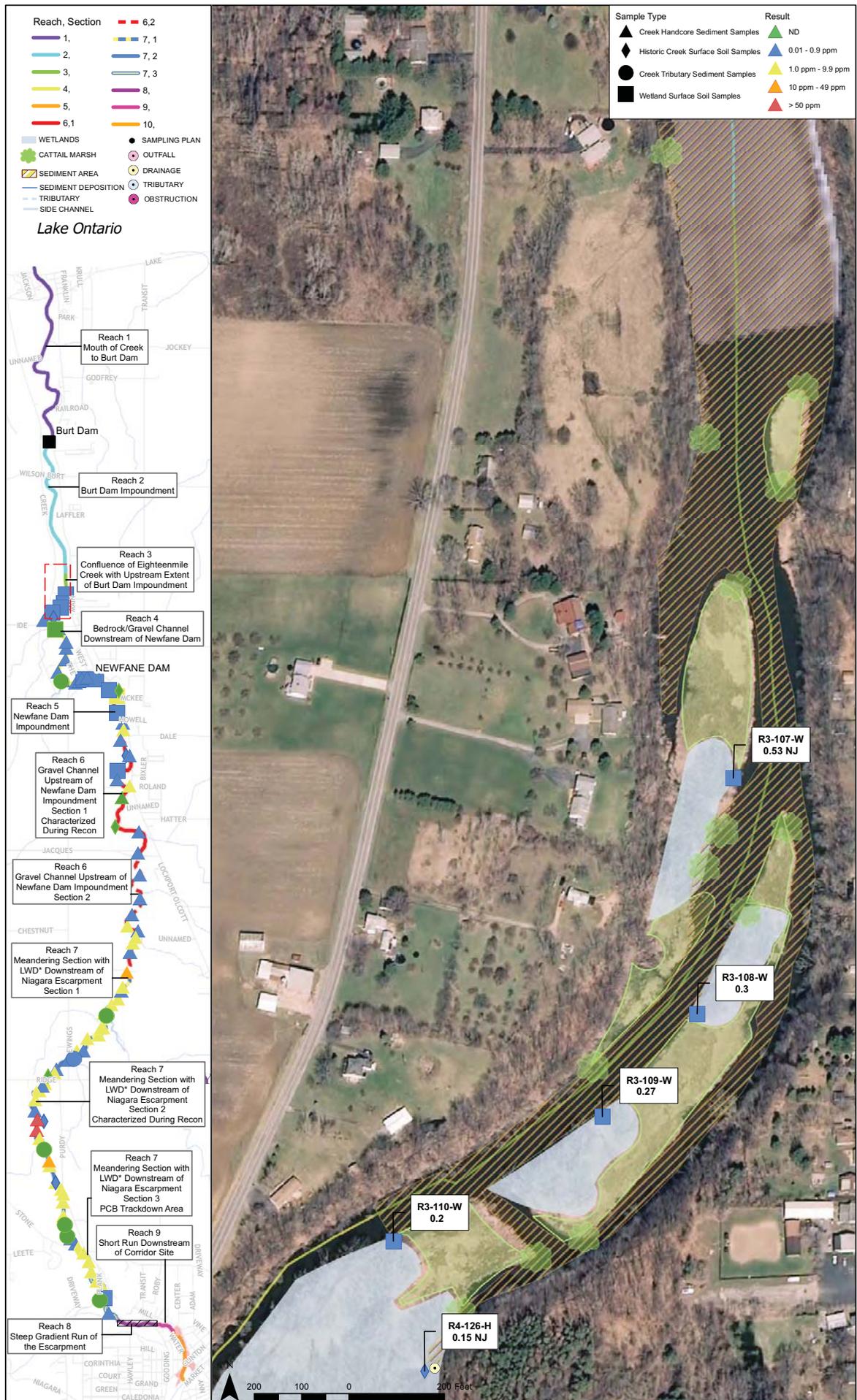


APPENDIX A

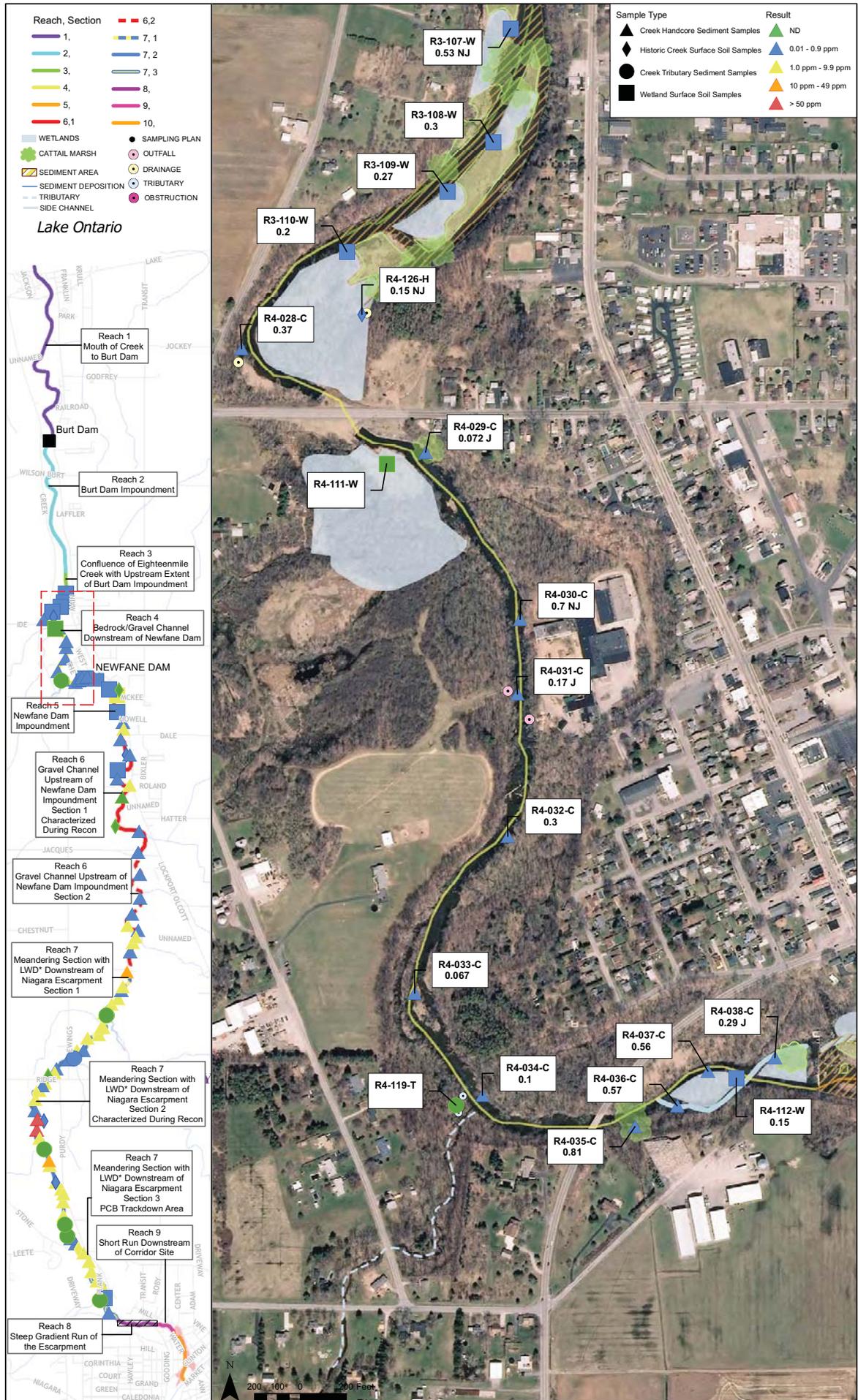
Data Summaries from the Great Lakes Legacy Act Sediment Characterization Study at Eighteenmile Creek

Appendix A: Sediment Data from Recent Investigations

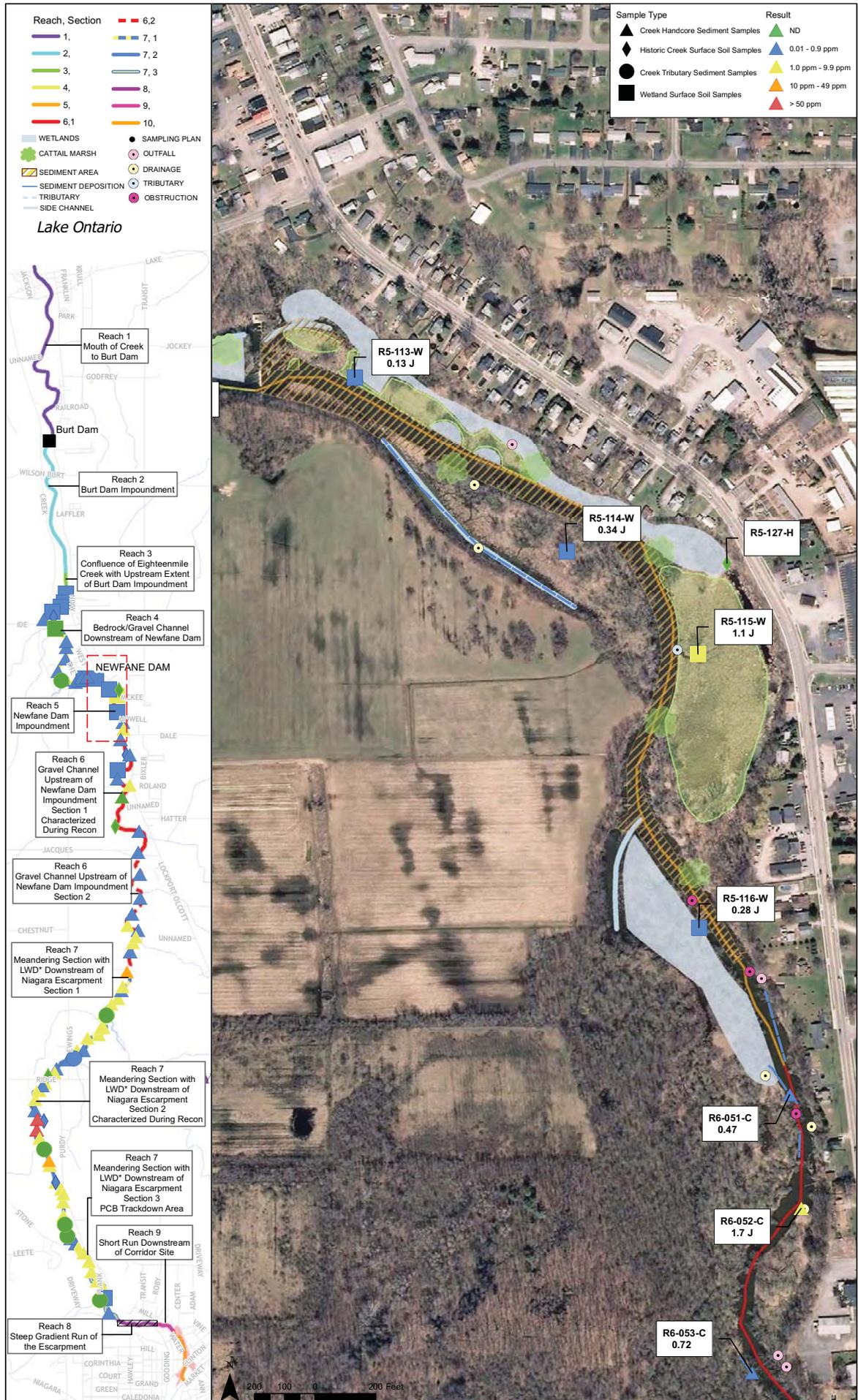
This appendix presents preliminary sediment data for polychlorinated biphenyls (PCBs) and selected metals collected recently (2009 and 2010) from Eighteenmile Creek above Burt Dam. It includes a series of figures showing total PCB levels in surface sediment.



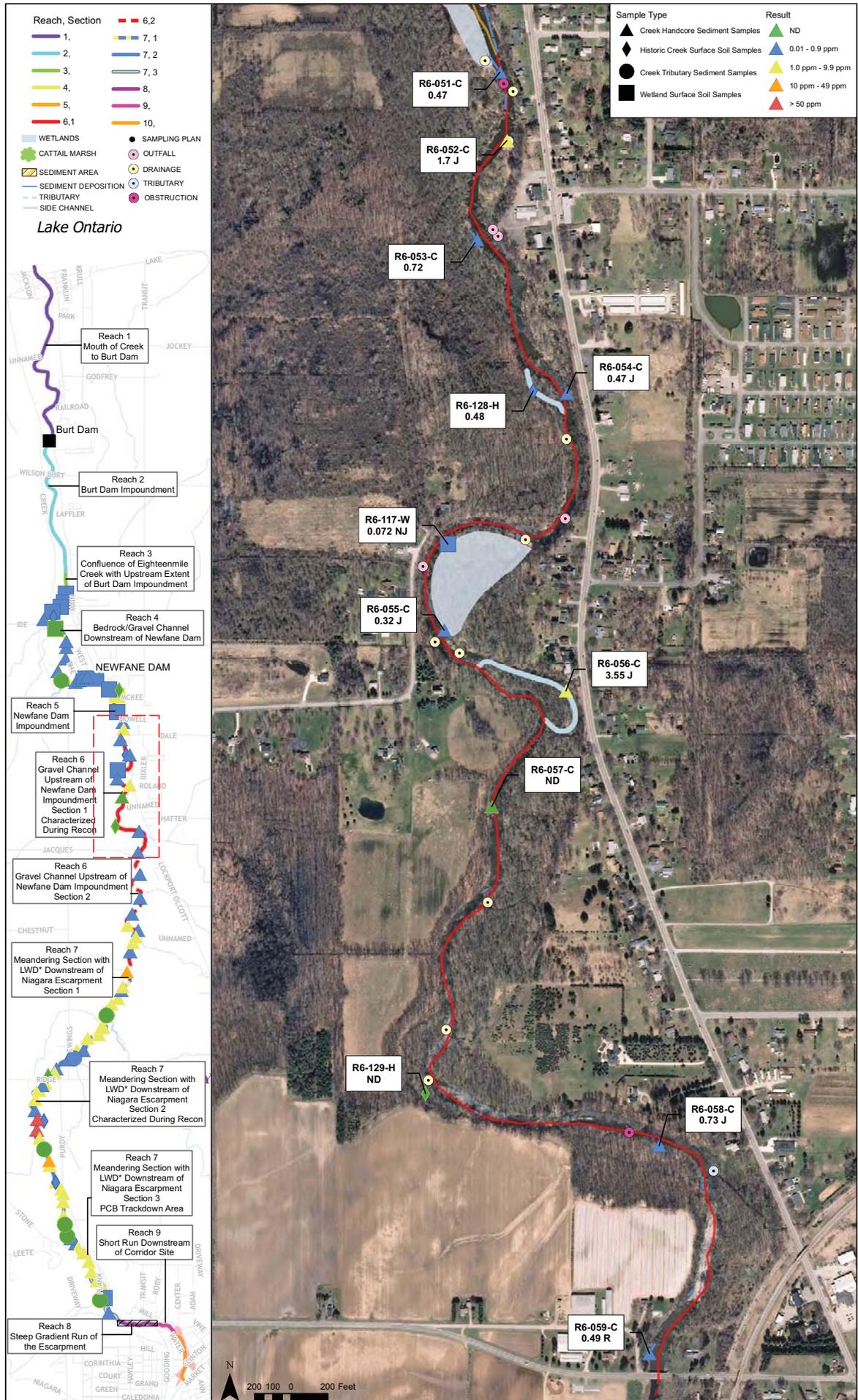
Reach 3 2009 Site Characterization PCB Results



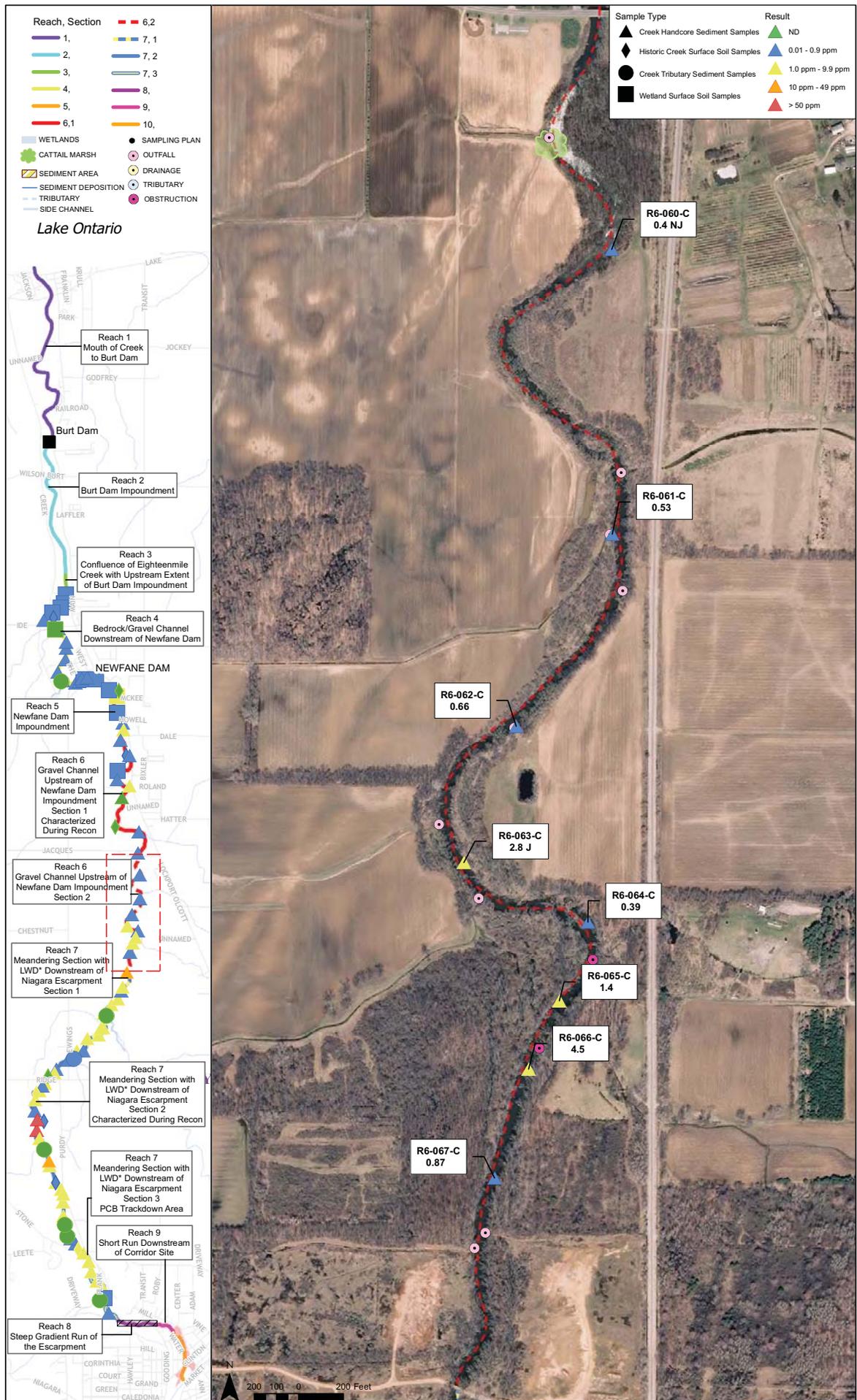
Reach 4 2009 Site Characterization PCB Results



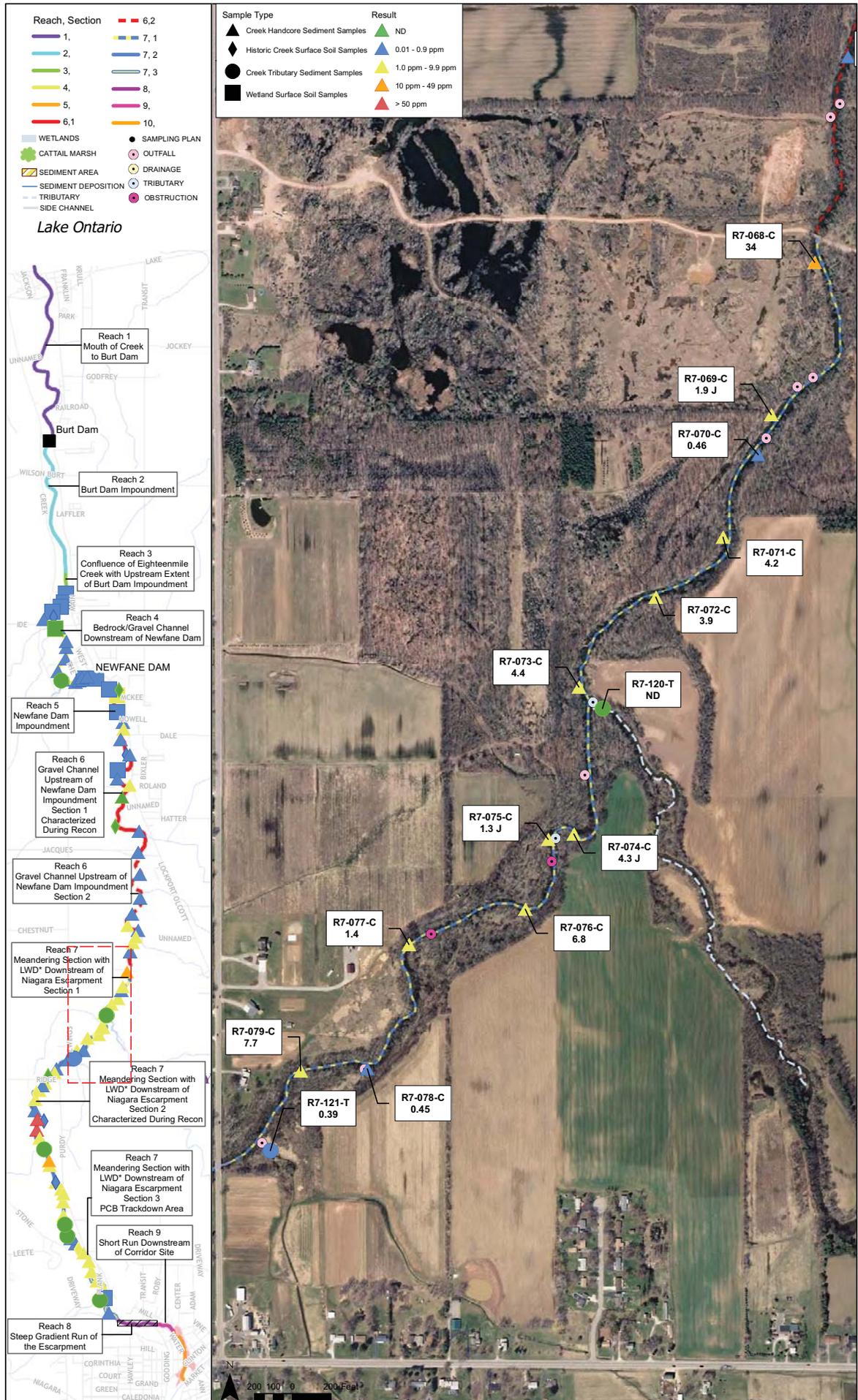
Reach 5 2009 Site Characterization PCB Results



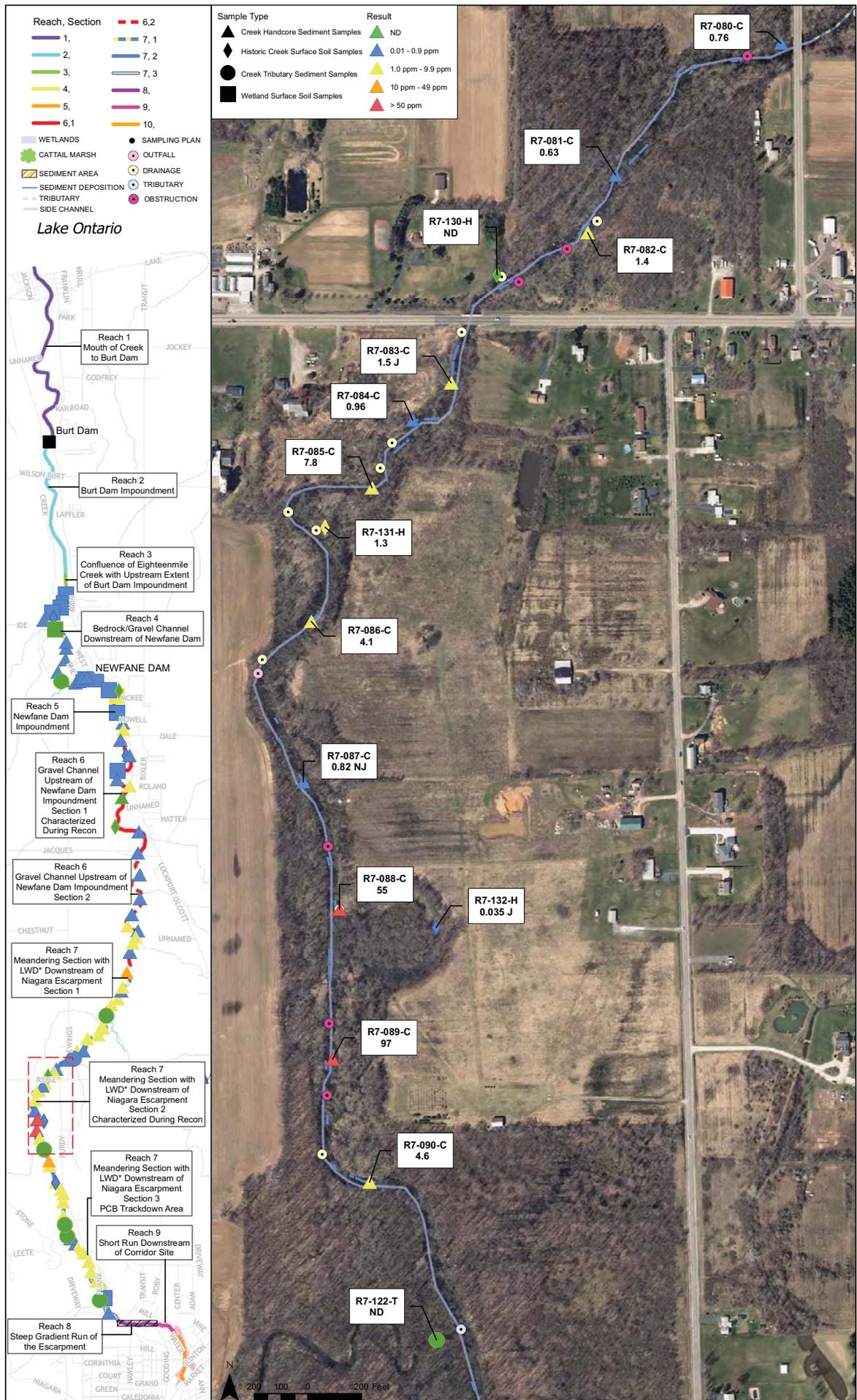
Reach 6 Section 1 2009 Site Characterization PCB Results



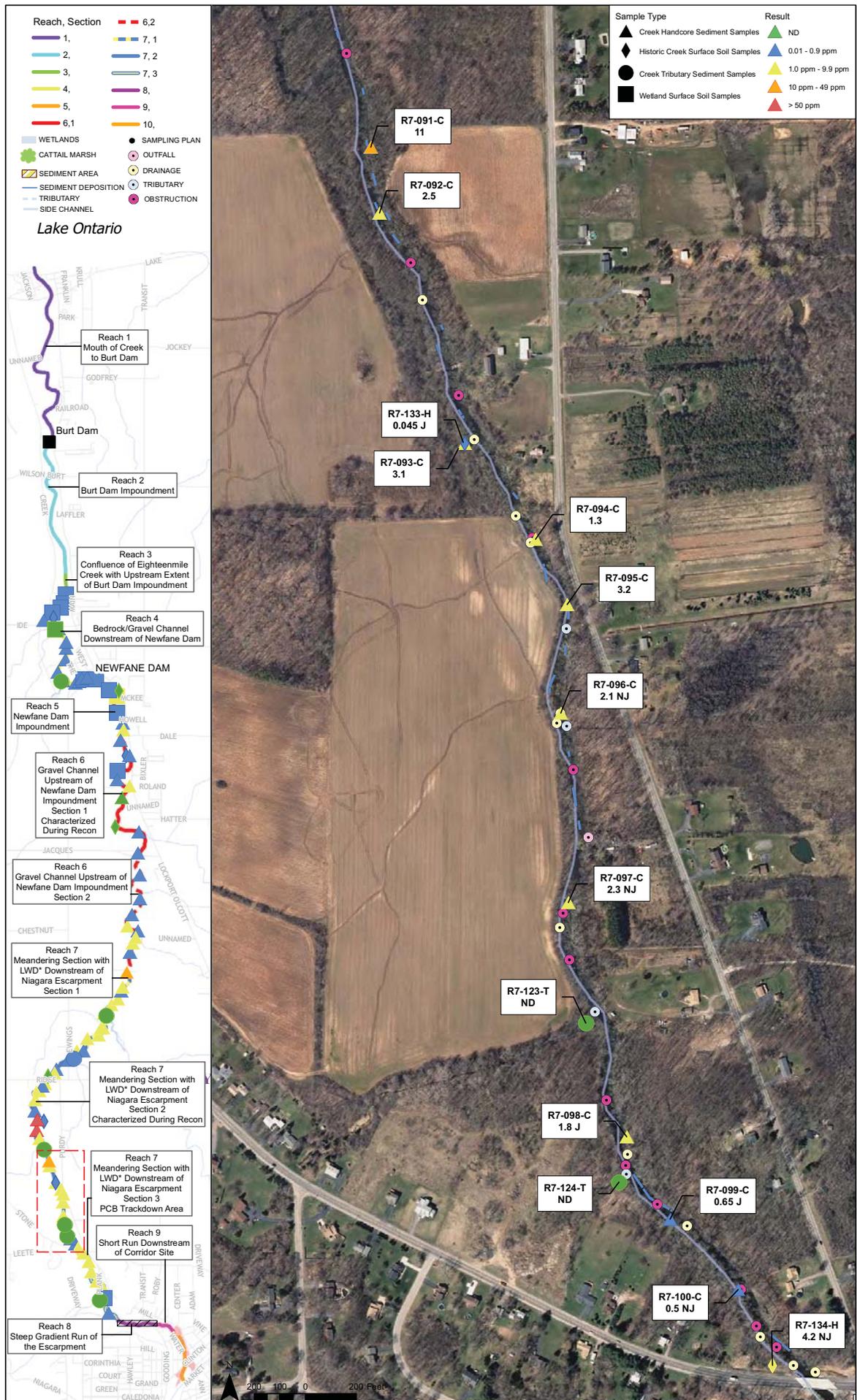
Reach 6 Section 2 2009 Site Characterization PCB Results



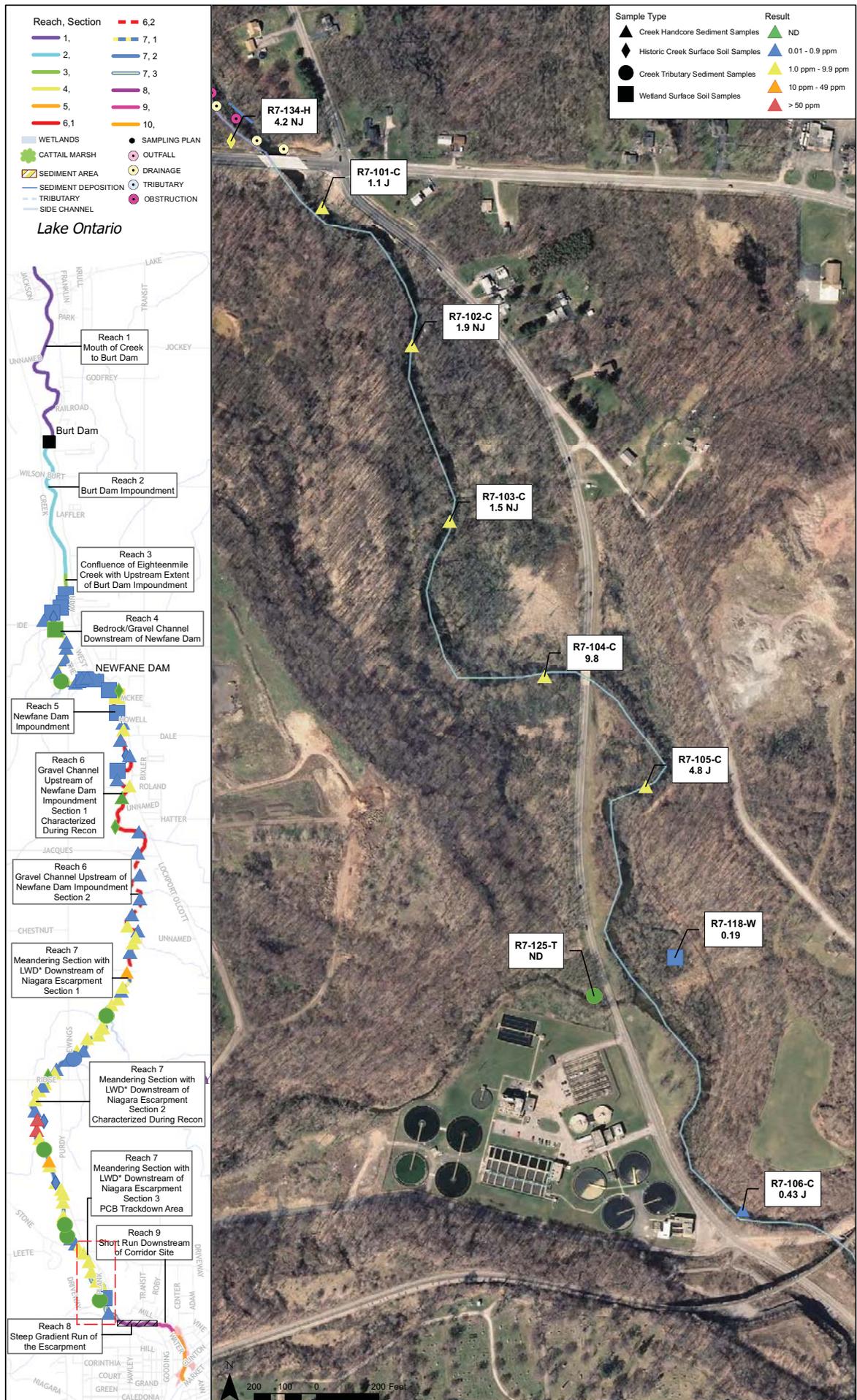
Reach 7 Section 1 2009 Site Characterization PCB Results



Reach 7 Section 2 Part 1 2009 Site Characterization PCB Results



Reach 7 Section 2 Part 2 2009 Site Characterization PCB Results



- Reach, Section**
- 1, 6,2
 - 2, 7, 1
 - 3, 7, 2
 - 4, 7, 3
 - 5, 8,
 - 6,1 9,
 - 10,

- WETLANDS**
- CATTAIL MARSH
 - SEDIMENT AREA
 - SEDIMENT DEPOSITION
 - TRIBUTARY
 - SIDE CHANNEL

Lake Ontario

Reach 1 Mouth of Creek to Burt Dam

Burt Dam

Reach 2 Burt Dam Impoundment

Reach 3 Confluence of Eighteenmile Creek with Upstream Extent of Burt Dam Impoundment

Reach 4 Bedrock/Gravel Channel Downstream of Newfane Dam

NEWFANE DAM

Reach 5 Newfane Dam Impoundment

Reach 6 Gravel Channel Upstream of Newfane Dam Impoundment Section 1 Characterized During Recon

Reach 6 Gravel Channel Upstream of Newfane Dam Impoundment Section 2

Reach 7 Meandering Section with LWD* Downstream of Niagara Escarpment Section 1

Reach 7 Meandering Section with LWD* Downstream of Niagara Escarpment Section 2 Characterized During Recon

Reach 7 Meandering Section with LWD* Downstream of Niagara Escarpment Section 3 PCB Trackdown Area

Reach 9 Short Run Downstream of Corridor Site

Reach 8 Steep Gradient Run of the Escarpment

Sample Type	Result
▲ Creek Handcore Sediment Samples	▲ ND
◆ Historic Creek Surface Soil Samples	▲ 0.01 - 0.9 ppm
● Creek Tributary Sediment Samples	▲ 1.0 ppm - 9.9 ppm
■ Wetland Surface Soil Samples	▲ 10 ppm - 49 ppm
	▲ > 50 ppm

Reach 7 Section 3 2009 Site Characterization PCB Results

APPENDIX B

Cost Estimates

Appendix B

Rough Cost Estimates and Descriptions of Recommended Actions

This appendix presents rough cost estimates and descriptions of recommended actions to advance delisting of beneficial use impairments at Eighteenmile Creek, Niagara County, New York. This appendix includes seven subsections:

- Appendix B.1 -- Remedial Costs for the Eighteenmile Creek Corridor Site and Former Flintkote Plant Site, Lockport, New York.
- Appendix B.2 -- Range of Sediment Remedial Costs for Great Lakes Sediment Sites.
- Appendix B.3 -- Rough Cost Estimate for Baseline Sampling and Long-Term, Post-Remedial Monitoring of Fish from Different Trophic Levels in the Eighteenmile Creek System.
- Appendix B.4 -- Pilot Study on Use of Powdered Activated Carbon to Reduce Bioavailability of Polychlorinated Biphenyls (PCBs) in Eighteenmile Creek Sediment.
- Appendix B.5 -- Rough Cost Estimate for Use of TrophicTrace Model to Establish Site-specific Sediment Remedial Goals for PCBs in Eighteenmile Creek.
- Appendix B.6 -- Mink Survey and Exposure Assessment within the Eighteenmile Creek Area of Concern (AOC) and Watershed: Project Description and Cost Estimate.
- Appendix B.7 -- Cost Estimate for Stocking Eighteenmile Creek with Salmonid Species.
- Appendix B.8 -- Rough Cost Estimate for Baseline Sampling and Long-Term, Post-Remedial Monitoring of the Benthic Community in the Eighteenmile Creek System.

Appendix B.1.1

Remedial Costs for the Eighteenmile Creek Corridor Site (Site No. 932121), Lockport, New York

Introduction

The New York State Department of Environmental Conservation (NYSDEC), in consultation with the New York State Department of Health (NYSDOH), is proposing remedies for Operable Units (OU) 1, 3, 4, 5 and 6 of the Eighteenmile Creek Corridor Site. These remedies are described in the Proposed Remedial Action Plan (RAP) for the site (NYSDEC 2010). Included below is a summary of the remedial goals and proposed remedial alternatives and their costs identified in the RAP. The site location map and OU map are included in Figures 1 and 2 (from NYSDEC 2010), respectively.

Summary of Remedial Goals

The remediation goals for this site are to eliminate or reduce to the extent practicable:

- Exposures of residents, anglers and workers at or around the site to semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and inorganic compounds in surface soil/fill, subsurface soil/fill, and sediment;
- Environmental exposures of flora or fauna to SVOCs, PCBs, and inorganic compounds in surface soil/fill, subsurface soil/fill and sediment;
- The release of contaminants from subsurface soil/fill into groundwater that may create exceedances of groundwater quality standards; and
- The release of contaminants from surface soil/fill and subsurface soil/fill into Eighteenmile Creek and the millrace through erosion and the discharge of contaminated storm water runoff.

Further, the remediation goals for the site include attaining to the extent practicable of:

- 6 NYCRR Part 375 soil cleanup objectives;
- TAGM 4046 soil cleanup objectives when Part 375 soil cleanup objectives are not available; and
- Sediment Screening Concentration Guidelines (SCGs) derived from the Department's Technical Guidance for Screening Contaminated Sediments.

Summary of Proposed Remedial Alternatives

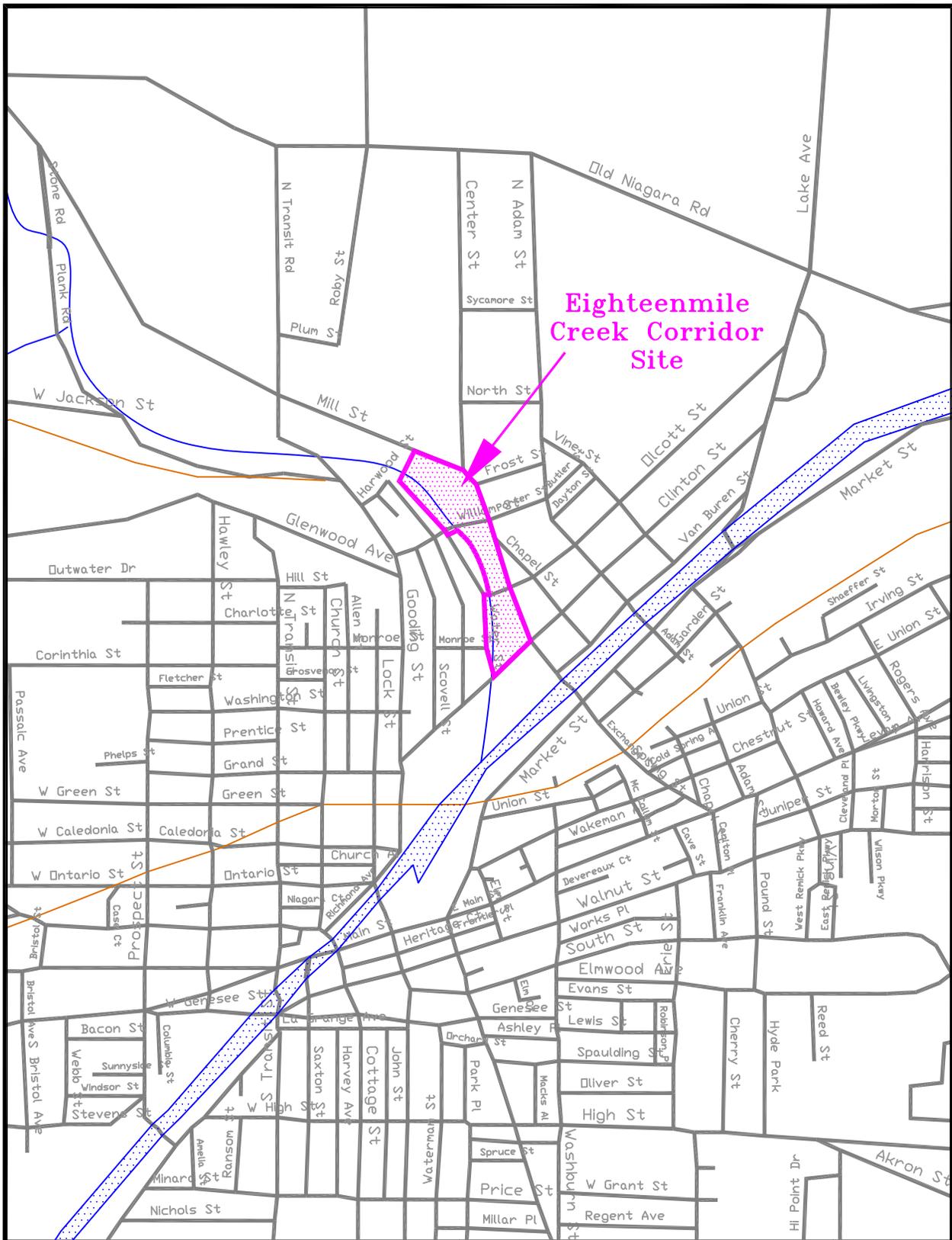
Table B.1-1, below, provides a summary of the costs for the proposed remedial alternatives identified for each OU. Costs of other alternatives that were evaluated and not selected are excluded from the table.

Reference

New York State Department of Environmental Conservation (NYSDEC). 2010. *Proposed Remedial Action Plan, Eighteenmile Creek Corridor Site, Operable Unit No. 1, 3, 4, 5 and 6, Lockport, Niagara County, New York, Site No. 932121*. Prepared by NYSDEC Division of Environmental Remediation. Available from <http://www.dec.ny.gov/chemical/49445.html> (accessed 12-5-10).

Table B.1-1 – Summary of Proposed Remedial Alternative Costs for the Eighteenmile Creek Corridor Site.				
Operable Unit	Remedial Alternative(\$)	Capital Costs(\$)	Annual Costs (\$)	Total Present Worth (\$)
1	Alt 7 - Sediment and Creek Bank Excavation with Restoration and Long-Term Monitoring: Dam and Pump Around	8,566,000	8,300 (annual) 18,200 (periodic)	8,818,000
3	Alt 3 - Hazardous Waste Removal with Bank Stabilization and Long-Term Monitoring	1,706,000	8,300 (annual) 24,700 (periodic)	1,985,000
4	Alt 3 - Hazardous Waste Removal with Bank Stabilization and Long-Term Monitoring	3,166,000	8,300 (annual) 22,900 (periodic)	3,438,000
5	Alt 3 - Hazardous Waste Removal with Bank Stabilization and Long-Term Monitoring	447,000	8,300 (annual) 14,000 (periodic)	681,000
6	Alt 4 - Limited Excavation with Bank Stabilization and Long-Term Monitoring	1,256,000	0	1,256,000
<i>Total Costs</i>		<i>15,141,000</i>	<i>33,200 (annual) 79,800 (periodic)</i>	<i>16,178,000</i>

Source: NYSDEC (2010)



**Eighteenmile
Creek Corridor
Site**

Lockport Quadrangle

Scale Depends on Final Plotted Size

SITE LOCATION MAP

DIVISION OF ENVIRONMENTAL REMEDIATION

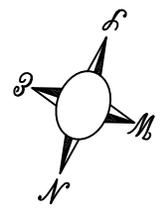
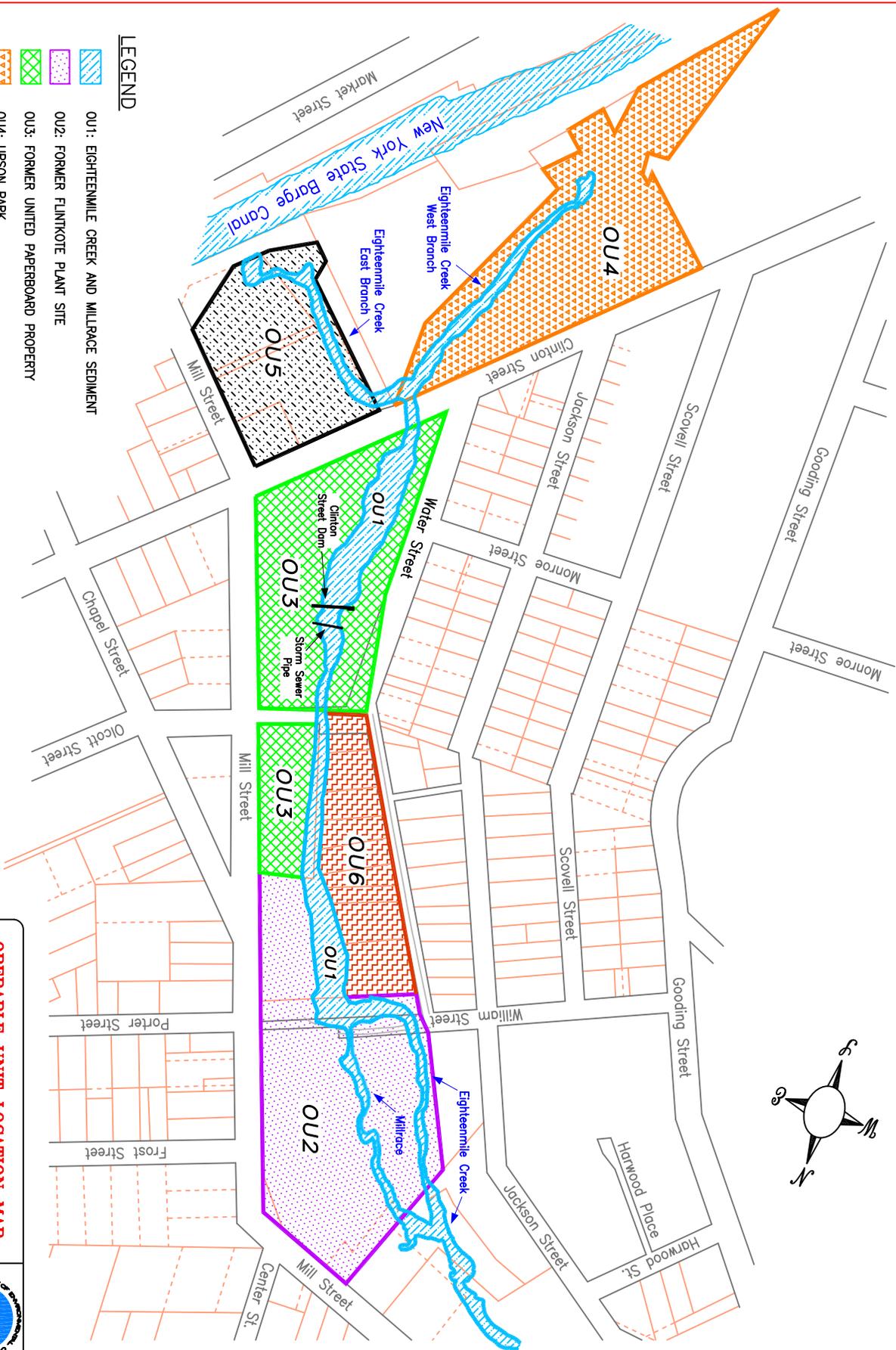
DATE: 02/20/03 DRAWING: Location Map.dwg

SITE: **EIGHTEENMILE CREEK CORRIDOR**



FIGURE 1

- LEGEND**
-  OU1: EIGHTEENMILE CREEK AND MILLRACE SEDIMENT
 -  OU2: FORMER FLINTKOTE PLANT SITE
 -  OU3: FORMER UNITED PAPERBOARD PROPERTY
 -  OU4: UPSON PARK
 -  OU5: WHITE TRANSPORTATION PROPERTY
 -  OU6: WATER STREET RESIDENTIAL PROPERTIES



OPERABLE UNIT LOCATION MAP

DIVISION OF ENVIRONMENTAL REMEDIATION

DATE: 08/12/09 DRAWING: Site Wide Map.dwg

SITE NAME: EIGHTEENMILE CREEK CORRIDOR



FIGURE 2

Appendix B.1.2
Estimates Remedial Costs for Former Flintkote Plant Site, Lockport, New York

Introduction

The New York State Department of Environmental Conservation (NYSDEC or Department) has selected a remedial action for the Former Flintkote Plant Site (B-00161-9) in its Record of Decision (ROD) published in 2006. Included below is a summary of the remedial goals and a description and cost for the selected remedial alternative. A site location map, site features map, and hazardous fill area map are provided as Figures 1, 2, and 7, respectively. The figures were taken directly from NYSDEC (2006) without modification.

Summary of Remedial Goals

The remediation goals for this site are to eliminate or reduce to the extent practicable:

- Exposures of persons at or around the site to semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, and metals in surface soil/fill, subsurface ash/fill, creek and millrace sediment, unfiltered groundwater, sediments in buildings, waste in buildings, and standing water in buildings;
- Environmental exposures of flora or fauna to SVOCs, PCBs, and metals in surface soil/fill, subsurface ash fill, and creek and millrace sediment;
- The release of contaminants from subsurface ash fill into groundwater that may create exceedances of groundwater quality standards; and
- The release of contaminants from surface soil/fill, subsurface ash fill, unfiltered groundwater, sediments in buildings, waste in buildings, and standing water in buildings into Eighteenmile Creek and the millrace through the discharge of contaminated stormwater runoff, discharge of contaminated sediments, waste and standing water in buildings, and erosion of contaminated surface soil/fill and subsurface ash fill.

Further, the remediation goals for the site include attaining to the extent practicable:

- Ambient water quality standards;
- Technical Administrative Guidance Memorandum (TAGM) 4046 soil cleanup objectives; and
- Sediment screening concentration guidelines (SCGs).

Summary of Proposed Remedial Alternative

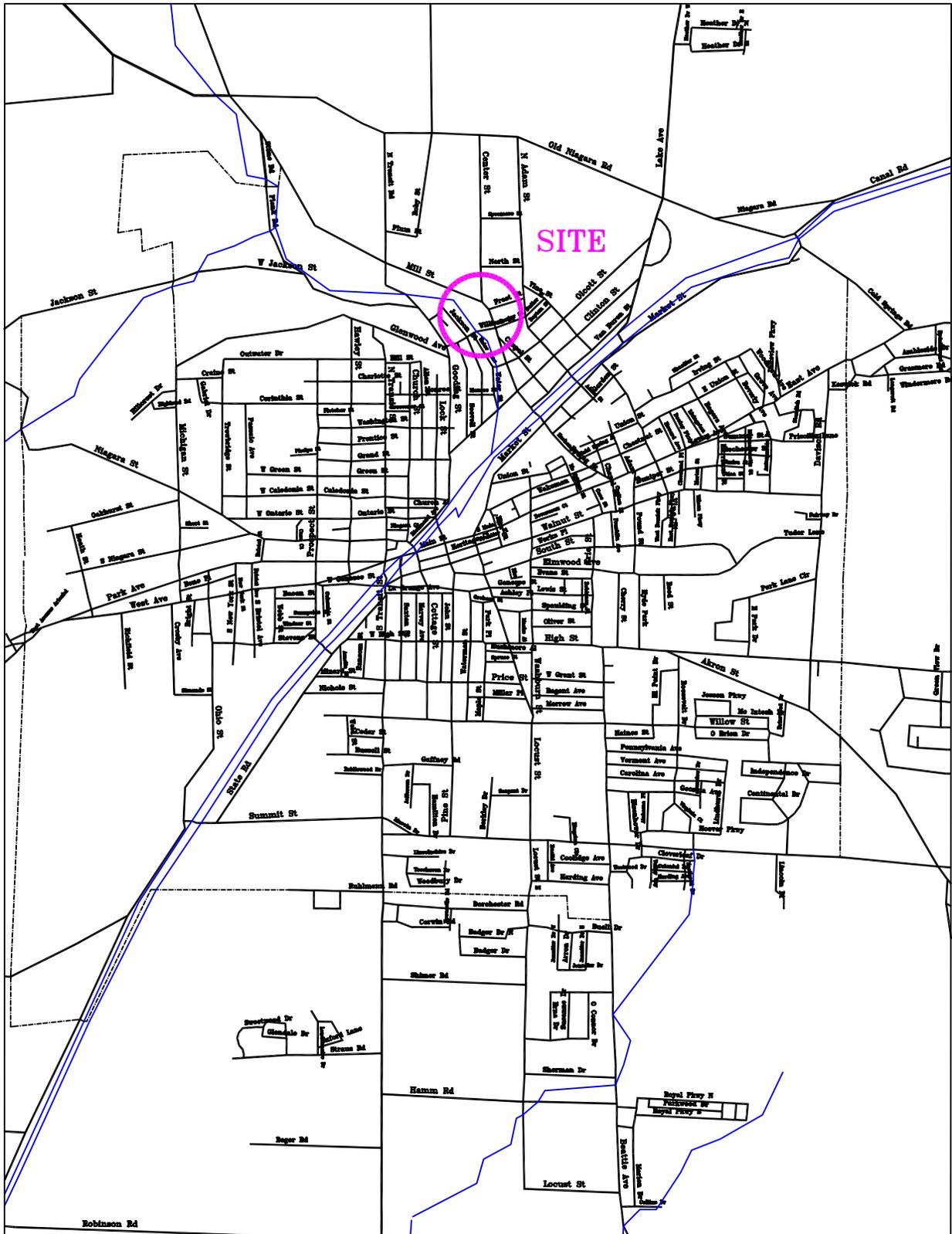
Table 1, below, provides a summary of the costs for the proposed remedial alternative identified in the ROD. Costs of other alternatives that were evaluated and not selected are excluded from the table.

Table 1 – Summary of Proposed Remedial Alternative Costs			
Selected Remedial Alternative	Capital Costs (\$)	Annual Costs (\$)	Total Present Worth (\$)
Alternative 4 – Excavation and Containment	5,552,000	6,800 (annual)	5,614,000

Source: NYSDEC (2006).

Reference

New York State Department of Environmental Conservation (NYSDEC). 2006. *Environmental Restoration Record of Decision: Former Flintkote Plant Site, City of Lockport Niagara County, New York, Site Number B-00161-9*. Prepared by NYSDEC Division of Environmental Remediation.



Lockport Quadrangle
 Scale Depends on Final Plotted Size

SITE LOCATION MAP

DIVISION OF ENVIRONMENTAL REMEDIATION

DATE: 08/29/00

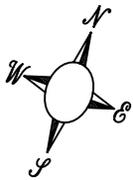
DRAWING: LOCATION2.DWG

SITE:

FORMER FLINTKOTE PLANT SITE



FIGURE 1



Residential Properties
(Not Part of Site)

Water Street

Flintkote Site,
Water Street Section

Residential Properties
(Not Part of Site)

Eighteenmile Creek

Half Buried
Concrete Structure

Timber Debris on
Slopes

Flintkote Site,
198 Mill Street

Partially Demolished
Buildings

Mill Street

Residential Properties
(Not Part of Site)

Chapel Street

Residential Properties
(Not Part of Site)

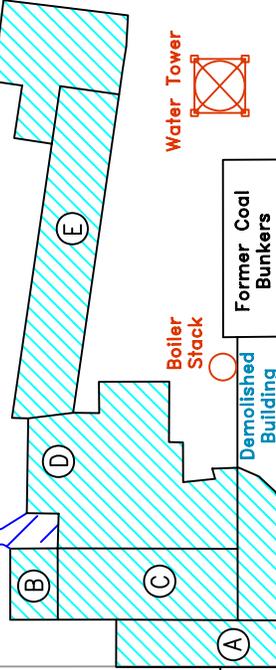
Eighteenmile Creek

Flintkote Site,
The Island

Millrace

Building Debris on Slopes

Flintkote Site,
300 Mill Street



Water Tower

Boiler Stack

Former Cool
Bunkers

Demolished
Building

Porter St.

Frost St.

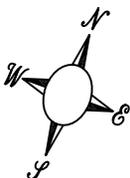


FLINTKOTE SITE MAP

DIVISION OF ENVIRONMENTAL REMEDIATION

DATE: 05/11/00 DRAWING: SITEMAP.DWG

SITE: FORMER FLINTKOTE PLANT SITE



LEGEND:

-  HAZARDOUS FILL AREAS
-  NON-HAZARDOUS FILL AREAS



LOCATION OF HAZARDOUS AND NON-HAZARDOUS FILL AREAS
DIVISION OF ENVIRONMENTAL REMEDIATION

DATE: 05/11/00 DRAWING: SITEMAP.DWG
SITE: FORMER FLINTKOTE PLANT SITE

Appendix B.2

Range of Sediment Remedial Costs for Great Lakes Sediment Sites

This appendix includes two tables that were used to help understand the cost of sediment remedial work at Eighteenmile Creek. The first table in this appendix was taken from the United States Environmental Protection Agency (EPA) Great Lakes Legacy Act web page (www.epa.gov/glla/remed/GreatLakesSedimentManagementPlan.pdf). The second table includes a subset of sites from the first table for which sediment remedial projects have been completed. Use of the information in these tables to estimate a cost for sediment remediation at Eighteenmile Creek (excluding the Corridor Site in Lockport, New York) is discussed in Section 2.1.

Great Lakes AOC Contaminated Sediment Site Management Plan - (October 29, 2010)

Site Name / Location	State	AOC	Estimated Volume of Contaminated Sediments	Estimated Cost (Average)	Responsible Office / Authority	Assessment Status	Remediation Complete?	Current Phase	Start Date (Current Phase)	Expected End Date (Current Phase)
MINNESOTA SITES										
St. Louis River/Interlake/Duluth Tar Superfund Site	MN	St. Louis River	455,000	\$45,600,000	State Superfund	Full	No	Implementation		
St. Louis River/Interlake/Duluth Tar Superfund Site - Carbon Mat (GLLA betterment to Superfund Remedy)	MN	St. Louis River	80,000	\$1,200,000	Legacy	Full	Yes	Carbon Mat Complete	2009	2010
St. Louis River/US Steel Superfund Site	MN	St. Louis River	225,000	\$27,500,000	Superfund		No	Assessment		2015
Minnesota Slip	MN	St. Louis River	33,000	\$6,000,000	Not Determined		No	Feasibility		
Minnesota Sites Needing Assessment										
Superior Bay Sites	MN	St. Louis River	4,329,000	\$433 million - \$4.3 billion	Not Determined	Not assessed	No			
St. Louis Bay Sites	MN	St. Louis River	3,418,000	\$342 million - \$3.4 billion	Not Determined	Not assessed	No			
Lower St. Louis River	MN	St. Louis River	4,872,000	\$487 million - \$4.9 billion	Not Determined	Not assessed	No			
Upper St. Louis River	MN	St. Louis River	4,986,000	\$499 million - \$5 billion	Not Determined	Not assessed	No			
WISCONSIN SITES										
St. Louis River/Duluth Harbor/Newton Creek/Superior Bay	WI	St. Louis River	500,000	\$27,500,000	Superfund		No	Assessment		
St. Louis River - Howards Bay	WI	St. Louis River	680,000		Legacy	Partial	No	Assessment	2010	2010
Hog Island / Newton Creek Inlet	WI	St. Louis River	40,000	\$6,300,000	Legacy	Full	Yes	Remediation Complete		2005
Fox River/Lower Green Bay [Superfund: OU 1 - Little Lake Butte des Morts]	WI	Fox River / Green Bay	784,000	\$97,000,000	Superfund	Full	Yes	Remediation Complete		2009
Fox River/Lower Green Bay [Superfund: OU 2 - Appleton to Little Rapids]	WI	Fox River / Green Bay	46,000	\$10,000,000	Superfund	Full	No	Implementation		2011
Fox River/Lower Green Bay [Superfund: OU 3 - Little Rapids to DePere]	WI	Fox River / Green Bay	586,000	\$26,000,000	Superfund	Partial	No	Implementation		2019
Fox River/Lower Green Bay [Superfund: OU 4- DePere to Green Bay]	WI	Fox River / Green Bay	5,880,000	\$258,000,000	Superfund	Partial	No	Implementation		2019
Fox River/Lower Green Bay [Superfund: OU 5 - Green Bay] - Monitored Natural Recovery	WI	Fox River / Green Bay	29,000,000	\$40,000,000	Superfund	Partial	No			
Appleton MGP Site (Lower Fox River)	WI	Fox River / Green Bay			Not Determined	Not Assessed	No			
Hewitt Machines (Lower Fox River)	WI	Fox River / Green Bay			Not Determined	Not Assessed	No			
Two MGP Sites in Neenah (Lower Fox River)	WI	Fox River / Green Bay			Not Determined	Not Assessed	No			
Fond du Lac River (Upper Fox River Basin)	WI	Fox River / Green Bay			Not Determined	Not Assessed	No			
Silver Creek / Ripon MGP Site (Upper Fox River basin)	WI	Fox River / Green Bay			Not Determined	Not Assessed	No			
Ostkosh MGP (Upper Fox River basin)	WI	Fox River / Green Bay			Superfund	Partial	No	Assessment		
Green Bay MGP (Upper Fox River Basin)	WI	Fox River / Green Bay			Superfund	Partial	No	Assessment		
Menominee River [RCRA: Anslu site]	WI	Menominee River	250,000	\$28,750,000	RCRA	Partial	No	Design	2011	2013
Menominee River MGP Site (Boom Landing)	WI	Menominee River	2,000	\$850,000	Superfund	Partial	No			

Site Name / Location	State	AOC	Estimated Volume of Contaminated Sediments	Estimated Cost (Average)	Responsible Office / Authority	Assessment Status	Remediation Complete?	Current Phase	Start Date (Current Phase)	Expected End Date (Current Phase)
Menominee Harbor	WI	Menominee River			Not Determined	Partial	No			
Milwaukee Estuary - Miscellaneous sites	WI	Milwaukee Estuary	300,000	\$52,500,000	Not Determined		No	Unknown		
Kimickinnic River	WI	Milwaukee Estuary	167,000	\$23,000,000	Legacy	Full	Yes	Remediation Complete	2009	2009
Lincoln Park (Phase 1 - Lincoln Creek / West Oxbow)	WI	Milwaukee Estuary	100,000	\$22,000,000	Legacy	Full	No	Design	2010	2011
Lincoln Park (Phase 2 - East Oxbow / Milwaukee River)	WI	Milwaukee Estuary			Not Determined	Partial	No	Assessment	2010	2010
Blatz Pavilion - WDNR Cleanup	WI	Milwaukee Estuary	5,000	\$2,000,000	WDNR	Full	Yes	Remediation Complete	2008	2008
Milwaukee Estuary [Menomonee R. Superfund: Moss American NPL site]	WI	Milwaukee Estuary	64,000	\$18,500,000	Superfund	Full	Yes	Remediation Complete		2010
Milwaukee Estuary [Superfund: Solvay Coke removal action]	WI	Milwaukee Estuary	50,000	\$12,500,000	Superfund		No	Assessment		
Cedar Creek - Milwaukee River Basin [Superfund: Amcast Industrial Corp. Cedar Creek]	WI	Milwaukee Estuary	75,000	\$15,000,000	Superfund		No	Feasibility		
Cedar Creek - Milwaukee River Basin [Superfund: Mercury Marine Cedar Creek]	WI	Milwaukee Estuary	150,000	\$30,000,000	Superfund		No	Feasibility		
Sheboygan River Upper Reach [Superfund: Sheboygan River and Harbor NPL site]	WI	Sheboygan River	35,000	\$15,000,000	Superfund		Yes	Remediation Complete		
Sheboygan River Lower Reach [Superfund: Sheboygan River and Harbor NPL site]	WI	Sheboygan River	50,000	\$10,000,000	Superfund		No	Design Complete		
Sheboygan River: Camp Marina MGP	WI	Sheboygan River	10,000	\$5,000,000	Superfund	Partial	No	Design		
Sheboygan River Lower Reach [Legacy Act]	WI	Sheboygan River	60,000	\$15,000,000	Legacy	Partial	No	Assessment	2010	2011
ILLINOIS SITES										
Waukegan Harbor [Superfund: Outboard Marine Corp. NPL site]	IL	Waukegan	280,000	\$36,000,000	Superfund	Full	No	Design		
INDIANA SITES										
Indiana Harbor Canal [Corps: WRDA, Indiana Harbor and Ship Canal dredging project]	IN	Grand Calumet River	4,000,000	\$350,000	Corps	Partial	No	CDF Construction		2011
Grand Calumet River West Branch - Reaches 1,2 (Roxanna Marsh)	IN	Grand Calumet River	266,000	\$46,400,000	Legacy	Full	No	Design / Implementation		
Grand Calumet River West Branch - Reaches 3,4,5 (Hammond Sanitary District)	IN	Grand Calumet River	110,000	\$22,500,000	Legacy	Full	No	Implementation		
Grand Calumet River West Branch - Reaches 6,7 (State Line / NIPSCO)	IN	Grand Calumet River	11,700*	\$11,100,000	Legacy	Partial	No	Assessment / Feasibility		
Grand Calumet River East Branch - (DuPont)	IN	Grand Calumet River	561,000*	\$89,400,000	Legacy	Partial	No	Assessment		
East Branch Grand Calumet River (RCRA: US Steel Project)	IN	Grand Calumet River	890,000	\$55,000,000	RCRA/CWA	Full	Yes	Post-remediation monitoring		2008
MICHIGAN SITES										

Site Name / Location	State	AOC	Estimated Volume of Contaminated Sediments	Estimated Cost (Average)	Responsible Office / Authority	Assessment Status	Remediation Complete?	Current Phase	Start Date (Current Phase)	Expected End Date (Current Phase)
Ashtabula River: (Corps Outer Harbor)	OH	Ashtabula	200,000	\$6,000,000	Corps	Partial	No	Design		2011
Cuyahoga River Old Channel (RM 0.9-1.3 Upper End)	OH	Cuyahoga River	116,000	\$12,000,000	Not Determined	Partial	No	Assessment		2011
Cuyahoga: LaFarge / Mirage Slip (RM 0.1)	OH	Cuyahoga River	15,000	\$1,000,000	Not Determined		No	Assessment		
Cuyahoga - RM 0-5.6, Inside Ship Channel (Corps, others)	OH	Cuyahoga River	350,000	\$35,000,000	Other		No			
Cuyahoga Gorge	OH	Cuyahoga River	100,000	\$15,000,000	Legacy	Partial	No	Assessment	2010	2011
Isolated Hot Spots throughout Cuyahoga AOC	OH	Cuyahoga River	100,000	\$11,500,000	Not Determined		No			
Ottawa River (Lower Reaches: RM 0 - RM 3.2)	OH	Maumee River	250,000	\$25,000,000	Not Determined		No	Assessment		
Ottawa River (Upper Reaches: RM 3.2 - RM 8.8)	OH	Maumee River	250,000	\$49,000,000	Legacy		No	Implementation	2009	2010
Maumee Bay - Ottawa River Connecting Channel	OH	Maumee River	117,333	\$6,453,333	Not Determined		No			
Maumee River Shipping Channel (Corps?)	OH	Maumee River	600,000	\$19,500,000	Other		No			
Maumee River - RM 0-7 (Corps?, inside Ship Channel, mouth to I-75 Bridge)	OH	Maumee River	300,000	\$9,750,000	Other		No			
Maumee River - RM 0-7 (outside Ship Channel, mouth to I-75 Bridge)	OH	Maumee River	800,000	\$63,200,000	Not Determined		No			
Al Creek/Swan Creek - RM 0-1 (mouth to I-75)	OH	Maumee River	50,000	\$5,000,000	Not Determined		No			
Duck Creek (Lower Reach)	OH	Maumee River	40,000	\$6,000,000	Legacy	Full	No	Assessment		
Otter Creek - Lower Reach	OH	Maumee River	120,000	\$18,000,000	Legacy	Full	No	Assessment		
Isolated Hot Spots throughout Maumee AOC	OH	Maumee River	300,000	\$20,100,000	Not Determined		No			
NEW YORK SITES										
Buffalo River	NY	Buffalo River	600,000	\$40,000,000	Legacy	Full	No	Design	2010	2012
Buffalo River (Corps navigation channel - GLRI)	NY	Buffalo River	400,000	\$8,000,000	Corps	Full	No	Design	2011	2011
Eighteenmile Creek	NY	Eighteenmile Creek	250,000	\$25,000,000	Legacy	Partial	No	Assessment	2008	2011
Niagara River	NY	Niagara River	250,000	\$31,250,000	Not Determined		No	Assessment		
Smokes Creek	NY	Niagara River			Legacy	Partial	No	Assessment		
St. Lawrence River (Massena)	NY	St. Lawrence River	1,000,000	\$125,000,000	Superfund		No	Assessment		

Note: Yellow Highlighted rows indicate projects where remediation work is substantially complete.

Table 2. Range of Costs for Completed Great Lakes Sediment Remediation Projects.

Site	Sediment Volume Remediated (cubic yards)	Cost
Baltz Pavilion, WI	5,000	\$2,000,000
St Mary's River, Former MGP Site, MI	8,000	\$1,500,000
Sheboygan River Upper Reach, WI	35,000	\$15,000,000
Hog Island and Newton Creek, WI	40,000	\$6,300,000
St Mary's River, Tannery Bay, MI	40,000	\$8,000,000
Milwaukee Estuary, Moss American Site, WI	64,000	\$18,500,000
Ruddiman Creek, MI	90,000	\$13,000,000
Manistique River and Harbor (non-time critical), MI	111,000	\$40,000,000
Ashtabula River, OH (Corps Federal Channel)	135,000	\$13,000,000
Kinnickinnic River, WI	167,000	\$23,000,000
Ashtabula River, OH (GLLA project)	500,000	\$60,000,000
Fox River OU1, WI	784,000	\$97,000,000

Source: Completed projects only from the U.S. Environmental Protection Agency Great Lakes Legacy Act web page (www.epa.gov/glla/remed/GreatLakesSedimentManagementPlan.pdf).

Appendix B.3

Rough Cost Estimate for Baseline Sampling and Long-Term, Post-Remedial Monitoring of Fish from Different Trophic Levels in the Eighteenmile Creek System

The cost of baseline sampling and one round of post-remedial sampling are estimated to be \$65,950 and \$59,950, respectively. The estimate for post-remedial sampling is less than the estimate for baseline sampling because the Sampling and Analysis Plan (SAP) prepared for baseline sampling is assumed to be useful for post-remedial sampling with little or no modification. The cost estimate for fish monitoring includes four tasks: (1) SAP preparation; (2) field sampling; (3) fish tissue analysis; and (4) reporting. It is expected that SAP development will be a desktop effort requiring approximately one week to complete. Field sampling is expected to be a three day effort by a team of three biologists. The sampling will entail collecting five forage fish composite samples and five game fish samples from each of three reaches of Eighteenmile Creek—below Burt Dam; between Newfane and Burt Dams; and upstream from Newfane Dam—for a total of 30 fish samples. We expect that fish sampling will take one day per reach. The fish samples will be analyzed for PCBs, lipids, and percent moisture. Finally, a report will be drafted and finalized summarizing the findings of fish sampling.

Appendix B.4

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

Introduction

This project will evaluate the effectiveness of using powdered activated carbon (PAC) to reduce bioavailability of polychlorinated biphenyls (PCBs) in Eighteenmile Creek sediment. Up to 90% reduction in PCB bioavailability has been observed at sites where this method has been used (Luthy et al. 2009, Clu-in 2010). The five beneficial use impairments (BUIs) at Eighteenmile Creek are all ultimately linked to high PCBs levels in sediment (see Section 2). If the pilot study proves to be successful (i.e., if PAC is effective in reducing PCB bioavailability in Eighteenmile Creek sediment), then application of this technique *in situ* has the potential to contribute to delisting of these BUIs. If implemented, the results of this study will be incorporated into the Eighteenmile Creek Feasibility Study (FS). Sediment treatment with PAC 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.

Project Specifics

This project will include a laboratory bench-top pilot study with Eighteenmile Creek sediment. Creek sediments representing a range of PCB concentrations will be collected and augmented with a range of PAC concentrations. Bioaccumulation in each treatment will be determined by USEPA (2000) Test Method 100.3 (28-day *Lumbriculus variegatus* Bioaccumulation Test for Sediments). For comparison, bioaccumulation in untreated sediment from Eighteenmile Creek also will be evaluated. Upon test completion, the sediment samples will be analyzed for PCBs and total organic carbon and the test organisms will be analyzed for PCBs and percent lipids. Bioaccumulation will be evaluated by comparing PCB levels in test organisms among treatments and by calculating and comparing biota-sediment accumulation factors among treatments. Additional information regarding this recommended action can be found in the Western Lake Ontario (WLO) factsheet project for regional stakeholders entitled *Pilot Study on Use of Powdered Activated Carbon to Reduce Bioavailability of Polychlorinated Biphenyls (PCBs) in Eighteenmile Creek Sediment*. The factsheet provides additional details on sampling locations and study design.

Rough Cost Estimate

\$70,820 total divided as follows: \$6,000 for preparation of plans; \$5,000 for sediment sampling; \$44,800 for bioaccumulation testing and chemical analysis; and \$15,000 reporting.

References

- Clu-in. 2010. *Contaminated Site Clean-Up Information*. Available online at: <http://www.clu-in.org/contaminantfocus/default.focus/sec/Sediments/cat/Overview/>. Accessed January 12, 2011.
- Luthy, Richard G., Yeo-Myoung Cho, Upal Ghosh, Todd S. Bridges, and Alan J. Kennedy. May 2009. *Field Testing of Activated Carbon Mixing and In Situ Stabilization of PCBs in Sediment*.
- United States Environmental Protection Agency (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.

Appendix B.5

Rough Cost Estimate for Use of TrophicTrace Model to Establish Site-specific Sediment Remedial Goals for PCBs in Eighteenmile Creek

This appendix contains e-mail correspondence between Karl Gustavson (U.S. Army Engineer Research and Development Center) and Carl Mach (Ecology and Environment, Inc.) regarding the scope and cost of this potential action.

From: Gustavson.Karl@epamail.epa.gov
Sent: Tuesday, March 08, 2011 12:13 PM
To: Mach, Carl
Cc: Katherine von Stackelberg; Hinterberger, Bryan A LRB
Subject: Fw: Eighteenmile Creek TrophicTrace Modeling Project

Attachments: 18MCestimate2-24-2011.xlsx

Carl,

Sorry for the delay on this. I wanted to run it by Bryan first as he is the current project sponsor.

A couple things to note. 1) The list is comprehensive and contains items to satisfy uncertainties at the site that relate directly and indirectly to foodweb modeling. Those uncertainties were identified during review of data and model output for the site. Some efforts may already be planned by others; 2) In that regard, there may be a hierarchy here for what could be supported, depending on your needs. At this point, our intent was to be inclusive; and 3) costs are "back-of-the envelope" estimates to give you a ballpark of what to expect if efforts are pursued.

So, based on where we are at now with modeling, I see two primary efforts.

1) Refine model and impacts to receptors by investigating exposure pathways. (Efforts seek to elucidate potentially unmodeled/unknown dietary source; possible water pathway).

- a. stomach contents of largemouth bass and bullheads during spring and summer timeframe (need to better understand diet during various seasons)
- b. sampling of crayfish contaminant levels (in fall they had a very large crayfish dietary component)
- c. water sampling to define dissolved fraction (we only have one sample of dissolved PCB congeners from 1998)
- d. In fall 2012, duplicate sediment and fish tissue sampling used in model development

2. Use of model to develop remedial goals

- a. evaluate PCB congener vs Aroclor relationship in sediment and biota to define appropriate metric for risk-based remedial goals (there is a large discrepancy between aroclors and congeners; both could be considered "total PCB"; they would give you vastly different results).
- b. use Feb 2011 model to develop risk-based remedial goals; update results based on above studies.
- c. update 2011 model and remedial goals based on Task 1 data
- d. high resolution geochronology and chemistry cores (provide an indication of chemistry changes over time to then predict time to remedial goals under no action, assuming rate continues).

Attached is a very rough cost estimate to give an indication as to the general cost.

Give me a call or email if you'd like to discuss.

(See attached file: 18MCestimate2-24-2011.xlsx)

Karl Gustavson, Ph.D.
US Army Engineer Research and Development Center Duty Station: Contaminated Sediments Team,
USEPA OSRTI
Phone: 703-603-8753
Fax: 703-603-9112

From: "Mach, Carl" <CMach@ene.com>
To: Karl Gustavson/DC/USEPA/US@EPA, "Katherine von Stackelberg"
<kvon@erisksciences.com>
Cc: "Bryan A LRB Hinterberger"
<Bryan.A.Hinterberger@usace.army.mil>, "Erickson, Kris"
<KErickson@ene.com>
Date: 02/18/2011 01:52 PM
Subject: RE: Eighteenmile Creek TrophicTrace Modeling Project

Karl, I would be interested in hearing from you and/or Katherine about the following: (1) how much effort is required to develop a sediment remedial goal for Eighteenmile Creek using the TT model and (2) what additional targeted sampling may be useful to refine the model. Can you provide rough cost estimates for these tasks? I would like to be able to convey in the Eighteenmile Creek AOC Strategic Plan about how much additional funding is needed from GLNPO and/or other sources to move the delisting process forward over the next year or two. Thanks in advance for your reply.

Carl Mach, Ph.D.
Ecology and Environment, Inc.
368 Pleasant View Drive
Lancaster, NY 14086
716-684-8060
cmach@ene.com

Table 1. Summary of Tasks and Cost Estimates for Additional TrophicTrace Modeling Work at Eighteenmile Creek from Karl Gustavson.

TASKS	<ol style="list-style-type: none">1) Refine model and impacts to receptors by investigating exposure pathways.<ol style="list-style-type: none">a. Stomach contents of largemouth bass and bullheads during spring and summer timeframe (\$51,250)b. Sampling of crayfish contaminant levels (\$48,500)c. Water sampling to define dissolved fraction of PCBs (\$79,750)d. In fall 2012, duplicate sediment and fish tissue sampling used in model development (\$102,500)2) Use of model to develop remedial goals.<ol style="list-style-type: none">a. Evaluate PCB congener vs Aroclor relationship in sediment and biota to define appropriate metric for risk-based remedial goals (\$45,000)b. Use Feb 2011 model to develop risk-based remedial goals (\$63,000)c. Update 2011 model and remedial goals based on Task 1 data (\$63,000)d. High resolution cores, chemistry, and geochronology markers (to indicate expected time to reach remedial goals) (\$59,250)
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Appendix B.6

Mink Survey and Exposure Assessment within the Eighteenmile Creek Area of Concern (AOC) and Watershed: Project Description and Cost Estimate

The mink survey and exposure assessment are discussed below in Sections 1 and 2, respectively. The work described in this appendix is a scaled-back version of the work described in the Western Lake Ontario (WLO) factsheet entitled *Survey for Levels of Bioaccumulative Chemicals in Wildlife Prey and Tissues and Wildlife Deformities within Western Lake Ontario and its Tributaries*. If that project is implemented, then the work described in this appendix is unnecessary.

1. Mink Survey

This investigation will take place within the Eighteenmile Creek AOC and watershed and include the following tasks:

- Desktop analysis to identify potential mink habitats within the AOC and watershed and site visits;
- Collection and analysis of video-recorded and field data; and
- Video and field data reporting of pertinent study findings.

1.1 Project Overview and Background

This project is designed to provide data regarding the relative abundance and population structure of mink in the Eighteenmile Creek AOC. This will be done using weather-proof video surveillance equipment as was done by Wellman and Haynes (2006) in and near the Rochester Embayment AOC. This study will be a scaled-down version of the Wellman and Haynes (2006) study, with the objective of determining if mink are present and reproducing in the Eighteenmile Creek AOC. The video surveillance data for Eighteenmile Creek will be compared with similar data collected by Wellman and Haynes (2007) at Iroquois National Wildlife Refuge and Bergen Swamp to qualitatively evaluate whether mink relative abundance at Eighteenmile Creek differs from these reference areas. The data from this study will be useful in determining if BUI #5—Bird or Animal Deformities or Reproductive Problems—is impaired at the Eighteenmile Creek AOC. The mink has been selected as the focus of this investigation for the reasons described below.

American Mink

The American mink (*Neovison vison*) is a medium sized mammal belonging to the *Mustelid* family, which also includes ferrets, weasels, fishers, otters, wolverine and badgers. This species exhibits an elongate body and a long tail with relatively short legs and ears. Mink occur throughout New York and in most areas of the United States (United States Environmental Protection Agency [USEPA] 1993). Mink prefer forested areas within permanent or semipermanent wetlands, riparian areas, lakes and marshes, and generally occupy dens in hollow logs, or those created by other aquatic to semi-aquatic species, such as beavers and muskrats. Within New York, habitat studies conducted by trappers have found mink most often in streams followed by beaver ponds, lakes, and marshes (New York State Department of Environmental Conservation [NYSDEC] 2011).

This species is carnivorous and lives on a diet consisting of animals that occupy riparian to aquatic ecosystems including small to medium-sized mammals, birds, fish, and crayfish (USEPA 1993). Mink are usually solitary animals, however, males and females will begin associating during the late winter, upon initiation of the breeding season (NYSDEC 2011). Between April and June, female mink give birth to between one to eight kits (with an average of four kits; NYSDEC 2011).

Mink have been described as a sentinel species, meaning that their presence/absence may indicate environmental conditions. Environmental contaminants, such as mercury, DDE, DDT, dieldrin, and PCBs have been reported as having negative impacts to mink by causing weight loss and reproductive

issues to captive individuals (NYSDEC 2011). It is for this reason that mink have been chosen as the harbingers of ecosystem health in the Great Lakes AOCs.

1.2 Project Specifics

Proposed Scope of Work for Mink Study in Eighteenmile Creek AOC

The employment of weather-proof video surveillance equipment should help reveal trends in mink relative abundance and population structure within the Eighteenmile Creek AOC and watershed. This information will be used for determining if the BUI for bird or animal deformities or reproductive problems should be designated as impaired or be considered for delisting. The overall scope can be implemented within one field season (February through November) and should be implemented within the next three years (2011, 2012, or 2013).

Task 1 – Desktop Analysis and Site Visit

This proposed project will begin with a brief desktop analysis to locate suitable video surveillance station locations. This task will include use of topographic map and aerial imagery within the Eighteenmile Creek AOC and watershed to locate potential video surveillance stations based on suitable mink habitat (e.g. forested swamps, riparian areas, etc.). Access to public and private land deemed suitable habitat will be coordinated with state and local agencies as well as land owners and any applicable wildlife study permits will be attained from NYSDEC.

A site visit will occur during late winter to field validate potential video station locations. Meetings with local fur trappers, if any—who are aware of local areas harboring mink populations—will also take place during the site visit to aid in video station site selection. Finally, the site visit will also include a time-meander field search. During this time, mink track concentrations that are found will be documented and incorporated as potential video surveillance stations. The two most suitable mink video surveillance sites along Eighteenmile Creek will be selected based on results from the desktop analysis, input from local trappers, and time-meander searches, with the goal of selecting one site above Burt Dam (upper Burt Dam site) and one below the dam (lower Burt Dam site).

Task 2 – Data Collection and Analysis

Eight video surveillance stations (four each at the upper and lower Burt Dam sites) will be set up in mid-May and will continue monitoring until mid-November, which is the post-breeding period, a time when mink families would likely travel together. All video surveillance stations will be visited once per week, during which time batteries and video cassettes will be exchanged, camera lenses will be cleaned and systems checks will be performed. All pertinent information concerning field data will be recorded onto standardized data sheets.

The video data will be analyzed for mink presence; however, other recorded wildlife species will also be noted. Special attention will be paid to the number of recorded mink at any given time, as multiple individuals recorded during the post-breeding season are indicative of family units and mink reproduction. All pertinent information concerning video data will be recorded onto standardized data sheets

Task 3 – Reporting

A report will be generated outlining key findings and recommendations based on the scope of work within approximately 3 month of completing field work. Also, a presentation of the study findings will be made to the Niagara County Soil and Water Conservation District (NCSWCD), U.S. Army Corps of Engineers (USACE), NYSDEC, and other interested parties.

1.3 Project Goals

To determine if mink are present and reproducing along Eighteenmile Creek above and below Burt Dam.

1.4 Project Outcomes

This project will lead to an understanding of mink presence/absence and population structure in the Eighteenmile Creek AOC and watershed. It will also increase current knowledge of the status of breeding mink within the region. The findings of this study will either support the delisting of BUI #5 at the Eighteenmile Creek AOC due to records of mink breeding (as occurred within the Rochester AOC) or, conversely, provide evidence suggesting that BUI #5 is impaired within the Eighteenmile Creek system.

1.5 Cost

E & E estimates that this task can be accomplished for roughly \$69,400 total (see Table 1 for details). The costs provided are estimates only; final costs could be higher or lower than provided here.

2. Mink Exposure Assessment

E & E (2009) indicated that the status of BUI #3 (Degraded Fish and Wildlife Populations) and BUI #5 (Bird or Animal Deformities or Reproductive Problems) likely are impaired in the Eighteenmile Creek AOC. For both BUIs, our conclusion regarding impairment was based on risk calculations for the mink done with site-specific data on PCB levels in brown bullheads. However, as noted in E & E (2009), mink consume other fish besides bullheads and other prey besides fish, including voles, muskrats, and amphibians, which would be expected to contain different levels of PCBs compared with bullheads. Therefore, assuming that mink consume only bullheads may either under- or overestimate their exposure and risk at the AOC. To better understand PCB exposure for the mink, we recommend that the mink exposure assessment presented in E & E (2009) be updated based on the new data for PCBs in forage and game fish collected from Eighteenmile Creek in 2010 to support the TrophicTrace model (Gustavson et al. 2010). We also recommend examining the importance of fish versus other prey as a source of dietary PCB exposure for mink based on a review of recent relevant literature. Because a large portion of the mink diet may consist of prey other than fish, this exercise will provide information regarding the potential uncertainty in the exposure assessment that may result from the assumption of an all fish diet.

E & E estimates that this task can be accomplished for roughly \$14,000 total (see Table 1 for details).

Table 1: Estimated Cost by Task for Mink Survey and Exposure Assessment

Task No. and Description	Schedule	Cost (\$)
Mink Survey		
1. Desktop analysis and site visit	February	\$ 10,600
2. Data collection and analysis	June – October	\$ 46,000
3. Reporting	November – December	\$ 12,800
SUBTOTAL		\$ 69,400
Mink Exposure Assessment		
1. Update exposure assessment with 2010 forage and game fish data		\$7,000
2. Examine importance of fish versus other prey to PCB exposure		\$7,000
SUBTOTAL		\$ 14,000
TOTAL		\$ 83,400

3. References

Ecology and Environment, Inc. (E & E). 2009. *Beneficial Use Impairment Investigation Report for Eighteenmile Creek, Niagara County, New York*. Prepared for the Niagara County Soil and Water Conservation District, Lockport, NY by E & E, Lancaster, NY.

Gustavson, K., S. Hendrix, and K. von Stackelberg. 2010. *Eighteenmile Creek Area of Concern: Data Gaps for Food Web Modeling*. Prepared for the United States Army Corps of Engineers (USACE) Buffalo District, Buffalo, NY and Niagara County Soil and Water Conservation

District (NCSWCD), Lockport, NY by USACE Engineer Research and Development Center (ERDC), Vicksburg, VA and E Risk Sciences LLP.

New York State Department of Environmental Conservation (NYSDEC). 2011. *Mink Factsheet*. Accessed at <http://www.dec.ny.gov/animals/9356.html> in January 2011.

United States Environmental Protection Agency (EPA). 1993. *Wildlife Exposure Factors Handbook*. U.S. EPA Office of Research and Development, Washington, D.C., EPA/600/r-93/187a and EPA/600/r-93/187b.

Wellman, S. T., and J. M. Haynes. 2006. Are there differences in the relative abundance of lakeshore and inland mink populations in and out of the Rochester Embayment of Lake Ontario Area of Concern? Monitoring populations using video traps. In Hayes, J. M., Wellman, S. T., and J. J. Pagano. 2007. *RAP Process in the Rochester Embayment of Lake Ontario: Population Monitoring, Trophic Relationships, and Levels of Bioaccumulative Chemicals of Concern in Mink, a Sentinel Species*. A final report to the New York Great Lakes Protection Fund, New York State Department of Environmental Conservation (NYSDEC), 270 Michigan Avenue, Buffalo, NY.

Appendix B.7
Cost Estimate for Stocking Eighteenmile Creek with Salmonid Species

The fishery at Eighteenmile Creek in Newfane, New York is renowned for its salmon fishing, with 15,000 angler visits annually. Presently, the stocking of this fishery falls under the jurisdiction of the New York State Department of Environmental Conservation (NYSDEC). There is a chance, however, that funding limitations due to state budget constraints may halt the state-run stocking effort. If this scenario comes to pass, then the future fish stocking will have to be undertaken by private sector fish hatcheries with funding from other sources.

Ecology and Environment, Inc. (E & E) contacted several private fish hatcheries in New York State to see if estimates could be provided for rearing and stocking the salmonid species typically stocked in Eighteenmile Creek. Fish species typically stocked at Eighteenmile Creek include: 3 to 4-inch Chinook salmon, 4-inch Coho salmon, and 4.5- and 6-inch steelhead (<http://www.dec.ny.gov/outdoor/23245.html>). Most of the hatcheries contacted did not provide estimates, as they usually deal with stocking private lakes and ponds, while NYSDEC stocks public streams and rivers with salmonid species. One hatchery owner in Bliss, New York was able to provide an estimate for this scenario; however, it is important to note that this is a very rough per inch estimate based on the cost to rear, deliver, and stock fish (50 cents per inch for all species). See Table 1 for a breakdown of the proposed cost of fish stocking at Eighteenmile Creek using private hatcheries as the source of fish. Additional details are provided in Table 2.

Table 1 Estimated Cost to Rear, Deliver and Stock Three Salmonid Species in Eighteenmile Creek, Newfane, New York

Length and Type of Fish ^a	Cost per Individual (in US Dollars)	Number of Fish per Group ^a	Cost per Fish Group (in US Dollars)
3" Chinook Salmon	1.50	80,370	120,555
4" Chinook Salmon	2.00	50,000	100,000
4" Coho Salmon	2.00	30,000	60,000
4.5" Steelhead	2.25	3,500	7,875
6" Steelhead	3.00	3,500	10,500
Total Estimated Cost			298,930

Notes:

a = Fish size and numbers stocked in 2009 in Eighteenmile Creek at Newfane, New York from <http://www.dec.ny.gov/outdoor/23245.html>.

Table 2 Estimated Costs for Fish Stocking at Eighteenmile Creek, Newfane, New York

Cost per inch (\$)	Total Effort	Fish Hatchery Effort Only
	0.5	0.25
Type and length of fish	cost per fish	cost per fish
cost for 3" chinook salmon	1.5	0.75
cost for 4" chinook salmon	2	1
cost for 4" coho salmon	2	1
cost for 4.5" steelhead	2.25	1.125
cost for 6" steelhead	3	1.5
Type and length of fish	number of fish	number of fish
3" chinook salmon	80,370	80,370
4" chinook salmon	50,000	50,000
4" coho salmon	30,000	30,000
4.5" steelhead	3,500	3,500
6" steelhead	3,500	3,500

Table 2 Estimates costs for fish stocking at Eighteenmile Creek, Newfane, New York

Cost per inch (\$)	Total Effort 0.5	Fish Hatchery Effort Only 0.25
Type and length of fish	Cost per fish type	Cost per fish type
3" chinook salmon	120,555	60,278
4" chinook salmon	100,000	50,000
4" coho salmon	60,000	30,000
4.5" steelhead	7,875	3,938
6" steelhead	10,500	5,250
TOTAL COST (this includes supping and rearing fees)	\$298,930	\$149,465

Notes:

Unit cost based on a call with Todd Garrison of Garrison's Smith Creek Fish Farm, Bliss, NY.

Mr. Garrison provided a rough estimate of the effort cost based on the length of fish to be raised.

Appendix B.8
Rough Cost Estimate for Baseline Sampling and Long-Term, Post-Remedial Monitoring of the Benthic Community in the Eighteenmile Creek System

The cost of baseline sampling and one round of post-remedial sampling are estimated to be \$41,570 and \$33,320, respectively. The estimate for post-remedial sampling is less than the estimate for baseline sampling because the Sampling and Analysis Plan (SAP) prepared for baseline sampling is assumed to be useful for post-remedial sampling with little or no modification. The cost estimate for monitoring the benthic community includes four tasks: (1) SAP preparation; (2) field sampling; (3) laboratory analysis; and (4) reporting. It is expected that SAP development will be a desktop effort requiring approximately 1.5 weeks to complete. Field sampling is expected to be a two day effort by a team of two biologists. The sampling will entail collecting sediment and benthic macroinvertebrate samples at three sites in the AOC. Sediment samples will be analyzed for PCBs, selected metals, toxicity, and ancillary parameters (total organic carbon, grain size, etc.). Benthic macroinvertebrate samples will be evaluated for taxonomic diversity and abundance. We expect that the sampling will take two days to implement. Finally, a report will be drafted and finalized summarizing the findings.

APPENDIX C

Timeline of Significant Investigations and Events

	1985	1990	1997	1998	2001	2003-2005	2004	2005	2006	2007		2008	2009	2010	2011	
	NYSDEC assumes role as AOC RAP coordinator. The creek was designated as an AOC because of water quality and bottom sediment problems associated with past industrial and municipal discharge practices, disposal of waste, and use of pesticides. Chemicals found in sediment and/or fish included PCBs, mercury, dioxins/furans, dieldrin, mirex, DDT, lead, and copper (http://www.epa.gov/greatlakes/aoc/eightheemile.html).	The benthic community was surveyed at three locations. Significant impairment was found at the Cornin location (near Jacques Road) compared with a control location on the East Branch. Inorganic (toxic) factors were judged to be the cause. High levels of PCBs, metals, and dioxins were found in invertebrates from this location. The benthic community at the Newfane location was found to be moderately impacted.	BUJs identified as being impaired or likely impaired include: Restrictions on Fish and Wildlife Consumption; Bird or Animal Deformities or Reproductive Problems; Degradation of Benithos; and Restrictions on Dredging. Sources of the problem are listed as contaminated creek sediments, inflow from the NYS Barge Canal, and an unidentified PCB source in Lockport (between Olcott Street and N. Transit Road).	Eight stations were sampled between Olcott Harbor and Lockport in 1994. High levels of metals (cadmium, chromium, copper, lead, nickel, and zinc) and PCBs were found in sediment samples from behind Burt and Newfane Dams. High sediment mercury levels were found in and near Burt Dam and in sediment in the diversion channel near the Former Flintkote Plant site.	Twelve stations in the creek and Barge Canal were sampled in 1998. High levels of cadmium, chromium, copper, lead, nickel, and zinc were found in sediment core samples from behind Burt and Newfane Dams. High sediment PCB levels were found behind Olcott Harbor.	Objectives were to improve public access to the heavily used portion of the creek between Fisherman's Park and Burt Dam while concurrently restoring riparian and aquatic habitats. Three significant reports were developed: Baseline Habitat and Threatened & Endangered Species Coordination; (2) Planting Plan for the Eighteenmile Creek Restoration Work Area; and (3) Restoration Monitoring Plan.	The study suggests greater than expected bioavailability of PCBs in Eighteenmile Creek AOC sediments.									
	Eighteenmile Creek below Burt Dam is designated as a Great Lakes AOC.	Eighteenmile Creek Biological Stream Assessment (NYSDEC 1990) is completed.	Eighteenmile Creek RAP (NYSDEC 1997) is released.	Eighteenmile Creek/Olcott Harbor Sediment Study (NYSDEC 1998) is completed.	Eighteenmile Creek Sediment Study Final Report (NYSDEC 2001) is released.	Eighteenmile Creek Restoration Project (E & E 2003a,b, 2005) is implemented.	Bioaccumulation Investigation (USACE 2004a,b) is released.	RAP coordination role for Eighteenmile Creek AOC is assumed by NCSWCD.	Former Flintkote Plant Site ROD (NYSDEC 2006a) is released.	Upper Mountain Road SI Report (NYSDEC 2007) is released.	Trackdown Project Final Report (E & E 2007b) is released.	Eighteenmile Creek PCB Source	Eighteenmile Creek BUI Investigation (Ross et al. 2011) is initiated.	Eighteenmile Creek BUI Investigation (E & E 2009a) is completed.	Eighteenmile Creek Corridor Site RAP (NYSDEC 2010) is released.	Strategic Plan for BUI Delisting for Eighteenmile Creek AOC is prepared.
	1985	1990	1997	1998	2001	2003-2005	2004	2005	2006	2007		2008	2009	2010	2011	
Key:	<p>The plan was prepared to initiate the process of creating a Comprehensive Watershed Management Plan (CWMP) specific to the Eighteenmile Creek Watershed. The plan also summarizes existing watershed information for Eighteenmile Creek to support the planning process and presents useful guidelines for CWMP development.</p> <p>The Soil Water Assessment Tool (SWAT) was implemented for the Eighteenmile Creek watershed to determine annual sediment yields and critical source areas of erosion in the watershed. Considerable spatial variation in sediment generation within the watershed was found (range of 0.2 to 5.5 tons per hectare per year). A group of agricultural subbasins on the southwestern end of the watershed were found to generate the highest sediment yields and it was recommended that they be targeted for implementation of best management practices.</p> <p>The RI documents: (1) elevated levels of PCBs and metals (arsenic, chromium, copper, lead, and zinc) in sediment in the creek and millrace adjacent to the Former Flintkote Plant Site; (2) contaminated sediment in the NYS Barge Canal immediately upstream from the creek; and (3) contaminated fill at Upton Park, the White Transportation property, the former United Paperboard Company property, and the Former Flintkote Plant site. NYSDEC concluded that the levels of PCBs and metals detected at these areas have the potential to adversely impact Eighteenmile Creek.</p> <p>The report describes existing features, resources, communities, and environmental issues in the Eighteenmile Creek watershed. Goals of the report are to increase awareness and interest in the watershed and the values it provides, promote stewardship, and develop a long-term vision for the basin.</p> <p>The report describes existing features, resources, communities, and environmental issues in the Eighteenmile Creek watershed. Goals of the report are to increase awareness and interest in the watershed and the values it provides, promote stewardship, and develop a long-term vision for the basin.</p> <p>Delisting criteria are provided for five BUJs: Restrictions on Fish and Wildlife Consumption; Degradation of Fish and Wildlife Populations; Bird or Animal Deformities or Reproductive Problems; Degradation of Benithos; and Dredging Activities. All five BUJs are linked to high levels of PCBs and metals in sediment throughout the length of the creek.</p> <p>The new data are used to support development of the RAP (NYSDEC 2010) for the site.</p> <p>The work involves an extensive literature review of existing water, sediment, and biota data for Eighteenmile Creek; collection of additional data for PCB congeners in forage and game fish; and collection of additional sediment PCB congener data.</p>															
AOC	Area of Concern															
BUI	Beneficial Use Impairment															
E & E	Ecology and Environment, Inc.															
GIS	Geographic information system															
GLLA	Great Lakes Legacy Act															
NCSWCD	Niagara County Soil and Water Conservation District															
NYS	New York State															
NYSDEC	New York State Department of Environmental Conservation															
OU	Operable Unit															
PAHs	Polycyclic aromatic hydrocarbons															
PCBs	Polychlorinated biphenyls															
RAP	Remedial Action Plan															
RI	Remedial Investigation															
SI	Site Investigation															
SVOC	Semi-volatile organic compound															
USACE	United States Army Corps of Engineers															
VOC	Volatile organic compound															
	Early Assessments and Investigations															
	Recent Comprehensive Investigations and Remedial Planning															

Figure C-1 Timeline of Significant Investigations and Events for the Eighteenmile Creek AOC from 1985 to 2011

APPENDIX D

Results of Beneficial Use Impairment Investigation for Eighteenmile Creek

**Beneficial Use Impairment
Investigation for
Eighteenmile Creek
Niagara County, New York**

April 2009

Prepared for:
NIAGARA COUNTY SOIL AND WATER CONSERVATION DISTRICT
4487 Lake Avenue
Lockport, NY 14094

Prepared by:
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3

Results

The results of this investigation are presented in this section in four primary sections: (1) Fish Community Surveys, (2) Wildlife Surveys, (3) Bullhead Chemical Residue Data and Risk Evaluation, and (4) Bullhead Deformities and Liver Pathology.

3.1 Results

Eighteenmile Creek and the reference creek (Oak Orchard Creek) had similar water quality parameters (see Table 3-1). Water temperatures, dissolved oxygen, and conductivity were slightly higher in Oak Orchard Creek in May, but all parameters were within concentrations suitable for fish survival and propagation. While flows are not gauged in either stream, their flows appeared similar during sampling events in each stream. During the May 2007 sampling events, no rainfall had occurred in either watershed for several days prior to and during the sampling events. During the August period, the region experienced drought conditions and both streams were in low flow conditions, influenced by controlled flow releases from the New York State Barge Canal.

Table 3-1 Water Quality Parameters¹ for Eighteenmile Creek (EMC) and Oak Orchard Creek (OOC) during the Fish Community Sampling Collection Periods in 2007.

Sampling Period	Creek	Water Temp (°F)	Air Temp (°F)	DO (mg/L)	pH	Conductivity (µS/cm)
May	EMC	58	55	8.49	9.19	585
May	OOC	65	68	11.05	8.69	698
August	EMC	72	79	7.03	ND	ND
August	OOC	76	82	8.41	ND	ND

Note:

¹ Measured with field meter calibrated as per the manufacturers instructions.

Key:

DO = dissolved oxygen.

ND = No data due to equipment malfunction.

Species Composition and Relative Abundance

Both creeks had similar species composition, with totals of 25 and 24 species being caught in Eighteenmile Creek and Oak Orchard Creek, respectively (see Table 3-2). Twenty-nine species were captured between both creeks, 20 of which were

sampled from both creeks. Species unique to Eighteenmile Creek included golden shiner, green sunfish, hybrid bluegill, silver redhorse, and steelhead. The steelhead, an adult, was captured in shallow water (approximately 1 foot depth) while backpack electro-fishing a riffle in Reach 3. Species unique to Oak Orchard Creek included banded killifish, brook silverside, gizzard shad, and tessellated darter. Several small coho salmon were captured in both creeks, and discussions with local fishermen and the DEC indicated that salmon had been stocked in the creeks several days prior to the sampling trips and that the captures were likely hatchery fingerlings (see Appendix B for fish community survey data-sheets).

Table 3-2 Species Captured in Eighteenmile Creek and Oak Orchard Creek

Eighteenmile Creek	Oak Orchard Creek
Alewife*	Alewife*
Black crappie*	Banded killifish
Bluegill*	Black crappie*
Bluntnose minnow*	Bluegill*
Bowfin*	Bluntnose minnow*
Brown bullhead*	Bowfin*
Coho salmon*	Brook silverside
Common carp*	Brown bullhead*
Common shiner*	Coho salmon*
Emerald shiner*	Common carp*
Golden redhorse*	Common shiner*
Golden shiner	Emerald shiner*
Green sunfish	Gizzard shad
Hybrid Bluegill	Golden redhorse*
Largemouth bass*	Largemouth bass*
Logperch*	Logperch*
Longnose gar*	Longnose gar*
Pumpkinseed*	Pumpkinseed*
Rock bass*	Rock bass*
Shortnose redhorse*	Shorthead redhorse*
Silver redhorse	Slimy sculpin*
Slimy sculpin*	Smallmouth bass*
Smallmouth bass*	Tesselated darter
Steelhead	Yellow perch*
Yellow perch*	

Note:

* = Indicates species found in both creeks.

The most common species captured in the creeks differed. During the May sampling, the top three species captured in Eighteenmile Creek were emerald shiner (115), alewife (110), and rock bass (28). In Oak Orchard Creek, the top three species captured in May were bluegill (45), rock bass (28), and golden redhorse (27). During the May sampling events, many cyprinids and clupeids (e.g., emer-

ald shiners and alewives) were concentrated in the sampling reaches of Eighteen-mile Creek. Many alewives were visible on the surface engaged in mating frenzies. While alewives were observed in Oak Orchard Creek engaged in the same behavior, large concentrations of fish were not observed within the sampling reaches.

During the August sampling, the top three species captured in Eighteenmile Creek were bluegill (61), largemouth bass (25), and slimy sculpin (23). In Oak Orchard Creek, the top three species captured were rock bass (21), bluegill (17), and brown bullhead and largemouth bass (13 each) (see Table 3-3). There are two likely reasons why fewer fish were captured during the Oak Orchard Creek sampling event in August. Foremost, only one netter was used; the remaining crew was assisting the brown bullhead processing team as part of the fish analysis. The warm weather and numbers of bullhead captured necessitated as many staff as possible processing fish.

Table 3-3 Totals for Fish Species Captured during Electro-fishing Sampling

Species	May		August	
	Eighteenmile Creek	Oak Orchard Creek	Eighteenmile Creek	Oak Orchard Creek
Alewife	110	1		
Banded killifish				1
Black crappie	3	2	1	
Bluegill	24	45	61	17
Bluntnose minnow	1	11	7	1
Bowfin	3	1	5	3
Brook silverside		1		
Brown bullhead	5	6	6	13
Coho salmon	1	1		
Common carp	1			2
Common shiner	1	19		3
Emerald shiner	115	15		
Gizzard shad		1		
Golden redhorse	3	27		
Golden shiner	2		3	
Green sunfish	3		10	
Hybrid Bluegill	1			
Largemouth bass	5	17	25	13
Logperch	2	1	5	4
Longnose gar		6	1	
Pumpkinseed	25	20	21	10
Rock bass	28	28	30	21
Shortnose redhorse		4	1	
Silver redhorse	1			
Slimy sculpin	15	2	23	12
Smallmouth bass	6	10	5	

Table 3-3 Totals for Fish Species Captured during Electro-fishing Sampling

Species	May		August	
	Eighteenmile Creek	Oak Orchard Creek	Eighteenmile Creek	Oak Orchard Creek
Steelhead	1			
Tessellated darter				1
Yellow perch	13	4	1	2

Catch Per Unit Effort

Eighteenmile Creek had a higher catch per unit effort (CPUE) for both sampling periods (see Table 3-4). These higher catch rates were observed in each of the three reaches during the May sampling period. The average CPUEs for Eighteenmile Creek (6.8 fish/minute) and Oak Orchard Creek (4.8 fish/minute) during the May sampling events were higher than those observed in August for both creeks (3.5 fish/minute and 1.3 fish/minute, respectively). Similarities in the CPUE data indicated that the lowermost reaches (i.e., closest to Lake Ontario) contained the highest abundance of fish during the spring sampling period. This pattern was observed in both creeks. Eighteenmile Creek had a slightly higher abundance of fish, primarily based on the high numbers of cyprinids and clupeids captured during the sampling events. For May, the data suggest that Oak Orchard Creek had a higher abundance of top predator fish (see Table 3-3). During May, Oak Orchard had 17 largemouth bass, compared to 5 largemouth bass in Eighteenmile Creek. In addition, six longnose gar were captured in Oak Orchard Creek, whereas none were captured in Eighteenmile Creek.

Table 3-4 Catch per Unit Effort (CPUE) Data for Community Fish Sampling in Eighteenmile Creek and Oak Orchard Creek

Area	E Time (sec)	Total No. of Fish	CPUE (fish/min)
May			
Eighteenmile Creek			
Reach 1	900	144	9.6
Reach 2	900	109	7.3
Reach 3	1,920	116	3.6
Average	1,240	123	6.8
Oak Orchard Creek			
Reach 1	900	106	7.1
Reach 2	900	89	5.9
Reach 3	1,269	27	1.3
Average	1,023	74	4.8
August			
Eighteenmile Creek			
Reach 1	1,176	58	3.0
Reach 2	1,045	108	6.2
Reach 3	1,760	39	1.3
Average	1,327	68	3.5

Table 3-4 Catch per Unit Effort (CPUE) Data for Community Fish Sampling in Eighteenmile Creek and Oak Orchard Creek

Area	E Time (sec)	Total No. of Fish	CPUE (fish/min)
Oak Orchard Creek			
Reach 1	1,431	32	1.3
Reach 2	1,517	27	1.1
Reach 3	1,680	44	1.6
Average	1,542	34	1.3

Key:

CPUE = total number of fish captured per electrofishing minute.

E Time = Electrofishing time.

During the summer sampling period, opposite patterns were observed. Eighteen-mile Creek had a higher abundance of dominant predators, including largemouth bass (almost twice as many), smallmouth bass (five compared to zero), bluegill (more than three times as many), bowfin, rock bass, and pumpkinseed (see Table 3-3). This pattern is likely a result of the focus on targeted bullhead sampling for the pathology and analytical work during the summer sampling period. The fish community sampling effort on Oak Orchard Creek was conducted during the day-time and with only one netter, whereas the sampling effort on Eighteenmile Creek involved more than one netter and was conducted at night.

Fish Condition

Fish condition also was computed to determine community-level differences in the length and weight relationships. Typically, smaller ratios indicate a healthy, prolific fish community. Due to small sample sizes, only 3 of the top five species caught during all sampling events are presented in this report. Tables 3-5 and 3-6 show the average weights, lengths, and associated condition factors for bluegill, pumpkinseed, and rock bass for Eighteenmile Creek and Oak Orchard Creek, respectively. For these three species in Eighteenmile Creek, fish condition was fairly similar during the May and August sampling events. For bluegill and pumpkinseed, the average condition factor was slightly higher during the May sampling event, whereas rock bass had a higher condition factor in August. In Oak Orchard Creek, condition factors for these three species were lower in August. Bluegill were most similar in Oak Orchard Creek, and rock bass had the largest variation between the two sampling events.

Condition factors closest to 1.0 indicate a healthy fish population. All of the condition factors were higher than one, which may suggest various influences in these waterbodies on the health of the fish community. Factors that influence fish condition include available food sources, environmental changes, and disease.

However, the scope of the fish sampling effort was limited to three sampling events in each creek per season. This small sample size may have influenced the results. Based on the sensitivity of condition factor to age and length of fish, the brown bullhead collected for tumor analysis were used to examine the age-specific condition of fish between the two creeks.

Table 3-5 Length, Weight, and Condition Factor Comparisons of Spring and Summer Sampling Results for Eighteenmile Creek1

May 2007				August 2007			
Species	Average Length (mm)	Average Weight (g)	Average Fulton Condition Factor	Species	Average Length (mm)	Average Weight (g)	Average Fulton Condition Factor
Bluegill	129.50	49.10	1.90	Bluegill	108.31	33.56	1.70
Pumpkinseed	117.28	38.99	2.19	Pumpkinseed	110.33	31.95	2.08
Rock bass	128.21	66.05	2.04	Rock bass	90.64	40.23	2.52

Table 3-6 Length, Weight, and Condition Factor Comparisons of Spring and Summer Sampling Results at Oak Orchard Creek¹

May 2007				August 2007			
Species	Average Length (mm)	Average Weight (g)	Average Fulton Condition Factor	Species	Average Length (mm)	Average Weight (g)	Average Fulton Condition Factor
Bluegill	120.9	42.1	1.99	Bluegill	97.47	22.86	1.85
Pumpkinseed	146.6	73.7	2.08	Pumpkinseed	118.90	35.40	1.87
Rock bass	140.5	92.2	2.68	Rock bass	106.95	30.97	1.86

Note:

¹ Blanks indicate species was not captured

To classify the various size classes of bullheads, length-frequency histograms were developed to determine size categories of fish. Figures 3-1 and 3-2 present the length frequency distribution for bullhead captured in Eighteenmile Creek and Oak Orchard Creek, respectively. Based on these size frequency distributions, the following size categories were established: 250-280 mm, 281-320 mm, 321-350 mm, 351-360 mm, and 361-390 mm. Table 3-7 summarizes the average lengths, weights, and condition factors for bullhead captured in the two creeks. Condition factors in both creeks were similar, ranging from 1.2 to 1.4. Overall, there was no consistent difference in the average weight or condition factor for the various size classes between creeks that would suggest that fish in Eighteenmile Creek were less healthy or fit than those in Oak Orchard Creek. Indeed, for the size class with the greater number of individuals (281 to 320 mm), the average weight and condition factor were greater for Eighteenmile Creek (see Table 3-7).

Table 3-7 Brown Bullhead Lengths and Weights for Various Size Categories in Eighteenmile Creek and Oak Orchard Creek

Length Category	Average Length (mm)	Average Weight (g)	Condition Factor	N
Eighteenmile Creek				
250-280	266.5	240	1.26	6
281-320	302	379	1.38	28
321-350	335	518	1.38	10
351-360	355	582	1.29	3
361-390	380	809	1.48	2
Oak Orchard Creek				
250-280	274	278	1.35	8
281-320	299	344	1.28	30
321-350	331	503	1.39	11
351-360	-	-	-	0
361-390	365	682	1.4	1

3.2 Wildlife Surveys

Wildlife surveys were conducted along Eighteenmile Creek within a stream length of approximately 1.3 miles and along Oak Orchard Creek within a stream length of approximately 3.8 miles. The percent cover was calculated for habitat types parallel to those stream lengths to determine their relative availability (see Table 3-8).

Eighteenmile Creek had more cattail marsh, developed (residential), and early successional habitat than Oak Orchard Creek, whereas Oak Orchard Creek had more agricultural land, open water, and there was a large golf course nearby. Both creeks had a similar relative percentage of surrounding forestland and orchard/vineyard habitat.

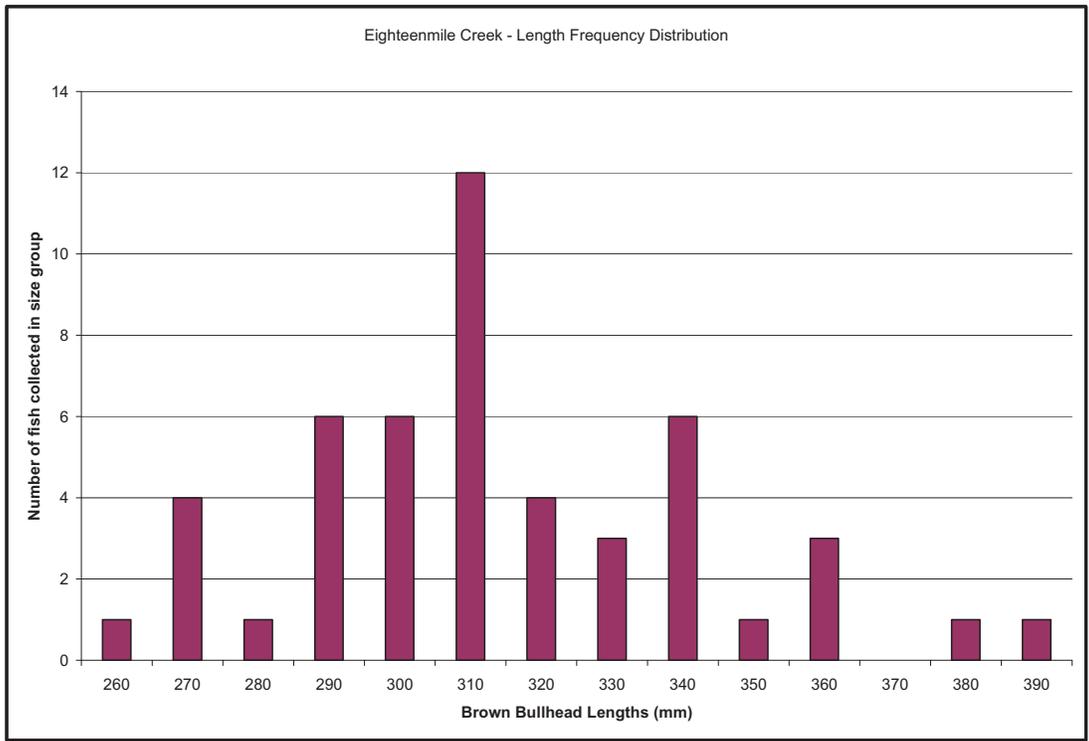


Figure 3-1 Length Frequency Distribution for Brown Bullhead in Eighteenmile Creek, August 2007

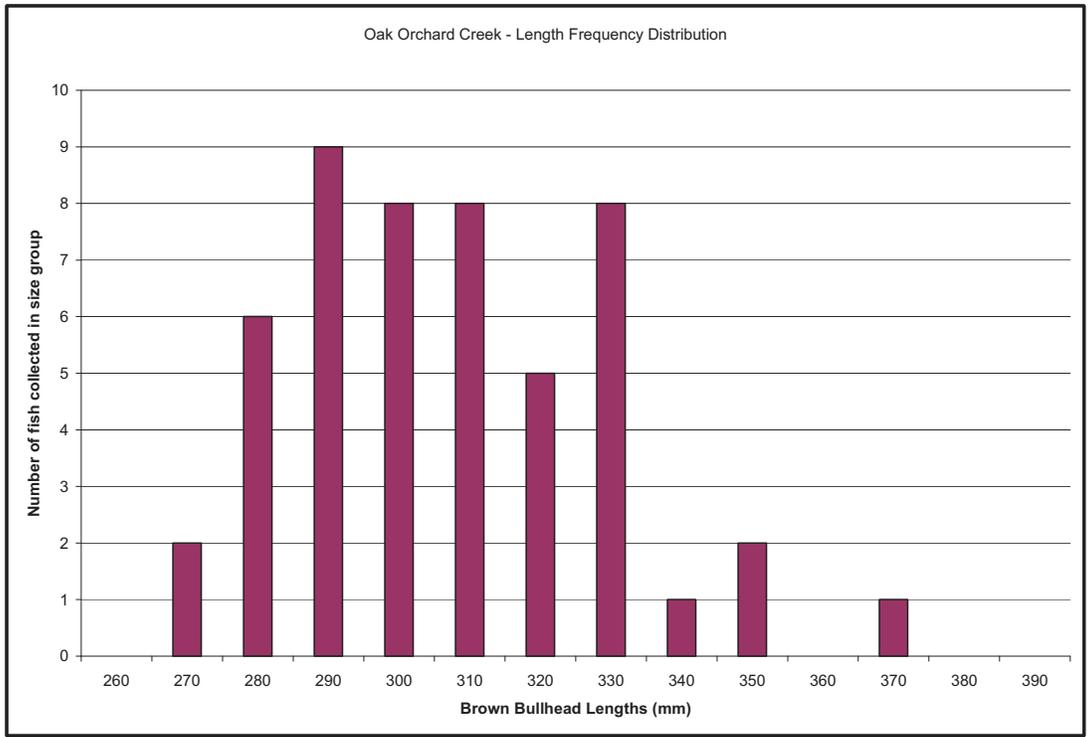


Figure 3-2 Length Frequency Distribution for Brown Bullhead in Oak Orchard Creek, August 2007

Table 3-8 Habitat Types along Eighteenmile Creek and Oak Orchard Creek¹

Habitat	Eighteenmile		Oak Orchard	
	Acres	%	Acres	%
Agricultural	147.70	20.46	464.40	31.71
Cattail Marsh	19.21	2.66	14.58	1.00
Developed	237.84	32.94	235.02	16.05
Forested	169.58	23.49	374.32	25.56
Open Water	34.30	4.75	127.94	8.74
Early Successional	62.22	8.62	6.17	0.42
Orchard/Vineyard	51.14	7.08	144.51	9.87
Golf Course	0.00	0.00	97.58	6.66
Total	721.98	100.00	1464.52	100.00

Note:

¹ Based on analysis of aerial photography.

3.2.1 Birds

Point Count Surveys – Eighteenmile Creek

Point counts were conducted at each of the six point locations along Eighteenmile Creek on May 5, May 19, June 29, July 23, August 19, and September 17, 2007 (see Appendix C for wildlife survey data). In total, 1,309 birds representing 66 species were identified during the six morning bird surveys at Eighteenmile Creek (see Tables 3-9 and C-1). Of the 1,309 birds observed, 431 birds were flyovers. Because the species observed were generally observed throughout the study area, they were believed to be local birds traveling through (versus migrants) and were included in the analyses that follow. The total number of birds observed per survey, defined as the sum of birds from the six point locations on a given survey day, ranged from 134 to 261 birds, with an average of 218 birds. The total number of species identified per survey ranged from 29 to 36, with an average of 32. The most numerous species recorded at Eighteenmile Creek were Red-winged Blackbird (198 birds), Mallard (116 birds), Common Grackle (95 birds), and Canada Goose (92 birds) (see Table C-1). There were no observations of deformed or obviously sick or diseased birds at either of the creeks.

By point location, the total number of birds ranged from eight birds at point B on September 17 to 77 birds at point F on July 23, with an overall average per point location of 36.4 birds at Eighteenmile Creek (see Table 3-9 and Figure 2-3). Total species per survey point location ranged from four species at point B on September 17 to 20 species at point A on June 29, with an overall average of 13.0 species. Point F consistently had higher numbers of birds and species, whereas points B and E usually had lower numbers of birds and species.

Point counts were conducted at each point location along Oak Orchard Creek on May 7, May 18, June 28, July 22, August 18, and September 16, 2007. At Oak Orchard Creek, a total of 1,309 birds representing 71 species were identified during the six morning surveys (see Table 3-9 and Appendix C). Of the 1,309 birds observed, 441 birds were flyovers. Because the species observed were generally

observed throughout the study area, they were believed to be local birds traveling through (versus migrants) and were included in the analyses that follow. The total number of birds ranged from 175 to 290 (see Figure 3-3), with an average of 218, and the total number of species per survey point ranged from 28 to 46 (see Figure 3-4), with an average of 35 species. The most numerous species recorded were Red-winged Blackbird (135 birds), American Goldfinch (114 birds), and Canada Goose (108 birds) (see Table C-1).

By point location at Oak Orchard Creek, the total number of birds ranged from nine at point 4 on August 18 to 79 birds at point 6 on June 28, with an overall average per point location of 36.4 birds (see Table 3-9). The total species per survey point location ranged from six at point 3 on September 16 to 21 at point 1 on June 28, with an overall average of 13.9 species. Point 6 consistently had higher numbers of birds and species, whereas point 2 consistently had lower numbers of birds and species.

The species composition at both creeks were generally consistent with what was anticipated for the habitat and location and was generally consistent with those species typically found in or near Niagara and Orleans counties (E & E 2007). No federally or state-listed threatened or endangered species were identified during the point count surveys; however, two state-listed species of concern (Osprey and Cooper's Hawk) were observed (see Table B-1). Osprey were observed at Eighteenmile Creek on August 19 and at Oak Orchard Creek on September 16. One Cooper's Hawk was observed at Eighteenmile Creek on August 19.

Marsh Monitoring Program Surveys

Marsh Monitoring Program (MMP) surveys were conducted at Eighteenmile Creek on June 14 and 28, 2007. A total of 278 birds representing 28 species were identified during the two surveys at the six Eighteenmile Creek point locations (see Table 3-10). Two hundred and fifty-six of the 278 birds observed were fly-overs; these birds were included in the analyses that follow. The most numerous species recorded were Red-winged Blackbird (85 birds) and Common Grackle (42 birds) (see Table C-2). By point location, the total number of birds on June 14 ranged from 21 to 30, with an average per point location of 26.3, and the total number of birds on June 28 ranged from nine to 29, with an average per point location of 20.0. On June 14, the total species per survey point location ranged from seven to 14, with an average of 11.0, and on June 28 the total species per survey point location ranged from four to nine, with an average per point location of 7.3. There were no observations of deformed or obviously sick or diseased birds at either of the creeks.

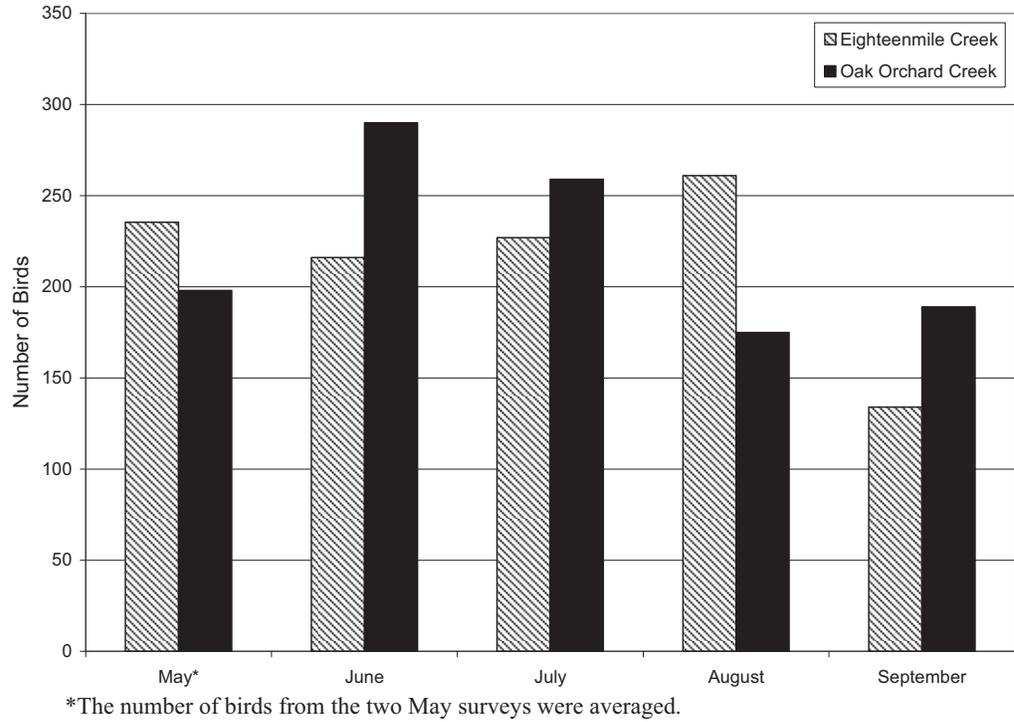


Figure 3-3 The Total Number of Birds Observed during the Monthly Surveys at Eighteenmile Creek and Oak Orchard Creek

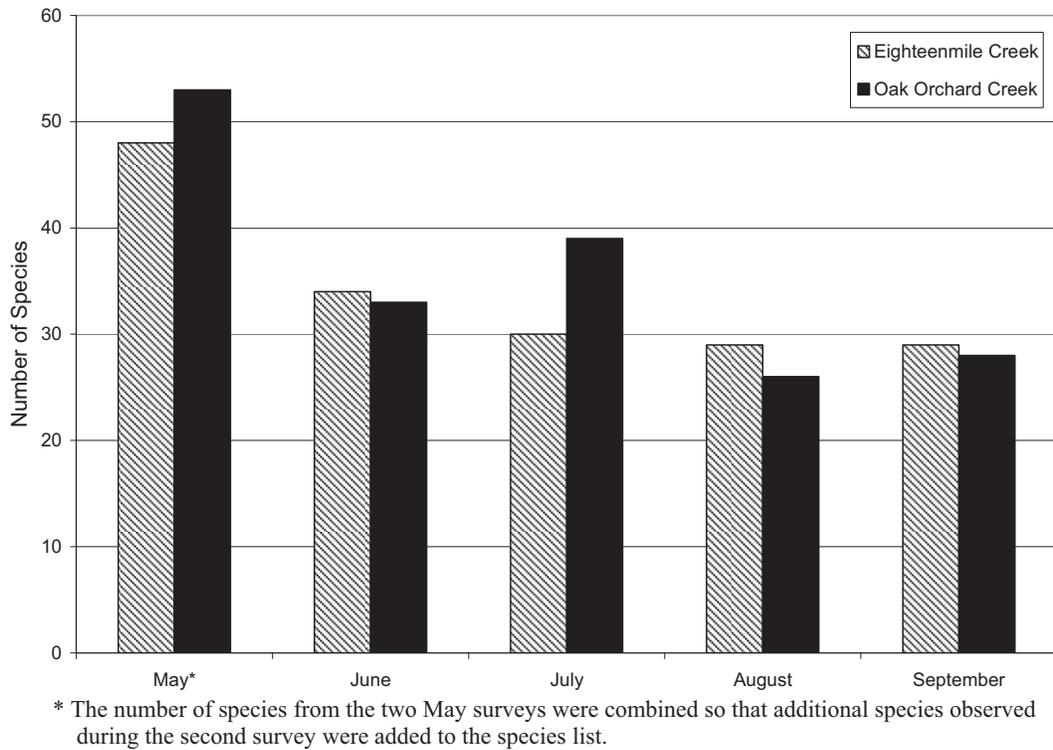


Figure 3-4 The Total Number of Species of Birds Observed during the Monthly Surveys at Eighteenmile and Oak Orchard Creeks

Table 3-9 Summary of Morning Point Count Surveys for Birds by Date and by Point Location along Eighteenmile Creek and Oak Orchard Creek (2007)

	Location	5/5	5/19	6/29	7/23	8/19	9/17	Overall
Eighteenmile Creek								
Total Birds	A	35	47	43	27	33	18	203
	B	38	35	22	35	51	8	189
	C	43	33	31	26	76	15	224
	D	44	30	27	29	37	17	184
	E	38	34	20	33	22	23	170
	F	35	59	73	77	42	53	339
	Total	233	238	216	227	261	134	1,309
Species Count	A	17	15	20	15	10	11	38
	B	14	14	12	12	11	4	33
	C	11	14	12	11	16	5	30
	D	12	16	11	14	13	10	40
	E	14	15	10	16	10	13	33
	F	14	16	19	17	12	13	40
	Overall	36	35	34	30	29	29	66
Oak Orchard Creek								
Total Birds	1	27	28	37	46	18	51	207
	2	38	41	36	65	41	32	253
	3	47	44	51	39	37	13	231
	4	27	30	39	36	9	24	165
	5	32	30	48	32	33	42	217
	6	28	24	79	41	37	27	236
	Total	199	197	290	259	175	189	1,309
Species Count	1	14	15	21	15	9	16	38
	2	17	18	17	14	14	11	35
	3	17	15	18	18	12	6	34
	4	10	16	15	15	7	6	38
	5	15	19	14	14	9	9	40
	6	17	17	16	16	9	10	44
	Overall	37	46	33	39	26	28	71

MMP surveys were conducted at Oak Orchard Creek on June 12 and 27, 2007. A total of 263 birds representing 38 species were identified during the two surveys at the six Oak Orchard Creek point locations (see Table 3-10). Two hundred and twenty-one of the 263 birds observed were flyovers; these birds were included in the analyses that follow. The most numerous species recorded were Red-winged Blackbird (68 birds), Cedar Waxwing (20 birds), and American Robin (18 birds) (see Table C-2). By point location, the total number of birds on June 12 ranged from 17 to 37, with an average per point location of 25.0, and on June 27 the total number of birds ranged from nine to 37, with an average per point location of 18.8. On June 12, the total number of species per survey point location ranged from nine to 17, with an average of 11.7, and on June 27, the total number of species ranged from three to 13, with an average per point location of 8.5.

Species detected during the evening surveys that were not detected during the morning surveys include Common Yellowthroat at Eighteenmile Creek and Least Flycatcher, Eastern Kingbird, and Eastern Bluebird at Oak Orchard Creek.

Bird Species List and Threatened/Endangered Species

During the surveys and other activities (e.g., installation of traps, paddling between point locations) in the Project Area, E & E identified a total of 79 species at Eighteenmile Creek and 94 species at Oak Orchard Creek throughout the study period (see Table 3-11). Sixty-four of the species were detected at both creeks, 15 were detected only at Eighteenmile Creek, and 30 were detected only at Oak Orchard Creek (see Table 3-12). Canada Goose, Mute Swan, Wood Duck, and Mallard were observed throughout the study; other species of waterfowl were observed only in early spring and late summer. Migrants were detected primarily in May and early June. Species observed from late June to mid-August were believed to be breeding birds. Observations of Osprey were limited to August and September. The species identified during the study period were generally consistent with those species expected for the geographic area (E & E 2007). Table C-3 identifies species presence by survey point location.

Some of the differences in species present at each creek can be attributed to differences in habitat availability. Species such as the Virginia Rail, Sora, Common Moorhen, Marsh Wren, and Swamp Sparrow that are often associated with cattail marsh were observed only at Eighteenmile Creek (see Table 3-11). Although there was only approximately 1.5% more of the area in cattail marsh at Eighteenmile Creek compared to Oak Orchard Creek (see Table 3-1), the expanses of cattail marshes along Eighteenmile were much larger than those at Oak Orchard Creek and may provide more suitable habitat for these marsh-dwelling species. More neotropical migrants (Tennessee Warbler, Nashville Warbler, Northern Parula, Magnolia Warbler, Black-throated Blue Warbler, Bay-breasted Warbler, American Redstart, Hooded Warbler, Scarlet Tanager, and Indigo Bunting) were observed at Oak Orchard Creek than at Eighteenmile Creek, possibly due to the lack of residential development along the forested riparian corridor.

Six state-listed species were identified, and no federally listed species were identified (see Table 3-11). At Eighteenmile Creek, Osprey (special concern) and Cooper's Hawk (special concern) were observed. At Oak Orchard Creek, American Bittern (special concern), Osprey (special concern), Bald Eagle (threatened), Northern Harrier (threatened), and Red-shouldered Hawk (special concern) were observed.

Table 3-10 Summary of MMP Surveys for Birds by Date and by Point Location at Eighteenmile Creek and Oak Orchard Creek (2007)

	Point	6/14	6/28	Overall
Eighteenmile Creek				
Total Birds	A	30	16	46
	B	27	29	56
	C	28	28	56
	D	22	19	41
	E	21	19	40
	F	30	9	39
	Total	158	120	278
Species Total	A	12	8	14
	B	13	9	14
	C	8	9	12
	D	14	7	16
	E	7	7	11
	F	12	4	13
	Overall	26	24	28
Oak Orchard Creek				
Total Birds	1	19	9	28
	2	27	12	39
	3	37	37	74
	4	17	12	29
	5	21	23	44
	6	29	20	49
	Total	150	113	263
Species Total	1	9	3	10
	2	9	8	13
	3	12	13	17
	4	10	6	13
	5	13	10	18
	6	17	11	21
	Overall	33	25	38

Table 3-11 Summary of Bird Species Detected at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile Creek	Oak Orchard Creek
Canada Goose	X	X
Mute Swan	X	X
Wood Duck	X	X
Gadwall	-	X
American Wigeon	-	X
American Black Duck	X	X
Mallard	X	X
Blue-winged Teal	X	X
Greater Scaup	X	-
Lesser Scaup	-	X
Bufflehead	X	X
Common Goldeneye	X	X
Hooded Merganser	-	X
Common Merganser	-	X
Red-breasted Merganser	X	-
American Bittern (SC)	-	X
Great Blue Heron	X	X
Green Heron	X	X
Black-crowned Night Heron	X	-
Turkey Vulture	X	X
Osprey (SC)	X	X
Bald Eagle (T)	-	X
Northern Harrier (T)	-	X
Cooper's Hawk (SC)	X	-
Red-shouldered Hawk (SC)	-	X
Red-tailed Hawk	X	X
American Kestrel	-	X
Virginia Rail	X	-
Sora	X	-
Common Moorhen	X	-
American Coot	-	X
Killdeer	X	X
Greater Yellowlegs	-	X
Spotted Sandpiper	X	X
American Woodcock	X	-
Ring-billed Gull	X	X
Caspian Tern	X	-
Rock Pigeon	X	X
Mourning Dove	X	X
Great Horned Owl	-	X

Table 3-11 Summary of Bird Species Detected at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile Creek	Oak Orchard Creek
Chimney Swift	X	X
Ruby-throated Hummingbird	X	X
Belted Kingfisher	X	X
Red-bellied Woodpecker	X	X
Yellow-bellied Sapsucker	-	X
Downy Woodpecker	X	X
Hairy Woodpecker	-	X
Northern Flicker	X	X
Eastern Wood-Pewee	X	X
Least Flycatcher	X	X
Eastern Phoebe	X	X
Great Crested Flycatcher	X	X
Eastern Kingbird	X	-
Blue-headed Vireo	X	X
Warbling Vireo	X	X
Red-eyed Vireo	X	X
Blue Jay	X	X
American Crow	X	X
Purple Martin	X	X
Tree Swallow	X	X
Northern Rough-winged Swallow	X	X
Barn Swallow	X	X
Black-capped Chickadee	X	X
White-breasted Nuthatch	X	X
Brown Creeper	X	X
Carolina Wren	X	-
House Wren	X	X
Marsh Wren	X	-
Golden-crowned Kinglet	X	X
Ruby-crowned Kinglet	-	X
Eastern Bluebird	-	X
Swainson's Thrush	X	X
Wood Thrush	X	X
American Robin	X	X
Gray Catbird	X	X
European Starling	X	X
Cedar Waxwing	X	X
Tennessee Warbler	-	X
Nashville Warbler	-	X
Northern Parula	-	X

Table 3-11 Summary of Bird Species Detected at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile Creek	Oak Orchard Creek
Yellow Warbler	X	X
Chestnut-sided Warbler	X	X
Magnolia Warbler	-	X
Black-throated Blue Warbler	-	X
Yellow-rumped Warbler	X	X
Black-throated Green Warbler	X	X
Blackburnian Warbler	X	X
Pine Warbler	X	-
Bay-breasted Warbler	-	X
American Redstart	-	X
Ovenbird	X	X
Common Yellowthroat	X	X
Hooded Warbler	-	X
Scarlet Tanager	-	X
Chipping Sparrow	X	X
Song Sparrow	X	X
Swamp Sparrow	X	-
Dark-eyed Junco	-	X
Northern Cardinal	X	X
Rose-breasted Grosbeak	X	X
Indigo Bunting	-	X
Bobolink	X	-
Red-winged Blackbird	X	X
Eastern Meadowlark	-	X
Common Grackle	X	X
Brown-headed Cowbird	X	X
Baltimore Oriole	X	X
American Goldfinch	X	X
House Sparrow	-	X
Species Count	79	94

Key:

E = State-listed as endangered

T = Threatened

SC = Special concern

Table 3-12 Species Observed Only at Eighteenmile Creek or Oak Orchard Creek (2007)

Species Detected Only at Eighteenmile Creek	Species Detected Only at Oak Orchard Creek	
Greater Scaup	Gadwall	Ruby-crowned Kinglet
Red-breasted Merganser	American Wigeon	Eastern Bluebird
Black-crowned Night Heron	Lesser Scaup	Tennessee Warbler
Cooper's Hawk	Hooded Merganser	Nashville Warbler
Virginia Rail	Common Merganser	Northern Parula
Sora	American Bittern	Magnolia Warbler
Common Moorhen	Bald Eagle	Black-throated Blue Warbler
American Woodcock	Northern Harrier	Bay-breasted Warbler
Caspian Tern	Red-shouldered Hawk	American Redstart
Eastern Kingbird	American Kestrel	Hooded Warbler
Carolina Wren	American Coot	Scarlet Tanager
Marsh Wren	Greater Yellowlegs	Dark-eyed Junco
Pine Warbler	Great Horned Owl	Indigo Bunting
Swamp Sparrow	Yellow-bellied Sapsucker	Eastern Meadowlark
Bobolink	Hairy Woodpecker	House Sparrow

3.2.2 Mammals

As indicated in Section 2.2.2, observations of mammals within the subject creeks were recorded coincident with the bird and amphibian surveys. Nine mammal species were identified at Eighteenmile Creek, and 13 species were identified at Oak Orchard Creek (see Table 3-13). Nine species were identified at both creeks, and four species were identified only at Oak Orchard Creek. No threatened or endangered species were observed. There were no observations of deformed or obviously sick or diseased individuals at either of the creeks.

Table 3-13 Mammal Species Observations at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile	
	Creek	Oak Orchard Creek
Bat Species	X	X
Beaver	X	X
Eastern Chipmunk	X	X
Gray Squirrel	X	X
Meadow Vole	-	X
Mouse (<i>Peromyscus</i> sp.)	-	X
Muskrat	X	X
Raccoon	X	X
Red Squirrel	X	X
Shrew Species	X	X
White-tailed Deer	X	X
Woodchuck	-	X
Unknown Small Mammal	-	X
Species Count	9	13

Species diversity appeared to be greater nearer to the dams at both creeks (see Table C-3). The species most frequently observed or heard along the entire length of both creeks was the eastern chipmunk. Commonly observed species within both stream corridors included beaver, gray squirrel, and red squirrel. Other species were observed at only a few locations along the creeks. For example, bats were primarily observed near the wooded areas in the vicinities of the dams at both creeks, and meadow voles were only found in the pitfall traps at Oak Orchard Creek at points 2 and 3, which were located on islands in the creek (see Section 3.2.3).

Generally, the diversity and overall numbers of wildlife species occurring within a given area are directly related to the number, size, and quality of the existing habitat types, and the degree to which land has been developed. Wildlife habitat contains a combination of resources (e.g., water, forage, cover) and environmental conditions (climate, temperature, predators, competitors) that promote the presence of certain species and allow for the relatively successful survival and reproduction of species over time (Morrison, Marcot, and Mannan 1998). An in-depth analysis of habitat structure, functions, and values were beyond the scope of this investigation. However, the slightly greater number of species observed along Oak Orchard Creek may be related to the larger overall area within which observations were made compared to the Eighteenmile Creek survey area. Additionally, there were minor differences in overall habitat structure and availability between the two study areas. Eighteenmile Creek is more characterized by a canyon or ravine environment where the walls are steep and rocky, which provides less habitat area for burrowing animals such as small mammals and woodchucks compared to Oak Orchard Creek.

3.2.3 Amphibians and Reptiles

Pitfall and Minnow Traps

Traps were open for a total of six nights at each creek (see Table 3-14). Individual traps were considered closed if a minnow trap was lost (i.e., vegetation occasionally made minnow traps difficult to find between surveys) or in the case of one trap, when the bucket popped out due to flooding and the hole collapsed.

Very few amphibians or reptiles were captured in the pitfall traps. One painted turtle was captured at Eighteenmile Creek (see Table 3-15). In addition, one shrew was captured in a pitfall trap at Eighteenmile Creek, but species identification could not be confirmed. At Oak Orchard Creek, two Eastern American toads were captured. Six meadow voles and two shrews (unknown species) also were found in the pitfall traps.

Table 3-14 Nights on Which Individual Traps Were Open (2007)

Eighteenmile Creek							
Location	Trap Type	5/4-5/5	5/18-5/19	6/28-6/29	7/22-7/23	8/18-8/19	9/16-9/17
A	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
B	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	C	X	X	X
C	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
D	Pitfall	X	C	C	C	C	C
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
E	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
F	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
Oak Orchard Creek							
Location	Type	5/6-5/7	5/17-5/18	6/27-6/28	7/21-7/22	8/17-8/18	9/15-9/16
1	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
2	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	C	R	X	X
3	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
4	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X
5	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	C	C	C	C
6	Pitfall	X	X	X	X	X	X
	Pitfall	X	X	X	X	X	X
	Minnow	X	X	X	X	X	X

Key:

- C = Closed trap.
- R = Replaced trap.
- X = Trap was open.

A number of small fish of a variety of species, including bass, brown bullhead, crappie, round goby, minnows, red-ear sunfish, and other sunfish species, were found in the minnow traps (see Table 3-15). One crayfish and one snail were also found in the minnow traps at Eighteenmile Creek. At Oak Orchard Creek, one crayfish and one snail were captured. Five tadpoles of two species (leopard frog and green frog) were captured at Oak Orchard Creek, but only one bullfrog tadpole was captured at Eighteenmile Creek.

Overall, 26 animals of ten species were captured at Eighteenmile Creek, and 44 animals of 14 species were captured at Oak Orchard Creek (see Table 3-15). Seven species were captured at both creeks, four species were captured only at Eighteenmile Creek, and eight species were captured only at Oak Orchard Creek. No threatened or endangered species were captured.

Marsh Monitoring Program Surveys

Four frog and toad surveys were conducted at Eighteenmile Creek on May 4 and 18 and June 14 and 28, 2007, and four frog and toad surveys were conducted at Oak Orchard Creek on May 6 and 17 and June 12 and 27, 2007 (see Table C-4). During MMP surveys, 63 individuals of six species were identified at Eighteenmile Creek and 66 individuals of six species were identified at Oak Orchard Creek (see Table 3-16). More frogs and toads were identified in the middle portions of both creeks (survey point locations B, C, D, 2, 3, and 4) than elsewhere. Few or individual frogs or toads were heard more often than larger groups of frogs or toads during surveys, and very few full choruses were detected (see Table 3-17). The most common species at both creeks were spring peeper, green frog, and bullfrog.

Amphibian and Reptile Species List and Threatened/Endangered Species

During trapping, surveys, and other activities in the Project Area (e.g., installation of traps, paddling between point locations), a total of 11 amphibian or reptile species were observed or heard at Eighteenmile Creek and 12 amphibian or reptile species were observed or heard at Oak Orchard Creek (see Table 3-18). No federally or state-listed species were identified.

Table 3-15 Summary of Species Captured in Pitfall and Minnow Traps at Eighteenmile Creek and Oak Orchard Creek in 2007

Common Name ¹	Eighteenmile Creek												Total
	5/5		5/19		6/29		7/23		8/19		9/17		
	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	
Bass	-	-	-	-	-	-	-	-	-	2	-	-	2
Bullfrog	-	-	-	-	-	1	-	-	-	-	-	-	1
Crappie	-	-	-	-	-	-	-	-	-	1	-	-	1
Crayfish	-	-	-	-	-	-	-	-	-	3	-	-	3
Goby	-	-	-	1	-	-	-	1	-	7	-	1	10
Minnow	-	1	-	-	-	-	-	-	-	2	-	-	3
Painted Turtle	-	-	-	-	-	-	-	-	-	-	1	-	1
Shrew	-	-	-	-	-	-	1	-	-	-	1	-	2
Snail	-	-	-	-	-	-	-	-	-	1	-	-	1
Sunfish	-	-	-	-	-	-	-	-	-	-	-	2	2
Grand Total	0	1	0	1	0	1	1	1	0	16	2	3	26
Species Count	0	1	0	1	0	1	1	1	0	6	2	2	10

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Table 3-15 Summary of Species Captured in Pitfall and Minnow Traps at Eighteenmile Creek and Oak Orchard Creek in 2007

Common Name ¹	Oak Orchard Creek												Total
	5/7		5/18		6/28		7/22		8/18		9/16		
	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	Pitfall	Minnow	
American Toad	-	-	-	-	2	-	-	-	-	-	-	-	2
Bass	-	-	-	-	-	-	-	1	-	1	-	1	3
Bass/sunfish?	-	2	-	-	-	-	-	-	-	-	-	-	2
Brown Bullhead	-	-	-	2	-	-	-	5	-	-	-	1	8
Crappie	-	-	-	-	-	-	-	-	-	-	-	1	1
Crayfish	-	-	-	-	-	1	-	-	-	-	-	-	1
Goby	-	-	-	1	-	-	-	-	-	-	-	1	2
Green Frog	-	2	-	-	-	-	-	2	-	-	-	-	4
Leopard Frog	-	-	-	-	-	-	-	1	-	-	-	-	1
Meadow Vole	-	-	1	-	1	-	2	-	1	-	1	-	6
Minnow	-	2	-	5	-	-	-	-	-	-	-	-	8
Redear Sunfish	-	-	-	-	-	-	-	-	-	-	-	1	1
Shrew	-	-	-	-	2	-	-	-	-	-	-	-	2
Sunfish	-	-	-	-	-	-	-	-	-	-	-	2	2
Waterbug	-	1	-	-	-	-	-	-	-	-	-	-	1
Grand Total	0	7	1	8	5	1	2	9	1	1	1	7	44
Species Count	0	4	1	3	3	1	1	4	1	1	1	6	14

¹ Species in bold were observed in only one creek.

Table 3-16 Summary of MMP Surveys for Frogs and Toads by Date and by Point Location at Eighteenmile Creek and Oak Orchard Creek (2007)

Eighteenmile Creek						
	Point	5/4	5/18	6/14	6/28	Overall
Total Frogs/ Toads	A	0	0	1	1	2
	B	4	5	3	1	13
	C	7	3	3	5	18
	D	6	4	3	4	17
	E	1	1	3	4	9
	F	1	0	0	3	4
	Total	19	13	13	18	63
Species	A	0	0	1	1	2
	B	1	2	3	1	4
	C	3	1	3	2	5
	D	3	2	3	2	5
	E	1	1	3	2	4
	F	1	0	0	2	3
	Overall	3	3	4	2	6
Oak Orchard Creek						
	Point	5/6	5/17	6/12	6/27	Overall
Total Frogs/ Toads	1	0	0	3	4	7
	2	0	6	3	2	11
	3	0	4	2	7	13
	4	6	3	2	9	20
	5	1	2	3	3	9
	6	3	0	3	0	6
	Total	10	15	16	25	66
Species	1	0	0	1	1	1
	2	0	2	3	2	6
	3	1	1	2	3	4
	4	2	1	2	3	4
	5	1	1	3	2	4
	6	1	0	3	0	4
	Overall	2	2	3	3	6

Table 3-17 Species, Number of Individuals, and Call Level Code for Frogs Detected at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile Creek				Oak Orchard Creek			
	Code			Total	Code			Total
	1	2	3		1	2	3	
American Toad	4	-	-	4	1	-	-	1
Gray Tree Frog	1	1	-	2	1	2	-	3
Green Frog	14	3	-	17	17	3	1	21
Spring Peeper	3	22	-	25	6	17	0	23
Bullfrog	10	1	1	12	7	-	4	11
Pickerel Frog	1	2	-	3	-	-	-	0
Leopard Frog	-	-	-	0	7	-	-	7
Grand Total	33	29	1	63	39	22	5	66

Key:

Code 1 = Individuals can be counted; calls not simultaneous.

Code 2 = Calls distinguishable; some simultaneous calling.

Code 3 = Full chorus; calls continuous and overlapping.

Table 3-18 Summary of Reptile and Amphibian Species Identified at Eighteenmile Creek and Oak Orchard Creek (2007)

Common Name	Eighteenmile Creek	Oak Orchard Creek
Amphibians		
Bullfrog	X	X
Eastern American Toad	X	X
Gray Treefrog	X	X
Green Frog	X	X
Northern Leopard Frog	X	X
Northern Redback Salamander	X	-
Northern Spring Peeper	X	X
Pickerel Frog	X	X
Wood Frog	X	X
Reptiles		
Common Snapping Turtle	-	X
Diamondback Terrapin	-	X
Northern Watersnake	X	X
Painted Turtle	X	X
Species Count	11	12

3.2.4 Summary of Similarities and Differences Between Study Areas

The wildlife survey results suggest that the species assemblages at the two creeks are similar, implying that both creeks are equally capable of providing the ecological services (e.g., food, shelter, nesting sites) needed by the bird and mammal species typically found in this part of New York State. The number of species observed at the two creeks throughout the season was similar, but a greater diversity of species was observed at Oak Orchard Creek (i.e., 15 more bird species, four more mammal species, and one more amphibian/reptile species) than at Eighteenmile Creek. In addition, greater numbers of tadpoles were observed at Oak Orchard Creek, possibly indicating better water quality; however, very few amphibians were observed overall, and this apparent difference between creeks may simply be an artifact of sampling. The species assemblages were also similar at the two creeks. A slightly greater diversity of waterfowl, raptors, and neotropical migrants were observed at Oak Orchard Creek.

The differences observed in species assemblages can mostly be attributed to differences in habitat availability. Overall, the two study areas were found to be comprised of similar cover types, with a few minor exceptions. The area evaluated immediately adjacent to Eighteenmile Creek is characterized by more areas of cattail marsh, developed (residential), and early successional habitat compared to Oak Orchard Creek, whereas Oak Orchard is characterized by areas containing agricultural land, open water, and a large golf course. Both creeks have similar amounts of surrounding forested land and orchard/vineyard habitat.

Amphibian values from 2007 may not be typical. The spring and summer of 2007 were particularly dry, which may have limited frog/toad calling rates and breeding. Further, very little immigration or emigration was detected, as indicated by the limited number of amphibians caught in the pitfalls traps, which also may be a result of the dry weather. In terms of the numbers of frogs detected, the instability of nighttime temperatures in the spring may have affected when frogs and toads were calling. In spite of the dry and unstable weather conditions, most of the species expected for this area of New York State were identified.

The similarity of wildlife, in terms of numbers and species, detected at both creeks and the relatively high diversity of species indicates that Eighteenmile Creek likely offers habitat of similar quality as Oak Orchard Creek.

3.3 Bullhead Chemical Residue Data and Ecological Risk Evaluation

In August 2007, eight brown bullheads were collected from both Eighteenmile and Oak Orchard creeks and analyzed for PCBs. Two bullheads from each creek also were analyzed for dioxins/furans. The data were collected to: (1) determine whether levels of PCBs and dioxins/furans in bullheads from Eighteenmile Creek are elevated compared with the levels in bullheads from Oak Orchard Creek; (2) determine whether these chemicals pose a potential risk to bullheads in these creeks; and (3) determine whether these chemicals pose a potential risk to fish-

eating birds and mammals at these creeks. These three topics are discussed in turn below.

3.3.1 Chemical Residues in Bullhead

Whole-body concentrations of Aroclors 1248, 1254, and 1260 and total PCBs were an order of magnitude greater in brown bullheads from Eighteenmile Creek compared with the levels in brown bullheads from Oak Orchard Creek (see Table 3-19). The less-chlorinated PCB Aroclors (1016, 1221, 1232, and 1242) were not detected in bullheads from either creek (see Appendix D). Whole-body concentrations of dioxins/furans (expressed as the TCDD toxic equivalent [TEQ]) in bullheads from Eighteenmile Creek were approximately five times greater than in bullheads from Oak Orchard Creek (see Table 3-20).

Elevated levels of PCBs and dioxins/furans in bullheads from Eighteenmile Creek probably are the result of historic industrial activities in the upstream reaches of the creek near Lockport, New York (NYSDEC 2006; EEEPC 2007a). These historic activities have resulted in elevated sediment concentrations of PCBs and dioxins in the lower reaches of Eighteenmile Creek, and these contaminants have been shown to be bioavailable in laboratory bioaccumulation studies (USACE 2004). The bullhead data collected for this study also indicate that sediment contaminants in the lower reaches of Eighteenmile Creek are bioavailable.

The principal Aroclor detected in the bullhead samples collected for this investigation was 1248 (see Table 3-19). Interestingly, Aroclor 1248 was the principal Aroclor found in sediment in lower Eighteenmile Creek by USACE (2008) and one of the principal Aroclors found in sediment in upper Eighteenmile Creek near Lockport (EEPC 2007a). Hence, it appears that the fish in Eighteenmile Creek are accumulating the principal Aroclor present in the system.

3.3.2 Risk Evaluation for the Brown Bullhead

Potential risks to bullheads from PCBs and dioxins/furans were assessed by comparing the measured whole-body concentrations of these chemicals with critical tissue concentrations from the literature. The following critical tissue concentrations were used:

- PCBs (all Aroclors): 440 micrograms per kilogram ($\mu\text{g}/\text{kg}$) wet weight (Dyer et al. 2000); and
- 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD): 72 nanograms per kilogram (ng/kg) wet weight (Windward 2004).

Whole-body concentrations of Aroclors 1248 and 1254 and total PCBs in bullheads from Eighteenmile Creek often exceeded the PCB critical tissue concentration (see shaded values in Table 3-19). No sample from Oak Orchard Creek exceeded the PCB critical tissue concentration. In both Eighteenmile Creek and

Table 3-19 Whole-Body PCB Concentrations in Brown Bullheads from Eighteenmile and Oak Orchard Creeks

Location	Sample1	Aroclor 1248		Aroclor 1254		Aroclor 1260		Total PCBs		Percent Lipids
		ug/kg wet	ug/g lipid	ug/kg wet	ug/g lipid	ug/kg wet	ug/g lipid	ug/kg wet	ug/g lipid	
Eighteenmile Creek	EMC-01-BB-LP	2000	50	960	24	230	5.8	3200	80	3.98
	EMC-05-BB-LP	1200	46	440	17	120	4.6	1800	69	2.6
	EMC-07-BB-LP	650	50	230	18	57	4.4	890	69	1.29
	EMC-18-BB-LP	2300	87	1400	53	380	14	3700	140	2.65
	EMC-19-BB-LP	4100	74	2000	36	570	10	6100	111	5.52
	EMC-25-BB-LP	3200	67	1500	31	380	7.9	4700	98	4.79
	EMC-31-BB-LP	1000	57	350	20	95	5.4	1400	80	1.76
	EMC-34-BB-LP	2700	82	1400	43	380	12	4100	125	3.29
	Minimum	650	46	230	17	57	4.4	890	69	1.29
	Maximum	4100	87	2000	53	570	14	6100	140	5.52
	Average	2144	64	1035	30	277	8.0	3236	96	3.24
Oak Orchard Creek	OOC-07-BB-LP	23	0.76	62	2.0	37	1.2	120	3.9	3.04
	OOC-08-BB-LP	19	0.59	35	1.1	28	0.88	63	2.0	3.2
	OOC-09-BB-LP	33	0.92	73	2.0	64	1.8	170	4.7	3.58
	OOC-16-BB-LP	30	0.77	50	1.3	31	0.79	110	2.8	3.91
	OOC-19-BB-LP	26	0.92	84	3.0	61	2.1	170	6.0	2.84
	OOC-28-BB-LP	43	0.74	100	1.7	66	1.1	210	3.6	5.84
	OOC-31-BB-LP	35	0.90	97	2.5	59	1.5	190	4.9	3.88
	OOC-38-BB-LP	71	1.18	230	3.8	160	2.6	460	7.6	6.04
	Minimum	19	0.59	35	1.1	28	0.79	63	2.0	2.84
	Maximum	71	1.18	230	3.8	160	2.6	460	7.6	6.04
	Average	35	0.85	91	2.2	63	1.5	187	4.4	4.04
EMC versus OOC	Mann-Whitney U Statistic	64	64	63.5	64	57	64	64	64	21
	Probability	0.001	0.001	0.001	0.001	0.008	0.001	0.001	0.001	0.248
	Significantly Different?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No

Key:

EMC = Eighteenmile Creek

OOC = Oak Orchard Creek

PCB = Polychlorinated biphenyl

ug/kg wet = microgram per kilogram wet weight

ug/g lipid = microgram per gram lipid

Notes:

1. Aroclors 1016, 1221, 1232, and 1242 were undetected in all bullhead samples from both creeks (see Appendix D [Analytical Data]).
2. Shading = Sample concentration equals or exceeds critical tissue concentration (440 ug/kg for all aroclors; Dyer et al. 2000) for effects on fish.

Table 3-20 Whole-Body Dioxin/Furan Concentrations in Brown Bullheads from Eighteenmile and Oak Orchard Creeks

Location	Sample ¹	TCDD TEQ (Fish) ²		TCDD TEQ (Mammalian) ²		TCDD TEQ (Avian) ²		Percent Lipids
		ng/kg wet ³	ng/kg lipid	ng/kg wet	ng/kg lipid	ng/kg wet	ng/kg lipid	
Eighteenmile Creek	EMC-01-BB-LP	-	-	-	-	-	-	3.98
	EMC-05-BB-LP	-	-	-	-	-	-	2.6
	EMC-07-BB-LP	-	-	-	-	-	-	1.29
	EMC-18-BB-LP	-	-	-	-	-	-	2.65
	EMC-19-BB-LP	7.5	136	6.3	114	16.9	306	5.52
	EMC-25-BB-LP	5.2	109	4.8	100	10.8	224	4.79
	EMC-31-BB-LP	-	-	-	-	-	-	1.76
	EMC-34-BB-LP	-	-	-	-	-	-	3.29
Oak Orchard Creek	OOC-07-BB-LP	-	-	-	-	-	-	3.04
	OOC-08-BB-LP	-	-	-	-	-	-	3.2
	OOC-09-BB-LP	1.0	27.9	0.95	26.5	1.76	49.2	3.58
	OOC-16-BB-LP	-	-	-	-	-	-	3.91
	OOC-19-BB-LP	-	-	-	-	-	-	2.84
	OOC-28-BB-LP	0.74	12.7	0.69	11.8	1.59	27.2	5.84
	OOC-31-BB-LP	-	-	-	-	-	-	3.88
	OOC-38-BB-LP	-	-	-	-	-	-	6.04

Key:

- (dash) = not analyzed
- EMC = Eighteenmile Creek
- ng/kg wet = nanogram per kilogram wet weight
- ng/kg lipid = nanogram per kilogram lipid
- NOAEL = no observed adverse effect level
- OOC = Oak Orchard Creek
- TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
- TEQ = toxic equivalent
- TEF = toxic equivalency factor

Notes:

- ¹ Only two fish from each creek were analyzed for dioxins/furans. See Appendix D for congener-specific concentrations.
- ² Fish and avian TEFs were taken from Van den Berg (1998). Mammalian TEFs were taken from Van den Berg (2006). See text for further explanation.
- ³ No samples exceeded the TCDD, NOAEL-based, critical tissue concentration (72 ng/kg, Windward 2004) for effects on fish.

Oak Orchard Creek, whole-body concentrations of dioxins/furans in bullheads were well below the critical tissue concentration (see Table 3-20). Overall, these results suggest that bullheads from Eighteenmile Creek may be at risk from elevated tissue residues of PCBs but not from dioxins/furans. These chemicals pose no risks to fish in Oak Orchard Creek.

3.3.3 Risk Evaluation for Fish-Eating Wildlife

Potential ecological risks to fish-eating wildlife from PCBs and dioxins/furans were assessed in accordance with accepted ecological risk assessment guidance (EPA 1993; Sample and Suter 1996). In brief, the bullhead data for total PCBs and dioxins/furans collected for this study were used to estimate exposure and risk for the great blue heron (*Ardea herodias*) and mink (*Mustela vison*), two wildlife species known to use lower Eighteenmile Creek and Oak Orchard Creek.

3.3.3.1 Heron and Mink Exposure to PCBs and Dioxins/Furans

Dietary exposure for the heron and mink was estimated separately for Eighteenmile Creek and Oak Orchard Creek using the following equation:

$$EE_{\text{diet}} = (C_f \times IR/BW) \times \text{SUF} \times \text{ED}$$

where:

EE_{diet} = estimated exposure from diet (mg/kg-day);

C_f = chemical concentration in fish (mg/kg wet weight);

IR = ingestion rate of receptor (kg/day wet weight);

BW = body weight of receptor (kg);

SUF = site use factor (unit-less); and

ED = exposure duration (unit-less), equal to fraction of year spent at site.

The SUF is the portion of a receptor's home range represented by the site. For this analysis, it was assumed that mink and heron at Eighteenmile Creek use only Eighteenmile Creek to satisfy their food and habitat needs, and those at Oak Orchard Creek use only Oak Orchard Creek. Hence, the SUF was set equal to 1 for the mink and heron at both creeks. Exposure duration (ED) is the percentage of the year spent at the site by the receptor species. A value of 1 (year-round resident) was assumed for the mink and 0.5 was assumed for the heron to account for the migratory nature of this species. The exposure parameters and estimated dietary exposure for the heron and mink for total PCBs are presented in Tables 3-21 and 3-22, respectively. Tables 3-23 and 3-24 present analogous information for dioxin/furans for the heron and mink, respectively.

Wildlife also may be exposed to chemicals through drinking contaminated surface water and by incidental ingestion of contaminated sediment. These exposure routes were not quantitatively evaluated in this assessment because they typically account for only a negligible portion of total chemical exposure for piscivorous wildlife, especially for highly bioaccumulative contaminants (Sample et al. 1998).

Table 3-21 Risk Analysis for Total PCBs for Great Blue Heron at Eighteenmile and Oak Orchard Creeks

Parameter	Units	Value	References and Notes
Heron Exposure Factors			
Body Weight (BW)	kg	2.23	USEPA (1993) for herons in eastern North America.
Food Ingestion Rate (FIR)	kg/d (wet wt.)	0.31	Calculated from body weight using allometric equation for all birds USEPA (1993) assuming 68% food moisture content.
Site Use Factor (SUF)	unitless	1	Assumed value of 1 implies that herons at EMC forage only at EMC and that herons at OOC forage only at OOC.
Exposure Duration (ED)	unitless	0.5	Assumed based on migratory nature of this species.
Avian Toxicity Reference Values			
Chronic NOAEL	mg/kg-day	0.18	Dahlgren et al. (1972) as cited in Sample et al. (1996); based on reproductive-effects study with ring-necked pheasants with Aroclor 1254.
Chronic LOAEL	mg/kg-day	1.8	Dahlgren et al. (1972) as cited in Sample et al. (1996); based on reproductive-effects study with ring-necked pheasants with Aroclor 1254.
Heron Exposure and Risk - Eighteenmile Creek			
Diet	Percent	100	Fish from Eighteenmile Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	4.43	95 percent upper confidence limit on the arithmetic average concentration for eight samples listed in Table 3.3.1 as calculated by ProUCL version 4 from USEPA .
Estimated Exposure from Diet	mg/kg-day	0.30	$((\text{Fish PBC Concentration}) \times \text{FIR} / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	1.7	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.17	Estimated Exposure from Diet / LOAEL
Heron Exposure and Risk - Oak Orchard Creek			
Diet	Percent	100	Fish from Oak Orchard Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	0.29	95 percent upper confidence limit on the arithmetic average concentration for eight samples listed in Table 3.3.1 as calculated by ProUCL version 4 from USEPA.
Estimated Exposure from Diet	mg/kg-day	0.020	$((\text{Fish PBC Concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	0.11	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.01	Estimated Exposure from Diet / LOAEL

Key:
 BW = body weight
 EMC = Eighteenmile Creek
 FIR = food ingestion rate
 HQ = hazard quotient
 LOAEL = lowest observed adverse effect level
 NOAEL = no observed adverse effect level
 OOC = Oak Orchard Creek
 PCBs = polychlorinated biphenyls
 shading = HQ exceeds 1.0 (see Section 3.3.3.2 for further explanation).

Table 3-22 Risk Analysis for Total PCBs for Mink at Eighteenmile and Oak Orchard Creeks

Parameter	Units	Value	References and Notes
Mink Exposure Factors			
Body Weight (BW)	kg	0.974	USEPA (1999).
Food Ingestion Rate (FIR)	kg/d (wet wt.)	0.21	Calculated from body weight using allometric equation for all mammals USEPA (1993) assuming 68% food moisture content.
Site Use Factor (SUF)	unitless	1	Assumed value of 1 implies that mink at EMC forage only at EMC and that mink at OOC forage only at OOC.
Exposure Duration (ED)	unitless	1	Year-round resident.
Mammalian Toxicity Reference Values			
Chronic NOAEL	mg/kg-day	0.14	Aulerich and Ringer (1977) as cited in Sample et al. (1996); based on reproductive-effects study with mink with Aroclor 1254.
Chronic LOAEL	mg/kg-day	0.69	Aulerich and Ringer (1977) as cited in Sample et al. (1996); based on reproductive-effects study with mink with Aroclor 1254.
Mink Exposure and Risk - Eighteenmile Creek			
Diet	Percent	100	Fish from Eighteenmile Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	4.43	95 percent upper confidence limit on the arithmetic average concentration for eight samples listed in Table 3.3.1 as calculated by ProUCL version 4 from USEPA.
Estimated Exposure from Diet	mg/kg-day	0.95	$((\text{Fish PBC Concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	6.8	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	1.4	Estimated Exposure from Diet / LOAEL
Mink Exposure and Risk - Oak Orchard Creek			
Diet	Percent	100	Fish from Oak Orchard Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	0.29	eight samples listed in Table 3.3.1 as calculated by ProUCL version 4 from USEPA.
Estimated Exposure from Diet	mg/kg-day	0.062	$((\text{Fish PBC Concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	0.44	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.09	Estimated Exposure from Diet / LOAEL

Key:
 BW = body weight
 EMC = Eighteenmile Creek
 FIR = food ingestion rate
 HQ = hazard quotient
 LOAEL = lowest observed adverse effect level
 NOAEL = no observed adverse effect level
 OOC = Oak Orchard Creek
 PCB = polychlorinated biphenyl
 shading = HQ exceeds 1.0 (see Section 3.3.3.2 for further explanation)

Table 3-23 Risk Analysis for Dioxins/Furans for Great Blue Heron at Eighteenmile and Oak Orchard Creeks

Parameter	Units	Value	References and Notes
Heron Exposure Factors			
Body Weight (BW)	kg	2.23	USEPA (1993) for herons in eastern North America.
Food Ingestion Rate (FIR)	kg/d (wet wt.)	0.31	Calculated from body weight using allometric equation for all birds USEPA (1993) assuming 68% food moisture content.
Site Use Factor (SUF)	unitless	1	Assumed value of 1 implies that herons at EMC forage only at EMC and that herons at OOC forage only at OOC.
Exposure Duration (ED)	unitless	0.5	Assumed based on migratory nature of this species.
Avian Toxicity Reference Values			
Chronic NOAEL	mg/kg-day	0.000014	Nosek et al. (1992) as cited in Sample et al. (1996); based on reproductive-effects study with ring-necked pheasants with 2,3,7,8-TCDD.
Chronic LOAEL	mg/kg-day	0.00014	Nosek et al. (1992) as cited in Sample et al. (1996); based on reproductive-effects study with ring-necked pheasants with 2,3,7,8-TCDD.
Heron Exposure and Risk - Eighteenmile Creek			
Diet	Percent	100	Fish from Eighteenmile Creek assumed to be sole food source.
Fish Dioxin/Furan Concentration	mg/kg (wet wt.)	0.0000169	Maximum TCDD TEQ (avian) for bullhead from Eighteenmile Creek (Table 3.3.2)
Estimated Exposure from Diet	mg/kg-day	0.0000012	$((\text{Fish dioxin/furan concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	0.08	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.01	Estimated Exposure from Diet / LOAEL
Heron Exposure and Risk - Oak Orchard Creek			
Diet	Percent	100	Fish from Oak Orchard Creek assumed to be sole food source.
Fish Dioxin/Furan Concentration	mg/kg (wet wt.)	0.0000018	Maximum TCDD TEQ (avian) for bullhead from Oak Orchard Creek (Table 3.3.2)
Estimated Exposure from Diet	mg/kg-day	0.00000012	$((\text{Fish dioxin/furan concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	0.009	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.001	Estimated Exposure from Diet / LOAEL

Key:

BW = body weight

EMC = Eighteenmile Creek

FIR = food ingestion rate

HQ = hazard quotient

LOAEL = lowest observed adverse effect level

NOAEL = no observed adverse effect level

OOC = Oak Orchard Creek

TCDD TEQ (avian) = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalent concentration (based on avian TEFs)

TEF = toxic equivalency factor

Table 3-24 Risk Analysis for Dioxins/Furans for Mink at Eighteenmile and Oak Orchard Creeks

Parameter	Units	Value	References and Notes
Mink Exposure Factors			
Body Weight (BW)	kg	0.974	USEPA (1999).
Food Ingestion Rate (FIR)	kg/d (wet wt.)	0.21	Calculated from body weight using allometric equation for all mammals USEPA (1993) assuming 68% food moisture content.
Site Use Factor (SUF)	unitless	1	Assumed value of 1 implies that mink at EMC forage only at EMC and that mink at OOC forage only at OOC.
Exposure Duration (ED)	unitless	1	Year-round resident.
Mammalian Toxicity Reference Values			
Chronic NOAEL	mg/kg-day	0.000001	Murray et al. (1979) as cited in Sample et al. (1996); based on reproductive-effects study with rats with 2,3,7,8-TCDD.
Chronic LOAEL	mg/kg-day	0.00001	Murray et al. (1979) as cited in Sample et al. (1996); based on reproductive-effects study with rats with 2,3,7,8-TCDD.
Mink Exposure and Risk - Eighteenmile Creek			
Diet	Percent	100	Fish from Eighteenmile Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	0.0000063	Maximum TCDD TEQ (mammalian) for bullhead from Eighteenmile Creek (Table 3.3.2)
Estimated Exposure from Diet	mg/kg-day	0.0000014	$((\text{Fish dioxin/furan concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	1.4	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.14	Estimated Exposure from Diet / LOAEL
Mink Exposure and Risk - Oak Orchard Creek			
Diet	Percent	100	Fish from Oak Orchard Creek assumed to be sole food source.
Fish PCB Concentration	mg/kg (wet wt.)	0.0000010	Maximum TCDD TEQ (mammalian) for bullhead from Oak Orchard Creek (Table 3.3.2)
Estimated Exposure from Diet	mg/kg-day	0.0000002	$((\text{Fish dioxin/furan concentration} \times \text{FIR}) / \text{BW}) \times \text{SUF} \times \text{ED}$
HQ-NOAEL	unitless	0.20	Estimated Exposure from Diet / NOAEL
HQ-LOAEL	unitless	0.02	Estimated Exposure from Diet / LOAEL

Key:

BW = body weight

EMC = Eighteenmile Creek

FIR = food ingestion rate

HQ = hazard quotient

LOAEL = lowest observed adverse effect level

NOAEL = no observed adverse effect level

OOC = Oak Orchard Creek

shading = HQ exceeds 1.0 (see Section 3.3.3.2 for further explanation)

TCDD TEQ (mammalian) = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalent (based on mammalian TEFs)

TEF = toxic equivalency factor.

3.3.3.2 Heron and Mink Risks from PCBs and Dioxins/Furans

The potential risks posed by PCBs and dioxins/furans were estimated by calculating a hazard quotient (HQ) for each receptor and chemical group. The HQ was calculated by dividing dietary exposure (EE_{diet}) by a no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL), as shown in the following equations:

$$HQ_{\text{NOAEL}} = EE_{\text{diet}}/\text{NOAEL}$$

$$HQ_{\text{LOAEL}} = EE_{\text{diet}}/\text{LOAEL}$$

For a given receptor and chemical, an HQ_{NOAEL} greater than 1 indicates that the estimated exposure exceeds the highest dose at which no adverse effect was observed. Such a result does not imply that the receptor is at risk, especially if the HQ_{NOAEL} is only marginally above 1. An HQ_{LOAEL} greater than 1 suggests that a chronic adverse affect is possible to an individual receptor, assuming that the estimated exposure for that receptor is accurate. For both the heron and mink, the NOAEL and LOAEL used in this assessment are based on a reproductive-effects study (see Tables 3-21 to 3-24 under mammalian and avian toxicity reference values). Hence, the resulting HQs for the heron and mink relate directly to the potential for reproductive impairment, or lack thereof, in the study areas.

Table 3-25 lists the HQs for the heron and mink at Eighteenmile Creek and Oak Orchard Creek. At Oak Orchard Creek, neither PCBs nor dioxins/furans pose a risk to the heron or mink, as all HQs are less than 1. Mink and heron exposure to total PCBs and dioxins/furans at Eighteenmile Creek is greater than at Oak Orchard Creek (see exposure estimate in Tables 3-21 to 3-24), and this difference is reflected in the magnitude of the HQs in Table 3-25, many of which exceed 1 at Eighteenmile Creek. Most importantly, the HQ_{LOAEL} for the mink for total PCBs exceeds 1 at Eighteenmile Creek, suggesting that mink reproduction at Eighteenmile Creek may be adversely impacted by PCBs. The heron at Eighteenmile Creek does not appear to be at risk from either total PCBs or dioxins/furans. Although the heron HQ_{NOAEL} for PCBs marginally exceeds 1 (see Table 3-25), this results does not necessarily indicate that the heron is at risk, for the reason noted above.

Table 3-25 Summary of Heron and Mink Hazard Quotients for Total PCBs and Dioxins/Furans at Eighteenmile and Oak Orchard Creeks

Receptor	Chemical	HQ _{NOAEL}	HQ _{LOAEL}
Eighteenmile Creek			
Heron	Total PCBs	1.7	0.17
	Dioxins/Furans	0.08	0.01
Mink	Total PCBs	6.8	1.4
	Dioxins/Furans	1.4	0.14
Oak Orchard Creek			
Heron	Total PCBs	0.11	0.01
	Dioxins/Furans	0.009	0.001
Mink	Total PCBs	0.44	0.09
	Dioxins/Furans	0.20	0.02

Key:

- HQ = hazard quotient
- LOAEL = lowest observed adverse effect level
- NOAEL = no observed adverse effect level
- PCBs = polychlorinated biphenyls

Note:

- ¹ HQ_{NOAEL} and HQ_{LOAEL} are from Tables 3-21 to 3-24.
- ² Shading = HQ exceeds 1. See Section 3.3.3.2 for further explanation.

3.3.3.3 Uncertainty Evaluation

It is common in risk assessments to indicate the main uncertainties affecting the exposure and risk estimates and indicate whether they would tend to under- or over-estimate exposure and risk. The main uncertainties associated with the risk evaluation presented in this section are described below:

- **Chemical Concentrations in Prey.** Measured concentration of total PCBs and dioxins/furans in brown bullheads were used to estimate dietary exposure to the heron and mink. Using these data in the risk evaluation eliminated the uncertainty associated with using modeling approaches to predict chemical concentrations in the prey of these receptors. However, the bullheads analyzed for this study were 9 to 12 inches in length and, therefore, would be considered large prey, particularly for the heron. In reality, the heron and other piscivorous birds in the study areas probably consume smaller fish from various species. Using only data for 9- to 12-inch bullheads in the risk evaluation likely overestimates exposure and risk for the heron because smaller forage fish typically contain lower levels of bioaccumulative contaminants.
- **Diet Composition.** The diet of the heron and mink were conservatively assumed to consist entirely of fish. For the heron, this assumption seems reasonable. However, mink consume other prey, including meadow voles, muskrats, and ducklings (EPA 1993), all of which would be expected to contain lower levels of sediment contaminants than bullheads. Therefore, assuming that mink consume only bullheads likely overestimates their exposure and risk in the study areas.

- **Site Use.** Both the heron and mink were assumed to acquire all of their prey from either Eighteenmile Creek or Oak Orchard Creek, depending on which creek they were assumed to reside at. For the mink, this assumption seems reasonable given the length of the creeks compared with the average home range size of the mink—about 2 kilometers (km) of stream length (EPA 1993). However, the heron is known to forage over a wider area (up to 20 km from colony sites; EPA 1993) and in reality probably forages at various aquatic habitats in the general vicinity of the study creeks. These other foraging areas could contain prey with either lower or higher levels of bioaccumulative contaminants compared with the study areas. Hence, assuming a site use factor of 1.0 for the heron (see Section 3.3.3.1) may lead to either an under- or overestimation of exposure and risk for this receptor.

3.4 Bullhead Deformities and Liver Pathology

This section describes the results of the external and internal examination of brown bullheads for tumors and other deformities (Section 3.4.1) and summarizes the liver pathology evaluation (Section 3.4.2).

3.4.1 External and Internal Examination Results

One hundred brown bullheads, 50 from Eighteenmile Creek and 50 from Oak Orchard Creek, were collected during the August sampling event. The majority of the specimens collected resulted from the targeted sampling efforts; a small number of specimens were incidentally collected during the fish community surveys. The external and internal condition of each fish from both creeks was visually evaluated and recorded according to the procedures outlined in Section 5.3 of the *Field Manual for Assessing Internal and External Anomalies in Brown Bullhead (Ameiurus nebulosus)* (Rafferty and Grazio, 2006; see Appendix A of the QAPP). The datasheets used were similar to the Fish Health Data Sheet in Rafferty and Grazio (2006) and are presented in Appendix F. Digital photography was used to provide further documentation of the external conditions of fish and of the livers (see Appendix F).

Differences were noted between the two creeks regarding the number of types of morphological aberrations (missing/truncated barbels, raised skin lesions, black/yellow pigmentation, ulcers, etc.) and their severity. Fish in Eighteenmile Creek exhibited a broader range of external aberrations and greater frequency of severity scores of 2 and 3 (on a scale of 0 to 3, with 3 being the most severe) compared with Oak Orchard Creek fish. In addition, while just less than half of the fish examined (21) from Oak Orchard Creek exhibited no morphological aberrations at all (score of 0 for each type of aberration), only three fish from Eighteenmile Creek scored 0 for all types of aberrations.

Table 3-26 compares the number and severity of four common types of aberrations observed in fish from the two creeks—raised mouth lesions, raised skin lesions, ulcers, and barbel deformities. The incidence (i.e., rate of occurrence) and severity of raised mouth lesions and barbell deformities was significantly greater

in fish from Eighteenmile Creek than in fish from Oak Orchard Creek. Overall, there was a very low incidence (2) of the most severe type (severity score 3) of ulcers, raised skin/mouth lesions, or barbel deformities. Only one fish from Eighteenmile Creek (EMC-27-BB-LP; see datasheets and photographs in Appendix F) exhibited the most severe rating of 3 for raised mouth and skin lesions (and black pigmentation). No fish from Oak Orchard Creek displayed such severe aberrations.

Table 3-26 Number and Severity of Raised Mouth Lesions, Raised Skin Lesions, Ulcers, and Barbel Deformities in Brown Bullheads from Eighteenmile and Oak Orchard Creeks

External Aberration Categories	Number ¹ and Severity ² of Aberrations		
	Eighteenmile Creek	Oak Orchard Creek	Probability
Raised Mouth Lesions	6 fish with score of 1 2 fish with score of 2 1 fish with score of 3 9 total	1 fish with score of 1 1 fish with score of 2 0 fish with score of 3 2 total	0.027
Raised Skin Lesions	1 fish with score of 1 1 fish with score of 2 1 fish with score of 3 3 total	1 fish with score of 1 0 fish with score of 2 0 fish with score of 3 1 total	0.300
Ulcers	8 fish with score of 1 1 fish with score of 2 0 fish with score of 3 9 total	2 fish with score of 1 1 fish with score of 2 0 fish with score of 3 3 total	0.072
Barbels	19 fish with score of 1 1 fish with score of 2 0 fish with score of 3 20 total	6 fish with score of 1 1 fish with score of 2 0 fish with score of 3 7 total	0.004

Notes:

¹ Out of 50 fish per creek.

² On a scale of 0 to 3 (0=normal, 1=mild, 2=moderate, 3=severe).

³ Two-tailed probability based on Mann Whitney U test (see Section 2.3.3).

According to Baumann and Dabrowski (2006), external aberrations such as those described in this section should not be used to determine the status of the *Fish Tumors and Other Deformities* BUI, but are relevant to the *Degraded Fish and Wildlife Populations* BUI. The greater incidence of raised mouth lesions and barbel deformities in fish from Eighteenmile Creek compared with Oak Orchard Creek suggests that bottom-dwelling fish in the AOC are experiencing some level of impairment.

Lesion: An area of abnormal tissue.

Parasite: An organism that lives on or in another from which it draws its nourishment. Flatworms are common fish liver parasites

Neoplasm: An abnormal mass of tissue that results when cells divide more than they should or do not die when they should. Neoplasms may be benign (not cancerous), or malignant (cancerous); also called tumor.

Hyperplasia: A general term referring to the proliferation of cells within an organ or tissue beyond that which is ordinarily seen. Hyperplasia may result in the gross enlargement of an organ, the formation of a benign tumor, or may be visible only under a microscope. Hyperplasia is considered to be a physiological response to a specific stimulus, and the cells of a hyperplastic growth remain subject to normal regulatory control mechanisms. This stands in contrast to neoplasia (the process underlying cancer and some benign tumors), in which genetically abnormal cells proliferate in a non-physiological manner which is unresponsive to normal stimuli

Alter focus: A pre-neoplastic lesion.

Internal visual observations of the fish from Eighteenmile Creek indicated that there appeared to be a relatively high incidence of discoloration and/or granular appearance to the livers (40 fish had some degree of pale discoloration, and many of those exhibited a granular texture [see photos in Appendix F]). However, the results for the Oak Orchard Creek specimens were similarly high, with 43 fish exhibiting the same or similar characteristics. Observations of parasites and lesions on the livers also were similar (and in low numbers) for specimens from both creeks. Overall, the incidence of visual liver abnormalities in fish from the two creeks was comparable.

3.4.2 Bullhead Liver Pathology

The objective of the liver pathology evaluation was to determine the prevalence of tumors and other abnormalities in the livers of brown bullheads collected from Eighteenmile Creek and Oak Orchard Creek. The work was done to provide data needed to assess the first BUI to be evaluated as part of the current investigation—existence of fish tumors and other deformities (status unknown). The liver histopathology was conducted by Dr. Jeffrey Wolf of Experimental Pathology Laboratories, Inc., in Sterling, Virginia, using 50 bullhead livers each from Eighteenmile Creek and Oak Orchard Creek. The livers were harvested in the field by personnel from Ecology and Environment, Inc. (E & E), preserved, and shipped to Experimental Pathology Laboratories as described in Section 2.1.2.2. Appendix E describes the laboratory methods used to process and examine the livers. The livers were examined for three primary categories of abnormalities: (1) proliferative epithelial lesions such as altered foci, hyperplasia, and neoplasia; (2) pigmented macrophage aggregates and hepatocellular vacuolation; and (3) other non-neoplastic lesions such as inflammation, necrosis, and endoparasitism. Definitions and examples of these abnormalities are provided in Blazer et al. (2006). A summary of the results for each of these categories of abnormalities is provided in Table 3-27 and discussed below. Appendix E provides a complete discussion of the results.

3.4.2.1 Proliferative Epithelial Lesions

A variety of proliferative epithelial lesions, including a low number of benign hepatocellular and bile duct neoplasms, various foci of hepatocellular alteration, and bile duct hyperplasia, were observed in the livers of fish collected from Eighteenmile Creek and Oak Orchard Creek. Proliferative bile duct lesions (bile duct hyperplasia and cholangiomas) were observed only in fish from Eighteenmile Creek; however, the incidences of these two findings were low, and the overall incidences of tumors and altered foci were not significantly different between sites (see Table 3-27).

Table 3-27 Summary of Statistical Comparison of Bullhead Liver Pathology Data from Eighteenmile and Oak Orchard Creeks

Parameter	Count		Probability ¹	Remarks
	Eighteenmile Creek (EMC)	Oak Orchard Creek (OOC)		
Proliferative Epithelial Lesions				
Altered foci	10 total	13 total	0.635	No difference between creeks.
Hyperplasia	4 total	0 total	0.117	No difference between creeks.
Neoplasia (benign)	5 total	2 total	0.436	No difference between creeks.
Pigmented Macrophage Aggregates and Hepatocellular Vacuolation²				
Pigmented Macrophage Aggregates	34 (grade 1)	44 (grade 1)	0.017	EMC had fewer grade 1 and more grade 2 than OOC.
	13 (grade 2)	5 (grade 2)		
	3 (grade 3)	1 (grade 3)		
	0 (grade 4)	0 (grade 4)		
Hepatocellular Vacuolation	16 (grade 1)	24 (grade 1)	0.007	EMC had more grade 3 than OOC.
	16 (grade 2)	22 (grade 2)		
	18 (grade 3)	4 (grade 3)		
	0 (grade 4)	0 (grade 4)		
Selected Non-Neoplastic Lesions				
Inflammation	62 total	41 total	0.002	Greater in EMC.
Necrosis	15 total	16 total	0.829	No difference between creeks.
Endoparasitism	28 total	17 total	0.027	Greater in EMC.

Key:

- (dash) = no remarks

 Shading = significant difference ($p < 0.05$).

Notes:

1. See Section 2.3.3 for description of statistical methods used.
2. Grade 1 is least severe and grade 4 is most severe.

3.4.2.2 Pigmented Macrophage Aggregates and Hepatocellular Vacuolation

Pigmented macrophage aggregate (PMA) and hepatocellular vacuolation (HV) scores were significantly higher ($p < 0.05$) in fish from Eighteenmile Creek than in fish from Oak Orchard Creek (see Table 3-27). Because these are nonspecific indicators of stress and condition, and because the differences were not dramatic, the biological importance of these results is uncertain.

3.4.2.3 Selected Non-Neoplastic Lesions

The incidences of inflammation and endoparasitism also were significantly higher ($p < 0.05$) in Eighteenmile Creek fish than in Oak Orchard Creek fish (see Table 3-27). Although inflammatory and parasitic lesions were common in the livers of fish from both creeks, the severity of the lesions was often minimal and never

greater than mild. The levels of inflammation and endoparasitism that were evident in the livers of brown bullheads in this study are considered typical for wild caught fish.

3.4.2.4 Relevance to BUI Assessment

Only some of the bullhead liver pathology data collected for this investigation are relevant to understanding the status of the *Fish Tumors and Other Deformities* BUI. Baumann and Dabrowski (2006) recommend that the delisting criteria for this BUI be based on bullhead liver neoplasia (i.e., tumors) because they are reliably associated with contaminant (principally PAH) exposure. Three results from the current study suggest that Eighteenmile Creek may be delisted regarding fish tumor impairments:

- No malignant tumors were observed in the livers of brown bullheads from Eighteenmile Creek;
- There was no significant difference in the number of benign liver tumors in brown bullheads from Eighteenmile and Oak Orchard Creeks; and
- There was no significant difference in the incidence of altered foci in the livers of brown bullheads from either creek. Altered foci are potential pre-neoplastic lesions (i.e., lesions that could lead to liver tumor formation) and therefore are also relevant to evaluating this BUI.

The finding of no fish tumor impairments at the Eighteenmile Creek AOC is not surprising given that the principal contaminant in the AOC are PCBs, not PAHs.

The other types of liver abnormalities evaluated in this study (e.g., vacuolation, inflammation, endoparasitism, etc.) are not considered relevant to determining the status of the fish tumor impairment BUI. These other types of liver abnormalities may provide some overall indication of fish health, but no specific guidance is available regarding the use of these data for assessing BUIs in Great Lakes AOCs.