Memorandum

October 13, 2016

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Subject: **Evaluation of Risk to Ecological Receptors Potentially Exposed to Polychlorinated Biphenyls in Silver Creek RACER Trust Property, Toledo, Ohio**

DRAFT

Overview

This Technical Memorandum presents an evaluation of risk to ecological receptors potentially exposed to polychlorinated biphenyls (PCBs) in Silver Creek, which is adjacent to the Racer Trust Property in Toledo, Ohio (Property). PCBs have been historically detected in groundwater collected from wells located within boundaries of the Property. The United States Environmental Protection Agency (USEPA), Region 5 has expressed concern that PCBs migrating from the Property may impact ecological receptors that inhabit or forage in Silver Creek. To date, assessment of risk to ecological receptors in Silver Creek has been based on groundwater data and assumptions regarding mixing of groundwater with the surface water of Silver Creek.

To reduce uncertainty in evaluating risk to ecological receptors, samples of surface water and sediment were collected in June 2016 at three locations in Silver Creek where groundwater from the Property most likely discharges into Silver Creek. Surface water was also collected at one location upstream of the Property. Samples were analyzed for seven Aroclors and total PCBs. For surface water, samples were analyzed for total and dissolved concentrations. In addition to PCBs, sediment was analyzed for total organic carbon (TOC).

Analytical Results

PCBs were not detected in either surface water (total or dissolved concentrations) or sediment, as individual Aroclors or total PCBs. Table 1 identifies the minimum and maximum detection limits for surface water and sediment.

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Table 1 Range for Detections for Surface Water and Sediment

All Aroclors and Total Polychlorinated Biphenyls	Range of Detection Limits			
	Surface Water (mg/L)		Sediment (mg/kg)	
	Minimum	Maximum	Minimum	Maximum
Bulk Sediment	---	---	4.1E-02	5.0E-02
Total	9.6E-05	9.7E-05	---	---
Dissolved	9.5E-05	9.6E-05	---	---

Risk to Aquatic Life

The absence of detected concentrations of PCBs in surface water and sediment provides evidence that, as suggested in past monitoring reports, that PCBs in groundwater adsorb to soil particles during migration and that discharge of PCBs into Silver Creek is negligible. To account for the possibility that PCBs are present at concentrations below detection limits, concentrations equal to the maximum detection limit (DL) and one-half the detection limit (DL/2) are compared to benchmarks for surface water and sediment.

Table 2 presents the comparison of the DL and DL/2 for surface water to the ecological screening level (ESL) identified by Region 5 (USEPA, 2003), the Ohio inside mixing zone maximum water quality criterion (IMZM WQC) identified in past monitoring reports, and final chronic value (FCV) for total PCBs developed by Fuchsman et al. (2006), which is based on a comprehensive review of toxicity data.

Table 2 Comparison of Detection Limits to Surface Water Benchmarks

Detection Limit	***Value (mg/L)***
Maximum	9.6E-05
Minimum/2	4.8E-05
Benchmark	
Region 5 ESL	**1.2E-07**
Ohio IMZM WQC	***4.8E-05***
FCV	5.4E-04

Notes:

Bold Font – Maximum Detection Limit and Maximum Detection Limit/2 exceed benchmark
Bold Italic Font – Maximum Detection Limit exceeds benchmark
ESL – Ecological Screening Value (USEPA, 2003)
FCV – Final Chronic Value (from Fuchsman et al., 2006)
IMZM WQC – Inside Mixing Zone Maximum Water Quality Criterion (State of Ohio, 2014)

Both the DL and DL/2 are greater than the Region 5 ESL for surface water, whereas only the DL is greater than the Ohio IMZM WQC. Both the DL and DL/2 are below the FCV, which has the strongest empirical basis. Based on a DL below the FCV, it can be concluded that PCBs are not present in surface water at concentrations that pose risk to aquatic life in the water column of Silver Creek.

Table 3 presents the comparison of the DL and DL/2 for sediment to the ESL identified by Region 5 (USEPA, 2003) and sediment quality benchmark (SQB) for Aroclor 1242, which is based on equilibrium partitioning (EqP), identified by Fuchsman et al. (2006). The SQB of 5.4E 04 mg/kg is normalized for organic carbon using the geometric mean of TOC in the three sediment samples collected in June 2016.

Table 3 Comparison of Detection Limits to Sediment Benchmarks

Detection Limit	*Value (mg/L)*
Maximum	5.0E-02
Minimum/2	2.5E-02
Benchmark	
Region 5 ESL	5.98E-02
Equilibrium Partitioning SQB	1.28

Notes:

ESL – Ecological Screening Value (USEPA, 2003)
SQB – Sediment Quality Benchmark (from Fuchsman et al., 2006)

The values for DL and DL/2 are below both the Region 5 ESL and SQB. Consequently, it can be concluded that PCBs are not present in the sediment of Silver Creek at concentrations that pose risk to benthic invertebrates.

Risk to Fish

To evaluate the potential risk to fish in Silver Creek, a concentration for total PCBs in whole body fish tissue was calculated and compared to benchmark concentrations for fish tissue. The concentration of total PCBs in fish was calculated as:

$$C_{fish} = BSAF * (f_{lipid}/(f_{oc}/C_{sediment})) \qquad \text{Equation 1}$$

where:

C_{fish} is the concentration of total PCBs in fish tissue (mg/kg wet weight),

BSAF is the biota-sediment accumulation factor (unitless),

f_{lipid} is the lipid fraction in fish tissue (unitless),

f_{oc} is the fraction of TOC in sediment (unitless), and

$C_{sediment}$ is the concentration of total PCBs in sediment (mg/kg dry weight).

Table 4 identifies the values and sources for the input parameters in Equation 1.

Table 4 Parameters for Calculation of Total PCBs in Fish Tissue

Parameter	Acronym	Units	Value	Source
Biota Sediment Accumulation Factor	BSAF	unitless	6.02E+00	Key et al. (2005)
Sediment Concentration	$C_{sediment}$	mg/kg dry weight	4.5E-02	Site-Specific
Fraction Organic Carbon	f_{oc}	unitless	6.1E-03	Site-Specific
Fraction Lipid	f_{lipid}	unitless	2.0E-02	USEPA (1995)

The BSAF of 6.02E+00 for the BSAF is for an uncontaminated reference site for the Kalamazoo River Superfund site in Michigan (Kay et al., 2005). This value is conservative, as it is higher than the BSAF of 2.61E+00 for the contaminated assessment area. The value of 4.5E 02 for $C_{sediment}$ is the geometric mean of the detection limits for the three sediment samples collected from Silver Creek. The value of 6.1E 03 for f_{oc} is the geometric mean of TOC for the three samples collected in Silver Creek. The value of 2.0E 02 for f_{lipid} is for spottail shiner as identified in the Great Lakes Water Quality Initiative (USEPA, 1995).

Table 5 presents the comparison of the calculated concentration of total PCBs in the tissue of fish in Silver Creek to the benchmark identified by Beyer et al. (1996) and concentrations in fish collected from the reference site for the Kalamazoo River Superfund site.

Table 5 Comparison of Calculated Fish Tissue Concentrations to Benchmarks

Source	Tissue Concentration (mg/kg wet weight)
Calculated for Silver Creek	8.81E-01
Beyer et al. (1996)	5.0E+01
Kay et al. (2005)	4.5E-01 – 1.3E+01

The concentration of total PCBs in tissue of fish in Silver Creek is below the benchmark identified by Beyer et al. (1996) and within the confidence limits for the uncontaminated reference site identified by Kay et al. (2005). Consequently, it can be concluded that the calculated concentration of total PCBs in tissue does not pose risk to fish in Silver Creek.

Risk to Avian Piscivores

Risk to avian piscivores, the most likely receptor group to forage in Silver Creek, is evaluated using a food chain model for belted kingfisher. Ingestion of total PCBs by belted kingfisher is calculated as:

$$IR_{total} = (IR_{food} * C_{food}) + (IR_{sediment} * C_{sediment}) + (IR_{water} * C_{water}) \quad \text{Equation 2}$$

Where:

IR_{total} = Total ingestion rate of total PCBs (mg/kg-day),

IR_{food} = Food ingestion rate (kg wet weight/kg body weight-day),

$IR_{sediment}$ = Sediment ingestion rate (kg dry weight/kg body weight-day),

IR_{water} = Water ingestion rate (L/kg body weight-day),

C_{fish} = Concentration of total PCBs in fish (mg/kg wet weight),

$C_{sediment}$ = Concentration of total PCBs in sediment (mg/kg dry weight), and

C_{water} = Concentration of total PCBs in surface water (mg/L).

Ingestion of total PCBs for all exposure routes ($\mathbf{IR}_{total}$), or dose, is divided by a no observed adverse effect level (NOAEL) to produce a HQ:

$$HQ = IR_{total}/NOAEL \quad \text{Equation 3}$$

A HQ greater than 1E+00 (i.e., the dose exceeds the NOAEL) identifies a potential for risk to wildlife. The NOAEL of 1.65E+00 for belted kingfisher is from Bridge and Kelly (2013).

Table 6 identifies the exposure parameters for belted kingfisher, which are from USEPA Region 4 (USEPA, 2013).

Table 6 Exposure Parameters for Belted Kingfisher

Parameter	*Acronym*	*Units*	*Value*
Food Ingestion Rate	IR_{food}	kg wet weight/kg body weight per day	5.0E-01
Sediment Ingestion Rate	$IR_{sediment}$	kg dry weight/kg body weight per day	0.0E+00
Water Ingestion Rate	IR_{water}	L/kg body weight per day	1.4E-01

The food chain model conservatively assumes that belted kingfisher eats only fish from Silver Creek and the bioavailability of PCBs is 100%.

Table 7 identifies the exposure point concentrations for fish, sediment, and surface water in Equation 2.

Table 7 Exposure Point Concentrations for Belted Kingfisher Food Chain Model

Exposure Medium	*Acronym*	*Units*	*Exposure Point Concentrations*
Fish	C_{fish}	mg/kg wet weight	8.81E-01
Sediment	$C_{sediment}$	mg/kg dry weight	4.5E-02
Surface Water	C_{water}	mg/L	9.7E-05

The EPC for fish (C_{fish}) was calculated using Equation 1. The EPC for sediment ($C_{sediment}$) is the geometric mean of the detection limits for the three samples collected from Silver Creek. The EPC for surface water (C_{water}) is the maximum detection limit for total concentration.

Table 8 Results of the Food Chain Model for Belted Kingfisher

Ingestion of Total PCBs Mg/kg-day				*NOAEL Mg/kg-day*	*HQ Unitless*
Fish	*Sediment*	*Water*	*Total*		
4.41E-01	0.00E+00	1.36E-05	4.41E-01	1.65E+00	2.7E-01

Notes:
HQ – Hazard Quotient
NOAEL – No Observed Adverse Effect Level
PCBs – Polychlorinated Biphenyls

The HQ of 2.7E0-1 is below the threshold of 1.0E+00. Consequently, it can be concluded that the conservative estimates of EPCs for total PCBs in fish, sediment, and surface water do not pose risk to avian piscivores, or other piscivorous wildlife, that may forage in Silver Creek.

Conclusions

PCBs were not detected in samples of surface water and sediment collected in Silver Creek. In the absence of detected concentrations, detection limits were conservatively used as exposure concentrations to evaluate the potential for risk to ecological receptors. The analysis presented in this Technical Memorandum

documents that PCBs detected in groundwater within the boundaries of the Property are not present in Silver Creek at concentrations that pose risk to aquatic life in the water column, benthic invertebrates, fish, or piscivorous wildlife that may forage in Silver Creek.

References

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