7 PREFERRED SEDIMENT REMEDY ALTERNATIVE

Remedy Alternative 5, Enhanced Protectiveness Dredging, is the remedy that most efficiently and effectively achieves the sediment-related ecological and human health RAOs of the Buffalo River AOC. The PCT recommends design and implementation of the Enhanced Protectiveness Dredging alternative at the Buffalo River AOC site.

7.1 Rationale

Remedy Alternative 1 (No Action) and Alternative 2 (Monitored Natural Recovery) are implementable, low cost alternatives. However, neither of these alternatives satisfies the RAO goals in a reasonable timeframe. Additionally, neither of these alternatives provides any additional short- or long-term reduction in risk to humans or the environment beyond the current ongoing and natural depositional processes. Therefore, both of these alternatives were removed from further consideration.

Remedy Alternative 3 (1,750,000 CY of dredging), Alternative 4 (640,000 CY of dredging), and Alternative 5 (820,000 CY of dredging) all contribute to RAO goals by permanently decreasing the mass of chemicals in the river and by improving long-term surface sediment concentrations and reducing risks to human health and the environment. Dredging is a proven technology and can be implemented at the Buffalo River. However, dredge remedies are expensive to implement and are accompanied by potentially significant short-term risks and short-term impacts. Dredging operations can negatively impact short-term surface sediment concentrations through sediment suspension and dredge residuals, and cause short-term increases of contaminant concentrations in the water column and in fish tissue. Additionally, dredging and transport operations are accompanied by short-term risks to construction workers as well as an increased risk of water vessel accidents due to the additional harbor traffic from dredging and transport vessels. Greater volumes of dredging are associated with higher costs, greater short-term impacts, and an increase for potential accidents.

Remedy Alternative 5 is recommended for design and implementation because this alternative most effectively and efficiently achieves risk reduction goals in both the surface and subsurface sediments without the diminishing returns of a larger-scale dredge remedy. Remedy Alternative 5 specifically targets the removal of areas that exceed the site-specific sediment chemistry guidelines, including elevated chemical concentrations at depth of 0-4 ft, and areas that are associated with the presence of oil and grease. Further evaluations also confirm that Remedy Alternative 5 reduces risks to human health and the environment in areas frequently accessed by the public, in sediment areas that may scour during high flow events, and in areas where sediment has been historically disturbed by ship traffic. Remedy Alternative 5 also can be completed within a reasonable timeframe and at a reasonable cost.

The evaluation of Remedy Alternative 5 against the nine criteria established under NCP, which also serves as a comparison of Remedy Alternative 5 against the RAOs, can be found in Section 6.

7.2 Description of Proposed Remedy

Remedy Alternative 5 proposes a combined remedy that includes sediment removal and capping (see Figure 5-1c) over a three year period and at an estimated cost of approximately $40 million. A description of Remedy Alternative 5 can be found in Section 5. The accuracy of the cost estimate is within the range of -30 percent to +50 percent, consistent with USEPA Guidance on FS development (USEPA 1988). The assumptions used in the volume and cost estimates are listed in Table 6-4 and in Appendix E. The main components of Remedy Alternative 5 are:

Sediment Removal and Disposal

- Sediment areas and depths targeted for removal are defined by the remedial goal of 1 TU for total PAHs in surface sediments, SWAC RGs for PCBs, Hg, and Pb, and maximum residual sediment concentrations of total PAHs, total PCBs, Hg, and Pb at depths of 0-4 ft. The sediment chemistry guidelines applied to Remedy Alternative 5 are provided in Section 5 and in Appendix D1.

- Based on the sediment chemistry guidelines, the estimated in-place sediment volumes targeted for removal include 720,000 CY from the Buffalo River (this includes 530,000 CY from outside the federally-defined navigation channel boundary and 190,000 CY from within the navigation channel) and 100,000 CY from the City Ship Canal (this includes 80,000 CY from outside the navigation channel and 20,000 CY from within the navigation channel).

- Both mechanical and hydraulic dredging could be used to remediate Buffalo River sediments. The most appropriate dredging method will be evaluated during remedy design and by the construction contractor during construction bidding and implementation.

- Best management practices, such as operational controls and specialty equipment, will be used during dredging operations to reduce potential contaminant release.

- A CDF designed specifically for the management and disposal of sediments from the Buffalo River is located within 3 to 9 miles of the AOC. Thus, the CDF is the most appropriate site for the dewatering/stabilization and disposal of dredged sediments.

- A small volume of dredge material (<1,000 CY) is expected to require disposal at a TSCA- or RCRA-approved disposal facility. The PCT will work with the USEPA Region 2 Division of Enforcement and Compliance Assistance to identify the appropriate disposal requirements for this portion of the sediment volume targeted for removal.

Capping

- Approximately 1,800 feet of the City Ship Canal is beyond the downstream boundary of the navigation channel and represents a low energy environment that is not susceptible to sediment scour from overlying flow, ice events, or navigational dredging. A sediment cap is targeted for this area (approximately 292,800 square feet) to isolate underlying sediment contaminants, provide a clean sediment surface, and provide an appropriate substrate for habitat restoration in this part of the AOC.

Short- and Long-Term Monitoring

- Confirmation monitoring, including bathymetric surveys and surface sediment chemistry, will be conducted during remedy implementation to ensure the selected implementation methods meet the remedy design specifications. A Confirmation Monitoring Plan, which outlines the decision criteria

for determining what, if any, additional remedial measures are warranted, will be included as part of the remedial design.

- Remedy Alternative 5 primarily relies on natural sedimentation after dredging to meet long-term RAO goals. In some dredge areas, the placement of a layer of material upon the sediment surface may be necessary to accelerate natural recovery processes and further protect ecological receptors.

- Long-term monitoring of the Buffalo River will assess the continuation of natural processes that reduce risk and ecological exposures. Furthermore, long-term monitoring focuses on gaining a better understanding of chemical and biological trends in the river against RAOs and to evaluate changes in conditions that are used to identify and delist BUIs.

Habitat Restoration

- An evaluation of the area and quality of existing habitat that would be impacted by Remedy Alternative 5 was conducted. Section 8 presents the results of this evaluation, and the mitigation and restoration measures proposed for the habitat areas likely to be disturbed by Remedy Alternative 5.

7.3 Next Steps

- BNR and NYSDEC have been active members of the PCT, and we plan to seek further State and community input on the proposed remedial technologies that make up Remedy Alternative 5. The first step toward accomplishing this goal is to submit the *FS* for public review.

- Further characterization is needed in various isolated areas identified in Figure 5-1c. These include confirmation sampling in areas supported by one sample location with surface sediment concentrations greater than 1 TU, additional sampling in areas with insufficient sediment chemistry data to delineate sediment chemistry, and confirmation sampling in the one area with potential TSCA-level PCB concentrations.

- The PCT will work with the USACE to coordinate remediation in areas that fall within the federally authorized navigation channel and to manage the disposal of contaminated material in the Buffalo Harbor Dike 4 CDF.

- Per the Great Lakes Legacy Act of 2002, the PCT will utilize all existing data/information to evaluate the sufficiency of source control and the potential for significant further or renewed contamination from existing sources of pollutants, which may lead to sediment contamination following completion of the project.

- The USEPA GLNPO will commence remedial design activities in close consultation with the PCT after completion of the *FS* following the public review period, and after the existing GLLA Project Agreement with USEPA, BNR, and Honeywell is modified accordingly.

The Buffalo River PCT will move the conceptual habitat restoration projects identified in the *FS* forward to the remedial design phase. Additional areas may be identified by the PCT to provide additional restoration above and beyond mitigation. The PCT will also coordinate closely on the Buffalo River Restoration Master Plan that is currently being developed by the USEPA GLNPO.

8 MITIGATION AND RESTORATION

8.1 Potential Remedy Impacts

For the purposes of this *FS*, the scale of potential impacts that may need to be mitigated was determined based on Preferred Remedy Alternative 5 (Section 7). The Preferred Remedy will likely impact 12,989 linear feet or 3.04 acres of aquatic vegetation beds (Tables 8-1 and 8-2, Figure 6-1c). It is important to note that the extent of these impacts may be modified during the remedial design, and as a result, mitigation area estimates may be updated to reflect any modifications.

Mitigation of impacted vegetation beds may occur as part of larger restoration projects described in detail in the EEE Report (described in Sections 8.3 and 8.4 and presented in Appendix F). The mitigation projects will be finalized during the remedy design phase and are anticipated to be comprised of the aquatic vegetation restoration components of the larger restoration projects described below. A more comprehensive ecosystem approach that maximizes ecological services can be achieved by combining mitigation with the restoration of aquatic habitat, bank, and riparian zones. Because of the close integration of mitigation and restoration, this chapter and the EEE report refer to them jointly as "restoration" projects. It may be feasible to incorporate some restoration projects into the remediation work. This will have the benefits of being cost effective and building the restoration project sooner. Some projects may take several years after construction/implementation to achieve 100% of their intended benefit.

Potential restoration projects are located within 0.75 miles of the impacted area in order to help ensure that the restored system addresses the same functions that may have been impacted by the remedy. Subaquatic vegetation restoration has been considered in six locations (Figure 8-1), totaling approximately 21 acres. The selected projects will mitigate the remedy impacts while providing additional restoration above and beyond mitigation requirements. Implementing only the aquatic portion of the restoration project at certain locations may also allow targeted mitigation independent of the bank and riparian restoration. However, areas where mitigation and restoration can be combined will enhance ecological benefits. The project locations include:

- Kelly Island (Section 8.3.1)
- City Ship Canal (Section 8.3.2)
- Ohio Street Shoreline (Section 8.3.3)
- Katherine St. Peninsula (Section 8.3.4)
- Buffalo Color Peninsula shoreline (Section 8.3.5)
- Riverbend (Section 8.3.6)

Land owner acceptance of these potential projects and project locations has not been resolved, but will be critical to project implementability and success. It is anticipated that additional due diligence (including

any necessary negotiations with land owners) will be conducted during the design phase and prior to implementation.

8.2 Selected Habitat Types and Associated Benefits

Ecological services may still be limited before or following remediation due to: 1) water quality (e.g., low dissolved oxygen, high temperatures); 2) habitat fragmentation (due to hardened shorelines); 3) heavy industrial uses; and 4) hydraulic function (e.g., stream flow, stream volume). These habitat limitations, which are unrelated to the impacted sediment, will be taken into consideration during the evaluation process for potential restoration projects where feasible. Projects that address these limiting factors can maximize potential ecological benefits. In order to facilitate this process, different habitat types are considered in the context of potential ecological benefits. The selected habitat types are categorized and described as follows.

8.2.1 In-Stream Shallows

In-stream shallow areas offer numerous benefits to the aquatic ecological community. Shallow areas often limit water flow, thereby reducing turbidity and promoting sediment stability and the establishment of EV. These areas support community structure by providing a diverse habitat and prey base for aquatic organisms, such as invertebrates and fish, as well as many wildlife species, such as amphibians, reptiles, waterfowl, and mammals.

Shallowing portions of the Buffalo River AOC can provide opportunities for the creation or enhancement of in-stream shallows and/or fringe wetlands. Substrate improvements at appropriate elevations support and provide habitat for plant, fish, and wildlife communities. Enhanced SAV or EV provides feeding, nursery, and spawning grounds for fish. The addition of in-stream features can enhance roughness, which serves to inject oxygen into the surface water. The addition of in-stream structures (e.g., woody debris, boulders) also creates important habitat for aquatic organisms and increases the overall diversity and value of these shallow areas.

Existing in-stream shallow areas are limited within the Buffalo River AOC due to historical dredging and the extent of the authorized navigation channel. Since sediment erosion usually occurs on the outside bends of a meandering river shoreline, shallow areas are typically located on the inside bends of the riverbank where water velocity and scouring are minimized.

8.2.2 Bank Slopes

Stream bank erosion is influenced by several characteristics, including stream bank height and steepness, density and composition of vegetation within the riparian zone, soil structure, composition of the stream bank materials, and the relationship of the stream bank to the thalweg (i.e., stream banks erode more quickly on the outside of a curve than on the inside). While stream bank erosion is a natural process, anthropogenic activities can greatly alter this process, typically by accelerating erosion issues. In the Buffalo River AOC, channel modifications, creation of steep river banks, and a reduction in effective riparian zones have increased the potential for stream bank erosion.

Gently sloping stream banks increase the overall stability of a stream bank and retard or minimize bank erosion. Gently sloping banks may even increase productivity of in-stream shallow areas by reducing soil runoff and inundation and allowing access to the in-stream shallow areas by riparian organisms. Additionally, the utilization of in-stream structures can redirect the thalweg to minimize bank undercutting.

8.2.3 Riparian Areas

Riparian areas are defined as the terrestrial areas adjacent to and/or associated with a given water resource. Effective riparian areas provide a buffer between the aquatic and terrestrial portions of the watershed. An effective riparian zone is vegetated and consists of diverse habitat types, often including wetland areas. Riparian zones provide the following benefits to streams: 1) shade to moderate stream temperature; 2) improved water quality by retaining sediment; 3) improved sediment quality by filtering nutrients and/or chemicals; 4) stream bank stabilization; 5) erosion control; 6) a source of nutrients; 7) near-bank cover; and 8) near-shore habitat. Shading the river can reduce surface water temperature, thereby increasing the dissolved oxygen carrying capacity. Decreasing runoff potential (by increasing filtration capacity) can improve dissolved oxygen by reducing potential algal blooms due to eutrophication from nutrient inputs.

Since a majority of the Buffalo River AOC is characterized by industrial, commercial, and urban use, physical modification to the riparian zone has resulted in an overall reduction in the effectiveness of these areas. However, as part of the mitigation and/or restoration effort, improvements to portions of the Buffalo River AOC riparian zone may include the following: 1) creation of water runoff buffers in parking lots; 2) invasive species management; 3) revegetation of areas devoid of vegetation; and 4) selected plantings (e.g., trees) in areas with only herbaceous or non-native vegetation.

8.3 Selected Restoration Locations for EEE Report

The EEE Report was developed in consultation with the habitat restoration subgroup and is presented in Appendix F. The EEE Report includes a list of selected restoration techniques that may be suitable for use in the Buffalo River. These restoration techniques were combined into restoration project examples for general shoreline types, including: commercial parking lots, bulkheads, riprap, and natural/softened shoreline (e.g., parks and greenways). These generalized combinations of restoration techniques may be incorporated into the Buffalo River Master Plan (described in Section 8.5) and can be tailored to specific locations as future projects by various community groups to support the formal redevelopment of the Buffalo River Corridor initiative.

The restoration techniques were also combined in the EEE Report to provide a set of restoration alternatives and a preferred conceptual approach for multiple locations within the Buffalo River AOC. The habitat restoration subgroup, which includes representatives of USEPA, NYSDEC, BNR, USACE, and Honeywell and its consultants, selected six locations for evaluation of potential restoration projects[15].

[15] Land owner acceptance of these potential projects will be necessary prior to project implementation. It is anticipated that additional due diligence (including any necessary access negotiations with land owners) will be conducted during the design phase.

The selected locations are: 1) Kelly Island, 2) City Ship Canal, 3) Ohio Street Shoreline, 4) Katherine Street Peninsula, 5) Buffalo Color Peninsula Shoreline, and 6) Riverbend.

8.3.1 Kelly Island

Kelly Island is located at the confluence of the City Ship Canal and the Buffalo River. The adjacent land is owned by General Mills. The toe of Kelly Island is characterized by a sloping concrete shoreline with a submerged stone apron. Portions of the aquatic area include SAV beds. This potential mitigation project location may be suitable for the creation or enhancement of in-stream shallows with EV and SAV beds.

This potential project location may be suitable for the creation or enhancement of in-stream shallows.

8.3.2 City Ship Canal

The head of the City Ship Canal is owned by CSX railroad and others. This area has been identified as one of the Buffalo River Habitat Opportunity Areas and is described as follows:

> "Although this is an artificial channel, it has increasing potential value as a habitat link between Lake Erie coastal and Buffalo River habitats, especially for waterfowl and fish in need of nesting and resting places off of Lake Erie. Native shoreline and aquatic vegetation has naturalized the western edge of the canal south of the active (ADM) industrial area. Buffering, removal of debris and slag piles from the eastern bank and sediment remediation would increase the habitat value of the canal." (BNR 2008).

This area is also directly named as part of the delisting targets developed by the Buffalo River Remedial Advisory Committee (RAC). Specifically, the delisting target includes "A minimum 25% of the AOC shoreline is restored to natural slope, shallows and aquatic (emerged and submerged) native vegetation, ***including naturalizing areas of the City Ship Canal shoreline***" [emphasis added]. Therefore, focusing on restoration of the head of the City Ship Canal could make significant progress towards a portion of this RAC delisting target.

Restoration of the Head of the City Ship Canal would enhance both ecological and human use of the site.

- Current Ecological Use: Numerous fish species have been observed at the Head of the City Ship Canal, including largemouth bass, rock bass, crappie, bullhead, carp, redhorse, sunfish, and goldfish.

- Current Human Use: It has been reported that local anglers access both sides of the City Ship Canal (south of the sand piles) on foot, bicycle, illegal vehicle access, canoe/kayak and powerboat; adolescents have been observed jumping, wading, and swimming off of old piers and pilings; and bass fisherman and other anglers fish in the area when the winds and waves on Lake Erie are too high (Jedlicka, personal communication 2008).

This potential project location may be suitable for the creation or enhancement of in-stream shallows, bank slopes, and riparian zones.

8.3.3 Ohio Street Shoreline

The Ohio Street Shoreline (formerly referred to as Dead Man's Creek) is part of the Buffalo River Urban Canoe Trail. Surrounding land ownership has to be verified, but it is believed that the City of Buffalo owns a narrow strip of property on either side of the canal that can be used for access. This remnant "canal" once connected the Buffalo River to what is now "Father Conway Park". The parcel now still functions as a combined sewer overflow (CSO) outfall. Due to river hydrology, this canal collects debris, trees, and litter. Schematics developed in the 1990s for the site called for a floating boom across the canal.

There is potential for a pocket wetland if debris control structures are installed. Shoreline improvements can be made along NYSDEC's Ohio Street Park, next to the historical Great Lakes Paper Fiber warehouse and the Bison Rod and Gun Club. There are ongoing discussions regarding future conversion of the warehouse into a boating club/recreation center.

Restoration of the Ohio Street Canal would enhance both ecological and human use of the site.

- Current Ecological Use: Fish species observed at this location include large mouth bass, small mouth bass, rock bass, and sunfish.

- Current Human Use: Anglers access the narrow strip on the north side of the "canal", many youth swim in this section of river; and recreational boats use the straight-away section of river with riders on inner-tubes. In addition, there is abundant fishing in this stretch in areas with natural and unnatural cover/overhanging vegetation.

This potential project location may be suitable for the limited creation or enhancement of in-stream shallows and more pronounced restoration of bank slopes and riparian zones.

8.3.4 Katherine Street Peninsula

This 4.8-acre parcel is owned by the City of Buffalo. It has been identified as one of the Buffalo River Habitat Opportunity Areas and is described as follows:

> "One of 15 publicly-owned Buffalo River habitat parcels identified by the Erie County DEP for restoration and the only one of the top 5 not completed. "Approximately 290 m (950 linear feet) of shoreline borders the east and south sides of the parcel. A 100 - foot floodplain has been delineated. The area is recognized as valuable fish habitat ... Many species of birds were observed." See EC DEP restoration recommendations (Poole, 1994)." (BNR 2008)

Restoration of Katherine Street Peninsula would enhance both ecological and human use of the site. The parcel provides an opportunity to provide upland public access. Additionally, potential shoreline restoration presents a potential for ecological enhancements. The site is being invaded by Japanese knotweed, comparable to surrounding disturbed areas, but many sections of the shoreline are naturalized, mature and have not been taken over by invasives yet. The proximity of shoreline invasive species must be taken into consideration prior to any shoreline disturbance above the water line.

This potential project location may be suitable for the creation or enhancement of bank slopes and riparian zones.

8.3.5 Buffalo Color Peninsula Shoreline

The Buffalo Color Peninsula site is located on the northern bank of the Buffalo River, between RM 4.5 and 5.0. In 1997, a remedy was implemented that consisted of the following measures: 1) installation of a slurry wall surrounding the entire site to isolate groundwater; 2) removal of wastefill from outside of the slurry wall, including sediment from the river bank; and 3) stabilization of the excavated river bank using riprap, geotextile liner, or concrete extending out to near the navigation channel dredge limit. Since the site has been remediated, additional restoration has not occurred to further enhance potential ecological value. This potential project location may be suitable for the creation or enhancement of SAV, EV, in addition to the enhancement of riparian zones.

8.3.6 Riverbend

The current title holder of the Riverbend property is the Buffalo Economic Renaissance Corporation (BERC). It also has been identified as one of the Buffalo River Habitat Opportunity Areas and is described as follows:

> "A major brownfield on the river that has been cleared for redevelopment. Depending on the extent of soil contamination, this site provides almost a mile of shoreline where natural slope and 100-200 foot vegetated buffers could be restored." (BNR 2008)

This site was the centerpiece of the South Buffalo Brownfield Opportunity Area (BOA) recently completed by the City of Buffalo. The final BOA report has plans and schematics for the vision of the site.

The site has a combination of steel bulkhead and sheet pile, but also large segments of naturalized shoreline. A comprehensive restoration approach could be taken along the mile of shoreline. Half of the site lies within the 3.25-5.5 mile stretch of the Buffalo River that includes areas targeted by the Preferred Remedy. Additionally, this location is adjacent to portions of the river that are authorized for deep navigational traffic, as well as a portion of the river at and upstream of the dredge limit for the authorized navigation channel.

Any new development along this section of the river must abide by the 100 foot setback ordinance. The landowner has expressed a willingness to cooperate with shoreline restoration/greenway implementation at this site and has also expressed a willingness to negotiate the amount of setback (i.e.: 50 feet trade off in one location, or 150 feet in another depending on its value).

This potential project location may be suitable for the creation or enhancement of in-stream shallows, bank slopes, and riparian zones.

8.4 Evaluation of EEE Restoration Alternatives

At each of the potential restoration locations, multiple alternatives were developed based on the selected restoration technique. These alternatives were then evaluated using criteria developed by the PCT habitat restoration subgroup. These evaluation criteria were intended to provide a basis for design and to allow comparison of relative costs and benefits of project alternatives (presented in the Appendix F) and for future proposed restoration projects (to be presented in the Master Plan).

The evaluation criteria were separated into screening criteria and scoring criteria. The screening criteria are similar in concept to the threshold criteria of the CERCLA Evaluation Criteria (40 CFR 300.430(e)(9)(iii)) in that they are required to be met for any given project to be evaluated as a mitigation alternative. The scoring criteria were used to rank or prioritize between various restoration alternatives at each of the project locations (Section 8.3). Members of the PCT habitat restoration subgroup independently scored each restoration alternative. The highest scoring alternative at each project location was selected as the Preferred Restoration Alternative. These Preferred Restoration Alternatives, to be implemented by the GLLA PCT and non-GLLA partners, will be constructed in parallel with the Preferred Remedy, or immediately following the remedy implementation.

8.5 Coordination with the Master Plan

The GLLA PCT and non-GLLA partners are not restricted to only implementing restoration projects at the six locations identified in Section 8.3. The Buffalo River Restoration Master Plan is currently being developed by the USEPA GLNPO in partnership with BNR. This master plan is intended to create a single list of potential restoration projects for the Buffalo River. The master plan will include, but is not limited to, a list of 12 projects within the Buffalo River AOC, and up to 37 potential habitat restoration projects for the Buffalo River watershed that have been identified by BNR (Figure 8-2). The majority of these projects fall within the AOC or the riparian zone of the AOC and thus, subject to evaluation using the criteria described above, may be considered for implementation under GLLA.

9 REFERENCES

Baumann, P., and J. Harshbarger. 1995. Decline in liver neoplasms in wild brown bullhead catfish after coking plant closes and environmental PAHs plummet. Env. Hlth. Perspect. 103: 168-170.

Baumann, P. and J. Harshbarger. 1998. Long term trends in liver neoplasm epizoitics of brown bullhead in Black River, Ohio. Env. Monitor. Assess. 53: 213-223.

Baumann, P., I. Smith, and C. Metcalf. 1996. Linkages between chemical contaminants and tumors in benthic Great Lakes fish. J. Great Lakes Res. 22: 131-152.

Baumann, P., V. Cairns, B. Kurey, L. Lambert, I. Smith and R. Thoma. 2000. Fish Tumors and Other Deformities. Lake Erie LaMP Technical Report No. 6. Lake Erie Lakewide Management Plan (LaMO). pp. 56.

Black, J, and P. Baumann 1991. Carcinogens and cancers in freshwater fishes. Env. Hlth. Persps. 90: 27-33.

Blum, J. 1964. Buffalo River studies, 1964. unpublished MS. 45.p. In: Assessment of Potential Aquatic Habitat Restoration Sites in the Buffalo River Area of Concern., Irvine, K., R. Snyder, T. Diggons, B. Sinn, J. Jedlicka, and J. O'Neill (eds.). October 2005.

BNR. 2008. Buffalo River Remedial Action Plan, 2008 Status Report. Draft. Buffalo Niagara Riverkeeper

Brenner, R.C., V.S. Magar, J.A. Ickes, E.A. Foote, J.E. Abbott, L.S. Bingler, E.A. Crecelius. 2004. "Long-Term Recovery of PCB Contaminated Surface Sediments at the Sangamo-Weston/Twelvemile Creek/Lake Hartwell Superfund Site." *Environ. Sci. Technol.* 38(8):2328-2337.

BRRAPCC. 2005. A request for delisting of degradation of benthos beneficial use impairment in the East Branch of the Black River, a sub-watershed of the Black River Area of Concern. Submitted by the Black River Remedial Action Plan Coordinating Committee, 24 March 2005.

Canfield, T.J. et al. 1992. Benthic community structure evaluations. In: C.G. Ingersoll, D.R. Buckler, E.A. Crecelius, and T.W. LaPoint, eds. Biological Assessment of Contaminated Great Lakes Sediment. Draft Final Report. Prepared for Great Lakes National Program Office, USEPA. Report 60/***/***, Chicago.

Computer Sciences Corporation (CSC). 2007. Upper Buffalo River Area of Concern Buffalo, New York. Exploratory Data Analysis. Prepared for: U.S. Environmental Protection Agency Great Lakes National Program Office. Contract Number: EP-W-06-046. November.

Diggins, T. P., and R. J. Snyder. 2003. Three decades of change in the macroinvertebrate community and associated water quality parameters of the Buffalo River Area of Concern, 1964 – 1993. Journal of Great Lakes Research 29: 652-663.

Ecology and Environment. 2008. Beneficial Use Impairment Delisting Criteria Report in Region 2 Areas of Concern. Preliminary Draft. November.

ENVIRON, MACTEC, and LimnoTech. 2009. Sediment Remedial Investigation Report for the Buffalo River, NY. March.

Great Lakes National Program Office, GLNPO. 2008. Memo: Various Criteria for Buffalo River. February.

Greer, M., K. Irvine, and T. Tang. 2002. Evaluating ecosystem integrity in Great Lakes tributaries. Clearwat. 32: 16-19.

Irvine, K.N, R.J. Syder, T.P. Diggins, B. Sinn, C.F. Chuey, J. Jedlicka, and J.B. O'Neill. 2005. Assessment of Potential Aquatic habitat Restoration Sites in the Buffalo River Area of Concern. Report Prepared for New York State Department of Environmental Conservation.

Korsu, K. 2004. Response of benthic invertebrates to disturbance from stream restoration: the importance of bryophytes. Hydrobiol. 523: 37-45.

Krauss, M. and W. Wilcke. 2001. Predicting soil–water partitioning of polycyclic aromatic hydrocarbons and polychlorinated biphenyls by desorption with methanol–water mixtures at different temperatures. Environmental Science and Technology, 35: 2319-2325.

Lauren, D.J., D. Hinton, M. Law, M. Sorensen, J. Lyndall, V. Magar, and M. Nielsen. 2010. Long-term trends in liver neoplasms in brown bullhead in the Buffalo River, New York, USA. Environmental Toxicology, published online April 19.

Loganathan, B.G., K. Kannan, I. Watanabe, M. Kawano, K. Irvine, S. Kumar, and H.C. Sikka. 1995. Isomer-specific determination and toxic evaluation of polychlorinated biphenyls, polychlorinated/brominated dibenzo-p-dioxins and dibenzofurans, polybrominated biphenyl ethers, and extractable organic halogen in carp from the Buffalo River, New York. Environmental Science and Technology. 29: 1832-1838.

Mack, W. 2000. Response of benthic macroinvertebrate community following decommissioning of a waster water treatment plant. Proc. NABS Mtg. Keystone (abstract).

Magar, V.S. and R.J. Wenning. 2006. "The Role of Monitored Natural Recovery in Sediment Remediation." *Integr. Environ. Assess. Manag*. 2(1):66-74.

Magar, V.S., K. Merritt, M. Henning, M. Sorensen, R. Coffman, R. Wenning. 2008. Approaches used for Remedy Selection at Contaminated Sediment Sites: Analysis of Three Case Studies. In: I. Linkov and R. Wenning (eds). Multi-Criteria Decision Analysis.

Magar, VS, DB Chadwick, TS Bridges, PC Fuchsman, JM Conder, TJ Dekker, JA Steevens, KE Gustavson, MA Mills. 2009. Technical Guide: Monitored Natural Recovery at Contaminated Sediment Sites. Published by the Environmental Security Testing and Certification Program (ESTCP). ESTCP-ER-0622. Virginia. Available at http://www.epa.gov/superfund/health/conmedia/sediment/documents.htm.

Meredith, D.D., and R.R. Rumer. 1987. Sediment Dynamics in the Buffalo River. Report, Department of Civil Engineering, State University of New York at Buffalo. 171 pp.

Muotka, T., R. Paavola, A. Haapala, M. Novikmec, and P. Laasonen. 2002. long-term recovery of stream habitat structure and benthic invertebrate communities from in-stream restoration. Biol. Conserv. 105: 243-253.

National Research Council (NRC). 1997. *Contaminated Sediments in Ports and Waterways – Cleanup Strategies and Technologies*. National Academy Press, Washington, DC.

NRC. 2007. Sediment Dredging at Superfund Megasites: Assessing the Effectiveness. Washington, DC: National Academy Press.

New York State Department of Environmental Conservation (NYSDEC). 1989. Buffalo River Remedial Action Plan. March 1989.

NYSDEC. 1999. Technical Guidance for Screening Contaminated Sediments. Division of Fish, Wildlife and Marine Resources. January.

NYSDEC. 2002. Quality Assurance Work Plan for Biological Stream Monitoring In New York State. Bode RW, Novak MA, Abele LA, Heitzman DL, Smith AJ. Stream Biomonitoring Unit, Bureau of Water Assessment and Management Division of Water.

NYSDEC. 2004. 30 Year Trends in Water Quality and Rivers and Streams in NY. Division of Water. http://www.epa.gov/bioindicators/pdf/NYSDEC30yrTrendsReport.pdf

NYSDEC. 2006. Chemical residues in carp from Buffalo River and upper Niagra River, 2004 data (memo). Division of Fish, Wildlife and Marine Resources. Albany, NY.

NYSDEC. 2007. Numerical Guidance Values for Assessing Risk to Aquatic Life from Contaminants in Sediment. Division of Fish, Wildlife, & Marine Resources. June 19.

NYSDEC. 2006. Buffalo River Sediment Study, City of Buffalo, Erie County. March.

NYSDEC. 2008a. Lower Buffalo River, City Ship Canal, and Confluence Area Sediment and Surface Water Study. NYSDEC Project Number 9BufRiv. Buffalo, NY. February.

New York State Department of Health (NYSDOH). 2009. Chemicals in Sportfish and Game, 2009-2010 Health Advisories. New York State Department of Health, Troy, N 27 p.

Ohio EPA. 1987. Biological criteria for the protection of aquatic life: volumes I-III. Ohio Environmental Protection Agency, Columbus, Ohio.

Parsons. 2003. Evaluation of Near Shore Environmental Conditions Adjacent to Buffalo Color Area D. August.

Skinner, L.C., B. Trometer, A.J. Gudlewski, and J. Bourbon. 2009. Data Report for Residues of Organic Chemicals and Four Metals in Edible Tissues and Whole Fish for Fish Taken from the Buffalo River, New York. http://www.dec.ny.gov/docs/fish_marine_pdf/buffalorep09.pdf

SulTRAC. 2007a. Technical Memorandum: Risk Assessment and Remedial Alternatives for Upper Buffalo River Area of Concern, Buffalo, New York. Prepared by SulTRAC for U.S. Environmental Protection Agency Region 5, Chicago, Illinois.

SulTRAC. 2007b. Final Screening-Level Ecological Risk Assessment and Food-Chain Model Assessment of Potential Risks to Site Receptors: Upper Buffalo River Area of Concern, Buffalo, New York. Prepared by SulTRAC for U.S. Environmental Protection Agency Region 5, Chicago, Illinois.

United States Army Corps of Engineers (USACE). 1988. Buffalo River Sedimentation Study. Buffalo and West Seneca, NY.

USACE. 2008a. Technical Guidelines for Environmental Dredging of Contaminated Sediments. ERDC/EL TR-08-29. By M.R. Palermo, P.R. Schroeder, T.J. Estes, and N.R. Francingues.

USACE. 2008b. The Four Rs of Environmental Dredging: Resuspension, Release, Residual, and Risk. ERDC\E TR-08-4. February.

USACE. 2008c. Appendix of the Section 312 Environmental Dredging Feasibility Study. US Army Engineering District, Buffalo, New York. 61 pp.

USACE. 2009a. Use of 2005 Toxicity Test on Upper Buffalo River for PRG Development for Protection of Benthic Macroinvertebrates. Power Point presentation to the Ecology Subgroup, January 16, 2009, Buffalo, NY.

USACE. 2009b. Development of a Preliminary Remedial Goal for total Polychlorinated Biphenyls (PCBs): Theoretical Bioaccumulation Potential. February 25. Pickard/SWP/4404.

U.S. Department of Energy. 1997. *Uncertainty Management: Expediting Cleanup Through Contingency Planning*. DOE/EH/(CERCLA)-002. February.

U.S. Environmental Protection Agency (USEPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*. EPA 540/G-89/004, OSWER 9355.3-01. Available at http://www.epa.gov/superfund/resources/remedy/pdf/540g-89004-s.pdf.

USEPA. 1991. Role of the baseline risk assessment in Superfund remedy selection decisions. Memorandum from Don R. Clay to Regional Directors. OSWER Directive 9355.0-30. April 22.

USEPA. 1994. Assessment and Remediation of Contaminated Sediments Program. Model data requirements and mass loading estimates for the Buffalo River mass balance study. USEPA, Chicago, Illinois. Document number: EPA 905-R94-005.

USEPA. 1998. *Assessment and Remediation of Contaminated Sediments (ARCS) Program Guidance for In-Situ Subaqueous Capping of Contaminated Sediments.* Prepared for USEPA, Great Lakes National Program Office. Chicago, IL. EPA/905/B-96/004. Available at: http://www.epa.gov/glnpo/sediment/iscmain.

USEPA. 2000a. Health of bullhead in an urban fishery after remedial dredging. Final Report- January 31, 2000. USEPA Great Lakes Monitoring. http://www.epa.gov/greatlakes/sediment/Bullhead/report.html

USEPA. 2000b. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. EPA 540-R-00-002 OSWER 9355.0-75. July. Available at: http://www.epa.gov/superfund/.

USEPA. 2003. Procedures for the derivation of equilibrium partitioning sediment benchmarks (ESBs) for the protection of benthic organism: PAH mixtures. EPA-600-R-02-013. Office of Research and Development. Washington, DC 20460.

USEPA. 2004. *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States*. National Sediment Quality Survey: Second Edition. Office of Science and Technology, Standards and Health Protection Division. Washington, DC. EPA-823-R-04-007.

USEPA. 2005a. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Office of Solid Waste and Emergency Response. EPA-540-R-05-012. December.

USEPA. 2005b. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metals Mixtures. EPA-600-R-02-001. Office of Research and Development.

U.S. Navy. 2003. *Implementation Guide For Assessing And Managing Contaminated Sediment At Navy Facilities*. http://enviro.nfesc.navy.mil/erb/erb_a/restoration/fcs_area/con_sed/ug-2053/ug-2053-sed.pdf

Washington Department of Ecology (WDE). 2005. *An Overview of the Contaminated Sediment Listing Process*. http://www.ecy.wa.gov/programs/wq/303d/2002/2004_documents/sed_9804-compare.pdf Washington State Department of Ecology. 1991. *Sediment Management Standards: Chapter 173-204 WAC*.

Wenning, R.J., M.T. Sorensen, and V.S. Magar. 2005. Importance of Implementation and Residual Risk Analyses in Sediment Remediation. *Integrated Environmental Assessment and Management 2*(1) 1-7.

Wenning, R.J., M.T. Sorensen, and V.S. Magar, 2007. Evaluating environmental risks from contaminated sediments at industrial ports and harbors. In Environmental Security in Harbors and Coastal Areas: Management using Comparative Risk Assessment and Multi-Criteria Decision Analysis. I. Linkov, G. Kiker, R.J. Wenning, (Eds). Springer-Verlag Press, Amsterdam, Netherlands. 520 pp.

Wooster, M., and L. Matthies. 2008. Buffalo and Niagara Rivers Habitat Assessment and Conservation Framework. Prepared for Buffalo Niagara Riverkeeper. Buffalo, NY. 118 pp.

Yang, X. 2004. Use of fish biomarkers to assess the contaminant exposure and effects in Lake Erie tributaries. Ph.D thesis, Ohio State University, pp. 150.

Yount, J.D. and Niemi, G.J. 1990. Recovery of Lotic Communities and Ecosystems from Disturbance – A Narrative Review of Case Studies. Environmental Management 14(5): 547-569.

Tables

Table 2-1
Buffalo River AOC Beneficial Use Impairment Indicators
Buffalo, NY

Impairment Indicator	1989 Status	2005 Status	2008 Status	Delisting Criteria/Restoration Target(s)
1. Restrictions on Fish & Wildlife Consumption	Impaired	Impaired	Impaired	1) There are no AOC-specific fish and wildlife consumption advisories by New York State (e.g. carp for PCBs); AND 2) When contaminant levels due to watershed or in-place contaminants in resident native and exotic fish and wildlife populations that could be consumed do not exceed current NYS standards.
2. Tainting of Fish & Wildlife Flavor	Likely Impaired	Likely Impaired	Impaired	1) No exceedances of water quality standards or criteria for compounds (specifically phenols) associated with tainting within the AOC; AND 2) No reports of tainting from fish and wildlife officials or informed public observers
3. Degradation of Fish & Wildlife Populations	Likely Impaired	Likely Impaired	Impaired	**Fish Populations** 1) Fish surveys find that the resident fish community is fair to good based on applicable fish community biolgical indices (IBI) for two consecutive surveys; AND 2) The frequency of occurrence of DELT anomalies in bottom-dwelling fish does not exceed recommended levels; AND 3) Whole-body concentrations of Endocrine Disruptors (including but not limited to: PCBs, dioxins, and pesticides) in bottom dwelling fish do not exceed critical tissue concentrations for adverse effects on fish; AND 4) Water quality measures meet state standards for at least a Class C river. **Wildlife Populations** 1) Wildlife surveys find that diversity and abundance of birds, mammals, reptiles, and amphibians in the AOC is comparable to a suitable reference site; AND 2) No change from September 2008 criteria; AND 3) Wildlife assessments confirm no significant toxicity from water column or sediment contaminants; AND 4) Diversity of amphibian populations in AOC pocket wetlands is similar to upstream and/or Tifft marsh levels; AND 5) Diversity of benthic populations in the AOC is comparable to upstream levels.
4. Fish Tumors and Other Deformities	Impaired	Impaired	Impaired	1) Survey data confirm the absence of neoplastic liver tumors in bullheads (as compared to control site) for two consecutive sampling events; AND 2) Contaminants in water and sediments in the AOC do not exceed NYS standards
5. Bird or Animal Deformities or Reproductive Problems	Likely Impaired	Likely Impaired	Impaired	1) Deformities or reproductive problem rates are not statistically different than inland background levels as reported from wildlife officials or trained observers; AND 2) Concentrations of bioaccumulative chemicals in fish do not exceed levels associated with reproductive problems in piscivorus wildlife; AND/OR 3) Concentrations in sediment do not exceed levels associated with benthic impairment that could result in reproductive problems in omnivorous and benthivorous birds and wildlife.
6. Degradation of Benthos	Impaired	Impaired	Impaired	1) Benthic macroinvertebrate communities are "non-impacted" or "slightly impacted" according to NYSDEC indices for two separate sampling events; OR 2) In the absence of conclusive community structure data, the toxicity of sediment-associated contaminants is not statically higher than controls.
7. Restrictions on Dredging	Impaired	Impaired	Impaired	1) There are no restrictions on routine commercial or recreational navigation dredging by the USACE or another entity across any part of the AOC, such that no special management measure or use of a confined disposal facility are required from the dredged material due to chemical contamination.
8. Eutrophication or Undesirable Algae	Not Impaired	Unknown	Not Impaired	None
9. Restrictions on Drinking Water Consumption or Taste and Odor Problems	Not Impaired	Not Applicable	Not Applicable	Not applicable
10. Beach Closings	Not Impaired	Not Applicable	Not Applicable	Not applicable

Table 2-1
Buffalo River AOC Beneficial Use Impairment Indicators
Buffalo, NY

Impairment Indicator	1989 Status	2005 Status	2008 Status	Delisting Criteria/Restoration Target(s)
11. Degradation of Aesthetics	Not Impaired	Impaired	Impaired	1) Minimize debris, general litter, floatables, or contaminants in the river or shoreline via point source or non-point sources through the implementation of Best Management Practices; AND 2) Organic, chemical, and biological contaminants should not persist in concentrations that can be detected as visible film, sheen, or discoloration on the surface, detected by odor, or form deposits on shorelines and bottom sediments.
12. Added Costs to Agriculture and Industry	Not Impaired	Not Impaired	Not Applicable	Not applicable
13. Degradation of Phytoplankton and Zooplankton Populations	Not Impaired	Not Impaired for Zooplankton; Unknown for Phytoplankton	Not Impaired	None
14. Loss of Fish & Wildlife Habitat	Impaired	Impaired	Impaired	**Restore Habitat Connectivity** 1) A minimum 100-foot buffer of native vegetation on new development on each riverbank is maintained and enforced upstream from the Ohio Street Bridge. 2) Significant floodplain, wetland, or riparian habitat areas in the AOC are protected and/or restored, 3) A minimum 25% of the AOC shoreline is restored to natural slope, shallows, and aquatic (emergent and submerged) native vegetation, including naturalizing areas of the City Ship Canal shoreline. **Improve Stream Quality Index scores from "poor" to at least "good"** 1) Basic water quality measures (based on NYS RIBS) consistently meet state standards for at least a Class C river. 2) Aquatic habitat scores are fair to good AND/OR the lower Buffalo River is no longer listed as "stressed" for aquatic life on the NYS Priority Waterbodies List. **Restore hydrologic function to support habitat and species goals listed in BUI #3** 1) Reduce navigational dredging in the AOC to support aquatic habitat and species goals (BUI #3) AND/OR 2) Restore and protect natural flows, meanders, and stream habitat in River Corridor opportunity areas upstream of the AOC.

Source: BNR 2008, Ecology and Environment 2008

AOC - Area of Concern
BUI - Beneficial use impairments
PCB - Polychlorinated biphenyl

Table 2-2a
Total PAH Surface Sediment Concentrations, Summary Statistics
Buffalo River, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	6	6	3.9	5.9	4.6	0.75	4.6
River Mile 0.5 - 1.0	33	33	2.0	48	8.4	10	6.1
River Mile 1.0 - 1.5	24	20	0.66	23	6.5	4.3	5.4
River Mile 1.5 - 2.0	24	23	0.66	15	5.7	3.0	5.0
River Mile 2.0 - 2.5	22	22	3.3	18	5.3	3.1	4.8
River Mile 2.5 - 3.0	26	26	3.2	39	6.9	7.1	5.6
River Mile 3.0 - 3.5	26	26	2.5	47	9.9	9.6	7.5
River Mile 3.5 - 4.0	41	41	3.5	91	16	22	8.7
River Mile 4.0 - 4.5	30	29	2.5	150	27	40	12
River Mile 4.5 - 5.0	35	35	2.5	85	13	21	6.9
River Mile 5.0 - 5.5	34	34	1.1	280	13	48	5.0
River Mile 5.5 - 6.0	23	23	1.2	10	5.5	2.3	5.0
River Mile 6.0 - 6.2	13	13	1.5	16	4.0	4.0	3.1
River Mile 6.2- 6.5, Upstream of the AOC	1	1	18	18	18	-	18
River Mile 6.5 - 7.0, Upstream of the AOC	1	1	3.8	3.8	3.8	-	3.8
Buffalo Harbor, Downstream of the AOC	9	9	1.8	42	7.1	13	3.6
City Ship Canal	59	56	1.7	300	21	41	11
Cazenovia Creek	2	2	2.1	3.4	2.8	0.94	2.7

mg/kg - milligrams per kilogram

Table 2-2b
Total PAH Subsurface Sediment Concentrations, Summary Statistics
Buffalo, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	12	12	3.1	41	15	16	9.3
River Mile 0.5 - 1.0	32	32	3.8	82	15	18	9.8
River Mile 1.0 - 1.5	38	36	0.62	110	23	27	12
River Mile 1.5 - 2.0	16	16	0.64	160	51	49	24
River Mile 2.0 - 2.5	21	21	3.1	58	12	16	7.0
River Mile 2.5 - 3.0	36	36	3.5	330	26	57	11
River Mile 3.0 - 3.5	25	25	2.2	42	11	9.9	8.0
River Mile 3.5 - 4.0	90	89	2.1	450	47	80	14
River Mile 4.0 - 4.5	62	60	2.4	410	56	90	18
River Mile 4.5 - 5.0	66	66	2.0	1800	120	330	14
River Mile 5.0 - 5.5	55	55	2.1	160	16	29	7.2
River Mile 5.5 - 6.0	29	29	2.1	13	5.5	2.8	5.0
River Mile 6.0 - 6.2	2	1	5.0	5.4	5.2	0.34	5.2
River Mile 6.2- 6.5, Upstream of the AOC	0	-	-	-	-	-	-
River Mile 6.5- 7.0, Upstream of the AOC	0	-	-	-	-	-	-
Buffalo Harbor, Downstream of the AOC	3	3	3.5	4.3	3.8	0.41	3.8
City Ship Canal	55	51	2.1	250	25	37	14
Cazenovia Creek	0	-	-	-	-	-	-

mg/kg - milligrams per kilogram

Table 2-3a
Total PCB Surface Sediment Concentrations, Summary Statistics
Buffalo, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	6	2	0.048	0.067	0.052	0.0074	0.052
River Mile 0.5 - 1.0	33	20	0.035	1.3	0.16	0.28	0.086
River Mile 1.0 - 1.5	24	9	0.030	0.70	0.10	0.14	0.065
River Mile 1.5 - 2.0	24	15	0.027	0.55	0.11	0.12	0.076
River Mile 2.0 - 2.5	22	10	0.044	0.54	0.094	0.11	0.071
River Mile 2.5 - 3.0	26	25	0.044	1.5	0.32	0.37	0.20
River Mile 3.0 - 3.5	26	15	0.038	0.60	0.16	0.16	0.10
River Mile 3.5 - 4.0	41	23	0.032	4.7	0.27	0.73	0.11
River Mile 4.0 - 4.5	30	18	0.012	10	0.62	1.9	0.13
River Mile 4.5 - 5.0	35	12	0.033	2.3	0.16	0.41	0.067
River Mile 5.0 - 5.5	34	12	0.032	1.1	0.12	0.20	0.075
River Mile 5.5 - 6.0	23	4	0.029	0.18	0.058	0.033	0.053
River Mile 6.0 - 6.2	13	2	0.027	0.36	0.063	0.090	0.042
River Mile 6.2- 6.5, Upstream of the AOC	1	0	0.069	0.069	0.069	0.00	0.069
River Mile 6.5 - 7.0, Upstream of the AOC	1	0	0.045	0.045	0.045	0.00	0.045
Buffalo Harbor, Downstream of the AOC	9	3	0.032	0.13	0.055	0.029	0.050
City Ship Canal	59	46	0.030	1.4	0.20	0.22	0.13
Cazenovia Creek	2	0	0.036	0.039	0.038	0.0021	0.037

mg/kg - milligrams per kilogram

Table 2-3b
Total PCB Subsurface Sediment Concentrations, Summary Statistics
Buffalo, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	12	11	0.038	1.0	0.33	0.36	0.18
River Mile 0.5 - 1.0	32	32	0.046	4.1	0.60	0.95	0.29
River Mile 1.0 - 1.5	38	32	0.029	3.1	0.47	0.82	0.17
River Mile 1.5 - 2.0	16	13	0.029	2.6	0.55	0.63	0.28
River Mile 2.0 - 2.5	21	16	0.039	1.4	0.22	0.32	0.12
River Mile 2.5 - 3.0	36	35	0.0033	2.9	0.41	0.56	0.22
River Mile 3.0 - 3.5	25	16	0.00087	1.6	0.22	0.35	0.080
River Mile 3.5 - 4.0	90	54	0.010	5.1	0.42	0.90	0.12
River Mile 4.0 - 4.5	62	40	0.032	10	1.0	2.1	0.20
River Mile 4.5 - 5.0	66	38	0.030	7.4	0.39	1.2	0.10
River Mile 5.0 - 5.5	55	33	0.035	160	4.5	22	0.19
River Mile 5.5 - 6.0	29	9	0.030	0.74	0.10	0.15	0.061
River Mile 6.0 - 6.2	2	1	0.047	0.86	0.45	0.58	0.20
River Mile 6.2- 6.5, Upstream of the AOC	0	-	-	-	-	-	-
River Mile 6.5- 7.0, Upstream of the AOC	0	-	-	-	-	-	-
Buffalo Harbor, Downstream of the AOC	3	3	0.083	0.22	0.13	0.073	0.12
City Ship Canal	55	40	0.029	4.9	0.54	0.96	0.20
Cazenovia Creek	0	-	-	-	-	-	-

mg/kg - milligrams per kilogram

Table 2-4a
Lead Surface Sediment Concentrations, Summary Statistics
Buffalo, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	6	6	26	38	33	5.0	33
River Mile 0.5 - 1.0	33	33	27	320	65	69	49
River Mile 1.0 - 1.5	24	24	10	490	69	99	43
River Mile 1.5 - 2.0	24	24	3.1	74	41	18	35
River Mile 2.0 - 2.5	22	22	26	250	45	47	38
River Mile 2.5 - 3.0	26	26	32	200	62	36	56
River Mile 3.0 - 3.5	26	26	25	250	70	57	56
River Mile 3.5 - 4.0	41	41	27	1100	120	180	69
River Mile 4.0 - 4.5	30	30	8.1	690	110	140	73
River Mile 4.5 - 5.0	35	35	19	2600	160	440	59
River Mile 5.0 - 5.5	34	34	14	430	51	71	38
River Mile 5.5 - 6.0	23	23	12	120	32	20	29
River Mile 6.0 - 6.2	13	13	6.2	98	26	26	19
River Mile 6.2- 6.5, Upstream of the AOC	1	1	24	24	24	0.00	24
River Mile 6.5 - 7.0, Upstream of the AOC	1	1	19	19	19	0.00	19
Buffalo Harbor, Downstream of the AOC	9	9	9.2	66	31	22	25
City Ship Canal	59	59	1.9	2700	130	350	68
Cazenovia Creek	2	2	12	18	15	4.2	15

mg/kg - milligrams per kilogram

Table 2-4b
Lead Subsurface Sediment Concentrations, Summary Statistics
Buffalo, NY

Location	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	12	12	34	260	85	71	65
River Mile 0.5 - 1.0	32	32	34	600	130	150	88
River Mile 1.0 - 1.5	38	38	9.1	730	160	170	94
River Mile 1.5 - 2.0	16	16	12	640	220	200	140
River Mile 2.0 - 2.5	21	21	31	530	110	130	71
River Mile 2.5 - 3.0	36	36	31	450	110	95	87
River Mile 3.0 - 3.5	25	25	11	230	76	51	61
River Mile 3.5 - 4.0	90	90	14	740	140	150	88
River Mile 4.0 - 4.5	62	62	14	1300	240	310	120
River Mile 4.5 - 5.0	66	66	24	8500	390	1100	110
River Mile 5.0 - 5.5	55	55	22	740	100	130	62
River Mile 5.5 - 6.0	29	29	14	120	39	22	35
River Mile 6.0 - 6.2	2	2	20	39	29	14	28
River Mile 6.2- 6.5, Upstream of the AOC	0	-	-	-	-	-	-
River Mile 6.5- 7.0, Upstream of the AOC	0	-	-	-	-	-	-
Buffalo Harbor, Downstream of the AOC	3	3	45	74	58	15	56
City Ship Canal	55	55	7.5	580	160	140	97
Cazenovia Creek	0	-	-	-	-	-	-

mg/kg - milligrams per kilogram

Table 2-5a
Mercury Surface Sediment Concentrations, Summary Statistics
Buffalo, NY

Mile Marker	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	6	6	0.053	0.17	0.11	0.047	0.10
River Mile 0.5 - 1.0	33	33	0.047	6.1	0.53	1.20	0.18
River Mile 1.0 - 1.5	24	20	0.0055	0.80	0.14	0.17	0.074
River Mile 1.5 - 2.0	24	22	0.0047	0.58	0.15	0.14	0.10
River Mile 2.0 - 2.5	22	22	0.031	0.37	0.10	0.075	0.087
River Mile 2.5 - 3.0	26	25	0.014	2.1	0.25	0.42	0.15
River Mile 3.0 - 3.5	26	24	0.013	1.8	0.25	0.36	0.14
River Mile 3.5 - 4.0	41	37	0.0085	9.5	0.85	1.70	0.22
River Mile 4.0 - 4.5	30	28	0.0090	7.1	0.81	1.60	0.21
River Mile 4.5 - 5.0	34	33	0.011	3.5	0.38	0.70	0.13
River Mile 5.0 - 5.5	34	33	0.0060	4.8	0.27	0.81	0.10
River Mile 5.5 - 6.0	23	18	0.0090	0.36	0.066	0.071	0.045
River Mile 6.0 - 6.2	13	4	0.0049	0.14	0.023	0.038	0.012
River Mile 6.2- 6.5, Upstream of the AOC	1	1	0.10	0.10	0.10	0.00	0.10
River Mile 6.5 - 7.0, Upstream of the AOC	1	1	0.019	0.019	0.019	0.00	0.019
Buffalo Harbor, Downstream of the AOC	9	9	0.026	0.44	0.11	0.13	0.078
City Ship Canal	59	55	0.0050	8.5	0.78	1.20	0.37
Cazenovia Creek	2	2	0.012	0.041	0.027	0.021	0.022

mg/kg - milligrams per kilogram

Table 2-5b
Mercury Subsurface Sediment Concentrations, Summary Statistics
Buffalo, NY

Mile Marker	Number of Samples	Number of Detects	Minimum Result (mg/kg)	Maximum Result (mg/kg)	Average Result (mg/kg)	Standard Deviation	Geometric Mean Result (mg/kg)
Buffalo River							
Downstream AOC Boundary - River Mile 0.5	12	12	0.066	4.0	1.1	1.4	0.41
River Mile 0.5 - 1.0	32	32	0.097	9.7	1.4	2.2	0.49
River Mile 1.0 - 1.5	38	37	0.0040	14	2.3	3.5	0.42
River Mile 1.5 - 2.0	16	15	0.0038	9.0	3.0	3.3	0.92
River Mile 2.0 - 2.5	21	21	0.066	5.8	0.89	1.7	0.27
River Mile 2.5 - 3.0	36	36	0.061	6.3	0.75	1.3	0.29
River Mile 3.0 - 3.5	25	25	0.036	2.7	0.53	0.77	0.23
River Mile 3.5 - 4.0	90	84	0.0043	15	1.9	3.2	0.43
River Mile 4.0 - 4.5	62	58	0.0081	9.2	1.8	2.6	0.43
River Mile 4.5 - 5.0	64	64	0.031	32	3.0	6.2	0.43
River Mile 5.0 - 5.5	55	55	0.044	44	1.9	6.4	0.25
River Mile 5.5 - 6.0	29	29	0.021	0.34	0.094	0.070	0.077
River Mile 6.0 - 6.2	2	1	0.014	0.14	0.077	0.089	0.043
River Mile 6.2- 6.5, Upstream of the AOC	0	-	-	-	-	-	-
River Mile 6.5- 7.0, Upstream of the AOC	0	-	-	-	-	-	-
Buffalo Harbor, Downstream of the AOC	3	3	0.10	0.37	0.21	0.14	0.18
City Ship Canal	55	50	0.0033	21	3.2	4.4	0.80
Cazenovia Creek	0	-	-	-	-	-	-

mg/kg - milligrams per kilogram

Table 2-6
Summary of Sediment Pore Water PAH Concentrations and Log Koc Values
Buffalo, NY

Chemical	Number of Detected Samples	Detection Limit	Pore Water Min Detected Sample	Pore Water Max Detected Sample	Pore Water Mean Detected Sample	Log Koc Minimum	Log Koc Maximum	Log Koc Mean
		ng/g	ng/g	ng/g	ng/g			
naphthalene	5	0.1	0.110	0.302	0.164	4.37	5.26	4.72
2-methylnaphthalene	1	0.05	0.078	0.078	0.078	4.86	4.86	4.86
1-methylnaphthalene	3	0.05	0.050	0.194	0.117	4.55	4.72	4.61
C2 naphthalenes	13	0.15	0.161	1.584	0.324	4.71	5.33	5.02
C3 naphthalenes	9	0.05	0.108	5.407	0.770	4.51	5.37	5.08
C4 naphthalenes	1	0.15	5.044	5.044	5.044	4.79	4.79	4.79
acenaphthylene	0	0.2	–	–	–	–	–	–
acenaphthene	3	0.1	0.037	0.430	0.194	4.45	5.11	4.74
fluorene	4	0.04	0.032	0.264	0.096	4.67	5.46	5.16
C1 fluorenes	10	0.02	0.038	0.646	0.137	5.21	5.59	5.42
C2 fluorenes	1	0.05	0.638	0.638	0.638	5.57	5.57	5.57
C3 fluorenes	0	0.06	–	–	–	–	–	–
phenanthrene	2	0.1	0.047	0.224	0.136	5.31	5.96	5.63
anthracene	2	0.05	0.014	0.184	0.099	5.54	6.34	5.94
C1 phenanthrenes/anthracenes	2	0.02	0.094	0.493	0.294	5.42	5.80	5.61
C2 phenanthrenes/anthracenes	1	0.05	0.938	0.938	0.938	5.92	5.92	5.92
C3 phenanthrenes/anthracenes	1	0.04	0.808	0.808	0.808	5.99	5.99	5.99
C4 phenanthrenes/anthracenes	0	0.02	–	–	–	–	–	–
fluoranthene	19	0.01	0.011	0.149	0.030	5.81	6.67	6.37
pyrene	18	0.01	0.010	0.151	0.028	5.77	6.62	6.33
C1 fluoranthenes/pyrenes	1	0.01	0.139	0.139	0.139	6.00	6.00	6.00
benz[a]anthracene	7	0.001	0.001	0.012	0.004	6.62	7.35	7.07
chrysene	7	0.001	0.002	0.016	0.005	6.57	7.74	7.16
C1 chrysenes	0	0.005	–	–	–	–	–	–
C2 chrysenes	0	0.01	–	–	–	–	–	–
C3 chrysenes	0	0.01	–	–	–	–	–	–
C4 chrysenes	0	0.01	–	–	–	–	–	–
benzo[b+k]fluoranthene	0	0.005	–	–	–	–	–	–
benzo[e]pyrene	0	0.005	–	–	–	–	–	–
benzo[a]pyrene	0	0.008	–	–	–	–	–	–
perylene	0	0.004	–	–	–	–	–	–
indeno[1,2,3-cd]pyrene	0	0.001	–	–	–	–	–	–
dibenz[ah]anthracene	0	0.002	–	–	–	–	–	–
benzo[ghi]perylene	0	0.001	–	–	–	–	–	–

ng/g - nanograms per gram

Table 2-7
Summary of Sediment Pore Water PCB Concentrations and Log Koc Values
Buffalo, NY

PCB Congener	Congener Number	Number of Detected Pore Water Samples	Detection Limit	Pore Water Min Detected Sample	Pore Water Max Detected Sample	Pore Water Mean Detected Sample	Log Koc Minimum	Log Koc Maximum	Log Koc Mean
			pg/L	pg/L	pg/L	pg/L			
2,2'-dichlorobiphenyl	4	17	34	27.5	1065	201	5.6	6.4	6.1
2,3'-dichlorobiphenyl	6	18	19	11.7	480	94.0	5.7	6.9	6.2
2,4'-dichlorobiphenyl	8	18	17	22.3	1400	178	5.5	6.5	6.0
4,4'-dichlorobiphenyl	15	20	8.1	89.3	978	196	6.1	6.9	6.5
2,2',3 (2,4',6)-trichlorobiphenyl	16+32	20	3.7	33.7	932	127	6.1	6.8	6.4
2,2',4-trichlorobiphenyl	17	18	3.4	18.0	602	85.6	5.9	6.7	6.3
2,2',5-trichlorobiphenyl	18	20	4.4	40.9	1933	234	5.6	6.7	6.2
2,3,4'-trichlorobiphenyl	22	19	2.4	14.0	460	62.6	6.2	7.1	6.5
2,3',5-trichlorobiphenyl	26	19	2.1	8.2	203	35.6	6.2	6.8	6.5
2,4,4'-trichlorobiphenyl	28	20	1.0	14.5	636	72.7	6.1	7.1	6.8
2,4',5-trichlorobiphenyl	31	20	1.8	24.2	898	107	6.0	6.9	6.6
2',3,4-trichlorobiphenyl	33	20	2.2	15.9	712	79.1	6.0	7.0	6.6
3,4,4'-trichlorobiphenyl	37	17	1.9	4.3	133	19.5	6.6	8.0	7.5
2,2',3,4'-tetrachlorobiphenyl	42	19	1.0	3.2	120	17.4	6.5	7.7	7.3
2,2',3,5'-tetrachlorobiphenyl	44	20	1.3	15.8	498	67.5	6.3	7.3	6.9
2,2',3,6-tetrachlorobiphenyl	45	15	2.4	4.5	185	32.4	6.3	7.4	6.9
2,2',4,4 (2,2',4,5)'-tetrachlorobiphenyl	47+48	20	1.2	7.4	139	34.6	6.2	7.3	6.9
2,2',4,5'-tetrachlorobiphenyl	49	20	0.8	8.3	264	39.7	6.4	7.7	7.1
2,2',5,5'-tetrachlorobiphenyl	52	20	1.1	25.9	535	80.1	6.7	7.6	7.1
2,3,3',4' (2,3,4,4')-tetrachlorobiphenyl	56+60	20	0.3	3.6	66.2	10.5	6.9	7.9	7.4
2,3,4',6-tetrachlorobiphenyl	64	20	0.8	9.7	175	28.0	6.2	7.2	6.8
2,3',4,4'-tetrachlorobiphenyl	66	20	0.5	4.2	167	19.5	6.9	7.6	7.4
2,3',4',5-tetrachlorobiphenyl	70	20	0.5	5.6	221	25.8	6.5	7.5	7.2
2,4,4',5-tetrachlorobiphenyl	74	20	0.4	3.2	97.1	11.7	7.1	7.7	7.5
2,2',3,3',4-pentachlorobiphenyl	82	15	0.4	1.4	14.5	3.6	7.4	7.9	7.6
2,2',3,3',6-(2,2',4,4',6pentachlorobiphenyl	84+101	20	0.2	3.0	46.4	8.9	7.4	8.0	7.8
2,2',3,4,4'-pentachlorobiphenyl	85	19	0.3	0.9	13.2	2.7	7.4	7.9	7.6
2,2',3,4,5'-pentachlorobiphenyl	87	20	0.4	2.2	38.3	7.3	7.2	8.1	7.8
2,2',3,5',6-pentachlorobiphenyl	95	20	0.7	10.1	126	25.1	6.8	7.3	7.1
2,2',3',4,5-pentachlorobiphenyl	97	20	0.5	2.1	36.5	6.5	7.0	8.0	7.5
2,2',4,4',5-pentachlorobiphenyl	99	20	0.3	1.5	31.3	5.9	7.2	7.8	7.6
2,3,3',4,4'-pentachlorobiphenyl	105	20	0.2	0.8	15.9	3.0	7.5	8.1	7.8
2,3,3',4',6-pentachlorobiphenyl	110	20	0.4	4.7	79.6	14.1	7.1	7.7	7.5
2,3',4,4',5-pentachlorobiphenyl	118	20	0.4	3.4	63.4	10.9	7.5	8.4	8.2
2,2',3,3',4,4'-hexachlorobiphenyl	128	18	0.1	0.2	2.2	0.8	8.5	8.5	8.5
2,2',3,3',4,6'-hexachlorobiphenyl	132	19	0.3	0.9	8.5	2.3	7.4	8.1	7.8
2,2',3,3',5,6'-hexachlorobiphenyl	135	19	0.5	0.6	7.4	2.4	7.4	8.1	7.7
2,2',3,3',6,6'-hexachlorobiphenyl	136	19	0.5	0.6	6.8	2.2	7.2	7.8	7.5
2,2',3,4,4',5'-(2,3,3',4',5,6)hexachlorobiphenyl	138+163	20	0.1	0.6	6.3	1.7	7.3	8.6	8.2
2,2',3,4,5.5'-hexachlorobiphenyl	141	19	0.2	0.2	3.4	1.1	7.5	8.2	7.8
2,2',3,4',5,5'-hexachlorobiphenyl	146	18	0.2	0.2	4.7	1.4	7.4	8.1	7.8
2,2',3,4',5',6-hexachlorobiphenyl	149	20	0.3	1.4	21.1	5.2	7.4	8.0	7.7
2,2',3,5,5',6-hexachlorobiphenyl	151	19	0.3	0.4	7.3	2.2	7.4	8.1	7.8
2,2',4,4',5,5'-hexachlorobiphenyl	153	20	0.1	0.8	8.4	2.1	7.7	8.5	8.1
2,3,3',4,4',5-hexachlorobiphenyl	156	16	0.1	0.1	1.4	0.6	8.4	8.8	8.6
2,2',3,3',4,4',5-heptachlorobiphenyl	170	16	0.1	0.2	3.4	1.3	8.5	8.8	8.6
2,2',3,3',4,4',6-heptachlorobiphenyl	171	16	0.1	0.1	1.3	0.6	8.1	8.7	8.4
2,2',3,3',4,5,6'-heptachlorobiphenyl	174	20	0.2	0.2	3.5	1.2	7.9	8.4	8.2
2,2',3,3',4',5,6-heptachlorobiphenyl	177	18	0.1	0.2	2.2	0.8	8.1	8.6	8.4
2,2',3,3',5,6,6'-heptachlorobiphenyl	179	16	0.3	0.2	2.6	1.0	7.4	8.6	8.1
2,2',3,4,4',5,5'-heptachlorobiphenyl	180	20	0.1	0.3	4.0	1.3	8.3	8.8	8.5
2,2',3,4,4',5',6-heptachlorobiphenyl	183	18	0.2	0.2	1.9	0.8	7.6	8.5	8.1
2,2',3,4',5,5',6-heptachlorobiphenyl	187	20	0.2	0.5	3.9	1.4	7.7	8.4	8.2
2,3,3',4,4',5',6-heptachlorobiphenyl	191	9	0.1	0.3	1.6	0.8	NA[a]	NA	NA
2,2',3,3',4,4',5,5'-octachlorobiphenyl	194	9	0.2	0.2	1.7	0.8	8.3	8.3	8.3
2,2',3,3',4,5,6,6'-octachlorobiphenyl	199	10	0.4	0.6	4.0	1.8	7.8	8.3	8.1
2,2',3,4,4',5,5'.6-octachlorobiphenyl	203	9	0.2	0.3	1.7	0.8	8.1	8.5	8.3

(a) 2,2',3,3',4,4',5,5'-octachlorobiphenyl was not detected in any of the sediment extracts (detection limit =1.0 ng/g).
Therefore log Koc values were not calculated for this chemical.

PCB - Polychlorinated biphenyl
pg/L - Picogram per liter
NA - Not Available
ng/g - nanograms per gram

Table 2-8
Summary of Mean Metrics Calculated for Sediment Grab Samples
Buffalo, NY

	All Buffalo River Stations	Buffalo River Upstream Stations	Buffalo River Downstream Stations	Cazenovia Creek	Cattaraugus Creek Reference Site	Tonawanda Creek Reference Site
Number of Stations	8	3	5	1	3	3
Species Richness	8.65	10	7.84	7.2	6.13	5.2
Abundance	158	76.5	206	93.6	54.9	25.4
EPT Richness	0.65	0.533	0.72*	0.6	0.2	0
Hilsenhoff Biotic Index	9.58	9.12	9.85	9.67	8.81	9.59
Percent Model Affinity	29%	27%	30%	26%	23%	16%
Species Diversity (base 2)	1.47	1.78	1.29	1.12	1.58	1.76
Dominance	67%	64%	69%	79%	60%	51%
Dominance-3	91%	85%	94%	94%	91%	89%
Non-Chironomid / Oligochaete Richness	5	4.6	5.24	3.2	2.6	3.13
Number of Deformities	22/471	5/249	17/222	3/36	14/416	5/95
	4.7%	2.0%	7.7%	8.3%	3.4%	5.3%

Notes:

*This EPT score includes the BR4-PP1 replicate which contained a large number of mayflies in comparison to the other replicates at that location.

EPT	Ephemeroptera, Plecoptera, and Trichoptera
Dominance-3	Dominance of the three most numerous organisms

Table 2-9
Summary of Mean Metrics Calculated for Hester-Dendy Samplers
Buffalo, NY

	All Buffalo River Stations	Buffalo River Upstream Stations	Buffalo River Downstream Stations	Cazenovia Creek	Cattaraugus Creek Reference Site	Tonawanda Creek Reference Site
Mean Number of Famillies	6.3	5.4	7.4	6.8	8.5	8.1
Mean Number of Species	18	17	20	21	19	21
Mean Number of Organisms	320	340	320	200	490	220
Mean EPT Species Richness	1.3	0.93	2.1	1.4	3.9	1.1
Mean Hilsenhoff Biotic Index	8	8.2	7.4	7.1	6.5	7.2
Mean Percent Model Affinity	46%	42%	47%	47%	38%	45%
Mean Species Diversity (Base 2)	3	2.9	3.1	3.4	2.7	3.4
Mean Dominance	35%	34%	34%	24%	43%	29%
Mean Dominance of top 3 organisms	64%	64%	62%	56%	68%	54%
Mean Non-Chironomid / Oligochaetes Richness	4.6	3.6	5.7	4.8	7	6.2
Total Number of Chironomid Deformities	54/7104	41/3144	13/3960	20/728	13/2388	20/2072
Percentage of deformed chironomids	0.8%	1.3%	0.3%	2.7%	0.5%	1.0%

Notes:
EPT - Ephemeroptera, Plecoptera, and Trichoptera

Table 2-10
Electrofishing Catch per Unit Effort (CPUE) on the Buffalo River and Cazenovia Creek during the Fish Community Assessment
Buffalo, NY

		Electrofishing Catch per Unit Effort (CPUE)					
Scientific Name*	**Common Name**	**BR1 RM 7.25**	**BR2 RM 6.6**	**BR3 RM 6.25**	**BR4 RM 5.5**	**BR5 RM 4.5**	**CC**
Hybopsis amblops	Bigeye chub						3.9
Lepomis macrochirus	Bluegill	3.9	7.9	3.9	10	47.5	7.9
Pimephales notatus	Bluntnose minnow	3.9	4	3.9	4	15.8	102.1
Ameiurus nebulosus	Brown bullhead	3.9					
Cyprinus carpio	Common carp	11.7	11.9	11.6	8	11.9	
Luxilus cornutus	Common shiner	19.5	4	11.6	4	4	11.8
Dorosoma cepedianum	Gizzard shad	3.9	27.7	19.3		27.7	
Moxostoma erythrurum	Golden redhorse	3.9			4		3.9
Notemigonus crysoleucas	Golden shiner	3.9			14	79.2	
Etheostoma nigrum	Johnny darter				2	7.9	
Micropterus salmoides	Largemouth bass	7.8	15.8	23.1	44.1	67.3	27.5
Hypentelium nigricans	Northern hogsucker					4	3.9
Lepomis gibbosus	Pumpkinseed	11.7	27.7	27	10	35.6	3.9
Oncorhynchus mykiss	Rainbow trout	3.9					3.9
Ambloplites rupestris	Rock bass	3.9		11.6		4	11.8
Micropterus dolomieui	Smallmouth bass	3.9					
Ictiobus bubalus	Smallmouth buffalo					4	
Notropis hudsonius	Spottail shiner			3.9			
Minytrema melanops	Spotted sucker					4	
Catostomus commersonii	White sucker		4	7.7		7.9	3.9
Ameiurus natalis	Yellow bullhead					4	
Perca flavescens	Yellow perch				8		3.9
CPUE Totals		**86**	**103**	**124**	**108**	**325**	**188**

Source

MACTEC 2008

Notes

* Only fish species that were collected via electrofishing are included.

BR - Buffalo River
CC - Cazenovia Creek
CPUE - Catch per unit effort (#1 hour)
RM - River mile

Table 2-11
Fish Community Metrics for Locations within the Buffalo River and Cazenovia Creek[(a)]
Buffalo, NY

	CC	BR1 RM 7.25	BR2 RM 6.6	BR3 RM 6.25	BR4 RM 5.5	BR5 RM 4.5
Total Taxa	12	15	8	10	10	15
Percent Centrarchids	27%	13%	50%	53%	59%	48%
Percent Catostomidae	6.3%	3.3%	3.8%	6.3%	3.7%	6.1%
Percent Cyprinidae	63%	80%	19%	25%	28%	34%
Percent Dominant Species	54%	49%	27%	22%	41%	24%
Similarity Index	NA	60%	75%	80%	70%	53%
Shannon-Wiener Diversity Index	1.7	1.7	1.8	2.1	1.9	2.2
Percent Tolerant Species	56%	56%	19%	19%	24%	37%
Percent Intolerant Species	2.1%	2.2%	0%	0%	0%	1.2%
Percent Omnivores	56%	56%	46%	34%	24%	44%
Percent Top Carnivores	23%	8.8%	15%	28%	41%	22%
Abundance (b)	0.052	0.099	0.029	0.034	0.060	0.090
Mean Condition Factor (K) (c)	0.98	1.1	1.3	1.4	1.3	1.3

Notes:

(a) Includes fish caught via electrofishing and seining.
(b) Only includes fish caught via electrofishing.
(c) Calculated based on Williams (2000).

AOC - Area of Concern
BR - Buffalo River
CC - Cazenovia Creek
NA - Not applicable
RM - River mile

Table 2-12
Summary of Fish Community Metrics: Buffalo River AOC, Buffalo River - Upstream, Cazenovia Creek[(a)]
Buffalo, NY

	Cazenovia Creek	Buffalo River AOC Mean	Buffalo River Upstream Mean
Number of Stations	1	2	3
Total Taxa	12	13	11
Percent Centrarchids	27%	54%	39%
Percent Catostomidae	6.3%	4.9%	4.5%
Percent Cyprinidae	63%	31%	41%
Percent Dominant Species	54%	33%	33%
Similarity Index	NA	62%	72%
Shannon-Wiener Diversity Index	1.7	2.0	1.9
Percent Tolerant Species	56%	31%	31%
Percent Intolerant Species	2.1%	0.60%	0.73%
Percent Omnivores	56%	34%	45%
Percent Top Carnivores	23%	32%	17%
Abundance (b)	0.052	0.075	0.054
Mean Condition Factor (K) (c)	0.98	1.3	1.3

Notes:
(a) Includes fish caught via electrofishing and seining.
(b) Only includes fish caught via electrofishing.
(c) Calculated based on Williams (2000).

AOC - Area of Concern
NA - Not applicable

Table 2-13
Histopathological Evaluation of Liver Lesions in Brown Bullhead
Buffalo, NY

n	37
Foci of Cellular Alteration (%)	29.8
Hepatocellular Carcinomas (%)	5.4
Cholangiocarcinomas (%)	0
Hepatocellular Tumors (%)	2.7
Bile Ductular Tumors (%)	0
Total Liver Tumors (%)	**8.1**

Notes:
% - Percent
n - Number of samples

Table 2-14
Physical and Chemical Characteristics of the Buffalo River by River Mile
Buffalo, NY

	RM 0.0 - 1.0	RM 1.0 - 2.0	RM 2.0 - 3.5	RM 3.5 - 5.0	RM 5.0+	City Ship Canal
Bathymetry / Cross-section	Shallower, with defined nav channel and shoulders	Narrow reach with deeper channel and narrow shoulders	Depths vary with bends; point bars and holes	Depths vary with bends; point bars and holes	Defined nav channel and shoulders	Shallower, U-shaped section
Hydrodynamics	Low velocity, lake impacted	High velocities	Moderate velocities	Moderate velocities	Low-moderate velocities	Low velocities
Bottom Stress	Low stress, moderated by lake	High event stress	Variable, zones of higher stress	Variable, generally lower stress	Low stress	Very low stress
Substrate Type	Fines (95%)	Fines/sand/gravel mix	Fines/ sand/ some gravel	Fines / sands/ limited gravel	Sand and fines	Fines
River Geomorphology	Mouth: wide, shallow	Straight, narrow reach	Highly sinuous	Highly sinuous	Lower sinuosity	
Sedimentation Rates	Deposition of fines from lake	Minimal deposition	Some deposition	Higher deposition of fines, some sands	Bedload deposition and some fines	Fines deposition, local biotic solids
Surficial Contaminant Distribution	Relatively low levels	Low to moderate levels	Moderate levels	Higher levels	Low to moderate levels	Moderate levels

% - Percent
RM River Mile

Table 3-1
Remedial Action Objectives and Supporting Goals for Buffalo River AOC
Buffalo, NY

	Target Environmental Medium or Receptor	Duration	RAO/Supporting Goal
RAO 1	Sediment and Human Health	Short-Term and Long-Term	Reduce human exposures for direct sediment contact and fish consumption from the Buffalo River by reducing the availability and/or concentration of COCs in sediments
RAO 2	Ecology	Short-Term and Long-Term	Reduce the exposure of wildlife populations and the aquatic community to sediment COC concentrations that are above protective levels
RAO 3	Sediment	Short-Term and Long-Term	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
RAO 4	Ecology	Short-Term and Long-Term	Implement a remedy that is compatible with the Buffalo-River Remedial Advisory Committee's goal of protecting and restoring habitat and supporting wildlife goals
Supporting Goal 1	Sediment	Short-Term and Long-Term	Reduce the potential of COC contaminated sediments to migrate outside of the Buffalo River AOC.
Supporting Goal 2	Ecology	Short-Term and Long-Term	Implement a sediment remedy that is compatible with and complements ongoing regional redevelopment goals, upland remediation, and restoration activities

AOC - Area of Concern
COC Chemical of concern
RAO - Remedial Action Objective

Table 3-2
Comparison of Remedial Action Objectives and Supporting Goals to Beneficial Use Impairments for the Buffalo River AOC
Buffalo, NY

		Beneficial Use Impairments						
		Restrictions on fish and wildlife consumption	**Fish tumors or other deformities**	**Degradation of aesthetics**	**Degradation of benthos**	**Restrictions on dredging activities**	**Loss of Fish and Wildlife Habitat**	**Degradation of fish and wildlife populations**
Remedial Action Objectives (RAOs)								
RAO 1	Reduce human exposures for direct sediment contact and fish consumption from the Buffalo River by reducing the availability and/or concentration of COCs in sediments.	X						
RAO 2	Reduce the exposure of wildlife populations and the aquatic community to sediment COC concentrations that are above protective levels.		X		X			X
RAO 3	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.					X		X
RAO 4	Implement a remedy that is compatible with the Buffalo-River Remedial Advisory Committee's goal of protecting and restoring habitat and supporting wildlife goals.	X	X	X	X		X	X
Supporting Goals								
Supporting Goal 1	Reduce the potential of COC contaminated sediments to migrate outside of the Buffalo River AOC.							
Supporting Goal 2	Implement a sediment remedy that is compatible with and complements ongoing regional redevelopment goals, upland remediation, and restoration activities.	X	X	X	X	X	X	X

Table 4-1
Summary of Technology and Process Options Retained for the Buffalo River Feasibility Study
Buffalo, NY

General Response Action	Appropriate Remedial Technology and Process Option	Reason for Consideration
No Action	No Action	Retain as required by the NCP for comparison to other alternatives.
Institutional Controls	Deed Restrictions	Routinely implemented and effective when combined with other process options to form an overall risk-management strategy. Retain as a component of other remedial alternatives.
	Recreational Use Restrictions	Routinely implemented and effective when combined with other process options to form an overall risk-management strategy. Retain as a component of other remedial alternatives.
Natural Recovery	Monitored Natural Recovery	MNR is readily implementable and can be highly effective at low-risk sites with strong evidence for natural recovery processes, such as the Buffalo River due to the natural depositional nature of large portions of the River Additional lines of evidence supporting MNR include historically reduced fish liver lesions, historical improvement in fish habitat, and historical decreases in edible fish PCB and mercury concentrations.
Sediment Capping	Isolation Capping an/or Thin Layer Capping	Areas suitable for capping within the Buffalo River are limited to non-navigable areas in the Buffalo River and City Ship Canal. This includes the narrow portions of the river and ship canal that border the navigational channel and the non-navigable portion at the end of the City Ship Canal. Thin-layer capping may also be considered in other areas of the AOC to augment remedies if it can be demonstrated that thin-layer capping does not exceed FEMA restrictions on increased flood potential during a 100-year flood event, or if thin capping can support a restoration alternative.
Sediment Removal	Mechanical and/or Hydraulic Dredging	Dredging can be implemented at the Buffalo River using the existing CDF facility at the Buffalo Harbor. As a mass-removal or source-removal technology, dredging is effective. However, dredging generally is ineffective at achieving low surface sediment concentrations. Apart from actual dredging, sediment removal involves transportation of dredged material from the contaminated site, and disposal of dredged material (see below). A combination of dredging techniques may be required to dredge around piers and abutments, submerged debris, cross channel utilities, and near bulkheads. Special consideration will be also required for slope backs from existing bulkheads so as to not compromise their structural integrity.
Dredged Material Dewatering, Transportation and Disposal	Confined Disposal Facility No. 4	The presence of CDF No. 4, specifically designed for the management and disposal of sediments from the Buffalo River, and within 3 to 9 miles of the area of concern, makes the CDF the most attractive alternative for the dewatering/stabilization and disposal of dredged sediments and barge transport or hydraulic conveyance the preferred sediment transport alternatives. The bulk of the materials can be off-loaded directly to the open water portion of the CDF. Staging areas may be required within the upland portions of the CDF to stage materials considered by USEPA and USACE as unsuitable for placement in the open water portion of the CDF. These materials can be placed within earthen berms to control sediment transport within the CDF. A much smaller fraction of material may require off-site disposal, if contaminant concentrations are considered by USEPA and USACE too high for CDF disposal. This material will likely require dewatering or physical stabilization and identification of a suitable upland disposal site. An alternative may be to add stabilizing materials to this subset of dredged sediment to allow CDF placement.

CDF Confined Disposal Facility
NCP National Contingency Plan
PCB Polychlorinated biphenyl

Table 5-1a
Surface Area of the Buffalo River AOC, Acres
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Main Channel	88	154	242
City Ship Canal	20	16	36
Total	108	170	**278**

Table 5-1b
Remedy Alterative 3 Surface Area, Acres
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Main Channel	43	95	138
City Ship Canal	15	11	26
Total	58	106	**164**

Table 5-1c
Remedy Alterative 4 Surface Area, Acres
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Main Channel	14	27	41
City Ship Canal	10	5	15
Total	24	32	**56**

Table 5-1d
Remedy Alterative 5 Surface Area, Acres
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Main Channel	22	35	57
City Ship Canal	12	7	19
Total	34	42	**76**

NOTE: Surface areas in the City Ship Canal, outside of the navigation channel, include the cap surface area of 6.7 acres for Remedy Alternatives 3, 4 and 5.

Table 5-2a
Remedy Alterative 3: Sediment Volumes Removed
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Buffalo River	1,010,000	560,000	1,570,000
City Ship Canal	150,000	30,000	180,000
Total	1,160,000	590,000	**1,750,000**

Table 5-2b
Remedy Alterative 4: Sediment Volumes Removed
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Buffalo River	420,000	140,000	560,000
City Ship Canal	60,000	20,000	80,000
Total	480,000	160,000	**640,000**

Table 5-2c
Remedy Alterative 5: Sediment Volumes Removed
Buffalo, NY

	Outside of Nav Channel	Inside Nav Channel	**Total**
Buffalo River	530,000	190,000	720,000
City Ship Canal	80,000	20,000	100,000
Total	610,000	210,000	**820,000**

Notes: Current volume estimates assume removal to shoreline and do not consider a dredge slope factor. Volumes are subject to change based an updated understanding of dredge delineation boundaries and shoreline offsets.

Table 6-1a
Time Recovery for Different Biological Health Metrics and Different Remediation Activities
Buffalo, NY

BUI	Location	Action	Recovery Time (Years)	Reference
Benthic Community	River Hull (UK)	Dredging	0.5	Pearson (1984)[a]
Benthic Community	James River (VA)	Dredging	0.25	Diaz 1994
Benthic Community	Ashtabula River (OH)	Dredging	5	OEPA (2006)
Vegetation	San Macros River (TX)	Dredging	0.5 to 1.0	Hannan and Doris (1970)[a]
Fish Tumors	Black River (OH)	Dredging	4	Baumann et al. 2000
Benthic Community	Un-named Stream (AK)	Construction	1	Peterson and Nyquist (1972)[a]
Benthic Community	Joe Wright Creek (CO)	Construction	Rapid	Cline et al. (1977)[a]
Benthic Community	Archibald Creek (BC)	Construction	2	Tsui and McCart (1981)[a]
Benthic Community	Coastal Plain stream (NC)	Restoration	2	Price and Roessler (2005)
Benthic Community	Reinikoski Rapids (Finland)	Restoration with Refugia	0.08	Korsu (2004)
Benthic Community	Headland Waters (Finland)	Restoration with Refugia	4 to 8	Muotka et al. (2002)
Benthic Community	Black River (OH)	Infrastructure	5	BRRAPCC (2005)
Benthic Community	North Platte River (WY)	Sedimentation	0.06	Gray and Ward (1982)[a]
Benthic Community	Rhone River (France)	Sedimentation	1	Roux (1984)[a]
Benthic Community	Black River E. Branch	WWTP improvements	5	BRRAPCC (2005)
Benthic Community	Cuyahoga River	WWTP decommissioning	4	Mack (2000)
Fish Tumors	Presque Isle Bay (PA)	WWTP improvements and curtailment of CSO overflows	5	Baumann et al. 2000

(a) References cited within Yount and Niemi 1990.

BUI - Beneficial use impairment
CSO - Combined sewer overflow
WWTP - Wasterwater treament facility

Table 6-1b
Aquatic Vegetation Impacted by Remedy
Buffalo, NY

	Buffalo River	City Ship Canal	Total
Current Conditions			
Length of Shoreline with EV and SAV, ft	22,468	8,012	30,480
Remedy Alternative 3			
Length of Shoreline with EV and SAV Impacted by Remedy, ft	16,118	5,516	21,634
Percent of Shoreline with EV and SAV Impacted by Remedy	72%	69%	71%
Remedy Alternative 4			
Length of Shoreline with EV and SAV Impacted by Remedy, ft	6,625	3,947	10,572
Percent of Shoreline with EV and SAV Impacted by Remedy	29%	49%	35%
Remedy Alternative 5			
Length of Shoreline with EV and SAV Impacted by Remedy, ft	8,461	4,528	12,989
Percent of Shoreline with EV and SAV Impacted by Remedy	38%	57%	43%

EV - Emergent Vegetation
SAV - Submerged Aquatic Vegetation

Table 6-2a
SWACs, Current Conditions
Buffalo, NY

River Miles	Total PAHs, mg/kg	Lead, mg/kg	Mercury, mg/kg	Total PCBs, mg/kg
Buffalo River				
0.33 - 0.67	5.0	38	0.17	0.09
0.67 - 1.0	10	70	0.76	0.19
1.0 - 1.33	6.0	77	0.15	0.08
1.33 - 1.67	6.1	39	0.12	0.08
1.67 - 2.0	4.8	38	0.12	0.09
2.0 - 2.33	4.5	34	0.11	0.08
2.33 - 2.67	6.8	62	0.21	0.17
2.67 - 3.0	5.7	64	0.17	0.31
3.0 - 3.33	7.0	56	0.17	0.13
3.33 - 3.67	10	100	0.38	0.15
3.67 - 4.0	24	129	0.81	0.36
4.0 - 4.33	31	136	1.02	0.75
4.33 - 4.67	19	67	0.42	0.12
4.67 - 5.0	17	173	0.49	0.27
5.0 - 5.33	19	64	0.39	0.15
5.33 - 5.67	4.6	29	0.08	0.05
5.67 -6.0	5.0	35	0.06	0.07
City Ship Canal				
0.0 - 0.33	13	331	0.65	0.21
0.33 - 0.67	13	73	0.60	0.15
0.67 - 1.0	10	62	0.82	0.20
1.0 - 1.33	13	116	1.00	0.21
1.33 - 1.45	70	156	0.60	0.30

Table 6-2b
SWACs Based on Remedy Alternative 3
Buffalo, NY

River Miles	Total PAHs, mg/kg	Lead, mg/kg	Mercury, mg/kg	Total PCBs, mg/kg
Buffalo River				
0.33 - 0.67	5.3	30	0.07	0.04
0.67 - 1.0	6.1	34	0.16	0.05
1.0 - 1.33	5.8	42	0.09	0.05
1.33 - 1.67	5.9	24	0.04	0.02
1.67 - 2.0	5.8	26	0.05	0.03
2.0 - 2.33	5.1	31	0.09	0.06
2.33 - 2.67	6.9	61	0.21	0.16
2.67 - 3.0	6.1	24	0.04	0.04
3.0 - 3.33	5.6	38	0.10	0.09
3.33 - 3.67	6.0	46	0.06	0.04
3.67 - 4.0	6.1	24	0.04	0.03
4.0 - 4.33	6.1	22	0.03	0.01
4.33 - 4.67	6.1	22	0.03	0.01
4.67 - 5.0	6.1	24	0.04	0.02
5.0 - 5.33	6.5	26	0.06	0.04
5.33 - 5.67	4.9	27	0.07	0.04
5.67 -6.0	5.0	35	0.06	0.07
City Ship Canal				
0.0 - 0.33	6.7	30	0.06	0.03
0.33 - 0.67	7.8	38	0.22	0.06
0.67 - 1.0	4.6	28	0.21	0.08
1.0 - 1.33	6.3	37	0.25	0.05
1.33 - 1.45	6.1	22	0.03	0.01

NOTES:
1) IDW interpolations of the 2005/2007 and 2008 surface sediment data are used to calculate SWACs.
2) Post remediation SWACs are calculated by applying average upstream surface sediment concentrations to remediated areas. The average upstream surface sediment concentrations are total PAHs, 6.1 mg/kg; Pb, 21.7 mg/kg; Hg, 0.029 mg/kg; total PCBs, 0.014 mg/kg.

Hg - Mercury
mg/kg - milligrams per kilogram
PAHs - Polycyclic aromatic hydrocarbons
PCBs - Polychlorinated biphenyl

Table 6-2c
SWACs Based on Remedy Alternative 4
Buffalo, NY

River Miles	Total PAHs, mg/kg	Lead, mg/kg	Mercury, mg/kg	Total PCBs, mg/kg
Buffalo River				
0.33 - 0.67	5.0	38	0.17	0.09
0.67 - 1.0	7.1	51	0.35	0.12
1.0 - 1.33	6.0	77	0.15	0.08
1.33 - 1.67	6.1	39	0.12	0.08
1.67 - 2.0	4.8	38	0.12	0.09
2.0 - 2.33	4.5	34	0.11	0.08
2.33 - 2.67	6.8	62	0.21	0.17
2.67 - 3.0	5.8	55	0.15	0.19
3.0 - 3.33	6.9	56	0.17	0.13
3.33 - 3.67	6.8	73	0.23	0.08
3.67 - 4.0	7.0	36	0.11	0.06
4.0 - 4.33	7.5	33	0.07	0.07
4.33 - 4.67	7.7	40	0.14	0.05
4.67 - 5.0	8.1	60	0.17	0.09
5.0 - 5.33	6.0	38	0.12	0.08
5.33 - 5.67	4.6	29	0.08	0.05
5.67 -6.0	5.0	35	0.06	0.07
City Ship Canal				
0.0 - 0.33	7.8	78	0.28	0.10
0.33 - 0.67	10	56	0.42	0.11
0.67 - 1.0	5.0	41	0.32	0.09
1.0 - 1.33	6.3	37	0.25	0.05
1.33 - 1.45	6.1	22	0.03	0.01

Table 6-2d
SWACs Based on Remedy Alternative 5
Buffalo, NY

River Miles	Total PAHs, mg/kg	Lead, mg/kg	Mercury, mg/kg	Total PCBs, mg/kg
Buffalo River				
0.33 - 0.67	5.0	38	0.17	0.09
0.67 - 1.0	7.1	51	0.35	0.12
1.0 - 1.33	6.0	77	0.15	0.08
1.33 - 1.67	6.1	39	0.12	0.08
1.67 - 2.0	4.8	37	0.11	0.08
2.0 - 2.33	4.5	34	0.11	0.08
2.33 - 2.67	6.8	62	0.21	0.17
2.67 - 3.0	5.6	43	0.08	0.11
3.0 - 3.33	6.0	40	0.10	0.08
3.33 - 3.67	6.4	64	0.20	0.07
3.67 - 4.0	6.8	32	0.09	0.04
4.0 - 4.33	7.5	32	0.07	0.07
4.33 - 4.67	7.6	38	0.13	0.04
4.67 - 5.0	7.9	36	0.11	0.07
5.0 - 5.33	5.8	34	0.10	0.07
5.33 - 5.67	4.7	28	0.08	0.05
5.67 -6.0	5.0	35	0.06	0.07
City Ship Canal				
0.0 - 0.33	7.3	50	0.24	0.08
0.33 - 0.67	8.9	46	0.31	0.08
0.67 - 1.0	4.9	38	0.29	0.09
1.0 - 1.33	6.3	37	0.25	0.05
1.33 - 1.45	6.1	22	0.03	0.01

NOTES:
1) IDW interpolations of the 2005/2007 and 2008 surface sediment data are used to calculate SWACs.
2) Post remediation SWACs are calculated by applying average upstream surface sediment concentrations to remediated areas. The average upstream surface sediment concentrations are total PAHs, 6.1 mg/kg; Pb, 21.7 mg/kg; Hg, 0.029 mg/kg; total PCBs, 0.014 mg/kg.

Hg - Mercury
mg/kg - milligrams per kilogram
PAHs - Polycyclic aromatic hydrocarbons
PCBs - Polychlorinated biphenyl

Table 6-3a
Current Conditions: Estimated Mass of Chemicals in Buffalo River AOC
Buffalo, NY

	PAH	Lead	Mercury	PCB
		Buffalo River		
Outside Nav Channel, kg	52,000	171,000	1,600	1,150
Inside Nav Channel, kg	13,400	57,700	470	230
		City Ship Canal		
Outside Nav Channel, kg	3,000	28,000	370	70
Inside Nav Channel, kg	600	7,000	60	13

Table 6-3b
Remedy Alternative 3: Estimated Mass of Chemicals Removed
Buffalo, NY

	PAH	Lead	Mercury	PCB
		Buffalo River		
Outside Nav Channel				
Mass removed, kg	51,000	163,000	1,500	1,100
Percent of Current Mass	98%	96%	97%	96%
Inside Nav Channel				
Mass removed, kg	12,700	50,300	440	220
Percent of Current Mass	95%	90%	94%	92%
		City Ship Canal		
Outside Nav Channel				
Mass removed, kg	2,200	19,800	290	50
Percent of Current Mass	72%	71%	78%	69%
Inside Nav Channel				
Mass removed, kg	500	5,700	40	10
Percent of Current Mass	81%	83%	77%	77%

Note: Volumes and mass removals are subject to change based an updated understanding of dredge delineation boundaries and shoreline offsets. Currently volumes and mass removal assume removal to shoreline and do not consider a dredge slope factor.

Table 6-3c
Remedy Alternative 4: Estimated Mass of Chemicals Removed
Buffalo, NY

	PAH	Lead	Mercury	PCB
		Buffalo River		
Outside Nav Channel				
Mass removed, kg	26000	70,300	730	180
Percent of Current Mass	50%	41%	46%	15%
Inside Nav Channel				
Mass removed, kg	4000	16,700	160	60
Percent of Current Mass	30%	30%	33%	25%
		City Ship Canal		
Outside Nav Channel				
Mass removed, kg	1300	12,600	180	30
Percent of Current Mass	41%	45%	48%	38%
Inside Nav Channel				
Mass removed, kg	300	3,900	20	6
Percent of Current Mass	44%	57%	43%	46%

Table 6-3d
Remedy Alternative 5: Estimated Mass of Chemicals Removed
Buffalo, NY

	PAH	Lead	Mercury	PCB
		Buffalo River		
Outside Nav Channel				
Mass removed, kg	37,000	99,000	930	450
Percent of Current Mass	71%	58%	59%	39%
Inside Nav Channel				
Mass removed, kg	8,000	24,300	230	90
Percent of Current Mass	58%	43%	49%	40%
		City Ship Canal		
Outside Nav Channel				
Mass removed, kg	1,600	14,700	200	30
Percent of Current Mass	53%	52%	54%	45%
Inside Nav Channel				
Mass removed, kg	400	4,500	30	6
Percent of Current Mass	59%	66%	52%	46%

Note: Volumes and mass removals are subject to change based an updated understanding of dredge delineation boundaries and shoreline offsets. Currently volumes and mass removal assume removal to shoreline and do not consider a dredge slope factor.

AOC - Area of Concern
kg - Kilogram
PAH - Polycyclic aromatic hydrocarbon
PCB - Polychlorinated biphenyl

Table 6-4
Remedial Alternative Cost Estimate Summary
Buffalo, NY

		Remedial Area	Remedial Volume	Cap Area	Total Cost	Unit Cost
Remedy 1	No Action	0 SF	0 CY	0 SF	$0	
Remedy 2	Monitored Natural Recovery of the Entire River	11,632,400 SF	0 CY	0 SF	$2,453,000	$0.21 /SF
Remedy 3	Sediment removal targeting the PAH RG of 1 TU at all sediment depths, and SWAC RGs for PCBs, Hg, and Pb and capping of the ship canal	6,309,200 SF	1,750,000 CY	292,400 SF	$73,883,000	$38 /CY dredged $9 /SF capped
Remedy 4	Sediment removal targeting the PAH RG of 1 TU in surface (0-1 ft) sediment, and SWAC RGs for PCBs, Hg, and Pb and capping of the ship canal	2,074,800 SF	640,000 CY	292,400 SF	$31,817,000	$41 /CY dredged $9 /SF capped
Remedy 5	Sediment removal targeting the PAH RG of 1 TU in surface (0-1 ft) sediment, SWAC RGs for PCBs, Hg, and Pb, and maximum residual PAH, PCB, Hg, and Pb concentrations in buried and surface sediments and capping of the ship canal	2,780,800 SF	820,000 CY	292,800 SF	$38,733,000	$41 /CY dredged $9 /SF capped

Key assumptions

USACE performs the dredging and only turbidity monitoring is required.

The percent debris in the total volume of sediments is 2.5 percent.

The percent of the total volume of sediments requiring additional confinement within the CDF is 5 percent.

None of the excavated sediments will require off-site disposal as hazardous waste.

No shoreline stabilization or improvements will be performed as part of the remedy.

Additional confinement within CDF will be performed using on-site materials. No importation will be required.

CDF	Confined Disposal Facility
CY	Cubic yards
SF	Square feet
Hg	Mercury
PAH	Polycyclic aromatic hydrocarbon
Pb	Lead
PCB	Polychlorinated biphenyl

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
CHEMICAL-SPECIFIC ARARS AND TBCS			
Clean Water Act 40 [Federal Water Pollution Control Act; as amended], 33 USC §§ 1251- 1387	40 CFR Part 129	Toxic Pollutant Effluent Standards for aldrin/dieldrin, DDT, endrin, toxaphene, benzidene and PCBs.	Part 129 is a potential relevant and appropriate chemical-specific ARAR for purposes of on-site response.
Safe Drinking Water Act, 42 USC §§ 300f - 300j-26	40 CFR Part 141	National Primary Drinking Water Regulations	Part 141 is a potential relevant and appropriate chemical-specific ARAR for purposes of on-site response.
New York State Environmental Conservation Law (ECL) Article 15, Title 3 and Article 17, Titles 3 and 8	6 NYCRR Part 608, Section 608.5	Section 608.5 includes the requirement to obtain a SPDES permit for certain discharges in any navigable waters of the State.	Sections 608.5 is potential relevant and appropriate chemical-specific ARARs for purposes of on-site response.
	7 NYCRR Part 608, Sections 608.6(a) and 608.9(a)	Section 608.6(a) requires development and submission of a sufficiently detailed construction plan with a map. Section 608.9(a) requires that construction or operation of facilities that may result in a discharge to navigable waters demonstrate compliance with CWA §§ 301 – 303, 306 and 307 and 6 NYCRR §§ 751.2 (prohibited discharges) and 754.1 (effluent prohibitions; effluent limitations and water quality-related effluent limitations; pretreatment standards; standards of performance for new sources.)	Sections 608.6(a) and 608.9(a) are potential relevant and appropriate chemical-specific ARARs for purposes of on-site response.
	6 NYCRR Part 701	Part 701 establishes classifications for surface waters and groundwater.	Part 701 classifications of waters of the State, as well as a general prohibition on any discharge that impairs the receiving water for its assigned best usages are potential relevant and appropriate chemical-specific ARARs for purposes of on-site response.
	6 NYCRR Part 703	Part 703 establishes surface water and groundwater quality standards and groundwater effluent limitations.	Part 703 includes general and chemical-specific water quality standards that are potential relevant and appropriate chemical-specific ARARs.
	6 NYCRR Part 704	Part 704 establishes criteria for thermal discharges.	Part 704 is a potential relevant and appropriate chemical-specific ARARs for alternatives involving dredging and dewatering at elevated temperatures and discharge to the river or Lake Erie at elevated temperatures.
International Joint Commission – United States and Canada	Great Lakes Water Quality Agreement of 1978, as amended	The concentration of total PCBs in fish tissue (whole fish, wet weight basis) should not exceed 0.1 µg/g for the protection of birds and animals that consume fish. Criterion for mercury is 0.5 µg/g mercury in whole fish [wet weight basis].	TBC

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
NOAA – Damage Assessment Center	Reproductive, Developmental and Immunotoxic Effects of PCBs in Fish: A Summary of Laboratory and Field Studies, March 1999 (Monosson, E.)	The effective concentrations for reproductive and developmental toxicity fall within the ranges of the PCB concentrations found in some of the most contaminated fish. There are currently an insufficient number of studies to estimate the immunotoxicity of PCBs in fish. Improper functioning of the reproductive system and adverse effects on development may result from adult fish liver concentrations of 25 to 71 ppm Aroclor 1254. PCB Congener BZ #77: 0.3 to 5 ppm (wet wt) in adult fish livers reduces egg deposition, pituitary gonadotropin, and gonadosomatic index, alters retinoid concentration (Vitamin A), and reduces larval survival. 1.3 ppm in eggs reduces larval survival.	TBC
EPA Office of Emergency and Remedial Response	Guidance on Remedial Actions for Superfund Sites with PCB Contamination, EPA/540/G-90/007, August 1990 (OSWER Dir. No. 9355.4-01).	Provides guidance in the investigation and remedy selection process for PCB-contaminated Superfund sites. Provides preliminary remediation goals for various contaminated media, including sediment (pp. 34-36) and identifies other considerations important to protection of human health and the environment.	TBC
NOAA (compilation of other literature sources for Sediment Quality Guidelines [SQGs])	Screening Quick Reference Tables for Organics (SQRTs)	Tables with screening concentrations for inorganic and organic contaminants.	TBC
EPA Great Lakes National Program Office, Assessment and Remediation of Contaminated Sediments (ARCS) Program	Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod *Hyalella azteca* and the midge *Chironomus riparius,* EPA 905- R96-008, September 1996	Provides sediment effect concentrations (SECs), which are defined as the concentrations of a contaminant in sediment below which toxicity is rarely observed and above which toxicity is frequently observed.	TBC
DEC Division of Fish, Wildlife and Marine Resources	Technical Guidance for Screening Contaminated Sediment, January 1999	Includes a methodology to establish sediment criteria for the purpose of identifying contaminated sediments. Provides sediment quality screening values for non-polar organic compounds, such as PCBs, and metals to determine whether sediments are contaminated (above screening criteria) or clean (below screening criteria). Screening values are not cleanup goals. Also discusses the use of sediment criteria in risk management decisions.	TBC
DEC Division of Fish, Wildlife and Marine Resources	Draft Technical Memorandum, Numerical Guidance Values for Assessing Risk to Aquatic Life from Contaminants in Sediment, June 2007	Provides sediment guidance values for the protection of benthic organisms and other varieties of aquatic or marine life, and is intended to provide only one component for evaluation, assessment, and managment of contaminated sediment in New York State. Guidance values are not clean up goals.	TBC
DEC-Division of Environmental Remediation	Technical Administrative Guidance Memorandum No. 94- Remediation HWR-4046	Recommended Soil Cleanup Objectives	TBC
USEPA	USEPA Safe Drinking Water Act	MCLPs	TBC
USEPA	USEPA Federal Register, Volume 57, No. 246, December 22, 1992	Ambient Water Quality Criteria	TBC
DEC	DEC TOGS 1.1.2	New York State Groundwater Effluent Limitations	TBC

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
LOCATION-SPECIFIC ARARS AND TBCS			
Fish and Wildlife Coordination Act	16 USC § 662	Whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose, by any department or agency of the United States, such department or agency first shall consult with the United States Fish and Wildlife Service, Department of the Interior, and with the head of the agency exercising administration over the wildlife resources of the particular State in which the impoundment, diversion, or other control facility is to be constructed, with a view to the conservation of wildlife resources by preventing loss of and damage to such resources.	Substantive portions of Section 662 are potential relevant and appropriate location-specific ARARs for purposes of on-site response.
Endangered Species Act	16 USC § 1531 et. seq.	Federal statute establishing programmatic protection for endangered and threatened species.	Substantive provisions in Sections 1538 is a potential applicable location-specific ARAR for on-site response. Substantive provisions in Sections 1539 is a potential relevant and appropriate location-specific ARAR for on-site response.
Section 404 of the Clean Water Act [Federal Water Pollution Control Act, as amended], 33 USC § 1344	33 CFR Parts 320-330	Includes requirements for issuing permits for the discharge of dredged or fill material into navigable waters of the United States.	Substantive portions of Parts 320 – 330 are potential relevant and appropriate location-specific ARAR for purposes of on-site response.
National Historic Preservation Act, 16 USC § 470 et seq.	36 CFR Part 800	Proposed remedial actions must take into account effect on properties in or eligible for inclusion in the National Registry of Historic Places. Federal agencies undertaking a project having an effect on a listed or eligible property must provide the Advisory Council on Historic Preservation a reasonable opportunity to comment pursuant to section 106 of the National Historic Preservation Act of 1966 (NHPA), as amended. While the Advisory Council comments must be taken into account and integrated into the decision-making process, program decisions rest with the agency implementing the under-taking. A Stage 1A cultural resource survey may be necessary for any active remediation to identify historic properties along the lakeshore to determine if any areas should be the subject of further consideration under NHPA.	Substantive portions of Part 800 are a potential applicable location-specific ARAR for purposes of on-site response.
Fish and Wildlife Coordination Act	40 CFR 6.302	Modification to Waterways that Affect Fish or Wildlife	A potential applicable or relevant and appropriate location-specific ARAR for purposes of on-site response.
Clean Water Act Section 401, 33 USC 1341	40 CFR Part 121	State Water Quality Certification Program	Substantive portions of Part 121 are potential relevant and appropriate location-specific ARAR for purposes of on-site response.
Clean Water Act	40 CFR Parts 122, 125 and 401	Wastewater Discharge Permits; Effluent Guidelines, Best Available Technology and BMPPT	Substantive portions of Parts 121, 125 and 401 are potential relevant and appropriate location-specific ARAR for purposes of on-site response.
Clean Water Act, Section 404, 33 USC § 1344	40 CFR Parts 230 and 231	No activity which adversely affects an aquatic ecosystem, including wetlands, shall be permitted if a practicable alternative that has less adverse impact is available. If there is no other practical alternative, impacts must be minimized.	Substantive portions of Parts 230 and 231 are potential relevant and appropriate location-specific ARAR for purposes of on-site response.

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
Clean Water Act	40 CFR § 403.5	Discharge to Publicly-Owned Treatment Works	Substantive portions of Section 403.5 are a potential relevant and appropriate location-specific ARAR for purposes of on-site response.
Toxic Substances Control Act (TSCA), Title 1,15 USC § 2601	40 CFR §§ 761.65 – 761.75	TSCA facility requirements: Establishes siting guidance and criteria*for* storage (761.65), chemical waste landfills (761.75), and incinerators (761.70).	Substantive portions of Sections 761.65 – 761.75 are potential relevant and appropriate location-specific ARAR for purposes of on-site response.
New York State ECL Article 24, Title 7 Freshwater Wetlands Law	6 NYCRR Parts 662-665	Defines procedural requirements for undertaking different activities in and adjacent to freshwater wetlands, and establishes standards governing the issuance of permits to alter or fill freshwater wetlands.	Substantive portions of Parts 662-664 are a potential relevant and appropriate location-specific ARAR for purposes of on-site response.
EPA Office of Solid Waste and Emergency Response	Policy on Floodplains and Waste and Wetland Assessments for CERCLA Actions, August 1985	Superfund actions must meet the substantive requirements of the Floodplain Management Emergency Executive Order (E.O. 11988) and the Protection of Response 1985 Wetlands Executive Order *(* E.O. 11990) (see Table 9-3: Location-Specific ARARs). This memorandum discusses situations that require preparation of a floodplain or wetlands assessment and the factors that should be considered in preparing an assessment for response actions taken pursuant to Section 104 or 106 of CERCLA. For remedial actions, a floodplain/wetlands assessment must be incorporated into the analysis conducted during the planning of the remedial action.	TBC
Executive Order No. 11988, 42 Fed. Reg. 26951 (May 25, 1977)	Floodplain Management	Executive Order describes the circumstances where federal agencies should manage floodplains.	TBC
Executive Order No. 11990, 42 Fed. Reg. 26961 (May 25, 1977)	Protection of Wetlands	Executive Order describes the circumstances where federal agencies should manage wetlands.	TBC
ACTION-SPECIFIC ARARS AND TBCS			
Section 10, Rivers and Harbors Act, 33 USC § 403	32 CFR Parts 320, 323, 325, 329 and 330	U.S. Army Corps of Engineers approval is generally required to excavate or fill, or in any manner to alter or modify the course, location, condition, or capacity of the channel of any navigable water of the United States.	Substantive portions of 33 CFR Parts 320, 323 325, 329 and 330 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Section 404(c) of the Clean Water Act, 33 USC § 1344	33 CFR Parts 320, 323, 325, 329 and 330	These regulations apply to all existing, proposed, or potential disposal sites for discharges of dredged or fill materials into U.S. waters, which include wetlands. Includes special policies, practices, and procedures to be followed by the U.S. Army Corps of Engineers in connection with the review of applications for permits to authorize the discharge of dredged or fill material into waters of the United States pursuant to Section 404 of the Clean Water Act.	Substantive portions of 33 CFR Parts 320, 323 325, 329 and 330 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Clean Air Act, 42 USC s/s 7401 et seq. (1970)	40 CFR Part 60	Standards of Performance for New Stationary Sources	Substantive portions of 40 CFR Part 60 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Clean Air Act, 42 USC s/s 7401 et seq. (1970)	40 CFR Parts 61 and 63	Part 61- National Emission Standards for Hazardous Air Pollutants. Part 63 - National Emission Standards for Hazardous Air Pollutants for Source Categories.	Substantive portions of 40 CFR Parts 61 and 63 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
Section 402 of the Clean Water Act	40 CFR Parts 121, 122, 125, 401 and 403.5	Provisions related to the implementation of the National pollutant Discharge Elimination System (NPDES) program	Substantive portions of 40 CFR Parts 121, 122, 125, 401 and 403.5 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Section 404(b) of the Clean Water Act	40 CFR Part 230	Guidelines for Specification of Disposal Sites for Dredged or Fill Material. Except as otherwise provided under Clean Water Act Section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. Includes criteria for evaluating whether a particular discharge site may be specified.	Substantive portions of 40 CFR Part 230 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act	40 CFR Part 257	Criteria for Classification of Waste Disposal Facilities	Substantive portions of 40 CFR Part 257 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act 42 USC s/s 6901 et seq. (1976)	40 CFR Part 261	Identification and listing of hazardous waste	Substantive portions of 40 CFR Parts 261 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act 42 USC s/s 6901 et seq. (1976)	40 CFR Part 262	Standards applicable to generators of hazardous waste	Substantive portions of 40 CFR Part 262 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act 42 USC s/s 6901 et seq. (1976)	40 CFR § 262.11	Hazardous waste determination	Substantive portions of 40 CFR § 262.11 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act, 42 USC s/s 6901 et seq. (1976)	40 CFR Part 262.34	Standards for Hazardous Waste Generators, 90-Day Accumulation Rule	Substantive portions of 40 CFR § 262.34 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act, 42 USC s/s 6901 et seq. (1976)	40 CFR Part 264 and 265, Subparts	Standards for Owners/Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.	Substantive portions of the referenced Subparts of Parts 264 and 265 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
	B-264.10 - .19	B- General Facility Standards	
	F-264.90 - .101	F- Releases from Solid Waste Management Units	
	G-264.110 - .120	G- Closure and Post Closure	
	J-264.190 - .200	J- Tank Systems	
	S-264.550 - .555	S- Special Provisions for Cleanup	
	X-264.600 - .603	X- Miscellaneous Units	
Section 3004 of the Resource Conservation and Recovery Act (Solid Waste Disposal Act, as amended), 42 USC § 6924	40 CFR § 264. 13(b)	Owner or operator of a facility that treats, stores or disposes of hazardous wastes must develop and follow a written waste analysis plan.	Substantive portions of 40 CFR § 264.13(b) are potential relevant and appropriate action-specific ARARs for purposes of on-site response.

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
Resource Conservation and Recovery Act, 42 USC s/s 6901 et seq. (1976)	40 CFR Part 264 and 265, Subparts	Standards for Owners/Operators of Hazardous Waste Treatment, Storage and Disposal Facilities.	Substantive portions of the referenced Subparts of Parts 264 and 265 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
	K-264.220 - .232	K- Surface Impounds	
	L-264.250 - .259	L- Waste Piles	
	N – 264.300 - .317	N- Landfills, Subtitle C	
Section 3004 of the Resource Conservation and Recovery Act, as amended, 42 USC § 6924	40 CFR § 264.232	Owners and operators shall manage all hazardous waste placed in a surface impoundment in accordance with 40 CFR Subparts BB (Air Emission Standards for Equipment Leaks) and CC (Air Emission Standards for Tanks, Surface Impoundments and Containers).	Substantive portions of 40 CFR § 264.232 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Resource Conservation and Recovery Act, 42 USC s/s 6901 et seq. (1976)	40 CFR Part 268	Land disposal restrictions	Substantive portions of 40 CFR Part 268 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
		C- Prohibitions on Land Disposal	
Toxic Substances Control Act (TSCA), Title 1,15 USC § 2605	40 CFR Part 761	Polychlorinated biphenyls (PCBs) manufacturing, processing, distribution in commerce, and use prohibitions	Substantive portions of 40 CFR Part 761 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Hazardous Materials Transportation Act, as amended, 49 USC §§ 5101 – 5127	49 CFR Part 170	Transport of hazardous materials program procedures.	Substantive portions of 49 CFR Part 170 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Hazardous Materials Transportation Act, as amended, 49 USC §§ 5101 – 5127	49 CFR Part 171	Department of Transportation Rules for Transportation of Hazardous Materials, including procedures for the packaging, labeling, manifesting and transporting of hazardous materials.	Substantive portions of 49 CFR Part 171 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Occupational Safety and Health Act	29CFR 1904, 1910, and 1926	Specifies minimum requirements to maintain worker health and safety during hazardous waste operations, including training and construction safety requirements.	Substantive portions of 29 CFR 1904, 1940, and 1926 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 17, Title 5	____	It shall be unlawful for any person, directly or indirectly, to throw, drain, run or otherwise discharge into such waters organic or inorganic matter that shall cause or contribute to a condition in contravention of applicable standards identified at 6 NYCRR § 701.1.	Substantive portions of 17-0501, 17-0503, 17-0505, 17-0507, 17-0509 and 17-0511 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 11, Title 5	NY ECL § 11-0503	Fish & Wildlife Law against water pollution. No deleterious or poisonous substances shall be thrown or allowed to run into any public or private waters in quantities injurious to fish life, protected wildlife, or waterfowl inhabiting those waters, or injurious to the propagation of fish, protected wildlife, or waterfowl therein.	Substantive portions of 11-0503 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 27, Title 3	6 NYCRR Part 364	Standards for Waste Transportation Regulations governing the collection, transport and delivery of regulated wastes, including hazardous wastes.	Substantive portions of 6 NYCRR Part 364 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 27, Title 9	6 NYCRR Parts 370 and 371	New York State regulations for activities associated with hazardous waste management.	Substantive portions of 6 NYCRR Parts 370 and 371 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 3, Title 3; Article 27, Titles 7 and 9	6 NYCRR Part 372	Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities. Includes Hazardous Waste Manifest System requirements for generators, transporters, and treatment, storage or disposal facilities, and other requirements applicable to generators and transporters of hazardous waste.	Substantive portions of 6 NYCRR Part 372 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
New York State ECL Article 27 Title 13	6 NYCRR Part 375	Inactive Hazardous Waste Disposal Sites. Establishes standards for the development and implementation of inactive hazardous waste disposal site remedial programs.	Substantive portions of 6 NYCRR Part 375 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 27, Title 9	6 NYCRR Part 376	Land Disposal Restrictions. PCB wastes including dredge spoils containing PCBs greater than 50 ppm must be disposed of in accordance with federal regulations at 40 CFR Part 761.	Substantive portions of 6 NYCRR Part 376 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL, Article 1. Title 1, Article 3 Title 3, Article 15 Title 3, Article 17 Title 1, 3, 8	6 NYCRR Part 700-706	New York limitations on discharges of sewage, industrial waste or other wastes.	Substantive portions of 6 NYCRR Parts 701 and 703 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL Article 17, Title 8	6 NYCRR Parts 750 – 758	New York State Pollutant Discharge Elimination System (SPDES) Requirements Standards for Storm Water Runoff, Surface Water, and Groundwater Discharges, In general, no person shall discharge or cause a discharge to NY State waters of any pollutant without a permit under the New York State Pollutant Discharge Elimination System (SPDES) program.	Substantive portions of 6 NYCRR Parts 750 - 758 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
New York State ECL, Article 8	6 NYCRR Part 617	State Environmental Quality Review, which provides general rules and actions for agencies to determine whether the actions they directly undertake, fund or approve may have a significant impact on the environment, and, if it is determined that the action may have a significant adverse impact, prepare or request an environmental impact statement.	Substantive portions of 6 NYCRR Parts 617 are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
Local County or Municipality Pretreatment Requirements	Local regulations	Local regulations	Local pretreatment requirements are potential relevant and appropriate action-specific ARARs for purposes of on-site response.
USEPA	Rules of Thumb for Superfund Remedy Selection (EPA 540-R-97- 013, August 1997)	Describes key principles and expectations, as well as "best practices" based on program experience for the remedy selection process under Superfund. Major policy areas covered are risk assessment and risk management, developing remedial alternatives, and groundwater response actions.	TBC
USEPA	Land Use in the CERCLA Remedy Selection Process (OSWER Directive No. 9355.7-04, May 1995)	Presents information for considering land use in making remedy selection decisions at NPL sites.	TBC
USEPA	Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (OSWER Directive 9285.6-08, February 2002)	Presents risk management principles that site managers should consider when making risk management decisions at contaminated sediment sites.	TBC
USEPA	Contaminated Sediment Strategy (EPA-823-R-98- 001, April 1998)	Establishes an Agency-wide strategy for contaminated sediments, with the following four goals: 1) prevent the volume of contaminated sediments from increasing; 2) reduce the volume of existing contaminated sediment; 3) ensure that sediment dredging and dredged material disposal are managed in an environmentally sound manner; and 4) develop scientifically sound sediment management tools for use in pollution prevention, source control, remediation, and dredged material management.	TBC
USEPA	Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (EPA-540-R-05-012, December 2005)	Provides technical and policy guidance for addressing contaminated sediment sites nationwide primarily associated with CERCLA actions.	TBC

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
USEPA	Structure and Components of Five-Year Reviews (OSWER Directive 9355.7-02, May 1991) Supplemental Five-Year Review Guidance (OSWER Directive 9355.7-02A, July 1994) Second Supplemental Five-Year Review Guidance (OSWER 9355.7-03A, December 1995)	Provides guidance on conducting Five-Year Reviews for sites at which hazardous substances, pollutants, or contaminants remain on-site above levels that allow for unrestricted use and unlimited exposure. The purpose of the Five-Year Review is to evaluate whether the selected response action continues to be protective of public health and the environment and is functioning as designed:	TBC
USEPA	40 CFR Part 50	Clean Air Act, National Ambient Air Quality Standards	TBC
USACE	Notice on Issuance of Nationwide Permits, new general conditions and 13 new definitions, 72FR11092, Mar 12, 2007.	Reissuance of Nationwide Permits, new general conditions and 13 new definitions	TBC
USACE	Notice Announcing NWP Final Regional Conditions, July 28, 2008	New regional condtions for NWP regional conditions for the Buffalo District	TBC
DEC	New York Guidelines for Soil Erosion and Sediment Control		TBC
DEC	Technical and Operational Guidance Series (TOGS) 1.1.1 Ambient Water	Provides guidance for ambient water quality standards and guidance values for pollutants	TBC
DEC	Technical and Operational Guidance Series (TOGS) 1.2.1 Industrial SPDES Permit Drafting Strategy for Surface Waters	Provides guidance for writing permits for discharges of wastewater from industrial facilities and for writing requirements equivalent to SPDES permits for discharges from remediation sites.	TBC
DEC	Technical and Operational Guidance Series (TOGS) 1.3.1 Waste Assimilative Capacity Analysis & Allocation for Setting	Provides guidance to water quality control engineers in determining whether discharges to water bodies have a reasonable potential to violate water quality standards and guidance values.	TBC
DEC	Technical and Operational Guidance Series (TOGS) 1.3.2 Toxicity Testing in the SPDES Permit Program	Describes the criteria for deciding when toxicity testing will be required in a permit and the procedures which should be followed when including toxicity testing requirements in a permit.	TBC
DEC, Division of Environmental Remediation	Technical and Administrative Guidance Memorandum (TAGM) 4031 Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites	Provides guidance on fugitive dust suppression and particulate monitoring for inactive hazardous waste sites.	TBC
DEC	Interim Guidance on Freshwater Navigational Dredging, October 1994	Provides guidance for navigational dredging activities in freshwater areas.	TBC
DEC Division of Fish, Wildlife and Marine Resources	Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites (FWIA), October 1994	Provides rationale and methods for sampling and evaluating impacts of a site on fish and wildlife during the remedial investigation and other stages of the remedial process	TBC

Table 6-5
ARARs for the Buffalo River Sediment Site
Buffalo, NY

Medium/Authority	Citation	Requirement Synopsis	Status for Buffalo River
DEC TAGM 3028	"Contained-In" Criteria for Environmental Media (November 30, 1992).	Provides "contained-in" concentrations/ action levels for environmental media and the basis for these criteria.	TBC

ARAR Applicable or relevant and appropriate requirement
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act
CFR Code of Federal Regulations
DEC Department of Environmental Conservation
ECL Environmental Conservation Law
NOAA National Oceanic and Atmospheric Administration
NYCRR New York Codes Rules and Regulations
OSWER Office of Solid Waste and Emergency Response
TAGM Technical and Administrative Guidance Memorandum
TBC To be considered
TOGS Technical and Operational Guidance Series
USACE United States Army Corps of Engineers
USC United States Code
USEPA United States Environmental Protection Agency

Table 8-1
SAV Beds Impacted by Remedy Alternative 5
Buffalo River

		Impacted by Dredging															Impacted by Capping		
Species Name	Common Name	SAV-3	SAV-4	SAV-5	SAV-6	SAV-15	SAV-17	SAV-18	SAV-19	SAV-20	SAV-25	SAV-26	SAV-27	SAV-28	SAV-29	**Total**	SAV-8	SAV-9	**Total**
Ceratophyllum demersum	coontail			X	X	X	X	X	X	X	X				X		X	X	
Elodea canadensis	Canadian waterweed		X		X	X							X				X		
Justicia americana	American waterwillow				X														
Myriophyllum spicatum	Eurasian watermilfoil		X	X	X	X		X	X	X	X	X	X	X	X		X	X	
Potamogeton crispus	curlyleaf pondweed	X	X			X		X	X			X	X		X		X	X	
Potamogeton nodosus	American pondweed	X				X	X	X	X	X		X	X	X	X				
Potamogeton pectinatus	sago pondweed	X	X	X		X	X	X	X	X	X	X	X	X	X		X	X	
Vallisneria americana	wild celery	X	X	X	X	X	X	X			X	X	X	X	X		X	X	
Water Depth (ft)		3	3.5	3	4.5	8	3	3	4.5	4	4.5	8	10	4	4		9	7	
Approximate Bed Width (ft)		18	10	10	7	10	5	12	10	12	7	8	8	10	14		7	6	
Approximate bed length disturbed by Remedy 5 (ft)		323	247	906	80	581	93	4,767	437	162	117	149	57	8	357	**8,284**	1,750	824	**2,574**
Approximate bed area disturbed by Remedy 5 (sq ft)		5,808	2,469	9,058	561	5,805	467	57,199	4,368	1,942	819	1,192	458	85	5,003	**95,234**	12,253	4,943	**17,197**

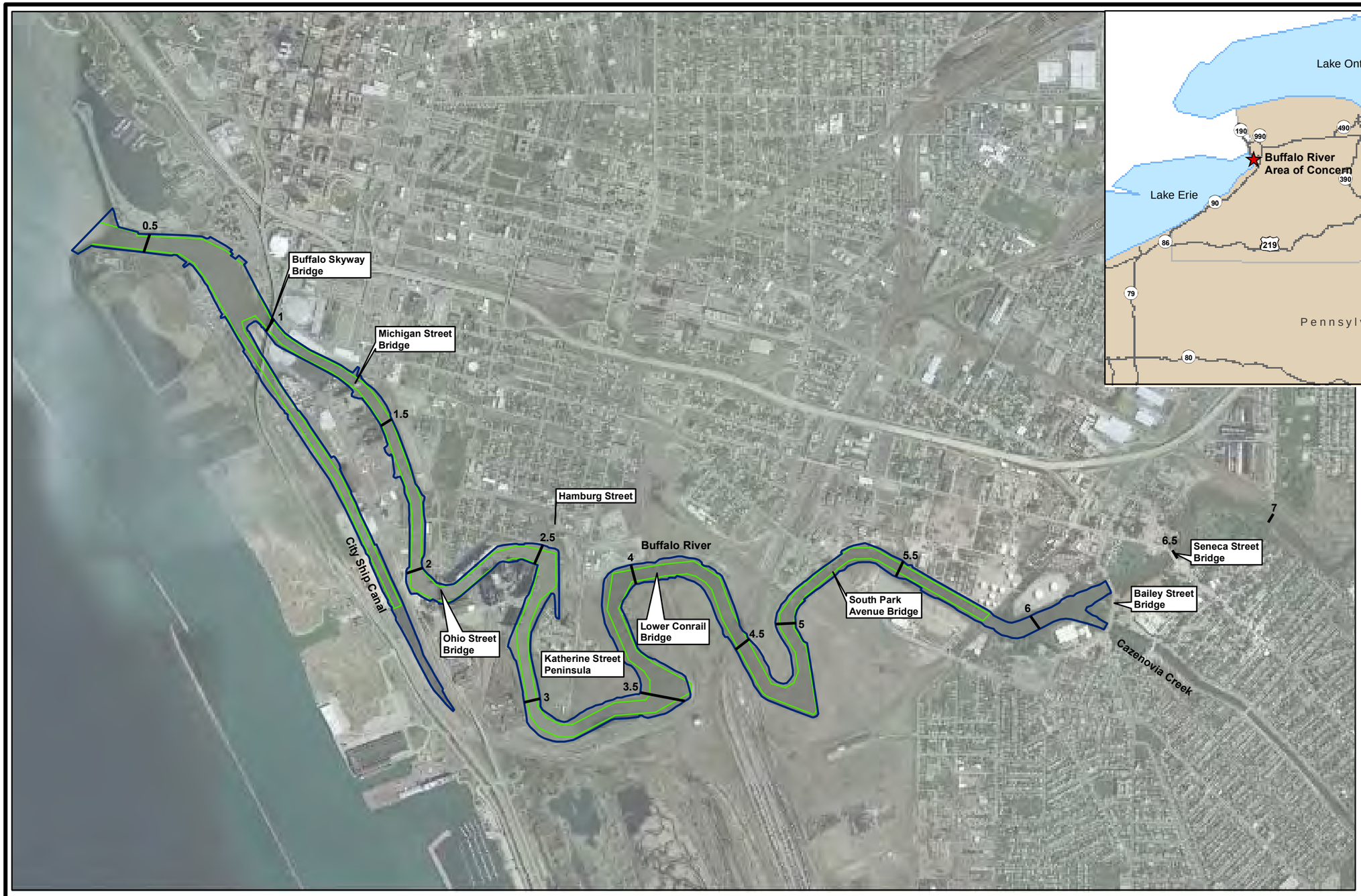
Notes:
AOC - Area of Concern
ft - feet
SAV - Submerged acquatic vegetation

Table 8-2
Emergent Vegetation Impacted by Remedy Alternative 5
Buffalo River, NY

		Impacted by Dredging										
Species Name	Common Name	EV-1	EV-2	EV-3	EV-4	EV-7	EV-9	EV-10	EV-11	EV-12	EV-13	**Total**
Lythrum salicaria	purple loosestrife	X	X	X	X		X			X	X	
Phragmites australis	common reed	X	X	X	X		X			X		
Polygonum cuspidatum	Japanese knotweed		X			X	X	X			X	
Sagittaria latifolia	broadleaf arrowhead										X	
Scirpus validus	softstem bulrush		X						X		X	
Typha latifolia	broadleaf cattail	X	X								X	
Pontederia cordata	pickerelweed										X	
Water Depth (ft)		1	1	0.5	0.5	0.5	0.5	0.5	1	0.5	1	
Approximate Bed Width (ft)		7.5	11	7	10	7.5	12	10	7	9	8.5	
Approximate bed length disturbed by Remedy 5 (ft)		67	38	28	587	570	507	51	79	77	125	**2131**
Approximate bed area disturbed by Remedy 5 (sq ft)		506	416	199	5872	4279	6089	510	552	694	1063	**20178**

Notes:
AOC - Area of Concern
EV - Emergent vegetation
ft - feet

Figures



Legend

- Buffalo River Area of Concern
- Federal Navigation Channel Boundary
- Mile Mark Designations

0 0.2 0.4 0.8 Miles

N

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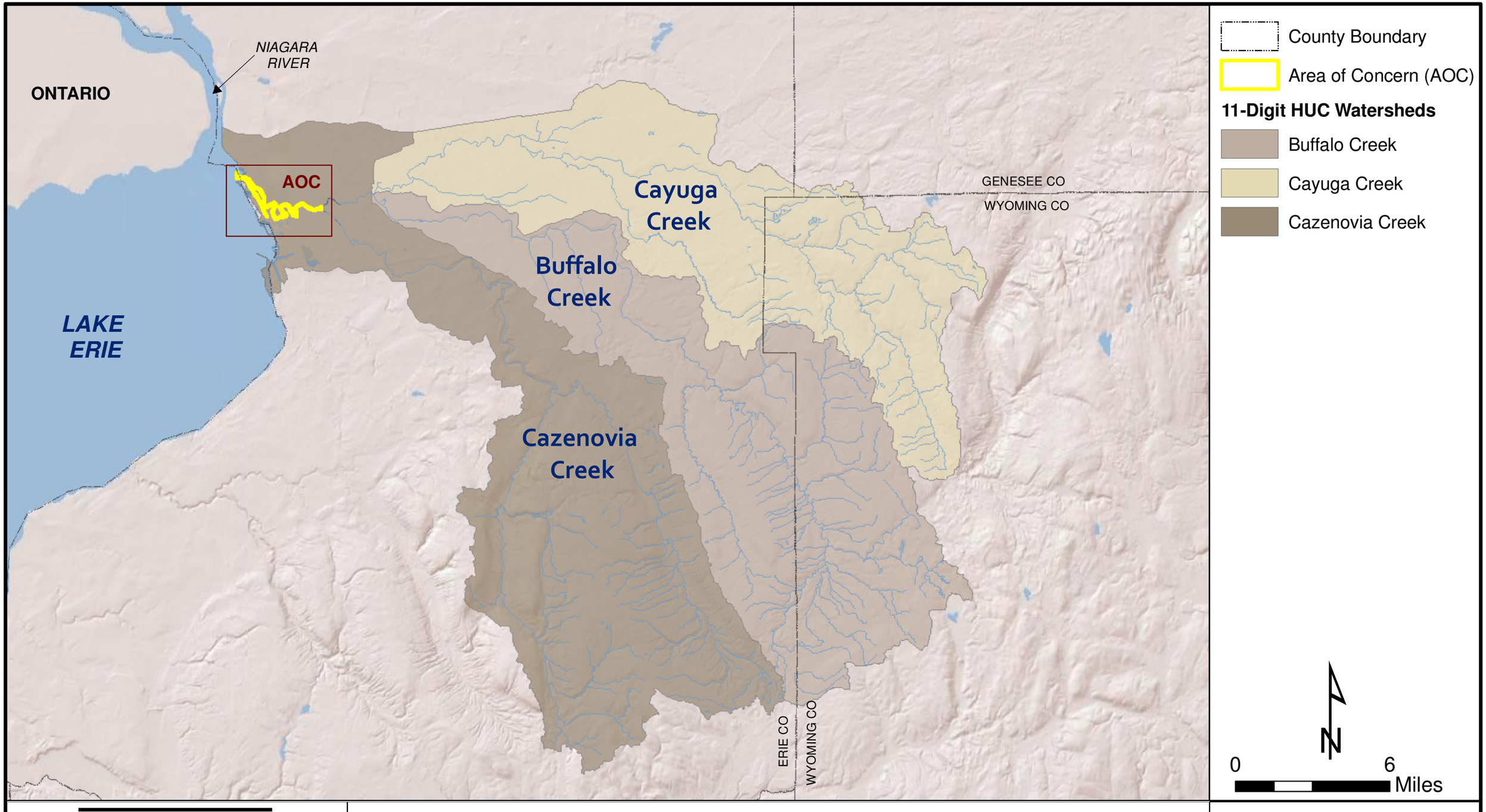
BUFFALO RIVER SITE LOCATION MAP
BUFFALO, NY

Figure 2-1

Drafter: B. Radakovich
Date: 10/15/2009
Name: 20090119_SiteLocation_Map.mxd



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BUFFALO RIVER AOC AND ASSOCIATED WATERSHEDS

Figure 2-2

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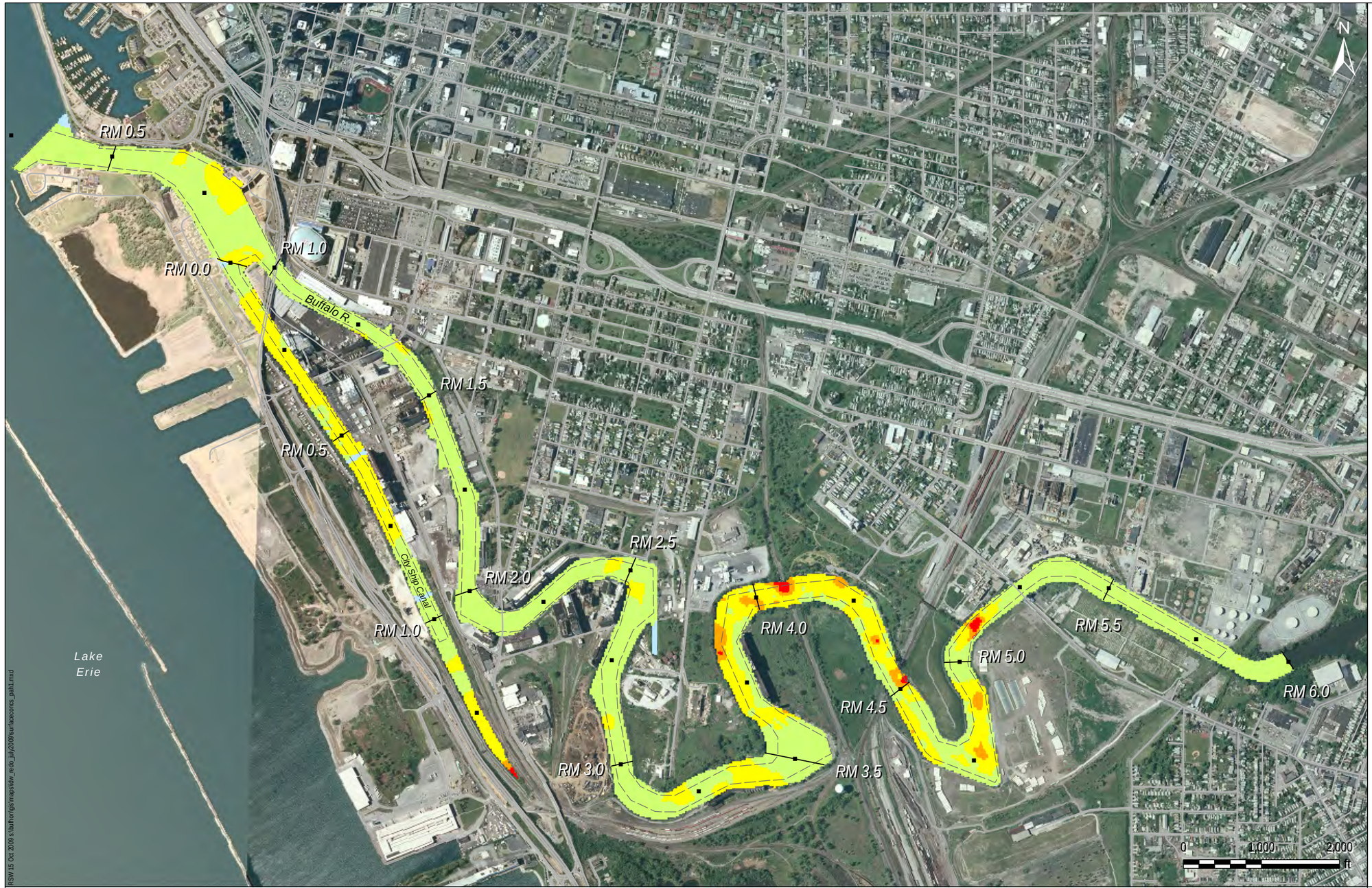

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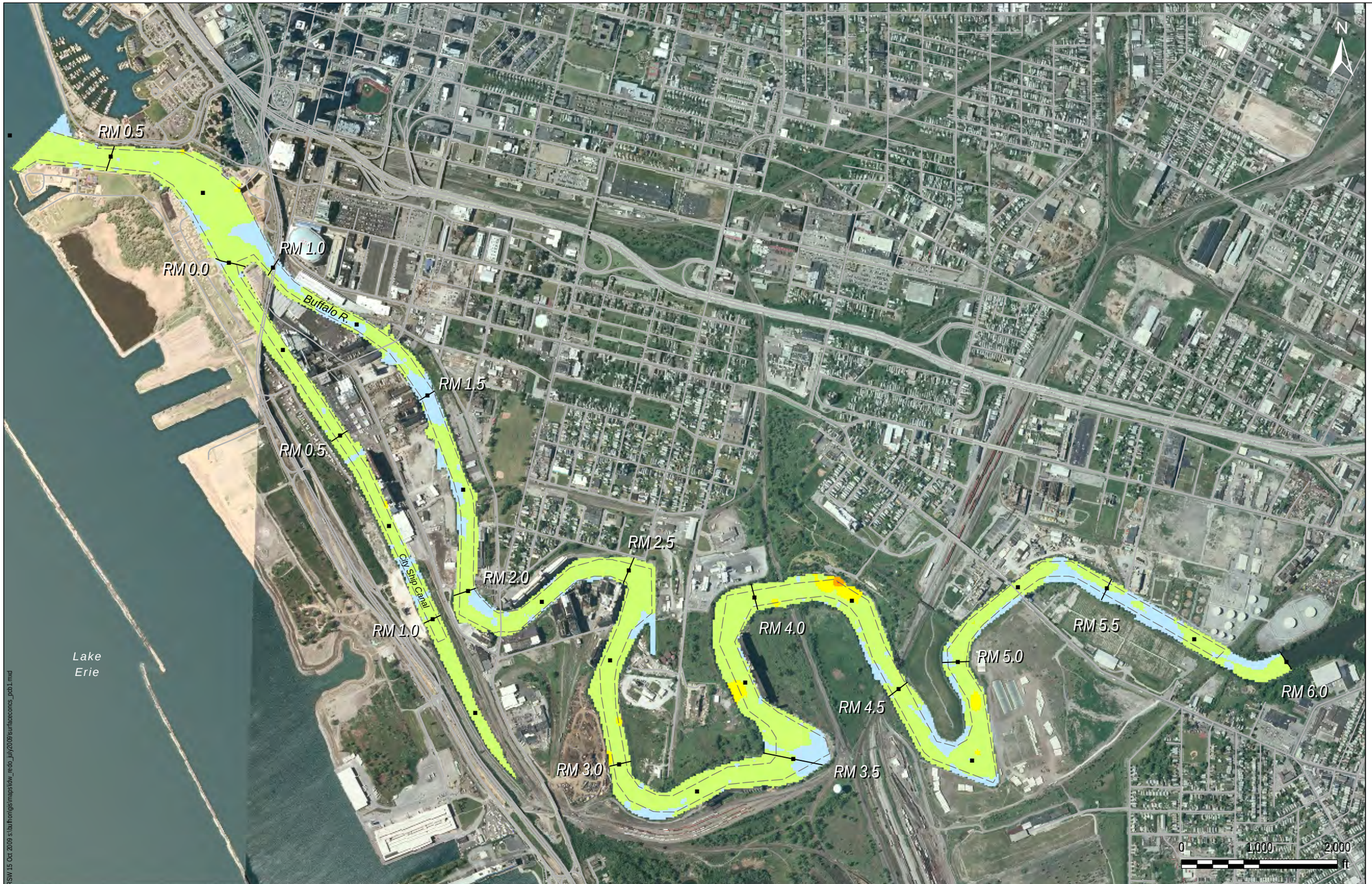
ESTIMATED TOTAL PAH CONCENTRATIONS IN BUFFALO RIVER SURFACE SEDIMENTS
BUFFALO, NY

Figure 2-3



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ESTIMATED TOTAL PCB CONCENTRATIONS IN BUFFALO RIVER SURFACE SEDIMENTS
BUFFALO, NY

Figure 2-4

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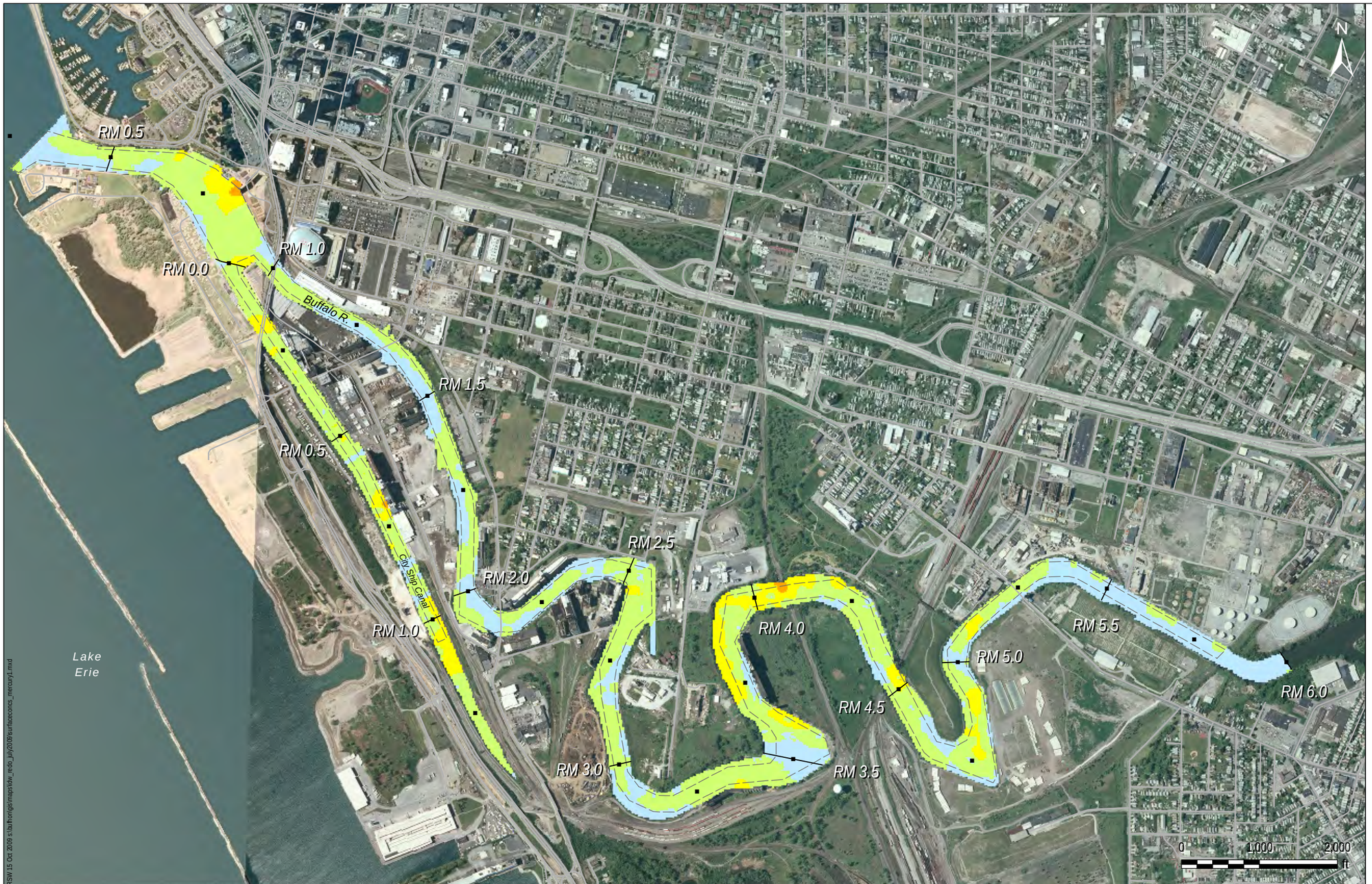
ESTIMATED LEAD CONCENTRATIONS IN BUFFALO RIVER SURFACE SEDIMENTS
BUFFALO, NY

Figure 2-5



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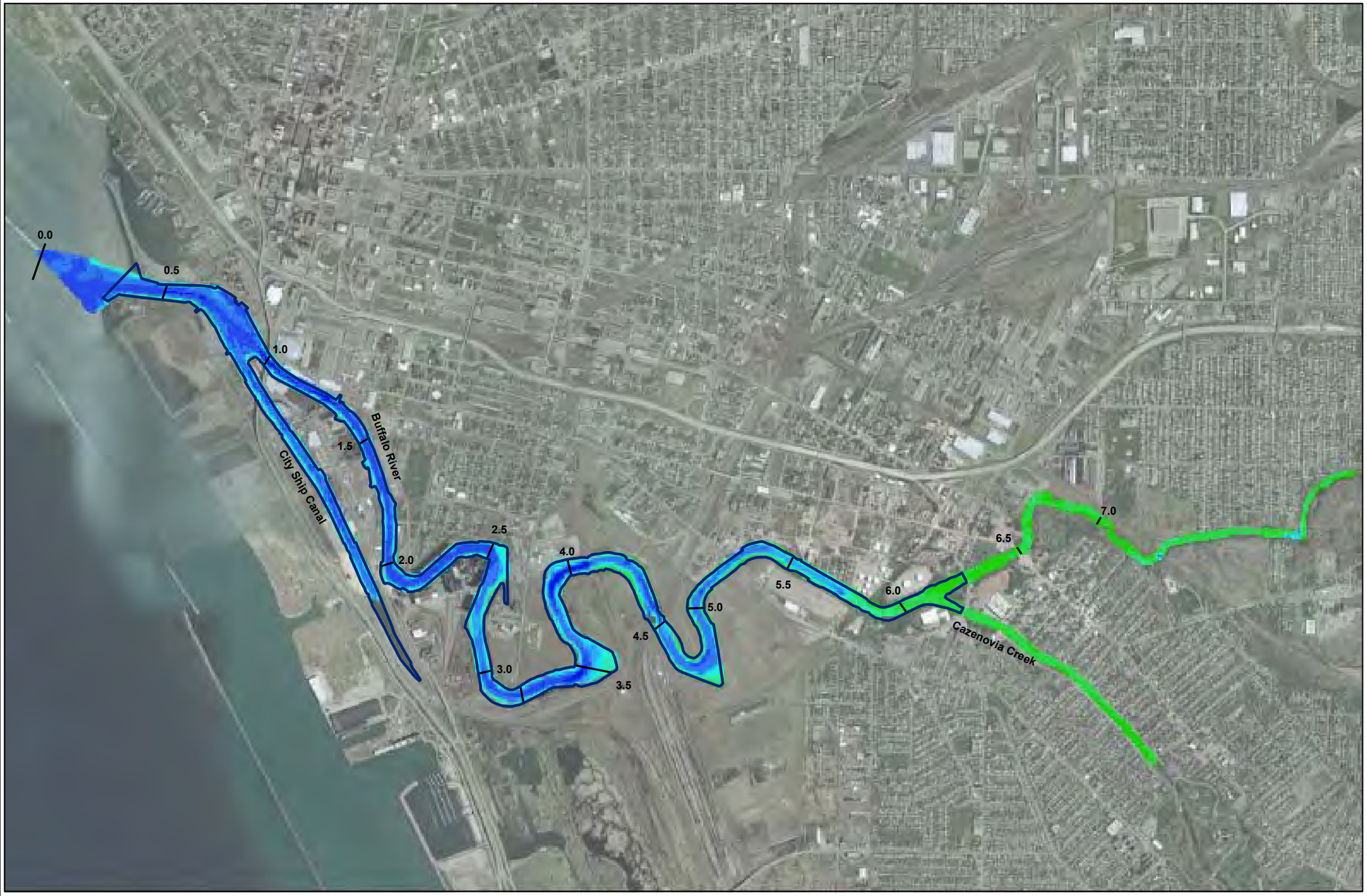
ESTIMATED MERCURY CONCENTRATIONS IN BUFFALO RIVER SURFACE SEDIMENTS
BUFFALO, NY

Figure 2-6



Legend

- Buffalo River Area of Concern
- River Mile Segments

Bathymetry
Feet Deep

- 1 - 5
- 5 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20- 23
- 23 - 26
- 26 - 42

0 0.2 0.4 0.8
Miles

N

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BUFFALO RIVER BATHYMETRY FROM 2007 AND 2008 SURVEYS BUFFALO, NY

Figure 2-7

Drafter: B. Radakovich
Contract Number:
File Name: 20090226_Bathymetry.mxd

Legend

River Half Mile

One Year Recurrence Interval - Peak High Flow Velocity

Velocity (cm/sec.)

- < 1.0
- 1.1 - 5.0
- 5.1 - 10.7
- 10.8 - 20.2
- 20.3 - 30.0
- 30.1 - 37.3
- 37.4 - 41.1
- 41.2 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0
- 70.1 - 80.0
- 80.1 - 90.0
- 90.1 - 100.0
- 100.1 - 125.0
- 125.1 - 150.0
- 150.1 - 175.0
- 175.1 - 200.0
- > 250

0 0.25 0.5

Miles

N

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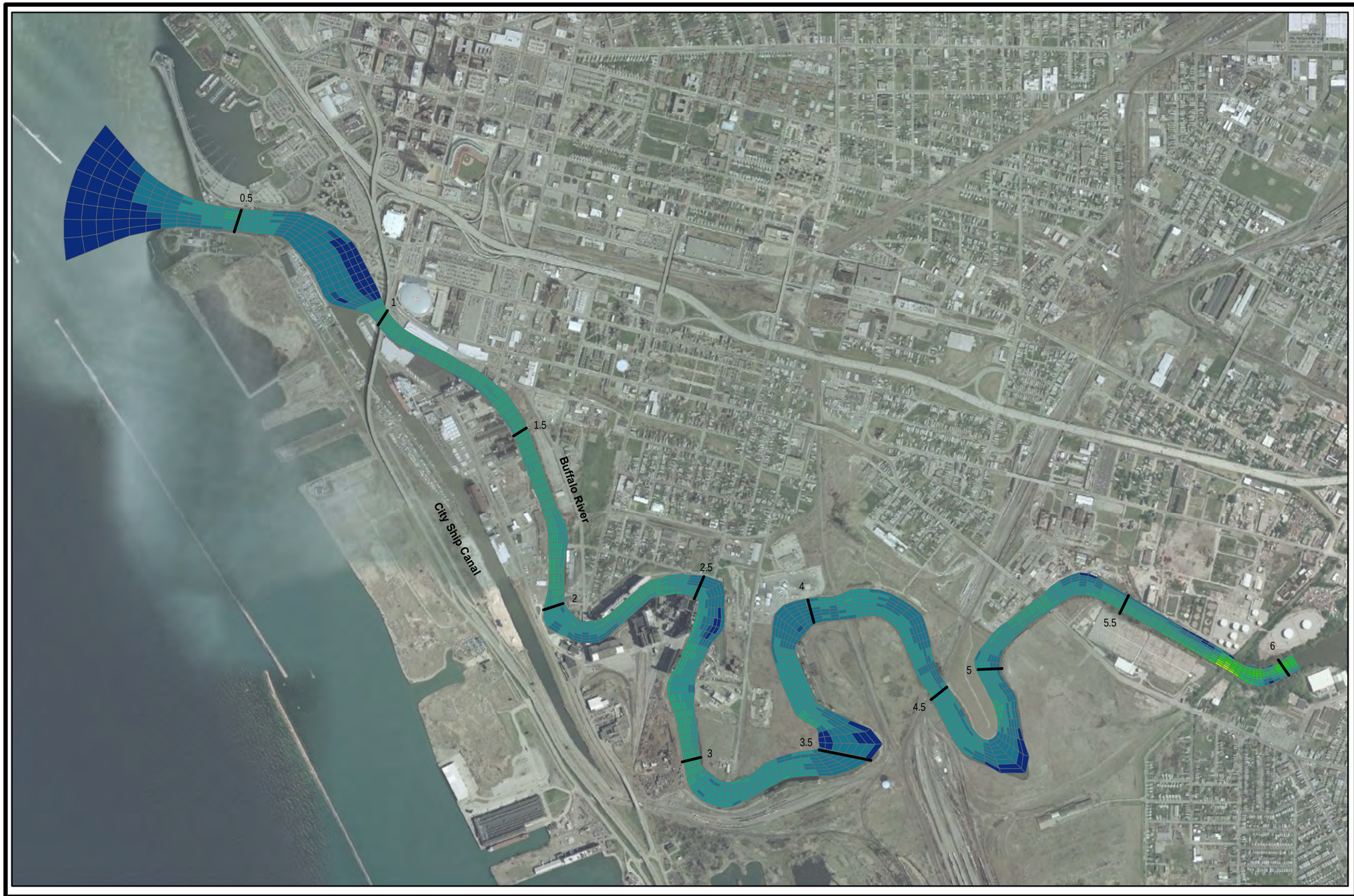
Buffalo River Model Predicted Velocity at the Peak of the October 16, 2008 High Flow Event (1-year Recurrence Interval)

Figure 2-8

Drafter: A. Motzny
Contract Number: BUFHON
File Name: Fig3_36_Velocity_HigFlow_Peak_1yr.mxd



River Half Mile

One Year Recurrence Interval - Peak High Flow Shear Stress

Shear Stress (dynes/cm2)

- < 1.0
- 1.01 - 1.04
- 1.05 - 5.00
- 5.01 - 10.00
- 10.01 - 20.00
- 20.01 - 30.00
- 30.01 - 40.00
- 40.01 - 50.00
- 50.01 - 60.00
- 60.01 - 70.00
- 70.01 - 80.00
- 80.01 - 90.00
- 90.01 - 100.00
- 100.01 - 125.00
- 125.01 - 150.00
- 150.01 - 175.00
- 175.01 - 200.00
- > 250

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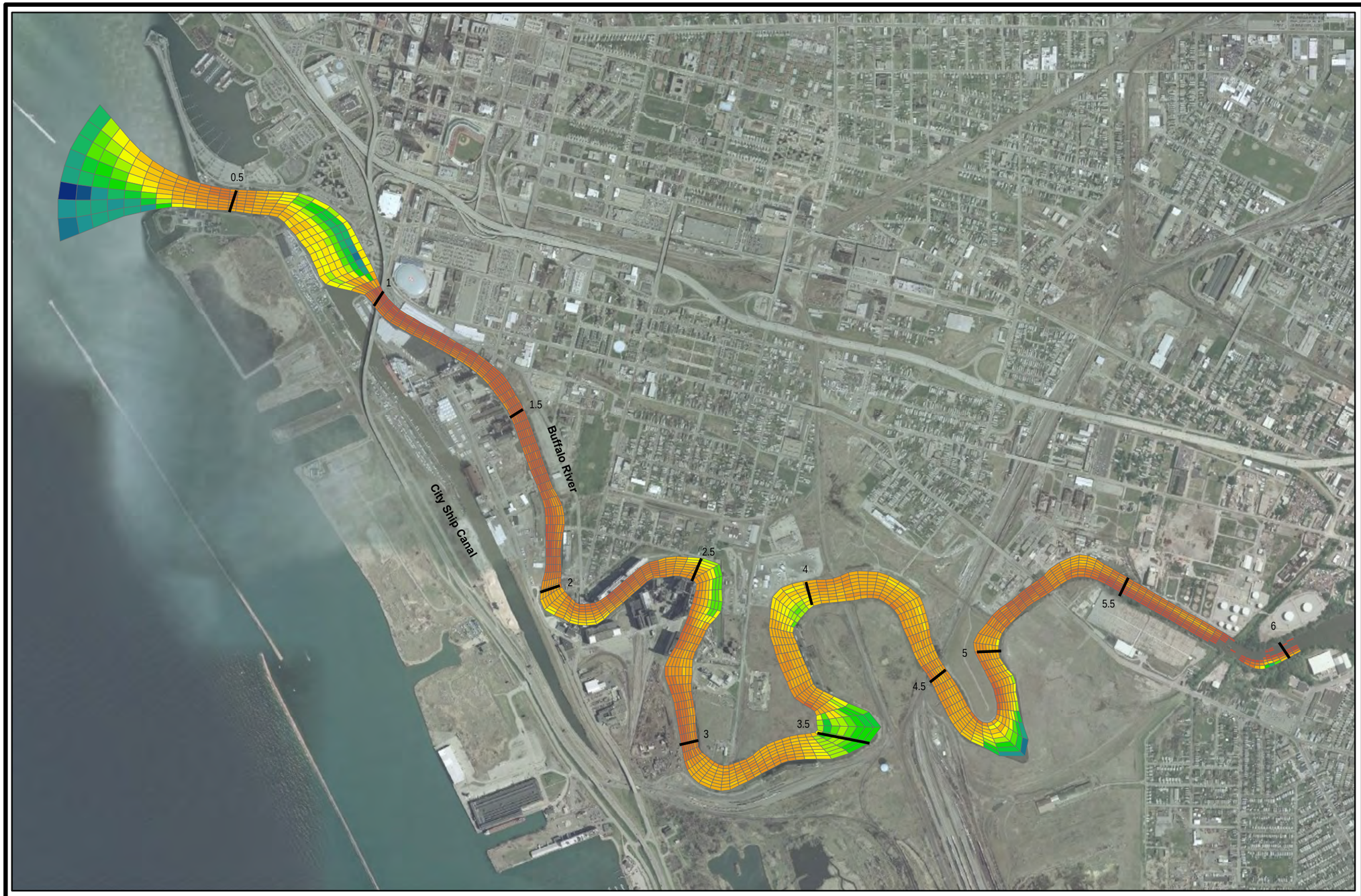
Buffalo River Model Predicted Bottom Shear Stress at the Peak of the October 16, 2008 High Flow Event (1-year Recurrence Interval)

Figure 2-9



Legend

River Half Mile

Ten Year Recurrence Interval - Peak High Flow Velocity

Velocity (cm/sec.)

- < 1.0
- 0.3 - 1.0
- 1.1 - 5.0
- 5.1 - 10.0
- 10.1 - 20.0
- 20.1 - 30.0
- 30.1 - 40.0
- 40.1 - 50.0
- 50.1 - 60.0
- 60.1 - 70.0
- 70.1 - 80.0
- 80.1 - 90.0
- 90.1 - 100.0
- 100.1 - 125.0
- 125.1 - 150.0
- 150.1 - 175.0
- 175.1 - 200.0
- > 250

0 0.25 0.5

Miles

N

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Buffalo River Model Predicted Velocity at the Peak of the January 29, 2002 High Flow Event (10-year Recurrence Interval)

Figure 2-10

Drafter: A. Motzny
Contract Number: BUFHON
File Name: Fig3_38_Velocity_HigFlow_Peak_10yr.mxd

River Half Mile

Ten Year Recurrence Interval - Peak High Flow Velocity Shear Stress (dynes/cm2)

- < 1.0
- 1.01 - 1.00
- 1.01 - 5.67
- 5.68 - 10.00
- 10.01 - 20.00
- 20.01 - 30.62
- 30.63 - 40.00
- 40.01 - 50.00
- 50.01 - 60.00
- 60.01 - 70.00
- 70.01 - 80.00
- 80.01 - 90.00
- 90.01 - 100.00
- 100.01 - 125.00
- 125.01 - 150.00
- 150.01 - 175.00
- 175.01 - 200.00
- > 250

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Buffalo River Model Predicted Bottom Shear Stress at the Peak of the January 29, 2002 High Flow Event (10-year Recurrence Interval)

Figure 2-11

Remedy Alternative 3

Target the PAH remedy goal (RG) of 1 TU at all sediment depths, and SWAC RGs for PCBs, mercury, and lead.

Remedy Alternative 3

- Dredge
- Area supported by only one sample station and to be resampled
- Cap
- US Army Corps of Engineers navigation channel
- River 1/2 mile marker
- River 1/4 mile marker

RSW 29 Sept 2009 s:\buffhon\gis\maps\dw_redo_july2009\rem3_v3.mxd

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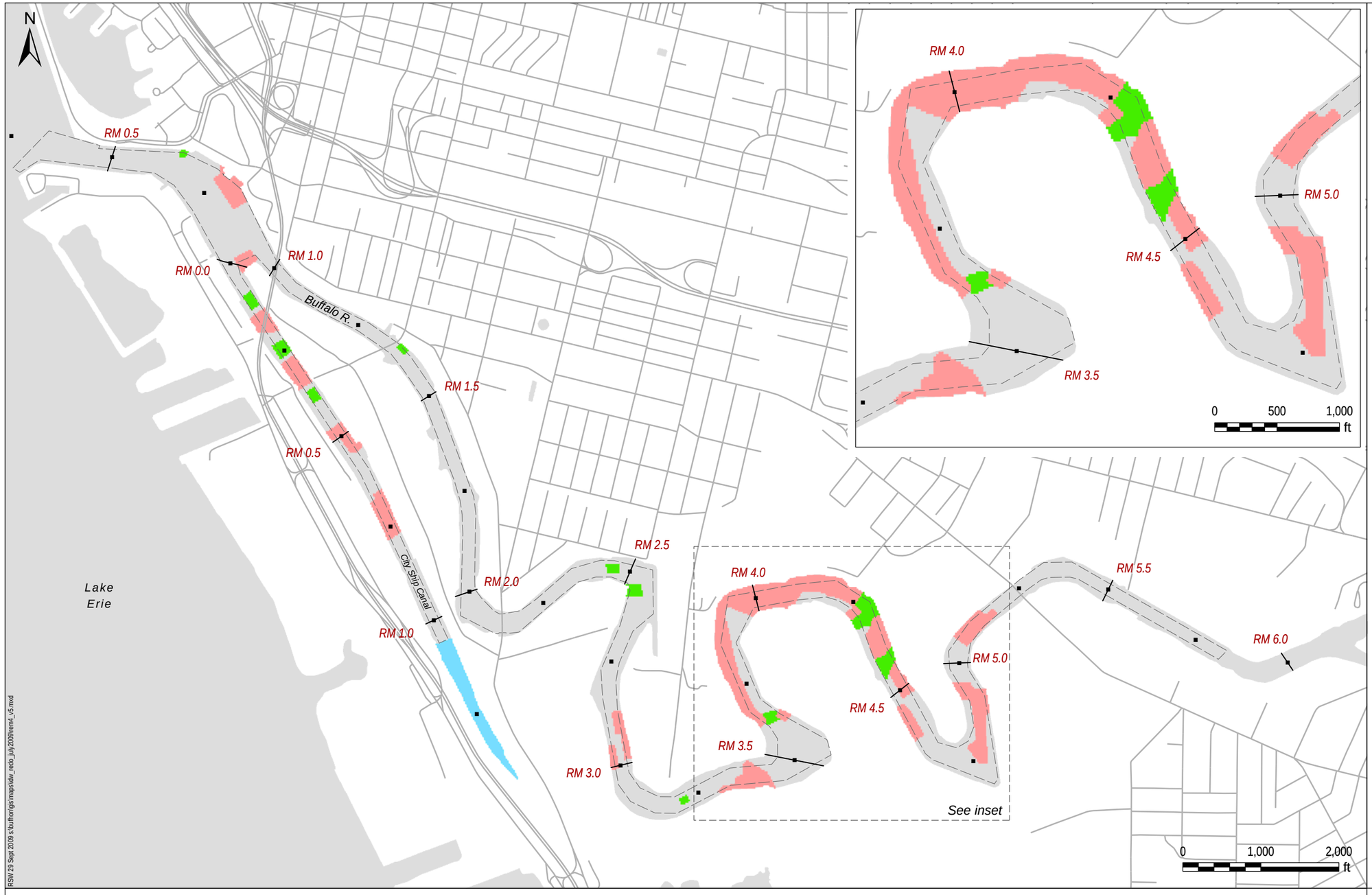
REMEDY ALTERNATIVE 3
BUFFALO, NY

Figure 5-1a



Remedy Alternative 4

Target the PAH remedy goal (RG) of 1 TU in surface (0-1 ft) sediment, and SWAC RGs for PCBs, mercury, and lead.

Remedy Alternative 4

- Dredge
- Area supported by only one sample station and to be resampled
- Cap
- US Army Corps of Engineers navigation channel
- River 1/2 mile marker
- River 1/4 mile marker

RSW 29 Sept 2009 s:\buffnon\gis\maps\dlw_redo_july2009\rema4_v5.mxd

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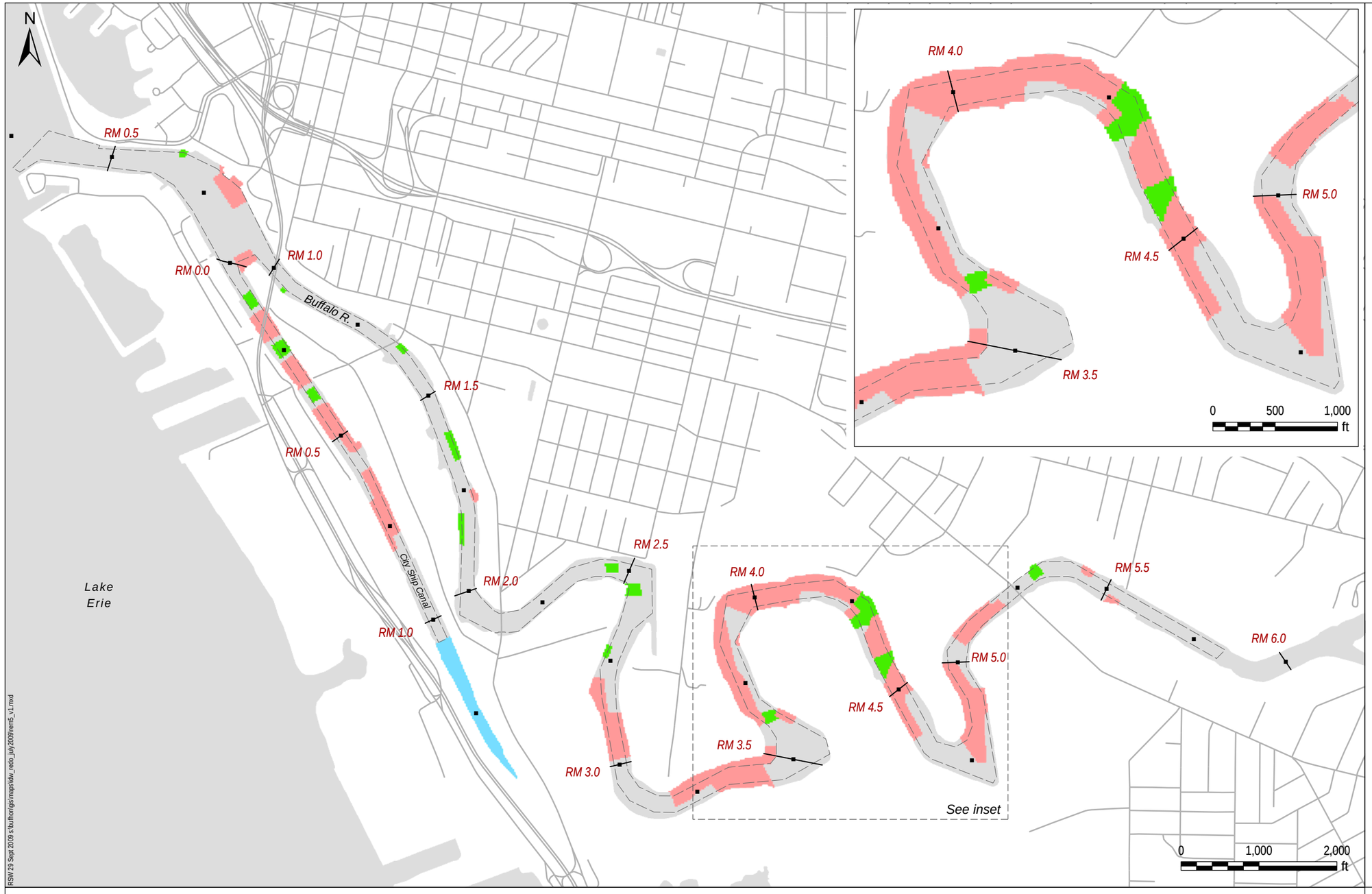
REMEDY ALTERNATIVE 4
BUFFALO, NY

Figure 5-1b



Remedy Alternative 5

Target the PAH remedy goal (RG) of 1 TU in surface (0-1 ft) sediment, SWAC RGs for PCBs, mercury, and lead, and elevated PAH, PCB, mercury, and lead concentrations at sediment depths of 0-4 ft.

Remedy Alternative 5

- Dredge
- Area supported by only one sample station and to be resampled
- Cap

- US Army Corps of Engineers navigation channel
- River 1/2 mile marker
- River 1/4 mile marker

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REMEDY ALTERNATIVE 5
BUFFALO, NY

Figure 5-1c

Legend

Aquatic Vegetation Survey
- Emergent Aquatic Vegetation
- Submergent Aquatic Vegetation

Remedy Alternative 3 Footprint

Remediation Type
- Dredge
- Cap

Notes:
--Aquatic vegetation provided by MACTEC 2008
--Aerial imagery provided by ESRI online services 09/2009

0 0.125 0.25 0.5
Miles

N

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REMEDY ALTERNATIVE 3 - REMEDIATION LIMITS AND AQUATIC VEGETATION SURVEY BUFFALO, NY

Figure 6-1a

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_AquaticVegetation_Remedy3.mxd

Legend

Aquatic Vegetation Survey
- Emergent Aquatic Vegetation
- Submergent Aquatic Vegetation

Remedy Alternative 4 Footprint

Remediation Type
- Dredge
- Cap

Notes:
--Aquatic vegetation provided by MACTEC 2008
--Aerial imagery provided by ESRI online services 09/2009

0 0.125 0.25 0.5
Miles

N

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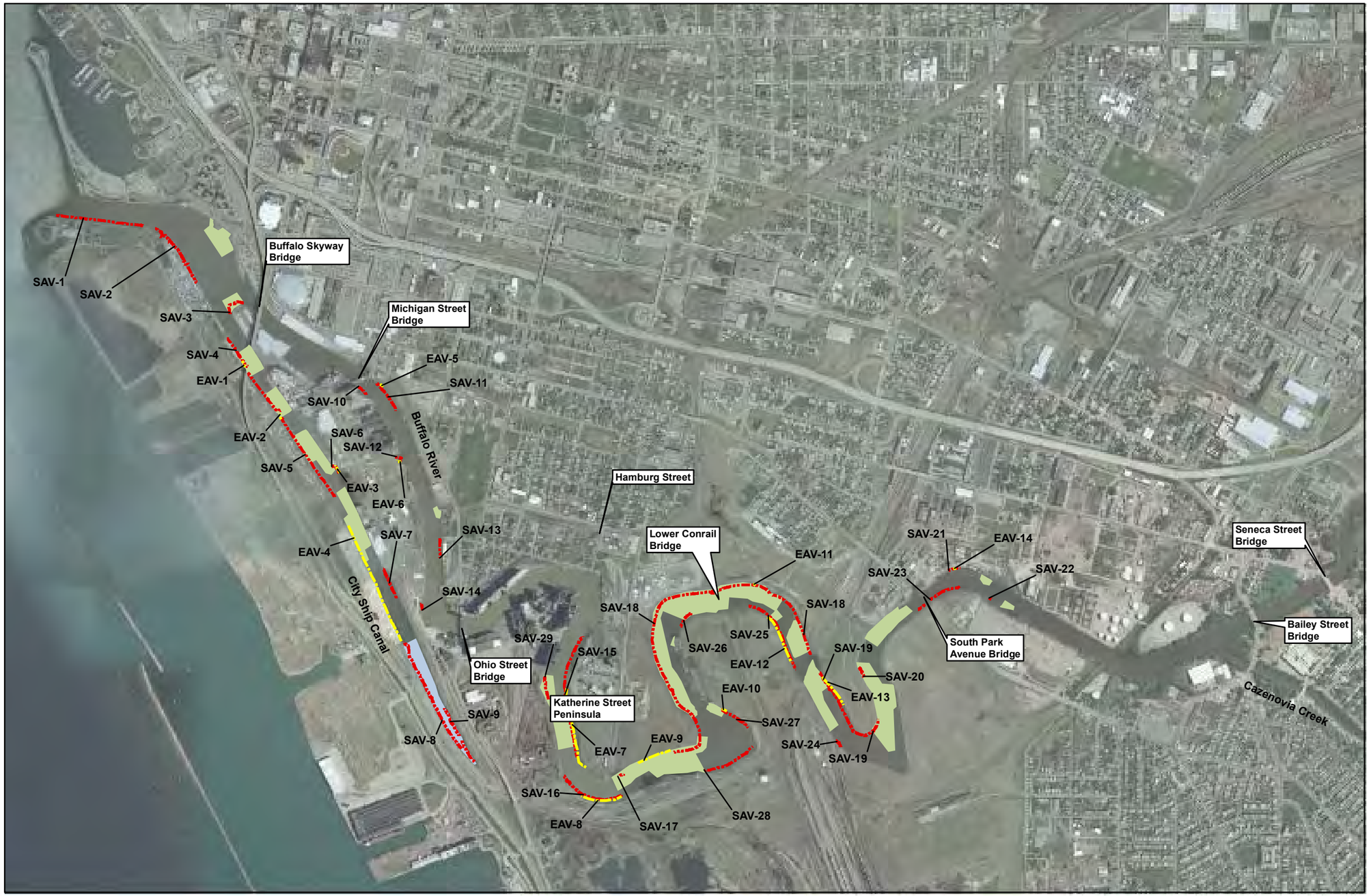
REMEDY ALTERNATIVE 4 - REMEDIATION LIMITS AND AQUATIC VEGETATION SURVEY BUFFALO, NY

Figure 6-1b

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_AquaticVegetation_Remedy3.mxd



Legend

Aquatic Vegetation Survey

- Emergent Aquatic Vegetation
- Subemergent Aquatic Vegetation

Remedy Alternative 5 Footprint

Remediation Type

- Dredge
- Cap

Notes:

--Aquatic vegetation provided by MACTEC 2008

--Aerial imagery provided by ESRI online services 09/2009

0 0.125 0.25 0.5

Miles

N

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REMEDY ALTERNATIVE 5 - REMEDIATION LIMITS AND AQUATIC VEGETATION SURVEY BUFFALO, NY

Figure 6-1c

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_AquaticVegetation_Remedy5.mxd

Ship Canal | Ohio St Bridge | NY Central RR Bridge | Park Ave Bridge | Cazenovia Creek

Right Bank

Navigation Channel

Left Bank

Depth from Sediment Surface (ft)

0 -2 -4 -6 -8 -10 -12 -14

0 1 2 3 4 5 6

Approximate Extent of Dredged Channel

Distance from River Mouth (Miles)

Total PAHs (TU)

- < 1
- 1 - 2
- 2 - 5
- > 5
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Total PAH Concentrations for the Buffalo River, Buffalo, NY

Figure 6-2a

Wednesday, October 21, 2009 3:51:01 PM
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Ship Canal | Ohio St Bridge | NY Central RR Bridge | Park Ave Bridge | Cazenovia Creek

Right Bank

Navigation Channel

Left Bank

Depth from Sediment Surface (ft)

0 -2 -4 -6 -8 -10 -12 -14

0 1 2 3 4 5 6

Approximate Extent of Dredged Channel

Distance from River Mouth (Miles)

Lead (mg/kg)

- < 90
- 90 - 400
- 400 - 800
- > 800
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Lead Concentrations for the Buffalo River, Buffalo, NY

Figure 6-2b

Wednesday, October 21, 2009 3:51:01 PM
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Ship Canal | Ohio St Bridge | NY Central RR Bridge | Park Ave Bridge | Cazenovia Creek

Right Bank

Navigation Channel

Left Bank

Depth from Sediment Surface (ft)

0 -2 -4 -6 -8 -10 -12 -14

0 1 2 3 4 5 6

Approximate Extent of Dredged Channel

Distance from River Mouth (Miles)

Mercury (mg/kg)

- < 0.44
- 0.44 - 3.0
- 3.0 - 6.0
- > 6.0
- ND
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Mercury Concentrations for the Buffalo River, Buffalo, NY

Figure 6-2c

Wednesday, October 21, 2009 3:51:01 PM
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Ship Canal | Ohio St Bridge | NY Central RR Bridge | Park Ave Bridge | Cazenovia Creek

Right Bank

Navigation Channel

Left Bank

Depth from Sediment Surface (ft)

0 -2 -4 -6 -8 -10 -12 -14

0 1 2 3 4 5 6

Approximate Extent of Dredged Channel

Distance from River Mouth (Miles)

Total PCBs (mg/kg)

- < 0.2
- 0.2 - 3
- 3 - 6
- > 6
- ND
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Total PCB Concentrations for the Buffalo River, Buffalo, NY

Figure 6-2d

Wednesday, October 21, 2009 11:46:47 AM
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East Side of Canal

West Side of Canal

Depth from Sediment Surface (ft)

0
-2
-4

0
0.5
1
1.5

Distance from River Mouth (Miles)

Total PAHs (TU)

- < 1
- 1 - 2
- 2 - 5
- > 5
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Total PAH Concentrations for the City Ship Canal, Buffalo, NY

Figure 6-3a

Wednesday, October 21, 2009 4:32:46 PM
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East Side of Canal

West Side of Canal

Depth from Sediment Surface (ft)

0
-2
-4

0
0.5
1
1.5

Distance from River Mouth (Miles)

Lead (mg/kg)

- < 90
- 90 - 400
- 400 - 800
- > 800
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Lead Concentrations for the City Ship Canal, Buffalo, NY

Figure 6-3b

Wednesday, October 21, 2009 4:32:46 PM
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East Side of Canal

West Side of Canal

Depth from Sediment Surface (ft)

0
-2
-4

0
0.5
1
1.5

Distance from River Mouth (Miles)

Mercury (mg/kg)

- < 0.44
- 0.44 - 3.0
- 3.0 - 6.0
- > 6.0
- ND
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Mercury Concentrations for the City Ship Canal, Buffalo, NY

Figure 6-3c

Wednesday, October 21, 2009 4:32:46 PM
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East Side of Canal

West Side of Canal

Depth from Sediment Surface (ft)

0
-2
-4

0
0.5
1
1.5

Distance from River Mouth (Miles)

Total PCBs (mg/kg)

- < 0.2
- 0.2 - 3.0
- 3.0 - 6.0
- > 6.0
- ND
- Approximate Remedy 5 Remediation Area
- Within Remedy 5 Remediation Area
- Approximate Remedy 5 Resample Area

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Remedy Alternative 5: Vertical Profiles of Total PCB Concentrations for the City Ship Canal, Buffalo, NY

Figure 6-3d

Wednesday, October 21, 2009 4:32:46 PM
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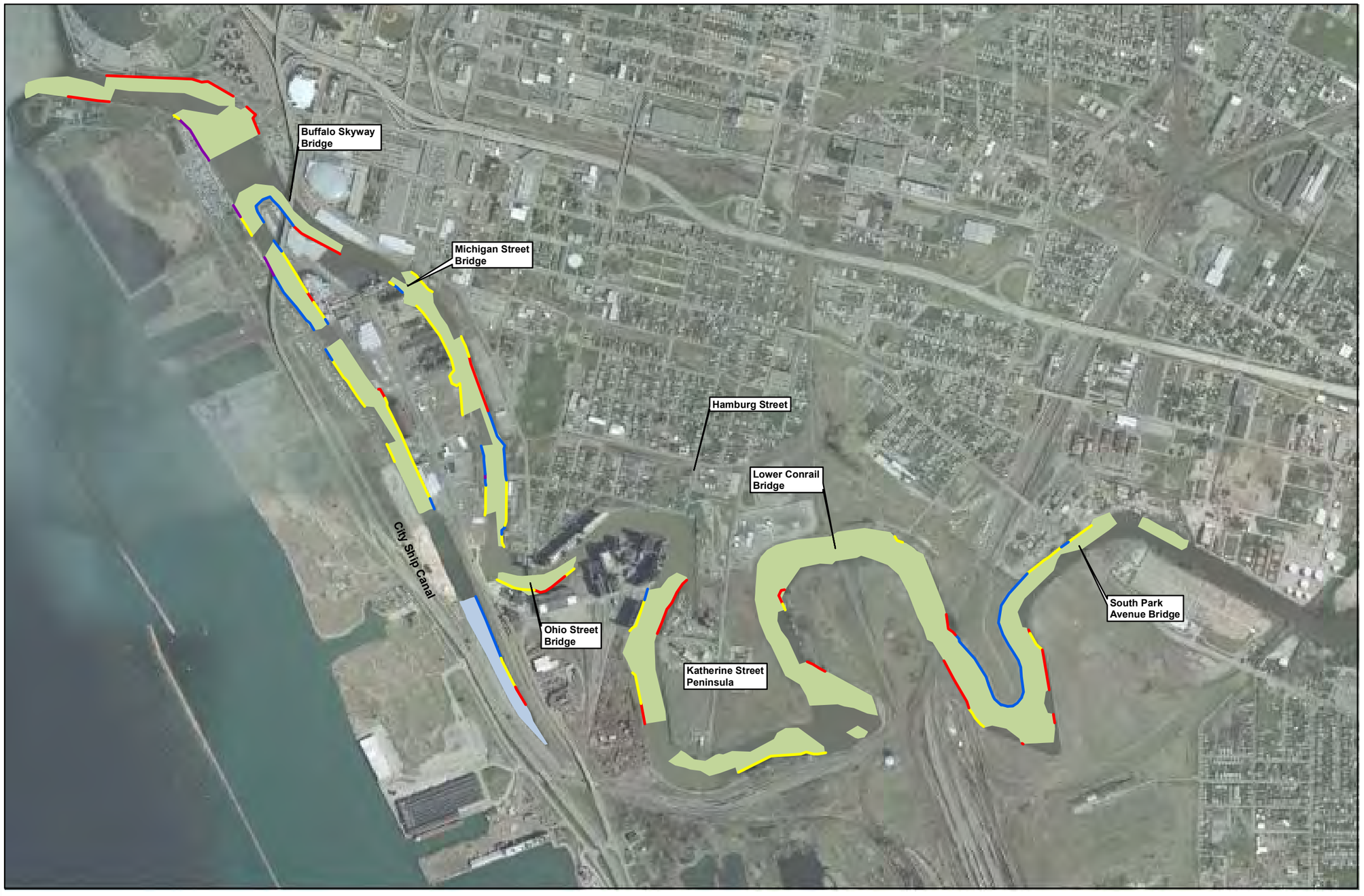

Legend

Shoreline Characteristics
- Capped Piles/Walls
- Uncapped Piles/Walls
- Sloped Stone
- Docks

Remedy Alternative 3 Footprint

Remediation Type
- Dredge
- Cap

Notes:
--Aerial imagery provided by ESRI online services 09/2009

0 0.1 0.2 0.4
Miles

N

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REMEDY ALTERNATIVE 3 - REMEDIATION LIMITS AND EXISTING SHORELINE CHARACTERISTICS BUFFALO, NY

Figure 6-4a

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_Shoreline_Remedy3.mxd

Legend

Shoreline Characteristics
- Capped Piles/Walls
- Uncapped Piles/Walls
- Sloped Stone
- Docks

Remedy Alternative 4 Footprint

Remediation Type
- Dredge
- Cap

Notes:
--Aerial imagery provided by ESRI online services 09/2009

0 0.1 0.2 0.4
Miles

N

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REMEDY ALTERNATIVE 4 - REMEDIATION LIMITS AND EXISTING SHORELINE CHARACTERISTICS BUFFALO, NY

Figure 6-4b

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_Shoreline_Remedy4.mxd

Legend

Shoreline Characteristics
- Capped Piles/Walls
- Uncapped Piles/Walls
- Sloped Stone
- Docks

Remedy Alternative 5 Footprint

Remediation Type
- Dredge
- Cap

Notes:
--Aerial imagery provided by ESRI online services 09/2009

0 0.1 0.2 0.4
Miles

N

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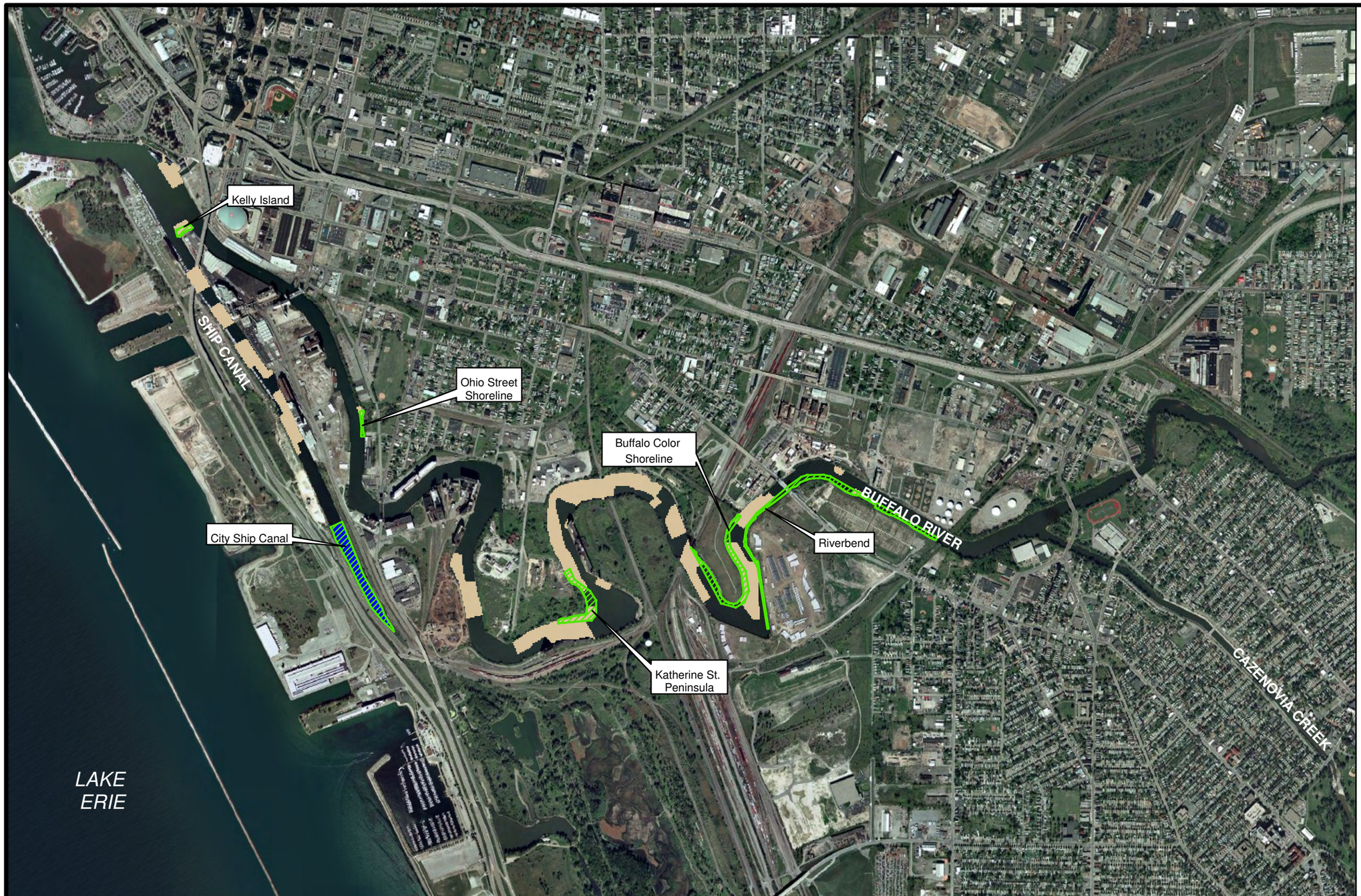
REMEDY ALTERNATIVE 5 - REMEDIATION LIMITS AND EXISITNG SHORELINE CHARACTERISTICS BUFFALO, NY

Figure 6-4c

Drafter: B. Radakovich
Contract Number: 02-20873B7
File Name: 20090929_Shoreline_Remedy5.mxd



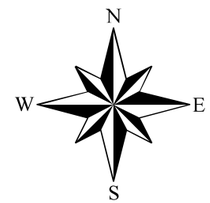
Legend

Habitat Restoration Project Locations

Remedy Alternative 5

Dredge

Cap



0 2,400 Feet

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POTENTIAL RESTORATION PROJECT LOCATIONS
BUFFALO RIVER, NY

Figure 8-1

Monday, October 19, 2009 3:47:23 PM
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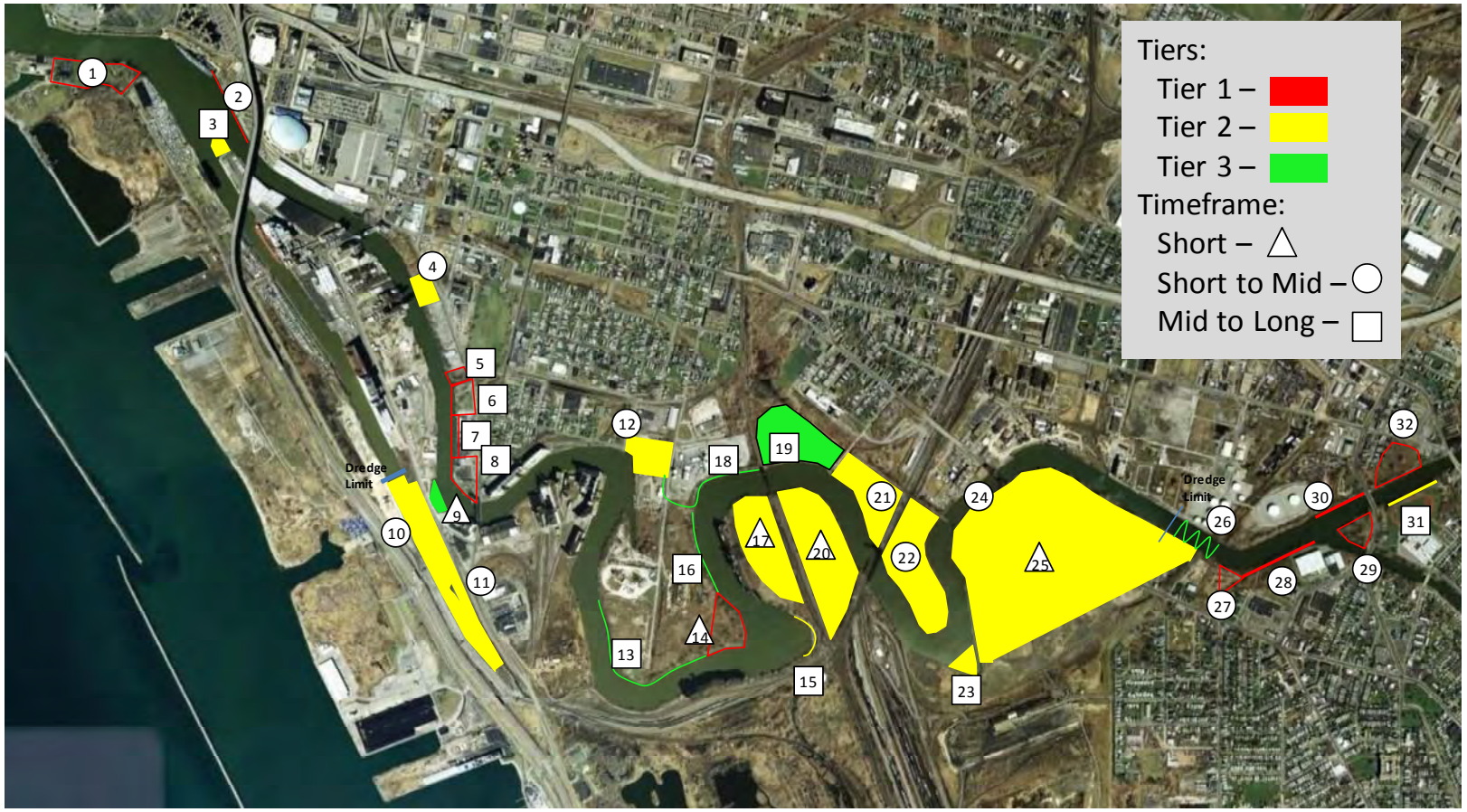

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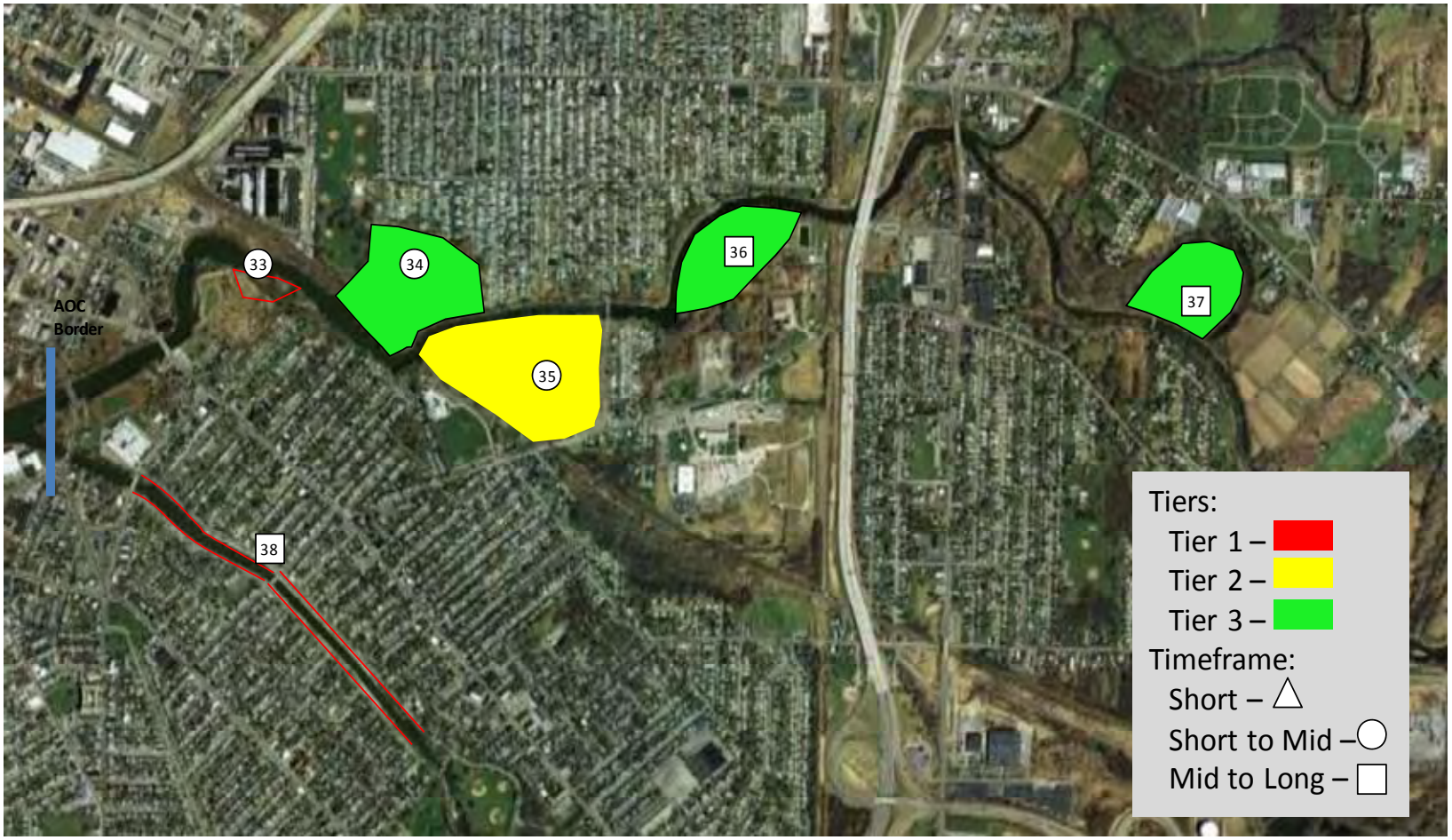
Potential Restoration Project Locations for Buffalo River Restoration Master Plan
(Provided by Buffalo-Niagara Riverkeeper)

Figure 8-2a



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Potential Restoration Project Locations for Buffalo River Restoration Master Plan
(Provided by Buffalo-Niagara Riverkeeper)

Figure 8-2b