in the top 0-3 cm versus the 3-6 cm and 6-10 cm sediment segments, since these fish feed at the sediment surface. Golden shiners collected from the same location did not show a significant difference (p=0.60) between years (Figure 15b), however, this species tends to feed on invertebrates associated with the water column.

In Zones 3 and 4 the 2015 tissue PCB concentrations in bluntnose minnow were greater

than in 2003, and for Zone 3, 2015 concentrations were also greater than in 2010 (Figure 15a). This increase in YOY PCB tissue concentrations mirrored the increase in amphipod PCB concentrations reported for these two zones over the same time period by Milani and Grapentine (2017).

a)



b)

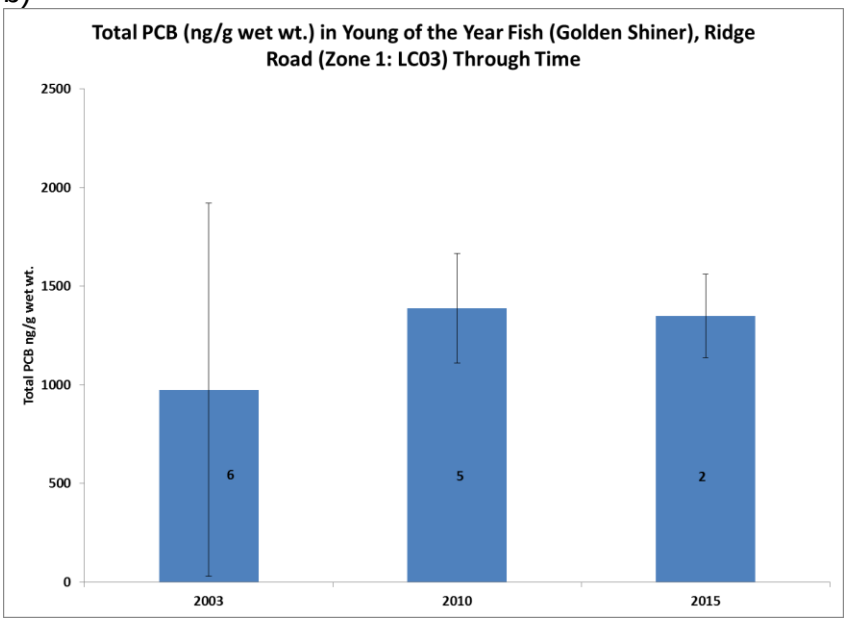


Figure 15: Total PCB (mean ± SD; ng/g wet wt.) in Young of the Year Fish through Time a) Bluntnose Minnow; b) Golden Shiner. Sample sizes are shown in or above the bars.

Since the YOY could have a home range of up to 1 km in either direction of the sampling location, change in PCB tissue concentrations through time was also reviewed by grouping all bluntnose minnow collected from Zones 1 to 4 for each year since these zones had the highest PCB sediment concentrations; these data were compared with the data for bluntnose minnow collected from Zones 6 and 7 combined (Figure 16). The YOY PCB tissue concentration in 2002 was significantly higher than that in 2003-2015 ($p<0.001$); however, there has been no change in concentration from 2003-2015. PCB tissue concentrations within Zones 1-4 have been consistently greater than YOY tissue concentrations in fish collected from Zones 6 and 7.

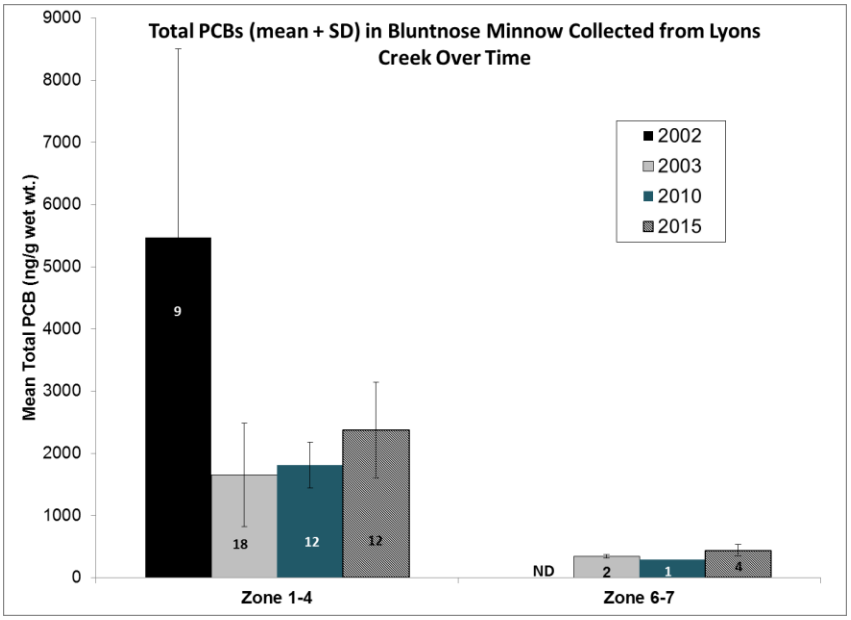


Figure 16: Total PCB (mean ± SD; ng/g wet wt.) in Bluntnose Minnow Collected from Lyons Creek East over time between Zones 1-4 and Zones 6-7. Sample sizes are shown in the bars. ND = no data.

Review of the ERA Sediment Target for the Kingfisher using Current PCB Sediment and YOY Fish Data

The ERA safe sediment PCB target (3.4 *u*g/g) for the Kingfisher (Golder Associates 2008) was re-evaluated since YOY fish tissue PCB concentrations measured in Zones 3 and 4 (described above) were almost two times higher (2967 ng/g) than the ERA safe prey target for the Kingfisher (1699 ng/g), despite mean surface sediment PCB concentrations being below the sediment target. The high fish tissue PCB concentrations indicated the need to reassess the relationship between PCBs in sediment and YOY fish with 2015 data. Additionally, the assumptions used within the ERA were reviewed.

The individual steps of the ERA were followed for each Zone using mean 2015 sediment and YOY data to determine if Risk Quotients (RQ) in 2015 were consistent

with the 2008 ERA. In 2008, risk to the kingfisher was identified in Zones 2 and 3 compared with Zones 1, 2, 3 and 4 using 2015 data. Additionally, the RQ in 2015 for Zone 1 was almost 5 times greater than in 2008 and for Zone 2 and 4 the RQ was at least 2 times greater (Table 2).

Table 2: Summary of Risks to the Kingfisher in Lyons Creek East by Zone - Comparison using Data from the ERA and Data from 2015.

	RQmatc	RQmatc
	Mean 2002/2003/2005 sediment data	Mean 2015 sediment data
	Mean 2002/2003 YOY fish data	Mean 2015 YOY fish data
	BSAF from ERA	2015 BSAF
	0.50	1.05
Zone 1	0.38	1.84
Zone 2	1.18	2.84*
Zone 3	1.16	1.20
Zone 4	0.58	1.26
Zone 5	0.064	No YOY Fish Data Available
Zone 6	0.28	0.35

*2010 YOY data was used since fish were not collected from this zone in 2015

The mean Biota Sediment Accumulation Factor (BSAF) for 2015 for Zones 1-6 was 1.05 compared with the value used in the Golder ERA: BSAF = 0.5. The different BSAFs were important since it was this equation that formed the basis for the calculations of the PCB exposure dose to the kingfisher, and was also used in the ERA to back-calculate the safe sediment target. A higher BSAF will result in a lower sediment target.

In the ERA, exposure of PCBs to the receptor was estimated (e.g. as a dose), and then compared to the PCB toxicity reference value (TRV) in order to calculate the risk to the receptor (Risk Quotient: RQ). Golder (2008) used the average of the maximum acceptable toxicant concentration (MATC) as the TRV by calculating the geometric mean of the lowest effect level (LOAEL) and the no effect level (NOAEL) derived from available literature. For total PCBs, the TRV based on the MATC was 0.5692 mg/kg-day (LOAEL, 1.800 mg/kg-day; NOAEL, 0.180 mg/kg-day). This MATC concentration was then used in the exposure (dose) equation to estimate a “safe prey” concentration, which was then used to back-calculate a “safe sediment target” using the BSAF equation.

1) Using the MATC as the desired PCB dose resulted in a safe prey PCB concentration of 1699 ng/g. This ultimately resulted in the sediment target of 3.4 *u*g/g for the Kingfisher when using the ERA BSAF of 0.5. If you substitute the equations with the current 2015 BSAF (1.05) – the safe sediment target is

lowered to 1.7 *u*g/g.

2) A more conservative approach to an ERA would be to use the NOAEL for the TRV instead of using the MATC. In fact, based on new research for the mink (Fuchsman et al. 2008), this approach was used to recalculate RQs for the mink in Lyons Creek East and revise the safe sediment target for the mink to <1 *u*g/g (Welsh 2008; Lyons Creek Long-term Monitoring Plan (*in prep* 2016). If the NOAEL was used instead of the MATC for the Kingfisher, the safe prey PCB concentration would drop from 1699 ng/g to 537 ng/g. The PCB sediment target that would generate prey with this safe PCB tissue concentration, using the 2015 BSAF, was 0.51 *u*g/g. Both these targets for YOY and sediment are coincidentally consistent with the YOY collected in Zone 6 (520 ng/g wet wt.), and with the current mean sediment concentration in Zones 6 (0.56 *u*g/g). YOY fish in Zone 7 have even lower PCB concentrations at 365 ng/g wet wt. and a mean sediment concentration of 0.56 *u*g/g.

In summary, this reassessment of the ERA using 2015 data suggested that the sediment target of 3.4 *u*g/g, should be lowered to 1.7 *u*g/g if the desired outcome is to reduce YOY PCB tissue concentrations to a safe prey concentration based on the MATC. However, challenging the use of the MATC as the TRV and replacing it with the NOAEL, would result in a sediment target below 1 *u*g/g in Zones 1 – 4, in order to reduce the YOY PCB tissue concentrations to a new safe prey concentration. YOY were not collected from Zone 5, however, the same logic would apply if fish tissue concentrations are elevated.

Although it may be considered conservative, a noteworthy potential long-term objective that is not risk-based (but results in a similar target sediment concentration as the risk based mink target), could be that PCB concentrations in YOY fish are no different than those in fish collected from Zone 7 and/or the reference site (Tee Creek) which suggests that sediment PCB concentrations must be <1*u*g/g. Based on the 2015 dataset, a sediment PCB concentration of < 1 ug/g, is also consistent with the revised ERA results using the NOAEL as the TRV.

Conclusions and Recommendations:

- Consistent with other studies, the 2015 sediment data (surface 0-3 cm and 0-10 cm) showed the highest mean concentrations of total PCB present in Zones 1 and 2.

- Zones 1 and 2 have the largest reservoir of PCBs at the sediment surface (0-3 cm and 0-10 cm) and at depth (>10 cm: up to 340 *u*g/g). Based on sediment core data, deposition rates may be lower in Zones 1 and 2 compared with Zones 3 to 5 suggesting that natural recovery will be slow. Improvements in surface sediment PCB concentrations in Zones 1 and 2 would provide the greatest

benefit to the creek since it would reduce the transport of highly contaminated sediment to downstream areas, and as a result, likely reduce exposure to wildlife.

- Mean total PCB concentrations in Zones 1 and 2 exceeded the 3 remedial action targets for the 0-10 cm sediment: 1) historical baseline concentrations, 2) protection of the kingfisher, and subsequently; 3) protection of mink. The exceedance of historical concentrations suggested that contamination in Zone 1 in particular was underestimated in 2005. However, in Zone 2 the mean surface sediment concentration within the top 3 cm was below the kingfisher target providing evidence of effective natural recovery within Zone 2. Additionally, total PCB concentrations in deeper sediment (3-6 cm and 6-10 cm) were typically higher than at the surface 0-3 cm throughout most of Zones 1 and 2.

- For Zones 3, 4 and 5, the mean total PCB concentrations in the top 0-3 cm and 0-10 cm segments were similar (Zone 4), or below (Zones 3 and 5), their respective 2005 baseline concentrations. In all cases total PCB concentrations were less than the kingfisher target. The successful achievement of all short and one of the long-term targets for baseline concentrations and protection of the kingfisher in these zones is an important milestone. However, surface sediment in these three zones exceeded the target for protection of mink (<1 *u*g/g). Given that PCB concentrations have not decreased significantly in sediment within the top 10 cm for Zone 3 and top 20-30 cm (representing about 20-30 years), for Zone 4 and 5 respectively, it is unclear how long it will take to achieve the target of <1 *u*g/g to protect the mink.

- Although there was little evidence of recent burial of contaminated sediment within the top 10 cm at most stations in Zones 3 to 5, higher contamination in deeper segments of the cores (> 30 cm depth) did indicate that natural recovery had occurred.

- Surface sediment total PCB concentrations in Zones 6 and 7 were below all short and long-term remediation targets.

- The limited decrease in total PCB concentrations within the surface sediment in Zones 3-5, which is reflective of about 10 to 30 years, could explain the lack of a significant change in PCB tissue concentrations in amphipods, chironomids, oligochaetes (Milani and Grapentine 2017) and YOY since 2002 at most stations. Bluntnose minnow PCB tissue concentrations ranged as high as 3000 ng/g.

- The 2008 ERA kingfisher safe sediment target of 3.4 *u*g/g was reassessed since YOY fish tissue PCB concentrations measured in 2015 in Zones 3 and 4 were almost two times higher than the ERA safe prey target for the Kingfisher, despite mean surface sediment PCB concentrations below the sediment target. When the ERA was recalculated with the current sediment and YOY PCB data, the

sediment target was reduced to <1.7 *u*g/g. Using more conservative ERA assumptions to be protective of the kingfisher (i.e. NOAEL replacing the MATC as the TRV), resulted in a safe sediment target concentration of <1.0 *u*g/g consistent with current conditions in Zones 6 and 7 and the safe sediment target for the mink.

- Based on the 2015 sediment and YOY PCB data, the 2008 ERA should be revised for all fish-eating receptors.

- *In Situ* amendments to the sediment surface in Zone 1 and the upstream portion of Zone 2 should be considered, at least at a pilot/bench scale, as a possible remedial option to bind the high concentrations of PCBs and reduce exposure potential to biota with limited disturbance to significant wetlands.

- A detailed sediment survey within Zones 1 and 2 is recommended to better delineate the spatial extent of high PCB concentrations both in the surface sediment and at depth. This information will be essential to assess the feasibility of alternative remedial options for these 2 Zones.

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Appendix Table 1: Lyons Ck E Long Term Monitoring - 2015 Sediment Cores

Zone	Description	MOECC Station #	Water Depth (m)	Longitude DD.ddddddddddd	Latitude DD	MM	Longitude DD.dd	DD	MM	DD.dd	UTM Zone	Northing	Easting
1	LC01 - Lyons Ck @ Outfall N	05 15 0043	0.8	-79.2207389977	42	58	26.67	-79	13	14.66	17	4759473	645087
	LC01 - Lyons Ck @ Outfall Mid	05 15 0044	1.0	-79.2207150254	42	58	26.61	-79	13	14.57	17	4759471	645089
	LC01 - Lyons Ck @ Outfall S	05 15 0045	0.8	-79.2206560168	42	58	26.53	-79	13	14.36	17	4759468	645094
	LC02 - W	05 15 0046	0.5	-79.2202631570	42	58	28.41	-79	13	12.95	17	4759527	645125
	LC02 - Mid	05 15 0047	0.5	-79.2202279530	42	58	28.39	-79	13	12.82	17	4759527	645128
	LC02 - E	05 15 0048	0.3	-79.2201790027	42	58	28.34	-79	13	12.64	17	4759525	645132
	LC03 - Lyons Ck @ Ridge Rd Bridge W	05 15 0049	0.7	-79.2201479897	42	58	28.84	-79	13	12.53	17	4759540	645134
	LC03 - Lyons Ck @ Ridge Rd Bridge Mid	05 15 0050	1.0	-79.2201039847	42	58	28.84	-79	13	12.37	17	4759541	645138
	LC03 - Lyons Ck @ Ridge Rd Bridge E	05 15 0051	0.6	-79.2200640030	42	58	28.80	-79	13	12.23	17	4759539	645141
	StnB - N	05 15 0052	0.3	-79.2199530266	42	58	29.56	-79	13	11.83	17	4759563	645149
	StnB - Mid	05 15 0053	0.4	-79.2199439742	42	58	29.52	-79	13	11.80	17	4759562	645150
	StnB - S	05 15 0054	0.3	-79.2199279647	42	58	29.49	-79	13	11.74	17	4759561	645152
	LC05 - N	05 15 0055	0.5	-79.2194351088	42	58	31.06	-79	13	9.97	17	4759610	645191
	LC05 - Mid	05 15 0056	0.5	-79.2194144893	42	58	30.98	-79	13	9.89	17	4759608	645192
	LC05 - S	05 15 0057	0.2	-79.2193969712	42	58	30.91	-79	13	9.83	17	4759605	645194
	StnC - W	05 15 0058	0.3	-79.2192549817	42	58	31.66	-79	13	9.32	17	4759629	645205
	StnC - Mid	05 15 0059	0.6	-79.2192210350	42	58	31.66	-79	13	9.20	17	4759629	645208
	StnC - E	05 15 0060	0.4	-79.2191859987	42	58	31.62	-79	13	9.07	17	4759628	645211
2	LC07 - N	05 15 0061	0.2	-79.2181550246	42	58	35.49	-79	13	5.36	17	4759749	645292
	LC07 - Mid	05 15 0062	0.5	-79.2181270290	42	58	35.31	-79	13	5.26	17	4759743	645295
	LC07 - S	05 15 0063	0.4	-79.2180820182	42	58	35.23	-79	13	5.10	17	4759741	645298
	LC08 - N	05 15 0064	0.2	-79.2173407227	42	58	36.27	-79	13	2.43	17	4759774	645358
	LC08 - Mid	05 15 0065	0.6	-79.2173500266	42	58	36.17	-79	13	2.46	17	4759772	645357
	LC08 - S	05 15 0066	0.2	-79.2173581570	42	58	36.08	-79	13	2.49	17	4759769	645357
	StnF - N	05 15 0067	0.2	-79.2147910316	42	58	35.82	-79	12	53.25	17	4759765	645566
	StnF - Mid	05 15 0068	0.4	-79.2148000002	42	58	35.66	-79	12	53.28	17	4759760	645566
	StnF - S	05 15 0069	0.5	-79.2148450110	42	58	35.45	-79	12	53.44	17	4759754	645562
	T4B - N	05 15 0070	0.2	-79.2139309645	42	58	36.20	-79	12	50.15	17	4759778	645636
	T4B - Mid	05 15 0071	0.3	-79.2139010411	42	58	35.97	-79	12	50.04	17	4759771	645639
	T4B - S	05 15 0072	0.3	-79.2139000352	42	58	35.75	-79	12	50.04	17	4759764	645639
	StnG - N	05 15 0073	0.2	-79.2131387908	42	58	37.42	-79	12	47.30	17	4759817	645700
	StnG - Mid	05 15 0074	0.2	-79.2130930256	42	58	36.82	-79	12	47.13	17	4759799	645704
	StnG - S	05 15 0075	0.4	-79.2131220270	42	58	36.20	-79	12	47.24	17	4759779	645702
	LC12 - N	05 15 0076	0.4	-79.2104079667	42	58	39.90	-79	12	37.47	17	4759898	645921
	LC12 - Mid	05 15 0077	0.7	-79.2104379740	42	58	39.52	-79	12	37.58	17	4759887	645919
	LC12 - S	05 15 0078	0.5	-79.2104440089	42	58	39.20	-79	12	37.60	17	4759877	645919
	LC13 - N	05 15 0079	0.7	-79.2086679675	42	58	37.30	-79	12	31.20	17	4759821	646065
	LC13 - Mid	05 15 0080	0.5	-79.2086910177	42	58	37.24	-79	12	31.29	17	4759819	646063
	LC13 - S	05 15 0081	0.3	-79.2087470088	42	58	37.08	-79	12	31.49	17	4759815	646058
3	T7A - N	05 15 0082	0.4	-79.2076089978	42	58	38.99	-79	12	27.39	17	4759875	646150
	T7A - Mid	05 15 0083	0.5	-79.2075100075	42	58	38.48	-79	12	27.04	17	4759860	646158
	T7A - S	05 15 0084	0.4	-79.2075260170	42	58	38.09	-79	12	27.09	17	4759848	646157
	LC14 - N	05 15 0085	0.4	-79.2069449835	42	58	40.73	-79	12	25.00	17	4759930	646203
	LC14 - Mid	05 15 0086	0.5	-79.2068820354	42	58	40.22	-79	12	24.78	17	4759915	646208
	LC14 - S	05 15 0087	0.5	-79.2068039998	42	58	39.63	-79	12	24.49	17	4759896	646215
	T7B - N	05 15 0088	0.4	-79.2065940332	42	58	42.10	-79	12	23.74	17	4759973	646231
	T7B - Mid	05 15 0089	0.5	-79.2064299993	42	58	41.59	-79	12	23.15	17	4759958	646244
	T7B - S	05 15 0090	0.6	-79.2062760238	42	58	41.01	-79	12	22.59	17	4759940	646257
	LC15 - W	05 15 0091	0.4	-79.2061350401	42	58	44.95	-79	12	22.09	17	4760062	646266
	LC15 - Mid	05 15 0092	0.8	-79.2060900293	42	58	44.34	-79	12	21.92	17	4760043	646270
	LC15 - Mid (Full Archive)	05 15 0092	0.4	-79.2060559988	42	58	44.50	-79	12	21.80	17	4760048	646273
	LC15 - E	05 15 0093	0.8	-79.2058939766	42	58	44.41	-79	12	21.22	17	4760045	646286
	LC16 - Lyons Ck U/S Hwy 140 W	05 15 0094	0.6	-79.2059239838	42	58	47.51	-79	12	21.33	17	4760141	646282
	LC16 - Lyons Ck U/S Hwy 140 Mid	05 15 0095	0.7	-79.2058460321	42	58	47.22	-79	12	21.05	17	4760132	646288
	LC16 - Lyons Ck U/S Hwy 140 E	05 15 0096	0.4	-79.2056189664	42	58	47.27	-79	12	20.23	17	4760134	646307
4	LC17 - Lyons Ck D/S Hwy 140 N	05 15 0097	0.3	-79.2045090348	42	58	52.29	-79	12	16.23	17	4760291	646394
	LC17 - Lyons Ck D/S Hwy 140 Mid	05 15 0098	0.4	-79.2044449970	42	58	52.22	-79	12	16.00	17	4760289	646399
	LC17 - Lyons Ck D/S Hwy 140 S	05 15 0099	0.2	-79.2044579890	42	58	52.06	-79	12	16.05	17	4760284	646398
	StnI - N	05 15 0100	0.4	-79.2033069860	42	58	55.17	-79	12	11.91	17	4760382	646490
	StnI - Mid	05 15 0101	0.5	-79.2033039685	42	58	54.78	-79	12	11.89	17	4760370	646490
	StnI - S	05 15 0102	0.5	-79.2031860352	42	58	54.44	-79	12	11.47	17	4760360	646500
	T8A - N	05 15 0103	0.4	-79.2024439853	42	58	57.40	-79	12	8.80	17	4760452	646559
	T8A - Mid	05 15 0104	0.4	-79.2023030017	42	58	57.10	-79	12	8.29	17	4760443	646571
	T8A - S	05 15 0105	0.4	-79.2022051010	42	58	56.89	-79	12	7.94	17	4760437	646579
	LC18 - Lyons Ck U/S CN Rail Track N	05 15 0106	0.3	-79.2011290323	42	59	1.51	-79	12	4.06	17	4760581	646663
	LC18 - Lyons Ck U/S CN Rail Track Mid	05 15 0107	0.5	-79.2009939998	42	59	1.17	-79	12	3.58	17	4760571	646675
	LC18 - Lyons Ck U/S CN Rail Track S	05 15 0108	0.6	-79.2009400204	42	59	0.90	-79	12	3.38	17	4760563	646679
5	LC20 - Lyons Ck D/S Buchner Rd N	05 15 0109	0.4	-79.1993055493	42	59	5.40	-79	11	57.50	17	4760704	646809
	LC20 - Lyons Ck D/S Buchner Rd Mid	05 15 0110	0.5	-79.1992830019	42	59	5.29	-79	11	57.42	17	4760701	646811
	LC20 - Lyons Ck D/S Buchner Rd S	05 15 0111	0.3	-79.1992600355	42	59	5.15	-79	11	57.34	17	4760697	646813
	LC21 - Lyons Ck Between Doans Ridge Rd and Buchner Rd N	05 15 0112	0.3	-79.1934219562	42	59	20.31	-79	11	36.32	17	4761175	647279
	LC21 - Lyons Ck Between Doans Ridge Rd and Buchner Rd Mid	05 15 0113	0.5	-79.1934049409	42	59	20.24	-79	11	36.26	17	4761172	647281
	LC21 - Lyons Ck Between Doans Ridge Rd and Buchner Rd S	05 15 0114	0.6	-79.1933890991	42	59	20.16	-79	11	36.20	17	4761170	647282
	LC22 - Lyons Ck U/S Doans Ridge Rd N	05 15 0115	0.3	-79.1857950110	42	59	32.87	-79	11	8.86	17	4761575	647893
	LC22 - Lyons Ck U/S Doans Ridge Rd Mid	05 15 0116	0.2	-79.1857019719	42	59	32.50	-79	11	8.53	17	4761564	647901
	LC22 - Lyons Ck U/S Doans Ridge Rd S	05 15 0117	0.4	-79.1855200008	42	59	31.83	-79	11	7.87	17	4761544	647916
6	LC23 - Lyons Ck D/S Doans Ridge Rd N	05 15 0118	0.3	-79.1838599648	42	59	36.32	-79	11	1.90	17	4761685	648048
	LC23 - Lyons Ck D/S Doans Ridge Rd Mid	05 15 0119	0.3	-79.1838832665	42	59	36.18	-79	11	1.98	17	4761681	648046
	LC23 - Lyons Ck D/S Doans Ridge Rd S	05 15 0120	0.3	-79.1838990245	42	59	36.03	-79	11	2.04	17	4761676	648045
	LC24 - Lyons Ck U/S Pearson Rd N	05 15 0121	0.4	-79.1796939913	42	59	42.42	-79	10	46.90	17	4761881	648384
	LC24 - Lyons Ck U/S Pearson Rd Mid	05 15 0122	0.5	-79.1795919836	42	59	42.20	-79	10	46.53	17	4761874	648392
	LC24 - Lyons Ck U/S Pearson Rd S	05 15 0123	0.3	-79.1795349866	42	59	41.85	-79	10	46.33	17	4761864	648397
	LC27 - N	05 15 0124	0.3	-79.1688169632	42	59	44.63	-79	10	7.74	17	4761968	649269
	LC27 - Mid	05 15 0125	0.5	-79.1688260157	42	59	44.44	-79	10	7.77	17	4761963	649268
	LC27 - S	05 15 0126	0.1	-79.1688120179	42	59	44.28	-79	10	7.72	17	4761958	649270
7	LC28 - Lyons Ck @ McKenny Rd N	05 15 0127	0.3	-79.1643639095	42	59	47.68	-79	9	51.71	17	4762070	649630
	LC28 - Lyons Ck @ McKenny Rd Mid	05 15 0128	0.5	-79.1643647477	42	59	47.48	-79	9	51.71	17	4762064	649630
	LC28 - Lyons Ck @ McKenny Rd S	05 15 0129	0.3	-79.1643670108	42	59	47.28	-79	9	51.72	17	4762058	649630
Ref	Ushers Ck Mid	05 15 0131	0.6	-79.0223349910	43	3	1.51	-79	1	20.41	17	4768313	661067
	Beavers Ck NW	05 15 0133	0.5	-79.0353639890	42	57	21.01	-79	2	7.31	17	4757784	660251
	Beavers Ck Mid	05 15 0134	0.8	-79.0353120212	42	57	20.90	-79	2	7.12	17	4757781	660256
	Beavers Ck SE	05 15 0135	0.6	-79.0352729615	42	57	20.71	-79	2	6.98	17	4757775	660259
	Tee Ck W	05 15 0136	0.5	-79.1121419705	43	0	26.04	-79	6	43.71	17	4763348	653860
	Tee Ck Mid	05 15 0137	0.5	-79.1121274699	43	0	26.04	-79	6	43.66	17	4763348	653861
	Tee Ck E	05 15 0138	0.5	-79.1121109575	43	0	26.04	-79	6	43.60	17	4763348	653863

Appendix Table 2: Total PCB Concentrations in Sediment Collected from Lyons Creek East, 2015

Sample Number	MOECC Station Number	Site	Description	Zone	Core Segment	Total PCB ng/g dry wt.	Total PCB ng/g dry wt. 0-10 cm	Transect Mean ng/g dry wt.	SD	Zone Mean ng/g dry wt.	SD	**Zone Mean** *u* g/g dry wt.	**SD**	TOC (%)	Total PCB TOC Corrected ng/g TOC dry wt.	Silt %	Sand %	Clay %
GL151566	500150043	LC01	LYON'S CK AT OUTFALL NORTH LC01	Zone 1	0-3	220								3.7	5946			
GL151567	500150043		LYON'S CK AT OUTFALL NORTH LC01	Zone 1	3-6	140								3.9	3590			
GL151568	500150043		LYON'S CK AT OUTFALL NORTH LC01	Zone 1	6-10	120	156							3.5	3429			
GL151563	500150044		LYON'S CK AT OUTFALL MID LC01	Zone 1	0-3	98								2.7	3630	65.1	5.6	29.3
GL151564	500150044		LYON'S CK AT OUTFALL MID LC01	Zone 1	3-6	210								2.8	7500	62.3	0.3	37.4
GL151565	500150044		LYON'S CK AT OUTFALL MID LC01	Zone 1	6-10	190	168							2.7	7037	63	6.2	30.8
GL151560	500150045		LYON'S CK AT OUTFALL SOUTH LC01	Zone 1	0-3	78								3	2600			
GL151561	500150045		LYON'S CK AT OUTFALL SOUTH LC01	Zone 1	3-6	310								3.4	9118			
GL151562	500150045		LYON'S CK AT OUTFALL SOUTH LC01	Zone 1	6-10	620	364	230	117					2.8	22143			
GL151551	500150048	LC02	LYON'S CK LC02 EAST	Zone 1	0-3	18000								12	150000			
GL151552	500150048		LYON'S CK LC02 EAST	Zone 1	3-6	23000								14	164286			
GL151553	500150048		LYON'S CK LC02 EAST	Zone 1	6-10	18000	19500							14	128571			
GL151554	500150047		LYON'S CK LC02 MID	Zone 1	0-3	18000								7.1	253521	61.5	16.3	22.2
GL151555	500150047		LYON'S CK LC02 MID	Zone 1	3-6	21000								6	350000	61.1	17.4	21.5
GL151556	500150047		LYON'S CK LC02 MID	Zone 1	6-10	23000	20900							6.5	353846	55.7	20.8	23.5
GL151557	500150046		LYON'S CK LC02 WEST	Zone 1	0-3	8700								6.7	129851			
GL151558	500150046		LYON'S CK LC02 WEST	Zone 1	3-6	15000								7.2	208333			
GL151559	500150046		LYON'S CK LC02 WEST	Zone 1	6-10	23000	16310	18903	2352					7.4	310811			
GL151511	500150051	LC03	LYON'S CK AT RIDGE RD BRIDGE EAST LC03	Zone 1	0-3	3500								7.4	47297			
GL151512	500150051		LYON'S CK AT RIDGE RD BRIDGE EAST LC03	Zone 1	3-6	1100								3.4	32353			
GL151513	500150051		LYON'S CK AT RIDGE RD BRIDGE EAST LC03	Zone 1	6-10	430	1552							4.5	9556			
GL151514	500150050		LYON'S CK ATRIDGE RD BRIDGE MID LC03	Zone 1	0-3	4400								6.1	72131	66.1	9.9	24
GL151515	500150050		LYON'S CK ATRIDGE RD BRIDGE MID LC03	Zone 1	3-6	4600								5.9	77966	65	6.8	28.2
GL151516	500150050		LYON'S CK ATRIDGE RD BRIDGE MID LC03	Zone 1	6-10	5100	4740							6	85000	60.7	13.7	25.6
GL151517	500150049		LYON'S CK AT RIDGE RD BRIDGE WEST LC03	Zone 1	0-3	1500								5.1	29412			
GL151518	500150049		LYON'S CK AT RIDGE RD BRIDGE WEST LC03	Zone 1	3-6	1800								6.1	29508			
GL151519	500150049		LYON'S CK AT RIDGE RD BRIDGE WEST LC03	Zone 1	6-10	4300	2710	3001	1614					5.6	76786			
GL151548	500150052	STN B	LYON'S CK STN B NORTH	Zone 1	0-3	1300								12	10833			
GL151549	500150052		LYON'S CK STN B NORTH	Zone 1	3-6	2200								11	20000			
GL151550	500150052		LYON'S CK STN B NORTH	Zone 1	6-10	1600	1690							6	26667			
GL151545	500150053		LYON'S CK STN B MID	Zone 1	0-3	2000								3.9	51282	60	15.4	24.6
GL151546	500150053		LYON'S CK STN B MID	Zone 1	3-6	6000								4.5	133333	53.5	23.7	22.8
GL151547	500150053		LYON'S CK STN B MID	Zone 1	6-10	59000	26000							8.8	670455	58.9	9.1	32
GL151533	500150054		LYON'S CK STN B SOUTH	Zone 1	0-3	1300								4.4	29545			
GL151534	500150054		LYON'S CK STN B SOUTH	Zone 1	3-6	1600								6.2	25806			
GL151535	500150054		LYON'S CK STN B SOUTH	Zone 1	6-10	950	1250	9647	14164					3.4	27941			
GL151527	500150055	LC05	LYON'S CK LCO5 NORTH	Zone 1	0-3	1300								10	13000			
GL151528	500150055		LYON'S CK LCO5 NORTH	Zone 1	3-6	14000								8.4	166667			
GL151529	500150055		LYON'S CK LCO5 NORTH	Zone 1	6-10	20000	12590							11	181818			
GL151530	500150055		LYON'S CK LCO5 NORTH	Zone 1	10-20	210000								19	1105263	48.1	32.8	19
GL151531	500150055		LYON'S CK LCO5 NORTH	Zone 1	20-30	340000								16	2125000	62.9	3.3	33.8
GL151532	500150055		LYON'S CK LCO5 NORTH	Zone 1	30-34	130000								12	1083333			
GL151524	500150056		LYON'S CK LCO5 MID	Zone 1	0-3	1300								5.2	25000	62.4	12.7	24.9
GL151525	500150056		LYON'S CK LCO5 MID	Zone 1	3-6	1900								6.3	30159	54.5	28.7	16.8
GL151526	500150056		LYON'S CK LCO5 MID	Zone 1	6-10	3500	2360							6.4	54688	61	20.2	18.8
GL151521	500150057		LYON'S CK LCO5 SOUTH	Zone 1	0-3	2000								6.6	30303			
GL151522	500150057		LYON'S CK LCO5 SOUTH	Zone 1	3-6	13000								7.6	171053			
GL151523	500150057		LYON'S CK LCO5 SOUTH	Zone 1	6-10	37000	19300	11417	8531					8.8	420455			
	500150060	STN C	LYON'S CK-STN C EAST	Zone 1	0-3	1200								4.6	26087			
	500150060		LYON'S CK-STN C EAST	Zone 1	3-6	1900								5.7	33333			
	500150060		LYON'S CK-STN C EAST	Zone 1	6-10	3100	2170							6.6	46970			
	500150059		LYON'S CK-STN C MID	Zone 1	0-3	1600								5.2	30769	64.8	12.6	22.6
	500150059		LYON'S CK-STN C MID	Zone 1	3-6	2200								6.6	33333	52	32.5	15.5
	500150059		LYON'S CK-STN C MID	Zone 1	6-10	2800	2260							7.2	38889	52.6	32.5	14.9
	500150058		LYON'S CK-STN C WEST	Zone 1	0-3	8100								9.9	81818	56.1	27.5	16.4
	500150058		LYON'S CK-STN C WEST	Zone 1	3-6	13000								9	144444			
	500150058		LYON'S CK-STN C WEST	Zone 1	6-10	98000	45530	16653	25008	9975	12424	10.0	12.4	11	890909			

Sample	MOECC Station	Site Description		Zone	Core	Total PCB	Total PCB	Transect		Zone		**Zone**		TOC (%)	Total PCB	Silt %	Sand %	Clay %
					Segment			Mean	SD	Mean	SD	**Mean**	**SD**		TOC Corrected			
Number	Number					ng/g dry wt.	ng/g dry wt.	ng/g dry wt.		ng/g dry wt.		***u* g/g dry wt.**			ng/g TOC dry wt.			
							0-10 cm											
GL151456	500150061	LC07	LYON'S CK - LC07 NORTH	Zone 2	0-3	990								10	9900			
GL151457	500150061		LYON'S CK - LC07 NORTH	Zone 2	3-6	1800								5.6	32143			
GL151458	500150061		LYON'S CK - LC07 NORTH	Zone 2	6-10	3100	2077							8.6	36047			
	500150062		LYON'S CK-LC07 MID	Zone 2	0-3	2400								6.7	35821	67.5	12.2	20.3
	500150062		LYON'S CK-LC07 MID	Zone 2	3-6	2300								6.5	35385	65.6	14.7	19.7
	500150062		LYON'S CK-LC07 MID	Zone 2	6-10	4000	3010							7.5	53333	66.8	12.3	20.9
GL151453	500150063		LYON'S CK - LC07 SOUTH	Zone 2	0-3	3500								6.2	56452			
GL151454	500150063		LYON'S CK - LC07 SOUTH	Zone 2	3-6	6900								7.3	94521			
GL151455	500150063		LYON'S CK - LC07 SOUTH	Zone 2	6-10	14000	8720	4602	3596					6.5	215385			
	500150064	LC08	LYON'S CK-LC08 NORTH	Zone 2	0-3	1100								5.9	18644			
	500150064		LYON'S CK-LC08 NORTH	Zone 2	3-6	1800								6.4	28125			
	500150064		LYON'S CK-LC08 NORTH	Zone 2	6-10	3600	2310							7	51429			
	500150065		LYON'S CK-LC08 MID	Zone 2	0-3	4200								5.9	71186	66.9	10.2	22.8
	500150065		LYON'S CK-LC08 MID	Zone 2	3-6	8500								6.8	125000	65.3	10.1	24.6
	500150065		LYON'S CK-LC08 MID	Zone 2	6-10	18000	11010							6.7	268657	65.3	3.2	31.5
	500150066		LYON'S CK-LC08 SOUTH	Zone 2	0-3	6700								9.8	68367			
	500150066		LYON'S CK-LC08 SOUTH	Zone 2	3-6	11000								11	100000			
	500150066		LYON'S CK-LC08 SOUTH	Zone 2	6-10	4600	7150	6823	4359					18	25556			
	500150067	STN F	LYON'S CK-STN F NORTH	Zone 2	0-3	3100								12	25833			
	500150067		LYON'S CK-STN F NORTH	Zone 2	3-6	2500								12	20833			
	500150067		LYON'S CK-STN F NORTH	Zone 2	6-10	2800	2800							11	25455			
GL151572	500150068		LYON'S CK STN F MID	Zone 2	0-3	2000								5.5	36364	68.5	3.7	27.8
GL151573	500150068		LYON'S CK STN F MID	Zone 2	3-6	2700								5.7	47368	66.9	8.8	24.3
GL151574	500150068		LYON'S CK STN F MID	Zone 2	6-10	3000	2610							6.2	48387	68.7	3.2	28.1
GL151569	500150069		LYON'S CK STN F SOUTH	Zone 2	0-3	1100								6.6	16667			
GL151570	500150069		LYON'S CK STN F SOUTH	Zone 2	3-6	1700								7.4	22973			
GL151571	500150069		LYON'S CK STN F SOUTH	Zone 2	6-10	2600	1880	2430	486					6.9	37681			
	500150070	T4B	LYON'S CK-T4B NORTH	Zone 2	0-3	2000								8.9	22472			
	500150070		LYON'S CK-T4B NORTH	Zone 2	3-6	2400								11	21818			
	500150070		LYON'S CK-T4B NORTH	Zone 2	6-10	2400	2280							11	21818			
	500150071		LYON'S CK-T4B MID	Zone 2	0-3	1700								9.8	17347	61.3	20.6	18.1
	500150071		LYON'S CK-T4B MID	Zone 2	3-6	1500								9.7	15464	57.7	24.8	17.5
	500150071		LYON'S CK-T4B MID	Zone 2	6-10	1600	1600							9.1	17582	59.6	20.3	20.1
	500150072		LYON'S CK-T4B SOUTH	Zone 2	0-3	1200								7.3	16438			
	500150072		LYON'S CK-T4B SOUTH	Zone 2	3-6	880								6.9	12754			
	500150072		LYON'S CK-T4B SOUTH	Zone 2	6-10	2200	1504	1795	423					6.9	31884			
	500150073	STN G	LYON'S CK-STN G NORTH	Zone 2	0-3	5000								8.7	57471	66.6	11.9	21.5
	500150073		LYON'S CK-STN G NORTH	Zone 2	3-6	18000								9.6	187500	66.7	10	23.3
	500150073		LYON'S CK-STN G NORTH	Zone 2	6-10	21000	15300							10	210000	64.7	9	26.3
	500150074		LYON'S CK-STN G MID	Zone 2	0-3	1900								6.1	31148			
	500150074		LYON'S CK-STN G MID	Zone 2	3-6	2200								5.9	37288			
	500150074		LYON'S CK-STN G MID	Zone 2	6-10	4100	2870							6.4	64063			
	500150075		LYON'S CK-STN G SOUTH	Zone 2	0-3	12000								9.4	127660			
	500150075		LYON'S CK-STN G SOUTH	Zone 2	3-6	19000								14	135714			
	500150075		LYON'S CK-STN G SOUTH	Zone 2	6-10	21000	17700	11957	7960					16	131250			
GL151542	500150076	LC12	LYON'S CK LC12 NORTH	Zone 2	0-3	1500								9.3	16129			
GL151543	500150076		LYON'S CK LC12 NORTH	Zone 2	3-6	1600								9.1	17582			
GL151544	500150076		LYON'S CK LC12 NORTH	Zone 2	6-10	1700	1610							8.3	20482			
GL151536	500150077		LYON'S CK LC12 MID	Zone 2	0-3	990								6	16500	70.1	4.1	25.7
GL151537	500150077		LYON'S CK LC12 MID	Zone 2	3-6	1200								5.8	20690	67.8	3.8	28.3
GL151538	500150077		LYON'S CK LC12 MID	Zone 2	6-10	1200	1137							5.5	21818	66.9	3.3	29.8
GL151539	500150078		LYON'S CK LC12 SOUTH	Zone 2	0-3	970								6.1	15902			
GL151540	500150078		LYON'S CK LC12 SOUTH	Zone 2	3-6	1100								6	18333			
GL151541	500150078		LYON'S CK LC12 SOUTH	Zone 2	6-10	1200	1101	1283	284					5.7	21053			
	500150079	LC13	LYON'S CK-LC 13 NORTH	Zone 2	0-3	3400								6.9	49275	67.4	10.6	22
	500150079		LYON'S CK-LC 13 NORTH	Zone 2	3-6	4000								6.9	57971	67.5	9.2	23.3
	500150079		LYON'S CK-LC 13 NORTH	Zone 2	6-10	7500	5220							8.6	87209	67.1	9.1	23.8
	500150080		LYON'S CK-LC 13 MID	Zone 2	0-3	1800								6.4	28125			
	500150080		LYON'S CK-LC 13 MID	Zone 2	3-6	1500								6.1	24590			
	500150080		LYON'S CK-LC 13 MID	Zone 2	6-10	2300	1910							6	38333			
	500150081		LYON'S CK-LC 13 SOUTH	Zone 2	0-3	2200								7.3	30137	66.7	3.3	30
	500150081		LYON'S CK-LC 13 SOUTH	Zone 2	3-6	2700								6.8	39706	65.6	4.1	30.3
	500150081		LYON'S CK-LC 13 SOUTH	Zone 2	6-10	3600	2910	3347	1698	4605	4743	4.6	4.7	6.9	52174	63.4	5.5	31.1

Sample	MOECC Station	Site Description		Zone	Core	Total PCB	Total PCB	Transect		Zone		**Zone**		TOC (%)	Total PCB	Silt %	Sand %	Clay %
					Segment			Mean	SD	Mean	SD	**Mean**	**SD**		TOC Corrected			
Number	Number					ng/g dry wt.	ng/g dry wt.	ng/g dry wt.		ng/g dry wt.		***u*** **g/g dry wt.**			ng/g TOC dry wt.			
							0-10 cm											
GL151508	500150082	T7A	LYON'S CK T7A NORTH	Zone 3	0-3	2300								11	20909			
GL151509	500150082		LYON'S CK T7A NORTH	Zone 3	3-6	2200								10	22000			
GL151510	500150082		LYON'S CK T7A NORTH	Zone 3	6-10	2600	2390							9.8	26531			
GL151505	500150083		LYON'S CK T7A MID	Zone 3	0-3	2400								7.3	32877	68.3	5.4	26.3
GL151506	500150083		LYON'S CK T7A MID	Zone 3	3-6	2700								6.8	39706	66.1	4.7	29.2
GL151507	500150083		LYON'S CK T7A MID	Zone 3	6-10	3100	2770							6.4	48438	67.8	0.6	31.6
GL151502	500150084		LYON'S CK T7A SOUTH	Zone 3	0-3	2000								6.8	29412			
GL151503	500150084		LYON'S CK T7A SOUTH	Zone 3	3-6	1400								6.9	20290			
GL151504	500150084		LYON'S CK T7A SOUTH	Zone 3	6-10	1700	1700	2287	542					6.8	25000			
	500150085	LC14	LYON'S CK-LC14 NORTH	Zone 3	0-3	2300								9.5	24211			
	500150085		LYON'S CK-LC14 NORTH	Zone 3	3-6	3500								9.7	36082			
	500150085		LYON'S CK-LC14 NORTH	Zone 3	6-10	6100	4180							9.6	63542			
	500150086		LYON'S CK-LC14 MID	Zone 3	0-3	1700								6.6	25758	68.4	0.7	30.9
	500150086		LYON'S CK-LC14 MID	Zone 3	3-6	1600								6.4	25000	71	5.3	23.7
	500150086		LYON'S CK-LC14 MID	Zone 3	6-10	1500	1590							6	25000	67.5	0.8	31.7
	500150087		LYON'S CK-LC14 SOUTH	Zone 3	0-3	1300								6.1	21311			
	500150087		LYON'S CK-LC14 SOUTH	Zone 3	3-6	1500								6.1	24590			
	500150087		LYON'S CK-LC14 SOUTH	Zone 3	6-10	1400	1400	2390	1553.1					6.1	22951			
GL151447	500150088	T7B	LYON'S CK - T7B NORTH	Zone 3	0-3	1800								9.4	19149			
GL151448	500150088		LYON'S CK - T7B NORTH	Zone 3	3-6	1600								9	17778			
GL151449	500150088		LYON'S CK - T7B NORTH	Zone 3	6-10	1800	1740							9	20000			
GL151450	500150088		LYON'S CK - T7B NORTH	Zone 3	10-20	8700								7	124286	61.1	6.3	32.6
GL151451	500150088		LYON'S CK - T7B NORTH	Zone 3	20-30	50000								10	500000	64.1	0.5	35.4
GL151452	500150088		LYON'S CK - T7B NORTH	Zone 3	30-44	730								6.3	11587	63.6	0.9	35.5
GL151444	500150089		LYON'S CK - T7B MID	Zone 3	0-3	1900								6.9	27536	67.9	5.7	26.4
GL151445	500150089		LYON'S CK - T7B MID	Zone 3	3-6	2100								6.6	31818	64.9	2.3	32.8
GL151446	500150089		LYON'S CK - T7B MID	Zone 3	6-10	2000	2000							6.2	32258	67.7	2.1	30.2
GL151441	500150090		LYON'S CK - T7B SOUTH	Zone 3	0-3	1200								5.8	20690			
GL151442	500150090		LYON'S CK - T7B SOUTH	Zone 3	3-6	950								5.6	16964			
GL151443	500150090		LYON'S CK - T7B SOUTH	Zone 3	6-10	1200	1125	1622	449					5.3	22642			
GL151433	500150093	LC15	LYON'S CK - LC15 EAST	Zone 3	0-3	470								6.2	7581			
GL151434	500150093		LYON'S CK - LC15 EAST	Zone 3	3-6	1000								5.9	16949			
GL151435	500150093		LYON'S CK - LC15 EAST	Zone 3	6-10	560	665							5.8	9655			
GL151436	500150093		LYON'S CK - LC15 EAST	Zone 3	20-30	6600								3.9	169231	51.9	0.1	48.1
GL151437	500150093		LYON'S CK - LC15 EAST	Zone 3	40-45	73000								8.6	848837	58.5	0.1	41.3
	500150092		LYON'S CK-LC 15 MID	Zone 3	0-3	2100								11	19091			
	500150092		LYON'S CK-LC 15 MID	Zone 3	3-6	3900								10	39000			
	500150092		LYON'S CK-LC 15 MID	Zone 3	6-10	5800	4120							12	48333			
GL151438	500150091		LYON'S CK - LC15 WEST	Zone 3	0-3	1500								7.7	19481			
GL151439	500150091		LYON'S CK - LC15 WEST	Zone 3	3-6	1600								7.5	21333			
GL151440	500150091		LYON'S CK - LC15 WEST	Zone 3	6-10	1200	1410	2065	1818					7.5	16000			
GL151424	500150096	LC16	LYON'S CK -U/S OF HWY 140 EAST LC16	Zone 3	0-3	1400								6.5	21538			
GL151425	500150096		LYON'S CK -U/S OF HWY 140 EAST LC16	Zone 3	3-6	1100								6.2	17742			
GL151426	500150096		LYON'S CK -U/S OF HWY 140 EAST LC16	Zone 3	6-10	1100	1190							5.9	18644			
GL151427	500150095		LYON'S CK -U/S OF HWY 140 MID LC16	Zone 3	0-3	1500								7.2	20833	68.3	3.3	28.4
GL151428	500150095		LYON'S CK -U/S OF HWY 140 MID LC16	Zone 3	3-6	1300								6.5	20000	66.2	5.4	28.4
GL151429	500150095		LYON'S CK -U/S OF HWY 140 MID LC16	Zone 3	6-10	1600	1480							5.8	27586	67.9	1.1	31
GL151430	500150094		LYON'S CK -U/S OF HWY 140 WEST LC16	Zone 3	0-3	1700								7.9	21519			
GL151431	500150094		LYON'S CK -U/S OF HWY 140 WEST LC16	Zone 3	3-6	1400								8	17500			
GL151432	500150094		LYON'S CK -U/S OF HWY 140 WEST LC16	Zone 3	6-10	1400	1490	1387	170	1950	1025	**2.0**	**1.0**	7.1	19718			

Sample Number	MOECC Station Number	Site Description		Zone	Core Segment	Total PCB	Total PCB	Transect Mean	SD	Zone Mean	SD	Zone Mean	SD	TOC (%)	Total PCB TOC Corrected	Silt %	Sand %	Clay %
						ng/g dry wt.	ng/g dry wt. 0-10 cm	ng/g dry wt.		ng/g dry wt.		u g/g dry wt.			ng/g TOC dry wt.			
GL151499	500150097	LC17	LYON'S CK D/S OF HWY-140 NORTH LC17	Zone 4	0-3	2500								9.9	25253	51.7	30.8	17.5
GL151500	500150097		LYON'S CK D/S OF HWY-140 NORTH LC17	Zone 4	3-6	2500								8.8	28409	53.4	26.5	20.1
GL151501	500150097		LYON'S CK D/S OF HWY-140 NORTH LC17	Zone 4	6-10	1700	2180							7.2	23611			
GL151496	500150098		LYON'S CK D/S OF HWY-140 MID LC17	Zone 4	0-3	3600								9.6	37500	51.8	28.9	19.3
GL151497	500150098		LYON'S CK D/S OF HWY-140 MID LC17	Zone 4	3-6	3400								9.7	35052	54	26.9	19.1
GL151498	500150098		LYON'S CK D/S OF HWY-140 MID LC17	Zone 4	6-10	2600	3140							8.5	30588	64	9	27
GL151493	500150099		LYON'S CK D/S OF HWY-140 SOUTH -LC17	Zone 4	0-3	3700								9.1	40659			
GL151494	500150099		LYON'S CK D/S OF HWY-140 SOUTH -LC17	Zone 4	3-6	3600								9.8	36735			
GL151495	500150099		LYON'S CK D/S OF HWY-140 SOUTH -LC17	Zone 4	6-10	2300	3110	2810	546					6.8	33824			
	500150100	STN I	LYON'S CK-STN I NORTH	Zone 4	0-3	4000												
	500150100		LYON'S CK-STN I NORTH	Zone 4	3-6	5200												
	500150100		LYON'S CK-STN I NORTH	Zone 4	6-10	900	3120											
	500150101		LYON'S CK-STN I MID	Zone 4	0-3	2300										70.6	5	24.4
	500150101		LYON'S CK-STN I MID	Zone 4	3-6	2300										69.3	4.9	25.8
	500150101		LYON'S CK-STN I MID	Zone 4	6-10	1900	2140									68.4	3.5	28.1
	500150102		LYON'S CK-STN I SOUTH	Zone 4	0-3	1400								6.5	21538			
	500150102		LYON'S CK-STN I SOUTH	Zone 4	3-6	1600								6.3	25397			
	500150102		LYON'S CK-STN I SOUTH	Zone 4	6-10	1300	1420	2227	853					5.8	22414			
	500150102		LYON'S CK-STN I SOUTH	Zone 4	10-20	1300										66.6	0.4	33
	500150102		LYON'S CK-STN I SOUTH	Zone 4	20-30	2800										62.7	0.3	37
	500150102		LYON'S CK-STN I SOUTH	Zone 4	30-40	24000										60.1	0.1	39.8
	500150102		LYON'S CK-STN I SOUTH	Zone 4	40-50	2200										63.5	1.9	34.6
	500150102		LYON'S CK-STN I SOUTH	Zone 4	50-60	110										61.7	1.3	37
	500150102		LYON'S CK-STN I SOUTH	Zone 4	60-70	17										59.9	0.3	39.8
GL151421	500150103	T8A	LYON'S CK -T8A NORTH	Zone 4	0-3	1900								7.6	25000			
GL151422	500150103		LYON'S CK -T8A NORTH	Zone 4	3-6	1800								7.5	24000			
GL151423	500150103		LYON'S CK -T8A NORTH	Zone 4	6-10	1600	1750							7.6	21053			
GL151418	500150104		LYON'S CK -T8A MID	Zone 4	0-3	1500								6.1	24590	67.4	0.4	32.2
GL151419	500150104		LYON'S CK -T8A MID	Zone 4	3-6	1200								5.5	21818	63	0.3	36.7
GL151420	500150104		LYON'S CK -T8A MID	Zone 4	6-10	890	1166							5.3	16792	66.5	0.4	33.1
GL151415	500150105		LYON'S CK -T8A SOUTH	Zone 4	0-3	1300								6.4	20313			
GL151416	500150105		LYON'S CK -T8A SOUTH	Zone 4	3-6	1300								5.7	22807			
GL151417	500150105		LYON'S CK -T8A SOUTH	Zone 4	6-10	990	1176	1364	334					5	19800			
GL151633	500150106	LC18	LYON'S CK U/S OF CN RAIL North- LC18	Zone 4	0-3	1200												
GL151634	500150106		LYON'S CK U/S OF CN RAIL North- LC18	Zone 4	3-6	2000												
GL151635	500150106		LYON'S CK U/S OF CN RAIL North- LC18	Zone 4	6-10	6400	3520											
GL151409	500150107		LYON'S CK U/S OF CN RAIL/MID LC18	Zone 4	0-3	1000								5.7	17544	66.2	0.4	33.4
GL151410	500150107		LYON'S CK U/S OF CN RAIL/MID LC18	Zone 4	3-6	910								5.8	15690	65.5	2.6	31.9
GL151411	500150107		LYON'S CK U/S OF CN RAIL/MID LC18	Zone 4	6-10	830	905							5.4	15370	64.4	0.5	35.1
GL151412	500150108		LYON'S CK U/S OF CN RAIL/SOUTH LC18	Zone 4	0-3	860								5.1	16863			
GL151413	500150108		LYON'S CK U/S OF CN RAIL/SOUTH LC18	Zone 4	3-6	860								5	17200			
GL151414	500150108		LYON'S CK U/S OF CN RAIL/SOUTH LC18	Zone 4	6-10	740	812	1746	1537	2037	978	2.0	0.98	4.6	16087			
GL151642	500150109	LC20	LYON'S CK -LC20 North	Zone 5	0-3	1700								6.6	25758			
GL151643	500150109		LYON'S CK -LC20 North	Zone 5	3-6	3100								7.4	41892			
GL151644	500150109		LYON'S CK -LC20 North	Zone 5	6-10	2800	2560							8.7	32184			
GL151645	500150109		LYON'S CK -LC20 North	Zone 5	10-20	2900								7.1	40845	60.1	19.2	20.7
GL151646	500150109		LYON'S CK -LC20 North	Zone 5	20-30	2400								5	48000	60.8	14.5	24.7
GL151647	500150109		LYON'S CK -LC20 North	Zone 5	30-40	5000								5.7	87719	63.7	6.3	30
GL151648	500150109		LYON'S CK -LC20 North	Zone 5	40-50	260								6.4	4063	60.3	1	38.7
GL151649	500150109		LYON'S CK -LC20 North	Zone 5	50-60	10								3.7	270	55.4	0.1	44.5
GL151650	500150109		LYON'S CK -LC20 North	Zone 5	60-70	10								2.6	385	58.1	0.1	41.9
GL151639	500150110		LYON'S CK -LC20 Mid	Zone 5	0-3	2300										59.1	16.7	24.2
GL151640	500150110		LYON'S CK -LC20 Mid	Zone 5	3-6	2200										60.5	13.5	26
GL151641	500150110		LYON'S CK -LC20 Mid	Zone 5	6-10	2400	2310							7.4	32432	58.2	21.5	20.3
GL151636	500150111		LYON'S CK -LC20 South	Zone 5	0-3	1400												
GL151637	500150111		LYON'S CK -LC20 South	Zone 5	3-6	450												
GL151638	500150111		LYON'S CK -LC20 South	Zone 5	6-10	730	847	1906	925									
GL151666	500150112	LC21	LYON'S CK- LC21 North	Zone 5	0-3	690								7.9	8734			
GL151667	500150112		LYON'S CK- LC21 North	Zone 5	3-6	1400								8.5	16471			
GL151668	500150112		LYON'S CK- LC21 North	Zone 5	6-10	3200	1907							8.9	35955			
GL151663	500150113		LYON'S CK- LC21 Mid	Zone 5	0-3	1500								7.2	20833	62.2	11.6	26.2
GL151664	500150113		LYON'S CK- LC21 Mid	Zone 5	3-6	1500								6.7	22388	65.4	6.9	27.7
GL151665	500150113		LYON'S CK- LC21 Mid	Zone 5	6-10	1200	1380							6.4	18750	67.7	3.9	28.4
GL151660	500150114		LYON'S CK- LC21 South	Zone 5	0-3	1100								5.5	20000			
GL151661	500150114		LYON'S CK- LC21 South	Zone 5	3-6	1400								5.7	24561			
GL151662	500150114		LYON'S CK- LC21 South	Zone 5	6-10	980	1142	1476	391					6.5	15077			
GL151657	500150115	LC22	LYON'S CK -LC22 North	Zone 5	0-3	940								9.5	9895			
GL151658	500150115		LYON'S CK -LC22 North	Zone 5	3-6	850								9.7	8763			
GL151659	500150115		LYON'S CK -LC22 North	Zone 5	6-10	750	837 36							9.8	7653			
GL151654	500150116		LYON'S CK -LC22 Mid	Zone 5	0-3	920								8.9	10337	66.3	6.3	27.4
GL151655	500150116		LYON'S CK -LC22 Mid	Zone 5	3-6	950								8.4	11310	65.9	7.3	26.8
GL151656	500150116		LYON'S CK -LC22 Mid	Zone 5	6-10	1800	1281							7.6	23684	67.2	1.2	31.6
GL151651	500150117		LYON'S CK -LC22 South	Zone 5	0-3	810								5.8	13966			
GL151652	500150117		LYON'S CK -LC22 South	Zone 5	3-6	600								5.9	10169			
GL151653	500150117		LYON'S CK -LC22 South	Zone 5	6-10	790	739	952	289	1445	666	1.4	0.7	4.6	17174			

Sample Number	MOECC Station Number	Site	Description	Zone	Core Segment	Total PCB ng/g dry wt.	Total PCB ng/g dry wt. 0-10 cm	Transect Mean ng/g dry wt.	SD	Zone Mean ng/g dry wt.	SD	**Zone Mean** *u* g/g dry wt.	**SD**	TOC (%)	Total PCB TOC Corrected ng/g TOC dry wt.	Silt %	Sand %	Clay %
GL151403	500150118	LC23	LYON'S CK D/S OF DOONS RIDGE RD NORTH LC-23	Zone 6	0-3	500								5.3	9434			
GL151404	500150118		LYON'S CK D/S OF DOONS RIDGE RD NORTH LC-23	Zone 6	3-6	500								5.7	8772			
GL151405	500150118		LYON'S CK D/S OF DOONS RIDGE RD NORTH LC-23	Zone 6	6-10	460	484							5.6	8214			
GL151400	500150119		LYON'S CK D/S OF DOONS RIDGE RD MID LC-23	Zone 6	0-3	620								5.7	10877	67	5.1	27.9
GL151401	500150119		LYON'S CK D/S OF DOONS RIDGE RD MID LC-23	Zone 6	3-6	590								5.9	10000	67.1	5.6	27.3
GL151402	500150119		LYON'S CK D/S OF DOONS RIDGE RD MID LC-23	Zone 6	6-10	760	667							5.5	13818	66.1	5.8	28.1
GL151397	500150120		LYON'S CK D/S OF DOONS RIDGE RD SOUTH-LC23	Zone 6	0-3	1100								6.1	18033			
GL151398	500150120		LYON'S CK D/S OF DOONS RIDGE RD SOUTH-LC23	Zone 6	3-6	720								6.7	10746			
GL151399	500150120		LYON'S CK D/S OF DOONS RIDGE RD SOUTH-LC23	Zone 6	6-10	1400	1106	752	320					7.4	18919			
GL151394	500150121	LC24	LYON'S CK U/S OF PEARSON RD NORTH LC-24	Zone 6	0-3	350								6.7	5224			
GL151395	500150121		LYON'S CK U/S OF PEARSON RD NORTH LC-24	Zone 6	3-6	350								6.3	5556			
GL151396	500150121		LYON'S CK U/S OF PEARSON RD NORTH LC-24	Zone 6	6-10	400	370							6.3	6349			
GL151391	500150122		LYON'S CK U/S OF PEARSON RD MID LC-24	Zone 6	0-3	470								5.3	8868	63.2	5.4	31.4
GL151392	500150122		LYON'S CK U/S OF PEARSON RD MID LC-24	Zone 6	3-6	490								5.4	9074	65.6	2.9	31.5
GL151393	500150122		LYON'S CK U/S OF PEARSON RD MID LC-24	Zone 6	6-10	400	448							5	8000	68.2	2.2	29.6
GL151388	500150123		LYON'S CK @ U/S OF PEARSON RD SOUTH-LC24	Zone 6	0-3	270								6.3	4286			
GL151389	500150123		LYON'S CK @ U/S OF PEARSON RD SOUTH-LC24	Zone 6	3-6	290								6.3	4603			
GL151390	500150123		LYON'S CK @ U/S OF PEARSON RD SOUTH-LC24	Zone 6	6-10	400	328	382	60.893					6.3	6349			
GL151385	500150124	LC27	LYON'S CK @ LC-27 NORTH	Zone 6	0-3	510								10	5100			
GL151386	500150124		LYON'S CK @ LC-27 NORTH	Zone 6	3-6	570								9.5	6000			
GL151387	500150124		LYON'S CK @ LC-27 NORTH	Zone 6	6-10	850	664							9	9444			
GL151382	500150125		LYONS CK @ LC-27 MID	Zone 6	0-3	860								16	5375	44.7	42	13.3
GL151383	500150125		LYONS CK @ LC-27 MID	Zone 6	3-6	420								12	3500	60.9	14.8	24.3
GL151384	500150125		LYONS CK @ LC-27 MID	Zone 6	6-10	230	476							8.5	2706	55.1	7.7	37.2
GL151379	500150126		LYONS CK @ LC-27 SOUTH	Zone 6	0-3	280								5.6	5000			
GL151380	500150126		LYONS CK @ LC-27 SOUTH	Zone 6	3-6	300								6.2	4839			
GL151381	500150126		LYONS CK @ LC-27 SOUTH	Zone 6	6-10	850	514	551	99	562	234	0.56	0.23	5.8	14655			
GL151376	500150127	LC28	LYONS CK @ MCKENNY RD NORTH- LC28	Zone 7	0-3	330								5.3	6226			
GL151377	500150127		LYONS CK @ MCKENNY RD NORTH- LC28	Zone 7	3-6	310								5.6	5536			
GL151378	500150127		LYONS CK @ MCKENNY RD NORTH- LC28	Zone 7	6-10	210	276							5.5	3818			
GL151373	500150128		LYONS CK @ MCKENNY RD MID -LC28	Zone 7	0-3	650								5.1	12745	65.6	8.2	26.2
GL151374	500150128		LYONS CK @ MCKENNY RD MID -LC28	Zone 7	3-6	930								4.9	18980	60.9	10.2	28.9
GL151375	500150128		LYONS CK @ MCKENNY RD MID -LC28	Zone 7	6-10	1200	954							4.3	27907	63.1	2	34.9
GL151370	500150129		LYONS CK @ MCKENNY RD SOUTH-LC28	Zone 7	0-3	330								5.4	6111			
GL151371	500150129		LYONS CK @ MCKENNY RD SOUTH-LC28	Zone 7	3-6	330								4.9	6735			
GL151372	500150129		LYONS CK @ MCKENNY RD SOUTH-LC28	Zone 7	6-10	640	454	561	352	561	352	0.56	0.35	5.9	10847			
GL151349	500150138		TEE CK EAST	Ref	0-3	10								0.51	1961			
GL151350	500150138		TEE CK EAST	Ref	3-6	10								0.28	3571			
GL151351	500150138		TEE CK EAST	Ref	6-10	10	10							0.28	3571			
GL151352	500150137		TEE CK MID	Ref	0-3	10								1.2	833	64.6	0.2	35.2
GL151353	500150137		TEE CK MID	Ref	3-6	10								1.2	833	60.4	0.1	39.5
GL151354	500150137		TEE CK MID	Ref	6-10	10	10							1.5	667	55.8	0.1	44.2
GL151355	500150136		TEE CK WEST	Ref	0-3	10								0.33	3030			
GL151356	500150136		TEE CK WEST	Ref	3-6	10								0.27	3704			
GL151357	500150136		TEE CK WEST	Ref	6-10	10	10							0.22	4545			
GL151364	500150133		BEAVERS CK NORTH/WEST	Ref	0-3	10								2.7	370			
GL151365	500150133		BEAVERS CK NORTH/WEST	Ref	3-6	10								1.8	556			
GL151366	500150133		BEAVERS CK NORTH/WEST	Ref	6-10	10	10							2.3	435			
GL151361	500150134		BEAVERS CK MID	Ref	0-3	10								3.3	303	61.4	3.4	35.2
GL151362	500150134		BEAVERS CK MID	Ref	3-6	10								6.4	156	63.7	8.1	28.2
GL151363	500150134		BEAVERS CK MID	Ref	6-10	10	10							8.6	116	67	7	26
GL151358	500150135		BEAVERS CK SOUTH/EAST	Ref	0-3	10								5.4	185			
GL151359	500150135		BEAVERS CK SOUTH/EAST	Ref	3-6	10								5.9	169			
GL151360	500150135		BEAVERS CK SOUTH/EAST	Ref	6-10	10	10							4.3	233			
GL151367	500150131		USHERS CK MID	Ref	0-3	10								0.53	1887			
GL151368	500150131		USHERS CK MID	Ref	3-6	10								0.51	1961			
GL151369	500150131		USHERS CK MID	Ref	6-10	10	10			10	0	0.01	0	0.45	2222	59.7	0.1	40.3

Figure 1: Lyon's Creek East Subdivided into Zones 1-7

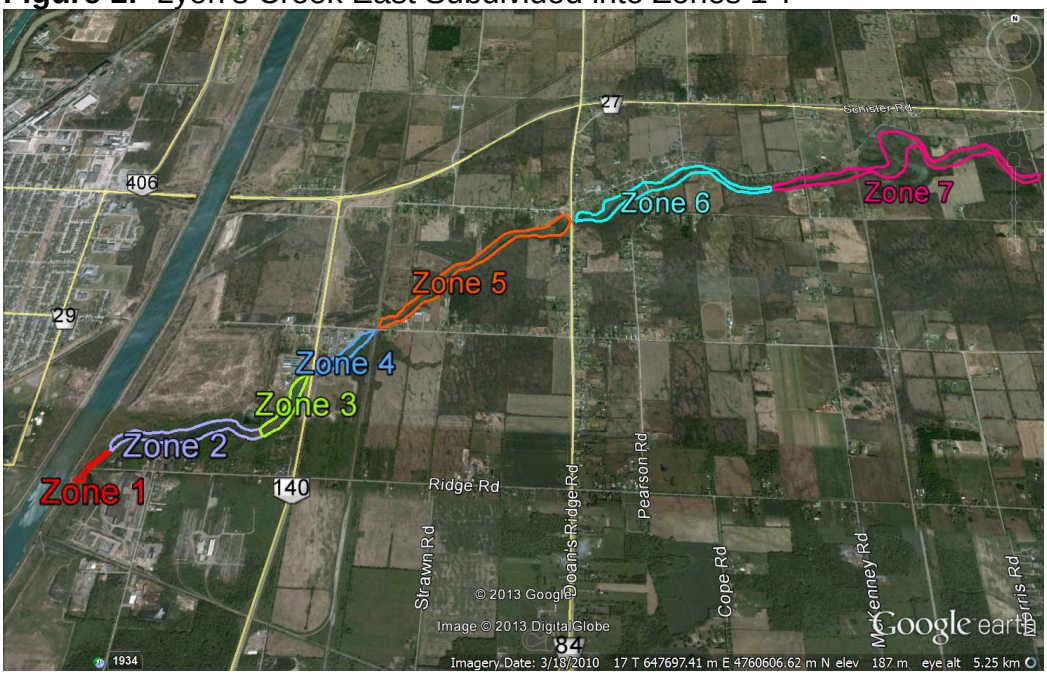


Figure 1a: Stations - Zone 1

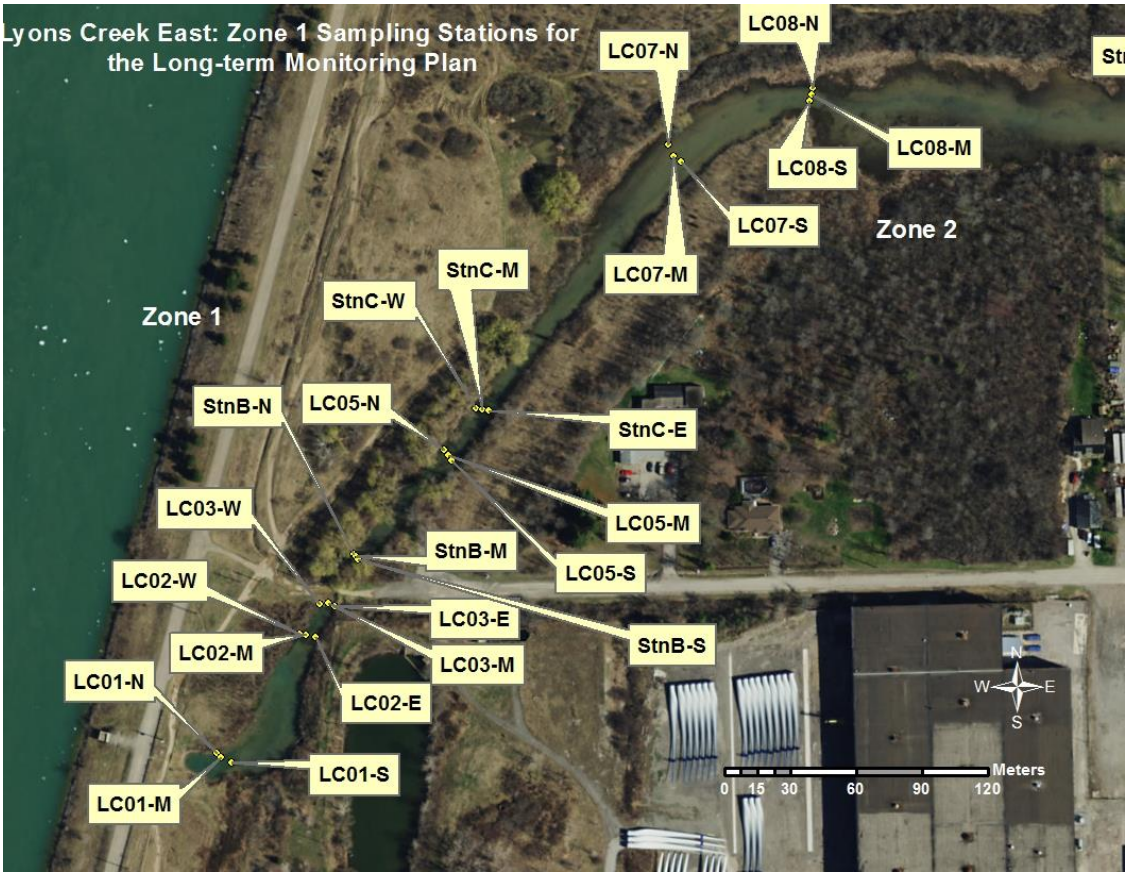


Figure 1b: Stations - Zone 2

Figure 1c: Stations - Zone 3

Figure 1d: Stations - Zone 4

Figure 1e: Stations - Zone 5

Figure 1f : Stations - Zone 6 and Zone 7

Figure 1g: Reference Creeks: Ushers Creek, Beaver Creek and Tee Creek (TC).

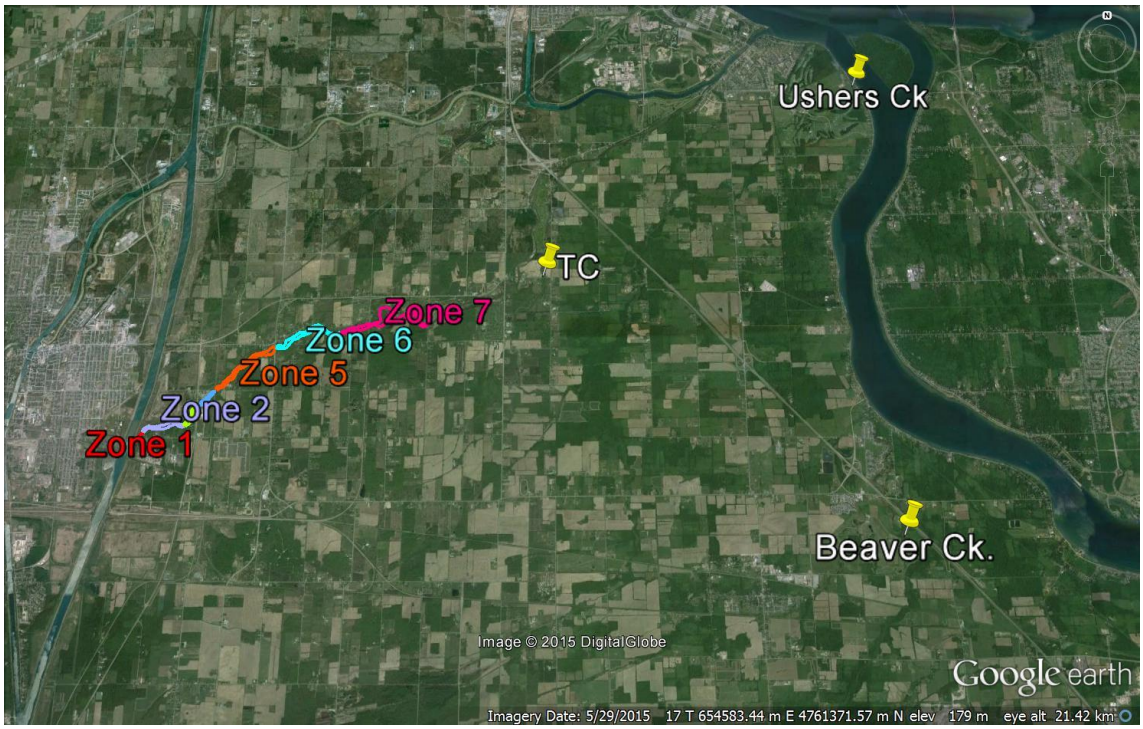
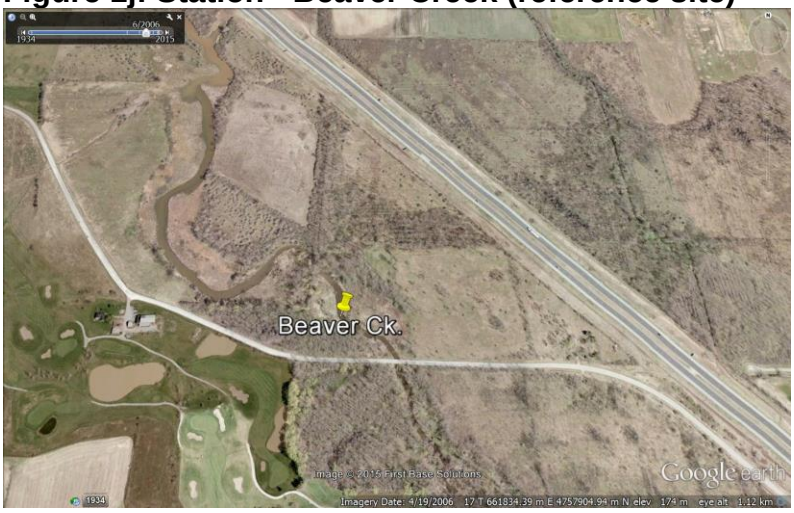


Figure 1h: Station - Tee Creek (reference site)

Figure 1i: Station - Ushers Creek (reference site)

Figure 1j: Station - Beaver Creek (reference site)



Appendix Figure 2: Total PCB (*u*g/g) in sediment vs Total Organic Carbon (TOC) (mg/g) for three sediment segments. Inset graph expands the y axis to highlight the relationship between TOC and PCBs for the 0-3 cm and 3-6 cm depths.