

# **Eighteenmile Creek Activated Carbon Field Study – Brief Description of Proposed Project and Approximate Cost Estimate**

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## **Background**

In 2012, a laboratory pilot study was undertaken to evaluate the efficacy of using powdered activated carbon (PAC) to reduce the bioavailability of polychlorinated biphenyls (PCBs) in Eighteenmile Creek sediment (E & E 2012a). The pilot study consisted of a laboratory bench-top experiment with sediment from three locations in the creek: (1) downstream from Burt Dam; (2) between Burt and Newfane Dams; and (3) upstream from Newfane Dam. Sediment from each area was augmented with PAC concentrations of 6%, 3%, and 1%. Bioaccumulation was evaluated with United States Environmental Protection Agency (USEPA) Test Method 100.3 (28-day *Lumbriculus variegatus* bioaccumulation test for sediments). For comparison, bioaccumulation in untreated (control) creek sediment from each location also was evaluated. The sediment samples used in the study were analyzed for PCB Aroclors and congeners and total organic carbon (TOC). At the end of the bioaccumulation tests, *Lumbriculus* biomass was analyzed for PCB Aroclors and congeners and lipids. The following results were noteworthy:

- Amending Eighteenmile Creek sediment with PAC was highly effective under laboratory conditions in reducing PCB levels in *Lumbriculus*. The sum of PCB congeners ( $\mu\text{g/g}$  lipid) in *Lumbriculus* in the 6%, 3%, and 1% PAC treatments was on average reduced by 99%, 97%, and 84%, respectively compared with *Lumbriculus* exposed to untreated Eighteenmile Creek sediment.
- Biota-sediment accumulation factors (BSAFs) were estimated using data for total PCBs and TOC in sediment and total PCBs and lipids in *Lumbriculus*. BSAFs were greatest for untreated Eighteenmile Creek sediment (1.4 to 2.7) and decreased with increasing PAC dose, decreasing to less than 0.2 at the greatest PAC treatment concentration (6%).

Overall, the results of the pilot study indicate that PAC was highly effective in reducing bioaccumulation of PCBs from Eighteenmile Creek sediment into benthic organisms. From the perspective of Beneficial Use Impairment (BUI) delisting, the pilot study results are encouraging because they suggest that it may be possible to reduce exposure and risk to people and wildlife from PCBs at Eighteenmile Creek using a remedial approach less costly and disruptive than sediment dredging and/or capping. *In situ* testing in one or more areas of the creek was recommended based on the pilot study results. This memorandum presents questions to be addressed by a follow-up field study and a preliminary study design.

## Field Study Questions

A field study is proposed for calendar year 2014 to address the following questions.

1. Can PAC be easily and cost-effectively applied to the sediment-water interface of Eighteenmile Creek with minimal environmental disturbance?
2. Are natural sediment bioturbation processes in Eighteenmile Creek adequate to mix PAC into the upper portion of the sediment profile?
3. Will PAC applied to Eighteenmile Creek sediment remain in place? If not, what fraction of the applied dose will be resuspended and transported downstream?
4. Will PAC be as effective in reducing PCB bioaccumulation *in situ* as in the laboratory study?

Other questions were considered; however, it was decided to limit the current project to the above questions to place reasonable bounds on the scope and cost of the field study. For example, various methods have been evaluated at other sites to apply activated carbon to sediments in the field, most of which were costly and greatly disturbed the sediment environment (e.g. Alcoa 2006). Those application methods are not being evaluated as part of this field study. Also, this project does not evaluate areas in Eighteenmile Creek with moderate to high current velocity. In such areas, there is little sediment accumulation and therefore low levels of sediment contamination, so these areas are unlikely to be in need of sediment remediation.

## Field Study Design

Three sediment plots (3 x 3 meters) with similar sediment and hydraulic characteristics will be selected in one of the three main reaches of the creek. The plots will be established in areas with soft muddy sediment, minimal current velocity, little or no likelihood of human disturbance, and in proximity to one another. The goal is to select a study area where the chance of the PAC being washed away is minimal and the sediment texture and benthic community are such that natural bioturbation would be expected to mix the PAC into the surface sediments. One plot each will be used for PAC treatments of 1%, 3%, and 6% dry weight, the same treatments used in the laboratory pilot study (see above). The required PAC mass will be applied to the sediment surface in each plot using SediMite ([www.sedimite.com](http://www.sedimite.com)). SediMite is a pelletized form of activated carbon that includes a non-toxic binding agent and inert weighing agent. The weighing agent makes the SediMite denser than water, enabling it to readily sink to the sediment water interface. After being submerged for a short period of time, the binding agent dissolves, releasing the activated carbon particles. Natural bioturbation will be relied upon to incorporate the PAC into the upper portion of the sediment profile. Muddy sediments in Eighteenmile Creek support abundant midges and Oligochaetes (E & E 2012b).

Each test plot will be sampled before PAC application, immediately after PAC application (to verify that the SediMite was properly applied), 90 days after PAC application, and 1 year after PAC application. Each plot will be sampled at four locations for PCB Aroclors and congeners in sediment, total organic carbon (TOC) in sediment, sediment bulk density, sediment grain size, and PCB bioaccumulation. PCB bioaccumulation will be evaluated in one of three ways: (1) *in situ* exposures with *Lumbriculus*

*variegatus* as described in Alcoa (2006); (2) laboratory exposures with *Lumbriculus* using field collected sediments from each study plot following USEPA (2000); or (3) by collecting and analyzing native benthos. Regardless of the method, the benthic-invertebrate samples will be analyzed for PCB Aroclors and congeners and lipids. The effect of PAC on PCB bioaccumulation in each study plot will be evaluated by comparing data collected before and after PAC addition. The t-test for paired comparisons or Wilcoxon's signed-ranks test will be used in the evaluation. The effect of PAC additions on lipid-normalized PCB levels in benthos and biota sediment accumulation factors (BSAFs) can be evaluated with this approach. A summary of the field study design is provided in Table 1 and Figure 1.

Lastly, E & E will coordinate with the New York State Department of Environmental Conservation (NYSDEC) regarding the need for a permit to apply activated carbon *in situ* to Eighteenmile Creek sediment and collect native benthos, if it is decided to do so to evaluate bioaccumulation. Also, the Eighteenmile Creek Remedial Advisory Committee will be consulted for technical support as needed.

## Cost

A cost estimate was prepared for budgeting purposes. The estimated cost to implement the above described field study, including costs to develop a Quality Assurance Project Plan, purchase necessary equipment, establish sediment test plots in the field, collect and analyze samples, and prepare draft and final study reports, is \$375,000. This cost estimate also includes time needed to refine the project scope. For example, additional effort will be needed to identify candidate study locations in Eighteenmile Creek, evaluate the sediment and hydraulic characteristics at these locations, identify the best method for evaluating bioaccumulation (i.e., collect native benthos or deploy exposure chambers with laboratory-reared organisms), coordinate with laboratories and other vendors, and finalize field sampling methods.

## References

- Alcoa. 2006. *In-situ PCB Bioavailability Reduction in Grasse River Sediments, Final Work Plan*. Available from [http://www.thegrassriver.com/major\\_reports.html](http://www.thegrassriver.com/major_reports.html) (accessed 4-2-13).
- Ecology and Environment, Inc. (E & E). 2012a. *Draft Eighteenmile Creek Powdered Activated Carbon (PAC) Pilot Study Report*. Prepared for Niagara County Soil and Water Conservation District, Lockport, NY by Ecology and Environment, Inc., Lancaster, NY.
- Ecology and Environment, Inc. (E & E). 2012b. *Draft Eighteenmile Creek Baseline Benthic Community Sampling Report*. Prepared for Niagara County Soil and Water Conservation District, Lockport, NY by Ecology and Environment, Inc., Lancaster, NY.
- USEPA. 2000. *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates, Second Edition*. USEPA Office of Research and Development, Duluth, Minnesota and Office of Water, Washington, D.C. EPA 600/R-99/064.

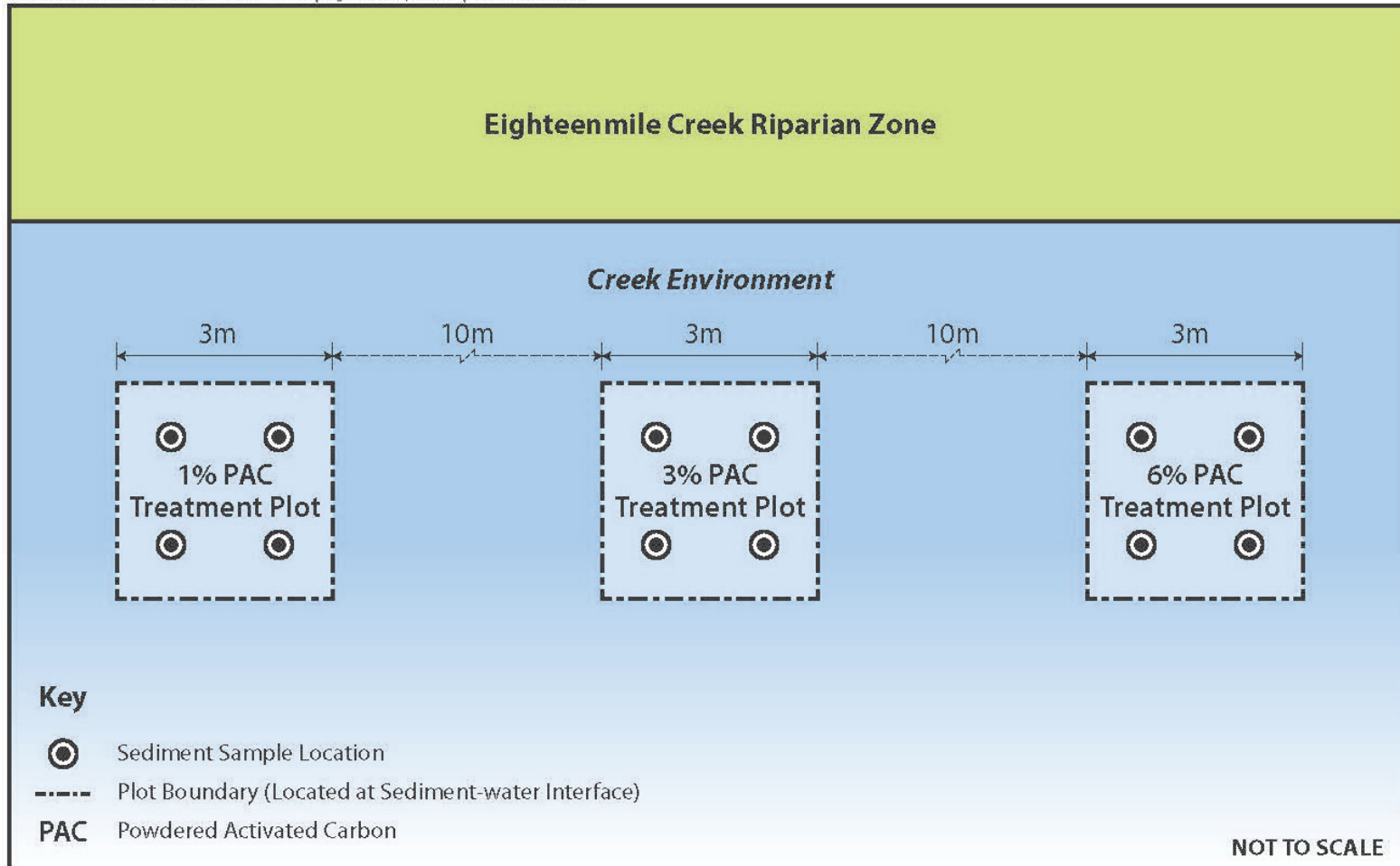
**Table 1. Summary of Eighteenmile Creek Activated Carbon Field Study Design.**

PAC Treatment	Number of Plots	Sampling Event	Sediment Parameters	Samples per Plot <sup>a</sup>	Benthos Parameters	Samples per Plot
1%	1	Before PAC Application	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 0)	TOC, black carbon	8	None	0
		After PAC Application (Day 90)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 365)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
3%	1	Before PAC Application	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 0)	TOC, black carbon	8	None	0
		After PAC Application (Day 90)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 365)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
6%	1	Before PAC Application	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 0)	TOC, black carbon	8	None	0
		After PAC Application (Day 90)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4
		After PAC Application (Day 365)	PCBs, TOC, black carbon, bulk density, % solids, grain size	8	PCBs, lipids	4

Key:

PAC = powdered activated carbon; PCB = polychlorinated biphenyls (congeners and Aroclors); TOC = total organic carbon

<sup>a</sup> Two sediment sample depths (0 to 1.5 inches and 1.5 to 3 inches) at each of four discrete sampling locations per plot.



Source: Ecology and Environment, Inc. (2013)

**Figure 1 Example Plot Layout for Powdered Activated Carbon Field Study (Plan View)**