Data Summary Report

Buffalo River AOC Baseline Remedial Assessment Study

Buffalo, New York

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Acronyms and Abbreviations

AOC	–	Area of Concern
BRAS		baseline remedial assessment study
CSO	–	Combined Sewer Overflow
DUSR	–	Data Usability Summary Report
EEE	–	Ecology Engineering Evaluation
GPS	–	Global Positioning System
LDB	–	Left Descending Bank
PCT	–	Project Coordination Team
RDB	–	Right Descending Bank
AEC	–	Architect/Engineer Services
AVS	–	acid volatile sulfide
BC	–	black carbon
BODR	–	Basis of Design Report
BRAS	–	Baseline Remedial Assessment Study
CLP	–	Contract Laboratory Program
COC	–	contaminants of concern
CPUE	–	catch per unit effort
CV	–	coefficient of variation
CY	–	cubic yard
DELT	–	deformities, eroded fins, lesions, and tumors
DEP	–	Department of Environmental Protection
DMU	–	dredge management unit
DQO	–	data quality objective
E & E	–	Ecology and Environment, Inc.
EPT	–	Ephemeroptera, Plecoptera, and Trichoptera
ERDC	–	Engineer Research and Development Center

ERMP	–	Ecological Restoration Master Plan
EV	–	emergent vegetation
FS	–	Feasibility Study
FSP	–	Field Sampling Plan
GLLA	–	Great Lakes Legacy Act
GLNPO	–	Great Lakes National Program Office
GLRI	–	Great Lakes Restoration Initiative
HBI	–	Hilsenhoff Biotic Index
HOC	–	hydrophobic organic contaminant
IBI		Index of Biotic Integrity
IDL	–	instrument detection limit
km	–	kilometer
LWD	–	low water datum
MDL	–	method detection limit
Mg/kg	–	milligrams per kilogram
NCO	–	Non-Chironomid/Oligochaete
NYSDEC	–	New York State Department of Environmental Conservation
O&G	–	oil and grease
OMOE	–	Ontario Ministry of the Environment
PAH	–	polynuclear aromatic hydrocarbons
PCB	–	polychlorinated biphenyl
PQL		practical quantitation limit
QA	–	quality assurance
QAPP	–	Quality Assurance Project Plan
QC	–	quality control
QHEI		Qualitative Habitat Evaluation Index
RA	–	Remedial Alternative
RBP		Rapid Bioassessment Protocols
RD	–	Remedial Design

RPD	–	relative percent difference
PEC	-	probable effect concentrations
SAV	–	submerged aquatic vegetation
SEM	–	simultaneously extracted metals
SRIR	–	Sediment Remedial Investigation Report
SVOC	–	semivolatile organic compound
TO	–	Task Order
TOC	–	total organic carbon
USACE	–	United States Army Corps of Engineers
USEPA	–	United States Environmental Protection Agency

SECTION 1

Project Overview

1.1 Introduction

This data summary report provides the results and methods of the baseline remedial assessment study (BRAS) for the Buffalo River Area of Concern (AOC) in Erie County, Buffalo, New York. This data summary report was submitted pursuant to Task Order (TO) No. TO-0069 issued to CH2M HILL under U.S. Environmental Protection Agency (USEPA) Region 10 Architect/Engineer Services (AEC) 2, No. 68 S7 04 01. Work was completed under the direction of the EPA's Great Lakes National Program Office (GLNPO) by CH2M HILL and their team subcontractor, Ecology and Environment, Inc. (E & E).

1.2 Project Background

The Buffalo River AOC is located in the city of Buffalo in western New York State. The river flows from the east and discharges into Lake Erie near the head of the Niagara River. The Buffalo River is a navigable channel maintained by the United States Army Corps of Engineers (USACE) at a depth of 22 feet below low water datum (LWD). The AOC includes the entire 2.3-kilometer (km) (1.4-mile) stretch of the Buffalo City Ship Canal (Ship Canal) and extends upstream approximately 10 km (6.2 miles) (see Figure 1-1). The AOC is regarded as the "impact area" and is characterized by historic heavy industrial development in the midst of a large municipality. Presently, the sources of contamination in the AOC are primarily from sediments and non-point sources in the Buffalo River watershed. The Buffalo River sediments have been impaired by past industrial and municipal discharges and disposal of wastes that have contributed elevated levels of polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and various metals.

From 1998 through 2008, GLNPO, in coordination with other federal, state, and local partners, completed a variety of remedial investigations, planning, and feasibility-level studies in the project area to evaluate the impacts of contaminated sediments on the aquatic system and determine an appropriate approach to remediating contaminated sediments within the Buffalo River AOC. These efforts have culminated in the release of a draft final feasibility study (FS) report in November 2010 (ENVIRON et al. 2010). Figure 1-1 provides an overview of the AOC as well as the area selected for remedial action. The preferred remedial action includes dredging and disposal of contaminated sediment, capping the area at the head of the ship canal, and habitat restoration.

The Great Lakes Restoration Initiative (GLRI) is a multi-year, multi-agency initiative to restore the Great Lakes. Using GLRI funds in 2011, the USACE will dredge contaminated sediments from the federal navigation channel in the Buffalo River and Ship Canal in order to complement sediment cleanup proposed under the FS. An estimated 450,000 to 650,000 cubic yards (CY) of sediment would be removed from these federal navigation channels. The dredging would be to a depth of 23.5 feet below LWD. An additional 6 inches of dredging "overdepth" would be allowed to ensure that the contract depths are obtained.

Under existing USACE authorities, this combined depth of up to 24 feet is allowed as advanced maintenance dredging. The USACE is authorized to operate and maintain the federal channel under the Rivers and Harbor Act and Water Resources Development Acts of 1986, 1988, and 2007. Sediment dredged from the Buffalo River federal navigation channel will be placed in Confined Disposal Facility No. 4, located next to the former Bethlehem Steel facility.

1.3 Purpose of the Project

This USEPA Great Lakes Legacy Act (GLLA) project will focus on the contaminated sediment outside the federal navigation channel but within the dredge footprint for Remedial Alternative (RA) 5 selected from the FS. The FS RA 5 areas are shown on Figure 1-1. As part of the remedial design (RD), the FS RA 5 areas were divided into 45 dredge management units (DMUs). The 30% preliminary RD was submitted in March 2011 and the 60% interim RD was submitted in December 2012. As additional investigations were conducted as part of the RD, some of the dredge boundaries have been modified and some potential dredge areas identified in the FS were eliminated from the proposed dredge program. Changes are identified in the Basis of Design Report (BODR; CH2M HILL/E & E 2011a). GLLA dredging is scheduled for late 2012 and 2013.

EPA's GLNPO needs to establish baseline conditions before dredging begins in 2011 with the USACE GLRI program. The purpose of the baseline assessment is to document current (i.e., pre-remediation) conditions in the area as a benchmark against which post-remediation monitoring will be evaluated. The baseline assessment and data from post-remediation monitoring will permit sound statistical comparisons of the spatial scale of contamination, the magnitude of stressor reduction after implementation of remedial action, and the effectiveness of the remediation.

This BRAS report presents current baseline data for the GLLA remediation project area for the following: chemicals in sediment and edible fish tissue, sediment toxicity, sediment chemical bioavailability, fish community composition, and habitat conditions. A summary of the field and analytical methods used for the BRAS also is provided. It should be noted that the GLLA project footprint covers almost the entire Buffalo River AOC; therefore, the data gathered for this investigation also provides current baseline information for the AOC as a whole. The data collected for this study will be used by GLNPO, along with data collected after completion of the planned remediation project, to evaluate the recovery of the Buffalo River AOC over time. A post-remediation study will likely be undertaken in the future.

1.4 Site Overview

The specific remedial action objectives (RAOs) for the Buffalo River dredging project are presented in the FS Report (ENVIRON et al. 2010) and summarized in the BODR (CH2M HILL/E & E 2011a). These RAOs are:

- Reduce human exposure for direct sediment contact and fish consumption from the Buffalo River by reducing the availability and/or concentrations of contaminants of concern (COCs) in sediment.

- Reduce the exposure of wildlife populations and the aquatic community to sediment COC concentrations above protective levels.
- Reduce or otherwise address legacy sediment COC concentrations to improve the likelihood that future dredged sediments (for routine navigational, commercial, and recreational purposes) will not require confined disposal.
- Implement a remedy compatible with the Buffalo River Remedial Advisory Committee's goal of protecting and restoring habitat and supporting wildlife.

Along with the RAOs, supportive goals were considered during the assessment of remedial alternatives, such as: (1) reducing the long-term potential of COC-contaminated sediments to migrate outside of the AOC; and (2) implementing a remedy that is compatible with and complements ongoing regional redevelopment goals, upland remediation, and restoration activities.

The BRAS was designed to measure baseline conditions that address each long-term objective for remediation. A sampling plan for the BRAS was developed to provide a reproducible statistical sampling design that allows for evaluation of pre- and post-remediation conditions. The sampling plan design is presented in the approved Quality Assurance Project Plan (QAPP) (CH2M HILL/E & E 2011c). The scope of the BRAS is limited to the assessment of present conditions. Although it is assumed that a follow-up comparison study of similar scope will be conducted, the design of that future study (specific elements or sample size) is not developed as part of the BRAS. The BRAS data includes sediment and tissue chemistry, contaminant bioavailability, and sediment toxicity. The data also includes fish community assessment surveys and habitat conditions that will be used to determine changes in ecosystem and habitat response and to evaluate impacts, if any, of contaminant removal/capping on ecosystem and habitat measures of health. Although numeric remedial action objectives have been established for this dredging project, a comparison of surficial sediment concentration to the numeric remedial goals is not a central objective of this study.

Previous investigations indicate that COCs in Buffalo River sediment that define the dredge footprint include PCBs, PAHs, and the metals lead and mercury. Pesticides and other metals also were identified as COC, but were not used to define the extent of contamination. A sediment sampling and analytical program was implemented for the BRAS that addressed all COCs including an extended list of PAHs and PCB congeners as well as physical parameters. The Buffalo River was divided into dredge and non-dredge areas and representative samples were collected from the surficial sediments as described in the QAPP and shown on Figures 1-2 and 1-3. Contaminant bioavailability was addressed by analyzing a portion of the samples for PCB congeners and acid volatile sulfides/simultaneously extracted metals (AVS/SEMs) and porewater for the extended list of PAHs. Fish tissue was analyzed for PCB congeners and total metals to address bioaccumulation. Sediment toxicity was assessed by testing a portion of the samples with a 10-day test using the amphipod, *Hyalella azteca*, and a 10-day test using the midge, *Chironomus dilutus*. For sediment bioaccumulation testing, the 28-day *Lumbriculus* test was performed on bulk sediments and the resulting *Lumbriculus* tissue was analyzed for mercury and PCB congeners. The details of the sediment sampling program are provided in a Sediment Sampling Summary Report in Appendix A.1.

The fish community assessment surveys documenting fish species composition and abundance was performed at selected sampling sites corresponding with the proposed habitat restoration sites. The assessment computes a number of common fish community metrics to summarize the overall condition of the fish community, as well as provides values to compare with existing and future sampling efforts. Sample locations were chosen to augment previous work and to document remedy effectiveness at sites proposed for restoration. Fish sampling was conducted in conjunction with the fish community assessment surveys.

Physical habitat assessment was conducted at each of four sampling locations associated with the fish community sampling. Data collected from these locations will be used to support a quantitative evaluation of baseline conditions that can be compared against results of future monitoring data regarding physical habitat conditions. The quantitative calculations presented include the Quantitative Habitat Evaluation Indices (QHEI Rankin 1989) for the habitat assessment and the Index of Biotic Integrity (IBI) for the fish community assessment. The details of the biological sampling program are provided in a Biological Sampling Summary Report in Appendix A.2.

1.5 Report Organization

The BRAS report presents a brief summary of the existing data evaluated for usability for establishing baseline conditions of the Buffalo River AOC in Section 2. The data discussed in Section 2 was used as part of the planning process to prepare the specific study design for this project. Section 3 presents an overview of the study design and field work implemented as part of the BRAS. Section 4 summarizes the results of the BRAS including data summary tables for each type of data collected.

The supporting data are provided in appendices to this report. Appendix A includes sampling summary memos that provide details on the field and analytical work. Appendix B includes detailed data tables for the chemistry results (Appendix B.1) and biological results (Appendix B.2). Appendix C includes the report on sediment toxicity testing. Supporting field documents and photographs are included in Appendix D and E, respectively. Supporting electronic and memo data validation reports are included in Appendix F. Appendix F also includes compiled electronic data in an Access database. PDF files of the actual analytical laboratory reports are included in Appendix G where they were provided as part of the laboratory contract.

SECTION 2

Existing Data Summary and Usability

2.1 General

This document and its appendices are intended to provide the baseline data that were collected during 2011 field efforts and provide reference to additional relevant information to present a complete picture of conditions in the Buffalo River prior to remedial actions. A review of previous data included data types that were updated with the 2011 field efforts (sediment chemistry, fish bioaccumulation, fish community, and some descriptors of physical habitat) and additional data that was not repeated because it was considered recent and thorough enough to provide adequate baseline conditions (vegetation, invertebrates, and additional physical habitat characteristics). The scope of this project does not include compiling all existing data sources for sediment, physical habitat, and fish into one document, but is intended to provide a recent, relevant snapshot of conditions prior to the proposed remedial action. A number of existing data sources were consulted in preparation of the QAPP (CH2M HILL/E & E 2011c) and several are included here to provide sources of additional information and to provide a context for the sampling rationale.

2.2 Available Data Sources

Several recent reports associated with the Buffalo River dredging project provide an overview of available data. *Buffalo River Section 312 Environmental Dredging Existing Conditions Report* prepared by E & E for the USACE Buffalo District summarizes the available data collected prior to 2008 (E & E 2008). The *Sediment Remedial Investigation Report (SRIR) for the Buffalo River, New York* (ENVIRON et al. 2009) and the *Data Summary Report for the Buffalo River Area of Concern* (CH2M HILL/E & E 2009) provide the detailed data reports for GLLA data collected in 2008. The BODR presents detailed data reports for the additional pre-design data collected in 2010 and 2011. The data are evaluated in both the FS report (ENVIRON et al. 2010) and the BODR (CH2M HILL/E & E 2011a).

The sediment chemistry for the Buffalo River has been extensively evaluated as part of the dredging project and is presented in the FS report (ENVIRON et al. 2010) and the BODR (CH2M HILL/E & E 2011a). However, the recent studies focus on the four indicator COCs (PAH, PCBs, lead, and mercury) in subsurface sediments. Sediment toxicity data were collected by USACE in 2003 (USACE 2003) and New York State Department of Environmental Conservation (NYSDEC) in 2005 (ASci Corporation 2005) and the results are summarized in the Existing Conditions Report and SRIR noted previously.

Fish communities had been surveyed at 10 locations within the AOC in 2003 and 2004 (Irvine et al. 2005). More recent fish community data was collected in 2008 for Buffalo River remedial investigation (ENVIRON et al. 2009). Fish community sampling locations were established at two upstream locations within the AOC between river miles 4.5 and 5.5. The 2008 Buffalo River SRIR also provides data regarding benthic conditions in the AOC.

Recent fish tissue data collected and analyzed by the NYSDEC (NYSDEC; Skinner et al. 2009) in the Buffalo River provides adequate spatial and temporal coverage of fish bioaccumulation of the river.

A significant amount of the data required to characterize habitat at the selected restoration sites have been previously collected as part of the pre-design investigation work performed by CH2M HILL and E & E in October 2010 for USEPA GLNPO and presented in the BODR for habitat restoration (CH2M HILL/E & E 2011b) and as part of the recent Buffalo River Ecological Restoration Master Plan (ERMP; E & E 2011). This is particularly true for in-stream and riparian zone vegetation, invasive species, and physical measurements at the selected habitat restoration sites. Both invasive species and physical habitat measurements on a broader scale (i.e., in the context of the entire AOC) has been documented in these previous studies.

2.3 Usability

An initial data analysis has determined that these previously-collected data will be usable for baseline monitoring. The evaluation was presented in the QAPP Section 1.4 as part of the sampling design and is summarized briefly below.

The most recent sediment chemistry data collected prior to the BRAS was focused on determining the extent of contamination of the four indicator COCs in subsurface sediments in planned dredge areas. These data, collected in 2010 and 2011, are not representative of current conditions for all COCs and do not provide a statistical basis to compare dredge with non-dredge areas. Hence, as part of the BRAS, additional data were collected to evaluate all the COCs in surface sediments in dredge and non-dredge areas of the AOC. Historic sediment bioassay data are of good quality, but do not provide up-to-date information on surface sediment toxicity in the dredge and non-dredge areas that were evaluated for the BRAS. Hence, sediment bioassays were conducted with surface sediment from a subset of the dredge and non-dredge areas as part of the BRAS.

Review of recent surveys of fish communities in the AOC shows that the previous sampling location distributions are not spatially adequate to characterize the fish community assemblages for the entire AOC, which will be impacted by the proposed remedial action. The fish community surveys conducted in 2008 are representative of recent baseline conditions in the upper reaches and can be reproduced for future monitoring. However, fish community survey data in the lower reaches and in areas proposed for restoration are needed to establish complete baseline conditions for the BRAS.

The data collected in 2008 for the SRIR to assess benthic conditions provides adequate coverage of the entire Buffalo River. These data were not replicated for the BRAS, as the dataset was considered complete and recent enough to provide baseline conditions prior to the proposed remedial action. The SRIR report also provides a comprehensive overview of historical toxicity data as it relates to benthic conditions (ENVIRON et al. 2009).

The recent data on fish bioaccumulation collected by NYSDEC are usable to assess baseline conditions (NYSDEC; Skinner et al. 2009). However, additional data were collected during this sampling event to provide more current data at the proposed restoration sites.

Data collected as part of the pre-design investigation are considered usable for establishing baseline habitat conditions at the selected restoration sites. However, as a part of the BRAS, specific data were collected at the proposed restoration sites to establish quantitative baseline habitat and biological metrics for the sites. Historical reports are available that provide a good overview of biological conditions in the AOC and upstream areas (e.g., BNR 2008, Irvine et al. 2005), but they are dated and/or insufficiently detailed to serve as the sole basis for defining current baseline habitat conditions at the selected restoration sites.

2.4 Integration Methods

Data from previous investigations provided minimal input to the results of this report except for establishing quantitative metrics of habitat conditions. The historical data and figures are reproduced in this report in Appendix B as necessary to provide a complete assessment of baseline habitat and fish community conditions.

The field and chemistry results will be compiled into an electronic data deliverable that complies with all requirements set forth in the GLLA Data Reporting Standard (Version 1.0, March 2010). This includes (but is not limited to) a complete set of field and laboratory data and a narrative detailing any concerns regarding data usability for the intended purpose associated with laboratory or field data flags or anomalies. The electronic data will be uploaded to the GLLA database for future use and is compiled with the electronic data in Appendix F.

SECTION 3

Methods

3.1 Study Design

Study design details are found in the Buffalo River AOC BRAS QAPP (CH2M HILL/E & E 2011c). The design was based on the general conceptual site model (CSM) provided as Figure 3-1. Selection of the sediment sampling locations and sample collection is described below. Table 2-1 of the QAPP lists the number of samples collected for each analysis, analytical method and number and type of quality assurance (QA)/quality control (QC) samples collected for each analysis. Table 2-2 of the QAPP includes the analyses performed on samples collected from specific sample locations as well as the dredge management units associated with each sample area. Table 3-1 of this report presents the actual samples collected and the date sampled. Figures 1-2 and 1-3 depict the sample areas and the proposed and actual sample locations (western and eastern portions of the study area).

3.2 Sediment and Porewater Sampling

Sediment grabs from five locations were composited based on equal volume.

Sediment and porewater samples were collected using a Ponar dredge as described in the field sampling plan (FSP) and Appendix A.1 Sediment Sampling Summary Report. The sediment sampling design for the baseline assessment includes 28 sample areas that cover most of the length of the Buffalo River and City Ship Canal. Five samples locations are in the Ship Canal including Cap Area (01), non-dredge area (02) and dredge areas (03, 04, and 05). The remaining 23 areas are located in the Buffalo River including nine non-dredge areas (06, 10, 18, 20, 22, 24, 26, 27, and 28) and 14 dredge areas (07, 08, 09, 11, 12, 13, 14, 15, 16, 17, 19, 21, 23, and 25). The sampling areas were determined based on similar length, DMU boundaries, and areas with similar sediment characteristics. Samples were collected from five grab sample locations within each sample area and composited into one sample from each area. Typically, three grabs were taken from the navigation channel and one grab each from the left and right littoral zones. Individual grab samples in dredge areas 05 and 11 and non-dredge area 22 were analyzed separately for metals to assess grab sample homogeneity. Field duplicates were collected from sample area 11 (field duplicate sample number BAS-SED30-2011) and sample area 13 (field duplicate sample number BAS-SED29-2011). Figures 1-2 and 1-3 present the original proposed target locations as well as the final, as-sampled locations. Deviations from the proposed locations are addressed in the Sediment Sample Summary Report (see Appendix A.1). Field supporting documentation is provided in Appendix D and photologs are provided in Appendix E.

Sample analysis was performed by USEPA's Contract Laboratory Program (CLP) for standard chemistry testing. The chemical analysis non-CLP methods, physical and geotechnical analyses were performed by Columbia Analytical Services. The porewater analysis was performed by the Energy and Environmental Research Center at the University of North Dakota. Sample results are summarized on tables by dredge area and non-dredge area in Appendix B.1. Electronic data and data validation reports are provided in Appendix F. Analytical reports are provided in Appendix G for non-CLP analysis.

3.3 Sediment Toxicity Testing

Sediment was collected for toxicity testing from 10 sample areas, which included dredge areas (six locations), and non-dredge areas (four). The 10 samples were collected from the following locations: 02, 04, 06, 08, 12, 16, 20, 21, 25, and 27 (see Figures 1-2 and 1-3). The locations were selected to provide geographic coverage throughout the AOC, including up-, mid-, and downstream portions of the river in addition to the City Ship Canal. Sediment collection followed the methods outlined in Section 3.2 with additional volume sampled for the toxicity testing. Additional details regarding the sediment sampling can be found in the Sediment Sampling Summary Report (see Appendix A.1).

Toxicity testing of sediments was performed by the USACE Engineer Research and Development Center (ERDC; USACE ERDC 2011). The methods are outlined in the QAPP and generally follow guidance provided in "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates" (USEPA 2000). Ten sediments were evaluated, and subject to 10-day acute toxicity tests conducted with the amphipod *Hyalella azteca* and the midge *Chironomus dilutus*, and a four-day acute toxicity test with the Oligochaete *Lumbriculus variegatus*. Additional details of the methods employed and results of the testing are presented in Section 4.2 and Appendix C.

3.4 Sediment Bioaccumulation Testing

Bioaccumulation testing of sediment was performed by the ERDC on the same sediment samples collected for toxicity testing. The methods are outlined in the QAPP and generally follow guidance provided in "Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates" (USEPA 2000). Ten sediments were evaluated, and subject to a 28-day bioaccumulation test conducted with *Lumbriculus*. Further details of the methods employed and results of the testing are presented in Appendix C.

The *Lumbriculus* tissue analyses were performed by Columbia Analytical Services. Sample results are summarized on tables in Appendix B.1. Electronic data and data validation reports are provided in Appendix F. Analytical reports are provided in Appendix G for non-CLP analysis.

3.5 Fish Sampling

3.5.1 Bioaccumulation


All fish were collected with electroshocking methods.

Fish bioaccumulation samples were collected at four sites: the City Ship Canal, Kelly Island, Ohio Street, and Katherine Street Peninsula (see Figures 1-2 and 1-3). In an effort to augment existing data and provide baseline information, sport fish were targeted. These were chosen to focus baseline information on species that have direct relevance to human recreation, beneficial use impairments, and were readily available. The species targeted were largemouth bass (*Micropterus salmoides*) and carp (*Cyprinus carpio*), as previous studies have shown these fish to be readily available in the Buffalo River (Skinner et al. 2009). Two white suckers (*Catostomus commersonii*) also were collected and submitted for analysis, but it was later determined that these fish should not be analyzed.

Fish bioaccumulation collection methods followed the methods outlined in Section 3.3 of the FSP for Fish Community Assessment and the two tasks were conducted concurrently. Sampling was performed using electroshocking. Ten samples of individual fillets of largemouth bass and 10 samples of individual fillets or carp species were collected, with skin on to match methodology from Skinner et al. (2009). The subsequent fish sample preparation and characterization was performed by experienced biologists. Additional details regarding the methods can be found in the Biological Sampling Summary Report (see Appendix A.2). Analytes include metals and 34 common PCB congeners, with all 209 PCB congeners analyzed on six fillets, three for largemouth bass and three for carp. As these species are relatively mobile, but not necessarily migratory, samples were collected across the AOC and are considered generally representative of the AOC.

Fish tissue samples were performed by Columbia Analytical Services. Electronic data and data validation reports are provided in Appendix F. Analytical reports are provided in Appendix G.

3.5.2 Fish Community Assessment

Fish community assessment data are based solely on the 2011 sampling effort. Some comparisons to the previous results from the 2008 FS assessment are also provided to further characterize the baseline condition. The 2011 data is presented to add more recent data to the database, as well as provide data from locations that are more-focused on the proposed remedial action.

Fish community sampling occurred at the same four sites as the bioaccumulation study, plus three additional sites upstream: Smith Street, Buffalo Color Area D, and Riverbend. The fish community assessment was performed concurrently with fish sampling for bioaccumulation. Fish were collected under a scientific collection permit approved by

NYSDEC (see Appendix A2). Data collected from these locations was ultimately used to support quantitative calculation of the IBI for the fish community assessment.

Sampling was conducted with a boat-mounted electrofishing unit in near-shore and shallow water areas. Collection efforts for each electroshocking run were 15 minutes in duration, with only one person netting fish. This time amount allowed sample results to be comparable with previous efforts performed by ENVIRON/MACTEC as part of the remedial investigation (ENVIRON et al. 2009). A similar level of effort was implemented at each site to ensure data comparability. One reach was sampled at each site. External lesions, anomalies, and parasites were also recorded and noted by the biologists for each fish collected, but a formal deformities, eroded fins, lesions, and tumors (DELT) survey was not conducted. The proposed seine netting was not implemented due to the successful capture of smaller fish species through electroshocking. Fish community assessment results are summarized in the tables in Appendix B.2. Field documentation is provided in Appendix D and photologs are provided in Appendix E.

3.6 Physical Habitat Assessment

In an effort to provide a quantitative evaluation of baseline conditions that can be compared against results of future monitoring efforts, data regarding physical habitat conditions were collected to support: the analysis of QHEI (Rankin 1989), and a visual habitat assessment, as described in NYSDEC's *Standard Operating Procedures: Biological Monitoring of Surface Waters in New York State* (NYSDEC 2009). As previous recent documentation of habitat conditions on the Buffalo River was performed at upstream locations, documentation during this sampling effort coincided with the fish monitoring sites.

Physical habitat characteristics are often linked to fish community indicators. To augment this linkage, a habitat assessment was performed using the QHEI (Rankin 1989). The index itself is most frequently used in wadeable streams, but has been previously applied to the Buffalo River (ENVIRON et al. 2009) and can be applied to any system with flowing water. Procedures are discussed in Section 3.7 of the FSP and Appendix F of the QAPP. Habitat field data are summarized on the tables in Appendix B.2. Field documentation is provided in Appendix D and photologs are provided in Appendix E.

SECTION 4

Baseline Results

4.1 Sediment and Porewater Sampling

4.1.1 Summary of 2011 Baseline Bulk Sediment Chemistry Data

In May 2011, composite sediment samples were collected from 28 sampling areas in the Buffalo River AOC to provide baseline (i.e., pre-remediation) data on chemicals in sediment. Eighteen of these areas were dredge areas. The dredge areas each contain one or more DMUs where sediment dredging will occur. Ten of the sampling areas were non-dredge areas (i.e., they contain no DMUs). The actual samples collected are summarized on Table 3-1. The samples were analyzed for selected metals, PCBs, organochlorine pesticides, and semivolatile organic compounds (SVOCs), including parent and alkylated PAHs. Sample results for the dredge and non-dredge areas are provided in Appendix B. Tables 4.1-1A and -1B provide summary statistics of the results for both dredge and non-dredge areas and compare the results to NYSDEC Freshwater Sediment Benchmark where applicable. For reporting of total PAHs, all detected PAH results from the EPA target compound list (TCL) were summed and if an individual TCL PAH compound was not detected in a sample, then a value of one-half the reporting limit was used in the sum. PAH results from the extended list PAH were not included in the total. PCB totals were determined by summing positive results for any PCB Aroclor detected. If PCB Aroclors 1242, 1248, 1254, and 1260 were not detected in the samples, then one-half the reporting limit was used to calculate total PCBs. This approach was the project specific approach adopted for the Buffalo River AOC project coordination team (PCT).

A total of 18 composite samples were collected from dredge areas and the following points are noteworthy (see Table 4.1-1A).

- Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected in all samples. Arsenic, cadmium, and chromium rarely exceeded the available NYSDEC sediment benchmarks for protection of freshwater benthos. In contrast, copper, lead, mercury, nickel, and zinc exceeded the available NYSDEC benchmarks in one-third to two-thirds of the samples. Chromium, lead, mercury, and zinc also exceeded the probable effect concentrations (PECs) from MacDonald et al. (2000) in one or more dredge area samples.

- PCBs were detected in one of 18 samples. The total PCB concentration in this sample exceeded the NYSDEC sediment benchmark of 0.06 milligrams per kilogram (mg/kg) by a factor of 10 and also exceeded the PEC for total PCBs.

- No organochlorine pesticides were detected in the samples.

- PAHs were detected in all samples at concentrations that routinely exceeded the available NYSDEC sediment benchmarks for PAHs. In from one to three dredge areas, PAHs also exceeded their respective PECs.

- Excluding PAHs, only three SVOCs were detected: bis(2-ethylhexyl)phthalate, carbazole, and dimethylphthalete. These compounds were each detected in only one sample and none exceeded the available NYSDEC sediment benchmarks.

A total of 10 composite samples were collected from non-dredge areas and the following points are noteworthy (see Table 4.1-1B).

- Arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc were detected in all samples. Except for nickel and lead, these metals did not exceed, or only rarely exceeded, the available NYSDEC sediment benchmarks for protection of freshwater benthos. No metal exceeded its respective PEC in the non-dredge areas. Average metals concentrations were consistently lower in non-dredge areas compared with dredge areas.
- PCBs were detected in one of 10 samples. The total PCB concentration in this sample exceeded the NYSDEC sediment benchmark of 0.06 mg/kg by a factor of two, but was much less that the PEC for total PCBs.
- No organochlorine pesticides were detected in the samples the same as the dredge areas.
- PAHs were detected in all samples. However, compared with the dredge area samples, the concentrations were lower and NYSDEC sediment benchmarks and PECs were less frequency exceeded. Average concentrations of PAHs were consistently lower in non-dredge areas compared with dredge areas.
- Excluding PAHs, only four SVOCs were detected: bis(2-ethylhexyl)phthalate, carbazole, dibenzofuran, dimethylphthalete. These four compounds were detected infrequently and none exceeded the available NYSDEC sediment benchmarks, the same as the dredge areas.

4.1.2 Summary of Results for Composite versus Individual Grab Sediment Samples

The composite sediment samples collected for the Buffalo River AOC baseline study were each created from five individual grab samples. Analysis of composite samples reduces analytical costs, but sacrifices information on within-area variability. To help understand contaminant variability within a sampling area, the individual grab samples in sampling areas 05, 11, and 22 were analyzed separately for metals. Sampling areas 05 and 11 are dredge areas. Sampling area 22 is a non-dredge area.

Sediment collected from under the CSX bridge at 11D was physically different from other sediments.

In sampling areas 05 and 22, there was little difference in metals concentrations among individual grab samples (see Tables 4.1-2A and 4.1-2C). As a result, the coefficient of variation (CV) for the metals concentrations for the five grab samples was small, typically between approximately 5% and 20%. The CV is the standard deviation expressed as a percentage of the mean. A small CV implies that the individual results lie near the mean and that the composite is representative of the individual grab samples. In contrast, in sampling area 11, the CV was high, near 150% for most metals. This resulted from one grab sample (D) that contained high levels of metals compared with the other grab samples (see Table 4.1-2B). Grab D was collected from the near-shore area beneath an active railroad bridge that crosses the river. A hotspot of sediment metals contamination appears to exist in this area, perhaps due to past and/or ongoing runoff from the railroad line.

4.1.3 Parameters Affecting Contaminant Bioavailability (AVS/SEM, TOC)

AVS and SEM in Sediment

Composite sediment samples from six dredge areas (-04, -08, -12, -16, -21, and -25) and four non-dredge areas (-02, -06, -20, -27) were analyzed for AVS/SEM. Also, an individual sediment grab sample from each area was analyzed separately for AVS and SEM for comparison with the composite sample result; the result is labeled with a letter from the actual sample location within the sampling area. Because AVS is present only in anoxic sediment, it is possible that AVS could be lost (i.e., oxidized) from the composite sample by entrainment of air during sample mixing. Consequently, if the AVS concentration in each composite sample was always substantially less than in the corresponding grab sample, it would suggest that some AVS may have been lost during sample compositing. However, because other factors could account for a difference between the composite and grab sample AVS results, comparing the two results is admittedly an imperfect method for examining the possibility of AVS loss during sample compositing.

The baseline AVS and SEM results for dredge and non-dredge areas are provided in Tables 4.1-3A and 4.1-3B, respectively. The following points are noteworthy:

- The SEM/AVS ratio in all dredge and non-dredge areas was greater than 1.0, indicating that inadequate AVS is present to bind toxic metals in Buffalo River AOC sediment. Such a result does not necessarily imply that the sediments will be toxic to benthos because other sediment constituents, including organic carbon, are able to bind with toxic metals and render them non-bioavailable.
- The SEM/AVS ratio in samples from non-dredge areas was generally greater than the SEM/AVS ratio in dredge areas. This result is due to lower levels of AVS in non-dredge areas compared with dredge areas (compare Tables 4.1-3A and 4.1-3B).
- A consistent difference between composite and grab sample AVS results from the same sample area was not apparent. For example, in the dredge area samples (see Table 4.1-3A), three grab samples contained more AVS than the corresponding composite samples and three grab samples contained less AVS than the corresponding composite samples.

Organic Carbon in Sediment

Oil and grease (O&G), total organic carbon (TOC), and black carbon (BC) were measured in composite sediment samples from all dredge and non-dredge areas as part of the baseline assessment. Complete analytical results are provided in Appendix B. A summary of the data for dredge and non-dredge areas is provided in Table 4.1-4. The following points are noteworthy:

- The O&G concentration in seven of 18 dredge area samples exceeded the Ontario Ministry of the Environment (OMOE) screening level of 0.15%. In contrast, the O&G concentration in all non-dredge area samples was less than the OMOE screening level. The OMOE screening level is an open water disposal guideline. NYSDEC has not established an O&G sediment screening level.

- There was a strong positive relationship between BC and total PAHs in dredge area sediment samples ($r^2 = 0.793$, $p < 0.0000007$). Black carbon has been shown to be an important carrier phase for many pollutants, including PAHs (Muri et al. 2003), so this result was not unexpected. In contrast, no relationship between BC and total PAHs was observed in non-dredge area samples, perhaps because the concentration range of BC and total PAHs in non-dredge area samples was smaller than in dredge area samples.

- The BC to TOC ratio in Buffalo River sediment samples from both dredge and non-dredge areas was greater than the ratio typically observed in sediments. Generally, BC levels are about 1 to 15% of TOC (Cornelissen and Gustafsson 2004). The BC to TOC ratio in Buffalo River sediment samples was 16% to 68% in dredge areas and 14% to 21% in non-dredge areas. Research has shown that sorption of hydrophobic organic contaminants (HOCs) to BC can be exceptionally strong with BC-water distribution ratios exceeded octanol-water ones by a factor of 100 or more (Cornelissen and Gustafsson 2004). Consequently, HOCs in Buffalo River sediments likely are less bioavailable than in sediments from other sites with similar TOC levels but more typical BC to TOC ratios.

4.1.4 Porewater PAHs

Sixteen composite sediment samples from the Buffalo River AOC were submitted to the Energy & Environmental Research Center at the University of North Dakota for analysis of dissolved PAHs in sediment porewater. Nine samples (04, -07, -08, -09, -12, -15, -16, -21, and -25) were collected from dredge areas and six samples (02, -06, -18, -20, -24, and -27) were collected from non-dredge areas. Complete analytical results are provided in Appendix B. A summary of the data for dredge and non-dredge areas is provided in Tables 4.1-5A and 4.1-5B, respectively. The following points are noteworthy:

- Twenty (20) PAHs were detected in porewater from dredge areas whereas only 14 PAHs were detected in porewater from non-dredge areas.

- The maximum and average porewater PAH concentration typically was greater in dredge areas than in non-dredge area, as would be expected.

- In dredge and non-dredge areas, the porewater PAH concentration and frequency of detection generally varied inversely with the octanol-water partition coefficient (log K_{ow}), as would be expected.

4.2 Sediment Toxicity Testing

The USACE ERDC conducted sediment toxicity and bioaccumulation tests with Buffalo River AOC sediment as part of the baseline assessment. Four tests were conducted: (1) 10-day survival and growth test with *Hyalella azteca* (amphipod); (2) 10-day survival and growth test with *Chironomus dilutus* (midge); (3) four-day survival test with the oligochaete worm

Lumbriculus variegates ; and (4) 28-day bioaccumulation test with *Lumbriculus.* Composite sediment samples from 10 locations in the Buffalo River AOC were tested. The tests were conducted in accordance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates* (USEPA 2000). A description of the test methodology and complete results are provided in the ERDC report (USACE ERDC 2011), which is included in Appendix C. Statistical analysis of test results followed USEPA guidelines (USEPA 2000). A summary of the test results is presented in Tables 4.2-1 to 4.2-3. The following points are noteworthy:

- **Test Acceptability –** For all tests, overlying water chemistry, porewater chemistry, and control organism survival and growth met acceptance criteria specified in USEPA guidelines (USEPA 2000).
- ***Hyalella* 10-Day Test Results (see Table 4.2-1) –** Organism survival and growth were high in sediment from both dredge and non-dredge areas and there was no significant difference in these parameters between areas (see notes in Table 4.2-1 for *p* values).
- ***Chironomus* 10-Day Test Results (see Table 4.2-2) –**Organism survival and growth were high in sediment from both dredge and non-dredge areas and there was no significant difference in these parameters between areas (see notes in Table 4.2-2 for *p* values).
- **Lumbriculus 4-Day Test Results (see Table 4.2-3) –** *Lumbriculus* survival after four days was high in sediment from dredge and non-dredge areas and there was no significant difference ($p = 0.91$, t-test) in this parameters between areas. This result indicates that contaminant levels in sediment were not acutely toxic to *Lumbriculus* and that all samples were suitable for use in the 28-day bioaccumulation test.
- ***Lumbriculus* 28-Day Bioaccumulation Test Results (see Table 4.2-3) –** Tissue mass recovery ranged from 49% to 93% in the sediment samples tested. The minimum acceptable tissue mass of 15 grams per sediment samples was obtained for all samples, with most tissue mass recoveries exceeding 20 grams per sediment sample. However, percent recovery of *Lumbriculus* biomass was significantly lower ($p = 0.025$, t-test) in dredge area sediment compared with non-dredge area sediment. This result suggests that contaminant levels in dredge area sediment are great enough to result in a chronic growth effect. The *Lumbriculus* tissue samples were frozen by ERDC and sent under chain-of-custody to Columbia Analytical Services for chemical analysis.

Overall, the test results indicate that contaminant levels on AOC sediments are not acutely toxic to benthic life, but may be great enough in dredge areas to result in a chronic growth effect.

4.3 Sediment Bioaccumulation Testing

As noted above, bioaccumulation tests were conducted with sediment from 10 areas in the Buffalo River AOC. A "clean" control sediment sample also was tested. The *Lumbriculus* tissue recovered from these sediment samples were analyzed for PCBs, mercury, and extractable lipids. A complete listing of the analytical results for the *Lumbriculus* tissue samples is provided in Appendix B. Tables 4.3-1 and 4.3-2 provide a summary of the data for dredge and non-dredge areas, respectively. The following points are noteworthy:

- Mercury and total PCBs were detected in all *Lumbriculus* samples from both dredge and non-dredge areas (see Tables 4.3-1 and 4.3-2).
- There was no significant difference between dredge and non-dredge areas regarding the levels of mercury ($p = 0.39$, Mann-Whitney U-test) and total PCBs ($p = 0.39$, Mann-Whitney U-test) in *Lumbriculus* tissue (see Table 4.3-1 and 4.3-2).

For reference, Tables 4.3-1 and 4.3-2 also provide analytical data for mercury, total PCBs, and TOC in sediment.

4.4 Fish Sampling

As part of the baseline assessment, sport fish were collected for analysis of bioaccumulative chemicals and a fish community assessment was undertaken to augment previous fish community assessment efforts. The results of these activities are summarized below.

4.4.1 Bioaccumulation

In June 2011, 10 carp between 22 and 30 inches total length and 10 largemouth bass between 12 and 18 inches total length were collected from the Buffalo River AOC by electrofishing. The fish were collected from four general areas: (1) Katherine Street Peninsula; (2) Ohio Street boat ramp shoreline; (3) Kelly Island; and (4) City Ship Canal. The sites were chosen to be consistent with proposed areas for restoration and the fish community surveys. In general, the fish testing is considered representative of the entire river. A skin-on fillet (without scales) was removed from each fish and analyzed for metals, PCBs, lipids, and percent moisture. Detailed field and analytical results are provided in Appendix B. Table 4.4-1 lists length and weight for the carp and bass samples. Tables 4.4-2 and 4.4-3 provide a summary of the analytical data for the carp and bass fillets, respectively. The following points are noteworthy:

- Total PCB levels in carp fillets were on average an order of magnitude greater than total PCB levels in bass fillets. This difference appears to be due to the tenfold greater lipid concentration in carp fillets compared with bass fillets.
- Mercury (methylmercury presumed) levels in bass fillets were on average three times greater than mercury levels in carp fillets. This difference most likely resulted from the fact that bass are top predators and feed higher on the food chain than carp. It is well known that methylmercury biomagnifies in aquatic food webs.
- Copper and zinc levels in carp fillets were on average two times greater than copper and zinc levels in bass fillets. This difference most likely results from the fact that carp have more exposure to sediment than bass. Both copper and zinc are elevated in Buffalo River AOC sediment.
- Cadmium was routinely detected in carp fillets, but only in one of 10 bass fillets. This difference may also be due to the greater exposure of carp to metals in sediment compared with bass.

4.4.2 Fish Community Assessment

The fish community assessment was intended to document the 2011 baseline fish community conditions at potential restoration areas in the Buffalo River sampling area. The results of the fish community assessment are summarized below and provided in Appendix A.2 and Appendix B.2.

The 2011 fish community assessment documented a total of 20 different fish species captured at all seven sampling locations (see Table 4.4-4A). Three of the species that were collected—carp, goldfish (*Carassius auratus auratus*), and round goby (*Neogobius melanostomus*)—are non-native species. Species diversity at individual sites ranged from a low of four (City Ship Canal) to a high of 12 species captured at the Ohio Street and Smith Street sites. Katherine Street, Kelly Island, and Riverbend all had 11 different species, and the Buffalo Color Site had 10 different species present. Except for the City Ship Canal, the number of different species observed was similar at the lower and upper river sampling locations. However, several unique species were captured at the lower most river site (Kelly Island) including the: quillback (*Carpiodes cyprinus*), gizzard shad (*Dorosoma cepedianum*), and the round goby. All three of these species are relatively ubiquitous living in rivers and streams, as well as lakes.

Largemouth bass and pumpkinseed (*Lepomis gibbosus*) were the species with the widest distribution, being captured at all seven fish community sampling locations. The most abundant species captured were emerald shiners (*Notropis atherinoides*) and pumpkinseed, followed by largemouth bass and spottail shiner (*Notropis hudsonius*). A number of species were relatively sparse during the sampling events and were captured at only one or two sampling locations; quillback, gizzard shad, round goby, goldfish, carp, common shiner (*Notropis cornutus*), and brook silverside (*Labidesthes sicculus*).

To assess the relative health of individual fish, as well as the overall fish population, several fisheries and ecological indices were computed (see Tables 4.4-4B, 4.4-4C, and 4.4-4D). These indices are intended to summarize current condition of the fish community, as well as for comparison with historic data sources and future sampling events. Fulton's condition factor (K, ratio of weight to length; Bolger and Connolly 1989) for individual fish was calculated. Condition factors for the seven sampling locations were relatively high (average of 2.04, see Table 4.4-4B), likely related to the time of year of the sampling effort with certain species in spawning condition and having higher weights, relative to other times of year. The Shannon Wiener Index (NYSDEC 2009) values for all of the sites were relatively low (overall average of 1.57, see Table 4.4-4B), suggesting a low diversity and evenness in the fish communities sampled. The Catch per Unit Effort (CPUE) values are presented to compare the overall density of fish species to past and future sampling events. The CPUE values in Table 4.4-6B are extrapolated for 1-hour of effort with boat electroshocking (actual effort involved a 15-minute electroshocking run with a one-man netting crew). Table 4.4-4C present a summary of an IBI developed based on the fish sampling data from 2011. The overall integrity classification ranged from fair to good; only two sites rated fair, the City Ship Canal and the Kelly Island site. Jaccard Similarity Index (Barbour et al. 1999) values are presented on Table 4.4-4D. It appears from the data that the downstream sites tended to have more unique fish species where the Jaccard Similarity Index values tended to be lower (e.g., Kelly Island and Ship Canal), than the upstream sites where the Jaccard Similarity Index values tended to be higher (e.g., Ohio Street).

The 2011 fish community assessment had some noticeable differences, but overall provided similar results to previous surveys efforts conducted during the FS phase. During the previous surveys (ENVIRON et al. 2009), the common carp (*Cyprinus carpio*) was collected at all five of the Buffalo River sampling locations; in 2011, carp were only captured at the Kelly Island and Riverbend sites. Two of the most abundant and widespread species captured in 2008 were the largemouth bass and the pumpkinseed; similar to results of the 2011 surveys. Total CPUE was higher in 2011 (average of 319), compared to the 2008 data which had an average CPUE of 156 at all of the sites. This could be related to differences in time of year for the sampling effort, with more fish being susceptible to electrofishing capture during June compared to October, or related to differences in sampling efficiency of the field crews. The Diversity Index Values were slightly higher in the previous sampling efforts, but condition factors were slightly lower, possibly related to differences in sampling season as previously discussed. Results of the previous investigations are shown in Figure B.2-1 reproduced from the SRIR and supporting data are provided in Appendix B.2.

4.4.3 Physical Habitat Assessment

The downstream portion of the Riverbend site had the poorest habitat score of all Buffalo River sites.

The NYSDEC visual method is a habitat assessment procedure based on the visual habitat assessment in the U.S. EPA's rapid bioassessment protocols (RBPs; NYSDEC 2009; Barbour et al. 1999). The RBPs are based upon a synthesis of existing methods that have been peer reviewed and widely used by various state water resource agencies (Ohio EPA, Florida Department of Environmental Protection [DEP], the Delaware Department of Natural Resources and Environmental Control, the Massachusetts DEP, the Kentucky DEP, and the Montana Department of Environmental Quality) (Barbour et al. 1999). A comprehensive approach to assessing the structure of habitat in rivers includes an evaluation of the variety and quality of the substrate, channel morphology, bank structure, and riparian vegetation (Barbour et al. 1999). The visual RBP for streams is separated into two basic approaches, one for high-gradient rivers and one for low-gradient rivers, such as the Buffalo River.

Because habitat conditions on the Buffalo River at upstream locations were recently documented (ENVIRON et al. 2009), locations covered by this current sampling effort coincided with the fish monitoring sites. Data collected augmented the data collected during previous site investigations by documenting existing conditions prior to remedy activities.

Tables 4.4-5A and 4.4-5B present the habitat assessment scores, as calculated using the QHEI (Midwest Biodiversity Institute 2006) and RBP (NYSDEC). QHEI scores ranged from 34 to 40.5, which corresponds to poor habitat quality, with the exception of the downstream portion of the Riverbend site, which scored 23, which corresponds with very poor habitat (see Table 4.4-5A). The QHEI assessment did not demonstrate any observable differences among the Buffalo River and Cazenovia Creek sample locations. Scores for the RBP had a broader range, from 73 at the downstream portion of the Riverbend site to 131 at Smith Street (see Table 4.4-5B). There is no corresponding word scale for the RBP as with the QHEI score, so values are to be used relative to each other and cannot be applied in a broader sense.

Additional data was collected during the Physical Habitat Assessment field work that also illuminates trends in the Buffalo River. These data include water quality data (taken from the RBP), aesthetic observations (taken from QHEI), percent riparian canopy cover (taken from

RBP) and observations regarding the form of the river (taken from QHEI) (see Tables 4.4-5A and 4.4-5B). Water quality data are generally consistent throughout the river except for Kelly Island which is located at the mouth of the river. The Kelly Island results show lower temperatures, higher clarity and dissolved oxygen consistent with influence from the lake. The mid river areas showed the lowest clarity and dissolved oxygen and higher conductivity and percent canopy.

4.5 Vegetation

Both aquatic and riparian vegetation have been monitored along the river. These have included river-wide assessments and specific site delineations at the proposed restoration sites.

4.5.1 Submerged Aquatic and Emergent Vegetation

The SRIR (ENVIRON et al. 2009) documented aquatic and emergent vegetation in 2008 from the mouth of the River to the confluence with Cazenovia Creek (see Figure B2-1 [reproduced from the SRIR]). Patches of vegetation less than 25 square meters were not documented. This information was then updated in 2010 by E & E, but focused only on the six proposed habitat restoration sites (CH2M HILL/E & E 2011b). Supporting data from these reports are provided in Appendix B.2.

In general, submerged aquatic vegetation (SAV) beds were found to be more concentrated in the downstream portions of the river, with fewer present upstream of the Buffalo Color site. The 2010 data generally confirmed the documentation from 2008, with only minor exceptions. In 2008, eight aquatic vegetation species were documented: coontail (*Ceratophyllum dermersum*), Canadian waterweed (*Elodea canadensis*), American waterwillow (*Justicia americana*), Eurasian watermilfoil (*Myriophyllum spicatum*), curlyleaf pondweed (*Potamogeton crispus*), American pondweed (*Potamogeton nodosus*), sago pondweed (*Potamogeton pectinatus*), and wild celery (*Vallisneria americana*). Sago pondweed, wild celery, and coontail were the most common species found within the SAV beds. The 2010 survey documented Canadian pondweed, Eurasian milfoil, curly pondweed, sago pondweed, claspingleaf pondweed (*Potamogeton perfoliatus*), and wild celery. Wild celery, Eurasian milfoil, curlyleaf pondweed and claspingleaf pondweed were observed to be the dominants at the proposed restoration sites. Note that the American waterwillow was classified as emergent vegetation (EV) in the 2010 survey. Curlyleaf pondweed and Eurasian watermilfoil are a non-native, invasive species.

EV was also documented in both surveys. Again, results of the two surveys were similar, with only slight discrepancies between the delineations. In general, EV was sparse with patches at or slightly higher in elevation than the waterline. The 2008 survey identified seven species of EV purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), Japanese knotweed (*Polygonum cuspidatum*), broadleaf arrowhead (*Sagittaria latifolia*), softstem bulrush (*Scirpus validus*), broadleaf cattail (*Typha latifolia*), and pickerelweed (*Pontederia cordata*). These species were also observed during the 2010 survey along with yellow iris (*Iris pseudacorus*), Plantain (*Plantago* sp.), reed canarygrass (*Phalaris arundinacea*), Common rush (*Juncus effessus*), hard stem bulrush (*Scirpus acutus*), and unidentified rush (*Juncus* spp.) and sedge (*Carex* spp.) species. Purple loosestrife, common reed, Japanese knotweed, and reed canarygrass are non-native, invasive species that have become well-established in the Buffalo River AOC.

4.5.2 Riparian Vegetation

Riparian vegetation was documented specifically at each restoration site in 2010 in both a general sense and with specific vegetation transects that were conducted with the intention of being resurveyed in the future to document change over time (see BODR for Habitat Restoration). The specific results of that survey can be found in Appendix B.2. Additional previous investigations conducted for the ERMP (E & E 2009) and summarized in the Appendix A of the BODR for habitat restoration (CH2M HILL/E & E 2011b) have general descriptions, including a brief description of species composition.

Riparian vegetation tends to be dominated by non-native vegetation interspersed with native shrubs. The canopy cover varies from zero at some heavily industrialized locations to full coverage at some of the more-naturalized shorelines (Smith Street). Evidence of beaver and deer browse tends to limit the establishment of new tree growth. Lack of suitable substrate is also a limiting factor for vegetation growth. Observed tree species at the proposed habitat restoration sites include cottonwood (*Populus deltoides*) and crack willow (*Salix fragilis*), with occasional tree-of-heaven (*Ailanthus altissima*), European black alders (*Alnus glutinosa*), black willow (*Salix nigra*), and green ash (*Fraxinus pennsylvanica*). Common species in the shrub strata consist mostly of buckthorn (*Rhamnus cathartica*), red osier dogwood (*Cornus sericea*), bush honeysuckle (*Lonicera sp.*), and winged sumac (*Rhus copallinum*) and willow saplings (*Salix* sp.) with dense relatively large areas of primarily Japanese knotweed. Common herbaceous species included Japanese knotweed, mugwort (*Artemisia vulgaris*), grapevine (*Vitis riparia*), golden rod (*Solidago* sp.), and white snakeroot (*Ageratina altissima*). Crack willow, tree-of-heaven, European black alder, buckthorn, bush honeysuckle, Japanese knotweed, and mugwort are non-native, invasive species that have become well-established in many places along the Buffalo River shoreline.

4.5.3 Benthic Invertebrates

Benthic invertebrate community composition was documented in 2009 and summarized in the SRIR (ENVIRON et al. 2009). No new data were collected as part of the recent investigation as the quality and spatial distribution of existing data were considered adequate to document baseline conditions. Eight locations were previously sampled in the AOC, including five in areas that will be directly affected by the proposed remedy. Sampling methods included both Ponar grab samples and passive Hester-Dendy samplers. Data analysis included standard metrics to quantitatively display the results, including: species richness; abundance; Ephemeroptera, Plecoptera, and Trichoptera (EPT) richness; Hilsenhoff Biotic Index (HBI); percent model affinity; species diversity; dominance; Non-Chironomid/Oligochaete (NCO) richness; and Chironomid mouthpart deformities. Results of the previous investigations are shown in Figure B2-3 reproduced from the SRIR and supporting data are provided in Appendix B.2.

4.6 Quality Assurance/Quality Control

The laboratory analytical data were reviewed and validated for precision and accuracy against the QA/QC requirements specified in the project QAPP. The CLP data were validated by a third-party validation firm, Shaw Environmental, Inc., following automated validation by CLP sample management office. The non-CLP data generated by the subcontracted laboratory were validated by the E & E Project Chemist. Non-conformance issues or deficiencies that could affect the reported result's precision or accuracy were identified and considered when assessing whether the results are sufficient to achieve project data quality objectives (DQOs), and in some cases resulted in the addition of a qualifier to the result. The reported laboratory methodology and reporting procedures and data quality overall met the project DQOs and the reported results are considered acceptable and usable for the project. Several results were qualified as estimated and no results were rejected.

The qualifiers were added to the data in both the electronic database and the final report tables. The qualifiers are defined as follows:

J - The qualifier indicates an estimated value because the associated QC data indicated a potential laboratory or matrix problem or interference. In addition, J flags assigned by the laboratory indicate the results are below the practical quantitation limit (PQL), but above the instrument detection limit (IDL), method detection limit (MDL), or lowest calibration standard (porewater results).

NJ - The qualifier indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification" (PCB results).

U – The result is considered non-detect at the reported value (ND for porewater results). The laboratory assigned this flag to analytes not present at detectable concentrations (above the IDL or MDL). The data validator assigned this flag when an analyte was considered non-detect due to blank contamination. If the result is above the PQL, the PQL is considered elevated.

UJ – The reported value for the PQL is estimated.

R – The result is rejected and not usable for environmental data assessment.

Specific results that are qualified due to QA/QC parameters that were outside acceptance criteria are discussed below. Results qualified with U (or ND) or J because they were below the MDL or PQL are not discussed. Results for PCBs and PAHs were totaled as described in the QAPP. Any qualifier on the individual results was carried over to the total and if all the results were non-detect the total was qualified as U. The data validation reports are available for review in Appendix F.

The only field QC samples were field duplicates for sediment chemistry analysis at two locations. The field QC results are presented in Appendix B.1. Field duplicates were evaluated by using two times the laboratory QC criteria for duplicates (i.e., relative percent differences [RPDs] of 40% for water and air and 70% for sediment). Field duplicates were not evaluated by the data validation chemist. In general, the results show good overall precision. No additional qualifiers were applied because the associated results were already qualified or non-detect.

4.6.1 Sediment and Porewater Sampling

The reported results for the sediment samples analyzed for pore water PAH-34 concentrations are considered usable for the project.

The reported results for the sediment samples analyzed for parameters affecting contaminant bioavailability (AVS/SEM, TOC, and grain size) are considered usable for the project. Some of the results were qualified with J as estimated for the following reasons:

- AVS results because accuracy for the matrix spike and precision for the matrix duplicate were outside criteria;
- SEM lead and nickel results because precision for the serial dilution was outside criteria;
- Carbon black results because precision for the matrix duplicate was outside criteria; and
- Grain size analysis because precision for the field duplicate sample pair was outside criteria.

The reported results for the sediment samples analyzed for metals, PCBs, organochlorine pesticides, PAHs, and SVOCs are considered usable for the project. Some of the results were qualified for the following reasons:

- Silver results were qualified with UJ because the MS recovery for silver was below criteria and silver was not detected in the associated samples;
- Lead results were qualified with J because precision for the serial dilution was outside criteria;
- PAH results were qualified with J because for various QC results outside criteria or because the calibration range was exceeded and a dilution was not performed;
- PCB results were qualified with NJ because the %D for columns one and two was outside criteria;
- PCB congeners results were qualified with J as estimated or as non-detects at and elevated reporting limits because several compounds were detected at low levels in the method blank;
- PCB congeners results were qualified with J as estimated because laboratory control sample recoveries or ion abundance ratios (for sample results) were outside criteria; and
- And SVOC results were qualified with a J as estimated (or UJ for non-detects) because the initial or continuing calibration %D was outside criteria.

4.6.2 Sediment Toxicity Testing

For all tests, overlying water chemistry, porewater chemistry, and control organism survival and growth met acceptance criteria specified in USEPA guidelines (USEPA 2000) (see Section 4.2 and Appendix C).

4.6.3 Sediment Bioaccumulation Testing

The reported results for the *Lumbriculus* tissue recovered from sediment samples analyzed for PCB congeners, mercury, and extractable lipids are considered usable for the project. The PCB congeners results were qualified with a J as estimated because several compounds were detected at low levels in the method blank and ion abundance ratios for several sample results were outside criteria.

4.6.4 Fish Sampling

The reported results for the fish tissue samples analyzed for PCB congeners, metals, mercury, and extractable lipids are considered usable for the project. Some of the PCB congeners results were qualified with UJ and elevated reporting limits due to matrix interferences, and some were qualified with J as estimated for QC results outside criteria.

Section 5

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Tables

Tables

Table 3-1 Actual Sample Listing Table - Buffalo River 2011 Baseline Assessment Study

Sample Location ID [1]	General Location	DMUs	Composite ID	Grab ID	Sample Date	Bulk Chemistry [2]	Porewater [2]	Toxicity / Bioaccumulation [2]	AVS/SEM [3]	PCB Congener and Metals, % Lipid [2]	Remarks [4]
Locations											
SED 01	Ship Canal	Capping Area	BAS-SED-01-2011		5/16/2011	x					
SED 02	Ship Canal	none	BAS-SED-02-2011	BAS-SED-02A-2011	5/16/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 03	Ship Canal	1,2	BAS-SED-03-2011		5/16/2011	x					
SED 04	Ship Canal	3, 4a	BAS-SED-04-2011		5/16/2011	x	x	x	x		
SED 05	Ship Canal	5, 6a, 6b, 7a	BAS-SED-05-2011	BAS-SED-05A-2011 to BAS-SED-05E-2011	5/16/2011	x					Individual metals analysis on grabs
SED 06	Buffalo River	none	BAS-SED-06-2011	BAS-SED-06D-2011	5/18/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 07	Buffalo River	8a,b&c	BAS-SED-07-2011		5/18/2011	x	x				
SED 08	Buffalo River	9,10	BAS-SED-08-2011	BAS-SED-08E-2011	5/18/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 09	Buffalo River	11, 12, 13, 14, 15	BAS-SED-09-2011		5/19/2011	x	x				
SED 10	Buffalo River	none	BAS-SED-10-2011		5/19/2011	x					
SED 11	Buffalo River	16, 17, 18, 19	BAS-SED-11-2011	BAS-SED-11A-2011 to BAS-SED-11E-2011	5/19/2011	x					Individual metals analysis on grabs. Field duplicate is BAS-SED-30-2011
SED 12	Buffalo River	20, 21, 22, 23, 24	BAS-SED-12-2011	BAS-SED-12A-2011	5/17/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 13	Buffalo River	25, 26, 27, 28	BAS-SED-13-2011		5/17/2011	x					Field duplicate is BAS-SED-29-2011
SED 14	Buffalo River	28, 29, 30, 31	BAS-SED-14-2011		5/17/2011	x	x				
SED 15	Buffalo River	32, 33, 37a	BAS-SED-15-2011		5/19/2011	x					
SED 16	Buffalo River	34, 35	BAS-SED-16-2011	BAS-SED-16C-2011	5/18/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 17	Buffalo River	36, 37c, 38	BAS-SED-17-2011		5/19/2011	x					
SED 18	Buffalo River	none	BAS-SED-18-2011		5/19/2011	x	x				
SED 19	Buffalo River	38, 39, 40	BAS-SED-19-2011		5/19/2011	x					
SED 20	Buffalo River	none	BAS-SED-20-2011	BAS-SED-20D-2011	5/18/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 21	Buffalo River	41, 42, 43	BAS-SED-21-2011	BAS-SED-21A-2011	5/17/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 22	Buffalo River	none	BAS-SED-22-2011	BAS-SED-22A-2011 to BAS-SED-22E-2011	5/20/2011	x					Individual metals analysis on grabs
SED 23	Buffalo River	44a, 44e, 44f	BAS-SED-23-2011		5/17/2011	x					
SED 24	Buffalo River	none	BAS-SED-24-2011		5/20/2011	x	x				
SED 25	Buffalo River	45a, 45b, 45d, 45e	BAS-SED-25-2011	BAS-SED-25D-2011	5/17/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 26	Buffalo River	none	BAS-SED-26-2011		5/20/2011	x					
SED 27	Buffalo River	none	BAS-SED-27-2011	BAS-SED-27E-2011	5/16/2011	x	x	x	x		AVS/SEM analysis on Grab and Composite Samples
SED 28	Buffalo River	none	BAS-SED-28-2011		5/17/2011	x					
Fish Tissue Sampling											
FSH 01	Katherine Street			BAS-FSH-01-2011-01 to BAS-FSH-01-2011-03	6/13/2011					x	Ten largemouth bass and ten carp samples were collected (see Table 4.4-1).
FSH 02	Ohio Street			BAS-FSH-02-2011-01 TO BAS-FSH-02-2011-06	6/13/2011					x	
FSH 03	Kelly Island			BAS-FSH-03-2011-01 to BAS-FSH-03-2011-06	6/13/2011					x	
FSH 04	Ship Canal			BAS-FSH-04-2011-01 to BAS-FSH-04-2011-06	6/13/2011					x	

Key:
AVS/SEM = acid volatile sulfides / simultaneously extracted metals
DMUs = Dredge Management Units

Notes: 1. See Figures 1-2 and 1-3 for actual locations.
2. Individual analyses for each group are shown in Table 2-1 of the QAPP.
3. One AVS/SEM analysis was performed on the composite sample from each sample area indicated and a second AVS/SEM analysis will be performed on one grab sample.
4. The composite sediment sample for each area included five discrete sediment grabs - 3 from the navigation channel and 2 from littoral zones (left and right banks).

Table 4.1-1A Dredge Area[a] Baseline Sediment Data Summary for May 2011 Composite Samples, Buffalo River AOC

Analyte[b]	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Concentration (mg/kg)[c]	Location of Maximum	Frequency of Detection[d]	NYSDEC Freshwater Sediment Benchmark (mg/kg)			MacDonald et al. (2000) PEC (mg/kg)	
						Value	Basis	FoE TEC	Value	FoE PEC
Metals										
ARSENIC	4.6	26	8.88	SED-11	18/18	10	TEC	1/18	33	0/18
CADMIUM	0.16 U	4.3 N	0.82	SED-11	18/18	1	TEC	1/18	4.98	0/18
CHROMIUM, TOTAL	10 NE	163 NE	35.5	SED-11	18/18	43	TEC	2/18	111	1/18
COPPER	20	128	42.7	SED-11	18/18	32	TEC	10/18	149	0/18
LEAD	14 J	321 J	69.6	SED-11	18/18	36	TEC	8/18	128	1/18
MERCURY	0.07 J	2.8	0.54	SED-11	18/18	0.18	TEC	10/18	1.06	2/18
NICKEL	17	40	27.2	SED-08	18/18	23	TEC	12/18	48.6	0/18
ZINC	52	661 N	189	SED-11	18/18	121	TEC	11/18	459	1/18
Polychlorinated Biphenyls (PCBs)										
PCB-1248 (AROCLOR 1248)	0.63	0.63	0.06	SED-11	1/18	--	--	--	--	--
PCB-1254 (AROCLOR 1254)	0.33 NJ	0.33 NJ	0.04	SED-11	1/18	--	--	--	--	--
TOTAL PCBS	1 NJ	1 NJ	0.1	SED-11	1/18	0.06	TEC	1/1	0.676	1/1
Organochlorine Pesticides										
None detected.										
Polycyclic Aromatic Hydrocarbons (PAHs)										
1-METHYLNAPHTHALENE	0.0041 J	0.99	0.18	SED-11	18/18	--	--	--	--	--
2-METHYLNAPHTHALENE	0.0054 J	1.6 J	0.28	SED-11	18/18	--	--	--	--	--
ACENAPHTHENE	0.0054 J	1.5 J	0.3	SED-11	18/18	--	--	--	--	--
ACENAPHTHYLENE	0.0071	0.15 J	0.0	SED-09	17/18	--	--	--	--	--
ANTHRACENE	0.015	2.3 J	0.6	SED-11	18/18	0.06	TEC	12/18	0.845	2/18
BENZO(A)ANTHRACENE	0.084	3.3 J	0.71	SED-05	18/18	0.11	TEC	15/18	1.05	3/18
BENZO(A)PYRENE	0.13	4.2 J	0.6	SED-05	18/18	0.15	TEC	15/18	1.45	1/18
BENZO(B)FLUORANTHENE	0.062	4.2 J	1	SED-05	18/18	--	--	--	--	--
BENZO(G,H,I)PERYLENE	0.076	2.8 J	0.47	SED-05	18/18	--	--	--	--	--
BENZO(K)FLUORANTHENE	0.055	3.7 J	0.61	SED-05	18/18	--	--	--	--	--
BENZO[E]PYRENE	0.062	1.7 J	0.4	SED-05	17/18	--	--	--	--	--
C1-CHRYSENES	0.0081 J	0.92 J	0.2	SED-05	18/18	--	--	--	--	--
C1-FLUORANTHENES/PYRENES	0.021 J	2.2 J	0.6	SED-11	18/18	--	--	--	--	--
C1-FLUORENES	0.012 J	8.2 J	0.52	SED-11	16/18	--	--	--	--	--
C1-NAPHTHALENES	0.007	1.8 J	0.3	SED-11	18/18	--	--	--	--	--
C1-PHENANTHRENES/ANTHRACENES	0.027	2.3 J	0	SED-11	18/18	--	--	--	--	--
C2-CHRYSENES	0.045 J	0.33	0.05	SED-05	7/18	--	--	--	--	--
C2-FLUORANTHENES/PYRENES	0.0045 J	0.97 J	0.30	SED-11	17/18	--	--	--	--	--
C2-FLUORENES	0.0073 J	0.35	0.10	SED-16	16/18	--	--	--	--	--
C2-NAPHTHALENES	0.013 J	1.9 J	0.38	SED-11	18/18	--	--	--	--	--
C2-PHENANTHRENES/ANTHRACENES	0.002 J	0.024 J	0.0	SED-05	3/18	--	--	--	--	--
C3-FLUORANTHENES/PYRENES	0.0026 J	0.4	0.1	SED-05	7/18	--	--	--	--	--
C3-FLUORENES	0.038 J	0.53	0.1	SED-16	11/18	--	--	--	--	--

Table 4.1-1A Dredge Area[a] Baseline Sediment Data Summary for May 2011 Composite Samples, Buffalo River AOC

Analyte[b]	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Concentration (mg/kg)[c]	Location of Maximum	Frequency of Detection[d]	NYSDEC Freshwater Sediment Benchmark (mg/kg)			MacDonald et al. (2000) PEC (mg/kg)	
						Value	Basis	FoE TEC	Value	FoE PEC
C3-NAPHTHALENES	0.018	2.2 J	0.41	SED-11	18/18	--	--	--	--	--
C3-PHENANTHRENES/ANTHRACENES	0.0065 J	1.1 J	0.2	SED-11	18/18	--	--	--	--	--
C4-NAPHTHALENES	0.0061 J	1.3 J	0	SED-11	18/18	--	--	--	--	--
C4-PHENANTHRENES/ANTHRACENES	0.0007 J	0.28	0.04	SED-16	14/18	--	--	--	--	--
CHRYSENE	0.057	3.2 J	0.62	SED-05	18/18	0.17	TEC	14/18	1.29	1/18
DIBENZ(A,H)ANTHRACENE	0.033 J	1.1 J	0.2	SED-05	17/18	0.03	TEC	17/17	--	--
FLUORANTHENE	0.005 J	9.1	1.8	SED-05	18/18	0.42	TEC	14/18	2.23	2/18
FLUORENE	0.011	1.9 J	0.4	SED-11	18/18	0.08	TEC	7/18	0.536	2/18
INDENO(1,2,3-C,D)PYRENE	0.09	3.2 J	0.60	SED-05	18/18	--	--	--	--	--
NAPHTHALENE	0.0078	0.85 J	0.2	SED-05	17/18	0.18	TEC	4/17	0.561	3/18
PAHs (total)	0.99 J	59 J	11	SED-05	18/18	1.61	TEC	15/18	22.8	2/18
PERYLENE	0.076	2.3 J	0.42	SED-05	17/18	--	--	--	--	--
PHENANTHRENE	0.054	10	1.47	SED-05	18/18	0.2	TEC	12/18	1.17	3/18
PYRENE	0.12	9	1.35	SED-05	18/18	0.2	TEC	15/18	1.52	2/18
Other Semivolatile Organic Compounds (SVOCs)										
BIS(2-ETHYLHEXYL) PHTHALATE	0.2 J	0.2 J	0.69[e]	SED-17	1/18	239	EqP(2%OC)	1/1	--	--
CARBAZOLE	0.25 J	0.25 J	0.71[e]	SED-09	1/18	--	--	na	--	--
DIMETHYL PHTHALATE	0.21 J	0.21 J	0.77[e]	SED-09	1/18	--	--	na	--	--

Key:
AOC = Area of Concern
-- (double dash) = not available or not applicable
EqP (2% OC) = Equilibrium partitioning assuming 2% organic carbon in sediment
FoE PEC = Frequency of Exceedance of PEC (i.e., number of detects > PEC over number of detects).
FoE TEC = Frequency of Exceedance of TEC (i.e., number of detects > TEC over number of detects).
J = estimated value
mg/kg = milligrams per kilogram
N = tentatively identified
NYSDEC = New York State Department of Environmental Conservation
PEC = Probable Effect Concentration
TEC = Threshold Effect Concentration (MacDonald et al. 2000)

Note:
a = Eighteen sampling areas: 1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 21, 23, 25.
b = Detected analytes only are listed.
c = Averages calculated using 1/2 of the Method Dection Limit (MDL) for U-qualified results.
d = Number of detects over number of samples.
e = Elevated MDLs for some samples resulted in the average exceeding the maximum.

Table 4.1-1B Non-Dredge Area[a] Baseline Sediment Data Summary for May 2011 Composite Samples, Buffalo River AOC

Analyte[b]	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Concentration (mg/kg)[c]	Location of Maximum	Frequency of Detection[d]	NYSDEC Freshwater Sediment Benchmark (mg/kg)			MacDonald et al. (2000) PEC (mg/kg)	
						Value	Basis	FoE TEC	Value	FoE PEC
Metals										
ARSENIC	4.2	8.7	7.01	SED-18	10/10	10	TEC	0/10	33	0/10
CADMIUM	0.22 J	0.33 J	0.36	SED-26	10/10	1	TEC	0/10	4.98	0/10
CHROMIUM, TOTAL	12 NE	20	19.5	SED-24	10/10	43	TEC	0/10	111	0/10
COPPER	21	33	29.8	SED-27	10/10	32	TEC	1/10	149	0/10
LEAD	19 J	32	29.3	SED-27	10/10	36	TEC	0/10	128	0/10
MERCURY	0.11 J	0.37	0.20	SED-02	10/10	0.18	TEC	2/10	1.06	0/10
NICKEL	16	32	27.2	SED-27	10/10	23	TEC	7/10	48.6	0/10
ZINC	87 N	137	127	SED-27	10/10	121	TEC	4/10	459	0/10
Polychlorinated Biphenyls (PCBs)										
PCB-1268 (AROCLOR 1268)	0.049 J	0.049 J	0.00	SED-24	1/10	--	--	--	--	--
TOTAL PCBS	0.11 J	0.11 J	0.01	SED-24	1/10	0.06	TEC	1/1	0.676	0/1
Organochlorine Pesticides										
None detected.										
Polycyclic Aromatic Hydrocarbons (PAHs)										
1-METHYLNAPHTHALENE	0.0034 J	0.15 J	0.03	SED-18	10/10	--	--	--	--	--
2-METHYLNAPHTHALENE	0.0046 J	0.24 J	0.04	SED-18	9/10	--	--	--	--	--
ACENAPHTHENE	0.0047 J	0.38 J	0.0	SED-18	10/10	--	--	--	--	--
ACENAPHTHYLENE	0.0053 J	0.019 J	0.0	SED-02	10/10	--	--	--	--	--
ANTHRACENE	0.0093	0.94	0.1	SED-18	10/10	0.06	TEC	2/10	0.845	1/10
BENZO(A)ANTHRACENE	0.06 J	2.9 J	0.42	SED-18	10/10	0.11	TEC	6/10	1.05	1/10
BENZO(A)PYRENE	0.081	2.9 J	0.5	SED-18	10/10	0.15	TEC	6/10	1.45	1/10
BENZO(B)FLUORANTHENE	0.041 J	2.1 J	0	SED-18	10/10	--	--	--	--	--
BENZO(G,H,I)PERYLENE	0.052 J	1.8 J	0.30	SED-18	10/10	--	--	--	--	--
BENZO(K)FLUORANTHENE	0.032	1.9 J	0.39	SED-18	10/10	--	--	--	--	--
BENZO[E]PYRENE	0.031	0.7 J	0.2	SED-18	10/10	--	--	--	--	--
C1-CHRYSENES	0.021	0.38 J	0.1	SED-18	10/10	--	--	--	--	--
C1-FLUORANTHENES/PYRENES	0.036	0.86 J	0.2	SED-18	10/10	--	--	--	--	--
C1-FLUORENES	0.014	0.085 J	0.02	SED-18	5/10	--	--	--	--	--
C1-NAPHTHALENES	0.0051 J	0.25 J	0.0	SED-18	8/10	--	--	--	--	--
C1-PHENANTHRENES/ANTHRACENES	0.027	0.62 J	0	SED-18	10/10	--	--	--	--	--
C2-CHRYSENES	0.038 J	0.042 J	0.02	SED-27	2/10	--	--	--	--	--
C2-FLUORANTHENES/PYRENES	0.012 J	0.071	0.04	SED-28	4/10	--	--	--	--	--
C2-FLUORENES	0.016	0.062	0.0	SED-02	5/10	--	--	--	--	--
C2-NAPHTHALENES	0.014 J	0.12	0.0	SED-02	8/10	--	--	--	--	--
C3-FLUORANTHENES/PYRENES	0.0027 J	0.0028 J	0.0	SED-22	2/10	--	--	--	--	--
C3-FLUORENES	0.0066	0.05 J	0.02	SED-02	3/10	--	--	--	--	--
C3-NAPHTHALENES	0.018	0.082 J	0.04	SED-18	10/10	--	--	--	--	--
C3-PHENANTHRENES/ANTHRACENES	0.015	0.086	0.0	SED-02	10/10	--	--	--	--	--
C4-NAPHTHALENES	0.015	0.049 J	0.0	SED-02	7/10	--	--	--	--	--

Table 4.1-1B Non-Dredge Area[a] Baseline Sediment Data Summary for May 2011 Composite Samples, Buffalo River AOC

Analyte[b]	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	Average Concentration (mg/kg)[c]	Location of Maximum	Frequency of Detection[d]	NYSDEC Freshwater Sediment Benchmark (mg/kg)			MacDonald et al. (2000) PEC (mg/kg)	
						Value	Basis	FoE TEC	Value	FoE PEC
C4-PHENANTHRENES/ANTHRACENES	0.0012 J	0.039 J	0.0	SED-27	4/10	--	--	--	--	--
CHRYSENE	0.053	1.3 J	0.27	SED-18	10/10	0.17	TEC	5/10	1.29	1/10
DIBENZ(A,H)ANTHRACENE	0.033	1.3 J	0.2	SED-18	10/10	0.03	TEC	10/10	--	--
FLUORANTHENE	0.0037 J	3.3 J	1	SED-18	10/10	0.42	TEC	4/10	2.23	1/10
FLUORENE	0.0091	0.64 J	0.09	SED-18	10/10	0.08	TEC	1/10	0.536	1/10
INDENO(1,2,3-C,D)PYRENE	0.086 J	3.6 J	0.50	SED-18	10/10	--	--	--	--	--
NAPHTHALENE	0.0061 J	0.73 J	0.1	SED-18	9/10	0.18	TEC	1/9	0.561	1/9
PAHs (total)	0.75 J	31 J	5.0	SED-18	10/10	1.61	TEC	5/10	22.8	1/10
PERYLENE	0.051 J	1.6 J	0.28	SED-18	10/10	--	--	--	--	--
PHENANTHRENE	0.042	3.7 J	0.47	SED-18	10/10	0.2	TEC	1/10	1.17	1/10
PYRENE	0.099 J	2.9 J	0.5	SED-18	10/10	0.2	TEC	5/10	1.52	1/10
Other Semivolatile Organic Compounds (SVOCs)										
BIS(2-ETHYLHEXYL) PHTHALATE	0.18 J	0.2 J	0.57[e]	SED-18	3/10	239	EqP(2%OC)	0/3	--	--
CARBAZOLE	0.59	0.59	0.60[e]	SED-18	1/10	--	--	--	--	--
DIBENZOFURAN	0.61	0.61	0.66[e]	SED-18	1/10	--	--	--	--	--
DIMETHYL PHTHALATE	0.21 J	0.21 J	0.61[e]	SED-26	1/10	--	--	--	--	--

Key:
AOC = Area of Concern
-- (double dash) = not available or not applicable
EqP (2% OC) = Equilibrium partitioning assuming 2% organic carbon in sediment
FoE PEC = Frequency of Exceedance of PEC (i.e., number of detects > PEC over number of detects).
FoE TEC = Frequency of Exceedance of TEC (i.e., number of detects > TEC over number of detects).
J = estimated value
mg/kg = milligrams per kilogram
N = tentatively identified
NYSDEC = New York State Department of Environmental Conservation
PEC = Probable Effect Concentration
TEC = Threshold Effect Concentration (MacDonald et al. 2000)

Note:
a = Ten sampling areas: 2, 6, 10, 18, 20, 22, 24, 26, 27, 28.
b = Detected analytes only are listed.
c = Averages calculated using 1/2 of the Method Dection Limit (MDL) for U-qualified results.
d = Number of detects over number of samples.
e = Elevated MDLs for some samples resulted in the average exceeding the maximum.

Table 4.1-2A Composite and Individual Grab Sample Metals Results[a] for Baseline Sampling Area 05[B]

Analyte	Composite Sample Result	Individual Grab Sample (A to E) Results and Summary Statistics							
		A	B	C	D	E	Mean	S.D.	C.V.
		DMU-05 Near Shore	DMU-06a Channel	DMU-06b Channel	DMU-05 Near Shore	DMU-07a Near Shore			
Arsenic	6.8	7.4	7.8	7.1	8.3	7.3	7.6	0.48	6%
Cadmium	0.37 J	0.44 J	0.33 J	0.39 J	0.36 J	0.42 J	0.39	0.044	11%
Chromium	22	28	23	22	25	22	24	2.55	11%
Copper	36	43	38	35	43	35	39	4.02	10%
Lead	34	40	35	46	39	45	41	4.53	11%
Mercury	0.3	0.43	0.25	0.3	0.53	0.21	0.34	0.13	39%
Nickel	30	36	33	27	36	28	32	4.30	13%
Selenium	1.5 U	1.6 U	1.6 U	1.4 U	1.7 U	1.4 U	--[c]	--[c]	--[c]
Silver	0.5 U	0.55 U	0.53 U	0.48 U	0.56 U	0.48 U	--[c]	--[c]	--[c]
Zinc	153	177	153	151	195	151	165	19.9	12%

Key:

C.V. = Coefficient of Variation (standard deviation as a percent of the mean)

DMU = Dredge Management Unit

J = Estimated value

S. D. = Standard deviation

U = Not detected, listed value is quantitation limit

Notes:

a = mg/kg, except where noted otherwise.

b = Dredge area; included DMUs 05, 06a, 06b, and 07a.

c = Not calculated when analyte was undetected in all grabs.

Table 4.1-2B Composite and Individual Grab Sample Metals Results[a] for Baseline Sampling Area 11[b]

Analyte	Composite Sample Result	Individual Grab Sample (A to E) Results and Summary Statistics							
		A DMU-16 Channel	B DMU-17 Channel	C DMU-19 Channel	D DMU-16 Near Shore	E DMU-18 Near Shore	Mean	S.D.	C.V.
Arsenic	26	8.1	6.6	6.9	101	22	29	41	141%
Cadmium	4.3 N	0.62 J	0.23 J	0.27 J	17 N	5.5 N	4.7	7.2	153%
Chromium	163 NE	31 NE	12 NE	19 NE	679 NE	142 NE	177	286	162%
Copper	128	36	22	27	532	119	147	219	149%
Lead	321 J	62 J	24 J	31 J	1360 J	278 J	351	574	163%
Mercury	2.8	0.37	0.099 J	0.31	11 D	1.9	2.7	4.7	171%
Nickel	32	30	23	23	57	36	34	14	42%
Selenium	1.7 U	1.6 U	1.6 U	1.6 U	1.8 U	1.6 U	--[c]	--[c]	--[c]
Silver	1.8 U	1.8 U	1.8 U	1.8 U	2.8 N	1.8 U	--[c]	--[c]	--[c]
Zinc	661 N	145 N	91 N	111 N	2560 N	491 N	680	1064	157%

Key:

C.V. = Coefficient of Variation (standard deviation as a percent of the mean)

D = Compounds at secondary dilution factor.

DMU = Dredge Management Unit

E = Estimated due to interferences.

J = Estimated value

N = Tentatively identified

S.D. = Standard deviation

U = Not detected; listed value is quantitation limit

Notes:

a = mg/kg, except where noted otherwise.

b = Dredge area; includes DMUs 16, 17, 18, and 19.

c = Not calculated when analyte was undetected in all grabs.

Table 4.1-2C Composite and Individual Grab Sample Metals Results[a] for Baseline Sampling Area 22[b]

Analyte	Composite Sample Result	Individual Grab Sample (A to E) Results and Summary Statistics							
		A	B	C	D	E	Mean	S.D.	C.V.
		Channel	Channel	Channel	Near Shore	Near Shore			
Arsenic	7.8	7.6	7.5	7.8	7.5	8.5	7.8	0.4	5%
Cadmium	0.29 J	0.26 J	0.23 U	0.3 J	0.25 J	0.35 J	0.28	0.048	17%
Chromium	18	17	16	21	16	21	18	2.6	14%
Copper	29	27	25	31	28	33	29	3.2	11%
Lead	24	20	20	27	22	29	24	4.2	18%
Mercury	0.16 J	0.12 J	0.11 J	0.15 J	0.12 J	0.18 J	0.14	0.029	21%
Nickel	29	29	28	31	28	33	30	2.2	7%
Selenium	1.6 U	1.6 U	1.6 U	1.4 U	1.5 U	1.7 U	--[c]	--[c]	--[c]
Silver	2 UJ	1.9 UJ	1.9 UJ	1.7 UJ	1.9 UJ	2.1 UJ	--[c]	--[c]	--[c]
Zinc	118	110	106	141	114	141	122	17.2	14%

Key:

C.V. = Coefficient of Variation (standard deviation as a percent of the mean)

DMU = Dredge Management Unit

J = Estimated value

S.D. = Standard deviation

U = Not detected; listed value is quantitation limit

Notes:

a = mg/kg, except where noted otherwise.

b = Non-dredge area (includes no DMUs).

c = Not calculated when analyte was undetected in all grabs.

Table 4.1-3A Dredge Area AVS (µmol/g) and SEM (µmol/g) Results[a]

Analyte	Sample Number, Result, and Qualifier											
	BAS-SED-04	BAS-SED-04B	BAS-SED-08	BAS-SED-08E	BAS-SED-12	BAS-SED-12A	BAS-SED-16	BAS-SED-16C	BAS-SED-21	BAS-SED-21A	BAS-SED-25	BAS-SED-25D
Sulfide	0.36	2.10	0.31	1.09	0.35	0.14 U	1.39	0.75	1.24	1.31	0.43	0.17 U
Cadmium	0.0057	0.0060	0.0021	0.0029	0.0031	0.0027	0.0083	0.0042	0.0038	0.0046	0.0036	0.0031
Copper	0.446	0.391	0.221	0.234	0.255	0.226	0.465	0.329	0.274	0.320	0.302	0.274
Lead	0.130 J	0.120 J	0.068	0.067	0.096	0.066	0.245	0.129	0.102	0.104	0.094	0.082
Nickel	0.337 J	0.350 J	0.128	0.206	0.216	0.203	0.256	0.244	0.245	0.264	0.249	0.243
Zinc	1.97	1.90	0.67	0.98	1.02	0.87	2.11	1.38	1.32	1.47	1.26	1.10
SEM/AVS	8.02	1.32	3.51	1.37	4.54	9.77	2.22	2.78	1.57	1.65	4.44	10.01

Key:
AOC = Area of Concern
AVS = Acid volatile sulfide
SEM = Simultaneously extracted metals
µmol/g = micromoles per gram

Note:
a = Samples collected on 16, 17, and 18 May 2011.

Table 4.1-3B Non-Dredge Area AVS (µmol/g) and SEM (µmol/g) Results[a]

Analyte	Sample Number, Result, and Qualifier							
	BAS-SED-02	BAS-SED-02A	BAS-SED-06	BAS-SED-06D	BAS-SED-20	BAS-SED-20D	BAS-SED-27	BAS-SED-27E
Sulfide	0.63 J	2.90	0.16 U	0.16 U	0.18 U	0.17 U	0.17 U	0.15 U
Cadmium	0.0031	0.0062	0.0026	0.0028	0.0034	0.0028	0.0043	0.0036
Copper	0.247	0.418	0.245	0.252	0.278	0.254	0.334	0.291
Lead	0.095 J	0.150 J	0.073	0.070	0.089	0.076	0.099 J	0.080 J
Nickel	0.148 J	0.303 J	0.213	0.217	0.239	0.224	0.281 J	0.260 J
Zinc	1.10	2.10	0.98	0.92	1.14	0.95	1.39	1.10
SEM/AVS	2.53	1.03	9.46	9.14	9.72	8.86	12.40	11.56

Key:

AOC = Area of Concern

AVS = Acid volatile sulfide

SEM = Simultaneously extracted metals

µmol/g = micromoles per gram

Note:

a = Samples collected on 16 and 18 May 2011.

Table 4.1-4 Dredge and Non-Dredge Area Results for Oil & Grease, Black Carbon, and Total Organic Carbon

Parameter	Frequency of Detection	Minimum Detected Concentration	Maximum Detected Concentration	Sediment Screening Level	Frequency of Exceedance of Screening Level
Dredge Areas[a]					
Oil & Grease (%)	18/18	0.04	0.75	0.15[c]	7/18
Black Carbon, Total (%)	18/18	0.20	1.13	--	--
Total Organic Carbon (%)	18/18	0.53	2.27	--	--
BC:TOC Ratio	--	16%	68%	--	--
Non-Dredge Areas[b]					
Oil & Grease (%)	10/10	0.08	0.13	0.15[c]	0/10
Black Carbon, Total (%)	10/10	0.18	0.40	--	--
Total Organic Carbon (%)	10/10	0.90	2.13	--	--
BC:TOC Ratio	--	14%	21%	--	--

Key:

BC = black carbon

% = percent

TOC = total organic carbon

Notes:

a = Eighteen sample areas: 1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 21, 23, 25.

b =Ten sample areas: 2, 6, 10, 18, 20, 22, 24, 26, 27, 28.

c = Persaud et al. (1993). Open water disposal guideline.

Table 4.1-5A Dredge Area[a] Porewater PAH Analytical Data Summary

Chemical	Log K_{ow}[b]	Frequency of Detection	Minimum Detected Concentration (ng/mL)	Maximum Detected Concentration (ng/mL)	Average[c] Concentration (ng/mL)
naphthalene	3.37	7/9	0.12 J	16.78 J	2.56 J
2-methylnaphthalene	3.87	3/9	0.05 J	0.76 J	0.30 J
1-methylnaphthalene	3.87	5/9	0.07 J	0.69 J	0.37 J
C2 naphthalenes	4.37	6/9	0.51 J	5.35 J	1.80 J
C3 naphthalenes	4.90	6/9	0.68 J	10.68 J	3.93 J
C4 naphthalenes	5.55	6/9	0.83 J	6.62 J	3.66 J
acenaphthylene	4.07	0/9	--	--	--
acenaphthene	3.92	4/9	0.21 J	0.53 J	0.33 J
fluorene	4.18	7/9	0.04 J	0.28 J	0.14 J
C1 fluorenes	4.97	4/9	0.17 J	0.43 J	0.29 J
C2 fluorenes	5.20	4/9	0.24 J	0.93 J	0.71 J
C3 fluorenes	5.50	0/9	--	--	--
phenanthrene	4.46	5/9	0.15 J	0.51 J	0.29 J
anthracene	4.54	4/9	0.05 J	0.70 J	0.24 J
C1 phenanthrenes/anthracenes	5.14	4/9	0.31 J	0.76 J	0.49 J
C2 phenanthrenes/anthracenes	5.51	4/9	0.61 J	1.09 J	0.83 J
C3 phenanthrenes/anthracenes	6.00	4/9	0.21 J	0.63 J	0.44 J
C4 phenanthrenes/anthracenes	6.51	0/9	--	--	--
fluoranthene	5.22	9/9	0.02 J	0.15 J	0.07 J
pyrene	5.18	9/9	0.02 J	0.14 J	0.07 J
C1 fluoranthenes/pyrenes	5.72	4/9	0.03 J	0.07 J	0.05 J
benz[a]anthracene	5.91	1/9	0.01 J	0.01 J	0.01 J
chrysene	5.86	1/9	0.01 J	0.01 J	0.01 J
C1 chrysenes	6.42	0/9	--	--	--
C2 chrysenes	6.88	0/9	--	--	--
C3 chrysenes	7.44	0/9	--	--	--
C4 chrysenes	8.00	0/9	--	--	--
benzo[b+k]fluoranthene	5.90	0/9	--	--	--
benzo[e]pyrene	6.04	0/9	--	--	--
benzo[a]pyrene	6.04	0/9	--	--	--
perylene	6.25	0/9	--	--	--
indeno[1,2,3-cd]pyrene	7.00	0/9	--	--	--
dibenz[ah]anthracene	6.75	0/9	--	--	--
benzo[ghi]perylene	6.50	0/9	--	--	--

Source: Energy and Environmental Research Center, GC/MS Laboratory, University of North Dakota, Grand Forks, ND.

Key:
-- (double dash) = not applicable
AOC = Area of Concern
J = Estimated value
ng/mL = Nanograms per milliliter (equivalent to µg/L)
PAH = Polycyclic aromatic hydrocarbon

Notes:
a = Nine sample areas: 4, 7, 8, 9, 12, 15, 16, 21, 25.
b = From Neff et al. (2004).
c = Zero assumed for non-detects.

Table 4.1-5B Non-Dredge Area[a] Porewater PAH Analytical Data Summary

Chemical	Log K_{ow}[b]	Frequency of Detection	Minimum Detected Concentration (ng/mL)	Maximum Detected Concentration (ng/mL)	Average[c] Concentration (ng/mL)
naphthalene	3.37	4/6	0.11 J	0.22 J	0.15 J
2-methylnaphthalene	3.87	0/6	--	--	--
1-methylnaphthalene	3.87	1/6	0.06 J	0.06 J	0.06 J
C2 naphthalenes	4.37	2/6	0.30 J	0.37 J	0.34 J
C3 naphthalenes	4.90	2/6	0.33 J	0.51 J	0.42 J
C4 naphthalenes	5.55	2/6	0.32 J	0.40 J	0.36 J
acenaphthylene	4.07	0/6	--	--	--
acenaphthene	3.92	1/6	0.14 J	0.14 J	0.14 J
fluorene	4.18	2/6	0.04 J	0.06 J	0.05 J
C1 fluorenes	4.97	1/6	0.03 J	0.03 J	0.03 J
C2 fluorenes	5.20	1/6	0.21 J	0.21 J	0.21 J
C3 fluorenes	5.50	0/6	--	--	--
phenanthrene	4.46	0/6	--	--	--
anthracene	4.54	0/6	--	--	--
C1 phenanthrenes/anthracenes	5.14	1/6	0.18 J	0.18 J	0.18 J
C2 phenanthrenes/anthracenes	5.51	1/6	0.85 J	0.85 J	0.85 J
C3 phenanthrenes/anthracenes	6.00	1/6	0.13 J	0.13 J	0.13 J
C4 phenanthrenes/anthracenes	6.51	0/6	--	--	--
fluoranthene	5.22	6/6	0.02 J	0.05 J	0.03 J
pyrene	5.18	6/6	0.01 J	0.05 J	0.03 J
C1 fluoranthenes/pyrenes	5.72	0/6	--	--	--
benz[a]anthracene	5.91	0/6	--	--	--
chrysene	5.86	0/6	--	--	--
C1 chrysenes	6.42	0/6	--	--	--
C2 chrysenes	6.88	0/6	--	--	--
C3 chrysenes	7.44	0/6	--	--	--
C4 chrysenes	8.00	0/6	--	--	--
benzo[b+k]fluoranthene	5.90	0/6	--	--	--
benzo[e]pyrene	6.04	0/6	--	--	--
benzo[a]pyrene	6.04	0/6	--	--	--
perylene	6.25	0/6	--	--	--
indeno[1,2,3-cd]pyrene	7.00	0/6	--	--	--
dibenz[ah]anthracene	6.75	0/6	--	--	--
benzo[ghi]perylene	6.50	0/6	--	--	--

Source: Energy and Environmental Research Center, GC/MS Laboratory, University of North Dakota, Grand Forks, ND.

Key:
-- (double dash) = not applicable
AOC = Area of Concern
J = Estimated value
ng/mL = Nanograms per milliliter (equivalent to µg/L)
PAH = Polycyclic aromatic hydrocarbon

Notes:
a = Six sample area: 02, 06, 18, 20, 24, and 27.
b = From Neff et al.(2004).
c = Zero assumed for non-detects.

Table 4.2-1 *Hyalella azteca* Mean Survival and Biomass (± one standard deviation)

Sample	Percent (%) Survival[a]			Total Biomass (mg)[a]			Dry Weight per Surviving Organism (mg)[a]		
Control	92.5	±	8.9	0.55	±	0.14	0.059	±	0.012
Dredge Areas									
BAS-SED-04	91.3	±	9.9	0.42	±	0.07	0.016	±	0.005
BAS-SED-08	92.5	±	7.1	0.54	±	0.05	0.059	±	0.006
BAS-SED-12	86.3	±	14.1	0.41	±	0.06	0.061	±	0.008
BAS-SED-16	96.3	±	5.2	0.55	±	0.07	0.042	±	0.006
BAS-SED-21	96.3	±	5.2	0.65	±	0.08	0.055	±	0.012
BAS-SED-25	95	±	7.6	0.6	±	0.11	0.068	±	0.01
Non-Dredge Areas									
BAS-SED-02	91.3	±	11.3	0.59	±	0.08	0.065	±	0.008
BAS-SED-06	78.8	±	23	0.46	±	0.15	0.059	±	0.01
BAS-SED-20	95	±	7.6	0.52	±	0.1	0.058	±	0.006
BAS-SED-27	93.8	±	7.4	0.66	±	0.24	0.064	±	0.011

Source: ERDC 2011.

[a] No significant difference between dredge and non-dredge areas for % survival ($p = 0.39$), total biomass ($p = 0.64$), or dry weight per surviving organism ($p = 0.28$) based on two-sample t-test.

Table 4.2-2 *Chironomus dilutus* Mean Survival and Biomass (± one standard deviation)

Sample	Percent (%) Survival[a]			Total Biomass (mg)[a]			Dry Weight per Surviving Organism (mg)[a]		
Control	93.8	±	7.4	13.8	±	2.7	1.49	±	0.37
Dredge Areas									
BAS-SED-04	87.5	±	10.4	9.3	±	2	1.06	±	0.16
BAS-SED-08	87.5	±	12.8	11.7	±	1.7	1.36	±	0.25
BAS-SED-12	100	±	0	13.8	±	5	1.38	±	0.5
BAS-SED-16	86.3	±	10.6	9	±	1.9	1.06	±	0.26
BAS-SED-21	92.5	±	10.4	12.5	±	1.1	1.36	±	0.13
BAS-SED-25	95	±	7.6	12.5	±	3.4	1.34	±	0.41
Non-Dredge Areas									
BAS-SED-02	96.3	±	7.4	11.5	±	1.8	1.2	±	0.16
BAS-SED-06	95	±	7.6	11.6	±	1.7	1.23	±	0.21
BAS-SED-20	87.5	±	12.8	11	±	1.9	1.28	±	0.32
BAS-SED-27	76.3	±	17.7	10	±	3.3	1.36	±	0.5

Source: ERDC 2011.

[a] No significant difference between dredge and non-dredge areas for % survival ($p = 0.57$), total biomass ($p = 0.68$), or dry weight per surviving organism ($p = 0.93$) based on two-sample t-test.

Table 4.2-3 *Lumbriculus variegatus* Mean Survival (± one standard deviation) during 4-day Acute Test and Mean Tissue Mass Recovered (± one standard deviation) after 28 Days

Sample	% Survival after 4 Days[a]			% Recovery of *Lumbriculus* Biomass after 28 Days[b,c]		
Control	95	±	10	49.3	±	6.1
Dredge Areas						
BAS-SED-04	100	±	0	61	±	20.7
BAS-SED-08	95	±	10	49.2	±	8.8
BAS-SED-12	97.5	±	5	67.9	±	7.2
BAS-SED-16	95	±	5.8	47.6	±	10.3
BAS-SED-21	100	±	0	58.8	±	7.5
BAS-SED-25	100	±	0	67.1	±	16.6
Non-Dredge Areas						
BAS-SED-02	100	±	0	61.7	±	18.5
BAS-SED-06	95	±	10	93.2	±	4.9
BAS-SED-20	100	±	0	68.8	±	8.2
BAS-SED-27	97.5	±	5	74.6	±	7.7

Source: ERDC 2011.

Notes:

[a] No significant difference (*p* = 0.90) between dredge and non-dredge areas based on two-sample t-test.

b Based on starting biomass of 7 grams per replicate and four replicates per sample.

[c] Significantly lower (*p* = 0.025) in dredge versus non-dredge areas based on two-sample t-test.

Table 4.3-1 *Lumbriculus* [a] Baseline Analytical Results Summary for Dredge Areas

Chemical	Sample Number, Result, and Qualifier for Buffalo River AOC Sediment Samples Used for *Lumbriculus* 28-Day Bioaccumulation Test					
	BAS-SED-04	BAS-SED-08	BAS-SED-12	BAS-SED-16	BAS-SED-21	BAS-SED-25
***Lumbriculus* tissue**						
Mercury (mg/kg)	0.09	0.225	0.965	0.15	0.196	0.194
Total PCBs (mg/kg)	0.026	0.211	0.012	0.113	0.037	0.031
Extractable Lipids (%)	1.1	1.9	1.3	1.8	1.3	0.88
Solids (%)	12	14	13	15	13	15
Sediment[b]						
Mercury (mg/kg)	0.32	0.17	0.11 J	0.36	0.18 J	0.11 J
Total PCBs (mg/kg)	0.00043 U	0.00026 U	0.00032 U	0.00035 U	0.00037 U	0.00039 U
Total Organic Carbon (%)	1.72	0.53	1.58	1.83	1.76	1.73

Key:

-- (double dash) = Not available
AOC = Area of Concern
BSAF = Biota sediment accumulation factor
Conc. = Concentration
J = Estimated quantity
mg/kg = Milligrams per kilogram
PCBs = Polychlorinated biphenyls
U = Undetected (listed value is quantitation limit)

Note:

a Bioaccumulation testing was initiated on 13 June 2011 and completed on 15 July 2011 (ERDC 2011).
b Sediment analytical data for are provided for selected parameters to facilitate BSAF calculation.

Table 4.3-2 *Lumbriculus* [a] Baseline Analytical Results Summary for Non-Dredge Areas

Chemical	Sample Number, Result, and Qualifier for Buffalo River AOC Sediment Samples Used for *Lumbriculus* 28-Day Bioaccumulation Test			
	BAS-SED-02	BAS-SED-06	BAS-SED-20	BAS-SED-27
Lumbriculus tissue				
Mercury (mg/kg)	0.169	0.165	0.16	0.164
Total PCBs (mg/kg)	0.034	0.013	0.032	0.020
Extractable Lipids (%)	1.31	1.2	1.0	0.87
Solids (%)	13	10	12	13
Sediment[b]				
Mercury (mg/kg)	0.37	0.14 J	0.12 J	0.11 J
Total PCBs (mg/kg)	0.00029 U	0.00038 U	0.00036 U	0.00038 U
Total Organic Carbon (%)	0.9	2.0	1.69	1.91

Key:

-- (double dash) = Not available

AOC = Area of Concern

BSAF = Biota sediment accumulation factor

Conc. = Concentration

J = Estimated quantity

mg/kg = Milligrams per kilogram

PCBs = Polychlorinated biphenyls

U = Undetected (listed value is quantitation limit)

Note:

a Bioaccumulation testing was initiated on 13 June 2011 and completed on 15 July 2011 (ERDC 2011).

b Sediment analytical data for are provided for selected parameters to facilitate BSAF calculation.

Table 4.4-1 Buffalo River Baseline Study Fish Sample Summary

Sample Number	Collection Date	Species	Length (mm)	Weight (g)
Katherine St. Peninsula				
BAS-FSH-01-2011-01	6/13/2011	Carp	626	1700
BAS-FSH-01-2011-02	6/13/2011	Carp	620	2200
BAS-FSH-01-2011-03	6/13/2011	Largemouth Bass	460	1350
Ohio Street				
BAS-FSH-02-2011-01	6/13/2011	Carp	532	2300
BAS-FSH-02-2011-02	6/13/2011	Carp	656	3750
BAS-FSH-02-2011-04	6/13/2011	Largemouth Bass	365	750
BAS-FSH-02-2011-05	6/13/2011	Largemouth Bass	340	600
BAS-FSH-02-2011-06	6/13/2011	Largemouth Bass	330	550
Kelly Island				
BAS-FSH-03-2011-01	6/13/2011	Carp	550	1950
BAS-FSH-03-2011-02	6/13/2011	Carp	770	>5000
BAS-FSH-03-2011-03	6/13/2011	Carp	650	3600
BAS-FSH-03-2011-04	6/13/2011	Carp	595	3250
BAS-FSH-03-2011-05	6/13/2011	Largemouth Bass	310	250
BAS-FSH-03-2011-06	6/13/2011	Carp	610	3150
BAS-FSH-03-2011-07	6/16/2011	Carp	760	>5000
City Ship Canal				
BAS-FSH-04-2011-01	6/13/2011	Largemouth Bass	348	600
BAS-FSH-04-2011-02	6/13/2011	Largemouth Bass	370	650
BAS-FSH-04-2011-03	6/13/2011	Largemouth Bass	365	650
BAS-FSH-04-2011-04	6/13/2011	Largemouth Bass	360	700
BAS-FSH-04-2011-06	6/13/2011	Largemouth Bass	372	850

Key:

g = gram

mm = millimeter

Table 4.4-2 Carp *(Cyprinus carpio) Ski* n-on Fillet Baseline Analytical Results Summary[a]

Chemical	Minimum Detected Conc.	Maximum Detected Conc.	FoD	Sampling Area, Sample Number, Analytical Result, and Qualifier									
				Katherine St. Peninsula		Ohio Street		Kelly Island					
				BAS-FSH-01-2011-01	BAS-FSH-01-2011-02	BAS-FAS-02-2011-01	BAS-FSH-02-2011-02	BAS-FSH-03-2011-01	BAS-FSH-03-2011-02	BAS-FSH-03-2011-03	BAS-FSH-03-2011-04	BAS-FSH-03-2011-06	BAS-FSH-03-2011-07
Metals (mg/kg)													
Arsenic	0.142 J	0.308	10/10	0.151	0.142 J	0.149	0.125 J	0.177	0.187	0.308	0.291	0.256	0.272
Cadmium	0.0014 J	0.0085	9/10	0.0024 J	0.0062 U	0.0014 J	0.0019 J	0.0073	0.0067	0.0038 J	0.026	0.0085	0.0037 J
Chromium	0.03 J	0.79	9/10	0.04 J	0.79	0.04 J	0.06 U	0.03 J	0.08	0.04 J	0.06 J	0.06	0.07
Copper	0.409	0.919	10/10	0.759	0.469	0.409	0.659	0.734	0.465	0.832	0.919	0.906	0.518
Lead	0.0063	0.13	10/10	0.016	0.07	0.0063	0.016	0.066	0.13	0.02	0.089	0.08	0.013
Mercury	0.061	0.22	10/10	0.075	0.126	0.075	0.073	0.082	0.094	0.126	0.134	0.220	0.061
Nickel	0.02 J	0.05 J	9/10	0.02 J	0.05 J	0.02 J	0.02 J	0.03 J	0.04 J	0.06 U	0.03 J	0.02 J	0.03 J
Zinc	15	29	10/10	24	29	20	18	15	21	16	25	20	25
Polychlorinated Biphenyls (PCBs, mg/kg)													
Total PCBs	0.47	1.03	2/2	na	na	na	1.03	na	na	na	0.47	na	na
Other Parameters (%)													
Extractable lipids	4	9.5	10/10	7	9.5	5.7	8.5	6.3	5	8.3	8.2	4	5.6
Total Solids	26	33	10/10	29	31	26	30	27	29	30	33	26	27

Key:

-- (double dash) = not available or not applicable
FoD = frequency of detection
J = estimated value
mg/kg = milligrams per kilogram
na = not analyzed
RAIS = Risk Assessment Information System
U = undetected, listed value is quantitation limit
TR = target (cancer) risk
THQ = target hazard quotient
% = percent

Notes:

a = Collected 13 June 2011 except BAS-FSH-03-2011-07, which was collected 16 June 2011.

Table 4.4-3 Largemouth Bass (*Micropterus salmoides*) Skin-on Fillet Baseline Analytical Results Summary[a]

Chemical	Minimum Detected Conc.	Maximum Detected Conc.	FoD	Sampling Area, Sample Number, Analytical Result, and Qualifier									
				Katherine St.	Ohio Street			Kelly Island	City Ship Canal				
				BAS-FSH-01-2011-03	BAS-FSH-02-2011-04	BAS-FSH-02-2011-05	BAS-FSH-02-2011-06	BAS-FSH-03-2011-05	BAS-FSH-04-2011-01	BAS-FSH-04-2011-02	BAS-FSH-04-2011-03	BAS-FSH-04-2011-04	BAS-FSH-04-2011-06
Metals (mg/kg)													
Arsenic	0.087 J	0.273	10/10	0.087 J	0.189	0.244	0.213	0.224	0.241	0.214	0.273	0.158	0.162
Cadmium	0.002 J	0.002 J	1/10	0.0047 U	0.002 J	0.0045 U	0.0048 U	0.0046 U	0.0044 U	0.0044 U	0.0043 U	0.0045 U	0.0043 U
Chromium	0.04 J	0.07	10/10	0.06	0.06	0.07	0.05	0.05	0.07	0.04 J	0.05	0.06	0.05
Copper	0.206	0.307	10/10	0.222	0.235	0.307	0.248	0.252	0.229	0.242	0.223	0.265	0.206
Lead	0.0035 J	0.019	10/10	0.017	0.0086	0.0035 J	0.0042 J	0.0041 J	0.0049	0.0036 J	0.019	0.0046	0.0053
Mercury	0.182	1.0	10/10	1.01	0.43	0.24	0.22	0.18	0.22	0.20	0.35	0.23	0.26
Nickel	0.01 J	0.02 J	9/10	0.01 J	0.01 J	0.02 J	0.02 J	0.02 J	0.02 J	0.02 J	0.02 J	0.01 J	0.04 U
Zinc	7.05	19	10/10	8.31	9.95	7.89	16	14	8.06	19	7.05	12	9.98
Polychlorinated Biphenyls (PCBs, mg/kg)													
Total PCBs	0.024	0.038	2/2	0.024	0.038	na	na	na	na	na	na	na	na
Other Parameters (%)													
Extractable lipids	0.1	0.26	10/10	0.11	0.24	0.25	0.14	0.17	0.26	0.2	0.24	0.1	0.2
Total Solids	22	24	10/10	24	23	23	24	23	22	22	22	23	22

Key:

-- (double dash) = not available or not applicable
FoD = frequency of detection
J = estimated value
mg/kg = milligrams per kilogram
na = not analyzed
RAIS = Risk Assessment Information System
U = undetected, listed value is quantitation limit
TR = target (cancer) risk
THQ = target hazard quotient
% = percent

Notes:

a = All samples collected 13 June 2011.

Table 4.4-4A Summary Table of Individuals Captured by Species at the Buffalo River Sampling Locations

Species (Common name)	City Ship Canal	Kelly Island	Ohio Street	Katherine Street Peninsula	Smith Street	Buffalo Color Area D	Riverbend	Grand Total
Blue Gill	1		1	2	7	3		14
Bluntnose Minnow			1		8	1	5	15
Brook Silverside			3		2			5
Brown Bulhead		1	1	4	1	5		12
Carp*		2					1	3
Common Shiner		1		7				8
Emerald Shiner			18	50	32	31	54	185
Gizzard Shad		1						1
Golden Shiner			4	7	1	1		13
Goldfish*							1	1
Largemouth Bass	10	21	3	5	5	4	3	51
Northern Hogsucker		1		1			1	3
Pumpkinseed	49	1	12	23	45	7	9	146
Quillback		2						2
Rock Bass	5		12		2	3	2	24
Round Goby*		1						1
Silver Redhorse			1		1		2	4
Smallmouth Bass		7	2	1		1		11
Spottail Shiner				19	16	1	7	43
Yellow Perch		2	3	2	7		1	15
Grand Total	65	40	61	121	127	57	86	557
Number of Species	4	11	12	11	12	10	11	20

* Non-native species.

Table 4.4-4B Additional Non-IBI Related Metrics

Metric	City Ship Canal	Kelly Island	Ohio Street	Katherine Street Peninsula	Smith Street	Buffalo Color Area D	Riverbend	Overall Average
Average Condition Factor (K)	3.42	1.59	3.58	1.75	1.09	0.71	2.16	2.04
Species Diversity: Shannon-Wiener Diversity Index (Hi)	0.76	1.65	2.00	1.76	1.84	1.58	1.40	1.57
CPUE (No of Fish Caught / Hour of electroshocking)	258.00	162.00	246.00	486.00	510.00	228.00	342.00	318.86

Table 4.4-4C Fish Community Metrics and Index of Biotic Integrity Scores

Metric	City Ship Canal		Kelly Island		Ohio Street		Katherine Street Peninsula		Smith Street		Buffalo Color Area D		Riverbend	
	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score
Species Richness	4	1	11	3	12	3	11	3	12	3	10	3	11	3
% "Round-Bodied" suckers	0	1	2.5%	1	1.6%	1	0.7%	1	0.8%	1	0	1	3.5%	1
Sunfish Species - Number	2	3	1	1	2	3	2	3	2	3	2	3	1	1
Sucker Species - Number	0	1	3	3	1	1	1	1	1	1	0	1	3	3
Intolerant Species - Number	0	1	2	3	3	3	2	3	2	3	1	1	2	3
% Tolerant Individuals	76.9%	1	30%	1	38.3%	1	44.2%	1	63.8%	1	33.3%	1	30.2%	1
% Omnivore Individuals	0%	5	12.5%	5	1.6%	5	0%	5	6.3%	5	1.8%	5	8.1%	5
% Insectivore Individuals	76.9%	5	10%	1	65.6%	5	94.3%	5	82.7%	5	84.2%	5	84.9%	5
% Carnivore Individuals	23%	5	70%	5	27.9%	5	4.3%	1	5.5%	3	14%	5	5.8%	3
Number of Fish (excludes: Tolerant, hybrid, and exotics)	65	5	37	5	55	5	129	5	117	5	50	5	79	5
% Simple Lithophil Individuals	0%	1	5.0%	1	31.1%	3	55.0%	5	26.0%	3	54.4%	5	66.3%	5
% DELT Anomalies	7.7%	3	2.5%	5	1.6%	5	5.7%	3	6.3%	3	3.5%	5	3.5%	3
Total IBI	**32**		**34**		**40**		**36**		**36**		**40**		**38**	
Integrity Class	**FAIR**		**FAIR**		**GOOD**		**GOOD**		**GOOD**		**GOOD**		**GOOD**	

Table 4.4-4D Fish Community Metrics Jaccard Similarity Index Values

	City Ship Canal	Kelly Island	Ohio Street	Katherine Street Peninsula	Smith Street	Buffalo Color Area D	Riverbend
City Ship Canal	x	18.2	50.0	33.3	50.0	66.7	33.3
Kelly Island	18.2	x	38.5	87.5	26.7	30.8	41.7
Ohio Street	50.0	38.5	x	114.3	550.0	225.0	77.8
Katherine Street Peninsula	33.3	87.5	114.3	x	114.3	160.0	60.0
Smith Street	50.0	26.7	550.0	114.3	x	225.0	114.3
Buffalo Color Area D	66.7	30.8	225.0	160.0	225.0	x	66.7
Riverbend	33.3	41.7	77.8	60.0	114.3	66.7	x

Table 4.4-5A QHEI Summary Score

Metric	City Ship Canal	Kelly Island	Ohio Street	Katherine Street Peninsula	Smith Street	Buffalo Color Area D	Riverbend Upstream	Riverbend Downstream
Substrate	14	9	5	6	1	3	14	0
Instream Cover	6	10	11	10	17	9	7	6
Channel Morphology	6	6	8	8	10	9	4	5
Bank Erosion and Riparian Width	3.5	3	5	7.5	6.5	5	3	4
Pool/Glide and Riffle/Run Quality	4	2	4	4	2	4	4	4
Riffle Function	0	0	0	0	0	0	0	0
Gradient	4	4	4	4	4	4	4	4
Total Metric Score	**37.5**	**34**	**37**	**39.5**	**40.5**	**34**	**36**	**23**
Associted Site Quality	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Very Poor**
% pool/glide/run/riffle	100% glide	100% glide	100% glide	100% glide	100% glide	100% glide	100% glide	100% glide
Survey Method	Boat	Boat	Boat	Boat	Boat	Boat	Boat	Boat
Approximate Site Distance (km)	0.5	0.12	0.2	0.5	0.2	0.5	0.5	0.5
Canopy (range of percent open)	>85%-open	>85%-open	55%-<85%	30%-<55%	10%-<30%	>85%-open	55%-<85%	>85%-open
River Stage	Up	Up	Up	Up	Up	Up	Up	Up
Clarity (ft - Secchi disk)	6.6	3.5	2	1.5	2	1.25	0.9	1
Observed Aesthetics	Nuisance algae, Invasive Macrophytes, trash	Nuisance algae	Invasive Macrophytes, foam, trash, CSO	Invasive Macrophytes, trash	Trash, CSO	Invasive Macrophytes, trash, CSO	Invasive Macrophytes, trash, CSO	Invasive Macrophytes, foam, trash
Comments	industrial/urban	NO EV veg	water level was high	private property	public park with small boat launch	previous restoration activities	some evidence of public use	armored banks/no public access

Notes:

All Sites: 0.90 ft/mi gradient and 447mi^2 drainage area

Table 4.4-5B RBP Physical Habitat Score and Summary

Habitat Parameter	City Ship Canal		Kelly Island		Ohio Street		Katherine Street Peninsula		Smith Street		Buffalo Color Area D		Riverbend Upstream		Riverbend Downstream	
	Condition Category	Score	Condition Category	Score	Condition Category	Score	Condition Category	Score	Condition Category	Score	Condition Category	Score	Condition Category	Score	Condition Category	Score
Epifuanal/Substrate Available Cover	Optimal	16	Optimal	17	Marginal	9	Marginal	7	Optimal	18	Suboptimal	15	Marginal	8	Poor	5
Substrate Characterization*	Suboptimal	15	Suboptimal	15	Suboptimal	12	Suboptimal	14	Marginal	10	Suboptimal	12	Suboptimal	11	Marginal	8
Variability*	Suboptimal	12	Suboptimal	13	Suboptimal	11	Suboptimal	11	Marginal	9	Optimal	17	Suboptimal	11	Suboptimal	11
Sediment Deposition	Optimal	20	Optimal	18	Marginal	6	Poor	5	Marginal	9	Marginal	8	Suboptimal	13	Suboptimal	13
Channel Flow Status	Optimal	20	Optimal	20	Optimal	20	Optimal	20	Optimal	18	Optimal	20	Optimal	20	Optimal	20
Channel Alteration	Marginal	8	Poor	2	Poor	3	Marginal	10	Suboptimal	14	Marginal	7	Poor	2	Poor	1
Channel Sinuosity	Poor	0	Poor	0	Poor	0	Poor	2	Marginal	7	Poor	3	Poor	1	Poor	1
Bank Stability (LB/RB)	LB-Suboptimal, RB-Suboptimal	LB-7, RB-7	LB-Optimal	LB-9	LB-Optimal, RB-Optimal	LB-10, RB-10	LB-Suboptimal, RB-Suboptimal	LB-7, RB-8	LB-Optimal, RB-Optimal	LB-10, RB-10	RB-Optimal	10	LB-Marginal, RB-Suboptimal	LB-4, RB-8	LB-Optimal	9
Vegetative Protection (LB/RB)	LB-Poor, RB-Poor	LB-2, RB-4	LB-Poor	LB-0	LB-Marginal, RB-Marginal	LB-3, RB-5	LB-Marginal, RB-Marginal	LB-3, RB-5	LB-Suboptimal, RB-Suboptimal	LB-8, RB-8	RB-Marginal	4	LB-Marginal, RB-Poor	LB-4, RB-1	LB-Marginal	3
Riparian Vegetative Zone Width (LB/RB)	LB-Poor, RB-Poor	LB-2, RB-1	LB-Poor	LB-0	LB-Poor, RB-Marginal	LB-1, RB-5	LB-Marginal, RB-Optimal	LB-3, RB-9	LB-Marginal, RB-Marginal	LB-5, RB-5	RB-Poor	2	LB-Marginal, RB-Poor	LB-3, RB-0	LB-poor	2
TOTAL SCORE	**114**		**94**		**95**		**104**		**131**		**98**		**86**		**73**	
Substrate Type	Gravel and sand		Gravel and silt		Gravel and silt		Silt		Silt some gravel		Riprap and silt		cobble, gravel (man-made		gravel (man-made materials)	
Approximate Current Speed	0		0		0.5ft/sec		0		0		0		0		0	
Canopy Cover	10%		0		30%		50%		80%		10%		30%		10%	
Temperature (Deg C)	20.42		15.02		21.5		22.25		22.7		23.25		22.37		22.6	
Specific Conductivity (ms/cm)	0.365		0.354		0.455		0.556		0.516		0.45		0.422		0.42	
pH	7.79		7.54		7.04		7.41		7.4		7.61		7.05		7.45	
Dissolved Oxygen: Percent Saturation, Value	72.4%, 6.51mg/L		81.0%, 8.14mg/L		54%, 4.75mg/L		50.4%, 4.31mg/L		57.8%, 4.87mg/L		66.7%, 5.69mg/L		63.9%, 5.52mg/L		63.4%, 5.44mg/L	

For an explanation of the Condition Category Scoring see NYSDEC 2009 and Barbour 1999

* These parameters are intended to be applied to Pools, but given the lack of distinguishable pools at the project sites, they were applied to the entire sites.

Figures

Figures

Navigation Channel
River Mile
Area of Concern

Great Lakes Legacy Act Dredge or Resample Area
"Area 05" - Dredge Area Five
"R-01" - Resample Area One

Figure 1-1 Buffalo River Area of Concern and Remedial Alternative 5 Footprint

© Ecology & Environment, Inc. GIS Department Project 001900.CH27.DE.02 \Buffalo\BuffaloRiver\buffalo_river_baseline_monitoring\maps\mxd\FSP_QAPP\Proposed_Points_West.mxd 1/03/2012

River Mile
Dredge Management Unit
Resample Area
Navigation Channel
Stationing Line
Fish Sampling and Habitat Community Assessment Location
Sample Area
Proposed Discrete Sample Location, Outside DMU
Proposed Discrete Sample Location, Inside of DMU
Final Sample Location

Figure 1-2 Proposed and Final Sample Locations, Western Portion
Buffalo River AOC Baseline Monitoring
Buffalo, New York

Figure 1-3 Proposed and Final Sample Locations, Eastern Portion
Buffalo River AOC Baseline Monitoring
Buffalo, New York

02:EE-001900-0027-04-03TTO-B3505\Figure 3-1.AI-01/12/12-GRA

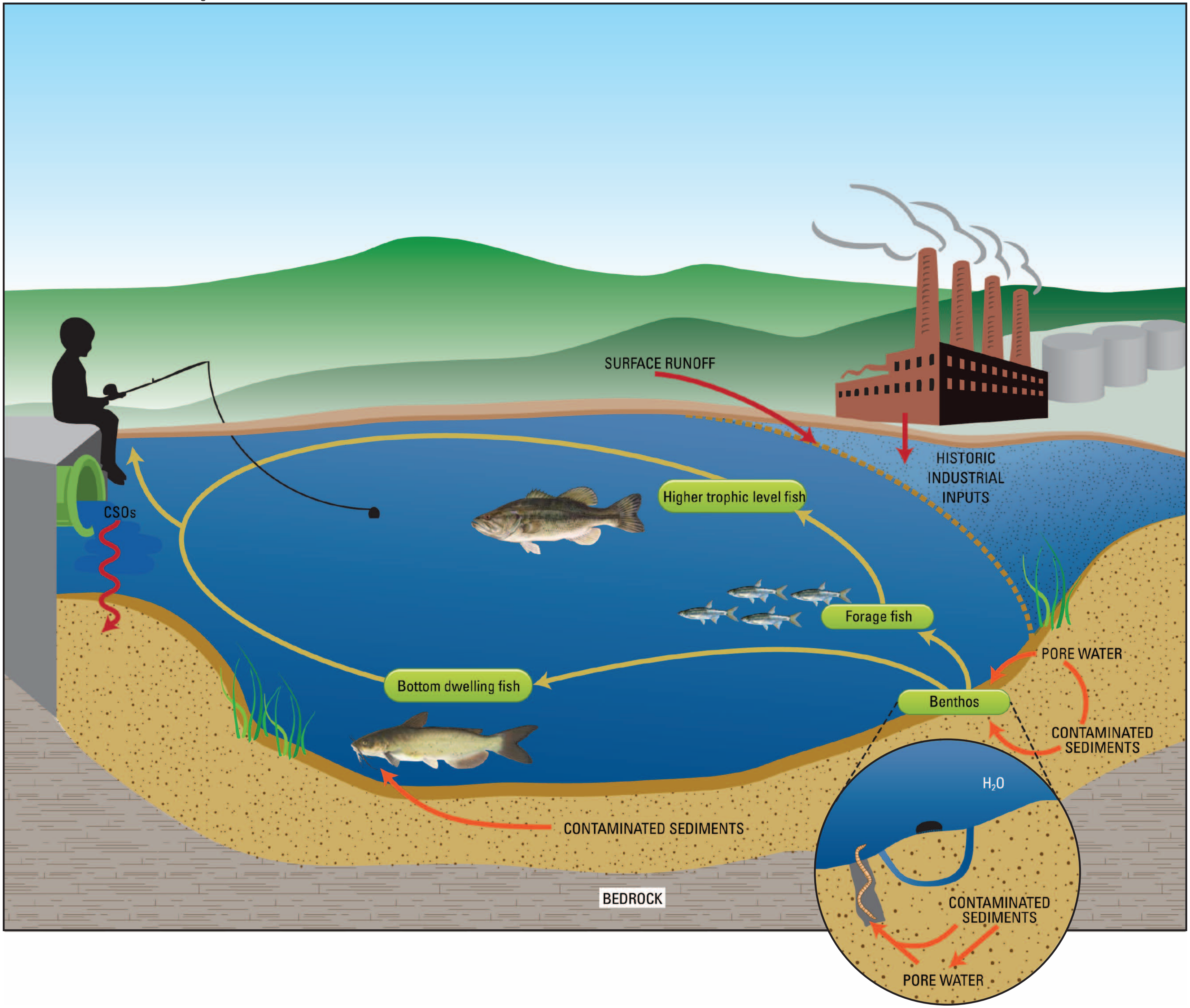

Figure 3-1 General Conceptual Site Model for Buffalo River Area of Concern

Appendix A

Sampling Summary Reports

See enclosed CD in back pocket.

A.1 Sediment Sampling Summary Report

See enclosed CD in back pocket.

A.2 Biological Sampling Summary Report

See enclosed CD in back pocket.

Appendix B
Data Tables

See enclosed CD in back pocket.

B.1 Sediment Data Tables

See enclosed CD in back pocket.

B.2 Biological Data Tables and Figures

See enclosed CD in back pocket.

Appendix C

Sediment Toxicity Test Report

See enclosed CD in back pocket.

Appendix D
Field Documentation

See enclosed CD in back pocket.

Appendix E

Photo Documentation

See enclosed CD in back pocket.

Appendix F

Data Validation Reports

See enclosed CD in back pocket.

Appendix G

Analytical Reports

See enclosed CD in back pocket.