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## Pilot Study on Use of Powdered Activated Carbon to Reduce Bioavailability of Polychlorinated Biphenyls (PCBs) in Eighteenmile Creek Sediment

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LAKE ONTARIO WATERWAYS



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This project will evaluate the potential effectiveness of using powdered activated carbon (PAC) to reduce bioavailability of polychlorinated biphenyls (PCBs) in Eighteenmile Creek sediment. Such a reduction would be beneficial to the aquatic ecosystem and habitat function in Eighteenmile Creek. Up to 90% reduction in PCB bioavailability has been observed at sites where this method has been used (Clu-in 2010). The method may be useful in Eighteenmile Creek as a polishing step in areas where sediment dredging is implemented and/or as the principal means of sediment remediation in areas that are difficult or impossible to access for dredging. This project addresses specific long-term goals of three Great Lakes Restoration Initiative (GLRI) Focus Areas, addresses five Beneficial Use Impairments (BUIs) in the Eighteenmile Creek Area of Concern (AOC), and supports Lake Ontario Management Plan (LaMP) Goals and Objectives.

### Project Overview and Background

#### Overview of Eighteenmile Creek Sediment Contamination

Poor water quality and sediment contamination in Eighteenmile Creek are largely the result of historical industrial and municipal waste discharges, pesticides from agricultural runoff, and other factors. Sediment and surface water contamination in Eighteenmile Creek have contributed to restrictions on fish and wildlife consumption, degradation of benthos, and restrictions on dredging activities in the Eighteenmile Creek AOC. Additionally, sediment contamination in the creek may be adversely affecting populations of some fish and wildlife species and increasing the prevalence of



The lower portion of Eighteenmile Creek is designated as a New York State significant Coastal Fish and Wildlife Habitat.

#### Eighteenmile Creek Sediment Pilot Study

- ✓ Addresses three GLRI Focus Areas
- ✓ Addresses delisting criteria for five BUIs in the Eighteenmile Creek AOC
- ✓ Addresses LaMP Goals and Objectives

deformities or reproductive problems in piscivorous mammals (E & E 2009). Contaminants that have been identified in Eighteenmile Creek sediments include PCBs, mercury, dioxins/furans, dieldrin, mirex, lead, copper, and dichlorodiphenyltrichloroethane (DDT). Of these, PCBs appear to be the greatest problem based on recent investigations which indicated that concentrations of PCBs in brown bullheads are ten times greater than background and exceed critical PCB tissue concentrations (E & E 2009) and current fish consumption advisories (NYSDOH 2010).

Recent bioaccumulation studies performed in the AOC by the U.S. Army Corps of Engineers (USACE) under a grant from the U.S. Environmental Protection Agency indicate that PCB levels in surficial sediments are highly bioavailable and present a bioaccumulation risk (Ross et al. 2011).



Eighteenmile Creek is the second most visited fishing destination in the Lake Ontario basin, attracting up to 15,000 anglers annually.

There is an on-going Great Lakes Legacy Act (GLLA) Remedial Investigation (RI) of in-stream contaminated sediments in Eighteenmile Creek between Lockport, New York and Burt Dam (Ross et al. 2011). The RI is examining the nature and extent of sediment contamination by PCBs, chlorinated pesticides (DDT and DDE), heavy metals, and cyanide to help understand migration of contaminants from upstream source areas to the AOC.

Contaminated sediments pose challenging cleanup and management problems. The standard approaches to addressing contaminated sediments are dredging and disposal or capping, which are expensive. *In situ* treatment of sediment contaminated with hydrophobic organic contaminants such as PCBs has the potential to greatly reduce remedial costs (Luthy et al. 2009). Please see the Case Study on the following page for additional details regarding potential remedial cost savings.

### Support of Great Lakes Restoration Initiative and Beneficial Use Impairment Delisting

Three GLRI Focus Areas are addressed by this project: (1) Toxic Substances and AOCs, (2) Habitat and Wildlife Protection and Restoration, and (3) Monitoring and Evaluation. The long-term goals of the Toxic Substances and AOCs Focus Area are to significantly reduce exposure of people and wildlife to toxic substances from historical contamination through source reduction or other methods, reduce the levels of toxic chemicals to the point that all restrictions on the consumption of Great Lakes fish can be lifted, and protect the health and integrity of wildlife habitat from adverse chemical and biological effects associated with the presence of toxic substances in the Great Lakes basin. This project would evaluate the effectiveness of a technique that, if successful, would reduce PCB bioavailability and therefore exposure of people, fish, and wildlife to PCBs. In addition, the project will also have direct relevance to delisting criteria for five BUIs within the Eighteenmile Creek AOC. If the pilot study proves to be successful (i.e., if

This pilot study would evaluate a potential technique that could be used to facilitate progress toward the delisting of five Eighteenmile Creek BUIs:

- ✓ Restrictions on Fish and Wildlife Consumption
- ✓ Degradation of Fish and Wildlife Populations
- ✓ Bird or Animal Deformities or Reproductive Problems
- ✓ Degradation of Benthos
- ✓ Restrictions on Dredging

PAC is effective in reducing PCB bioavailability in Eighteenmile Creek sediment), then application of this *in situ* technique has the potential to contribute to delisting of these BUIs.

The long-term goals of the Habitat and Wildlife Protection and Restoration Focus Area include maintaining or improving the conditions of native fish and wildlife populations through the protection and restoration of Great Lakes aquatic and terrestrial habitats, including physical, chemical, and biological processes and ecosystem

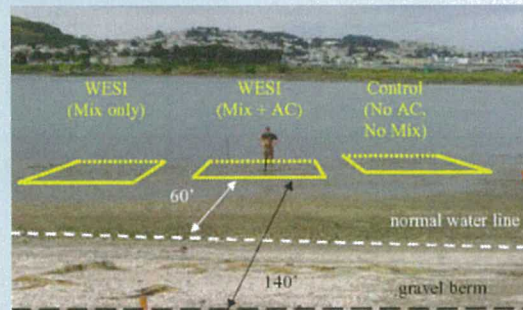
functions. Through the implementation of this project, aquatic habitat quality would be improved, leading to overall increases in ecosystem functions. Long-term goals of the Monitoring and Evaluation Focus Area include providing integrated and scaled data and information from the Great Lakes Basin to decision makers at various levels within a framework of established baselines, targets, and indicators of progress.

### Support of LaMP Goals and Objectives

The LaMP presents ecosystem goals for Lake Ontario based on indicators selected to provide a good characterization of the ecosystem; one group of these indicators, critical pollutant indicators, would be addressed by this project. The results would support the objectives of three of the LaMP criteria pollutant indicators: criteria pollutants in offshore waters, criteria pollutants in young-of-the-year fish, and criteria pollutants in fish tissue, by decreasing the concentrations of PCBs in sediment. Each of these indicators focuses on the fact that critical pollutants, such as PCBs, should not pose a threat to human, animal or aquatic life, including the consumption of fish.

This project would test the effectiveness of a treatment using PAC to decrease the bioavailability of PCBs in Eighteenmile Creek sediments.

### Case Study: Hunters Point Shipyard, San Francisco



#### Project:

- ✓ Field-scale test of *in situ* activated carbon (AC) amendment for PCB-contaminated sediment remediation – 3 test plots; 1 control plot
- ✓ Based on prior laboratory studies and a preliminary field pilot-scale study which showed that the addition of AC to sediment contaminated with PCBs significantly reduced the chemical and biological availability of PCBs

#### Results:

- ✓ AC sorbent mixed with sediment is a cost-effective non-removal management strategy for reducing risk and bioavailability of PCBs
- ✓ Cost analysis showed that scaling up AC treatment method would result in a total potential cost savings of 70-75% less than dredging/disposal
- ✓ Field-scale AC amendment reduced availability of PCBs to water and biota without adversely impacting natural benthic communities or releasing PCBs into overlying water
- ✓ Tests showed 50-66% reductions in PCBs uptakes in AC-amended test plots

### Project Specifics

This project will include a laboratory bench-top pilot study using sediment from three reaches of Eighteenmile Creek: below Burt Dam, between Burt Dam and Newfane Dam, and upstream from Newfane Dam. Samples spanning a range of PCB concentrations of an order-of-magnitude or more will be included in the study. Sediment sampling locations will be selected based on data from the recent GLLA sediment investigation above Burt Dam (Ross et al. 2011) and recent sediment sampling below Burt Dam for the TrophicTrace modeling work (Gustavson et al. 2010). Each of the three sediment samples collected for this study

will be subjected to four treatments: high PAC treatment, medium PAC treatment, low PAC treatment, and no PAC treatment. High, medium, and low PAC treatments will be defined based on Luthy et al. (2009) and similar studies (see Experimental Design for Pilot Study).

Sediments in each treatment will be analyzed for individual chemical compounds in the PCB category to determine how much of the PCBs remain following treatment. In addition, the effectiveness of the treatment in decreasing the PCB bioavailability will be determined using a bioaccumulation test on worms (*Lumbriculus*

*variegates*). This test will follow USEPA (2000) Test Method 100.3 (28-day *Lumbriculus variegates* Bioaccumulation Test for Sediments). The worms will be tested and after 28 days will be analyzed for the presence of PCBs in their tissue. Bioaccumulation will be evaluated by comparing PCB levels in the worms among treatments and by calculating and comparing biota-sediment accumulation factors (BSAFs) across treatments. A BSAF is a parameter which describes bioaccumulation of sediment-associated compounds into the tissues of an ecological receptor, like a worm. Thus, by comparing the BSAFs across the four treatment types, a determination can be made as to which treatment is most effective in decreasing the bioavailability of the PCBs in the test sediment.

If the pilot study proves to be successful, then application of this *in situ* technique has the potential to contribute to delisting of the five BUIs for the Eighteenmile Creek AOC. The results of

this study will be incorporated into the Eighteenmile Creek Feasibility Study (FS) and Remedial Design (RD) and used in developing cost-effective remedial alternatives for the site.

#### EXPERIMENTAL DESIGN FOR PILOT STUDY

Sample	Location	Treatment	Possible PAC Treatment Concentration
1	Downstream from Burt Dam	High PAC	5%
		Medium PAC	3%
		Low PAC	1%
		No PAC	0%
2	Between Burt and Newfane Dams	High PAC	5%
		Medium PAC	3%
		Low PAC	1%
		No PAC	0%
3	Upstream from Newfane Dam	High PAC	5%
		Medium PAC	3%
		Low PAC	1%
		No PAC	0%

PAC = Powdered activated carbon

## Project Goals

- Increase understanding of alternative remediation techniques, their effectiveness, and their potential to reduce remedial costs at Eighteenmile Creek
- Facilitate progress toward the long-term goals of three GLRI Focus Areas
- Collect data that could ultimately lead to the delisting of five BUIs for the Eighteenmile Creek AOC
- Address ecosystem indicators of the LaMP

## Project Objectives

- Treat Eighteenmile Creek sediment samples with PAC and undertake a bioaccumulation test
- Use test organisms (worms) to assess the effectiveness of the PAC treatment on PCB sediment bioaccumulation
- Calculate the BSAF for each treatment

## Project Outcomes

- Determine the potential effectiveness of treating PCB contaminated sediment from Eighteenmile Creek with PAC to reduce PCB bioavailability and potential risks
- Demonstrate applicability of *in situ* remedial approach for use in Great Lakes AOCs

## Costs

Total cost estimate is \$70,820 which includes: preparation of plans (\$6,000), sediment sample collection (\$5,000), bioaccumulation testing and chemical analysis (\$44,820), and reporting (\$15,000).

## Project Sponsors and Collaborators

Eighteenmile Creek Remedial Action Plan (RAP) Coordinator

Sources Available Upon Request

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