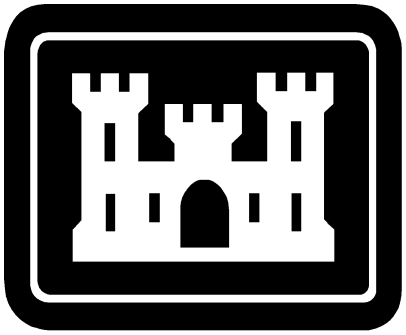
DRAFT ENVIRONMENTAL ASSESSMENT AND FEASIBILITY STUDY

5TH AVENUE DAM SECTION 206 AQUATIC ECOSYSTEM RESTORATION PROJECT COLUMBUS, FRANKLIN COUNTY, OHIO



US Army Corps of Engineers, Huntington District
Huntington, West Virginia

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1.0 EXECUTIVE SUMMARY

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FIFTH AVENUE DAM SECTION 206
AQUATIC ECOSYSTEM RESTORATION PROJECT
COLUMBUS, FRANKLIN COUNTY, OHIO

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1. Name of Action: Fifth Avenue Dam Section 206 Aquatic Ecosystem Restoration Project, Columbus, Franklin County, Ohio.

2. Description of Proposed Action: The proposed project consists of restoring two miles of natural river function and habitat along the lower Olentangy River affected by the 5th Avenue Dam impoundment. Under this action, the dam would be removed down to near its abutments and foundation to restore natural flow to the river channel. Artificial riffles would be constructed at locations within the channel that lack habitat structure, and riparian vegetation would be planted and maintained between the river channel and the levees.

3. Environmental Impacts: Project implementation would result in no significant adverse long-term impacts to those fish and wildlife resources within the project area. Flora and fauna listed on the Federal List of Endangered and Threatened Species will not be adversely impacted and because there are no wetlands involved with the project, none will be affected.

Temporary impacts on water quality may result from the suspension of sediment during project construction. The action will not adversely disturb any known archeological or historical sites.

In summation, implementation of the proposed Fifth Avenue Dam Section 206 Aquatic Ecosystem Restoration Project, will not adversely affect the long-term quality of the human and/or natural environment within the identified project area.

2.0 AUTHORITY

The authority for this investigation is Section 206 of the Water Resource Development Act of 1996, as amended, Aquatic Ecosystem Restoration. The local sponsor for this study and report is the City of Columbus, Department of Public Utilities.

3.0 PURPOSE AND NEED

The lower Olentangy River is impaired due to excess of nutrients and sediment, alteration of habitat and flow, and bacteria resulting from urban development, impoundment from low head dams, combined sewer overflows and urban stormwater runoff. The proposed project would include comprehensive management measures designed to restore the aquatic ecosystem towards attainment of the warmwater habitat designated use criteria.

The Ohio Environmental Protection Agency (OEPA) monitored stream conditions above and below the 5th Avenue Dam in 1999, and determined that biological and water quality standards were not being met. The lower Olentangy River was placed on the state's 303(d) list of impaired waters in 2006, and was listed as impaired due to excess of nutrients and sediment, alteration of habitat and flow, and bacteria. Subsequently, the OEPA prepared a Total Maximum Daily Load (TMDL) document for the Olentangy watershed which identified sources of the impairments and detailed actions needed to bring the stream conditions into attainment status. The study identified that nutrient enrichment and sedimentation were resulting from urban development in the surrounding watersheds. Lowhead dams on the Olentangy were also identified as a key factor to ecosystem impairment.

The largest of a series of lowhead dams on the Lower Olentangy, the 5th Avenue Dam, has changed the natural habitat and flow of the river around the Ohio State University (OSU) campus area. In the OEPA study in 1999, the pool above the 5th Avenue Dam had the lowest habitat scores of any location on the lower Olentangy River. Pollution-intolerant fish are rare in the impounded reach, although they still thrive in reaches with natural flow. Due to physical habitat degradation within an area surrounded by healthier habitat, this reach of the lower Olentangy River would benefit from habitat restoration.

In order to address the various sources of impairments on the Lower Olentangy River, a comprehensive restoration plan is needed. Restoration measures will be assessed on their potential to improve habitat conditions measured by the Qualitative Habitat Evaluation Index (QHEI), the objective to restore the stream towards attainment of the designated warmwater habitat use. This would be accomplished by re-establishing the aquatic and riparian habitat along the Lower Olentangy River in order to reduce nutrient and sediment delivery to the stream, and by restoring natural flow and habitat conditions.

4.0 STUDY AREA

The Lower Olentangy River extends from the Corps of Engineer's Delaware Dam and Reservoir downstream to the confluence with the Scioto River in downtown Columbus. There are twelve lowhead dams on the Olentangy River, the largest of which, the 5th Avenue Dam, is also the last impoundment before the Olentangy meets the Scioto River. The 5th Avenue Dam is located 2 miles upstream from the confluence with the Scioto in downtown Columbus, just south of the Ohio State University campus. The primary study area extends from the 5th Ave Dam to the end of its impoundment, about 2 miles upstream at the Dodridge Street Dam (Figure 1).

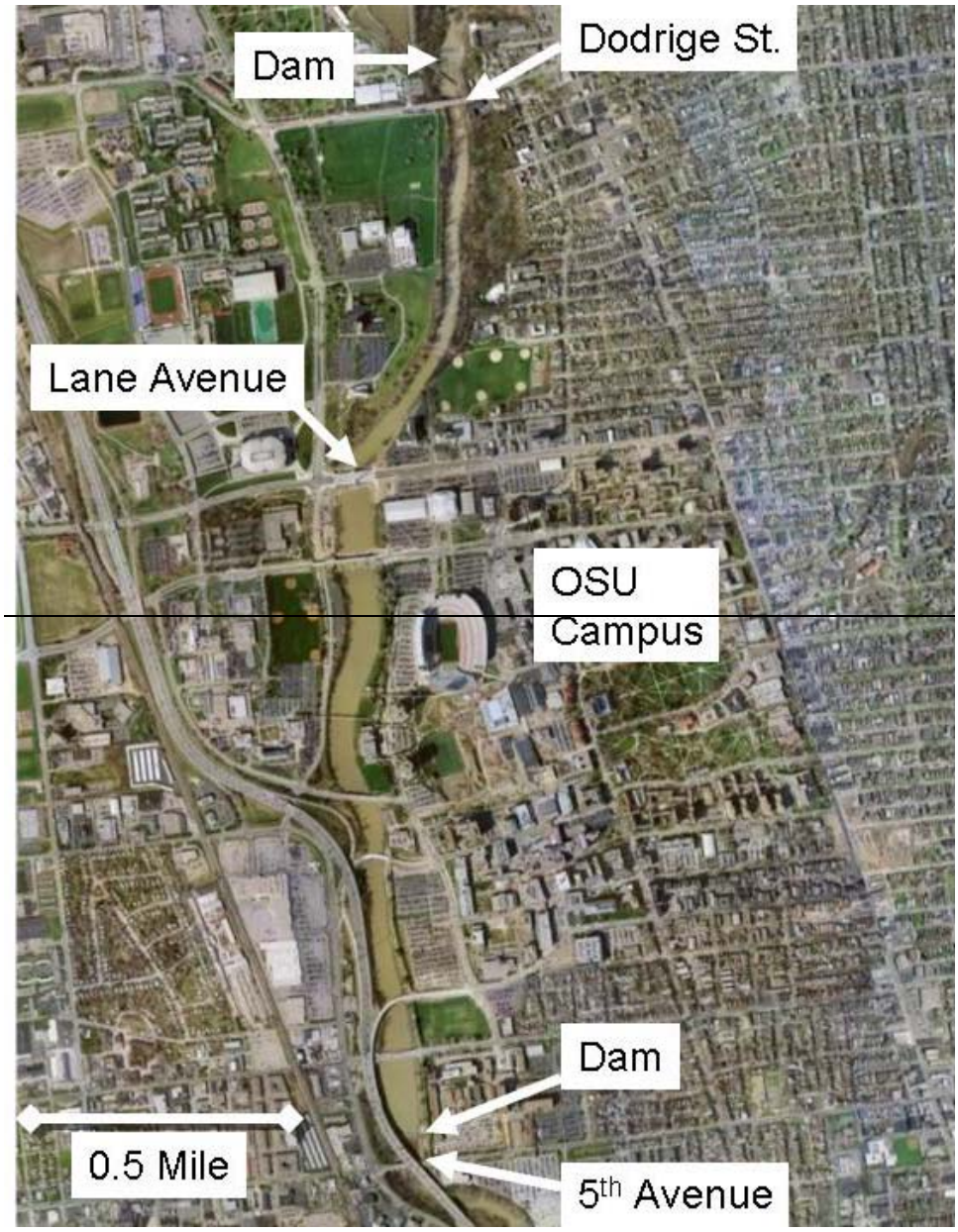

Figure 1. Project area showing campus area and urban development along Olentangy River.

5.0 BACKGROUND

The entire Olentangy River watershed spans six counties and provides for a diverse habitat that includes fish, mollusks, aquatic macroinvertebrates, migratory birds, and mammals, such as beaver, otter, and raccoons. The Lower Olentangy River begins at the Delaware Dam in Delaware County and flows into the Scioto River in downtown Columbus. Twenty-two of the thirty two miles of the Lower Olentangy River have been designated a State Scenic River by the Ohio Department of Natural Resources. The state designation ends at Wilson Bridge Road, about 7 miles upstream of the proposed project area. Despite urban impacts, healthy habitat still exists in naturalized reaches downstream of the Wilson Bridge and within the City of Columbus limits.

The portion of the Olentangy River running through the University campus has many recreational uses. The paved bike trail along the bank attracts commuters as well as recreational bikers, joggers, and others. The OSU Crew Club and Women's Novice Crew team use the dam impoundment for practice rowing and some competition. Being in the center of campus makes the Olentangy an ideal place to attract and retain new rowing recruits. Fishing is also a popular sport on the Olentangy, but because free-flowing reaches below the lowhead dams are preferred, few anglers are seen along campus. Kayakers and canoeists also run the Olentangy, but have difficulty bypassing the dangerous lowhead dams. Recreational sports such as fishing and kayaking have been adversely impacted by deterioration of water quality and habitat on the Olentangy.

The EPA measures the quality of the Olentangy River using parameters such as the Index of Biotic Integrity (IBI), Invertebrate community Index (ICI) and the Qualitative Habitat Evaluation Index (QHEI) to measure health of fish, invertebrates, and overall habitat, respectively. The pool above the dam that borders the OSU campus had the lowest habitat scores of any location on the lower Olentangy River. This section of the river is listed by the State of Ohio as an "impaired water" in accordance with Section 303(d) of the Clean Water Act. The OEPA documented several factors for the non-attainment of water quality standards, such as a lack of good habitat and the impact of the lowhead dam interfering with the free flow of the river. This reach of the Lower Olentangy River has been straightened, widened, and deepened over time, and during low flow periods takes on the appearance of a stagnant, muddy pond rather than a free-flowing river. Manmade impacts continue to impair the natural habitat of the river.

Urban development such as buildings, infrastructure, sewage overflows, and increased and polluted runoff are factors for the aquatic degradation. Such development has encroached upon and degraded the riparian ecosystem along the Olentangy River. The riparian zone is a transition from riverine to upland habitat that harbors a high diversity of plant and animal life. It includes the vegetated zone directly alongside the river, bottomland hardwood forest, and other periodically flooded lands. Riparian ecosystems function as a filter and a food source to rivers. The "flood pulse concept" explains that as flood waters advance and recede through the riparian zone, they become filtered and cleaned while connecting the upland and riverine food web (Junk et al. 1989). Loss of riparian habitat therefore directly impacts aquatic habitat and water quality.

Urban discharges, including runoff from impervious surfaces and combined sewage overflows, also impair the water quality of the Olentangy River. Combined sewers are systems that collect both sanitary sewage and stormwater runoff. In the event of large

storm event, inflow at the treatment facility can be above the capacity of the facility, requiring discharge of untreated sewage and stormwater from into the receiving stream. The sewage main built in the 1970s that parallels the Olentangy is a combined sewer overflow (CSO) system, which overflows directly into the Olentangy River. CSO discharges release pathogens, excess nutrients, and organic material. The high amount of anthropogenic organic matter and nutrients reduce dissolved oxygen in the water when digested by microorganisms. Anoxia is exacerbated by the slow-moving water of the dam impoundment, which hinders aeration.

The City of Columbus has implemented a 40-year wet weather management plan (WWMP) designed to solve the deficiencies of the City's outdated sewer system. The WWMP, which includes redirecting of storm flows, consolidation of CSO discharges, and updated sewer relief tunnels, proposes to reduce the majority of pollution from untreated discharges by 85% within the first 20 years of the program (Division of Sewerage and Drainage 2005). The City's long-term plan will eventually address a major contribution to water quality deterioration in the lower Olentangy River.

A feasibility study was requested by the City of Columbus to look at restoration measures around five of the six major lowhead dams within the Greater Columbus Area. These dams were built as crossings for sewer and other utility lines. The least diverse habitat in the Olentangy River is found within the impoundments of these lowhead dams. Although dam removal was considered as a restoration measure, only when the Olentangy Relief Tunnel is completed in 2042 as part of the WWMP would removal of the dams be feasible due to the embedded sewer lines. Stone grade controls to circumvent the dams were also deemed infeasible due to negative hydraulic impacts. Only boat portages and fish ladders were found to be feasible in the short run, but these would have negligible benefit to the stream habitat. The last one of the 6 major lowhead dams on the Olentangy River, the 5th Avenue Dam, was not investigated in the study (FMSM 2005).

The 5th Avenue dam was constructed in 1935 to provide an impoundment to supply cooling water for the Ohio State University power plant; it houses no utility lines. The dam was subsequently raised 1.5 feet in 1964 to its present height of 8 feet. The dam is a fixed, concrete structure, 458 feet long, with no controls for changing the height of the pool (Figure 2). Although there is some deterioration of the stone and concrete abutments, the dam is considered to be structurally sound with no danger of failure. The dam is owned and maintained by the City of Columbus. The impoundment is no longer required as a source of cooling water, but the pool is used for recreation.

The 5th Avenue Dam and its impoundment create a major change to the natural flow of the Olentangy River. Natural rivers contain series of swift, rocky shallows called riffles, and deep pools with slower current. Pool-riffle complexes support aquatic life by providing aeration and a diversity of habitat for growth, foraging and breeding. The effect of the dam impoundment combined with other urban impacts such as CSOs have produced documented impacts to aquatic life. In the OEPA study in 1999, the pool above the 5th Avenue Dam had the lowest habitat scores of any location on the Lower Olentangy River. Pollution-intolerant fish are rare in the impounded reach and some sensitive mussels are becoming increasingly rare or have been extirpated from the river. Although dams impair the migration of fish, a high diversity of native fish reside both upstream and downstream of the dam, with the more pollution tolerant fish concentrating

in the dam impoundment (OEPA 1999-2005). This indicates that the major problem in the impoundment is the loss of suitable habitat and water quality problems intensified by the dam impoundment, not impairment of fish passage alone. According to the FMSM study (2005) the other lowhead dam impoundments upstream of the 5th Avenue dam may not be good candidates for restoration until the City's WWMP is implemented. The greatest habitat loss, however, is found within and the impoundment of the 5th avenue dam, which makes this reach of river a good candidate for a restoration project.

The City of Columbus requested assistance from USACE (Aug 2001) for improving environmental quality in the Lower Olentangy River under Section 206 of the WRDA of 1996, aquatic ecosystem restoration authority. The City indicated its willingness to be the sponsor for a restoration project and established a steering committee to help direct subsequent investigation. Funds became available in FY 06 and a Preliminary Restoration Plan (PRP) was completed for the potential removal of modification of the 5th Avenue Dam.

Figure 2. 5th Avenue Dam and 315 Highway bridge

6.0 BASELINE CONDITIONS OF AFFECTED ENVIRONMENT

6.1 Aesthetics

The Olentangy River along OSU campus is an impacted waterway. Despite habitat degradation, OSU maintains a clean appearance along the river by removing trash

and debris. Due to the impoundment, the downstream mile of the campus river takes on the appearance of a narrow lake crossed by bridges of distinctive architecture. Halfway up 5th Avenue Dam impoundment, adjacent to the OSU Stadium, the Olentangy displays its most visible reach to students, visitors, and motorists. Here the Lane Avenue, Woody Hayes, and John Herrick bridges are surrounded by grass-covered levees and trails on the left descending bank overlooking the Olentangy (Figure 3). Despite mowing and improvements on this area, there is still unkempt vegetation and CSO discharges lining the water's edge.

Figure 3. The impounded Olentangy along its most visible reach looking upstream at the Lane Avenue bridge. A CSO discharge location is visible in the lower left.

The upper reach of the 5th Avenue Dam impoundment, flanked by parks and forests, takes on a more natural look with overhanging trees winding with footpaths (Figure 4).

Figure 4. Upper mile of the 5th Avenue Dam impoundment along Tuttle Park takes on the appearance of a natural, slow-moving river.

6.2 Recreation

The 5th Avenue Dam pool is the primary location for recreation activities performed by the university rowing club and team; however, the river itself is used for other general recreation purposes including fishing, boating, canoeing and kayaking, and walking and bicycling along the shore. In fact, during the past three to four years, the university has been moving portions of bicycle trails from the campus to the river banks, with plans to have a complete trail following the river in the future. The dam presents an obstacle for canoeing and kayaking activities, with few people participating in this activity currently. A recreation analysis was completed to investigate the impacts of project alternatives on recreation. The focus of this study was on impacts to the OSU Crew Club and the OSU Women's Novice Crew team, who presently use the dam impoundment for practice and competition. The recreation study also investigated general recreation around the 5th Avenue Dam pool and how alternatives may enhance or detract from recreation overall.

6.3 Education

OSU is a major research university with strong programs in biology and engineering of river systems. The Olentangy River around campus is currently not a major part of curriculum or study due to its degraded habitat. Classes must travel by vehicle to study non-impounded, high-quality rivers, such as the Big Darby, or the scenic portion of the Lower Olentangy. A 319 grant from the EPA is currently in place for

university-based research groups to monitor water quality and habitat in 5th Ave Dam reach for two years.

6.4 Water Quality

Water quality in the Lower Olentangy River is heavily impacted by urbanization and agriculture. Sewer overflows, urban runoff, loss of in-stream and riparian habitat, and lowhead dam impoundments have degraded water quality in the Lower Olentangy River. Because of low water quality, the portion of the river impounded by the 5th Avenue Dam was listed as an impaired water by the EPA and given the lowest habitat and water quality scores of any reach of the Olentangy. If no action is taken, the water quality issues would remain the same or may continue to degrade. Improvements are expected when the city puts its WWMP into action. The dam helps retain nutrients, organic matter, and pollutants, all of which contribute to low water quality in the dam impoundment. Although the retention of these constituents prevents their flow downstream, much of the natural function of a natural river is to break down materials through a balance of aerobic and anaerobic biological processes. The dam impoundment creates a predominately anaerobic environment which is unable to break down many organic compounds effectively, resulting in stagnation and eutrophication of the water. The greatest increase in aquatic pollutants downstream of the Delaware Dam occurs in the Columbus area where urban runoff, sewer overflows, and lowhead dam impoundments affect water quality (Figure 5).

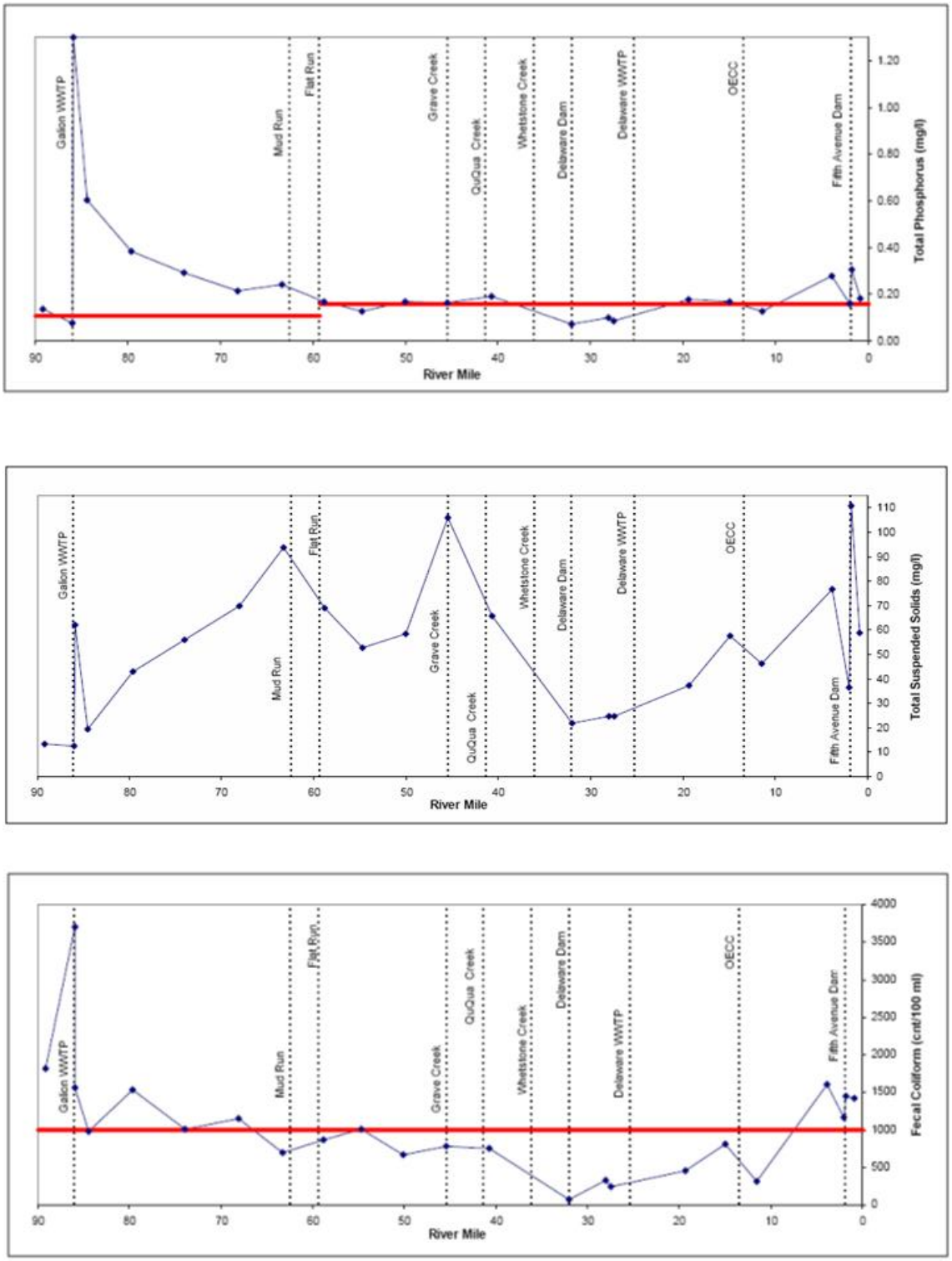

Figure 5. Longitudinal water quality profiles along the Olentangy River for phosphorus, suspended solids, and fecal coliforms. Red lines indicate thresholds for attainment criteria (OEPA 2006).

6.5 Hazardous, Toxic, and Radioactive Waste (HTRW)

In 1999 and 2003, OEPA monitored upstream and downstream of the dam and found that biological and water quality standards were not being met. Sediment sampling

by OEPA and OSU revealed some metals and organic pollutants background levels. The EPA concluded that the elevated levels were not a significant threat to human health given the current use of the Olentangy River. A phase I HTRW investigation was performed in December of 2006 by USACE which included site visits and record searches. In addition to SSOs and CSOs, leaking underground storage tanks (LUSTs) and other sites of environmental concern, all common to urban areas, were identified near the project area. The potential exists for leaking petroleum products and NPDES discharges above approved limits. USACE concluded that the EPA and OSU samples were not quantitatively sufficient in the vicinity of the 5th Avenue Dam to make conclusions about contaminants in the sediments and the impacts of potential dam modifications. The samples were also not broad enough in scope of parameters measured. Before construction, further sampling will test for pollutants such as pesticides, herbicides, PCBs, PAHs, metals, and oil and grease (HTRW report, USACE 2007).

6.6 Aquatic Resources

6.6.1 Habitat

In October of 2006, the Corps contracted a QHEI analysis of the impounded project area and the upstream and downstream unimpounded reaches for comparison. These data were used together with the hydraulic model to predict the future QHEI values for each alternative. The final QHEI values are based on conditions that would be assumed to be present in 25 years in the future because that is when steady state is assumed to be effectively reached after a major stream restoration effort (future QHEI values will not change appreciably after 25 years post-restoration).

The QHEI values at each station ranged from 88 in the unimpounded reference reach upstream to 35 in the 5th Avenue impoundment. In general, the average QHEI score in the unimpounded reaches upstream and downstream of the dam was 67 and the average QHEI score within the impoundment was 44 (Figure 6). A QHEI score of 60 is the minimum required to reach EPA's warmwater habitat (WWH) attainment.

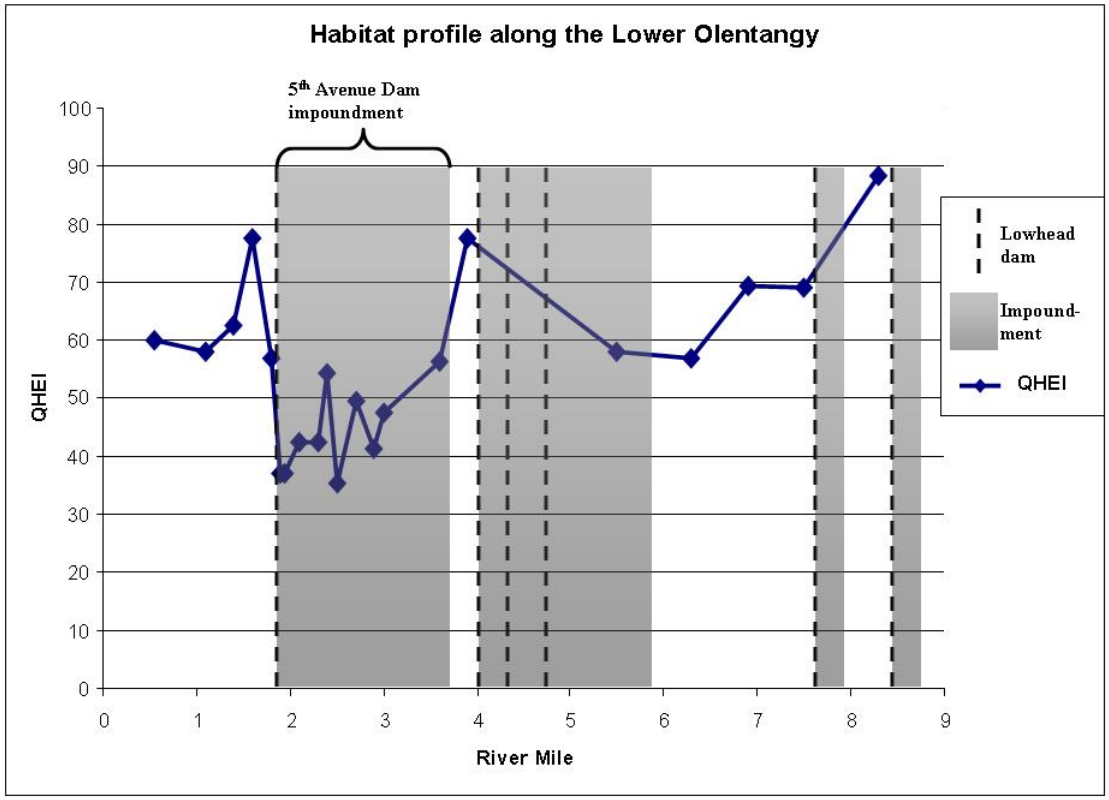

Figure 6. QHEI values measured along the Olentangy River in 2006.

The QHEI values measured for this study are supported by previous data published by the Ohio EPA. Using data from the EPA's technical support document (TSD), habitat indices along the Lower Olentangy, including QHEI, IBI, and ICI, were lower within the impoundments formed by lowhead dams than in the unimpounded reaches (Figure 7). The independent QHEI scores measured by the EPA closely reflect this study's QHEI scores for impounded and unimpounded reference reaches.

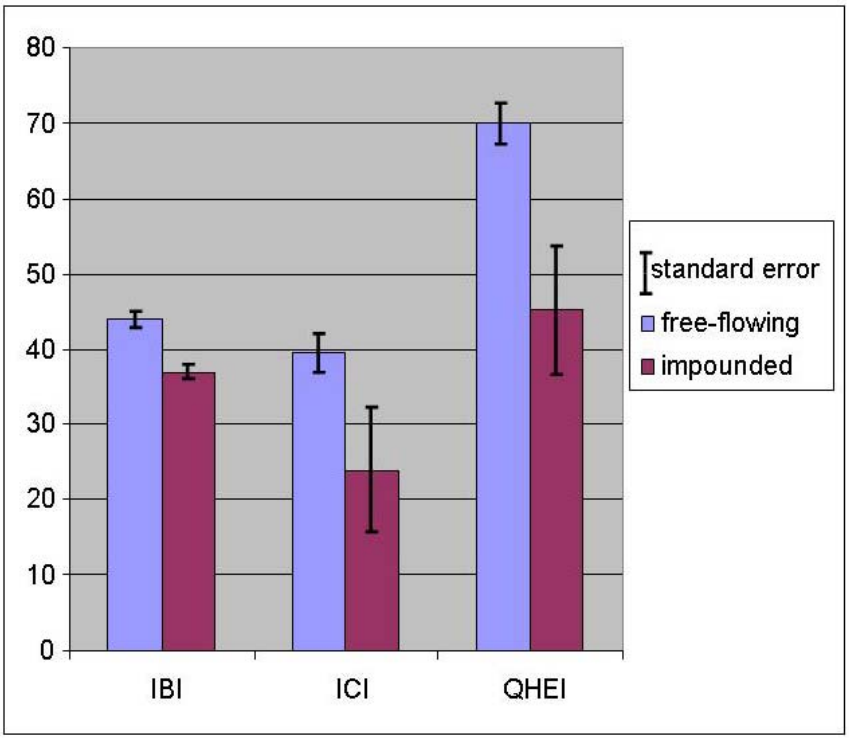

Figure 7. Present average habitat indices on impounded and unimpounded reaches of the Lower Olentangy (based on EPA TSD data)

6.6.2 Fish and macroinvertebrates

Both fish and macroinvertebrates may be used as indicators of water quality and general stream health. Many fish are insectivores and are thus dependent on a healthy macroinvertebrate community. Creating high-quality habitat for fishing is one of the attainment goals of the Clean Water Act. The Lower Olentangy River supports abundant fish and macroinvertebrate populations, many of which are intolerant of pollutants, such as excess sedimentation. The numbers of tolerant species in different reaches seem to follow the water quality trends in those sections. Intolerant species are limited to high water quality areas upstream of the 5th Avenue Dam impoundment. Tolerant species occur in the impoundment where silt material is retained. A mix of tolerant and intolerant species occurs below the dam where water quality is more variable. IBI and ICI scores are high in areas with good riffle-pool development and lower in areas where habitat structure is impounded (Figure 7). Many of the target species are intolerants that reside in or use riffle-pool complexes, particularly, stoneflies, caddisflies, and some redhorse species (e.g. the Black and Greater Redhorse).

6.6.3 Mussels

With 122 known species of unionid mussels, the Olentangy watershed supports a diverse ecosystem. Recent sampling between Kenny Park and Broadway showed that a diverse mussel habitat still thrives even in urbanized areas. The sampled reach of the Olentangy, although surrounded by city and suburbs, is surrounded by parks that form a

wide riparian buffer and has developed riffles and pools that are not impacted by lowhead dam impoundments. Although some diverse communities still exist, many pollution intolerant species are heading towards extirpation. After a major channel realignment around the OSU stadium, some sensitive and rare species largely disappeared from the local area (FLOW 2003).

6.6.4 Vegetation

The non-developed floodplains adjacent to the Olentangy River are dominated by bottomland hardwood forests. In the 5th Avenue Dam impoundment, these bottomland areas comprise the reach of river upstream of campus, beginning at Tuttle Park and some of the right descending bank opposite of main OSU campus. Extensive studies of these hardwood forests have been compiled over the past decade at the Olentangy River Wetland Research Park (1994-2006), just upstream of the Dodridge dam.

The naturalized areas of the dam impoundment are characterized by deep waters with steep, tree-lined banks. Point bars and islands with riparian and emergent vegetation, including extensive water willow (*Justicia americana*) beds are located immediately downstream of the Dodridge and 5th Avenue Dams. These non-impounded riparian areas foster higher species richness and diversity than the impounded areas where shallow banks are not exposed during low flow.

The developed portions of the 5th Avenue Dam impoundment adjacent to OSU campus feature grasses that are periodically mowed down to the water line or interrupted by occasional shrubs, many of them invasive or nuisance species, and landscape tree plantings.

6.6.5 Nuisance species

Riparian areas along the Olentangy are dominated by the invasive amur honeysuckle (*Lonicera maackii*), which prefers bottomland forests and high river banks (Swab et. Al). Other non-native and invasive plants in the riparian ecosystem include but are not limited to periwinkle (*Vinca minor*) and purple loosestrife (*Lythrum salicaria*).

Invasive fish and mollusks are also present in the Olentangy River. The common carp (*Cyprinus carpio*) is an Asian species of fish that is widespread in waters of the US. The Ohio EPA found the carp to be the dominant fish in the Olentangy river by biomass, comprising 33% of total fish weight (2001). Carp prefer slow moving, muddy water, and so are believed to congregate in areas such as the 5th Avenue Dam. They also find ways into the Olentangy River Wetland Research Park (ORWRP) where they interfere with wetland experiments and functions by disturbing sediments (bioturbation). The invasive Asian clam (*Corbicula fluminea*) is also well established in the river bed.

6.6.6 Threatened and endangered species

Some small populations of state-endangered “Snuffbox” and “Pondhorn” mussel species may still occur in the lower Olentangy River. Due to loss of in-stream habitat and pollution, many T&E mussel species are believed to have been extirpated from the Lower Olentangy, and none are believed to exist in the 5th Avenue Dam impoundment (Figure 8). Dead specimens of the state-threatened “Pondhorn” have been collected by FLOW members (2000) from macrophyte-stabilized, low-energy backwater areas below the 5th

Avenue Dam. These occurrences suggest that small populations of this species still exist in the lower Olentangy River. The federally endangered Indiana Bat is also known to exist in the county, but preferred roosting locations in trees with shaggy or loose bark are not affected by the 5th Avenue Dam impoundment and associated aquatic ecosystem.

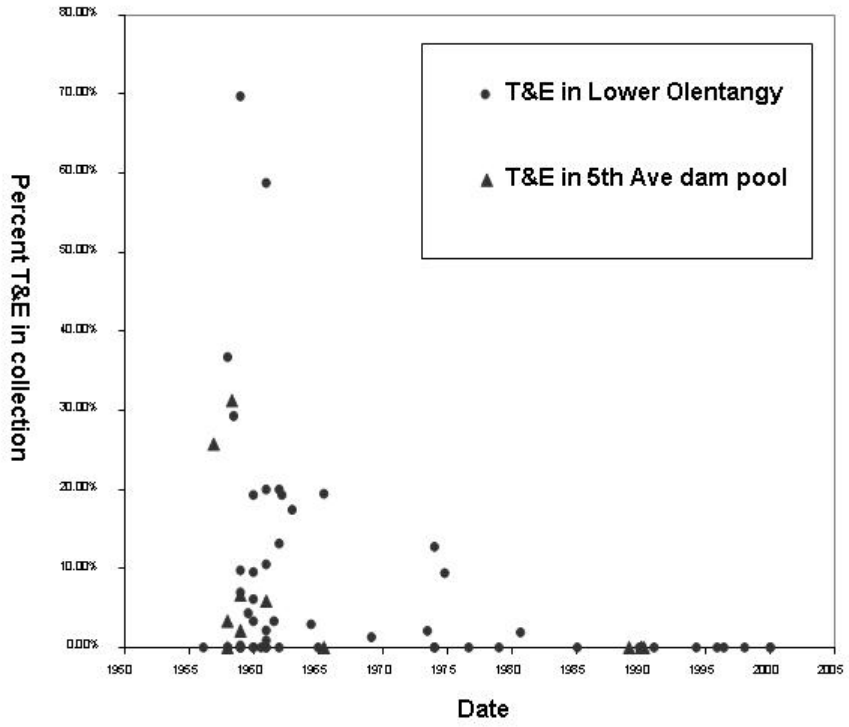

Figure 8. Decline of Threatened and Endangered (T&E) mussels documented in samples from the OSU museum of Biological Diversity.

6.7 Safety

The 5th Avenue Dam was inspected by the Ohio Division of Water in 1999 and was determined to be structurally sound. Although there are some areas of concrete deterioration at the dam abutments, the structural integrity of the dam is not considered a threat to downstream population. Nevertheless, there are some safety concerns associated with this dam. Lowhead dams can become a danger during high and moderate flows when powerful return currents trap victims, even experienced swimmers, below the dam structure. In 1964, a man drowned when his boat overturned and he was caught in the undercurrents below the 5th Avenue Dam. Unfortunately, such drownings are common and occur at lowhead dams nationwide. Lowhead dams are sometimes referred to as "drowning machines" (ODNR 2003).

6.8 Cultural & archeological resources

The project area is disturbed urban environment. The Olentangy river along campus has been relocated and channelized. The 5th Avenue Dam structure itself has been structurally modified since its original construction and is not of significant cultural

or historical significance. None of the structural or non-structural alternatives are expected to make a significant impact on in-situ soils, potentially disturbing cultural or archaeological artifacts.

6.9 Future without project conditions

The current conditions are stable without preventative action. No change is planned in operation of the Corps-owned Delaware Dam that feeds the lower Olentangy River. Some bridge construction continues to impede on the riparian and aquatic habitat, but most of the surrounding urban area is mature. Much of the riparian area around campus is mowed or maintained and would therefore not mature over time without a change in practice. The major improvements that would be expected are that the water quality would improve with modernization of the stormwater sewer system with the WWMP. Eventual updating of the sewer system would allow removal of the other lowhead dams, as suggested for restoration in the FMSM feasibility report (2005). Although sewer upgrades and removal of other lowhead dams would improve the absolute water quality of the entire river, certain areas of low habitat quality will remain disturbed relative to the surrounding area. In particular, the 5th Avenue Dam impoundment would always harbor relatively lower-quality habitat due to unnatural flow and altered sediment transport. Sediment-tolerant species would continue to dominate these reaches because dam impoundments concentrate sediment, burying native habitat. Lack of flow diversity in shallow waters also fosters a less diverse riparian fringe around the dam impoundment. In the long run, the 5th Avenue Dam impoundment would become the last remaining impediment to habitat connectivity and maximum possible restoration of the Olentangy River.

7.0 PLAN FORMULATION

7.1 Summary of Problem and Needs

The aquatic ecosystem of the Olentangy River is degraded in the area of the 5th Avenue Dam impoundment by excess of nutrients and sediment, alteration of habitat and flow, and bacteria resulting from urban development, impoundment from low head dams, combined sewer overflows and urban stormwater runoff. The proposed project would include comprehensive management measures designed to restore the aquatic ecosystem towards EPA attainment status for a warmwater habitat. This would be accomplished by restoring the aquatic and riparian habitat along the Lower Olentangy River in order to reduce nutrient and sediment delivery to the stream and restore natural flow and habitat conditions.

7.2 Planning Objectives

- Improve riparian habitat along the lower Olentangy River from the 5th Avenue Dam upstream to the Dodridge Street Dam;
- Restore the lower Olentangy River in the study area to a more natural stream that is characterized by riffle-pool sequences;

- Improve the habitat and water quality of the pool above the 5th Ave Dam toward attainment of the EPA use designation.
- Restore native species assemblages similar to those found in non-impounded reference reaches of the Olentangy.

7.3 Management Measures Considered

A number of management measures were proposed for restoring the aquatic ecosystem of the Olentangy River along OSU campus. However, some of these scenarios do not fit within the proposed authority and are not likely to be cost effective. Only the measures that were believed to be cost-effective and within the Corps of Engineers' Section 206 authority were retained for further analysis.

The primary objective of this investigation is to restore the aquatic and riparian habitat along the Lower Olentangy River. Restoring the lower four miles to a more natural free-flowing stream would require either removing or modifying the 5th Avenue Dam. The No Action Alternative would leave the dam, impoundment, and river "as is;" consequently, there would be no improvement to the aquatic ecosystem. This option is retained for comparison with other restoration measures because planning guidance requires evaluation of the No Action Alternative.

Because reconnaissance investigations show that the habitat along the 5th Avenue Dam impoundment is impaired by the impoundment itself, removal of the dam is a natural solution to the problem. Removing all or a portion of the 5th Avenue Dam would result in the total elimination of the impounded pool. This would change this reach of the river from a shallow, mud-bottom lake to a free-flowing stream with the potential for developing a riffle-and-pool type environment. An increase in the biotic diversity from the creation of habitat for fish and other species would likely result. Because this approach restores natural conditions back to the entire impoundment, full pool removal is retained for further investigation.

Modifying the 5th Avenue Dam to lower the height of the impoundment could achieve some of the ecosystem restoration objectives. The impounded pool would become smaller and take on some characteristics of a free-flowing stream, particularly in the upper reach below the Dodridge Street Dam. The selected pool elevation would be the result of an optimization involving aesthetics, recreation needs (crew rowing) and dam stability. In attempt to restore habitat while minimizing recreation impacts, this alternative is also retained for further investigation.

Other modifications to the dam were also considered to restore habitat while minimizing recreation impacts. An adjustable-head outlet structure on the 5th Avenue Dam would allow raising of the water level of the dam to suit recreational rowing needs and lowering of the water to suit habitat needs; however, this measure would be very expensive. Largely fluctuating water levels would also have very unpredictable effects on the ecosystem and environment, and could even instigate geotechnical instability along the river banks. Because of cost and uncertain outcome of this option, an adjustable-head outlet structure was not considered further.

The dam could also be modified to restore fish passage. Stone placed on the downstream face of the 5th Avenue Dam to form a rock ramp would restore fish passage. A side-channel or "whitewater" bypass could also restore fish passage. Because fish passage is not the main concern of the habitat degradation on the Olentangy, however,

fish ramps or bypasses would not be economically justifiable and were dropped from further consideration.

Water quality improvement measures were proposed to improve the habitat of the Lower Olentangy. Fountains or bubblers could be added to the 5th Avenue Dam impoundment to aerate the water, thereby increasing the dissolved oxygen level and helping the digestion and breakdown of excess organic solids. Also, treatment facilities could be constructed to control the pollution, both point source and non-point source, that enters the river. Fountains and bubblers only affect a small area, and require expensive equipment, energy, and maintenance for continued operation. Treatment facilities for major pollution sources would be very costly and the total investment would be beyond the scope of the Corps' restoration authority. In the long run, the WWMP by the City of Columbus should address many of the polluted runoff and sewer overflow issues. Due to the high costs of water quality treatment, and the responsibility of the City to address these issues within the WWMP, these measures were dropped from further consideration in the current project.

Riparian and in-stream improvements would restore the aquatic habitat of the Olentangy without modification of the dam. In-stream structures include woody debris and stone clusters anchored along the shoreline as habitat for fish and other aquatic species. Stone may also be placed across the river at strategic locations to act as artificial riffles, thus enhancing in-stream habitat. Much of the Olentangy riparian area along OSU campus is mowed and cleared, greatly reducing habitat value. Allowing for naturalization of the flood plain and planting of native species within an easement or "no mow" zone would revitalize the riparian community and thus the greater river habitat. Both in-stream structures and riparian restorations would potentially be cost-effective means of enhancing the Olentangy River habitat. These will be considered further as a nonstructural alternative and can be independently combined with any structural dam modification alternative or the no dam modification alternative.

Table 1. Initial management measure screening.

	Water quality	**Physical habitat**	**rowing**	**other recreation**	**cost**	**Consider further**	**Comments**
Partial pool dam lowering	Small improvement	Moderate improvement	Moderate impact	Small improvement	Moderate	**YES**	balance between habitat improvements and preservation of recreational rowing
Full pool dam removal	Moderate improvement	Large improvement	Large impact	Moderate improvement	Moderate	**YES**	Remove liability of dam and return river to natural state
Dam bypass	Small improvement	Small improvement	No impact	Moderate improvement	Moderate	NO	No room adjacent to dam for bypass channel. Not enough benefit to habitat of entire river
Adjustable head outlet structure	Uncertain	Uncertain	Small impact	Small improvement	High	NO	Excessive cost and unclear environmental benefit
Fish ladder	No Change	Small improvement	No change	Small improvement	Moderate	NO	low habitat benefit and migration is not primary concern
Water quality improvement	Large improvement	Small improvement	No change	Small improvement	High	NO	high cost and indirect habitat benefit; beyond scope of project
In-stream restoration	Small improvement	Moderate improvement	Small impact	Small improvement	Low	**YES**	Direct habitat benefit
Riparian restoration	Small improvement	Small improvement	No impact	Small improvement	Low	**YES**	Direct habitat benefit
No pool removal	No change	No change	No change	No change	No change	**YES**	No Action alternative always considered for comparison

8.0 MANAGEMENT MEASURES CONSIDERED IN DETAIL

8.1 Final Measures Considered in Detail

The final measures screened from the initial list (Table 1) are defined in this section. The details will be used to assign and cost, in dollars, and a benefit, in Habitat Units, to each measure.

Structural measure 1: Full Pool Removal

In this scenario, the 8' head behind the dam would be lowered to a natural flow elevation. Although "removing the dam" sounds straightforward, there are many ways to accomplish the removal of pool behind the dam. The goal of this project is to find the most cost-effective method of restoration while considering all impacts to the human environment. Two methods of fully lowering the dam impoundment head are proposed, both of which leave some of the dam structure in place to save on construction costs.

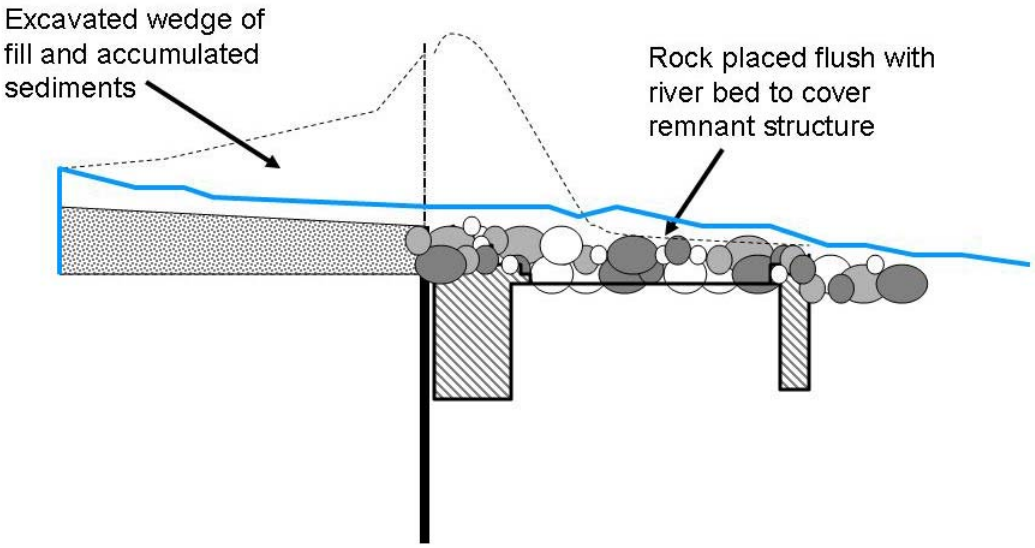

Figure 9. Cross section of full Pool Removal at 5th Avenue Dam

Measure 1A: Full pool removal with full-width dam removal

The above-ground width of the dam would be removed to where the dam apron meets the footer. The footer (foundation) and adjacent sheet piling would be left in place because their removal is not necessary and would have excessive costs. Engineered fill, accumulated sediments, and concrete rubble would be spoiled on site along the right descending bank of the river. Because the channel is artificially over-widened along the dam reach, the spoil section functions to backfill the artificial channel, bringing it closer to its natural form. The new bank created will be revegetated to look like a natural stream bank. The abutments and footer of the dam would be left in place to reduce construction costs. Leaving the footer of the dam in place creates an additional factor of safety in the design by leaving a non-erodible grade control that would prevent channel headcutting.

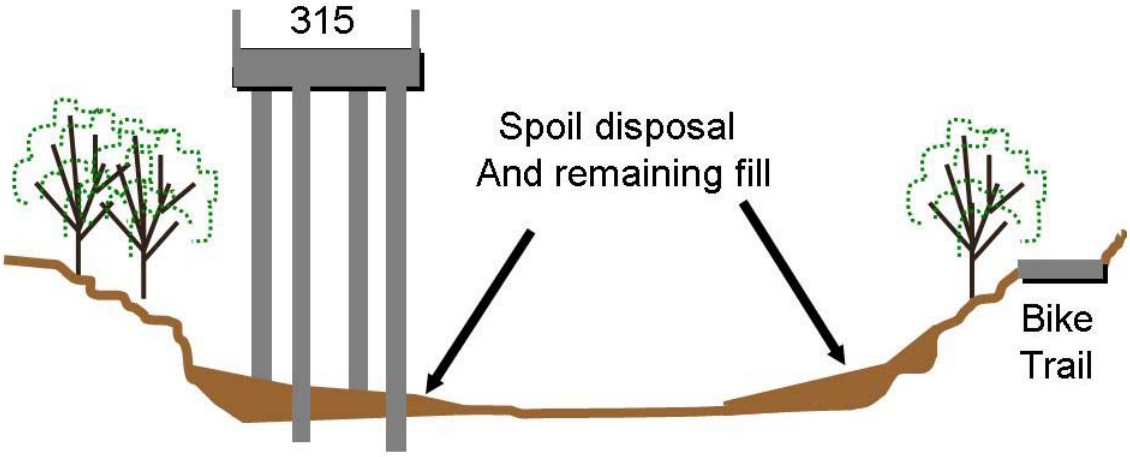

Figure 10. Front view of full-width dam removal.

Measure 1B: Full pool removal with partial-width dam removal

A 160 foot section near the middle of the dam would be removed from the dam to allow the river to reach its natural elevation. As in Measure 1A, the footing below the stream bed elevation would remain in place and function as a grade control. The width of the section removed from the dam is based on the natural width of the channel in unimpounded reaches upstream and downstream of the dam. The cross section of the remaining dam would emulate the natural channel and floodplain cross-sectional shape. Rubble from the demolished portion of the dam and excavated material from behind the removed section would be spoiled on site by surrounding and burying the remaining dam structure. Burial of the dam sidewalls fulfills the dual purpose of cost-effective use of waste material and reduction of aesthetic liability of the remaining structure which would likely become a target for vandalism. This narrower configuration of the channel at the dam represents conditions that are expected to occur naturally—aggradation of sediments at the overwidened portion of the river would eventually fill in to form banks and a narrower channel. This measure accelerates a natural process.

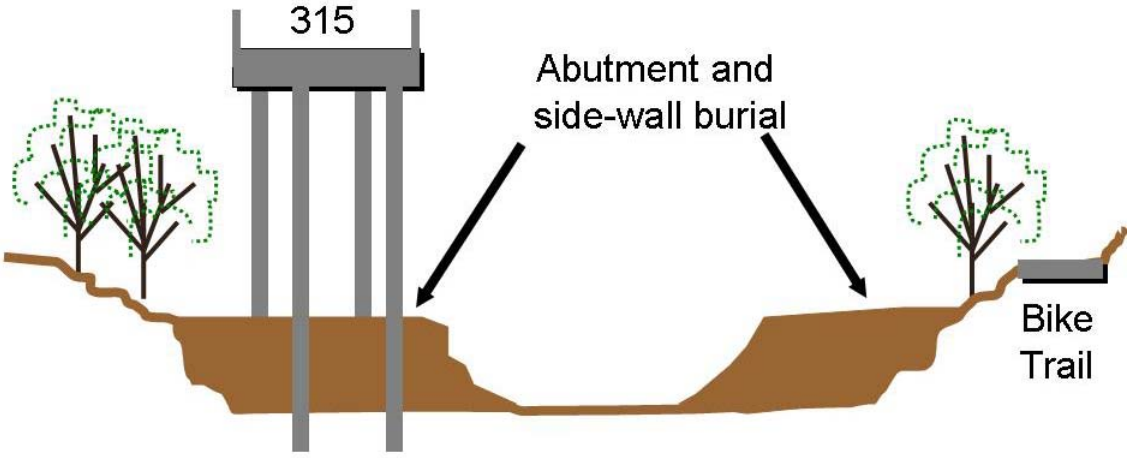

Figure 11. Front view of partial-width dam removal.

Structural measure 2: Partial Pool Removal

In this measure, the dam head would be reduced from 8' to approximately 4.' A 160' wide section along the upper portion of the dam would be lowered approximately 5' by conventional

demolition. Because the resulting surface would be uneven and exposed concrete would likely be damaged, a 1' thick concrete spillway surface would be placed over the demolished surface, spanning the lowered 160' section. Although the head behind the dam would be reduced, the remaining dam would have to retain structural function and would still require periodic maintenance and inspection. Spoil of material around the dam structure as in Measure 1B would make inspection and maintenance difficult and are therefore not recommended. Instead, off-site or side-of-channel spoil would be utilized.

The recommended change in head on the dam from 8' to 4' was chosen to balance the creation of free-flowing river on the upper half of the 5th Avenue Dam impoundment while still leaving enough impoundment in place for recreation such as rowing. The assumed channel dimensions after pool lowering were based on a 1-dimensional HEC-RAS hydraulic model. Due to the level of precision at the feasibility level, the hydraulic model is only an approximation. To ensure a channel appropriate for crew rowing, a more accurate bathymetric survey and hydraulic model would be required before final design of the Partial pool removal measure to optimize the elevations. The crew team would also need to be consulted to ensure that the dual purpose of the partial restoration is fulfilled.

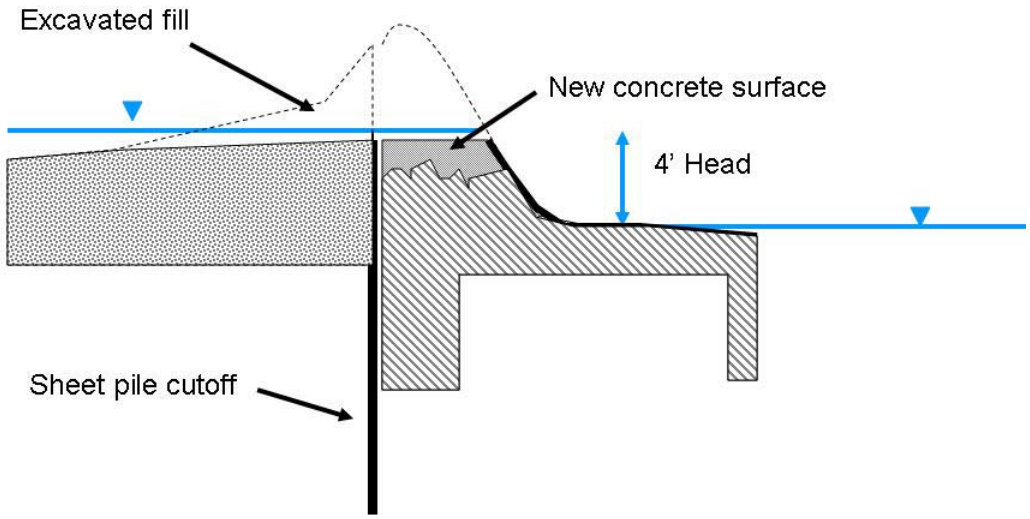

Figure 12. Cross section of partial pool removal by lowering the dam 4 feet.

Structural measure 3: Pool retention (No Action)

In this measure, the dam would be left in place and operations and maintenance of the dam structure would remain as they are presently (Figure 13). In-stream and riparian restorations may be combined with this measure (Table 2). For any measures analysis, a No Action measure must be considered as a point of comparison for the other measures. In this project, the No Action measure will be considered further as a baseline comparison: no pool removal with no in-stream or riparian restoration. Conditions are assumed to be the same as the baseline conditions existing presently.

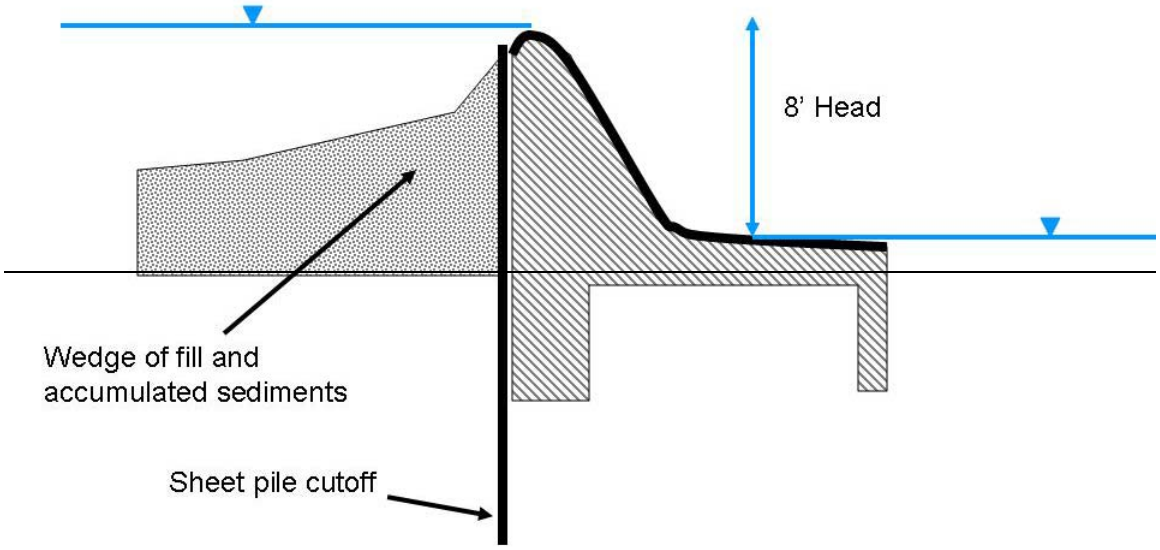

Figure 13. Cross section of 5th Ave Dam as it would remain under the No Action alternative.

Nonstructural measure: In-stream and riparian habitat restoration

In-stream and riparian habitat will be analyzed in different combinations with the three structural measures: full pool removal, partial pool lowering, and pool retention.

In-stream habitat restoration

Habitat weirs and dikes, such as artificial riffles, J hooks, W and V weirs, and cross vanes (Figure 14), are rock structures that traverse all or a portion of a stream channel. By redirecting flow and creating scour pools, they can be used to artificially emulate the function of natural riffles and pools. These structures create a diversity of flow and substrate that is necessary for survival of fish, invertebrates, vegetation, and other aquatic life. In-stream habitat features can also help to stabilize a channel reach if implemented properly.

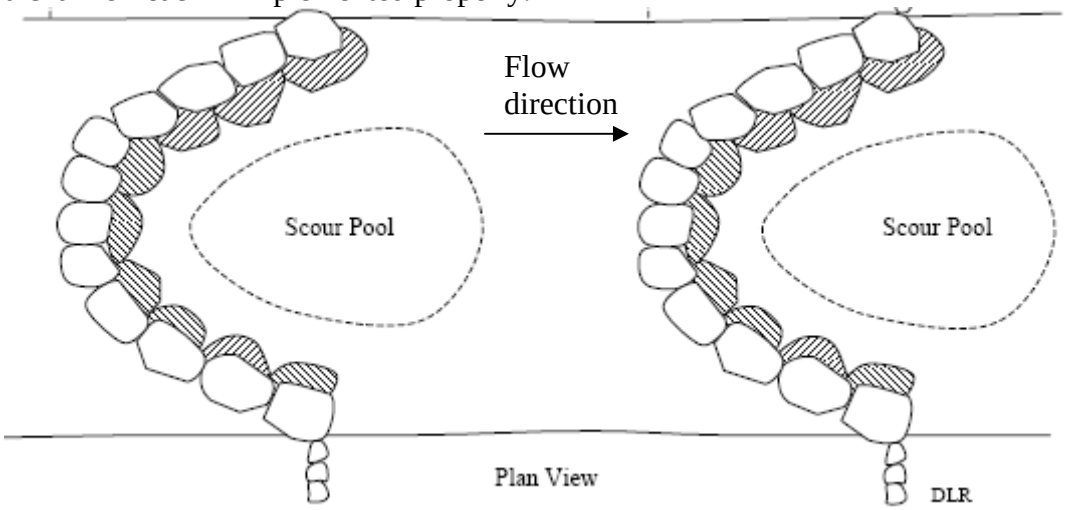

Figure 14. Example of a cross vanes or v-weirs used as an in-stream habitat and channel stability structure (Rosgen 2003)

Other in-stream habitat features include woody and stone debris that may be anchored under the normal water line along a bank that lacks suitable habitat structure (Figure 15). These features create niches for shelter, food, and breeding of aquatic life. The feasibility level study will investigate only the v weir, which is an artificial riffle that is appropriate for a channel such as the Olentangy River that lacks pool and riffle structure. Other similar structures could be implemented adaptively during construction phase, as determined by site conditions.

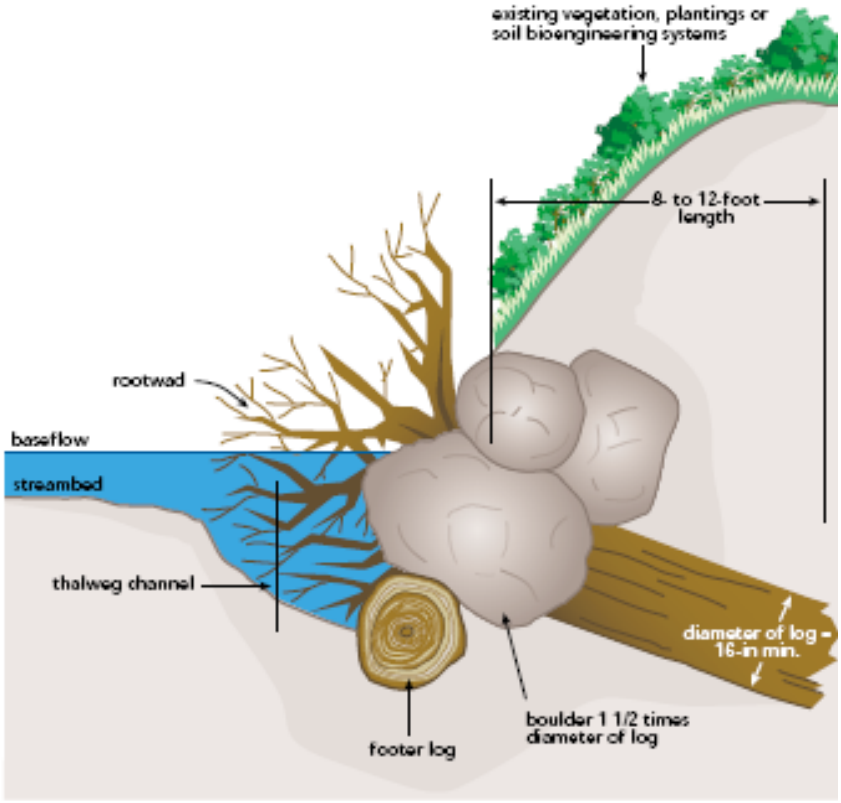

Figure 15. Habitat created with woody debris and stone also functions as slope stabilization.

Riparian habitat restoration

The purpose of the riparian option is to restore and naturalize the riparian habitat along the project area. The proposed riparian areas are currently mowed or contain invasive vegetation and would not improve without active restoration techniques. Plantings would be made to encourage a diversity of native species and restoration would include seeding and stabilization of disturbed areas. Species will include trees, shrubs, grasses, and forbs. Annual reports from the Olentangy River Wetland Research Park (1994-present) have monitored species development and yearly changes to the riparian and bottomland areas along the Lower Olentangy near campus. These reports and other local publications should be consulted for lists of native and locally-adapted species. Riparian restoration is a long-term endeavor and should be implemented with respect of natural succession, including a long-term operation and maintenance plan to ensure success.

Riparian restoration would include:

- Seed and naturalize west slope, and exposed slopes upstream of campus and downstream of John Herrick bridge
- Conservation easement or moratorium on mowing certain portions of riparian corridor between the levee and river.

- Work with OSU on natural landscaping around Lane Ave. and Woody Hayes Dr.
- Seed and stabilize exposed slopes for dam modification measures
- Long-term eradication of nuisance species and maintenance of native diversity until succession is complete and ecosystem is mature.

Riparian restoration would restore and protect approximately 13 acres of land along OSU campus that is currently maintained and mowed. Additionally, approximately 25 acres of additional land would be exposed under the pool removal measures and all of this additional land would be restored and protected under the riparian restoration measure.

8.2 Alternatives Array

The structural and non-structural measures were combined to make a total of 16 alternatives (Table 2).

Table 2. Combining the 4 structural measures with nonstructural measures results in 16 total combinations. Each combination is assigned a code for analysis.

	No additional restoration	In-stream restoration (S)	Riparian restoration (R)	In-stream & Riparian (RS)
1A Complete pool removal full width	1A	1AS	1AR	1ARS
1B complete pool removal partial width	1B	1BS	1BR	1BRS
2 pool lowering	2	2 S	2 R	2 RS
3 No pool removal	3 **(No Action)**	3 S	3 R	3 RS

8.3 Evaluation of Alternatives

Identifying cost-effective alternatives requires assigning costs and benefits to each of the 16 combinations of alternatives. Costs are assigned using traditional, feasibility-level cost engineering techniques. Methods for assigning habitat benefits are more variable than monetary benefits and are therefore examined with more care in this report. There are many ways to assign value to habitat. Habitat can be assigned a monetary worth, or a type of habitat unit may be contrived from habitat quality and size of affected area. In this project, the QHEI habitat index was used to measure habitat quality and then combined with miles of restored river to produce habitat units.

QHEI is a 0 to 100 scale index used by the Ohio EPA and other resource agencies as a measure of general stream health. Based on physical characteristics of the river such as substrate quality, meander pattern, riffle-pool sequences, and riparian corridor, QHEI infers the biological potential of a river based on mainly physical or static features that can be easily modeled and predicted. QHEI is therefore minimally affected by ephemeral changes such as season, weather, or temporary disturbances. Other metrics of aquatic health, such as IBI or ICI, may be very dependent on conditions during sampling. QHEI correlates strongly with IBI, demonstrating its strong merit in predicting aquatic habitat (Lau et al. 2006). A dam removal study on the Sandusky river in Ohio found that QHEI recovery after dam removal occurs as a first-order rate change with asymptotic approach to steady state with a continuous rate of 16%/year (Tomsic and Granata, in press). Under this rate, 50% of recovery is achieved in 4 years and 98% in 25 years. Because the stream will have

effectively recovered fully after 25 years, the predicted 25 year values were used for QHEI modeling. QHEI was normalized on a 0-1 scale and multiplied by stream miles to produce habitat units. Habitat units were used as the benefit metric for present and future conditions for each alternative. These benefits were compared incrementally with cost to identify cost effective and best-buy alternatives.

The habitat benefit analysis used reference reaches and a hydraulic model to measure baseline conditions and predict values of alternatives. Past studies (FLOW 2003) have identified naturalized, unimpounded reaches upstream and downstream of the 5th Avenue Dam impoundment that still retain healthy habitat. The naturalized reaches represent the potential restoration that should be reasonably expected to occur within the 5th Avenue Dam pool because they are subject to similar urban stresses and pollutants. Two reaches of the Olentangy, one upstream and one downstream, will be used as reference reaches during the QHEI analysis (Figure 16).

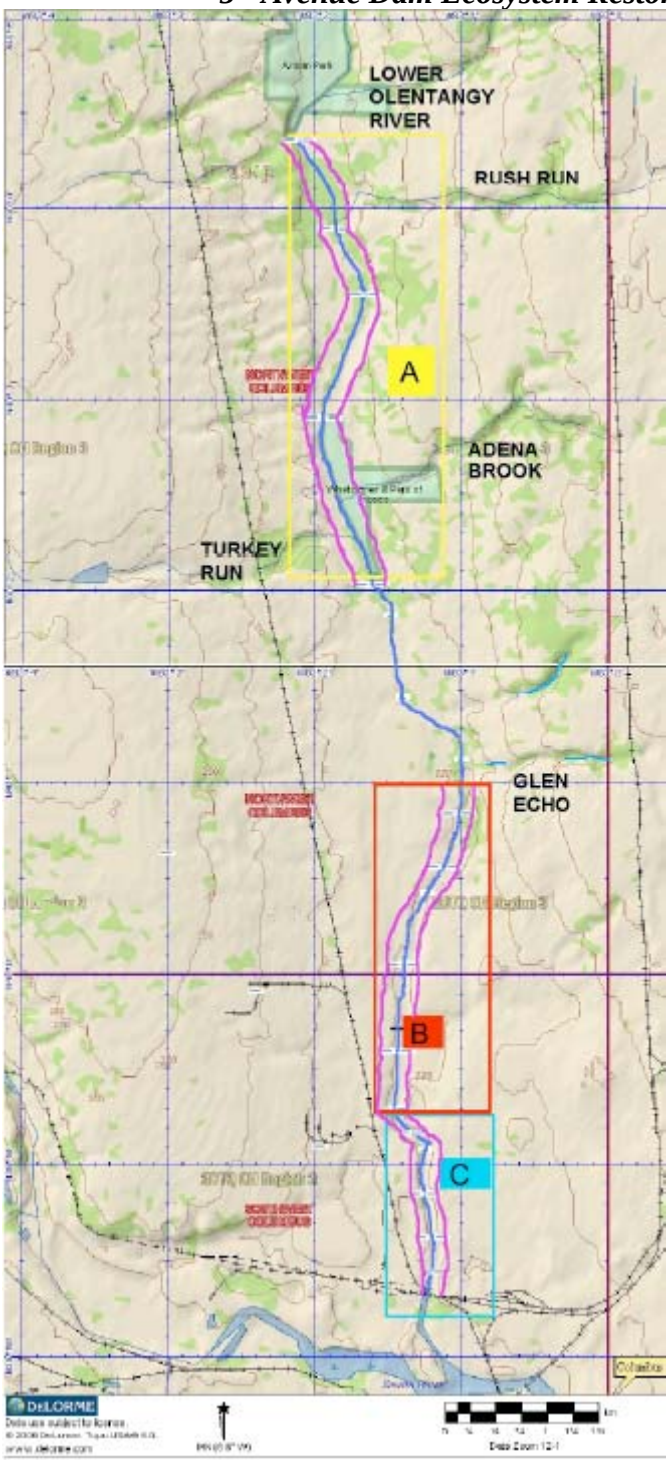

Figure 16. Location of the study area on the Lower olentangy river. The project area, section B, comprises the 5th Avenue Dam impoundment area along OSU campus. Sections A and C are reference reaches.

9.0 COST EFFECTIVENESS AND INCREMENTAL COST ANALYSIS

The purpose of cost effectiveness and incremental cost analysis (CE/ICA) is to help identify the most effective and efficient plan for ecosystem restoration along the 5th Avenue Dam impoundment of the Olentangy River. Because ecosystem benefits cannot easily be expressed in monetary units,

the Corps' restoration policy (including EC 1105-2-210, *Ecosystem Restoration in the Civil Works Program,* 1 June 1995 and EC 1105-2-214, *Project Modification for Improvement of the Environment and Aquatic Ecosystem Restoration,* 30 November 1997) requires CE/ICA to evaluate restoration alternatives. CE/ICA is conducted in a series of steps that progressively identify alternatives that meet specified criteria and screen out those that do not. These analyses help determine whether the additional environmental outputs for increasing levels of restoration are worth the additional monetary cost. Although neither cost effectiveness analysis (CEA) nor incremental cost analysis (ICA) necessarily result in the identification of a single "best" alternative, they contribute to informed decision making for ecosystem restoration.

CEA begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every possible level of restoration output. CEA screens out plans that are inefficient or ineffective. The result of CEA is a cost effectiveness curve that consists of the most economically efficient plans for various output levels. Habitat units and costs for each combination of management measures are shown in Table 3. The costs were calculated at a screening level of detail for comparison and do not include feasibility/planning and real-estate costs, which are expected to be the same for all alternatives.

Table 3. Cost and benefit table for all combinations of alternatives. Costs are annualized over 50 years. .

Alternative	QHEI	Habitat Units	Construction	Operation & Maintenance	Total Annual Cost
1A	54	91.8	$29,000	$600	$29,600
1AS	58	98.6	$32,100	$1,200	$33,300
1AR	60.8	103.36	$33,400	$1,800	$35,200
1ARS	64.8	110.16	$36,400	$2,400	$38,800
1B	54	91.8	$24,000	$2,950	$27,000
1BS	58	98.6	$27,300	$3,550	$30,800
1BR	60.8	103.36	$28,900	$4,750	$33,700
1BRS	64.8	110.16	$32,200	$5,350	$37,500
2	48.1	81.77	$24,600	$1,200	$25,800
2S	51	86.7	$27,000	$1,800	$28,800
2R	54.7	92.99	$28,300	$2,400	$30,700
2RS	57.6	97.92	$30,700	$3,000	$33,700
3	47.4	80.58	$0	$0	$0
3S	50.3	85.51	$8,510	$600	$9,110
3R	53.8	91.46	$2,190	$1,200	$3,390
3RS	56.7	96.39	$10,700	$1,800	$12,500

After the cost effectiveness of the alternatives has been established, incremental cost analysis (ICA) can be used to reveal and evaluate incremental changes in costs for increasing levels of environmental output. The primary purpose of ICA is to explicitly compare the incremental costs and the incremental outputs associated with each successively larger plan. The explicit comparisons of incremental costs and outputs allow evaluation of alternative scales of plans and plan components. The incremental evaluation of project costs and outputs provides more insight than average or total costs, since it can be used to identify significant increases in project costs necessary to achieve additional units of ecological output for the full range of plans. CE/ICA does not provide a discrete decision criterion (*i.e.,* it does not identify the "best" plan). However, it does provide information to decision makers which allow explicit comparisons between the relative changes in costs and outputs for each plan. The advantages of CE/ICA are that it ensures a rational approach

for considering and selecting alternative methods to produce environmental outputs. It also provides decision makers with a range of alternatives of varying scales, rather than an all-or-nothing choice, and it specifies the most cost effective plans for various output levels.

CEA identified three "best buy" alternatives: the No Action alternative (3), riparian restoration with no structural alterations to the dam (3R), and partial-width, full-pool dam removal structural option with riparian and in-stream restorations (1BRS) (Figure 17). The No Action and Alternative 3R are the most efficient plans with the lowest incremental cost per unit output (Table 4), but they do not meet the desired habitat unit goals for the project. The "best buy" alternative 1BRS, on the other hand, meets more of the planning objectives and is more complete, effective, and acceptable than the other "best buys". Alternative 1BRS meet the EPA's QHEI criteria (QHEI>60) for warmwater habitat; thus, it contributes towards at least one aspect of designated use attainment. It also meets the planning objectives of restoring natural flow and species assemblages to the river. Although this alternative has higher incremental cost per unit output (Table 4), the cost is acceptable and the desired level of restoration is achieved. Alternative 1BRS is therefore considered the National Ecosystem Restoration (NER) plan. Because the Federal restoration objectives go beyond meeting habitat unit goals based on QHEI, all three best buy plans will be analyzed with their expected impact on the affected environment. Additionally, the NER plan, 1BRS, was found nearly the same in cost and benefit to the Alternative 1ARS (Figure 17), so the alternative 1ARS will be further analyzed together with 1BRS. The 3% difference in costs between the two plans is well within the expected error range of cost estimates, so 1ARS should be given equal consideration as 1BRS. In most cases, the ecological benefits of 1ARS and 1BRS are assumed to be similar. Full dam removal (1ARS), is a standard and tested approach, whereas partial dam removal (1BRS) has little precedent and is a more complicated design. Although a larger contingency was added to the more unusual design of 1BRS, there may be other unforeseen costs, risks, or uncertainties that would make 1ARS preferred over 1BRS.

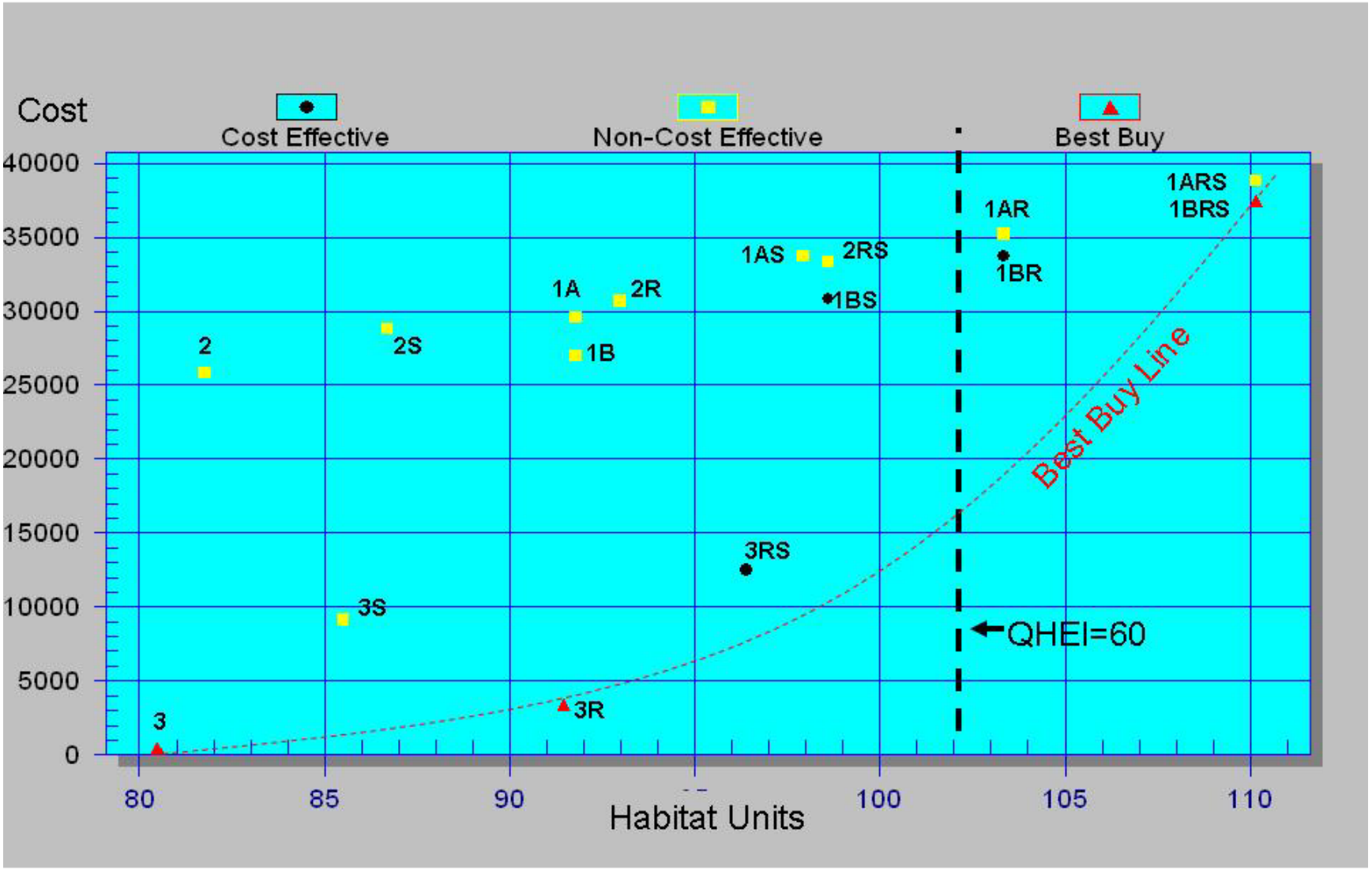

Figure 17. Incremental analysis from IWR-PLAN. Best buy alternatives (red triangles) are from left to right: No Action, No pool removal with riparian restoration, and Partial width full depth removal with riparian and in-stream restoration.

Table 4. Average costs and incremental cost analysis of best buy restoration plans.

Plan Combination	Score (Units)	Costs ($)	Average Cost ($ per unit)	Incremental Costs ($)	Incremental Output (unit)	Incremental Cost per Output ($ per unit)
3 (No Action)	80.58	0	0	0	0	0
3R	96.39	$3,390	$37.07	$3,390	10.88	$311.58
1BRS	110.16	$37,500	$340.41	$34,110	18.7	$1,824.06

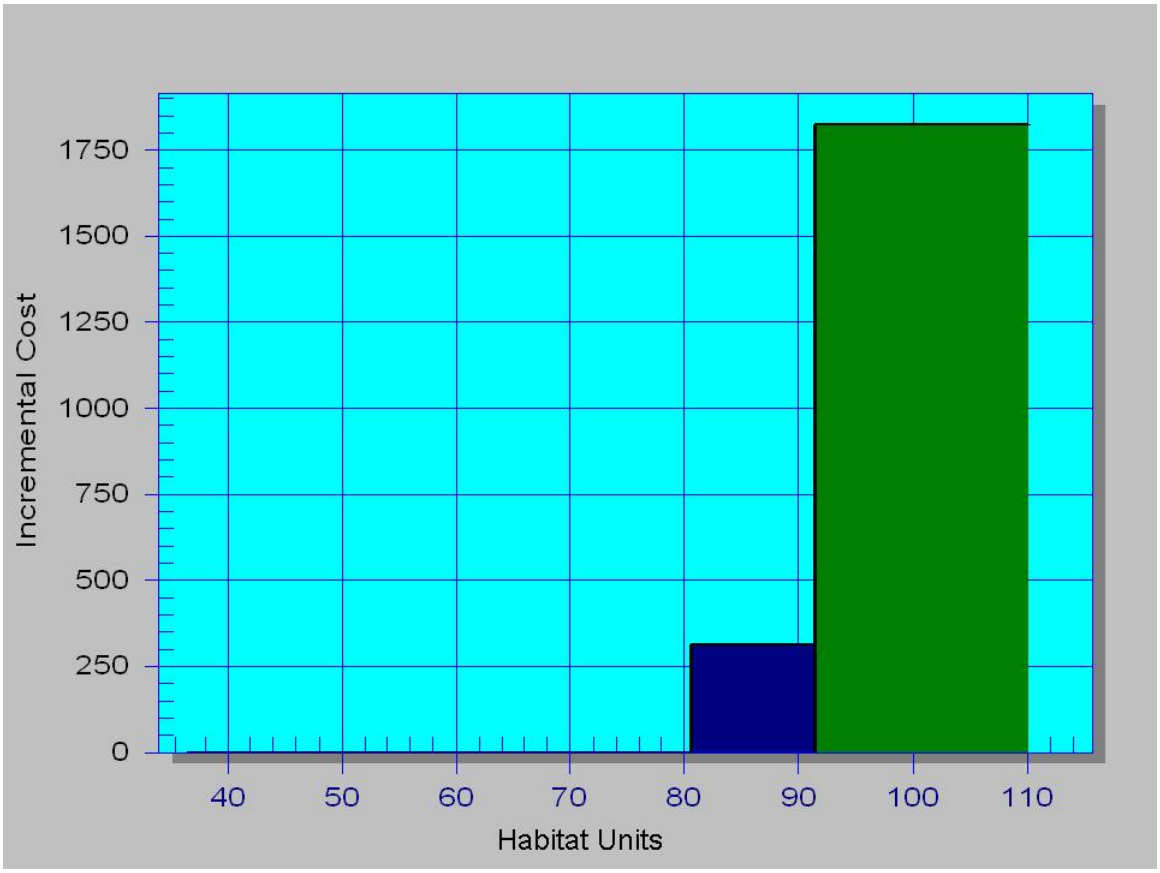

Figure 18. Incremental cost bar chart.

10.0 AFFECTED ENVIRONMENT AND CONSEQUENCES OF THE ALTERNATIVES

The proposed project would be located on an urbanized corridor of the Olentangy. The No Action would perform no restoration of the river or modification of the dam impoundment, leaving the area "as is". After a review of this information and existing conditions, an initial screening of potential impacts determined that the following resources would not be impacted by the proposed project or No Action alternative, or impacts would be inconsequential:

- Noise
- Transportation
- Wild and Scenic Rivers
- Land Use
- Prime Farmland
- Air quality
- Environmental Justice
- Wetlands

10.1 Aesthetics

No Action

Under the No Action alternative, the aesthetics will remain unchanged. It is a matter of perception whether one prefers the impounded, lake-like body of water or a restored, more natural-looking river.

Alternative 3R

Riparian restorations would restore the natural appearance of the area. Although native and site-appropriate vegetation would be planted or allowed to naturalize along the entire project area, the heavily visited areas around the OSU stadium require landscaping and maintenance by OSU to suit their visibility and appearance goals. Rather than seedlings, larger, specimen-quality, native trees would be planted in the areas where mowing would continue and some grassy fields around Drake Union would be maintained for public congregation.

Alternative 1ARS

Full pool lowering (Structural Alternatives 1A and 1B) would affect appearance of dam and the impounded pool. Pool lowering would initially expose a muddy shoreline, which would need a period of time for vegetation to establish itself. The visual appeal of a narrower channel is subjective; some people have indicated that wider, more naturally vegetated banks would be attractive; others indicate that the decrease in reflective pool would not compliment the architecture of some of the bridges crossing the river. No net improvement or detraction from appearance is therefore predictable. Pool lowering may also expose unsightly staining or pilings on bridges that are not meant to be

seen. The engineering designs for pool lowering include contingency for cleaning and patching bridge piers and abutments. Riparian and in-stream restoration in addition to pool removal will enhance the natural appearance of the river.

Alternative 1BRS

Partial width, full pool lowering (Alternative 1B) would create a mound of soil over the existing dam structure. To prevent becoming washed away, this mound would require stabilization from a lining of riprap stone. Vegetation is anticipated to establish on this mound and eventually take on the appearance of a naturally-vegetated river bank and channel. This development would likely take many years to look natural, and maintenance may be necessary to keep the appearance intact. There is some local concern that the fill would look unnatural or that it may become unstable, exposing part of the dam structure. Because this design is not common for dam removals, the final appearance would be difficult to predict and there is risk that it may become unattractive. Maintenance required to keep pleasing aesthetics would likely be too expensive and not pursued.

10.2 Recreation

No Action

The present conditions are expected to continue under the No Action alternative. The dam impoundment offers quality rowing opportunities for the crew teams. Kayaking is hindered by the dam structure.

Alternative 3R

Riparian restoration without dam modification would preserve the pool for rowing, while enhancing the beauty of the surrounding uplands. Non-aquatic uses, such as picnicking, walking, and biking would be indirectly enhanced by naturalized vegetation along the trails.

Alternatives 1ARS and 1BRS

Full lowering of the pool removes or modifies the dam, which has been viewed as an obstacle for boating, canoeing, and kayaking activities. More recreation users may be attracted to the river for these activities if the pool were removed. Compared to the impact likely to occur to the OSU Crew Club and the OSU Women's Novice Crew, the number of recreation users attracted is likely to be less than the number of OSU students impacted by the dam removal. This assumption is supported by the fact that the river has little utilization for these activities currently beyond the 5th Avenue Dam Pool. Being near downtown Columbus with limited residential access, the unimpounded project area may not attract as much in-stream recreation as other accessible and more natural rivers nearby.

While not likely to attract significant water recreation usage, removal of the dam would enhance the opportunities for recreation activities on the shoreline including (but not limited to) bicycling, walking, and picnicking. The current trail system located along the Olentangy River could be enhanced, with the removal of the dam creating a more aesthetically pleasing environment in which to participate in these activities. Although

significant positive recreation benefits would result from pool removal alternatives, these benefits are difficult to quantify and compare to the disadvantages to crew rowing losses.

Pool removal impacts to rowing would require that rowing practice take place at an off-campus location, most likely Hoover or O'Shaughnessy Reservoir. The OSU Women's Novice Crew team would be affected minimally because the Griggs Reservoir is their primary practice site, with the Olentangy used only if weather, such as wind or ice, does not permit use of the Griggs Reservoir during the winter months. Griggs reservoir is currently overcrowded, however, and would not be a feasible site for the OSU Crew Club. Several of the impacts associated with removal of the dam to the OSU Crew Club include:

- Membership loss through decreased visibility on Campus and therefore loss of associated opportunities for leadership/character development.
- Increased cost through the requirement of access fees for other reservoirs as well as for transportation and insurance.
- Loss of direct access to storage/practice facilities, resulting in either lost time for loading/unloading equipment or more realistically increased cost for the construction of a new storage/training facility.
- Additional time commitment needed due to travel time to off-campus practice facilities range from 30-40 minutes one-way from campus. Using estimates of practice days per year for 138 current members, this could result in up to 630 days of additional time commitment that would be subtracted from other activities.

In-stream and riparian restorations in addition to dam modification would provide greatest advantage to users not participating in crew activities; the most significant recreation benefit from this alternative would be the improved aesthetics from the habitat restoration, thereby encouraging non-water related activities including bicycling, walking, and picnicking. Restoration may also provide enhancements for fishing, boating, canoeing, and kayaking.

10.3 Education

No Action

Presently, the Olentangy River around campus is not used for biological studies and classes. This lack of educational opportunity would continue under the No Action alternative.

Alternative 3R

Riparian restoration would improve the biological diversity on campus, but without a fully functioning river ecosystem, vegetation alone would not significantly enhance educational opportunities.

Alternatives 1ARS and 1BRS

Full pool removal would restore the natural function of the Olentangy River around campus, lending opportunities for university research and class study. Monitoring after pool removal would compliment 319 grant monitoring and would be an important contribution to dam removal studies. In-stream and Riparian restorations would also enhance the educational opportunities for the campus-area Olentangy.

10.4 Water Quality

No Action

Poor water quality is a detriment to aquatic life on the Olentangy. Water quality would not improve under the No Action alternative until improvements under the WWMP would be implemented by the City of Columbus.

Alternative 3R

Riparian plantings would enhance the flood-pulse effect (Junk 1989) which will capture and convert nutrients and organic constituents from floods and overland flow, leading to a small but appreciable increase in water quality. This effect may not be measurable over a small distance, such as the 2 miles of the project area. Cumulatively, however, riparian habitat along an entire river significantly enhances water quality.

Alternatives 1ARS and 1BRS

Pool removal is expected to return natural function to the river and increase sediment transport, aeration, and biological productivity, which will, in turn, improve water quality. Immediately following either the pool lowering or dam removal, some retained sediments would wash downstream. Although construction would remove accumulated material directly upstream of the dam, some temporary increase in sediment transport will be unavoidable, which may adversely impact water quality downstream of the dam in the short run. In the long run, however, full pool removal with riparian and in-stream restoration is expected to bring the greatest improvement to water quality. In-stream restoration is expected to increase aeration, which may also contribute to increase in water quality, though the effect will be minor and localized near the individual habitat structures. Although Alternatives 1ARS and 1BRS would have similar effects on the entire impounded reach of the river, alternative 1BRS leaves more erodible fill material near the center of the channel. It is possible that some of this material could be eroded during a high-flow event, leading to a greater risk of excess sedimentation downstream of the previous dam location, which could be harmful to sensitive organisms.

Pool lowering does not fix the water quality problems associated with urban runoff and discharges. A direct and local effect, beneficial or detrimental, has not yet been documented of the dam impoundments on water quality. The benefit of a free flowing river more likely affects the entire river cumulatively. Aeration and sediment transport associated with a free-flowing river would ultimately reduce concentration and stagnation of organic pollutants in the river system. These pollutants, however, will still be present during large runoff events as long as CSO discharges and urban runoff continue unchecked.

10.5 Hazardous, Toxic, and Radioactive Waste (HTRW)

No Action

No change to HTRW conditions is anticipated under the No Action alternative. Although some pollutants are present in amounts typical for an urban environment (USACE HTRW report 2006), these pollutants do not appear to be concentrated in the

sediments. Although sediments will continue to accumulate behind the dam, there is no indication that there will be any accumulation of pollutants beyond the existing background concentrations.

Alternative 3R

Riparian vegetation restoration (Nonstructural Alternative R) would likely stabilize slopes, reducing sediment transport in the river, and would pose no HTRW threat.

Alternatives 1ARS and 1BRS

Pool removal is expected to disturb and release sediments that have accumulated in the impoundment. Although the sediments are primarily sandy and not expected to concentrate pollutants beyond what already exists downstream, further sampling will determine the risk before pursuing dam modification. Although construction of in-stream structures would temporarily disturb sediments, this is not expected to mobilize sufficient quantities of sediments to be of concern. Riparian restoration would stabilize slopes reducing sediment transport.

10.6 Aquatic Resources

10.6.1 Habitat

No Action

With the No Action alternative, the aquatic ecosystem conditions would most likely worsen over time. As sediments continue to deposit within the dam impoundment, any remaining diverse substrates will become buried in silt and no pool-riffle complexes will develop within the foreseeable future

Alternative 3R

Riparian restoration and conservation easements would create a small riparian buffer that would enhance the aquatic habitat by providing shade, food, shelter, and treatment of runoff and flood water. The area that can be restored, however, is minimal.

Alternatives 1ARS and 1BRS

Full pool removal (Alternatives 1A and 1B) is expected to bring QHEI scores closer to the present non-impounded scores (Figure 7). Sediment dynamics would be similar to those in their natural state, restoring substrate and pool-riffle diversity. In-stream restoration (Nonstructural alternatives R and S) would provide additional habitat where the required riffle substrate is not present. Riparian benefits would be similar to 3R except a larger riparian buffer would be available for restoration and naturalization due to the narrowed river channel.

10.6.2 Fish and macroinvertebrates

No Action

Baseline conditions would persist under No Action and poor-quality fish and macroinvertebrate communities would remain unchanged. Although water quality would increase in the future under the WWMP, the substrate and riffle-pool complexes required

for the life cycles of fish and macroinvertebrates would continue to degrade behind the dam impoundment.

Alternative 3R

Restoration of the riparian corridor along OSU campus would provide shade, food, and improvement to water quality in the river, enhancing the habitat for fish and macroinvertebrates. This effect would be small, however, because fish and macroinvertebrate communities are highly sensitive to their physical surroundings, which would remain a stagnant impoundment. The upper half of the dam impoundment, for example, has a mature and healthy riparian zone but does not exhibit the habitat diversity found in the free-flowing reference reaches. Many sensitive species that are found in the reference reaches would not be restored to the 5th Avenue Dam impoundment with riparian restoration alone.

Alternatives 1ARS and 1BRS

Full pool removal is expected to restore pool-riffle complexes in the project area and prevent excess accumulation of sediment. Removal of the dam pool would reduce the residence time in Section B (Figure 16) and promote higher water quality for target organisms migrating to the former impoundment (Cheng et al., 2006). Unlike other habitat restorations projects which have had limited success in recruiting fauna (e.g Wang, Lyons and Kanehl 2006), the restoration of section B should succeed in establishing good to excellent biotic scores since nearby source populations are present and should recruit to these suitable habitats (Sethi et al. 2004; Yoder and Beaumier 1986). Construction due to dam modification will have a temporary negative effect on fish and macroinvertebrates. The majority of past studies indicate that fish and invertebrate communities, although temporarily impacted, re-establish after dam removals (Bushaw-Newton et al. 2002; Stanley et al. 2002; Pollard and Reed 2004; Brooks et al. 2005; Tiemann et al., 2005a,b)

Because of the long-term, urban disturbances to the channel and riparian corridor along the OSU campus, full recovery to the levels of the reference reaches would be enhanced with in-stream and riparian restoration. Habitat restoration, such as constructed rock riffles, would provide physical habitat in areas that lack the necessary substrate and topography. Constructed rock riffles reduce the depth locally, provide suitable substrate, and accelerate velocities, all of which will mimic the heterogeneity of natural habitats (Gillenwater, Granata and Zika 2006). Where sufficient stone and structure currently exists under water, quality riffle habitat would also emerge as a result of pool removal. The riffle-pool sequences that would result from full restoration would provide quality habitat for resident target fish species, such as Black and Greater Redhorse and the rare River Redhorse (Yoder and Beaumier 1986), as well as for invertebrates, such as stoneflies and caddisflies who are primary food sources for target fish species. These species require the aeration created by swift and turbulent water over riffles. Large stones provide locations for refuge and rest and smaller gravel and cobbles provide spawning and foraging ground. Restoration of the riparian zone will also benefit macroinvertebrate and fish communities (Zimmerman and Death 2002). Organic plant litter provides food for invertebrates, shade from trees cools the river, overhanging root

masses provide refuge, and the entire riparian ecosystem functions as a filter to improve water quality and thus habitat for fish and macroinvertebrates.

10.6.3 Mussels

No Action

The historic trend of loss of sensitive mussel species (Figure 8) is not expected to change with No Action. Without restoration to free-flowing river conditions, no recovery is expected for mussel species.

Alternative 3R

Mussels would benefit slightly from the increase in water quality and potential food sources associated with development of a riparian buffer. Many river mussel species, however, require rocky substrate and swift, aerated flow that is currently lacking in the impounded pool. Riparian restoration would not improve substrate or aeration of the pool and would therefore not enhance intolerant species that have been lost due to the impoundment.

Alternatives 1ARS and 1BRS

Riparian restoration with dam removal and restoration of pool-riffle sequences is expected to benefit mussel communities. Aquatic ecosystem restoration has the potential to emulate conditions found in the reference reach near Kenny Park, where healthy and diverse mussel communities still thrive. Species sensitive to pollution and sediments are already rare or extirpated from the urbanized reaches of the Olentangy and are not expected to return without major improvements to water quality, which is beyond the scope of this project. More tolerant species that still require diverse flow and substrate, such as those found near the reference reaches, would stand to benefit greatly from the restoration. Because native, riverine mussel communities are often slow to recolonize the restored river, recolonization has not been well documented over the shorter lifetimes of recent dam removal studies.

Dam removal construction will have some temporary impacts on mussel species. Previous dam removal studies have observed high mussel mortality in the dewatered area (Sethi et al. 2004). Communities of mussel species adapted to lake-like conditions often establish in the impoundment during the lifetime of a dam. When the impoundment is released, the sessile mussels are unable to migrate toward the new water level and they may not be adapted to the newly established riverine conditions. There is also the possibility of some disturbances downstream of the site following construction due to movement of sediments. Mussel experts from the local area have expressed interest in dam removal to restore the river, noting that the benefits would exceed the costs of temporary disturbance. They have suggested observing the downstream mussel beds during and after construction to determine if siltation would be a problem. If there is a threat to any important mussel beds, species can be moved to a hatchery near the Columbus Zoo.

10.6.4 Vegetation

No Action

Disturbance to the riparian corridor by periodic maintenance and mowing would remain as long as the current maintenance practices hold. Under the No Action alternative, no change is expected relative to the baseline conditions.

Alternative 3R

Riparian restoration would entail mainly naturalization of the existing floodplain. In coordination with the University and the City, native riparian and bottomland species would be planted or allowed to establish naturally along selected areas of OSU campus that are currently mowed or otherwise maintained. Due to safety regulations of OSU along the bike trail, these areas of plant establishment would be limited, but would nonetheless contribute to healthy plant diversity.

Alternative 1ARS and 1BRS

With pool removal, additional river bank would be exposed. These exposed banks represent areas that could be established for a net gain in riparian and bottomland habitat. Based on the non-impounded reference reaches, it is expected that exposed banks along the free-flowing river would have higher species diversity and richness than found in the present project area, representing a healthier riparian ecosystem.

10.6.5 Nuisance species

No Action

Nuisance species will remain as present or may continue to invade or outcompete native species over time, lowering native species diversity over time.

Alternative 3B

Riparian restoration by planting native species would give naturalized areas a head start against invasive and nuisance species. Long-term monitoring and eradication of nuisance species would be necessary to preserve the native plant assemblages over time.

Alternatives 1ARS and 1BRS

Although no measure will eradicate the nuisance carp, full pool lowering would reduce stagnant, muddy water, thus eliminating the carp's preferred habitat and discouraging congregation and bioturbation. Because Asian clam is already well established along the Olentangy, there is no anticipated change in its population due to any of the project alternatives. There are no other anticipated changes to nuisance aquatic species under the in-stream restoration alternatives. If the zebra mussel, which prefers calm, slow-moving water, ever becomes established in the Olentangy, pool removal may discourage its taking over.

Riparian restoration should be done with an effort to discourage nuisance species. Riparian bottomlands along the Olentangy are dominated by amur honeysuckle (*Lonicera mackii*). It is anticipated that honeysuckle will eventually displace or outcompete at least some native vegetation in restored areas. Seeding and sprigging with aggressive native vegetation would help prevent invasives from gaining a foothold. Eradication of honeysuckle and other nuisance species is recommended as a part of long-term maintenance of the restored river corridor.

10.6.6 Threatened and endangered species

No Action

There are no known threatened and endangered species within the project area and none are expected to colonize in the area without further restoration.

Alternative 3R

Riparian restoration is expected to improve water quality, provide food and terrestrial habitat. Improved habitat will benefit all native species and would not adversely impact T&E species.

Alternative 1ARS and 1BRS

The pool lowering alternatives would restore the river corridor closer to its original state, which would be beneficial to rare native species. Although effects of urbanization will continue to adversely affect sensitive species, the fact that some threatened and endangered aquatic mussels live upstream and possibly downstream of the dam indicates that recovery is possible within the restored reach in the long term. Construction associated with alternatives would utilize best management practices to minimize sedimentation and other short-term impacts to all sensitive organisms. Mussel experts believe that construction would not pose a threat to T&E species. As a precaution, however, they have requested to be notified and present during construction to monitor sediment deposition following construction in relation to known mussel beds. If sediment deposition threatens to impact any important mussel beds, some mussels could be moved to a special hatchery at the Columbus Zoo. It is not anticipated that trees would need to be cut, but trees with crevices that could be used as roosts by the endangered Indiana Bat would be avoided.

10.7 Safety

No Action

The dam has already led to one drowning death. In the populated area around OSU campus, the 5th Avenue Dam will continue to pose a real drowning hazard if it is left as is.

Alternative 3R

Although riparian vegetation restoration (Nonstructural Alternative R) would not have a direct impact on public safety, OSU has safety regulations concerning height of vegetation adjacent to walking paths for visibility. Mowing and clearing along the walking path would be necessary for compliance with OSU regulations. Short-statured native vegetation should be planned along walkways accordingly.

Alternatives 1ARS

Complete dam removal is expected to reduce all drowning danger associated with lowhead dams. In-stream habitat features are not expected to have a significant effect on public safety. OSU safety regulations must be met with riparian plantings around biking trails.

Alternative 1BRS

Although the lowhead dam would be breached in this alternative, it is unknown how the remaining dam structure would behave under high flow conditions. The proposed dirt and stone fill may reduce dangerous recirculating currents, but only if the fill remains in place. It is also possible that the peninsulas created by the fill could attract people, which could be dangerous due to high flow or exposed construction materials.

10.8 Cultural & archeological resources

No Action and Alternative 3R

The site is already disturbed and no significant effects are expected on cultural & archeological resources.

Alternatives 1ARS and 1BRS

None of the structural or non-structural modifications are expected to make a significant impact on in-situ soils, potentially disturbing cultural or archaeological artifacts. The dam removal alternatives would remove a wedge of material from behind the dam that is composed of engineered fill and recently accumulated sediments. Any dam modifications, instream structures, or riparian restorations would therefore not impact cultural and archeological artifacts.

10.9 Summary of Environmental Impacts

None of the proposed alternatives are expected to have a significant negative impact on the environment. The restoration alternatives would restore native habitat and improve the human environment in comparison to the No Action alternative. Under the No Action alternative, the current environmental degradation is expected to remain unimproved. Riparian restoration alone (Alternative 3B), although having little to no negative effects, will only lend a subtle benefit to the aquatic ecosystem. The combination of riparian restoration, full-depth pool removal, and in-stream restoration (Alternatives 1ARS and 1BRS), however, is expected to effect a significant and measurable improvement on many aspects of the aquatic ecosystem. This comes at a cost, however, of displacing the established rowing teams.

Table 5 – Summary of cumulative impacts for all best-buy alternatives

	Alternative Impacts			
Resource	**3 (no action)**	**3R**	**1ARS**	**1BRS**
Safety	Drowning hazard continues	None	Eliminate drowning hazard associated with dam	Reduce drowning hazard
Cultural Resources	None	None	None	None
Aesthetics	None	Increased riparian vegetation	Temporary exposure of features previously under water; removal of reflective pool; naturalized appearance of river	Installation of fill and stone rip rap not in keeping with naturalized area. Temporary exposure of features previously under water; removal of reflective pool; naturalized appearance of river
Recreation	None	None	Removal of pool eliminates use by OSU crew teams; removal of dam allows for passage of canoes and kayaks	Removal of pool eliminates use by OSU crew teams; removal of dam allows for passage of canoes and kayaks
Education	None	Minor improvements in educational opportunity by increased riparian vegetation	Increased opportunities for education and research for OSU and local students of natural stream	Increased opportunities for education and research for OSU and local students of natural stream
Water Quality	No water quality improvement	Minor local improvement from filtering action of riparian vegetation removing nutrients and sediment from overland flow	Major increases in quality from increased aeration and biological productivity; temporary minor increase in sediment after dam removal	Major increases in quality from increased aeration and biological productivity; temporary minor increase in sediment after dam removal. Risk of sediment release from eroded fill material during high-flow events
Hazardous, Toxic and Radioactive Waste	None	None	None	None
Aquatic Ecosystem	None; no	Increased riparian	Major improvement in habitat	Major improvement in habitat

	improvement in habitat quality; 80 Habitat Units	habitat; improved aquatic habitat benefiting from shading and organic contribution of vegetation; 91 Habitat Units	quality; partially or fully restore ecosystem by creating natural functionality; 110 Habitat Units	quality; partially or fully restore ecosystem by creating natural functionality 110 Habitat Units
Fish and Macroinvertebrates	None; no improvement in biological communities	Some improvement in communities, but limited by remaining impoundment conditions	Restoration of natural stream conditions would significantly improve aquatic communities	Restoration of natural stream conditions would significantly improve aquatic communities
Mussels	None; no improvement or recovery of mussels would be expected	Slight increase in quality of habitat from riparian buffer	Significant improvement in habitat would encourage improvement in diversity and recovery of sensitive species	Significant improvement in habitat would encourage improvement in diversity and recovery of sensitive species
Vegetation	None	Improvement of diversity and quality of riparian corridor	Improved species diversity and quality of riparian corridor; increased riparian area for vegetation exposed by pool removal	Improved species diversity and quality of riparian corridor; increased riparian area for vegetation exposed by pool removal
Nuisance Species	Existing nuisance species remain, potential to displace native species in future	Planting of native species and management plan would reduce and limit nuisance species	Elimination of preferred habitat for carp; no change expected for asian clam; planting of native species and management plan would reduce and limit nuisance vegetation species	Elimination of preferred habitat for carp; no change expected for asian clam; planting of native species and management plan would reduce and limit nuisance vegetation species
Threatened and Endangered Species	None	Riparian vegetation would improve potential habitat for T&ES	Potential to create conditions for recovery of native rare or threatened mussels; no significant impacts to T&ES through mitigative measures during construction	Potential to create conditions for recovery of native rare or threatened mussels; no significant impacts to T&ES through mitigative measures during construction

11.0 SELECTION OF ALTERNATIVE

11.1 Selection Criteria

Four criteria are used for the evaluation of the selected alternative: completeness, effectiveness, efficiency, and acceptability (Table 6). For example, the No Action alternative is efficient because it has no additional cost or work to implement. It is not complete, however, because it relies completely on outside forces to make any positive habitat benefits; it is not effective because none of the restoration goals are achieved; it is not acceptable because the future conditions do not meet minimum standards of habitat quality.

Alternative 3R is the most efficient of the remaining best buy alternatives because it has the lowest cost for the greatest benefit. It is also not complete, however, because it cannot address major problems with the substrate, flow, and sediment transport of the river that have caused habitat degradation. It is partially effective because some of the riparian restoration goals are achieved, but full, in-stream restoration is not. Alternative 3R is also not acceptable because it does not achieve the minimum EPA standards or project goals of habitat restoration.

Alternative 1ARS and 1BRS are still efficient plans, as they were identified as "best buy" alternatives. These are the most effective alternatives because they are the most comprehensive plans, addressing in-stream, riparian, and flow restoration on the river. Although their success depends in part on urban development and implementation of the WWMP, they achieve comprehensive habitat restoration and a significant improvement on the current habitat despite urban impacts; they are therefore most complete in their scope of restoration. Although similar in most accounts, these two alternatives differ on their completeness and acceptability.

The artificial, rock-lined mound of soil covering the partially demolished dam structure of Alternative 1BRS was considered to not be aesthetically pleasing and an attractant to vandalism. Although it restores the dam impoundment area, there is a greater risk of downstream ecosystem damage if the in-stream fill is eroded. For this risk of damage and for the undesirable appearance, the planning guidance criteria for acceptability are not fully met. This partial-width approach for dam impoundment removal would be new and unproven. Although it potentially could be a novel and worthy experiment, having an uncertain outcome places a maintenance burden on the local sponsors that they would not be required or expected to uphold. The uncertain and possibly unfulfillable maintenance requirements would not satisfy the planning guidance criteria for completeness. Alternative 1ARS, on the other hand is acceptable because it, like 1BRS, is projected to eventually meet project goals and EPA criteria for aquatic habitat without environmental, aesthetic, or vandalism liability. Alternative 1ARS also places the least reliance on the local sponsor to perform complicated repairs and maintenance, making the alternative the most complete (Table 6).

Table 6. Planning guidance criteria for selection of alternatives.

Criteria	3 (No Action)	3R	1BRS	1ARS
Completeness	Least complete	Not Complete	Partially incomplete	Most complete
Effectiveness	Least effective	Partially effective	Most effective	Most effective
Efficiency	Most efficient	Very efficient	Efficient	Efficient
acceptability	Least acceptable	Not accetpable	Partially acceptable	Most acceptable

11.2 Selection Discussion

The analysis of the affected environment confirms that the best buy Alternative 3R does not meet the full objectives of the study. In addition to not attaining the EPA designated use criteria, riparian restoration alone does not restore natural flow characteristics of a river with riffle-pool sequences and it would not attract the diverse and more sensitive species that thrive in the reference reaches. With 91.5 habitat units, Alternative 3R offers an increase of 10 habitat units over the No Action condition. The full pool removal alternatives, 1ARS and 1BRS, on the other hand, contribute 30 habitat units over the No Action condition. Only full pool removal together with riparian and in-stream restoration would achieve the study objectives and approach the stream health and diversity found in the reference reaches.

Although Alternative 1BRS was determined by CE/ICA to be the NER plan, issues were identified that could not be expressed in terms of monetary cost or QHEI benefits. Alternative 1BRS does not fully comply with acceptability and completeness criteria for selection of alternatives. Partial-width removal was originally conceived to have a potentially significant cost savings over full removal, and in this manner the plan is more efficient. With its more complicated design, however, the final cost difference between the full and partial removal plans was small. The more common and simpler full-removal plan was only 3% more expensive than the partial-removal plan, a difference that is not considered a significant increase when the uncertainty of the NER plan is considered. Because the benefits of plans 1BRS and 1ARS are the same, planning objectives are met and cost would not be significantly greater by moving up to the full removal plan. In addition, Alternative 1ARS would meet the acceptability criteria for its appearance and completeness criteria due to its more stable and well-tested design. Based on considerations revealed through the NEPA process, full dam removal with riparian and structural restoration (Alternative 1ARS) is therefore the recommended plan for aquatic ecosystem restoration (Figure 19).

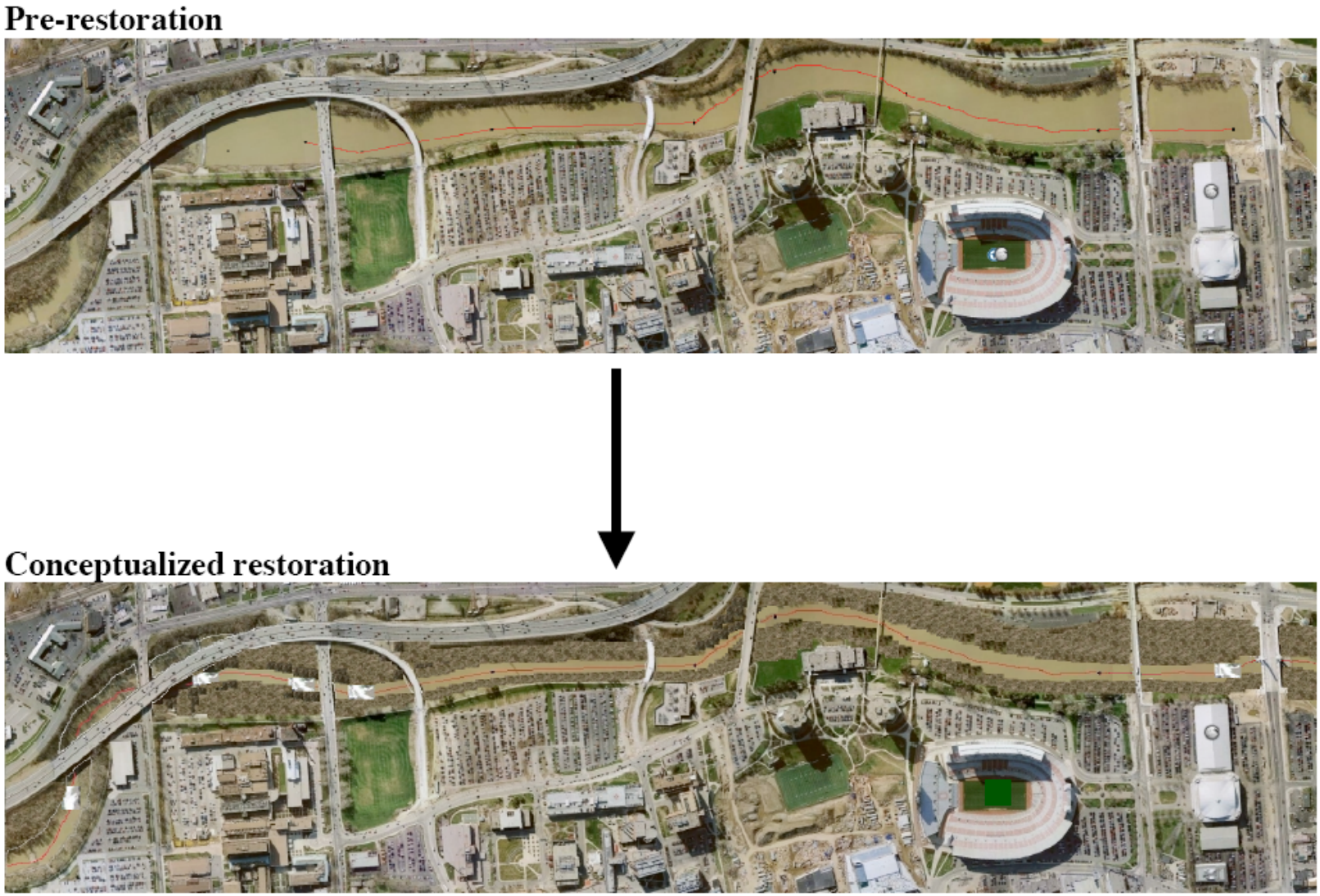

Figure 19. Conceptualization of pre- and post-restoration of the Olentangy River corridor.

12.0 CONCLUSIONS

The proposed project would meet the project objectives of bringing the physical habitat towards meeting warm water fishing criteria within the project area. The aquatic ecosystem of the river is degraded by excess of nutrients and sediment, alteration of habitat and flow, and bacteria resulting from urban development, impoundment from low head dams, combined sewer overflows and urban stormwater runoff. The selected alternative would include comprehensive management measures designed to restore the aquatic ecosystem towards attainment criteria of a warmwater habitat. This would be accomplished by removing the dam to its foundation and thereby eliminating the pool, in conjunction with the installation of in-stream habitat features and establishment of riparian vegetation. The selected alternative would meet the project goals and objectives by reducing nutrient and sediment delivery to the stream and restoring natural flow and habitat conditions to the Olentangy River.

Although many environmental factors continue to hinder ecological recovery on the Olentangy River, the proposed dam removal and stream restoration scenario would be an important first step towards recovery. Other lowhead dams and polluted urban runoff would continue to negatively affect flora and fauna within and around the project area. Removal of the utility-carrying lowhead dams and CSO outfalls will only be possible after infrastructure upgrades of the Wet Weather Management Plan being undertaken by the City of Columbus. In the mean time, useful ecological restoration can begin immediately on the 5th Avenue Dam reach of the Olentangy. Restoring this reach will provide impetus and habitat continuity to support future restoration of the entire river.

13.0 COST APPORTIONMENT

A summary of fully funded non-federal and Federal costs, by year, is presented in Table 7. This table presents the cost summary for full implementation of the recommended plan based on fully funding requirements assuming construction to occur within a one year period during 2008. The 35% non-Federal cost share is estimated to be $636,000, including prior studies, planning, engineering and design (PED), engineering during construction, and for lands, easements, rights of way, relocations, and dredged material disposal areas (LERRDDs). The remaining 65% Federal costs are estimated to be $1,181,000 which is for prior studies, PED and construction costs. The non-Federal cost sharing partner (City of Columbus, Department of Public Utilities) will be required to assume the total annual operation, maintenance, repair, replacement, and rehabilitation costs for all features.

Table 7: Cost estimate for total project costs.

Cost			FiscalYear		
	FeatureAccount		Prior	FY08	Grand Total
01	**Lands and Damages**				
		Cost to Owner		$300,100	**$300,100**
		Contingency		$75,025	**$75,025**
04	**Dams**				
		Cost to Owner		$602,225	**$602,225**
		Contingency		$150,556	**$150,556**
22	**Feasibility Studies**				
		Cost to Owner	$520,788		**$520,788**
		Contingency	$0		**$0**
30	**Engineering and Design**				
		Cost to Owner		$90,000	**$90,000**
		Contingency		$22,500	**$22,500**
31	**Supervision and Administration**				
		Cost to Owner		$45,000	**$45,000**
		Contingency		$11,250	**$11,250**
Grand Total			**$520,788**	**$1,296,656**	**$1,817,444**

14.0 PUBLIC INVOLVEMENT AND COORDINATION

14.1 Required Coordination

Public review

The Draft Environmental Assessment will be made available to resource agencies and the general public for a 30 day review and comment period. A Notice of Availability (NOA) will be published in the Columbus Dispatch regarding this document. All comments received during the review period will be considered in the Final Environmental Assessment.

Stakeholder coordination

Two stakeholder committees met regularly with the Corps. The Advisory Panel was composed of members of resource agencies, city government officials, university professors, and representatives of local neighborhoods and the OSU Crew teams. The Olentangy Technical Advisory Committee (OTAC) was composed of Professors and technical experts with specialties in science of aquatic ecosystem restoration. A meeting was also held with representatives from the OSU Facilities, Operations, and Development (FOD) to coordinate OSU landscaping, planning, and operations and maintenance needs.

FWS coordination

The Fish and Wildlife Service was consulted during project planning regarding potential impacts to fish and wildlife resources including endangered species. Information provided by the Service has been considered in the formulation and planning of the project.

404(B)(1) Guidelines and 401 Water Quality Certification (WQC):

The proposed project meets Nationwide Permit (NWP) 27 criteria as described under the under the March 12, 2007 Federal Register, Final Notice of Issuance of Nationwide Permits (72 FR 11092). Prior to issuance of the NWPs, the Corps determined projects meeting NWP 27 criteria comply with the 404(B)(1) guidelines. OEPA has issued 401 WQC for the NWPs. Given the project is within the limitations of this NWP, the project complies with the 404(B)(1) guidelines and a separate 404(B)(1) guideline analysis is not required.

14.2 Distribution List

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APPENDIX A
DRAFT FINDING OF NO SIGNFICANT IMPACT

DRAFT FINDING OF NO SIGNFICANT IMPACT
FIFTH AVENUE DAM SECTION 206
AQUATIC ECOSYSTEM RESTORATION PROJECT
COLUMBUS, FRANKLIN COUNTY, OHIO

1. Members of my staff have conducted an environmental assessment, in the overall public interest, concerning implementation of the Fifth Avenue Dam Section 206 Aquatic Ecosystem Restoration Project. The purpose of this project is to restore natural river function and habitat along the reach of the lower Olentangy River impounded by the 5th Avenue Dam. The proposed project is authorized under Section 206 of the Water Resources Development Act of 1996 (Public Law 106-53), as amended.

2. The possible consequences of the project have been studied for environmental, cultural and social well-being effects. Another factor bearing on the assessment was the capability of the project to meet the public needs for which it was proposed.

3. The Proposed Project Action Alternative and the No Federal Action Alternative were carried forward for detailed evaluation. The Proposed Alternative is the most cost effective and is both environmentally and socially acceptable. The "No Action" alternative would not be in the public's best interest and would have a continued significant impact on the economic and social resources of the area.

4. An evaluation of the Proposed Alternative and the No Action Alternative produced the following pertinent conclusions:

a. Environmental Considerations. The Huntington District has taken reasonable measures to assemble and present the known or foreseeable environmental impacts of the project in the Draft Environmental Assessment (DEA). These impacts involve biological and human resources. The proposed project will restore natural stream flow and habitat diversity to an impacted reach of the Olentangy River. All adverse effects of project implementation are considered insignificant and should last only a few months longer than the construction period.

b. Social Well-Being Considerations. The proposed project will restore natural stream flow and habitat diversity to an impacted reach of the Olentangy River. No significant economic or social well-being impacts that are both adverse and/or unavoidable are foreseen as a result of the proposed project. The project will not have any impact on sites of known significant archeological or historical importance.

c. Coordination with Resource Agencies. Pursuant to the Fish and Wildlife Coordination Act (FWCA) of 1958, coordination with the U.S. Fish and Wildlife Service (FWS), USDA, Natural Resource Conservation Service (NRCS), Ohio State Historic Preservation Office (OSHPO), Ohio EPA (OEPA) and Ohio Department of Natural Resources (ODNR) were maintained through the National Environmental Policy Act

(NEPA) process. Appropriate measures and best management practices have been identified and incorporated into the proposed action alternative.
Also, in accordance with the Endangered Species Act, as amended, the recommended plan should not impact listed species.

d. Other Pertinent Compliance. No prime or unique farmland under the Farmland Protection Policy Act will be involved. The proposed action is also in compliance with the National Historic Preservation Act (Section 10632 CFR 300), Executive Order (EO) 11988 (Floodplain Management), and EO 11990 (Protection of Wetlands).

e. Other Public Interest Considerations. There has been no significant opposition to the proposed action by state or local Governments, or organized environmental groups. Comments received during the public review period will be included in the Final Environmental Assessment (FEA). There are no unresolved issues regarding the implementation of the project.

f. Section 176(c) Clean Air Act. The proposed action has been analyzed for conformity and applicability pursuant to regulations implementing Section 176(c) of the Clean Air Act. Based on Ohio Environmental Protection Agency (OEPA) emission standards, air quality in Franklin County will meet all primary and secondary standards will not exceed *de minimis* levels or direct emissions of a criteria pollutant or its precursors and is exempted by 40 CFR Part 93.153. Any later indirect missions are generally not within the Districts' continuing program responsibility and generally cannot be practicably controlled by the District. For these reasons a conformity determination is not required for this action.

5. I find the Fifth Avenue Dam Section 206 Aquatic Ecosystem Restoration Project has been planned in accordance with current authorization as described in the DEA. The project is consonant with national policy, statutes and administrative directives. This determination is based on thorough analysis and evaluation of the project and alternative course of action. In conclusion, I find the proposed the Fifth Avenue Dam Section 206 Aquatic Ecosystem Restoration Project will have No Significant Adverse Impacts on the quality of the human and/or natural environment.

_____ _____

Date

Matthew S. Orenstein
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

APPENDIX B
NOTICE OF AVAILABILITY

NOTICE OF AVAILABILITY
FEASIBILITY STUDY AND DRAFT ENVIRONMENTAL ASSESSMENT
FIFTH AVENUE DAM SECTION 206 AQUATIC ECOSYSTEM
RESTORATION PROJECT, FRANKLIN COUNTY, OHIO

The U.S. Army Corps of Engineers, Huntington District, by this Notice of Availability (NOA), advises the public that the Feasibility Study and Draft Environmental Assessment (DEA) for the 5th Avenue Dam Section 206 Aquatic Ecosystem Restoration Project is complete and available for public review. The project is located in Franklin County, Ohio. A Finding of No Significant Impact (FONSI) is anticipated for the proposed project. A Draft FONSI is included with the DEA for public review.

In compliance with the National Environmental Policy Act (NEPA) and 40 CFR 1501.4, the DEA and draft FONSI will be available to the public in the affected area for thirty (30) days for review and comment. Final determination regarding the need for additional NEPA documentation will be made after the public review period, which begins on or about August 1, 2007. Copies of the documents may be viewed at the following locations:

Grandview Heights Public Library
1685 West First Avenue
Columbus OH 43212

Columbus Metropolitan Library
96 S. Grant Ave.
Columbus, OH 43215

The documents may also be viewed at the following website: http://www.lrh.usace.army.mil/projects/review/. Copies of the Feasibility Study, DEA and draft FONSI may be obtained by contacting Huntington District Office of the Corps of Engineers at 304-399-5873. Comments pertaining to the documents should be directed by letter to:

Mr. Peter K. Dodgion, Chief
Environmental Analysis Section, Planning Branch
Huntington District Corps of Engineers
502 Eighth Street
Huntington, West Virginia 25701-2070