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Mike Hermanson
Water Resources Manager
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Mike,

This letter constitutes my proposed scope of work for additional PMF analysis and conducting a holistic analysis of PMF and MLR results to further the understanding of PCB sources and pathways within the Spokane River Watershed.

Type of Proposal: Time and Material/Labor Hour

Place of performance: 46 Stella Drive, Bridgewater, NJ 08807

Period of performance: March 1, 2020 to June 30, 2021

Offeror is a Sole Proprietor

Point of contact: Lisa A. Rodenburg

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Sincerely,

Lisa Rodenburg

Lisa Rodenburg

BACKGROUND

To date two projects have been completed, and one is underway, for the SRRTTF including: 1) Spokane River Regional PMF Analysis-Blank Influence Analysis; 2) Report for SRRTTF of Monsanto Litigation Analysis (in draft form), and 3) PMF Analysis of Municipal Influent and Effluent Data. For these projects the following datasets have been analyzed:

Spokane River Regional PMF Analysis-Blank Influence Analysis:

Data Source	Samples
Water Column Samples-2014 SRRTTF Synoptic Sampling	71
Water Column Samples-2014 SRRTTF Synoptic Sampling	29
Water Column Samples-2016 SRRTTF Monthly Sampling	39
TOTAL	**139**

Monsanto Litigation Analysis:

Sample Type	Samples	Analysis Type
Surface water	191	PMF
City of Spokane WWTP Influent & CSO	236	PMF
Fish tissue	105	PMF
Spokane stormwater	106	PMF
Kaiser groundwater	166	PMF
Kaiser outfalls (effluent)	225	PMF
City of Spokane CSO (DB5 column)	2	MLR
City of Spokane Stormwater (SPB-octyl	23	MLR
Storm drain solids	8	MLR
City of Spokane effluent	14	MLR
Bulk atmospheric deposition	21	MLR
Biofilm	21	MLR
River sediment	45	MLR
GE site groundwater	8	MLR
IEP effluent	40	MLR
Surface water CLAM samples	7	MLR
City of Spokane Municipal Products Study	104	MLR

PMF-Positive Matrix Factorization, MLR-Multiple Linear Regression

PMF Analysis of Municipal Influent and Effluent:

Data Source	Samples
Post Falls effluent	15
Coeur d'Alene effluent	21
Spokane County effluent	34
City of Spokane effluent	28
Hayden Area Regional Sewer Board effluent	18

IEP tertiary treatment effluent	7
Effluent TOTAL	**123**
Post Falls influent	24
Coeur d'Alene influent	30
Spokane County influent	88
City of Spokane influent	30
IEP tertiary treatment influent (secondary effluent)	7
Hayden Area Regional Area Sewer Board influent	24
Influent TOTAL	**203**

Each of these projects have, or will have upon completion, a report describing the analysis and findings of the listed data sets. The purpose of the following scope of work is to conduct a holistic analysis utilizing PMF and MLR analysis of PCB results from multiple environmental compartments (i.e. surface water, influent/effluent, biofilm, etc.) in conjunction with hydrologic, hydrogeologic, land use, spatial, temporal, and other associated factors to further the understanding of PCB sources and pathways within the Spokane River Watershed.

SCOPE OF WORK

Task 1 – Additional PMF Analysis

- Conduct PMF analysis on 2018 and 2019 biofilm samples (52). Evaluate SPMD samples collected in 2020 to determine if inclusion in the data matrix is appropriate, and if so, include in the biofilm dataset for PMF analysis.
- Conduct PMF analysis of the fish tissue data collected in the fall of 2020. Include appropriate additional fish tissue data from other sampling events to create a dataset sufficient for PMF analysis.

Task 2 – Holistic analysis of PMF and MLR results in conjunction with hydrologic, hydrogeologic, land use, spatial, temporal and other associated factors. The analysis will include the following:

- What are the main sources of PCBs to the Spokane River? Are they related to Aroclors or inadvertent sources? What proportion of the PCBs enter the river via groundwater, treated sewage, stormwater, etc.? This question will be addressed by matching the PMF-derived congener patterns in the water column to those of the suspected sources.
- What are the spatial trends in PCB concentrations in the River, and can they help us identify source areas? This will be addressed by mapping the PMF results for the water column.
- Conduct a mass balance by factor with data sets utilized previously to conduct the total PCB mass balance.

- Can the PMF analysis indicate the type of Aroclor responsible for the Mission reach hotspot? This will be addressed by examining the spatial distribution of PMF-derived fingerprints in the water column, sediment, and fish.
- Are PCB concentrations in various media declining over time? Is this decline experienced for all PCB sources or only some? This question will be addressed by examining time trends in the water column data.
- Are concentrations of various PCB sources in the Spokane River a function of river flow rate? If some sources (PMF factors) are affected by river flow but others are not, this fact may help us to identify the PCB sources. For example, PCBs from groundwater might be diluted at high flow, but PCBs from stormwater might increase in concentration during large rain events. This question will be addressed by analyzing the abundance of the PMR-derived fingerprints in the water column as a function of river flow rate.
- Compare the PMF-derived fingerprints in the fish with those in the water column and sediment at similar locations.
- How important is groundwater as a source of PCBs to the River? This question will be addressed by calculating a mass balance on PMF-derived PCB fingerprints (sources) at various locations, including just upstream and downstream of the suspected groundwater source, which is comprised of Aroclor 1248.
- Is degradation of PCBs occurring anywhere in the watershed? This question will be addressed by examining the PMF-derived fingerprints in water, sediment, groundwater, and municipal dischargers for fingerprints that are indicative of degradation.
- How do treatment plant upgrades affect loads of PCBs to the Spokane River? This question will be addressed by examining the PMF results from the dischargers to determine whether they decrease in abundance after the upgrade of the treatment process to membrane filtration.
- How does the Spokane River compare with other rivers for which PCB sources have been evaluated? With the strategies used in other watershed work for the Spokane River? Or is the Spokane River unique, requiring different approaches to PCB control? This will be addressed by comparing the PMF results for the water column, sediment, fish, and dischargers with those from other systems, such as the Delaware River, NY/NJ Harbor, and Duwamish River.

All spreadsheets and other work products will be provided to SRRTTF so that they may perform additional analysis of the results if they desire.

Cost estimate

The primary deliverable of the project will involve writing a report that uses the fingerprinting results in a holistic way to understand PCBs sources to the Spokane River and make recommendations for management strategies for controlling these sources. The time required to conduct the additional PMF analysis and write this report for all environmental compartments that have already been analyzed is estimated to be no more than 150 hours. At $200 per hour, this comes to $30,000.

Outcomes

Modeling will be used to provide the following work products:

1. A written report answering, to the extent possible, the questions posed above. The report will include maps, figures and tables.
2. All electronic files of raw data, PMF inputs and outputs, maps, charts and figures used in the final report.

Summary

The proposed work will allow an in-depth understanding of the sources and fate of PCBs in the Spokane River. Dr. Rodenburg is a recognized expert in PCB data management and analysis via factor analysis. She pioneered the use of PMF to understand PCB sources with her work in the Delaware River Basin.[5-8] Through her collected published works, she is the only researcher who has attempted to understand PCB sources on the watershed scale in complex systems involving multiple potentially responsible parties (PRPs) and in a variety of environmental media (water, sediment, fish, air, and permitted discharges). Given sufficient data quality and quantity, Dr. Rodenburg should be able to provide the same level of understanding of PCBs sources to this system as she achieved in the Delaware River Basin and Green-Duwamish River.

References

1. Rodenburg, L. A.; Leidos *Green-Duwamish River Watershed PCB Congener Study: Phase 2 Source Evaluation*; Seattle, WA, 2017.

2. Rodenburg, L. A.; Du, S. Y.; Lui, H.; Guo, J.; Oseagulu, N.; Fennell, D. E., Evidence for Dechlorination of Polychlorinated Biphenyls and Polychlorinated Dibenzo-p-Dioxins and -Furans in Wastewater Collection Systems in the New York Metropolitan Area. *Environmental Science & Technology* **2012,** *46*, (12), 6612-6620.

3. Paatero, P.; Tapper, U., Positive Matrix Factorization - a Nonnegative Factor Model with Optimal Utilization of Error-Estimates of Data Values. *Environmetrics* **1994,** *5*, 111-126.

4. Rushneck, D. R.; Beliveau, A.; Fowler, B.; Hamilton, C.; Hoover, D.; Kaye, K.; Berg, M.; Smith, T.; Telliard, W. A.; Roman, H.; Ruder, E.; Ryan, L., Concentrations of dioxin-like PCB congeners in unweathered Aroclors by HRGC/HRMS using EPA Method 1668A. *Chemosphere* **2004,** *54*, 79-87.

5. Du, S.; Belton, T. J.; Rodenburg, L. A., Source apportionment of polychlorinated biphenyls in the tidal Delaware River. *Environmental Science & Technology* **2008,** *42*, 4044-4051.

6. Praipipat, P.; Rodenburg, L. A.; Cavallo, G. J., Source Apportionment of Polychlorinated Biphenyls in the Sediments of the Delaware River. *Environ. Sci. Technol.* **2013,** *47*, 4277−4283.

7. Du, S.; Wall, S. J.; Cacia, D.; Rodenburg, L. A., Passive Air Sampling for Polychlorinated Biphenyls in the Philadelphia, USA Metropolitan Area. *Environ. Sci. Technol.* **2009,** *43*, 1287-1292.

8. Rodenburg, L. A.; Du, S.; Fennell, D. E.; Cavallo, G. J., Evidence for Widespread Dechlorination of Polychlorinated Biphenyls in Groundwater, Landfills, and Wastewater Collection Systems. *Environ. Sci. Technol.* **2010,** *44*, 7534-7540.