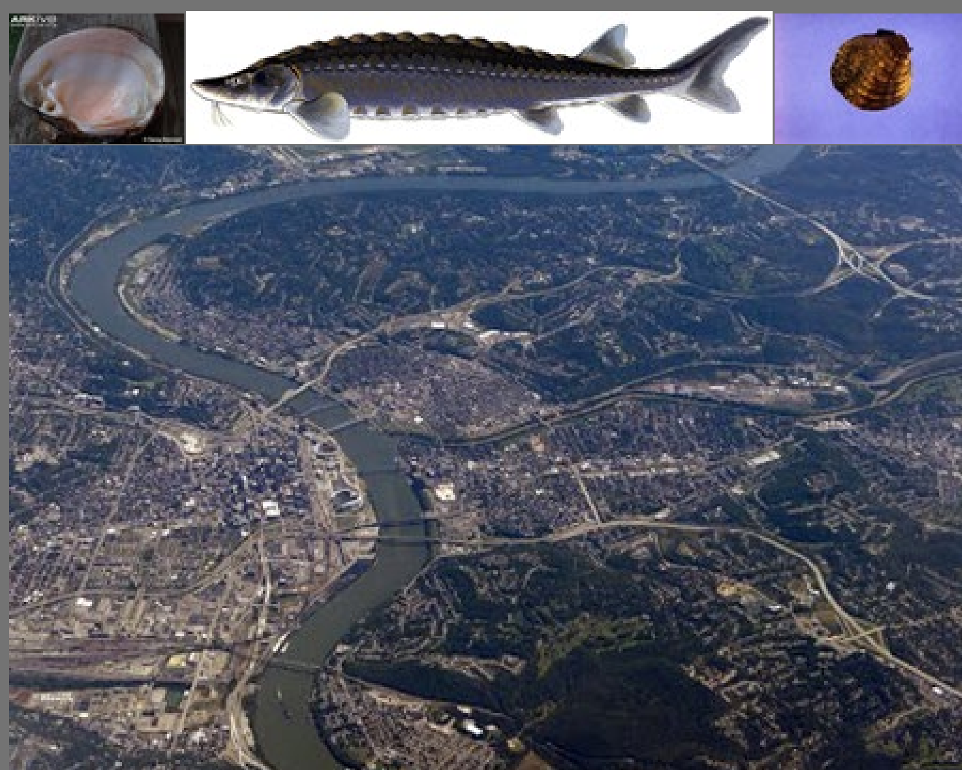
2019

Northern Kentucky Riverfront

Campbell and Kenton Counties, KY
Section 1135 Aquatic Ecosystem Restoration Study

Draft Final - Detailed Project Report and Environmental Assessment



Louisville District
US Army Corps of Engineers
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1 INTRODUCTION

1.1 STUDY PURPOSE AND SCOPE

The purpose of this study is to investigate the feasibility of restoring significant ecosystem structure, function and processes, such as habitat for endangered mussel species, which had been lost within the study area along the middle Ohio River. The intent of the project is to address serious environmental degradation that has resulted from the U.S. Army Corps of Engineers (USACE) construction of the Markland Locks and Dam in 1959, which created alterations to the Ohio River and Licking River floodplains, their associated riparian areas and tributaries. Based on the request from the non-federal sponsor, there is a need within the study area to restore threatened and endangered species habitat, floodplain connectivity, riparian habitat quality, and stream connectivity. This Detailed Project Report and Environmental Assessment includes an analysis of project costs, benefits, and environmental impacts for several potential alternatives.

1.2 LOCATION

1.2.1 Study Area

The study area lies within the Fourth Congressional District of Kentucky, and is part of Cincinnati, Ohio's Metropolitan Statistical Area. The study area is contained within the middle section of the Ohio River basin (Figure 1) and includes the drainage of the Little Miami (National Wild and Scenic River), Ohio Brush and White Oak Creeks, Licking River, Middle Ohio-Laughery and other smaller sub basins. The sizable drainage basins of Figure 1 illustrate the importance of the study area in terms as a nexus of connection between the middle Ohio River and the thousands of stream and river miles that drain into the area. The study area is along the left descending bank of the Ohio River as shown in **Figure 1** (next page). It is inclusive of the riparian zone of the Ohio River and approximately 0.5 miles of the Licking River. The study area includes the Kentucky cities of Ft. Thomas, Dayton, Bellevue, Newport, Covington and Ludlow.

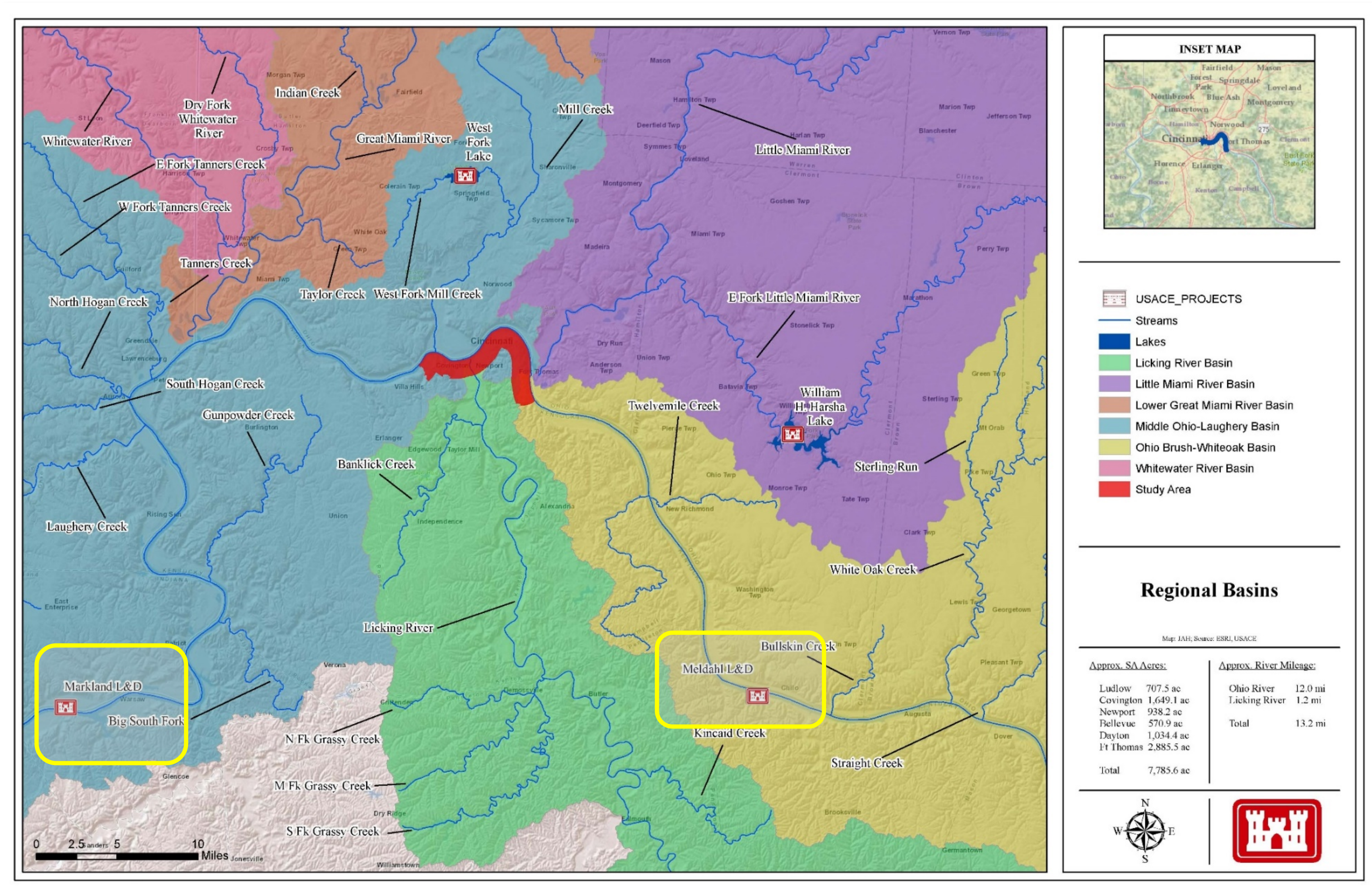


Figure 1 - Map of Study Area with Major Drainage Basins along the middle Ohio River. Locations of Lock and Dams encircled in yellow.

1.2.2 Project Area

The project area is located along 12 miles of the Ohio River shoreline across from Cincinnati, Ohio (Figure 2). The project area includes the riparian areas of the cities of Ft. Thomas, Dayton, Bellevue, Newport, Covington and Ludlow, including approximately 0.5 miles of the Licking River from its confluence with the Ohio River.

1.2.2.1 Study Reaches

For this study, the project area has been partitioned into six reaches based on city limits and opportunities for restoration actions based on current conditions of those locations.

Ft. Thomas

Ft. Thomas is geographically the largest of the cities, contains the highest proportion of natural land cover and the longest stretch of the Ohio River shoreline out of the other cities within the project area. Ft. Thomas also contains numerous small tributaries that emerge from the ravines lining the shoreline of the Ohio River. These tributaries provide a valuable aquatic resource as fish spawning habitat and nursery/refuge areas for juvenile fish. They also provide sources of gravel and cobble needed to form fish habitat within the main stem of the Ohio River. Additionally, they provide coarse woody and plant debris - the basis of the food web which contributes to sustainable aquatic life within the middle Ohio River basin. Compared to the other cities, Ft. Thomas has much less development along the shoreline, which presents opportunities to increase habitat connectivity and improve fish habitat along the Ohio River riparian zone. The Ft. Thomas reach includes approximately 18,000 linear feet of shoreline and 8 acres of land considered for restoration measures.

Dayton

Although Dayton is smaller in area compared to Ft. Thomas, it does contain a good portion of the Ohio River shoreline. Similar to other cities within the study area, a significant portion of the riparian area has been developed for industrial and residential use. However, because of the length of Dayton's shoreline, and the city's openness to ecosystem restoration, there are opportunities to improve the quality of habitat within the riparian zone and increase habitat connectivity along the Ohio River. The Dayton reach includes approximately 6,300 linear feet of shoreline and 3 acres of land considered for restoration measures.

Bellevue

Bellevue is the smallest of the cities and with the smallest portion of the Ohio River shoreline. Although similar in amount of development within the riparian zone as the other cities, Bellevue has retained a good portion of their shoreline as public parkland. Bellevue offers an important area of restoration opportunity within the park, which would increase habitat connectivity along the Ohio River. The Bellevue reach includes approximately 1,300 linear feet of shoreline and 1 acres of land considered for restoration measures.

Newport

Newport sits at the confluence of the Ohio River and the Licking River (western shoreline), offering a unique opportunity to address loss of habitat connectivity and improve quality of the floodplain forests along two important riparian zones. The Newport reach includes approximately 6,100 linear feet of shoreline and 3 acres of land considered for restoration measures.

Covington

Covington is one of the largest cities in the study area, and just like Newport, is located at the mouth of the Licking River (eastern shoreline). Covington also offers multiple opportunities to restore lost habitat connectivity and improve habitat quality along the Ohio Licking Rivers and their associated floodplain forests. The Covington reach includes approximately 12,100 linear feet of shoreline and 5.5 acres of land considered for restoration measures.

Ludlow

Ludlow is one of the smaller cities within the project area and has one of the smallest portions of the Ohio River shoreline. However, similar to Bellevue, Ludlow has retained portions of their shoreline as public space and offers important restoration opportunities for increasing habitat connectivity along the Ohio River shoreline. The Ludlow reach includes approximately 2,700 linear feet of shoreline and 1.25 acres of land considered for restoration measures.

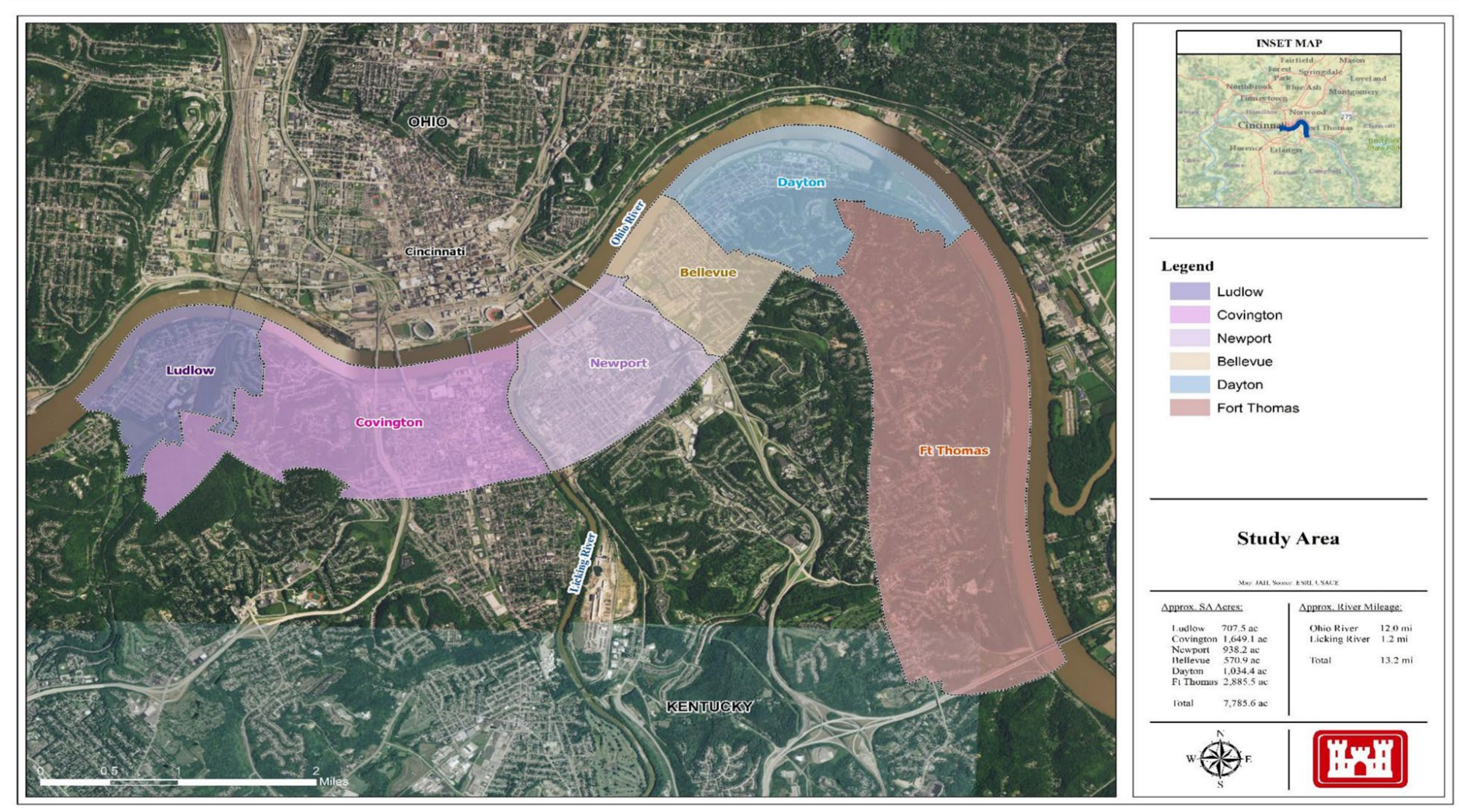


Figure 2 – Map of Project Area

1.3 STUDY AUTHORITY

This study is authorized by Section 1135 of the Water Resources Development Act of 1986, as amended (Public Law 99-662). Section 1135 provides the authority to modify existing USACE projects to restore the environment and construct new projects to restore areas degraded by USACE projects with the objective of restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition considering the ecosystem's natural integrity, productivity, stability and biological diversity. This authority is primarily used for manipulation of the hydrology in and along bodies of water, including wetlands and riparian areas. Section 1135 is one of several authorities under the USACE Continuing Authorities Program, which focuses on water resource related projects of limited scope, cost and complexity.

The following is a description of past and current USACE activities and relevance of the Section 1135 authority to the study area:

The genesis of the Federal Navigation Project on the Ohio River can be found in a May 24, 1824, act of Congress that provided for the improvement of the Ohio and Mississippi Rivers. In his annual message dated December 7, 1824, President Monroe stated that "the superintendence of them has been assigned to officers of the Corps of Engineers". For the Ohio River an initial appropriation of $75,000 was provided by Congress for the improvement of certain sand bars that had been identified by the various states along the Ohio River as the most serious impediments to commercial navigation. Subsequently, the first stone training dikes were constructed at various sand bars for the purpose of contracting the channel and increasing the scour of the Ohio River. In 1836 the first dam on the upper Ohio River was constructed at Browns Island (adjacent to Weirton, West Virginia).

In 1875, at the urging of many local interests along the Ohio River, Major William E. Merrill of USACE proposed a comprehensive plan to provide permanent year round slack water navigation throughout the entire length of the river using a series of locks and dams. This initial plan to canalize the full length of the Ohio River called for the construction of 68 dams with an average lift for each lock of about 6 feet. By 1916, after repeated design modifications involving increases in the lift of the locks and their locations, the project was reduced to 54 locks and dams. While the average lift per lock had been increased, it was still quite moderate with three-quarters of the locks included in the project having a lift of less than 8.5 feet.

In 1944 USACE proposed, and Congress authorized, a major modification to the project that would replace the system of low lift locks and dams with 19 high lift locks and dams. This last modification to the Federal Navigation Project was completed in 2018 with the opening of the Olmsted Locks and Dam near Ohio River Mile (ORM) 964, some 16 miles upstream of the confluence of the Ohio and Mississippi Rivers. Specific to the study area, the Markland Locks and Dam was constructed at ORM 531.5 and began operation in 1959. This facility has a lock lift of 35 feet and maintains a minimum navigation pool at elevation 455 North American Vertical Datum of 1988 (NAVD88) for a length of some 93 miles of the Ohio River. It eliminated the need for five of the then existing low lift locks and dams in the system at ORM 450, 459, 481, 501 and 529.

The project area is located between ORM 462 and 474. At this location along the Ohio River, construction of Markland Locks and Dam resulted in the minimum navigation pool being raised from elevation 441 to elevation 455 NAVD88, an increase of 14 feet along the Ohio River. At the Licking River's confluence with the Ohio River the depth was increased by 14 feet, with the 9-foot minimum navigation pool on the Licking River extending an additional 4 miles upstream (the total influence from the Ohio River extends for approximately 7 miles on the Licking River).

As a result of this increase in pool elevation on the Ohio and Licking Rivers, many public infrastructure facilities along the shoreline of both rivers (e.g., water intakes, storm water discharge lines, boat docks, mooring facilities, roads and the like) had to be modified and the costs for these modifications were included as part of the implementation costs for Markland Locks and Dam. However, during this same time, minimal consideration was given to the significant impacts by this change in the river on the ecology and/or physical scale of the riverine habitat impacted by modifications to the Ohio River.

Some of the most significant detrimental impacts caused by the impoundment have occurred along the riparian corridor of the Ohio River. Riparian processes have a crucial ecological role in most landscapes. Riparian ecosystems offer varied habitats for many species, function as filters between land and water, and serve as pathways for dispersing and migrating organisms. Riparian ecosystems can also have many economic and recreational values.

The construction of Markland Locks and Dam converted the free-flowing waters of the rivers into a more lake-like, lacustrine environment during low flow periods due to the drastic increase in minimum pool level. Such modification has caused both the alteration of the natural erosion-transport deposition processes and the development of new riverbed and riverbank landforms. These hydrogeomorphic alterations of the river ecosystem have significantly affected the structure and distribution of the upstream riparian plant and the fish communities along the Ohio River. These disturbances, coupled with other anthropogenic influences, have also facilitated the spread of invasive plant species throughout the once-healthy riparian vegetative communities. Implementation of the Section 1135 project will act to restore riparian and aquatic habitat that has been degraded from alteration of the hydrologic conditions caused by the construction of the Markland Locks and Dam.

1.4 RELEVANT PRIOR STUDIES, REPORTS AND USACE PROJECTS

1.4.1 Study Background

In March 2007 USACE completed a 905(b) Reconnaissance Analysis for the Northern Kentucky Riverfront, which identified a number of possible project components under the categories of recreation, public access, and regional economic development. Under that current administration policy and guidelines, these items would have low budgetary priority when compared with navigation, flood damage reduction, and ecosystem restoration projects. Additionally, there is no stand-alone authority under which these project components could be developed. Consequently, the 905(b) analysis recommended that no follow-on feasibility studies be completed at that time.

Between 2007 and 2009 Southbank Partners Incorporated (representing the Northern Kentucky Port Authority, Ludlow, Covington, Newport, Bellevue and Dayton) engaged USACE to expand on the 905(b)

Analysis with a targeted focus on ecosystem restoration opportunities along the Ohio and Licking Rivers in these northern Kentucky communities. In 2010 USACE executed a Feasibility Cost Sharing Agreement (FCSA) with the Northern Kentucky Port Authority (NKPA), which serves as the financial sponsor for this study and has delegated study coordination to Southbank Partners.

Non-federal matching funds from NKPA were provided in 2011 for USACE to initiate a review and reevaluation of the 905(b) Analysis completed in 2007. However, at that time matching federal appropriations were not available to complete this work. In 2014 the Louisville District initiated a reprogramming request for federal funds and a limited amount of funding was received in 2014 to complete a scoping charrette with key stakeholders under the 2010 agreement. The purpose of this charrette, in part, was to refine study focus so that an updated cost estimate could be completed.

Following the charrette the study was placed on hold until additional federal appropriations were received in April 2016 with the intent to complete the feasibility study. Continuing with the study, the Alternatives Milestone Meeting was held with the Vertical Team (Louisville District, Great Lakes and Ohio River Division and USACE Headquarters) in December 2016, which supported the current study analysis, as well as the proposed restoration alternatives. An In-Progress Review meeting subsequently held in September 2017 with the Vertical Team and affirmed the previous alternative array, environmental models, and confirmed the path forward to the Tentatively Selected Plan (TSP) Milestone.

Up to this point, the study was conducted and assumed to be completed under the USACE General Investigation program, which requires Congressional authorization for project design and implementation. At the January 2017 TSP Milestone Meeting the Louisville District recommended that the study be converted to a Section 1135 study under the Continuing Authorities Program based on the estimated cost of implementation and straight-forward nature of the project alternatives under consideration. During the TSP Milestone Meeting the Vertical Team concurred with the selection of the TSP, as well as the recommendation to convert to a Section 1135 study. The Vertical Team also recommended that the Louisville District find a logical termination point for work to complete under the General Investigation program and convert to the Continuing Authorities Program.

In coordination with the Great Lakes and Ohio River Division and USACE Headquarters, the Louisville District determined that termination of the study under the General Investigation program would occur following the completion of the Agency Technical Review (ATR) of the draft report, which was completed in November 2018. (Note, the objective of ATR is to ensure that a recommended project is consistent with established USACE criteria, guidance, procedures and policy.) The Great Lakes and Ohio River Division Commander ultimately made the official decision to terminate the study under the General Investigations program and continue under the Continuing Authorities Program. Following termination of the General Investigation study, a new FCSA was signed on April 3, 2019 between the USACE and the NKPA (Non-federal sponsor) to complete remaining work on the feasibility study under the Section 1135 study authority. Specifically, finalizing the Section 1135 feasibility study includes completion of policy, legal, agency and public reviews, as well as Great lakes and Ohio River Division review of the Draft Detailed Project Report and Environmental Assessment. After the Division

Commander approves the Final Detailed Project Report, the feasibility study will be complete and a Project Partnership Agreement will be executed to initiate the design and implementation phase of the project.

1.4.2 Previous Studies and Reports

A search on Google Scholar (http://scholar.google.com) from 1980-2016 with the key words of 'Ohio River' revealed around 805,000 research articles, books and book chapters that contained information related to the Ohio River. The three most heavily cited articles presented information on zooplankton assemblages (Thorp et. al. 1994), riverine productivity modeling (Thorp and Delong 1994) and modeling the relationship between land use and surface water quality (Tong and Chen 2002). Additionally, there are a number of agency reports on a wide range of topics produced within the range of the study area. The following is an abbreviated list of reports consulted to inform this study.

- Sanitation District No. 1 (SD1) of Northern Kentucky produced the report "Summary of Biological and Habitat Survey Results for Northern Kentucky Watersheds: Kenton, Campbell and Boone Counties, Phase 1 – 2007 – 2011" (2014). Their results indicate that the majority of aquatic resources including smaller streams, Licking and Ohio Rivers are in poor condition, with some areas in fair to excellent condition.
- The Ohio River Foundation published a report titled "A Framework for Ecosystem Restoration of the Ohio River and its Watershed" (2004). This report details the various environmental problems and potential restoration opportunities within the Ohio River Basin, including riverine habitat diversity, habitat quality at tributary mouths, riparian forests, freshwater mussels and fish movements and mussel dispersal.
- In October 2000, USACE documented problems in a feasibility report titled "The Ohio River Ecosystem Restoration Program" and that study resulted in an authority in Section 101(b) of WRDA 2000. The Ohio River Ecosystem Restoration Program was subsequently deauthorized in 2012.
- The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) produced a report titled "The Licking River Watershed - Rapid Watershed Assessment (RWA), Hydrologic Unit Code (HUC) 05100101" (2008). The report presents various organizational interests in the conservation of the Licking River. For example:
    - NRCS has prioritized the Licking River for its Wetland Reserve Program; the Kentucky State Nature Preserves Commission has identified the Licking as a priority area for conservation efforts;
    - Kentucky Department of Fish and Wildlife Resources has identified the Licking River as a Bird Priority Conservation Area and Bivalve Conservation Area (along with Ohio River shoreline within Ft. Thomas); and
    - Kentucky Division of Water has numerous projects aimed at improving water quality within the Licking River.
- The Nature Conservancy in Ohio and the Ohio River Basin Fish Habitat Partnership (ORBFHP), in a report titled "The Ohio River Fish Habitat Partnership Strategic Plan" (2011). The report identified the Licking River, including its confluence with the Ohio, as a "Priority Area", and as an

"Early Action Site." This means that the ORBFHP has found, through rigorous modeling, that the Licking River both needs ecosystem restoration and is predicted to respond well to it. Additionally, a panel of technical professionals (from ORBFHP) evaluated all of the watersheds and modeling results in the Ohio River Basin, and identified this as one that should be targeted first for restoration.

1.4.3 Projects completed by USACE

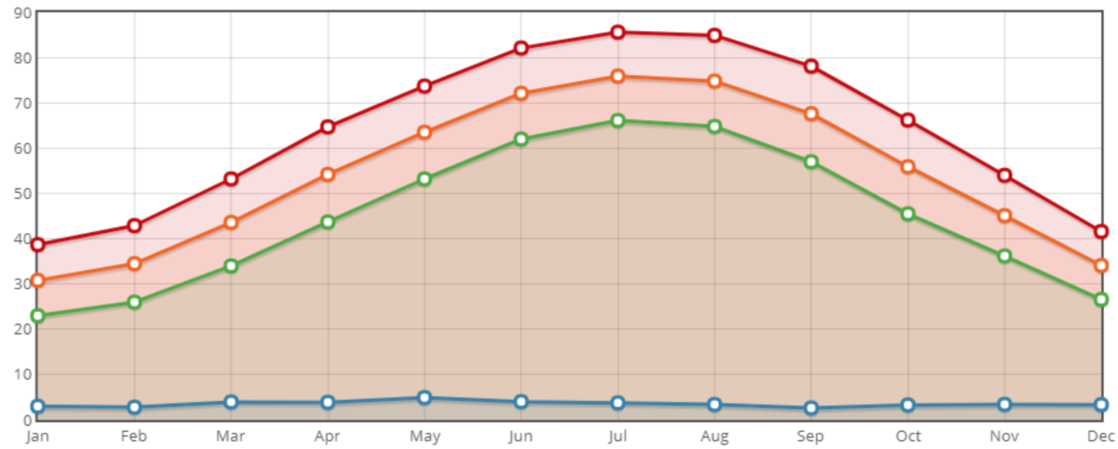
In addition to Markland Locks and Dam (see Section 1.3 for additional information), USACE has completed several local protection projects near the proposed project area. Although these projects did contribute to overall environmental degradation, the effects were insignificant in comparison to the alternations caused by the Markland Locks and Dam. These USACE constructed projects include the following:

- Boone County, Kentucky at left bank of the Ohio River – bank protection and roads repair
- Cincinnati, Ohio at Mill Creek– channel improvement, barrier dam, levee, walls, pumping plants
- Covington, Kentucky at the confluence of Licking and Ohio Rivers – levee, walls, pumping plants
- Dayton, Kentucky at left bank of Ohio – levee, pumping plants, relocation of storm sewers
- Newport, Kentucky at left bank of the Ohio River and right bank of the Licking River at their confluence – levee, flood walls, pumping plants

2 AFFECTED ENVIRONMENT - EXISTING CONDITIONS

2.1 CLIMATE

A wide range of temperatures are experienced in the greater Cincinnati area throughout its four seasons. A typical weather pattern moves from southwest to northeast across the region. Summers in greater Cincinnati are marked by warm and humid days, with about 20 days per year above 90 degrees Fahrenheit. Winters are moderately cold and cloudy with total snowfalls averaging between 18 and 20 inches per season (Woolpert, Inc. 2006). Figure 3 depicts monthly averages for temperature and precipitation using data from the closest National Oceanic and Atmospheric Administration (NOAA) weather station to the project site at the Cincinnati Northern Kentucky International Airport (Network:ID GHCND:USW00093814) in Hebron, KY (NOAA, 2010). Although climate information was published in articles for the greater Cincinnati area, no local climate studies of the project area (e.g., Ft. Thomas) were found during a literature search.



MONTH	PRECIP (IN)	MIN TMP (°F)	AVG TMP (°F)	MAX TMP (°F)
01	3.00	23.0	30.8	38.7
02	2.81	26.0	34.5	42.9
03	3.96	34.0	43.6	53.2
04	3.89	43.7	54.2	64.7
05	4.93	53.2	63.5	73.7
06	4.03	62.0	72.1	82.1
07	3.76	66.1	75.9	85.6
08	3.41	64.8	74.8	84.9
09	2.63	57.0	67.6	78.1
10	3.30	45.5	55.9	66.2
11	3.43	36.2	45.1	54.0
12	3.37	26.6	34.1	41.6

Figure 3 - Monthly temperature and precipitation averages, as well as average maximum and minimum temperatures, for Hebron, KY from 1981 to 2010.

Findings of the U.S. Global Change Research Program in the 2014 National Climate Assessment (Melillo et al. 2014) indicated the average annual temperature during the last century across the Southeast cycled between warm and cool periods (see Figure 4, black line). The document defined the Southeast region as the states of Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Arkansas, Louisiana, Mississippi, Alabama, Georgia, and Florida. A warm peak occurred during the 1930s and 1940s followed by a cool period in the 1960s and 1970s. Temperatures increased again from 1970 to the present by an average of 2°F, with higher average temperatures during summer months. Figure 4 shows observed annual average temperature for the Southeast (Including northern Kentucky and the project area) and projected temperatures assuming substantial emissions reductions (lower emissions) and assuming continued growth in emissions (higher emissions). For each emissions scenario, shading shows the range of projections and the line shows a central estimate. The projections were referenced to observed temperatures for the period 1901-1960. The region warmed during the early part of last century, cooled for a few decades, and is now warming again. The lack of an overall upward trend over the entire period of 1900-2012 is unusual compared to the rest of the U.S. and the globe. This observed lack of warming has been dubbed the "warming hole" and has been the subject of considerable research, although a conclusive cause has not been identified. Parts of the Great Plains and Midwest Regions are also included in the warming hole. Several hypotheses have been suggested to explain it, including increased cloud cover and precipitation, increased aerosols and biogenic production from forest re-growth, and decreased sensible heat flux due to irrigation (Melillo et al. 2014).

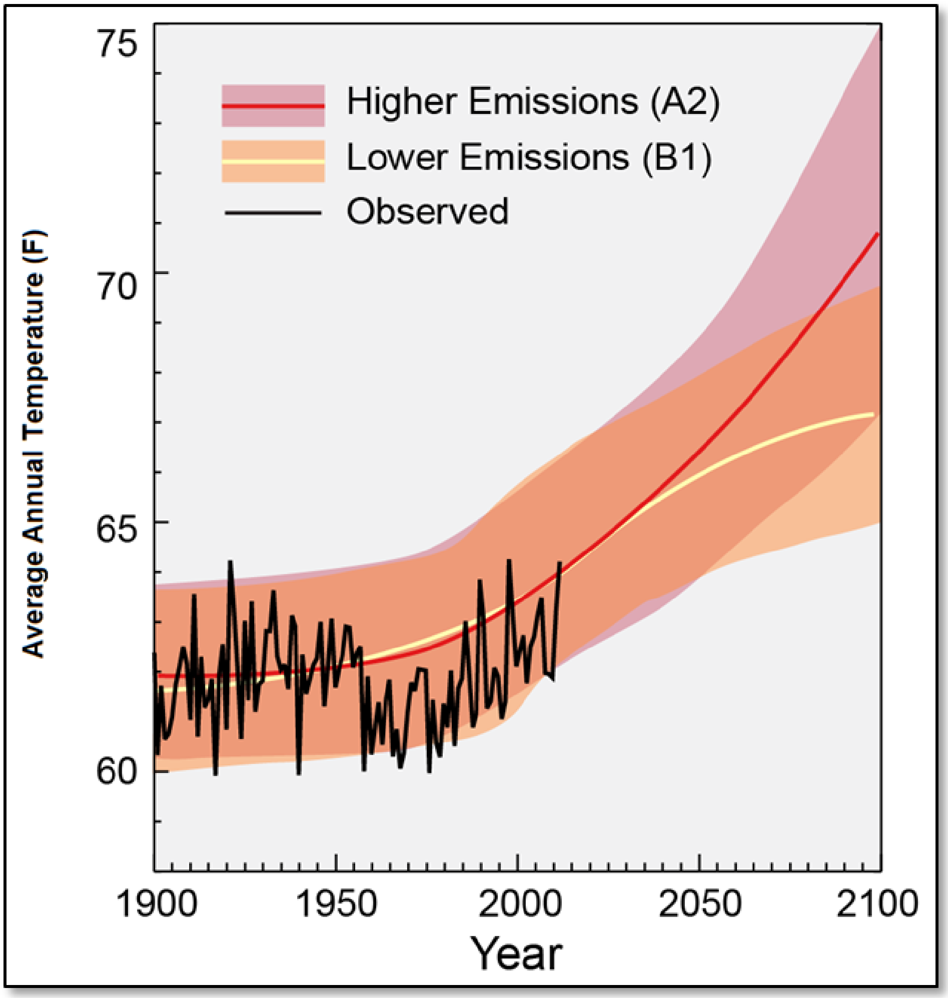


Figure 4. Southeast temperature: observed and projected (adapted from Kunkel et al. 2013).

In 2015, USACE published the Climate Change and Hydrology Literature Synthesis for the U.S. Army Corps of Engineers Missions in the United States – Ohio Region. This is part of a series of 21 regional climate syntheses prepared by USACE under the leadership of the Institute for Water Resources (IWR) Global and Climate Change team at the scale of two (2)-digit U.S. Geological Survey (USGS) Hydrologic Unit Codes (HUC) across the continental United States, Alaska, Hawaii, and Puerto Rico. The trends and literary consensus of observed and projected primary variables noted in the Ohio Region are summarized for reference and comparison in Figure 5.

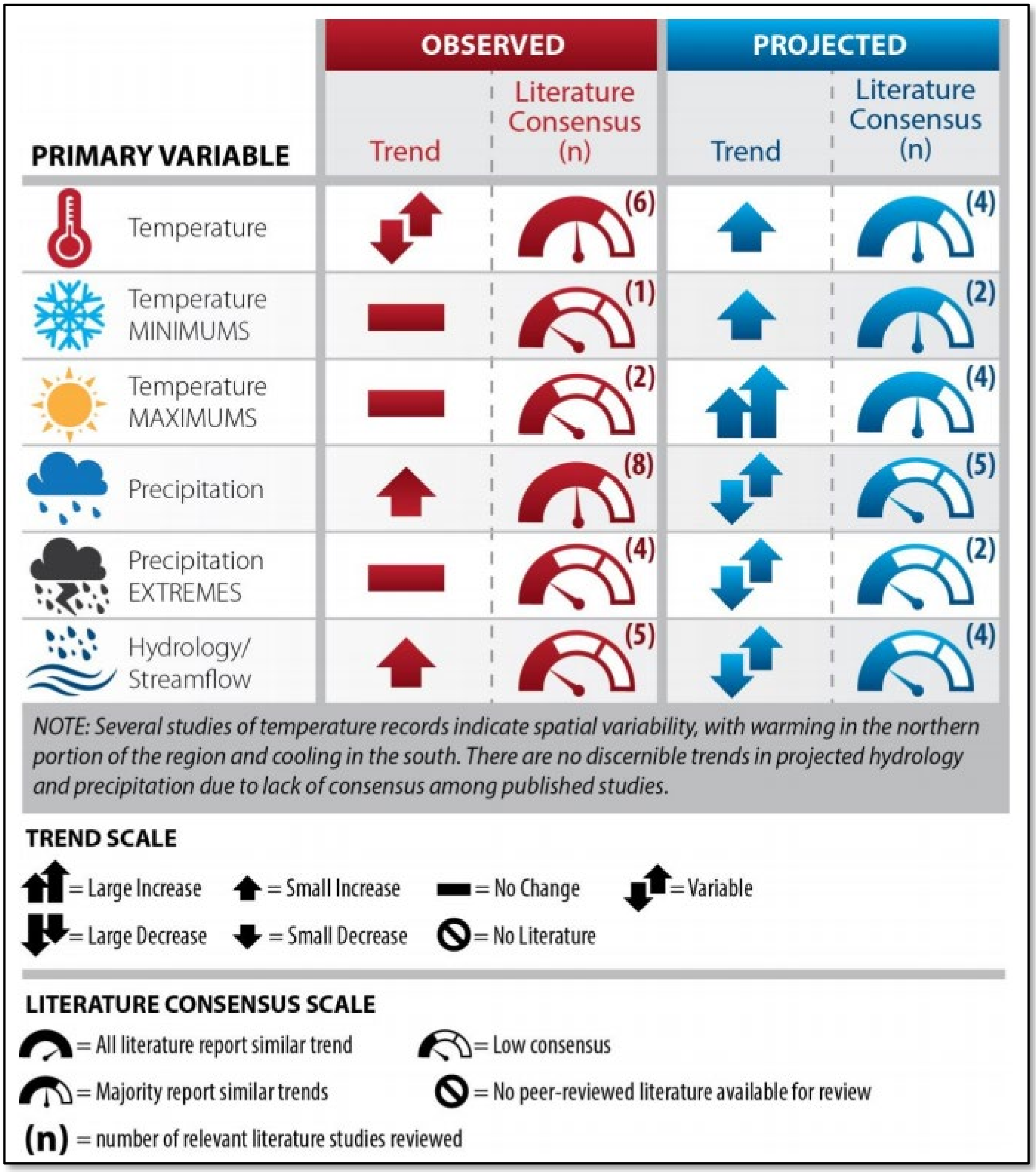


Figure 5. Summary matrix of observed and projected climate trends and literary consensus (USACE 2015).

The USACE Climate Hydrology Assessment Tool was used to identify historic trends in instantaneous peak flows at the gages nearest the study area as a proxy for understanding how flows in the watershed have changed over the period of record. The hydrologic time series of annual peak instantaneous streamflow at the gage on the Licking River near Catawba, Kentucky (3253500) is shown in Figure 6.

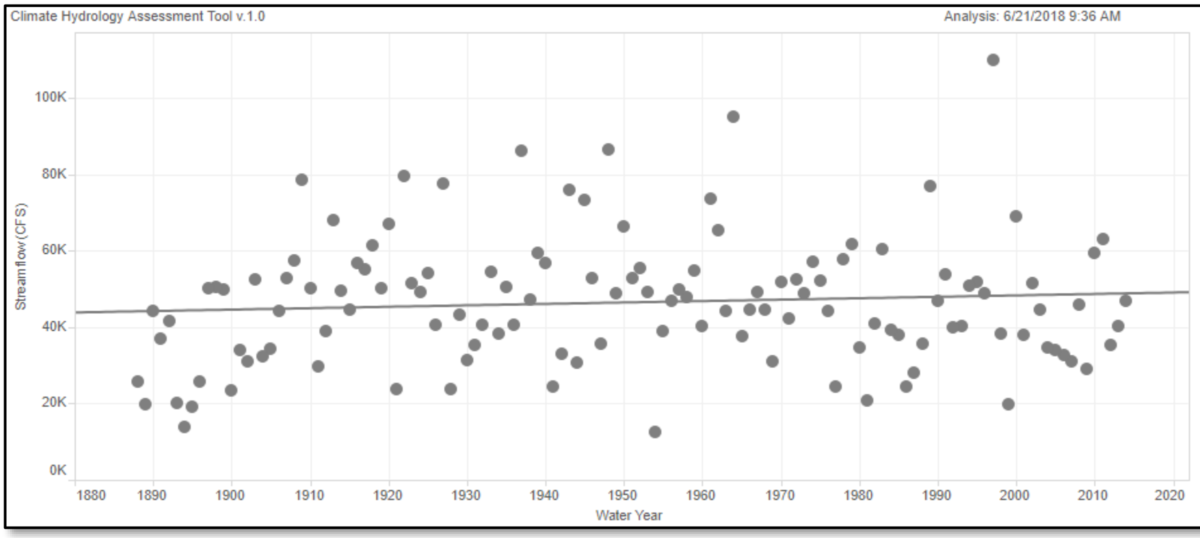


Figure 6. Annual Peak Instantaneous Streamflow, Licking River at Catawba, KY. Trend line equation: Q = 37.2246*(Water Year) -26171.7, p = 0.360576.

This gage was chosen for the assessment because it is the nearest gage to the project area with continuous data for at least 20 years (Figure 7, locations of gages and study area in relation to HUC boundaries, blue dot indicates location of gage in analysis). In Figure 8, Gage 3253500 is located south of Cincinnati. The proposed project site is located near the northern border of the HUC 0510.

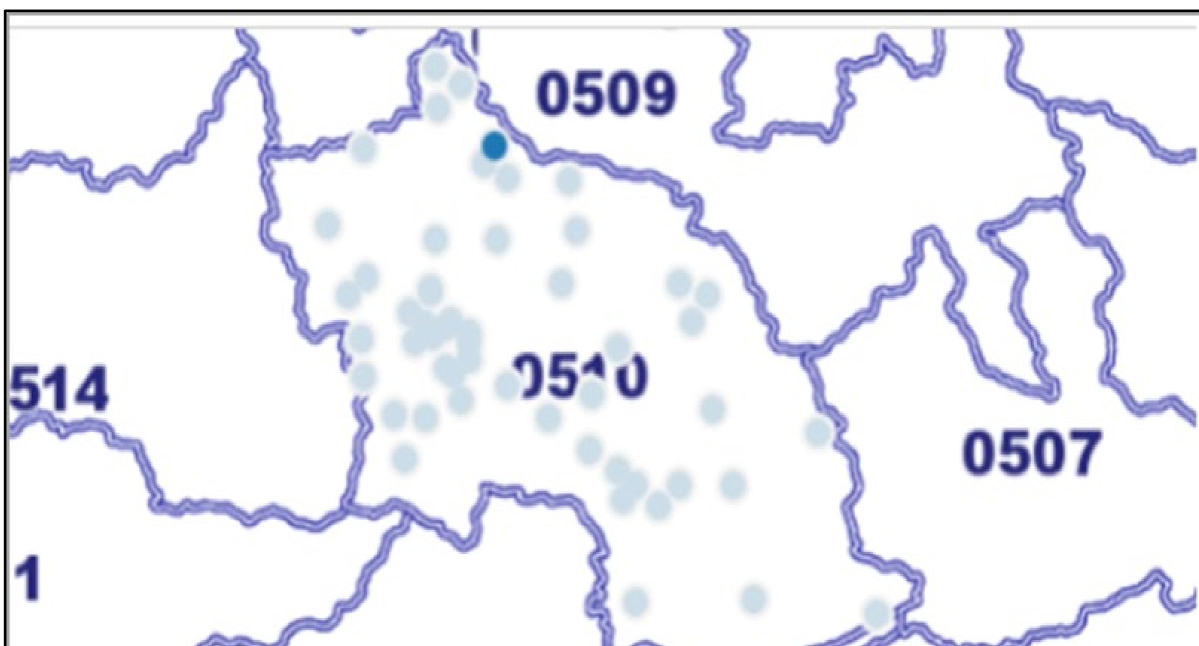


Figure 7. River gages within HUC 0510. Dark blue dot indicates gage in analysis.

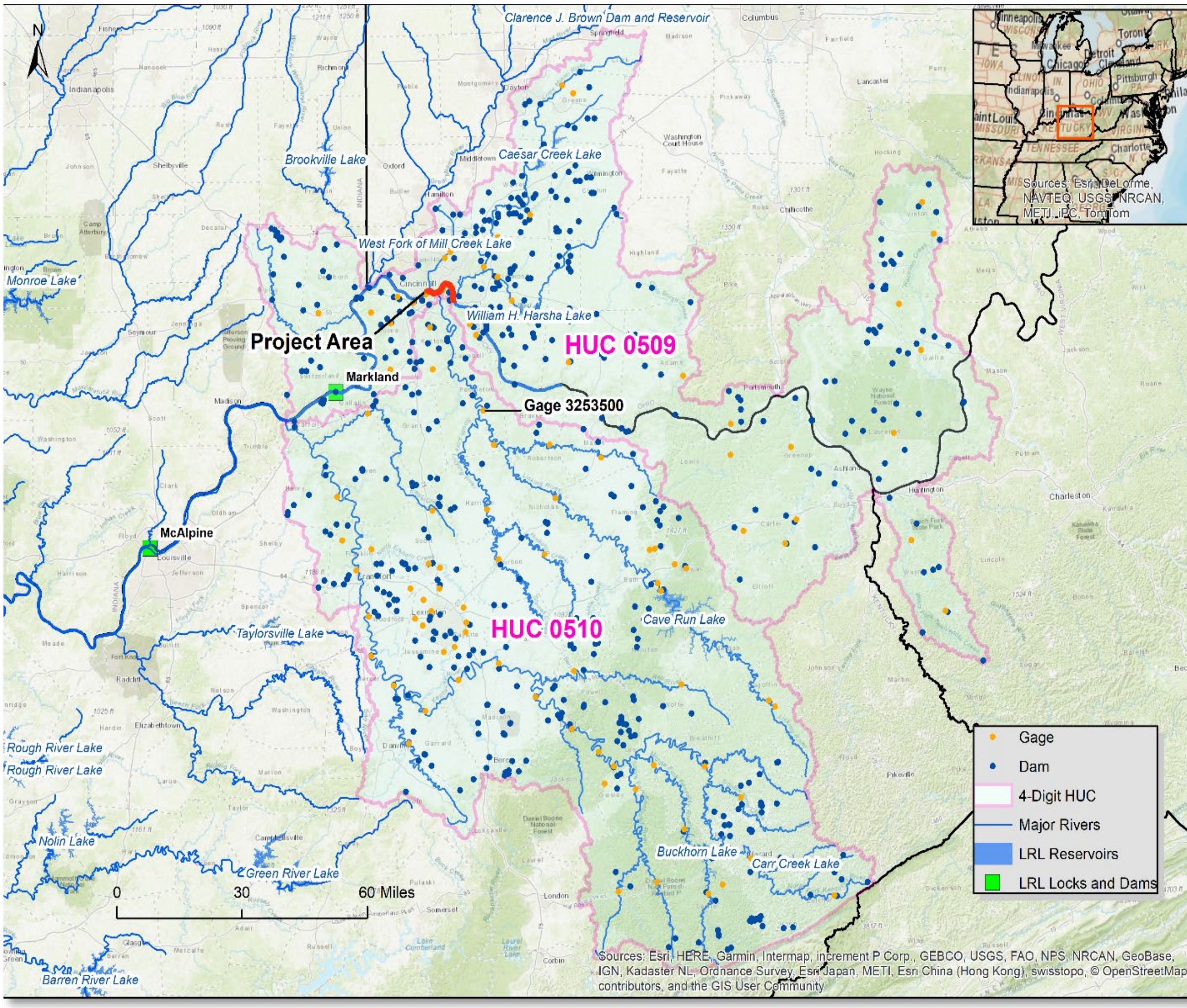


Figure 8. River gages within HUCs 0510 and 0509 located around study area. Project area represented by the red line.

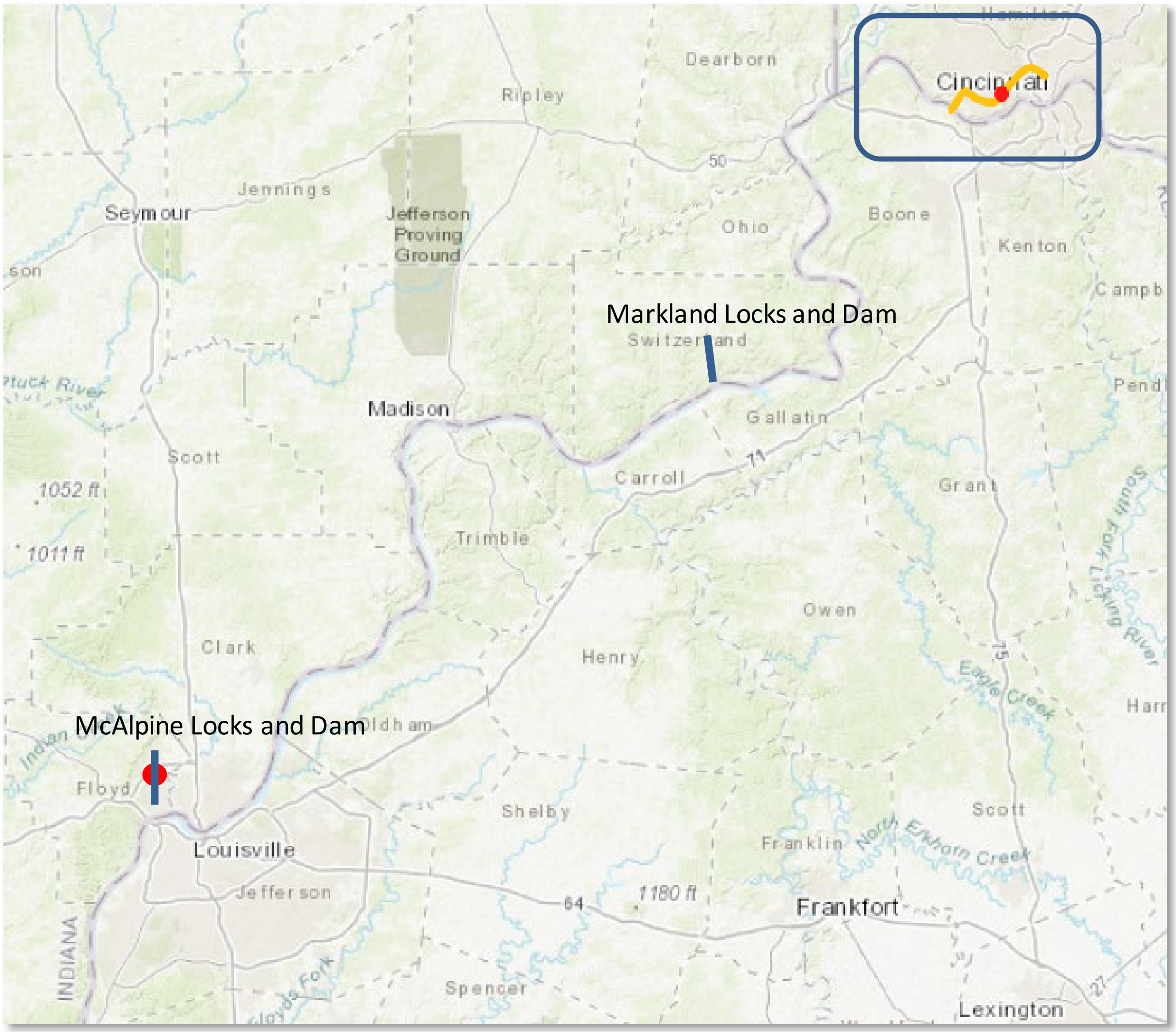


Figure 9. Locks and dams located near study area.

Gages on the Ohio River at Louisville, KY and Cincinnati, OH (red dots in Figure 9) show that river level fluctuations at both locations are comparable in duration, magnitude, and timing (see hydrographs in section 2.3, Surface Water). Locations of McAlpine and Markland locks and dams are indicated with blue lines (Figure 9). Gage 3253500 (next to Cincinnati, Figures 7-8) exhibits a slight increasing trend in annual peak instantaneous streamflow; however, this trend is not statistically significant as indicated by the high p-value (p = 0.360576). This indicates that overall, there has been no change in flood risk, as measured by the annual maximum flood, over the last 126-year period of record (1888-2014). A p-value of 0.05 or less is typically adopted as the threshold of significance to determine whether a trend is present. Using projected hydrology introduces inherent uncertainties. Many variables contribute to the error in temporal downscaling, error in spatial downscaling, errors in hydrologic models, errors associated with emission scenarios and errors associated with global climate models.

The Nonstationarity Detection Tool was also used to examine the hydrologic time series at the gage in the Licking River near Catawba, Kentucky (3253500). No changes to the default sensitivity parameters of the tool were applied to the analysis. Nonstationarities were detected in the record by three tests for the year 1906 (Figure 10), indicating that a change can be detected in the distribution and long term mean of the maximum annual flow time series during that year, however this change cannot be attributed to one specific driver such as the construction of a water management structure. Changes in flow at the project site would likely be caused by land use changes farther up in watersheds. For instance, the clearing of terrestrial vegetation for agricultural and development and an increase in impervious area may have played a role in influencing flow rates by increasing runoff. The USACE completed construction of Cave Run Lake in 1973 on the Licking River, 173.6 miles above the mouth, however no nonstationarities were detected in the flow record from dam construction. Input from large tributaries downstream of the Cave Run Lake Dam, specifically the North and South forks of the Licking River likely act to diminish the hydrologic influence of the dam at the proposed project site. Various smaller dams have also been constructed on tributaries of Licking River over the past century. The effects from the completion of the Markland Locks and Dam at ORM 531.5, below Cincinnati, did not show up in the analysis as a nonstationarity in the flow data from the selected gage. This seems to indicate that construction of the locks and dams on the Ohio River did not greatly influence flow at this gage site on the Licking River. Over the period of record, the same gage shows an increasing trend in annual peak instantaneous streamflow; however, this trend is not statistically significant. The results of the nonstationarity detection analysis indicate that overall, there has been no statistically significant change in flood risk, as measured by the annual maximum flood, since 1906.

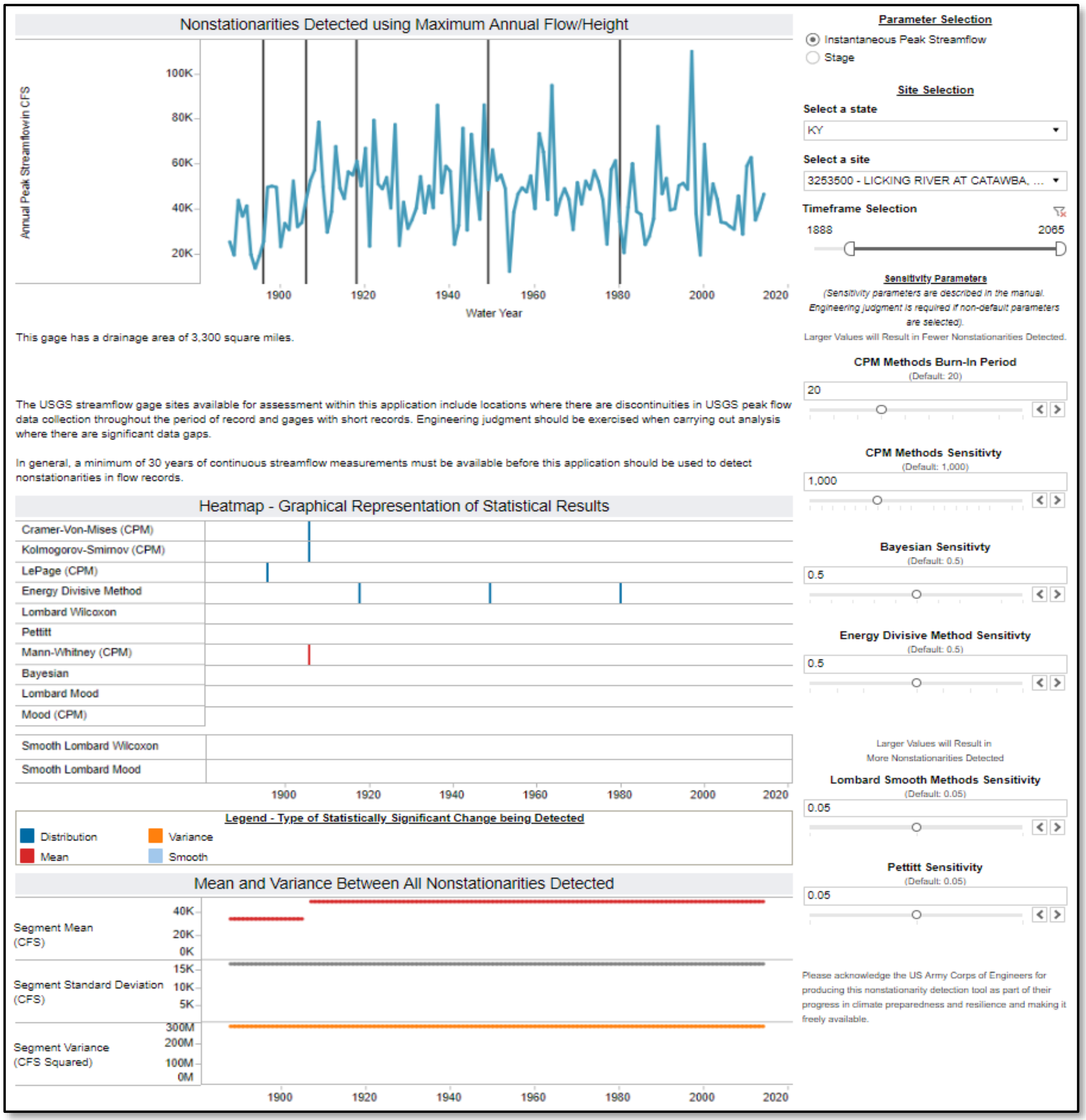


Figure 10. Nonstationarity Analysis of Maximum Annual Flow, Licking River near Catawba, Kentucky.

The USACE Climate Hydrology Assessment Tool was also used to investigate potential future changes to flood flows in the region, using observed and projected data from the Middle Ohio (HUC 0509) and the Kentucky-Licking (HUC 0510) River Basins. Because the project area lies at the convergence of these basins, both basins were used in the assessment. Figures 11 and 12 display the range of the forecast annual peak instantaneous monthly stream flows computed by 93 different hydrologic climate models for a period of 1952 – 2099 for both watersheds. These forecast flows display trends consistent with that of observed data as well as available literature. High flows are critically important to understand in terms of timing and magnitude. Low flows are important as well, but not to the extent of high flow events in term of impacts to natural functions and processes.

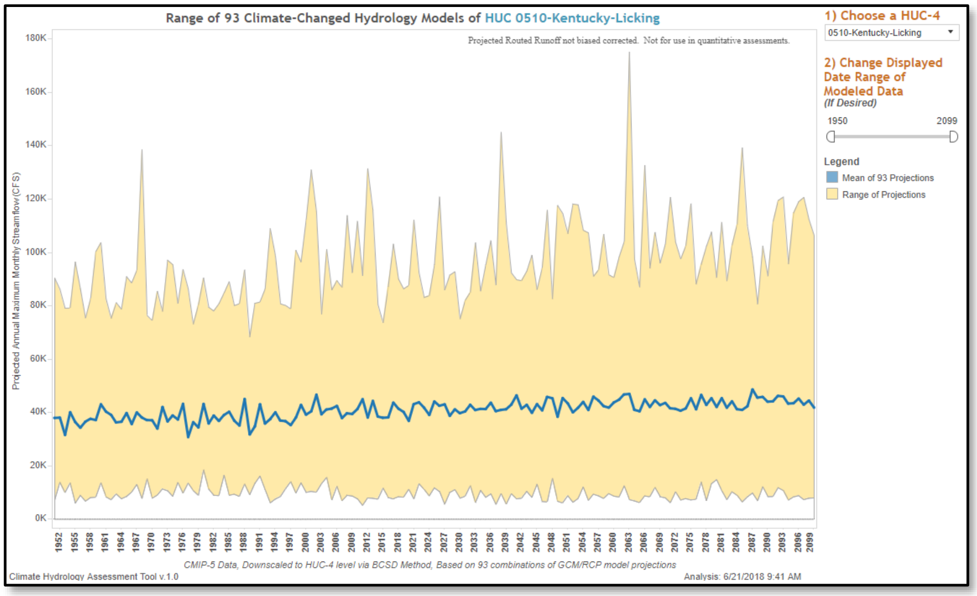


Figure 11. Range of projected annual maximum monthly streamflow among ensemble of 93 climate-changed hydrology models, HUC 0510 Kentucky-Licking Rivers.

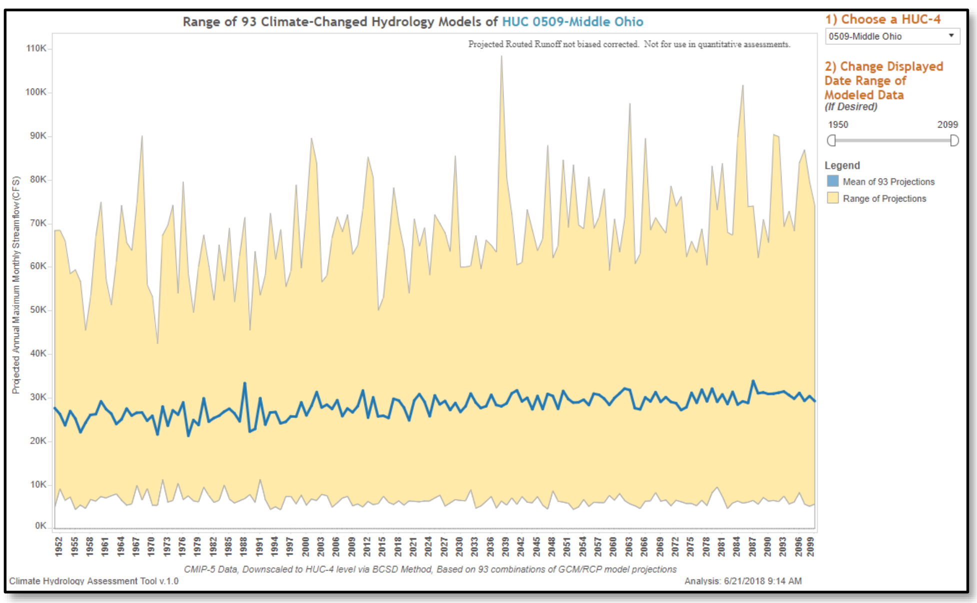


Figure 12. Range of projected annual maximum monthly streamflow among ensemble of 93 climate-changed hydrology models, HUC 0509 Middle Ohio River.

Looking closer at the trend of mean projected annual maximum monthly stream flows, a statistically-significant, positive trend is observed for both watersheds (Figures 13 and 14). These increases are statistically-significant (p-value <0.0001), which suggest that there may be potential for flood risk to increase in the future in the study area relative to the current time. This result is qualitative only.

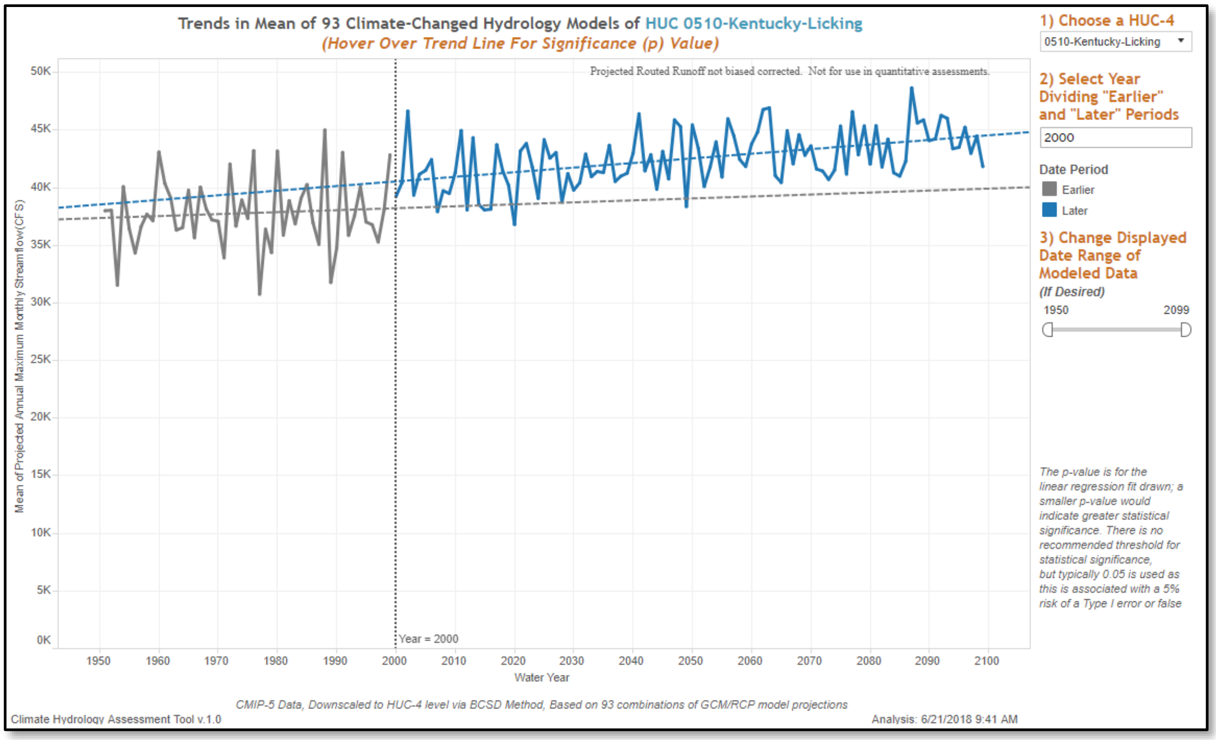


Figure 13. Mean projected annual maximum monthly streamflow. HUC 0510 Kentucky- Licking Rivers. Trend line equation: Q = 40.0513*(Water Year) -39607.3, p = < 0.0001.

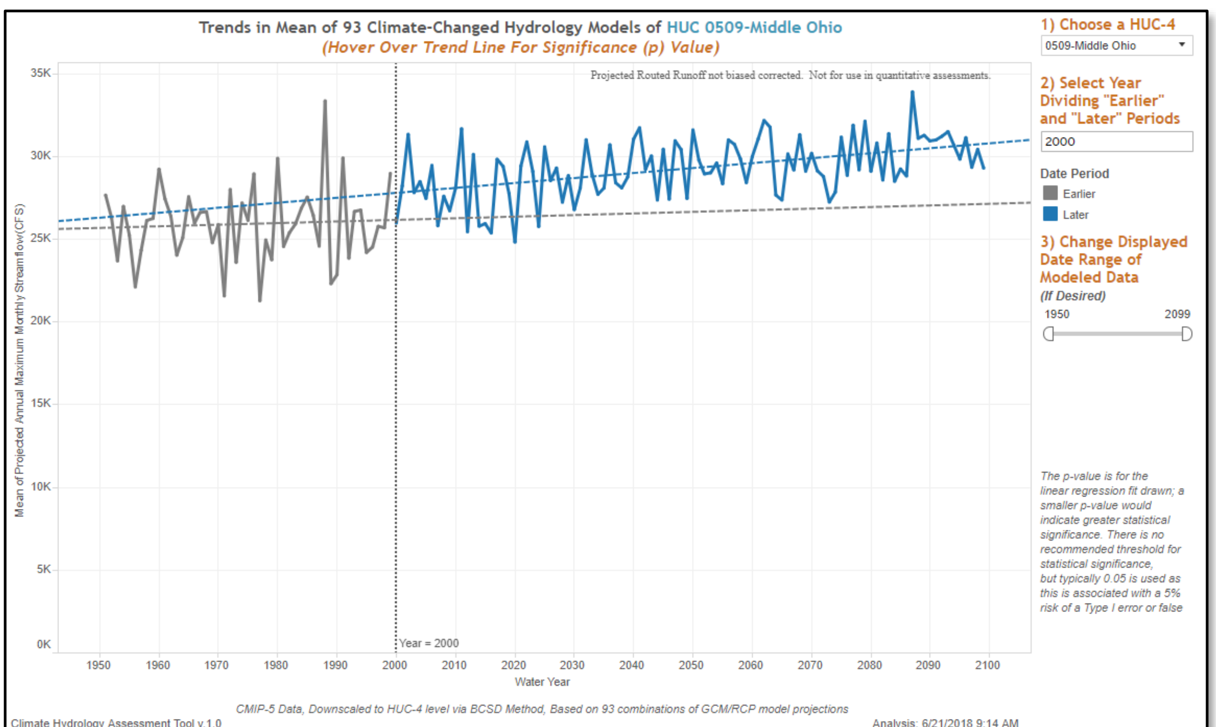


Figure 14. Mean projected annual maximum monthly streamflow. HUC 0509 Middle Ohio River. Trend line equation: Q = 29.9778*(Water Year) - 32192.4, p = < 0.0001.

Climate vulnerability assessments are necessary to help guide adaptation planning and implementation so that USACE can successfully perform its missions in an increasingly dynamic physical, socioeconomic, and political environment. The USACE Climate Change Vulnerability Assessment (VA) Tool (USACE, 2016a) was used to examine the vulnerability of the Middle Ohio (HUC 0509) and the Kentucky-Licking (HUC 0510) River Basins to fulfill their primary mission objectives given a changing climate; the mission business line considered for this analysis was ecosystem restoration. Although the study area does encompass navigation and flood risk reduction business lines, these business lines are not expected to be impacted by the proposed project. An analysis of the vulnerability to climate change of all other business lines within the Louisville District for future wet and dry scenarios indicated low vulnerability, as no business lines exceeded the 20% vulnerability threshold in any of the four future scenarios. The VA Tool was used to determine vulnerability through the following steps:

1) Standardize climate change indicators – indicators are processes that contribute to climate change vulnerability
2) Calculate vulnerability using a weighted order weighted average (WOWA)
3) Second weighting based on vulnerable indicators (ORness). An ORness level of 0.7 was used in this analysis.
4) Adjustment of vulnerability thresholds (20% in this analysis) and integrated analysis type (Four thresholds computed – dry 2050, dry 2085, wet 2050, and wet 2085).

The VA Tool did not identify the ecosystem restoration business line as within the top 20% of vulnerable watersheds. While these basins were not identified as within the top 20% of vulnerable watersheds, that does not to imply that vulnerability to climate change does not exist within the watersheds. Of the vulnerability indicators examined by the VA Tool, there was one that reliably drives the vulnerability of the ecosystem restoration business line- percentage of freshwater plant communities at risk (8). This was the dominant indicator for both basins for two climate scenarios (wet and dry) over two epochs (2050 and 2085). The wet scenario was defined by the wetter 50% of General Circulation Models (GCMs), and the dry scenario was defined by the drier 50% of GCMs. The next two dominant indicators for both basins were high elasticity between increasing precipitation and streamflow (277) and monthly coefficient of variation of runoff (221C). Factsheets that detail how each of these indicators are calculated are located in the Environmental Appendix.

The VA Tool was utilized to identify potential vulnerabilities in the Middle Ohio and Kentucky-Licking basins at the HUC-4 watershed level. Figure 15 shows dominant indicators of vulnerability for each basin as identified by the tool for two climate scenario (wet and dry) over two epochs (2050 and 2085). As indicated by the results, the percentage of freshwater plant communities at risk was the highest contributor to vulnerability for both basins. This indicator measures the percentage of wetland and riparian plant communities that are at risk of extinction based on remaining number and condition, remaining acreage, threat severity, etc.

All HUC-4 watersheds within the United States were assigned values for this indicator that ranged from 11.9 (not vulnerable) to 72.17 (most vulnerable). The VA Tool indicated the Middle Ohio and Kentucky-

Licking watersheds had values of 50.49 and 43.48, respectively.

The "Weighted Ordered Weighted Average," or WOWA, reflects the aggregation approach used to get the final score for each HUC. After normalization and standardization of indicator data, the data are weighted with "importance weights" determined by the USACE (the first "W" in "WOWA"). Then, for each HUC-epoch-scenario, all indicators in a business line are ranked according to their weighted score and a second set of weights, which we call "OWA weights," are applied, based on the specified ORness level. This yields a single aggregate score for each HUC-epoch-scenario called the WOWA score. WOWA contributions/Indicator contributions are calculated after the aggregation to give a sense of which indicators dominate the WOWA score at each HUC. Below are the WOWA scores for the ecosystem restoration business line in HUC 0510:

Scenario	2050	2085	Change Over Time
Dry	70.688	70.55	-0.19%
Wet	70.346	71.343	1.42%

The analysis indicated an increase in vulnerability over for the ecosystem restoration business in the wet scenario and a decrease in vulnerability over time in the dry scenario. The increase of 1.42% in the wet scenario was largest increase in vulnerability of the HUC-4 watersheds within the Louisville District of the USACE.

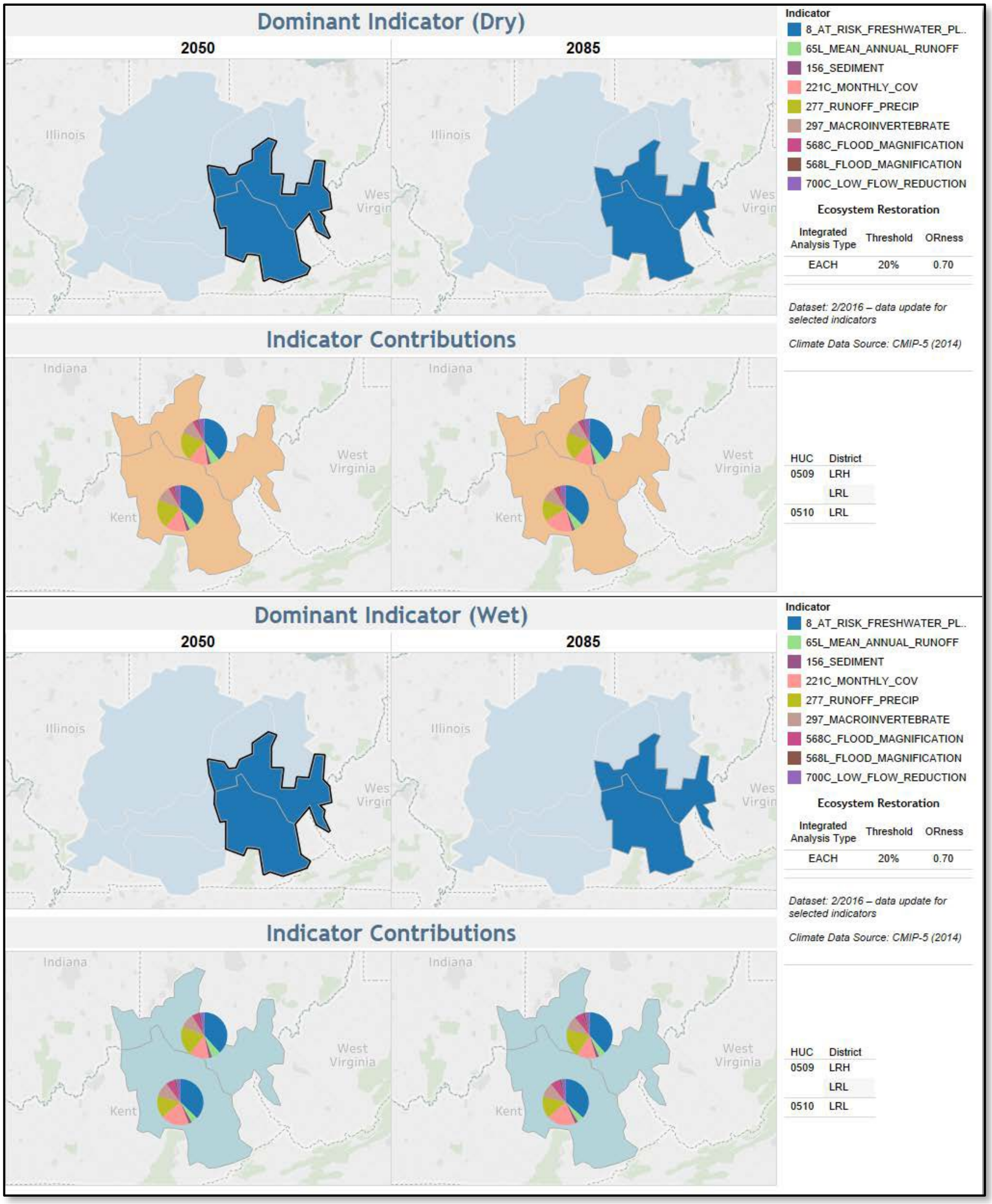


Figure 15. USACE Vulnerability Assessment Tool Results for the Middle Ohio HUC-4 watershed

2.2 SOILS AND GEOLOGY

2.2.1 Geology and Physiography

The project area lies at the northern tip of the Outer Bluegrass physiographic region, characterized as a rolling lowland and composed of limestones, dolomites, and shales of Late Ordovician and Silurian age. Specifically, the study site lies on the eastern edge of the “Cincinnati arch,” an outcrop of Ordovician carbonates and shales (Newell, 2001).

2.2.2 Soil Associations

The project area lies within the Eden-Cynthiana soil association. However, a few hilltops in Campbell County near the Ohio River, which may be within the project area, lie within the Rossmoyne-Jessup association (Weisenberger, 1973). According to the NRCS Web Soil Survey, approximately 27% of the project area is contained in the Eden silty clay loam map unit, which is well drained soil. Approximately 22% of the project area is encompassed by the urban land map unit. While the above soils characterize the soil types contained in the general project area, the below soil types refer to the specific project site along the Kentucky shore of the Ohio River. Huntington silt loam, 0 to 4% slopes (occasionally flooded) and alluvial land (rarely flooded) comprise the project area west of Licking River. Huntington silt loam is well-drained floodplain soil, ideal for farmland. Urban land dominates the shore from Newport to western Dayton. Central and eastern portions of Dayton’s shoreline include Alluvial land, Lakin loamy fine sand (occasionally flooded), Huntington silt loam, and Wheeling silt loam. Alluvial land entirely comprises the shoreline of Fort Thomas, the easternmost portion of the project area (NRCS Web Soil Survey). Most of the soils formed from weathered limestone or calcareous shale or formed in glacial deposits (Weisenberger, 1973).

2.2.3 Hydric Soils

The project area is comprised of approximately 1.5% hydric soils and is therefore classified as “not hydric” by the NRCS Web Soil Survey.

2.3 SURFACE WATER AND OTHER AQUATIC RESOURCES

2.3.1 Surface Water

The project area lies within the upper pool of the Markland Locks and Dam Project (Ohio River Mile 531) on the Ohio River. The Markland upper pool has three major tributaries draining into it, the Licking River in Kentucky, and the Miami and Little Miami Rivers in Ohio. Both the Ohio and the Licking Rivers are used for commercial navigation. This area contains a varied set of hydraulic and hydrologic conditions that are influenced by heavy industrial/urban land uses to farmland to natural woodlands and is a major connecting (nexus) point between differing physiographical zones. An example photo of the Ohio River within the study area is shown below (Photo 1). Due to run-off from coal mining and coal-fired power plants, combined sewer overflows (CSO’s), and agricultural run-off, as well as other pollutants such as mercury, the Ohio River has historically had low water quality, but still boasts a large diversity of organisms within its waters and along its shoreline. High levels of nutrients from farming and CSOs can accumulate in the surface water as a result of the operations of Markland Locks and Dam (e.g., maintaining minimum navigation depth), particularly during times of low water. Excess nutrients and warmer temperatures in the summer months can cause harmful algal blooms. Harmful algal blooms can cause environmental damage to aquatic resources. The map of existing outfall locations managed by SD1 is located in the Environmental Appendix.

Both the Ohio and Licking Rivers in Campbell and Kenton counties were listed on the Draft Kentucky Energy and Environment Cabinet, Division of Water 2016 Section 303(d) List of Impaired Waters. This is a requirement of states under Sections 305(d) and 303(d) of the Clean Water Act (CWA). The cause of impairment for the Licking River is *Escherichia coli* (E. coli), from municipal sources due to being an urbanized high density area and from urban runoff/storm sewers. The Ohio River in Campbell and Kenton counties is impaired due to the presence of Dioxin (including 2,3,7,8-TCDD) or polychlorinated biphenyls (PCBs), or both, in the edible tissue of fish, at levels exceeding Kentucky's human health criteria for these contaminants. These pollutants were both identified at multiple points in the Ohio River within the project area. The Ohio River is also impaired due to the presence of E. coli; the source of this contaminant is not known. To date, the U.S. Environmental Protection Agency (EPA) has not issued a decision regarding Kentucky's 2016 303(d) List of Impaired Waters.

Photo 1. Ohio River shoreline area – location Covington

The Ohio River system is a dynamic river with significant elevation fluctuations. Within the project area, the Ohio River normal pool elevation is 25.4 feet (453.6 NAVD88), ordinary high water is 37.9 feet (466.1 NAVD88) and flood stage is at 52 feet (480.2 NAVD88). Recent historical crests have exceeded 60 feet (64.7 feet, 492.9 NAVD88, on 05 March 1997) and the record crest is 80.0 feet (508.26 NAVD88) set on

26 January 1937. The normal pool on this segment of the Ohio River is directly influenced by Markland Locks and Dam (Figures 8-9). The Ohio River fluctuates approximately 44 feet between normal pool (455 NAVD88) and the 1% chance annual exceedance event. The fluctuation between normal pool and the 10% chance annual exceedance event is approximately 32.5 feet. Duration of exceedance events vary between hours to days (Figure 16). Hydrograph of Ohio River at Louisville is used for comparison (Figure 17). Typically a draw-down is performed rapidly to maintain normal pool levels.

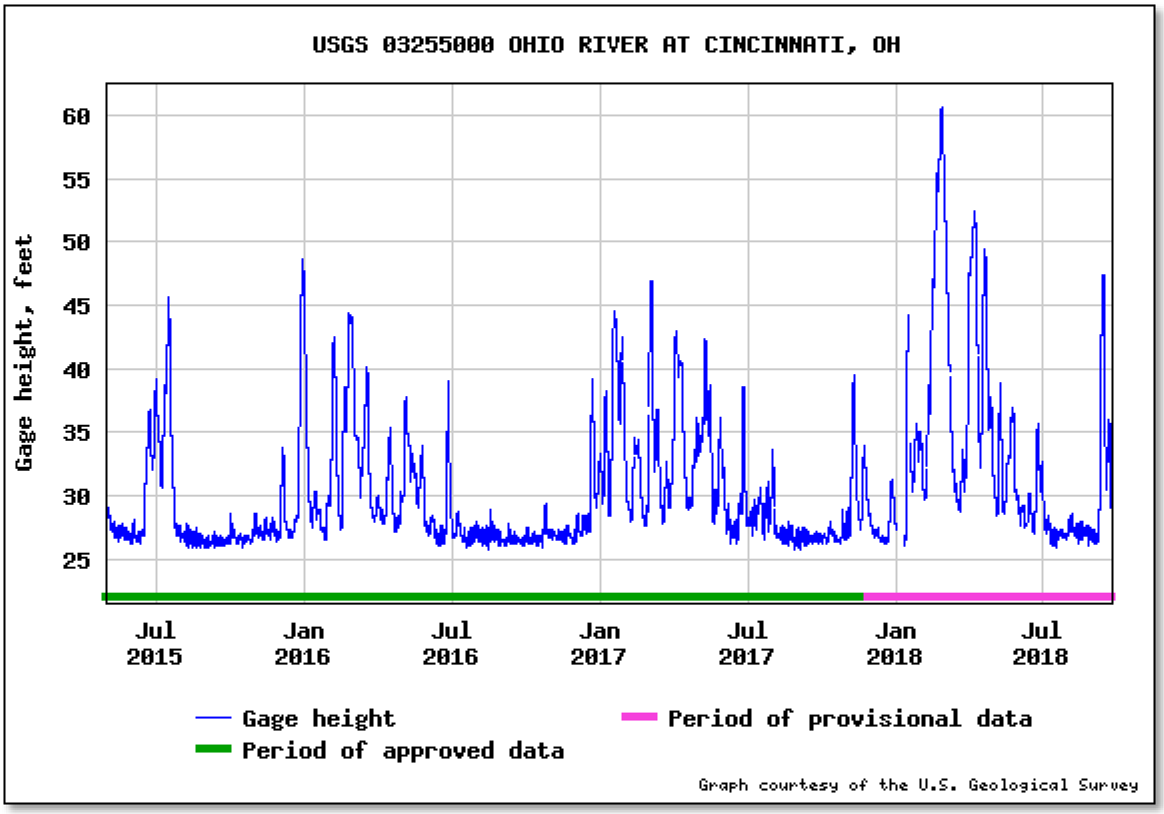


Figure 16. USGS River Gage 03255000 Ohio River at Cincinnati, OH

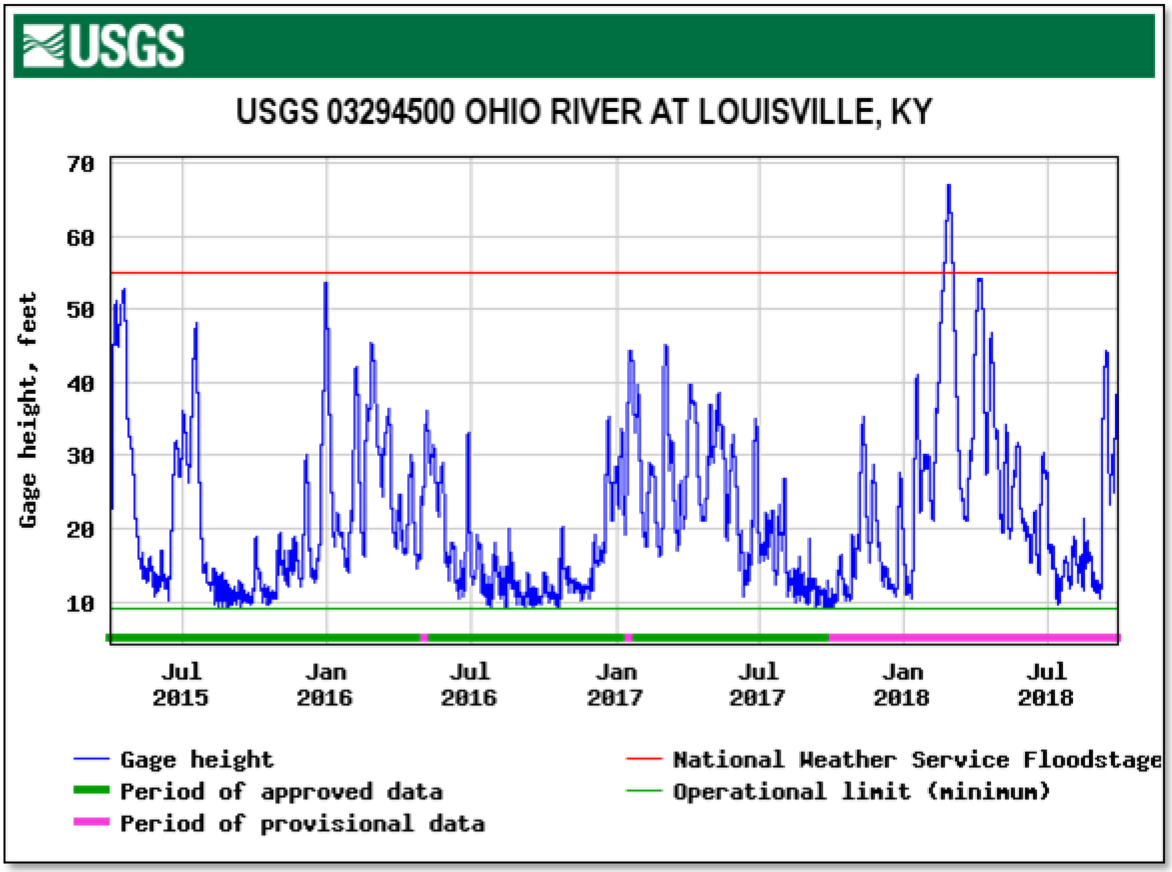


Figure 17. USGS River Gage 03294500 Ohio River at Louisville, KY

2.3.2 Groundwater

The Ohio River alluvium is the best source of groundwater in both Campbell and Kenton counties. Many properly constructed drilled wells in the alluvium will produce several hundred gallons per minute; most wells are able to produce enough for a domestic supply at depths of less than 100 feet. Water is hard or very hard, but otherwise of good quality (Carey and Stickney, 2005).

2.3.3 Floodplains

A floodplain is flat or nearly flat land adjacent to a stream or river that experiences periods of flooding during high discharge events. Urban development and the existence and location of floodwalls and levees have altered the probability of inundation of floodplains within the study area. Federal Emergency Management Agency's (FEMA) Flood Hazard Mapping does not define floodplains, but the flood hazard zones for use in assigning flood insurance rates. Nonetheless, these maps are useful assessing flood risk and understanding how the rivers may interact with their floodplains. According to FEMA's National Flood Hazard Layer, the northern portion of Dayton is within the 1% Flood Zone, particularly the area surrounding the Manhattan Harbor Yacht Club and west of the club (top right oval in Figure 18). Bellevue's shoreline where restoration would occur (middle oval in Figure 18) is also within this zone. The Licking River floodplain is extremely narrow within the project site. Additionally, the eastern portion of Ludlow along the Ohio River, including in City Park where shoreline restoration would take place (leftmost oval in Figure 18), is within the 1% Annual Chance Flood Hazard Zone. A more detailed floodplain map can be found in the Environmental Appendix.

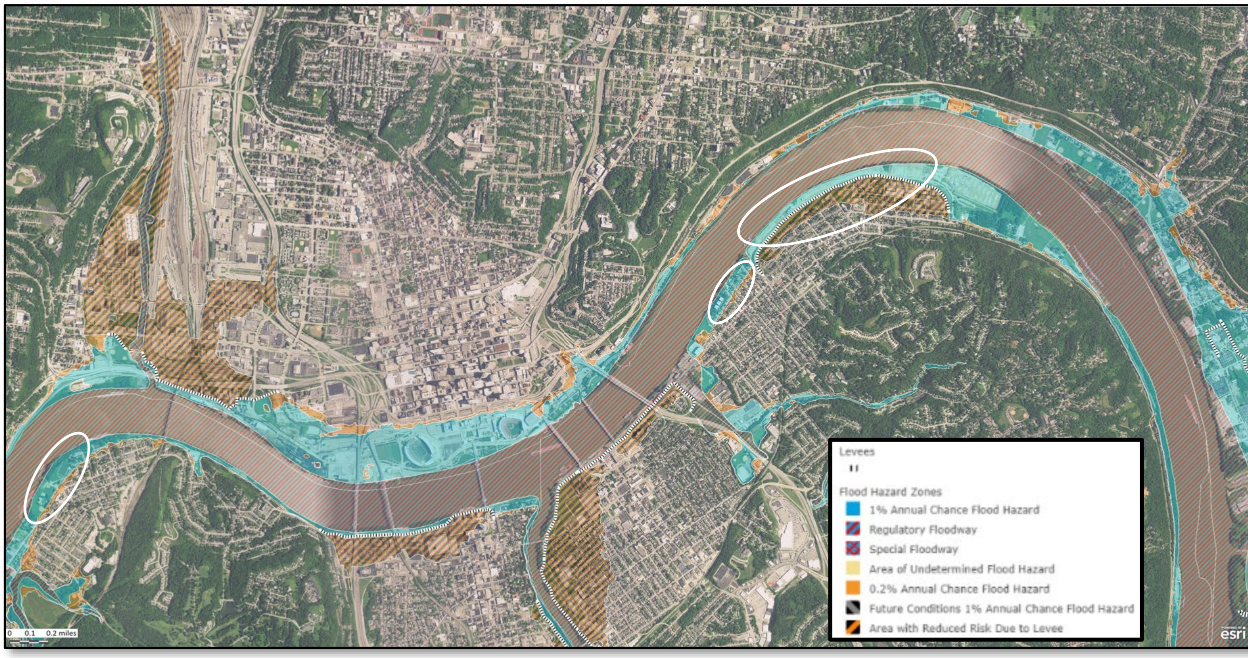


Figure 18. Map of flood risk within study area, generated with FEMA's official National Flood Hazard Layer.

2.3.4 Wetlands

A review of more than 1,200 peer-reviewed publications by the USEPA (2015) clearly showed that wetlands and open waters in riparian areas and floodplains are physically, chemically, and biologically integrated with rivers via functions that improve downstream water quality. These systems act as effective buffers to protect downstream waters from pollution and are essential components of river food webs. The United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) indicates there are no wetlands within the project area or sites. See Environmental Appendix for the NWI map of the project area. According to the NWI, there are freshwater forested/shrub and freshwater emergent wetlands east of the project site on the Ohio side of the river, but these areas would not be impacted by the proposed work.

2.4 FISH AND WILDLIFE HABITATS

2.4.1 Habitat Types and Associated Flora and Fauna

Habitat refers to the living space of an organism or community of interacting organisms and can be described by its physical or biotic properties, such as substrate, woody debris or a depression. Communities are naturally occurring groups of species that live and interact together as a relatively self-contained unit, such as a floodplain forest. Ecosystems may contain many communities and habitat types. These are usually assessed by describing and/or quantifying the physical structure, quality and/or present organism community contained in the area of interest. They may also be assessed at various scales, depending on the level of resolution needed to answer specific questions.

Due to urbanization within the project area, the natural calcareous mesophytic forest comprised of species such as sugar maple (*Acer saccharum*), basswood (*Tilia americana*), beech (*Fagus grandifolia*), white oak (*Quercus alba*), white ash (*Fraxinus americana*) and slippery elm (*Ulmus rubra*), has given way to unvegetated or mown lawns, planted non-native species as well as voluntary/invasive species, and in some places, local urban forest, consisting of eastern cottonwood (*Populus deltoides*), american sycamore (*Plantanus occidentalis*), boxelder (*Acer negundo*), silver maple (*Acer saccharinum*), black locust (*Robinia pseudoacacia*) and willow (*Salix* spp.). Within the understory layer, Japanese honeysuckle (*Lonicera japonica*) and Russian olive (*Elaeagnus angustifolia*) dominate.

Nearly all plant communities in Kentucky have been adversely affected through human disturbance. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology and hydraulics, increased colonization of invasive species, urbanization pressures and fragmentation. While natural communities can be described in terms of dominant organisms, the quality of their habitat is directly related to the level at which natural processes function, such as groundwater discharge, fire, and fluvial erosion and deposition. Habitat quality displays a negative relationship to the amount of human disturbance, in which the disturbance affects natural areas in direct or indirect ways.

To date, the observed project area communities are impacted to the point where native species have been replaced by a high percentage of weedy, non-native species. In this urbanized area of Kentucky, primary examples of disturbed communities, often referred to as ruderal habitats, include ditches, old fields, thickets, yards, railroads, vacant lots, sidewalks, parking lots, landfills, mine spoils, waste yards, cultivated fields, gardens, farm ponds, roadsides, rubbish heaps, etc. (Jones 2005). These areas are occupied primarily by Eurasian weedy annuals, perennials, woody vines, shrubs and trees. Some of the most problematic species include poison hemlock, thistles, garlic mustard, purple loosestrife, privets, and honeysuckles. These common weeds not only physically preclude native species, but invasive species, such as the European buckthorn also chemically alter the soils to prevent natives from growing. When a waterbody's riparian zone becomes dominated by these disturbed communities, it also has the potential to disrupt the stability of the waterbody and cause adverse effects on habitat and organic matter inputs into the waterbody.

The riparian zone is the area where terrestrial and aquatic ecosystems converge: it is the area between the stream channel and the furthest upland extent of the aquatic system's influence. A riparian zone occupies space in all directions of a stream or river. Biological activity and processes occur in, above (canopy and air), below (hyporheic) and adjacent to streams, which protect and provide for aquatic organisms. Many riparian zones lack discrete boundaries and gradually transition through various plant communities which are driven by geomorphic position (topography and soils), flooding (surficial hydrology), and subsurface hydrology (groundwater discharge).

Tributary Streams

Small streams that form at the top of ravines and flow directly into the Ohio River are referred to as tributaries for the purposes of this study. Pracheil et al. (2013) proposed that large tributaries offer underappreciated opportunities to conserve large-river specialist species by serving as high-value main stem restoration surrogates or supplements that can restore some ecosystem function in spite of main stem river alterations. Tributaries to altered main stem rivers, have been found to be critical to the success of many native river fish species (Pracheil. et al. 2009). Tributaries in the project area are mostly located along Ft. Thomas and are significant resources for spawning fish species of the Ohio River, sources of nutrients and organic material for the Ohio River, and provide important riparian areas along their shorelines.

Tributaries have been impacted by residential and industrial development through encroachment, increased storm water discharge, and modified channel geomorphology (e.g., culverts, underground pipes, channel straightening) resulting in increased sediment load, scour and erosion. Additionally, bank erosion and stream incision (e.g., erosion and deepening of stream channel), coupled with invasive plant species, have degraded their adjacent riparian areas and caused a decrease in native biodiversity. Dominant plant species are Silver Maple and Box Elder (weedy native species) in the canopy layer, Japanese Honeysuckle (non-native invasive species) in the shrub layer and Pinkweed and Poison Ivy (weedy native species) in the herbaceous layer. The distinction between weedy and invasive is that invasive species will cause significant harm to an ecosystem. Weedy native/non-native species are typically at low levels in high-quality, healthy ecosystems and usually do not pose a threat to the structure and function of a healthy system. Invasive species should be eradicated to the fullest extent possible, while weedy species will generally become less numerous once natural processes and higher quality native plant species are introduced.

Photo 2. Bank erosion in Tributary 1 – location Ft. Thomas

Shoreline

The riparian zone, or sometimes referred to as shoreline, adjacent to flowing rivers (Ohio River and Licking River) and tributary streams, is a critical component of aquatic resources. Riparian zones provide habitat and resources for numerous aquatic dependent species at different life stages (e.g., reproduction) and/or seasonal use (e.g., winter hibernation). The health and quality of riparian zones reflect in a large way the overall health of the entire aquatic resource. The riparian zones within the study area are considered to be in poor condition with low native biodiversity. They have been impacted by river management actions (e.g., barge traffic), flood risk management (e.g., levees) and economic development (e.g., housing, businesses, etc.). Water quality within the Ohio River historically (post-settlement) has been very poor and had a negative impact on its riparian zones. As a result of past human activities, the riparian zone has been fragmented with disconnected patches of natural vegetation. Common plant species within the remnant areas are mostly non-native (Japanese honeysuckle and black locust) mixed with weedy native species (silver maple).

Native plant recovery has been hindered by multiple factors. Local native plant species populations have been mostly destroyed or highly degraded from human activities with the remaining populations being small and fragmented. Recruitment (e.g. seed rain) from local native plant species populations is very low, resulting in low likelihood of native volunteers establishing in former habitat. Compounding low recruitment, if established in former habitat, native plant species volunteers are likely outcompeted by aggressive invasive and weedy plant species. Removal of invasive species, establishment of large numbers of native individuals, to provide buffering against disturbance, and other buffering agents like woody debris, will allow for the establishment of a diverse native plant community.

Photo 3. Degraded riparian zone along Tributary 1 – location Ft Thomas

Main Stem Fish Habitat

Habitat from the toe of the shoreline to the center line of the channel has been heavily altered by human activities. Navigation has changed the structural components of the Ohio River by straightening and deepening the main channel. This has resulted in a loss of shallow riffle/gravel bar habitat that used to be abundant. Shallow habitat provides critical refuge and food resources for small fish and for juveniles of larger river species as cover from predators. In addition, waterway management has resulted in the loss of numerous complex woody debris piles or snags. These structures also provide cover and resources for small fish species and refuge for large fish species during flood events. Although some large woody debris occurs naturally along the more wooded portion of the study area in Ft. Thomas, there are large gaps between these snags and this makes it more risky for fish and other species to move between the snags as they will become exposed to predators. Fish habitat along the Ohio River is in need of restoration and greater connectivity between habitat areas (e.g., increase number of habitat patches to decrease average distance between patches).

Photo 4. Shoreline of Ohio River – lack of fish habitat – location Newport

Floodplain Forest

Remnant patches of forested floodplain are located along the Ohio River on the shoreline side of the levee system in Covington and along the Licking River on both Covington and Newport sides. The remnant patches along the Ohio River remain because the levee system creates a disincentive for intensive development activities on the unprotected side of the levee along that portion of the shoreline. Floodplain forest was once the dominant land cover along the Ohio and Licking Rivers prior to human settlement. High quality floodplains provide a host of environmental benefits, from flood water storage to breeding grounds for multiple species, such as migratory birds, amphibians, reptiles, mammals and insects. Remnant patches of floodplain forest suffer from loss of native plant diversity, invasive plant species, loss of natural hydrology and poor water quality. This list of problems has resulted in reduction of native ground cover plant species (e.g., herbaceous species), lack of native sub-canopy plant species (e.g., shrubs, small trees), dominance of invasive shrub species and low abundance of high quality native tree species (e.g., sycamore). In general, the project area floodplain forests are in poor shape, but because the canopy is still mostly intact, offers a tremendous opportunity to restore native biodiversity back to these remnant patches. Results from the Sacramento River Project, suggest that it is feasible to re-establish native trees and shrubs along large, regulated rivers, at least at certain sites for an initial period of several years with appropriate management actions (Alpert et al. 1999). Additionally, Gore and Shields (1995) suggest there is considerable potential for rehabilitation, that is, the partial restoration of riverine habitats and ecosystems along large rivers, like the Ohio River.

Due to the urban influence of Cincinnati, Ohio, the reach of the Licking River in Kenton and Campbell counties in Kentucky is the most developed in the river's entire watershed (USDA 2008). Opportunities for restoration of aquatic or riparian habitat are exceedingly rare in this area, but are present at several locations within study area where riparian habitats and connectivity of small tributaries could be restored. This would result in restoring a portion of the river's natural processes and providing areas that could support essential elements for fish and wildlife habitat.

Photo 5. Poor quality floodplain forest – lack of herbaceous layer– location Covington

Photo 6. Degraded shoreline – location Licking River and confluence with Ohio River

2.5 ENDANGERED AND THREATENED SPECIES

2.5.1 Federal

Nearly 80 species of native freshwater mussel species are known from the Ohio River, 15 are now federally listed and five are probably extinct. Mussels are an important component of the aquatic ecosystem. They naturally filter water, improve water quality (Li et. al., 2010), are food for other aquatic species, and were an important economic driver by providing tools, food, ornamentation and pearls.

According to the USFWS scoping letter dated November 22, 2016 (Environmental Appendix), there are 17 federally threatened or endangered species that may be present within the project area (Table 1). The federally endangered status represents any species that is in danger of extinction throughout all or a significant portion of its range. A federally threatened status represents any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Table 1 Federally listed species that may occur within the project area

Scientific Name	Common Name	Federal Status
Pleurobema clava	Clubshell (mussel)	Endangered
Cyprogenia stegaria	Fanshell (mussel)	Endangered
Epioblasma torulosa rangiana	Northern Riffleshell (mussel)	Endangered
Plethobasus cooperianus	Orangefoot Pimpleback (mussel)	Endangered
Lampsilis abrupta	Pink Mucket (mussel)	Endangered
Epioblasmaobliquata obliquata	Purple Cat's Paw (mussel)	Endangered
Quadrula cylindrica cylindrical	Rabbitsfoot (mussel)	Threatened
Villosa fabalis	Rayed Bean (mussel)	Endangered
Obovaria retusa	Ring Pink (mussel)	Endangered
Pleurobema plenum	Rough Pigtoe (mussel)	Endangered
Plethobasus cyphyus	Sheepnose Mussel	Endangered
Epioblasma triquetra	Snuffbox Mussel	Endangered
Cumberlandia monodonta	Spectaclecase (mussel)	Endangered
Trifolium stoloniferum	Running Buffalo Clover	Endangered
Myotis grisescens	Gray Bat	Endangered
Myotis sodalis	Indiana Bat	Endangered
Myotis septentrionalis	Northern Long-Eared Bat	Threatened

2.5.2 State

The Kentucky Department of Fish and Wildlife Resources classifies rare species into three categories: "endangered," "threatened," and "special concern." State endangered taxa are those that are in danger of extirpation and/or extinction throughout all or a significant part of their ranges in Kentucky. State threatened taxa are those that are likely to become endangered within the foreseeable future throughout all or a significant part of their ranges in Kentucky. A taxon of special concern in Kentucky should be monitored because (1) it exists in a limited geographic area in Kentucky; (2) it may become threatened or endangered due to modification or destruction of habitat; (3) certain characteristics or requirements make it especially vulnerable to specific pressures; (4) experienced researchers have identified other factors that may jeopardize it; or (5) it is thought to be rare or declining in Kentucky but insufficient information exists for assignment to the threatened or endangered status categories (KY State Nature Preserves Commission).

According to the Kentucky Department of Fish and Wildlife Resources species observations for Campbell and Kenton counties, the Kentucky State Nature Preserves Commission county reports, and an analysis of the known ranges of the endangered species (IUCN, 2015), the project site lies within the ranges of 62 species that are state endangered, threatened, or of special concern (Table 2).

Table 2. State listed species that may occur within the project area. Birds marked with asterisks are those that breed within Campbell and Kenton Counties.

Scientific Name	Common Name	Kentucky Status
Birds		
Fulica americana	American Coot	Endangered
Peucaea aestivalis	Bachman's Sparrow	Endangered
Riparia	Bank Swallow	Special Concern
Tyto alba	Barn Owl	Special Concern
Thryomanes bewickii	Bewick's Wren	Special Concern
Nycticorax	Black-Crowned Night-Heron	Threatened
Anas discors	Blue-Winged Teal	Threatened
Certhia americana	Brown Creeper	Endangered
Junco hyemalis	Dark-Eyed Junco	Special Concern
Phalacrocorax auritus	Double-Crested Cormorant	Threatened
Ardea alba	Great Egret	Threatened
Lophodytes cucullatus	Hooded Merganser	Threatened
Sternula antillarum athalassos	Interior Least Tern	Endangered
Chondestes grammacus	Lark Sparrow	Threatened
Anas clypeata	Northern Shoveler	Endangered
Falco peregrinus	Peregrine Falcon	Endangered
Sitta canadensis	Red-Breasted Nuthatch	Endangered
Pheucticus ludovicianus	Rose-Breasted Grosbeak	Special Concern
Passerculus sandwichensis	Savannah Sparrow	Special Concern
Accipiter striatus	Sharp-Shinned Hawk	Special Concern
Actitis macularius	Spotted Sandpiper	Endangered
Pooecetes gramineus	Vesper Sparrow	Endangered
Fish		
Atractosteus spatula	Alligator Gar	Endangered
Ictiobus niger	Black Buffalo	Special Concern
Acipenser fulvescens	Lake Sturgeon	Endangered
Notropis hudsonius	Spottail Shiner	Special Concern
Reptiles		
Clonophis kirtlandii	Kirtland's Snake	Threatened
Amphibians		
Cryptobranchus alleganiensis	Eastern Hellbender	Endangered
Rana pipiens	Northern Leopard Frog	Special Concern
Plethodon cinereus	Redback Salamander	Special Concern
Mussels		
Pleurobema clava	Clubshell	Endangered
Lasmigona compressa	Creek Heelsplitter	Endangered
Alasmidonta marginata	Elktoe	Threatened
Cyprogenia stegaria	Fanshell	Endangered
Epioblasma torulosa rangiana	Northern Riffleshell	Endangered
Plethobasus cooperianus	Orangefoot Pimpleback	Endangered
Epioblasma capsaeformis	Oyster Mussel	Endangered
Lampsilis abrupta	Pink Mucket	Endangered
Lampsilis ovata	Pocketbook	Endangered

Scientific Name	Common Name	Kentucky Status
Epioblasma obliquata	Purple Cat's Paw	Endangered
Pleurobema rubrum	Pyramid Pigtoe	Endangered
Quadrula cylindrica	Rabbitsfoot	Threatened
Obovaria retusa	Ring Pink	Endangered
Pleurobema plenum	Rough Pigtoe	Endangered
Simpsonaias ambigua	Salamander Mussel	Threatened
Plethobasus cyphyus	Sheepnose Mussel	Endangered
Epioblasma triquetra	Snuffbox Mussel	Endangered
Cumberlandia monodonta	Spectaclecase	Endangered
Other Invertebrates		
Leptoxis praerosa	Onyx Rocksnail	Special Concern
Calephelis borealis	Northern Metalmark	Threatened
Dryobius sexnotatus	Sixbanded Longhorn Beetle	Threatened
Bats		
Myotis grisescens	Gray Bat	Threatened
Myotis sodalis	Indiana Bat	Endangered
Myotis septentrionalis	Northern Long-Eared Bat	Endangered
Corynorhinus townsendii virginianus	Virginia Big-Eared Bat	Endangered
Other Mammals		
Spilogale putorius	Eastern Spotted Skunk	Special Concern

2.5.3 Critical Habitat

Both the Indiana Bat and the Rabbitsfoot mussel have final critical habitat designations; however, there is no critical habitat located within the project area.

2.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

2.6.1 Local Resources

Currently, the Cincinnati metropolitan area has a population near 2 million people. The 2015 estimate prepared by the U.S. Census Bureau (Population Estimates Program) reports that Campbell and Kenton Counties have a combined population of approximately 260,000 people. The cities of Fort Thomas, Dayton, Bellevue, Newport, Covington and Ludlow have a combined population of approximately 86,000 people.

Transportation infrastructure crossing the Ohio River includes five vehicle bridges, three rail lines, and one pedestrian bridge. Additionally, two vehicle bridges and one rail line cross the Licking River.

The study area has several existing flood risk management projects, including the Dayton, KY Local Flood Protection Project (LFPP); the Newport, KY LFPP; and the Covington, KY LFPP. These projects were built in response to the 1937 flood, which was approximately equivalent to a 5,000 year event.

The Cincinnati metropolitan area is projected to grow 11% from 2010 to 2040 and reach a total population of near 2.2 million (2010 Census; 2020-2040 projections by the Ohio Development Services -

2013 Edition, Kentucky State Data Center -2011 Edition and Indiana Business Research Center -2012 Edition). The Kentucky State Data Center (KSDC) forecasts that population growth in Campbell County will remain flat at around 92,000 through the year 2040. Projections by KSDC forecasts that Kenton County will generally follow the overall trend for the Cincinnati region with a growth rate between 2010 and 2040 of 13% and total population of 180,00 projected in 2040.

2.6.2 Regional Resources

Aside from the draw of Cincinnati cultural attractions, Newport offers riverboat tours of the Ohio River. A pedestrian bridge connecting Cincinnati and Newport serves as an attraction for tourists from New York, Tennessee, and other parts of Kentucky and Ohio. These types of attractions, in conjunction with the Licking River Greenway and Trails plan, makes this stretch of the river attractive for regional tourists to enjoy natural resources in addition to urban cultural resources.

2.7 CULTURAL RESOURCES

2.7.1 Cultural History

In general, the cultural resources history of the Northern Kentucky area provides a useful framework for organizing and describing archaeological data. The prehistoric cultural sequence developed for the region is Paleo-Indian (9,500-8,000 BC), Archaic (8,000-6,000 BC), Middle Archaic (6,000-3,000 BC), Late Archaic (3,000-1,000 BC), Early Woodland (1,000-200 BC), Middle Woodland (200 BC- AD 500), Late Woodland (AD 500-900), and Mississippian (AD 900-1,600). Within the project area there are no known prehistoric sites.

The Ohio River played an important role in immigration settlements into the region, especially the for Scotch-Irish, German, and Irish immigrants (Woolpert 2006). The confluence of the Licking and Ohio Rivers became site of the Newport Barrick between 1803 and 1894, which was an important in Northern Kentucky's history. The riverfront was also a major crossing destination on the Underground Railroad, allowing people to escape from slavery into Cincinnati. The Northern Kentucky Riverfront has been and continues to be a strong economic driver in the region.

2.7.2 Previous Investigations

A number of steps were taken in effort to identify any cultural resources within a two-kilometer radius of the proposed ecosystem restoration study areas on the Ohio and Licking Rivers in Northern Kentucky. These include a background check of the National Register of Historic Places (NRHP), Louisville District Geographic Information System (GIS), and the Kentucky Office of State Archaeology (OSA) records, previous cultural resources reports that have occurred at or in the vicinity of the project area and have been coordinated with the Kentucky State Historic Preservation Office. There are no known prehistoric or historic sites in the immediate project areas.

The site file search of the GIS database allowed the use of topographic maps, previous investigations, and historic structures and archaeological sites to collect information about the project vicinity. Reviews of the previous reports of Campbell and Kenton counties in Northern Kentucky were used to provide background information around the project area. The NRHP was used to collect information on NRHP eligible or listed properties within a two-kilometer project radius. A total of four historic districts were found within the two-kilometer radius of the project area using these resources. Those historic districts are: Riverfront, Licking River, Mansion Hill, and Taylor's Daughter. The C & O Railroad Bridge (KHS site number KEC 107) is on the NRHP listing.

The John A. Roebling Bridge (Cincinnati and Covington Suspension Bridge) is listed on the NRHP and National Historic Landmarks (NHL) for its engineering significance and link to John A. Roebling under Criteria B and C. The bridge features two sandstone towers, from which two 12.5 inch iron cables, suspenders, and numerous diagonal stays are strung to support the bridge deck. The system of diagonal stays was an innovation in bridge design at the time, much along the lines of the Brooklyn Bridge. The bridge has excellent integrity with the engineering elements, and decorative details that make up the bridge's significance remain evident (Hemberger 2009). The proposed undertaking has no potential to cause affect to the historic bridge.

A site visit to the Kentucky Office of State Archaeology was conducted on May 22, 2018 and identified 23 prehistoric and historic archaeological sites within a two-kilometer radius of the project location. The majority of the project area was previously surveyed by Woolpert Inc., in July 2015 to provide cultural resources services for the proposed construction of the multi-use path (known as Riverfront Commons) in the communities of Bellevue, Covington, Ludlow, and Newport, Kentucky, located on the south bank of the Ohio River (Sewell 2015). The survey methods by Woolpert Inc. included visual pedestrian survey, shovel probe testing, and mechanical trenching. The visual inspection indicated the majority of ground disturbance was a result of urban development, as well as of grading and filling activities from the construction of the flood wall and levee system. The shorelines were kept clear of development for barges loading and uploading, which kept development along tops of the terraces. Woolpert Inc. coordinated their recommendation that no additional work was needed for the multi-use path to the KY-State Historic Preservation Office (SHPO). The KY-SHPO concurred with the findings and recommendations.

Shovel probe testing also occurred at the project area in Ludlow (Sewell 2015). The shovel probes were set at 20 meters to a depth of two feet below ground surface, to possibly obtain information about deeply buried sites. A total of 18 shovel probes were excavated along the proposed multi-use trail. Artifacts that were observed included brick fragments, coal, asphalt, clear bottle, plastic and Styrofoam. No archaeological resources were identified in the Ludlow project area.

Mechanical testing occurred at the Covington project area along the multi-use trail. A total of 19 trenches were excavated to observe any deeply buried intact deposits to include historic foundations and to note the amount of disturbance in the area considering the Covington area was being highly developed over the years. Historic material including a brick sidewalk was observed during the mechanical testing. Only one trench was recommended for additional testing.

The Bellevue project area for the multi-use path consists of minor improvements of existing sidewalks and parking lot, with a short section of new trail placed in an area that has previously been disturbed by construction of a parking garage (Sewell 2015). Historical aerial photographs show the entire project area being disturbed over time.

During the Sewell (2015) survey, the Newport project area results revealed no further investigation due to the heavy disturbance of construction of the levee in the 1940's and installation of modern day sidewalks, roads, bridge and utilities. The area was visually inspected only.

In 2015, Sullivan and Hodgson conducted a phase I archaeological reconnaissance for a cell tower replacement in South Ludlow, Kenton County, Kentucky. The survey methods consisted of a pedestrian survey with shovel testing. No prehistoric or historic archaeological resources were identified during the survey.

In 2013, AMEC conducted a phase I archaeological survey for the proposed U.S. Department of Housing and Urban Development (HUD) Scholar House and park development project in Newport, Kentucky. The area of potential effects (APE) covers 2.5 acres that span two urban blocks. During the 2013, phase I survey, backhoe trenches were excavated to search for intact cultural remains. Three previously undocumented sites were recorded: 15Cp88, 89, and 90. The three sites appeared to be eligible for the NRHP, under Criterion D, which yields historic information on the history of the Newport Area (Prybylski and Darr 2013). The sites are known as historic residences dating from the late nineteenth and early twentieth centuries. The authors and the Kentucky Heritage Council recommend that the area be avoided or subjected to additional Phase II testing to evaluate their National Register eligibility.

In 2011, Gray and Pape, Inc., conducted a phase I intensive archaeological survey with the proposed replacement/rehabilitation of the Brent Spence Bridge (Garrard et al. 2011). The survey methods included shovel testing, surface collection, and visual inspection of 330 acres. A total of 13 historic archaeological sites were identified, along with three "historic, non-localities" (Garrard et al. 2011). One archaeological site was identified adjacent to the Riverfront Commons project area. Historical site 15Ke160 is a historic scatter situated on the banks of the Ohio River, north of the terrace (Garrard *et al* 2011). This site could be associated with a possible land building; however no historical development has been identified through archival research in this section of Covington.

In September 2011, Cultural Resources Analysts, Inc., conducted an archaeological survey of portions of I-471 and HWY 8 interchange in northern Campbell County, Kentucky (Cooper et al. 2011). The survey focused on the discontinuous segments where improvements have been proposed and where intact cultural resources possibly be located. The methods of the survey included a pedestrian survey with the use of auger probes every 10 meters, due to the potential of deeply buried sites. Two previously recorded sites (15Cp85 and 86) were located during the survey. Both sites are historic residences within the Mansion Hill Historic District, which is on the NRHP.

A phase I archaeological survey was conducted on August 22, 2006 at the request of the Kentucky Department of Transportation to assess potential impacts to cultural resources by adding a turning lane. The survey area covers approximately 0.71 acres. It was determined that the majority of the area was disturbed due to previous road, sidewalk, and parking lot construction activities and residential development. Historic site 15Cp79 was identified during the survey and consisted of architectural remnants, historic artifacts, and a large rectangular depression correlating with a house (Hunter 2006). Portions of 15Cp79 that were within the proposed turn lane were considered not eligible for the NRHP;

however, based on the artifact densities, the potential of intact deposits, and the presence of a house depression, the reminder of the 15Cp79 may be eligible for the NRHP and additional phase II testing would be needed if the project boundaries changed (KY-SHPO coordination letter January 29, 2007).

In 1998, New South Associates conducted a phase II archaeological survey and evaluation for the U.S. Courthouse sites. The archaeological survey was conducted to be in compliance with Section 106 of the NRHP to determine the presence of archaeological sites and assessing them for the inclusion of NRHP. (Joseph and Yallop 1998). A total of four backhoe trenches and striped blocks measuring approximately 100 square feet in size were excavated in areas with the highest potential to yield archaeological deposits (Joseph and Yallop 1998). The trenches had numerous artifacts and cultural deposits within them. The evidence of cultural material such as brick and granite building stone, preserved wood framing and flooring sections, and historic artifacts like earthenware, glass bottles, metal fragments, and nails, just to name a few were observed. Well shafts and cisterns were also filled in. The historic material dates to the late 19th and early 20th century. The authors concluded that the current project was not eligible for the NRHP and no additional work was needed.

An intensive archaeological investigation of three city blocks of Covington was directed by Robert Genheimer in 1987. The survey was located between the floodwall and East Second Street, and bounded by the Roebling Bridge on the east and earthen levee on the west. The survey was conducted for the development of the Covington Riverfront Commons project, which took place in 1987 (Genheimer 1987). A total of 51 backhoe trenches and 13 hand-excavated test units in three different areas. The backhoe trenches revealed the entire project area was covered with deeply buried historic fill in certain locations. The majority of the artifact densities consisted of historic materials associated with the Hemingray Glass Factory location, indicating an active history of landfilling along the top of the terrace overlooking the Ohio River (Genheimer 1987). No undisturbed prehistoric landforms were identified during the survey.

The majority of the archaeological surveys that have occurred within the two-kilometer radius of the project areas have occur within the downtown areas in historical neighborhoods. In 1984, Schock conducted a cultural resources survey for a proposed parking lot and access road for a floating restaurant. The methods for the survey included two backhoe tests to determine the existence if any deeply buried intact prehistoric sites. However, the two trenches showed evidence of a thin historic trash layer ranging from 0.6 to 1 foot in depth, as well as a brick, cinders, and rock mixed layer extending to 2.4 feet deep. Even though historic debris was noted, the overall survey revealed no intact prehistoric or historic sites.

The City of Dayton and Development Management Associates requested an archaeological survey of a proposed park location within the study area, which was conducted in 1976. The authors' focus was to determine if any significant cultural resources would be adversely affected by the development of the park. The method of the survey was not standard, meaning a walk over survey was conducted along the streets and alleyways. Even though the authors suggest the park is in a prime location to expect archaeological sites, no shovel tests were excavated. Collins and Coyle (1976) recommend additional testing for any future development to include any construction or vegetation clearing. In addition, the authors noticed a number of historic standing structures dating to the last century that should be further assessed.

In 1975, an archaeological survey of the relocation of Kentucky Highway 8 was conducted under contract between the Commonwealth of Kentucky, Department of Transportation, and Mr. Jack Schock of the Department of Sociology and Anthropology Department of Western Kentucky University and Mr. Gary Foster. The purpose of the survey was to locate all prehistoric and historic sites along the proposed alternates and determine the cultural affiliation, site boundaries, and recommendations for sites if they were identified during the survey. No prehistoric or historic archaeological sites were located during the survey.

2.8 AIR QUALITY

Both Campbell and Kenton counties are in attainment with National Ambient Air Quality Standards as of 2017 measurements. However, Campbell County did not attain the 8-Hour Ozone (2008) standard from 2012 to 2016 or the Sulfur Dioxide (2010) standard from 2013 to 2016. Kenton County was not in attainment of the 8-Hour Ozone (2008) standard from 2012 to 2016 (U.S. Environmental Protection Agency, 2017).

2.9 NOISE

In the proposed project area vicinity, noise levels are typical of a metropolitan area with over two million people, but may vary based on the time of year and events within the Cincinnati metropolitan area. Changes in noise are typically measured and reported in units of dBA, a weighted measure of sound level. The primary sources of noise within the project area would include everyday vehicular traffic along the adjacent highways (typically between 50 and 60 dBA at 100 feet) as well as commercial and recreational boat traffic along the rivers. Noise ranging from about 10 dBA for the rustling of leaves to as much as 115 dBA (the upper limit for unprotected hearing exposure established by the Occupational Safety and Health Administration) is common in areas where there are sources of recreational activities, construction activities, and vehicular traffic.

2.10 HAZARDOUS AND TOXIC SUBSTANCES

The United States Environmental Protection Agency's (EPA) Envirofacts website was queried to identify the presence of EPA-regulated facilities within one mile of the Ohio and Licking River shorelines within the proposed project area. The Envirofacts website contains information collected from regulatory programs and other data relating to environmental activities with the potential to affect air, water, and land resources in surrounding areas. There are two hundred EPA-regulated facilities within a mile of the shorelines, but none would be affected by the proposed project. An EPA Superfund site is 0.75 miles from the southeastern-most portion of the Licking River floodplain forest proposed work. The site is the Newport Dump (EPA Registry ID: 110013802581) and was taken off of the Superfund program's National Priorities List (NPL) in 1996. The site was placed on the NPL in 1983 because of "contaminated groundwater, leachate, soil and surface water resulting from waste handling practices" and is currently being monitored and remediated. These facilities and links to summary, facility, and compliance reports are listed in the Environmental Appendix.

2.11 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE

2.11.1 EO 12898 Environmental Justice

Maps and data on demographics with respect to race and income are provided by justicemap.org, which uses data from the U.S. Census Bureau (the 2010 Census and the 2011-2015 American Community Survey). According to justicemap.org, the majority of the project area contains households with incomes of $40,000 or more (Figure 19). Additionally, the majority of the project area contains tile layers that are 90% or more white, with the exception of an area between I-75 and I-471 (Figure 20).

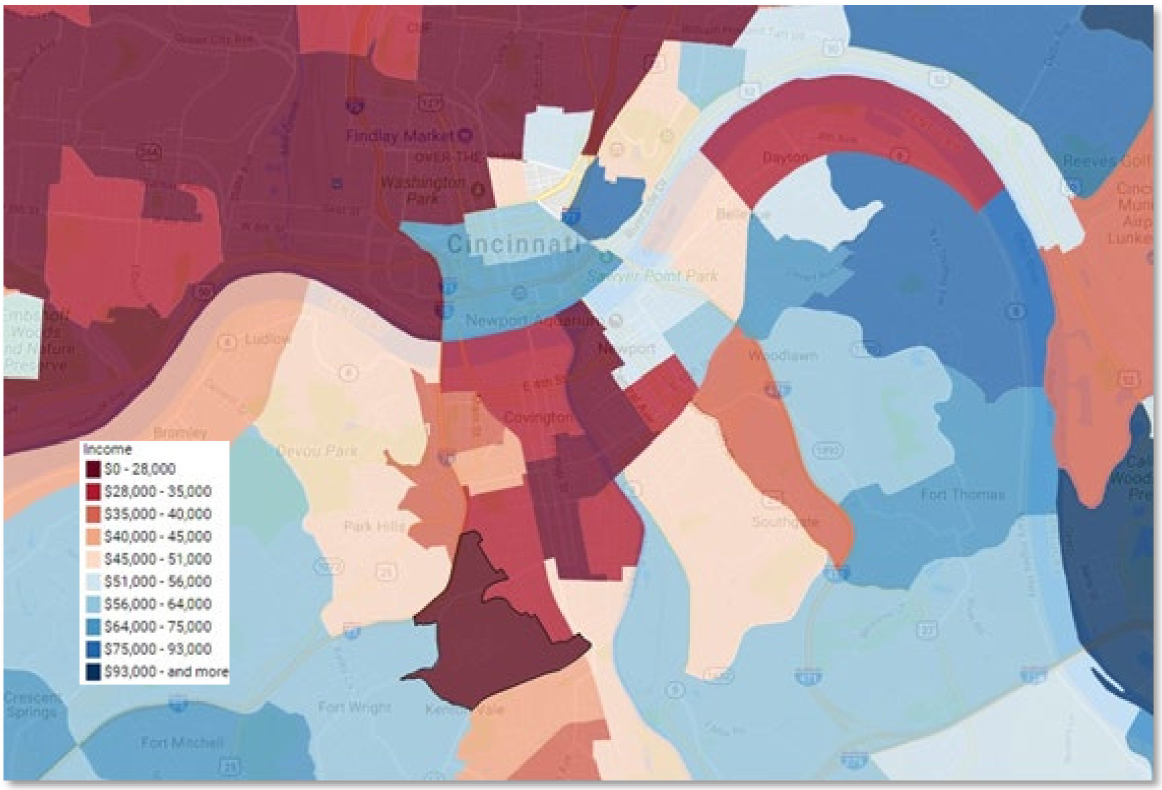


Figure 19. Visualization of income within the project site, from justicemap.org.

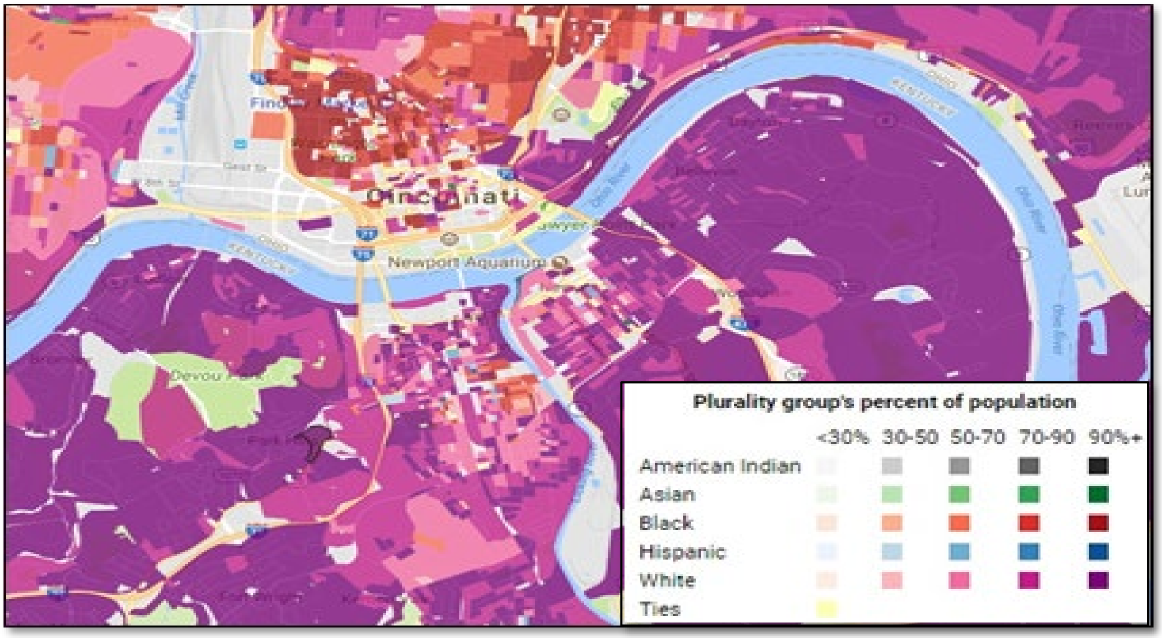


Figure 20. Geographic distribution of races within the project area, including an area of greater diversity between I-71 and I-471.

2.11.2 EO 13045 Protection of Children

Under this order, federal agencies must identify and assess environmental health and safety risks that may disproportionately affect children as a result of the implementation of federal policies, programs, activities, and standards. The EPA's EJScreen environmental justice mapping tool was used to assess the environmental and demographic indicators within the project area. According to EJScreen, 6% of the population within the project area is under five years of age. This is in the 49 percentile in the United States. The full EJScreen Report is included in the Environmental Appendix.

3 PLAN FORMULATION

This chapter discusses restoration objectives, opportunities, and constraints within the study area. Based on these objectives and opportunities, a series of restoration alternatives were developed.

3.1 PROBLEMS AND OPPORTUNITIES

3.1.1 Problems

The problem is loss and degradation of riparian (inclusive of shoreline and tributary streams) and floodplain habitat in the study area.

Elaboration: This problem results in the scarcity of high quality habitat, decreased habitat connectivity and reduced native biodiversity. This problem is representative of the larger corresponding loss and degradation of riparian habitat along the managed inland waterway system, and does not provide high quality habitat for threatened and endangered species.

3.1.2 Opportunities

The opportunity is to restore tributary streams, riparian (shoreline) zone habitat, main stem fish habitat and forested floodplain habitat in the study area.

> Elaboration: This opportunity allows for the increase of scarce high quality habitat found along the managed inland waterway system by increasing habitat connectivity and native biodiversity while providing habitat for threatened and endangered.

A second opportunity is to provide compatible public access to the riparian habitat restoration areas.

3.2 OBJECTIVES AND CONSTRAINTS

3.2.1 Study Planning Objectives

Objectives are statements that describe the desired results of the study in solving the problems and taking advantage of the opportunities identified. Objectives must be clearly defined, specific, flexible, measurable, attainable, congruent, and acceptable; they should be realistic, quantifiable targets that measure the accomplishment of the goal over a specified period of time.

The desired results of the planning process are to:

1. Restore the quantity, quality, biodiversity and connectivity of scarce riparian (inclusive of tributary streams, main stem shoreline and forested floodplain) habitat suitable for native species in the study area within the period of analysis.
2. Provide opportunities for compatible public access to restored areas consistent with maintaining and protecting their ecological integrity.

3.2.2 Federal Planning Objectives

Plans to address ecosystem restoration should be formulated, and measures for restoring ecological resources may be recommended, based on their non-monetary benefits. These measures do not need to exhibit net national economic development (NED) benefits associated with traditional flood control economic analysis. Rather, they should be viewed based on nonmonetary outputs, typically in terms of habitat output units, compatible with Corps Planning Guidance selection criteria. Plans selected for recommendation are then offered for consideration and budgetary support for their National Environmental Restoration (NER) outputs.

3.2.3 Planning Constraints

'Constraint' is a restriction that limits the extent of the planning process and impacts plan formulation within the study area. There are several significant issues for which it would be extremely difficult to justify or implement changes. These considerations are introduced below.

1. <u>Ohio River Management</u> – The Ohio River within the study area is managed principally for navigation and flooding above the river levels required to maintain a minimum navigation pool.

In order to have a viable riparian habitat area, the plant communities must be adaptable (designed) to the flood elevations and frequencies provided by the managed system.

2. Ohio River Navigation – Avoid impacts to commercial and recreational river traffic and infrastructure.
3. Flood Risk Management Infrastructure – Any restoration feature will avoid negative impacts to the existing flood risk management (FRM) infrastructure in place. This includes the Dayton, KY LFPP; the Newport, KY LFPP; and the Covington, KY LFPP.
4. Transportation Infrastructure – Regional and municipal infrastructure (e.g. roads, bridges, culverts, railroads) may place design requirements on restoration features. Also, any restoration features will avoid adversely affecting infrastructure's functional purpose.
5. Urban Hydrology – Existing storm water infrastructure and hydrologic influences may limit restoration options.

3.3 MOST PROBABLE FUTURE WITHOUT PROJECT CONDITIONS

3.3.1 Hydrology

The study area is in a region with immense urban impact dating back to the mid nineteenth century. The Cincinnati metro area has long been a regional manufacturing center based on its central location and various transportation options. With river access to markets from the interiors of Ohio, Kentucky, and to a lesser extent Indiana, early urbanization was fast paced with many manufacturing and agricultural processing centers locating on the local river access. The result was a near total loss of natural riparian habitats, increased runoff from precipitation events due to impervious land cover, and loss of water quality due to untreated waste dumping.

Although, the trend of heavy industrialization in this study corridor has been severely curtailed in recent history, the effects of this land usage still remain. Currently, the study area suffers from many different ecosystem impacts resulting from compromised hydrology and hydraulic conditions. These include, but are not limited to, eroding soils due to precipitation runoff, limited aquatic habitat, loss of interconnectivity between different ecosystems, and the prevalence of invasive plant species in existing riparian habitats.

Without mediation the existing conditions will most likely continue to degrade.

High stream flows from increased precipitation runoff will continue to create situations where shear stresses on river, stream, and shoreline soils exceed the cohesion of the soils resulting in exacerbated erosional conditions. Several areas currently exhibit severe down cutting of stream channels with significant head cutting. Left unchecked, these conditions will only continue to worsen; further degrading the environmental conditions and eventually threaten existing infrastructure (small bridges, water/sewage pipes).

Erosional down cutting of stream channels disconnects the stream from its floodplain. This loss of stream/flood plain connectivity destroys the riparian habitat leaving what becomes essentially a poor quality ditch.

As bank erosion and down cutting of tributary stream channels continues, floodplain habitat that act as aquatic species nursery habitats, become cut off from the major river system. This removes the interconnectivity between habitat areas resulting in the severe loss of the ability for the system to sustain aquatic populations.

Depleted shore line soils and high stresses caused by runoff and stream velocities have created conditions favorable for invasive species of aquatic and woodland species. Again, unless the hydraulic and hydrological conditions are addressed the underlying issues of riparian and floodplain plant habitats will continue to degrade allowing further invasive species recruitment.

Section 2.1 of this report discusses the effects of climate change on inland hydrology within the study area. A review of 126 years of data from the Licking River gage indicated a slight increasing trend in annual peak instantaneous streamflow that was not statistically significant. This indicates that overall, there has been no change in flood risk, as measured by the annual maximum flood during the period of record (1888-2014).

A literature review indicated majority consensus for projected small increases in temperature and minimum temperatures and large increases in maximum temperatures for the Ohio Region. There was low consensus among published studies regarding precipitation amounts, precipitation extremes, and hydrology. Because of this lack of consensus, there are no discernible trends in projected hydrology and precipitation.

3.3.2 Habitat Types

Tributary Streams

The future without project conditions of tributaries is expected to stay the same or worsen as urban development continues to change hydrology and land use within the study area. Without restoration tributaries would be unable to passively recover natural stream geomorphology and correct severe erosion issues that are the primary drivers of environmental degradation.

Shoreline

The future without project conditions may see a slight improvement in remnant patches of natural vegetation because water quality conditions within the Ohio River have been improving over the last 20 years. However, the fragmented nature of the remnants and loss of habitat connectivity are not expected to change and may worsen as development continues along the shoreline areas of the Ohio and Licking Rivers.

Main Stem Fish Habitat

Main stem fish habitat is expected to be maintained or worsen under the assumptions that Ft. Thomas's shoreline is unlikely to be developed in the future, but the other municipalities will likely continue to develop places along their shorelines. In areas were development is unlikely, passive recovery of fish habitat may occur in small, but insignificant, increments by falling trees. Shallow riffles areas are unlikely to recover on their own. Areas under development pressure will likely worsen because of increased removal of woody species needed for the formation of large woody debris piles. Continued shoreline development will also increase distances between fish habitat patches decreasing the overall quality of fish habitat within the project area.

Floodplain Forest

Floodplain forests are expected to decrease in quality in the future. Even though the Ohio River water quality has improved in current years this has been outweighed by the invasion of non-native plant species that have been able to outcompete native species under poor water quality conditions. Without restorative actions, invasive species will continue to dominant the understory and sub-canopy, thus continuing to reduce the suitability of floodplain forests for other native resident and migratory species.

3.4 Measures to Achieve Planning Objectives

3.4.1 Ecosystem Restoration Approaches

The practice and science of ecological restoration is still relatively young; however, the latest research and observations point to the knowledge that restoring ecosystem processes that enhance and sustain ecosystem structure and function should be a priority for the long term persistence of native ecosystems. Additionally, restoration measures should be tailored to the specific conditions of the site of concern, so as to account for altered landscape-scale processes that result from human or natural phenomenon outside the scope of the restoration project. For example, most restoration planners and practitioners now recognize that the past can help to guide restoration decisions, but it cannot provide a perfect template for restoration under changing environmental conditions (Alagona et. al. 2012). Restoration targets are now formulated with the knowledge that ecosystems are fluid and dynamic and that the target may have many similar aspects of a historical condition, but it does not attempt to perfectly replicate any specific remnant or historical condition. Restorations should be designed to adapt and be resilient to climatic changes and sustainable over the long term.

Photo 7. Shoreline restoration along the Chicago River.

Generally, urban stream restoration has proven to be beneficial to recipient streams and provide long term benefits (Purcell et. al. 2002). Urban stream restoration techniques range from soft techniques (e.g., reinstating processes that form the targeted structure and function) to hard techniques (e.g., installed structures that form the targeted function). Urban stream restoration techniques generally include: bank protection/stabilization, grade control, flow deflection/concentration, in-stream habitat, and riparian buffer zone (Brown 2002).

Large river restoration is also fairly well understood with numerous examples of restoration, such as the Kissimmee River in Florida, Chicago River in Illinois, Upper Mississippi River in Minnesota and the Rio Grande in New Mexico. These examples have provided evidence that large-scale river restoration is possible within highly altered landscapes. Large rivers that have been highly altered, such as the Ohio River, have a loss of historical hydrologic regimes and hydraulics. Although hydrologic regime is a constraint in formulating restoration measures, incorporating substrates in appropriate conditions (depth), such as cobble bars, protected coves and/or large woody debris (LWD), can restore not only quality structure, but restore hydraulic function needed for many native fish species. Additionally, restoring lost habitat connectivity between the river and floodplain is a priority goal for most large river restoration projects. Floodplain function is often restored through pulling back steep banks for a gentler slope, removing or notching levees/barriers and restoring quality native vegetation that can support a diversity of habitat structure and food resources. In addition, remnant areas of floodplain forest along large highly modified rivers are typically low quality dominated by invasive plant species. In general, removing invasive species and replacing or recruiting high quality native plant species will restore quality habitat and increase native biodiversity of the region.

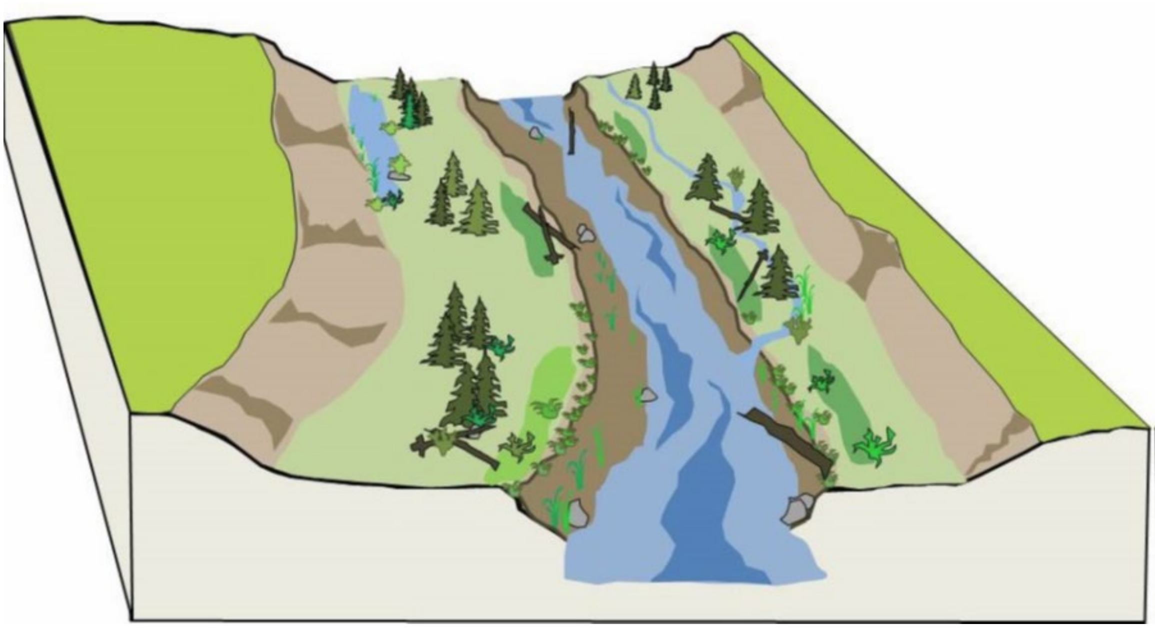


Figure 21. Example of a fully functional riparian zone and connected vegetated floodplain (diagram from American Rivers).

3.4.2 Conceptual Ecosystem Model

Ecosystem is a term used to describe organisms and their physical and chemical environments and can be described and delineated at various scales. For example, a pond or an ocean can be equally referred to as an ecosystem.

The term 'conceptual model' is a widely accepted term in the field of environmental science and research. Conceptual models are descriptions of the general functional relationships among essential components of an ecosystem: they tell the story of how the system works.

The main purpose of the diagram below (Figure 22) is to provide a graphical representation of the ecosystem's function in the study area. It is intended to foster a common understanding of how the system works, and to facilitate generating restoration actions that address the problems.

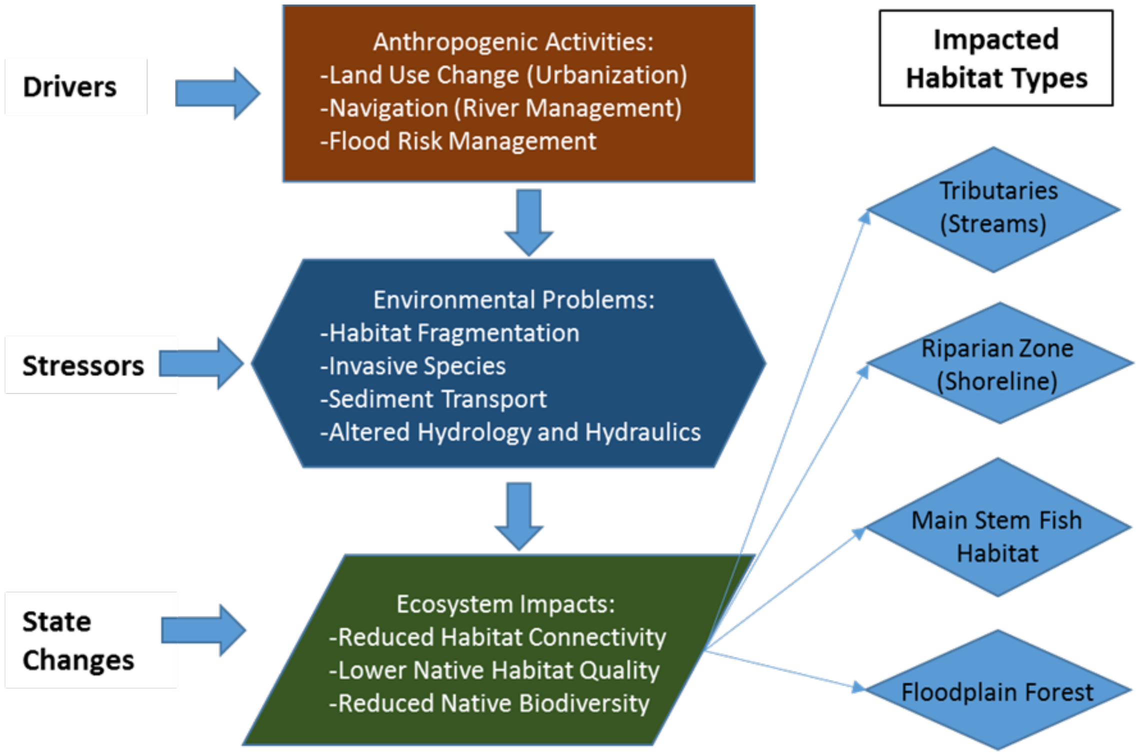


Figure 22. Conceptual Ecosystem Model for Study Area

3.4.3 Proposed Ecosystem Assessment Methodology

Many methods are available to measure current ecosystem resource conditions and to predict future conditions of those resources. Habitat assessment methods developed for individual species may have limitations when used to assess ecosystem level restoration alternatives. They do not consider communities of organisms and typically consider habitat in isolation from its ecosystem context. The assessment methods proposed for this study were chosen by how well the technique meets the needs of the study goals, objectives, and level of detail. One proposed assessment method is the Gray Squirrel Habitat Suitability Index (Gray Squirrel) that focuses on structure (e.g., percent canopy cover) and function (e.g., number of hard mast species) of the vegetation community (USFWS 1987). The Gray Squirrel HSI was developed by the USFWS and approved for use in USACE planning studies. Another proposed method is the Qualitative Habitat Evaluation Index (QHEI). This was developed by the Ohio EPA (1989) as a method to quantify the quality of in-stream habitat as it relates to its ability to sustain native aquatic species. The QHEI is a regionally approved model for USACE planning studies. The third proposed model is the Smallmouth Bass Habitat Suitability Index (Smallmouth Bass). Smallmouth Bass would be used to capture benefits of restoring fish habitat along the main stem of the Ohio River. The Smallmouth Bass was developed by the USFWS (1983) and approved for use in USACE planning studies. Even though the QHEI and Smallmouth Bass measure similar properties of the ecosystem in relation to quality of fish habitat, the QHEI is limited in applicability to wadable areas and would not be appropriate to use along the main stem of the Ohio River. These proposed methods were chosen to assess the ecological value of the proposed future without-project condition and any ecosystem level changes that result from the proposed restoration alternative for the project area (Table 3). There will be no weighting per community type since each part of the ecosystem is just as important as the other.

Table 3. List of Habitat Assessment Models and Habitat Types

Environmental Models	**Acronym**	**Developers**	**Targeted Habitat Types**			
			Streams	Shoreline Zone	Main Stem Fish Habitat	Floodplain Forest
Gray Squirrel Habitat Suitability Index	Gray Squirrel	USFWS		**X**		**X**
Qualitative Habitat Evaluation Index	QHEI	State of OH-EPA*	**X**			
Smallmouth Bass Habitat Suitability Index	Smallmouth Bass	USFWS			**X**	

3.4.4 Preliminary Structural and Non-Structural Measures

Potential restoration measures were identified based on the problems (e.g., stream connectivity) and opportunities (e.g., increase native species biodiversity) within the project area. Many of the opportunities available within the project area involve restoring the structure (e.g., disconnected stream) and function (e.g., streambank erosion) of an ecosystem that will then support a high level of native biodiversity. For purposes of this study, ecosystem structure refers to structural elements of a system (e.g., geomorphology) that directly or indirectly supports species or ecosystem function. Ecosystem function relates to a process that can be measured such as erosion or deposition.

Reestablishing high quality habitat is dependent upon fixing the current conditions of the physical environment. For example, if one were to remove invasive species and replant native species along the Ohio River shoreline without first addressing the geomorphic and hydrologic setting, the biological measures (planting natives) would fail over time. Thus, complimentary measures were being developed to address physical parameters (hydraulics, geomorphology) and biological reestablishment (invasive species removal, planting) and will be assessed in an incremental fashion to guide decisions in identifying and selecting the most significantly beneficial plan that has an associated reasonable cost. Below is a list of potential measures, not every measure includes a description since some are intuitive or already well known. Measures have been lumped into 8 categories to better represent their focus on identified ecosystem problems. Table 4 presents each measure and their applicably within the study areas.

1. Stream Connectivity – This strategy would address fish passage needs. Potential measures to consider include:

- 1.a. barrier modification:

  A barrier modification would involve making changes to the form and function of a barrier, such as a replacing a small restrictive perched culvert with a larger one (also bottomless culverts), that would allow increased connectivity while maintaining the original intent of the barrier.

- 1.b. barrier removal (including removal of non-essential outdated infrastructure such as old culverts, pipes, walls)

- 1.c. fish ladders

- 1.d. rock ramps (definition taken from U.S. Dept. of Interior 2007):

  Intent of rock ramps are to reconnect portions of lotic rivers and streams that have barriers to fish passage during low flows. "The rock ramp consists of a low-flow channel designed to maintain biologically adequate depth and velocity conditions during periods of small discharges. The remainder of the ramp is designed to withstand and pass large flows with minimal structural damage."

- 1.e. bypass channels:

  This measure would involve excavating a connected channel around a barrier so fish could bypass the barrier.

- 1.f. removal of locks and dams

2. In-stream Habitat – This strategy would address physical in-stream habitat needs. Potential measures to consider include:

- 2.a. meander induction (this relates to the smaller streams):

  Strategically placed riffles, boulder clusters and woody debris complexes to influence the flow of the water to erode and accrete in a fashion that will allow the stream to meander along the length of it channel. Restricted to smaller streams with available floodplain.

- 2.b. grade control structures and channel substrate (amend substrates to add complexity)
    - riffles
    - cross-veins
    - J-hooks (definition taken from Rosgen 1997):

      "The J-Hook Vane is an upstream directed, gently sloping structure composed of natural materials. The structure can include a combination of boulders, logs and root wads and is located on the outside of stream bends where strong downwelling and upwelling currents, high boundary stress, and high velocity gradients generate high stress in the near-bank region. The structure is designed to reduce bank erosion by reducing near-bank slope, velocity, velocity gradient, stream power and shear stress. Redirection of the secondary cells from the near-bank region does not cause erosion due to back-eddy re-circulation. The vane portion of the structure occupies 1/3 of the bankfull width of the channel, while the "hook" occupies the center 1/3."
    - wing-dikes
    - boulder clusters
    - cobble bars
- 2.c. woody debris
    - Rootwads
    - Logs
    - Woody toe protection
- 2.d. riparian buffers to reduce sedimentation and nutrients:

  Reestablish or increase the width of native vegetation that starts from the toe of the slope upwards into the riparian/floodplain area.
- 2.e. limiting CSOs through gray and green infrastructure (partner with Sanitation District 1 for sewage impacts, better infrastructure, e.g. detention)
- 2.f. reduce chemical pollution by reducing pesticide use:

  Work with non-pro-fit groups (Ohio River Foundation) to develop a public outreach campaign to educate public about misapplication and overuse of pesticides in urban and rural areas.
- 2.g. manage public access to minimize damage to ecosystem:

Integrate compatible walking trails and viewing areas within restoration areas that are expected to attract public use (Ohio riparian areas within Newport, Covington, etc.)

- 2.h. restrict barges from restoration areas:

  Work with barge operators and the Coast Guard to identify and agree on areas that will no longer be used for barge traffic or barge resting areas.

<u>3. Geomorphic Contouring</u> –This strategy would address disturbance and alteration to natural geomorphic features. Potential measures to consider include:

- 3.a. bank grading:

  Pulling back very steep banks to a more gently slope with varying levels of terracing and stabilizing those banks through limestone placement and native plant installation)

- 3.b. floodplain terracing:

  Create terraced areas along steep shorelines as a way to stabilize riparian areas and allow for reestablishment of native habitat. For areas along the shoreline that don't allow for pulling back of banks.

- 3.c. compaction relief:

  For areas that have undergone activities, such as dredging/filling or grading, that may have negatively compacted the soil. This will allow native plant species to be reestablished.

  - disking
  - tilling

- 3.d. topographic diversity:

  Creating a diversity of topographic features that increases the diversity of habitat types and therefore native biodiversity within an area.

  - wetland depressions, connected to floodplain
  - vernal pools (connected to the varying river water levels, made to dry up part of the year)

- 3.e. dredging:

  Removing sediment that is detrimental to restoring an essential ecosystem structure or function, such as dredging out a tributary mouth (area of discharge to Ohio River) to allow a natural delta to form.

4. Soil Amendments – This strategy would address adverse effects to soils from invasive plant species, soil horizon mixing, farming practices, etc. Potential measures to consider include:

- organic carbon (leaf litter)
- pine saw dust
- sand
- native top soils

5. Invasive Species Removal – This strategy would address invasive plant species effects on the natural plant community. Physical and chemical measures are usually coupled for maximum effectiveness. Potential measures to consider include:

- 5.a. physical removal
    - site clearing and grubbing
    - selective tree removal
    - understory clearing
- 5.b. chemical removal (herbicide)
- 5.c. leverage other projects such as Covington's removal of invasive species
- 5.d public outreach program to combat aquatic invasive species such as zebra mussels and carps

6. Native Plantings – This strategy would address the absence of native plant species per natural community type. Potential measures to consider include:

- 6.a. seeding
- 6.b. live plugs
- 6.c. shrubs and trees
- 6.d. source material
    - contract growing
    - nursery purchased

7. Native, Threatened and Endangered Species – Mussels, bats, migratory birds (birds protected under the Migratory Bird Treaty Act and Bald and Golden Eagle Act). Potential measures to consider include:

- 7.a. provide targeted habitat improvements to help sustain T and E species and other species of concern:

Habitat for fish that assist in mussel reproduction, high diversity of fruit and seed bearing plants to support migrating birds, etc.

8. Compatible Access to River – Potential measures to consider include:

- 8.a. multipurpose trails for access, including maintenance access
- 8.b. remove or add hard infrastructure (sidewalks)
  - nature trail
  - board walks
  - paved trail
  - fences
- 8. c. improve safety of access pathways with lighted walkways, trails, fencing to protect sensitive areas. Location of features to be chosen carefully so as to not impede the development of restored ecosystem function and structure
- 8.d. public education about the ecosystem restoration and access points:

  Work with local sponsor to develop signage explaining the purpose of certain habitat features and their intentions to support T and E species and other native species.

3.4.5 Excluded Measures

Potential restoration measures were evaluated for further consideration using two (2) criteria (Table 4). The first criteria is whether the measure would be acceptable for the project area in terms of impacting navigation and/or current or planned recreation (boat docks) and economic development. Planning constraints include avoiding impacts to commercial (e.g., barge rest areas) and recreational river traffic (e.g., marinas) and flood damage reduction infrastructure (e.g., levees). The second criteria is the need for the restoration feature to be effective (e.g., actualize environmental benefits) in the project area being mindful of navigation, recreation and flood infrastructure constraints. Any potential restoration measure that is found to be either unacceptable or ineffective has been removed from further evaluation.

Table 4. Screening Restoration Measures

	Evaluation Criteria		
Potential Restoration Measures	Acceptable	Effective	Retained for Evaluation
1. Stream Connectivity – These measures would address fish passage needs. Potential measures to consider include:			
1.a. barrier modification	Yes	Yes	Yes
1.b. barrier removal (including removal of non-essential outdated infrastructure such as old culverts, pipes, walls)	Yes	No - during survey of area, all known storm water infrastructure would need to stay in place, but could be modified	No
1.c. fish ladders	Yes	No - areas that exhibited barriers to movement are not appropriate for fish ladders	No
1.d. rock ramps	Yes	Yes	Yes
1.e. bypass channels	No - road and sanitary infrastructure would prohibit creation of bypass channels	No - areas that exhibited barriers to movement are not appropriate for bypass channels	No
1.f. removal of locks and dams	Yes - in small tributaries	No - potential restoration sites do not contain locks and dams to be removed	No
2. In-stream Habitat – These measures would address abiotic in-stream habitat needs. Potential measures to consider include:			
2.a. meander induction (this relates to the smaller streams)	Yes - in tributaries with adequate floodplain	Yes	Yes

	Evaluation Criteria		
Potential Restoration Measures	Acceptable	Effective	Retained for Evaluation
2.b. grade control structures and channel substrate (amend substrates to add complexity)	Yes	Yes	Yes
riffles	Yes	Yes	Yes
cross-veins	Yes	Yes	Yes
J-hooks	Yes	Yes	Yes
w ing-dikes	Yes	Yes	Yes
boulder clusters	Yes	Yes	Yes
cobble bars	Yes	Yes	Yes
2.c. w oody debris	Yes	Yes	Yes
rootw ads	Yes	Yes	Yes
logs	Yes	Yes	Yes
2.d. riparian buffers to reduce sedimentation and nutrients	Yes	Yes	Yes
2.e. limiting CSOs through gray and green infrastructure (partner w ith Sanitation District 1 for sew age impacts, better infrastructure, e.g. detention)	Yes - w ould require w illingness of SD1 to partner on projects	Yes	Yes
2.f. reduce chemical pollution by reducing pesticide use	Yes	No - USACE does not set local policy or law s and although the USACE could support a public outreach program, the USACE w ould not take the lead, thus effectiveness of measure is uncertain	No
2.g. manage public access to minimize damage to ecosystem	Yes - w ould be compatible w ith access and maintenance	Yes	Yes
2.h. restrict barges from sanctuary areas (make sanctuary areas)	No - w ould impact navigation	Yes	No
<u>3. Geomorphic Contouring</u> –These measures w ould address disturbance and alteration to natural geomorphic features. Potential measures to consider include:			

	Evaluation Criteria		
Potential Restoration Measures	Acceptable	Effective	Retained for Evaluation
3.a. bank grading	Yes	Yes	Yes
3.b. floodplain terracing	Yes	Yes	Yes
3.c. compaction relief	Yes	Yes	Yes
disking	Yes	Yes	Yes
tilling	Yes	Yes	Yes
3.d. topographic diversity/dredging	Yes	Yes	Yes
w etland depressions, connected to floodplain	Yes	Yes	Yes
vernal pools (connected to the varying river w ater levels)	Yes	Yes	Yes
3.e. dredging	Yes	Yes	Yes
4. Soil Amendments – These measures w ould address adverse effects to soils from invasive plant species, mixing, farming practices, etc. Potential measures to consider include:			
organic carbon (leaf litter)	Yes	Yes	Yes
pine saw dust	Yes	Yes	Yes
sand	Yes	Yes	Yes
native top soils	Yes	Yes	Yes
5. Invasive Species Removal – This strategy w ould address invasive plant species effects on the natural plant community. Physical and chemical measures are usually coupled for maximum effectiveness. Potential measures to consider include:			
5.a. physical removal	Yes	Yes	Yes
site clearing and grubbing	Yes	Yes	Yes
selective tree removal	Yes	Yes	Yes
understory clearing	Yes	Yes	Yes
5.b. chemical removal (herbicide)	Yes	Yes	Yes
5.c. leverage other projects such as Covington's removal of invasive species	Yes	Yes	Yes

	Evaluation Criteria		
Potential Restoration Measures	Acceptable	Effective	Retained for Evaluation
5.d. public outreach program to combat aquatic invasive species such as zebra mussels and carps	Yes	No - USACE does not set local policy or laws and although the USACE could support a public outreach program, the USACE would not take the lead, thus effectiveness of measure is uncertain	No
6. Native Plantings – This strategy would address the absence of native plant species per natural community type. Potential measures to consider include:			
6.a. seeding	Yes	Yes	Yes
6.b. live plugs	Yes	Yes	Yes
6.c. shrubs and trees	Yes	Yes	Yes
6.d. source material	Yes	Yes	Yes
contract growing	Yes	Yes	Yes
nursery purchased	Yes	Yes	Yes
7. Native, Threatened and Endangered Species – Mussels, bats, migratory birds (birds protected under the migratory species act). Potential measures to consider include:			
7.a. provide targeted habitat improvements to help attract native species	Yes	Yes	Yes
8. Compatible Access to River – Potential measures to consider include:			
8.a. multipurpose trails for access, including maintenance access	Yes	Yes	Yes
8.b. remove or add hard infrastructure (sidewalks)	Yes	Yes	Yes
nature trail	Yes	Yes	Yes
board walks	Yes	Yes	Yes
paved trail	Yes	Yes	Yes
fences	Yes	Yes	Yes

	Evaluation Criteria		
Potential Restoration Measures	Acceptable	Effective	Retained for Evaluation
8. c. improve infrastructure w ith lighted w alkw ays, trails, fencing to protect areas.	Yes	Yes	Yes
8.d. public education about the ecosystem restoration and access points	Yes	Yes	Yes

3.5 FORMULATION AND COMPARISON OF ALTERNATIVE SOLUTION SETS

For this phase of the study process a two-step method was needed to formulate an array of alternatives. The first step was to identify which restoration measures would be appropriate per habitat type present within each study reach (Table 5). The second step was to identify where these would be implemented within each study reach. Appropriate measures per study reach were identified based on each study reaches problems (e.g., stream habitat fragmentation), opportunities (e.g., stream connectivity) and limitations (e.g., extant of built environment). Please see Figure 23 for location of alternatives per study reach. Alternatives have been categorized based on their targeted habitat type (e.g., tributaries/streams, floodplain forest, etc.). Some study constraints are also noted in the description, such as limiting CSOs, which helps to account for potential limits of restoration features. Also, when threatened and endangered species are listed, this points out alternatives that have direct connection to main stem fish habitat that support fish host species that in turn support the reproductive cycle of mussel species of concern.

3.6 Alternative Plan Descriptions

Alternative 1. Ft. Thomas - Stream Restoration:

1. Stream Connectivity – barrier modification (e.g., replace culvert), rock ramps

2. In-stream Habitat – meander induction, grade control structures and channel substrate (riffles, cross-veins, j-hooks, wing-dikes, boulder clusters, cobble bars), woody debris, limiting CSOs

3. Geomorphic contouring – remeandering, bank grading, compaction relief

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

Alternative 2. Ft. Thomas – Main Stem Fish Habitat:

2. In-stream Habitat – channel substrate (cross-veins, j-hooks, wing-dikes, boulder clusters, cobble bars), woody debris

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels

Alternative 3. Dayton – Shoreline Restoration:

2. In-stream Habitat – woody debris along toe of bank, limiting CSOs

3. Geomorphic contouring – bank grading, floodplain terracing (e.g., hard – limestone stability or soft- bioengineered stability), compaction relief

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

<u>Alternative 4* (a and b). Bellevue – Shoreline Restoration:</u>

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

3. Geomorphic contouring – bank grading, floodplain terracing (e.g., hard – limestone stability or soft- bioengineered stability), compaction relief

*Floodplain terracing and stability will be evaluated with 2 options:

Option a. Abundant native plantings, combined with temporary erosion control will be used to stabilize regraded, terraced shoreline

Option b. Limestone slabs will be placed in a stacked or stair step fashion to stabilize regraded, terraced shoreline area, native plantings will be installed in small localized areas.

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

<u>Alternative 5. Newport – Shoreline Restoration</u>

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

3. Geomorphic contouring – bank grading, floodplain terracing (e.g., hard – limestone stability or soft- bioengineered stability), compaction relief

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

Alternative 6. Newport – Floodplain Forest:

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

Alternative 7. Covington – Shoreline Restoration:

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

3. Geomorphic contouring – bank grading, floodplain terracing (e.g., hard – limestone stability or soft- bioengineered stability), compaction relief

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

Alternative 8. Covington – Floodplain Forest:

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

Alternative 9. Covington – Main Stem Fish Habitat:

2. In-stream Habitat –channel substrate (cross-veins, j-hooks, wing-dikes, boulder clusters, cobble bars), woody debris

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels

Alternative 10. Ludlow – Shoreline Restoration:

2. In-stream Habitat –woody debris along toe of bank, limiting CSOs

3. Geomorphic contouring – bank grading, floodplain terracing (e.g., hard – limestone stability or soft- bioengineered stability), compaction relief

4. Soil Amendment – organic carbon, pine saw dust, sand, native top soils

5. Invasive Species Removal – physical removal, clear and grubbing, selective tree removal, chemical treatment

6. Native Plantings – seeding, live plugs, shrub/trees, contract grow, nursery purchased

7. Native, Threatened and Endangered Species – fish hosts of endangered mussels, migratory birds

8. Compatible Access to River – multipurpose trails, board walks, paved trails, fences

Alternative 11* (a and b). Maximize Shoreline Habitat Connectivity:

-Restore shoreline sections in Dayton, Bellevue, Newport, Covington and Ludlow. * Options a and b will be evaluated.

*Floodplain terracing and stability will be evaluated with 2 options:

Option a. Abundant native plantings, combined with temporary erosion control will be used to stabilize regraded, terraced shoreline

Option b. Limestone slabs will be placed in a stacked or stair step fashion to stabilize regraded, terraced shoreline area, native plantings will be installed in small localized areas.

<u>Alternative 12: Maximize Floodplain Forest Habitat Connectivity:</u>

-Restore floodplain forest sections in Newport and Covington

<u>Alternative 13. Maximize Main Stem Fish Habitat:</u>

-Restore fish habitat in sections of Ft. Thomas and Covington

<u>Alternative 14* (a and b): Maximize Habitat Connectivity:</u>

-Restore all habitat types in all sections

*Floodplain terracing and stability will be evaluated with 2 options:

Option a. Abundant native plantings, combined with temporary erosion control will be used to stabilize regraded, terraced shoreline

Option b. Limestone slabs will be placed in a stacked or stair step fashion to stabilize regraded, terraced shoreline area, native plantings will be installed in small localized areas.

Table 5. Array of Alternatives

Alt. No.	Study Reaches	Main Stem Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
		Alternative Arrays			
1	**Ft. Thomas - Stream Restoration**		Stream Connectivity, In-stream Habitat, Geomorphic Contouring, Native Threatened Endangered Species		
2	**Ft. Thomas - Main Stem Fish Habitat**	In-stream Habitat (woody debris, riffles, cobble bars, etc.), Geomorphic Contouring, Native Threatened Endangered Species			
3	**Dayton - Shoreline Restoration**			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	
4*	**Bellevue - Shoreline Restoration**			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	

*Options a and b

		Alternative Arrays			
Alt. No.	Study Reaches	Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
5	**Newport - Shoreline Restoration**			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	
6	**Newport - Floodplain Forest**				In-stream Habitat (woody debris), Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River
7	**Covington - Shoreline Restoration**			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	

		Alternative Arrays			
Alt. No.	Study Reaches	Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
8	**Covington - Floodplain Forest**				In-stream Habitat (woody debris), Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River
9	**Covington - Main Stem Fish Habitat**	In-stream Habitat (woody debris, riffles, cobble bars, etc.), Geomorphic Contouring, Native Threatened Endangered Species			
10	**Ludlow - Shoreline Restoration**			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	

		Alternative Arrays			
Alt. No.	Study Reaches	Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
11*	Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow			In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	
12	Maximize Floodplain Forest Habitat Connectivity - Restore floodplain forest in Newport and Covington				In-stream Habitat (woody debris), Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River
13	Maximize Main Stem Fish Habitat Connectivity - All Study Reaches	In-stream Habitat (woody debris, riffles, cobble bars, etc.), Geomorphic Contouring, Native Threatened Endangered Species			

*Options a and b

		Alternative Arrays			
Alt. No.	Study Reaches	Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
14*	Maximize Habitat Connectivity - All Study Reaches	In-stream Habitat (woody debris, riffles, cobble bars, etc.), Geomorphic Contouring, Native Threatened Endangered Species	Stream Connectivity, In-stream Habitat, Geomorphic Contouring, Native Threatened Endangered Species	In-stream Habitat (woody debris), Geomorphic Contouring, Soil Amendment, Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River	In-stream Habitat (woody debris), Invasive Species Removal, Native Plantings, Native Threatened Endangered Species, Compatible Access to River

*Options a and b

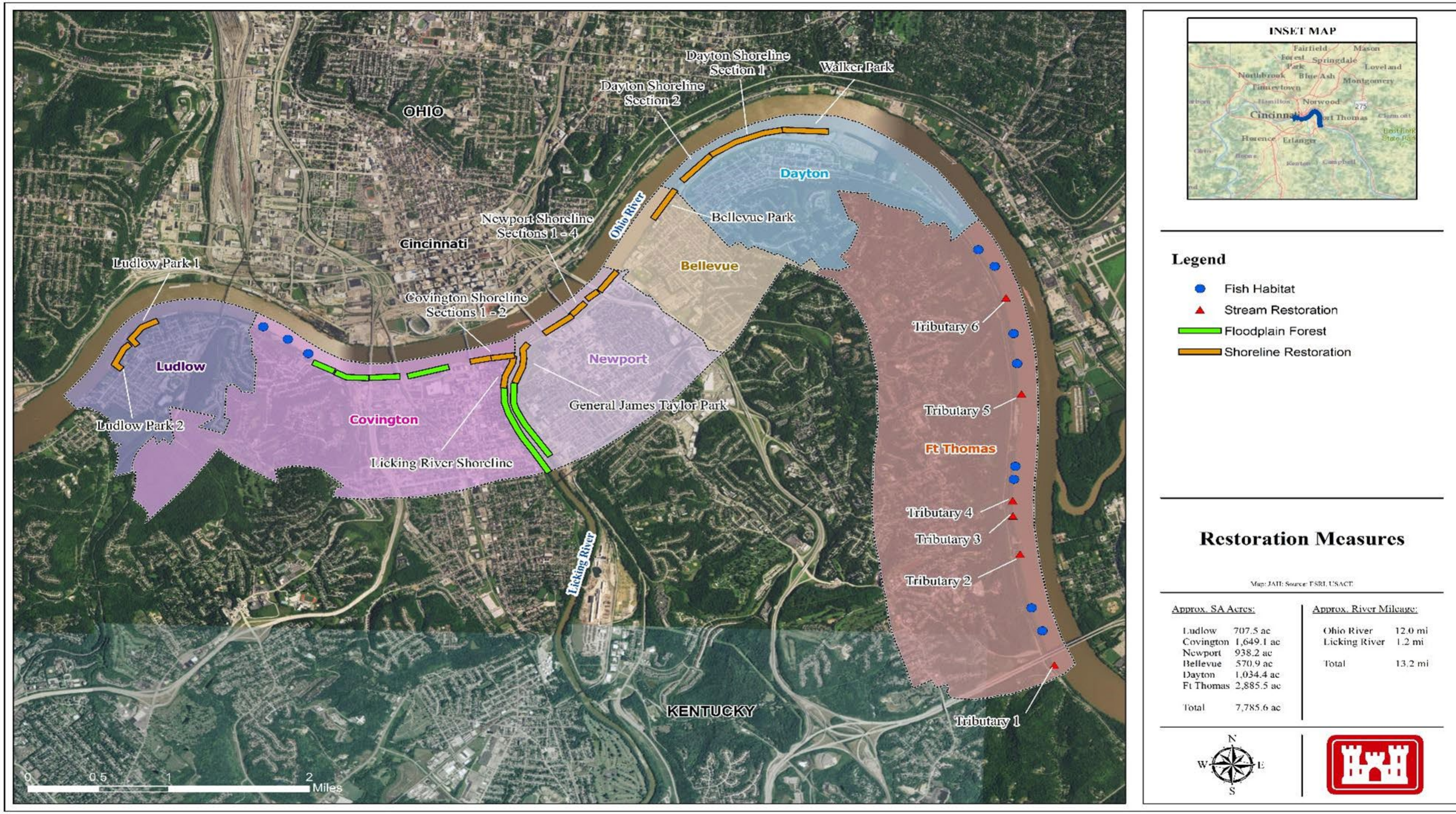


Figure 23. Location of Restoration Alternatives

Figure 24. Location of Restoration Alternatives in Ft. Thomas

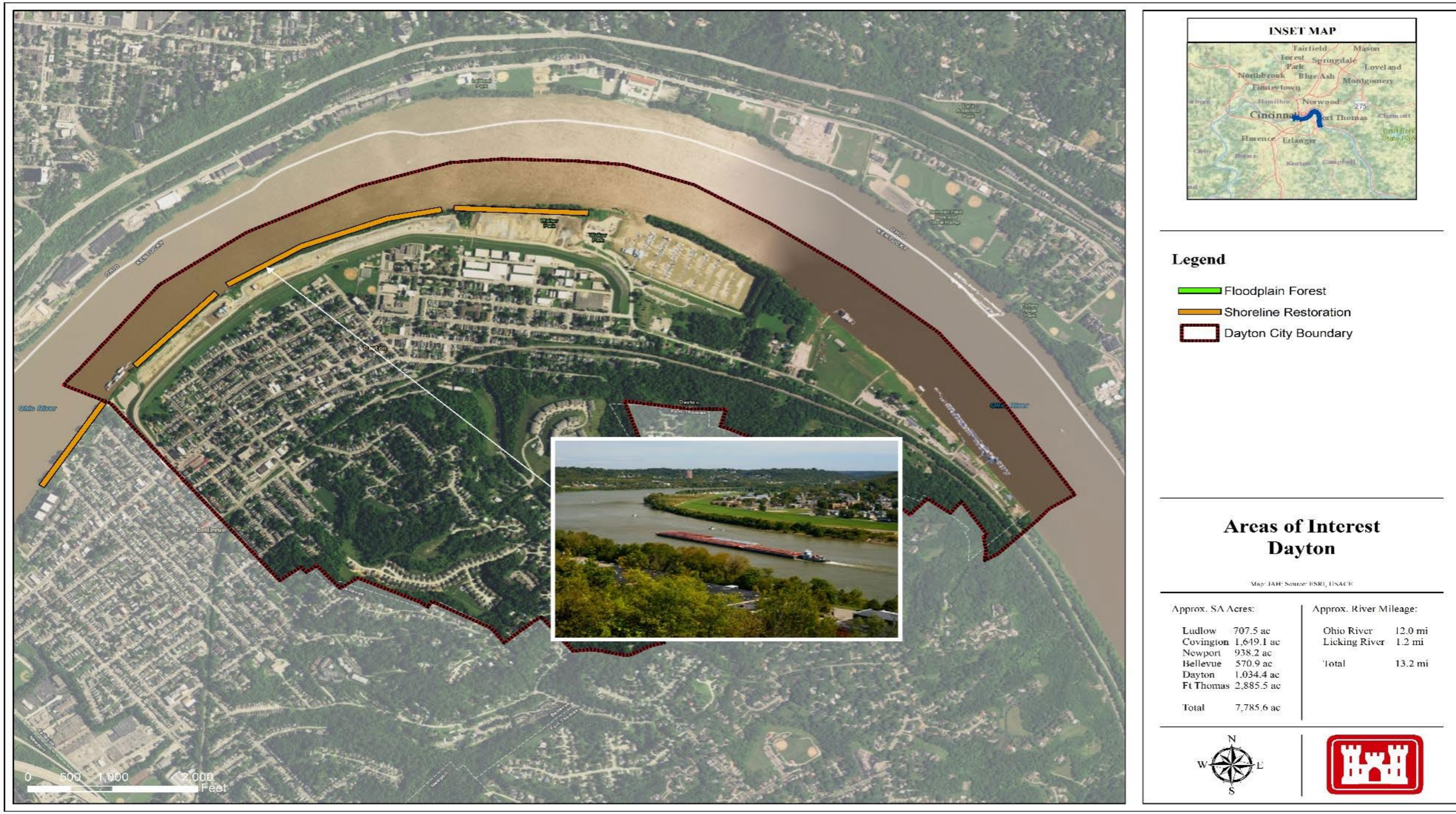


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Figure 25. Location of Restoration Alternatives in Dayton

Figure 26. Location of Restoration Alternatives in Bellevue

Figure 27. Location of Restoration Alternatives in Newport

Figure 28. Location of Restoration Alternatives in Covington

Figure 29. Location of Restoration Alternatives in Ludlow

3.7 Evaluation of Alternative Plans

Evaluation of the alternative arrays was conducted using a number of metrics. Each metric was then rated Low (L), Medium (M) or High (H) based on what level the alternative met the metric description. The following metrics, and their corresponding definition from EP 1165-2-502, were used in the evaluation:

Effectiveness – The extent to which an alternative plan alleviates the specified problems and realizes specified opportunities. This metric was broken into four (4) sub parts that assessed how much each alternative was going to achieve portions of the study objectives. The four parts are: 1. Biodiversity, 2. Scarcity, 3. Threatened and Endangered Species (T & E) and 4. Connectivity. Low – no expected increase, Medium – some expected increase, High – significant increase.

Efficiency – The extent to which a plan should represent a cost-effective means of addressing the problem or opportunity. This metric assessed how much effort would be involved with subsequent operations and maintenance of each alternative once complete. Low – low effort per year, Medium – more than a low effort per year, High – significant effort per year.

Acceptable – This is the workability and viability of the plan with respect to acceptance by Federal, state, tribal and local entities. Public acceptance and compatibility with laws, regulations and policies are part of acceptability. This metric assessed how well received each alternative would be to study partners, including navigation (e.g., barges), flood risk management, economic development (e.g., view of river) and recreation opportunities (e.g., Southbank Partners). Low –non-support, Medium – no overt support, but no opposition, High – high level of support.

Completeness – The extent to which a plan provides and account for all necessary investment or other action needed to ensure realization of the projected environmental outputs. This metric assessed how well each alternative met the overall objectives, including the four subparts above with additional targeted habitat types, such as streams, main stem fish habitat, shoreline and floodplain forest. Low – few objectives met, Medium – most but not all objectives met, High – all objectives met.

Ranking – is based on the number of Highs (H), Mediums (M) and Lows (L). The cut off for remaining for further consideration is at least 4 Highs. Anything ranked with less than 4 Highs is removed from further consideration. See table 6 for evaluation of alternative arrays.

Based on the results of the rankings, 3 alternatives were removed from further consideration (Table 6). Alternatives 7, 9 and 10 were removed. Table 7 is the final array of alternatives considered in the next planning step

Table 6. Evaluation of Alternative Arrays

Alt No.	Study Reaches	Effectiveness				Efficiency	Acceptable	Completeness	Ranking
		Biodiversity	Scarcity	T & E sp.	Connectivity				
1	**Ft. Thomas - Stream Restoration**	H	H	M	H	H	H	M	5-H/2-M
2	**Ft. Thomas - Main Stem Fish Habitat**	M	H	H	H	H	M	M	4-H/3-M
3	**Dayton - Shoreline Restoration**	H	H	H	M	M	H	M	4-H/3-M
4*	**Bellevue - Shoreline Restoration**	H	H	H	M	M	H	M	4-H/3-M
5	**Newport - Shoreline Restoration**	H	H	H	H	H	M	M	5-H/2-M
6	**Newport Floodplain Forest**	H	H	H	M	M	H	M	4-H/3-M
7	**Covington - Shoreline Restoration**	H	H	H	M	M	M	M	3-H/4-M
8	**Covington - Floodplain Forest**	H	H	H	H	H	H	M	6-H/1-M
9	**Covington - Main Stem Fish Habitat**	M	H	H	M	H	M	M	3-H/4-M
10	**Ludlow - Shoreline Restoration**	H	H	H	M	M	M	M	3-H/4-M
11*	**Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow**	H	H	H	H	M	M	M	4-H/3-M

Alt No.	Study Reaches	Effectiveness				Efficiency	Acceptable	Completeness	Ranking
		Biodiversity	Scarcity	T & E sp.	Connectivity				
12	**Maximize Floodplain Forest Habitat Connectivity - Restore floodplain forest in Newport and Covington**	H	H	H	H	H	H	M	6-H/1-M
13	**Maximize Main Stem Fish Habitat Connectivity - All Study Reaches**	M	H	H	H	H	M	M	4-H/3-M
14*	**Maximize Habitat Connectivity - All Study Reaches**	H	H	H	H	M	M	H	5-H/2-M

*Includes 2 (a and b) options.

Table 7. Final Array of Alternatives

Alt. No.	Alternative	Fish Habitat	Stream Restoration	Shoreline (Riparian) Restoration	Floodplain Forest
1	Ft. Thomas - Stream Restoration		X		
2	Ft. Thomas - Main Stem Fish Habitat	X			
3	Dayton - Shoreline Restoration			X	
4*	Bellevue - Shoreline Restoration			X	
5	Newport - Shoreline Restoration			X	
6	Newport - Floodplain Forest				X
8	Covington - Floodplain Forest				X
11*	Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow			X	
12	Maximize Floodplain Forest Habitat Connectivity - Restore floodplain forest in Newport and Covington				X
13	Maximize Main Stem Fish Habitat Connectivity - All Study Reaches	X			
14*	Maximize Habitat Connectivity - All Study Reaches	X	X	X	X

*Will be compared with 2 (a and b) options.

3.8 Comparison of Alternative Plans

This section will present the results of the comparison of the benefits and costs of each alternative. Benefits were projected by habitat type, based on the type of restoration proposed for each alternative and listed in Table 7 – Final Array of Alternatives, through their associated environmental habitat models (described in section 3.4.3 Proposed Ecosystem Assessment Methodology).

3.8.1 Environmental Habitat Modeling Results

The period of analysis was 50 years into the future for all future projections. Base year was 2020, when construction is projected to start (base year determined with [1]ER-1150-2-100).

Stream (Tributary) Habitat Restoration:

The stream (also referred to as tributaries) restoration habitat modeling consisted of using the Qualitative Habitat Evaluation Index (QHEI). As described in section 3.4.3, the QHEI is an approved planning model that is commonly used to assess wadable stream conditions within the Midwest region of North America. The QHEI uses a variety of metrics that span from substrate to coverage of macrophytes (e.g., aquatic plants) to quantify the degree of disturbance to a section of stream. Model outputs range from 0 to 100. Scores were converted to 0 to 1 in order to be comparable with the outputs from the other models. Converted scores are called Habitat Suitability Index (HSI). Baseline conditions were evaluated in the field for all of the streams present within the study area. For further information on how each variable was evaluated refer to section 3.4.3 and model documentation (Ohio EPA 2006). Streams were limited to the Ft Thomas area. Streams #2-5 were lumped together because of their similarity in size and condition. Future Without Project (FWOP) conditions was assumed to be the same as baseline based on the knowledge that most of the degradation has already occurred in these streams. Some further minor degradation is expected to occur in some features of the streams, but insignificant compared to prior disturbance. Future With Project (FWP) conditions is projected to occur as a result of restoration actions (described in section 3.6). Tables 8a-c are the outputs for stream restoration. Changes to model outputs over time are assumed to capture ecosystem changes as a result of restoration actions that reestablish suitable substrate and geomorphology.

[1]ER-1150-2-100 (Page 2-11).The period of analysis shall be the time required for implementation plus the lesser of: (1) the period of time over which any alternative plan would have significant beneficial or adverse effects, (2) a period not to exceed 50-years except for major multiple purpose reservoir projects, or, (3) a period not to exceed 100 years for major multiple purpose reservoir projects.

Table 8a. Stream (Tributary) Restoration Model

Tributary #1	2017						
QHEI	**Habitat Variables**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
	Substrate	18.00	0.18	18.00	0.18	20.00	0.20
	Cover	6.00	0.06	4.00	0.04	18.00	0.18
	Channel	5.00	0.05	5.00	0.05	13.50	0.14
	Riparian	4.50	0.05	4.50	0.05	7.00	0.07
	Pool/Current	5.00	0.05	5.00	0.05	7.00	0.07
	Riffle/Run	3.00	0.03	3.00	0.03	5.00	0.05
	Gradient	6.00	0.06	6.00	0.06	6.00	0.06
	Score/Suitability	**47.50**	**0.48**	**45.50**	**0.46**	**76.50**	**0.77**

Table 8b.

Tributaries #2-5	2017						
QHEI	**Habitat Variables**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
	Substrate	15.50	0.16	15.50	0.16	19.50	0.20
	Cover	4.00	0.04	4.00	0.04	11.00	0.11
	Channel	5.00	0.05	5.00	0.05	8.50	0.09
	Riparian	4.50	0.05	4.50	0.05	5.50	0.06
	Pool/Current	5.00	0.05	5.00	0.05	5.00	0.05
	Riffle/Run	2.00	0.02	2.00	0.02	3.50	0.04
	Gradient	6.00	0.06	6.00	0.06	6.00	0.06
	Score/Suitability	**42.00**	**0.42**	**42.00**	**0.42**	**59.00**	**0.59**

Table 8c.

Tributary #6	2017						
QHEI	**Habitat Variables**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
	Substrate	20.00	0.20	18.00	0.18	20.00	0.20
	Cover	4.00	0.04	4.00	0.04	15.00	0.15
	Channel	9.00	0.09	9.00	0.09	12.50	0.13
	Riparian	4.00	0.04	4.00	0.04	5.00	0.05
	Pool/Current	7.00	0.07	7.00	0.07	9.00	0.09
	Riffle/Run	3.00	0.03	3.00	0.03	4.50	0.05
	Gradient	8.00	0.08	8.00	0.08	8.00	0.08
	Score/Suitability	**55.00**	**0.55**	**53.00**	**0.53**	**74.00**	**0.74**

Shoreline Habitat Restoration:

The potential environmental benefits from shoreline restoration was modeled by the Gray Squirrel Habitat Suitability Index (Gray Squirrel), as described in section 3.4.3. The Gray Squirrel assesses the structure and function of riparian vegetation communities and is an approved planning model (USFWS 1983b). Scores range from 0 to 1. Baseline conditions of the shoreline within the study area was assessed in the field with some variables further refined based on reported data from literature sources. FWOP was mostly projected to remain the same with some improvement through passive means (e.g., some individual trees expected to mature through time unassisted). FWP was projected to increase the suitability of the habitat based on the restoration actions described in section 3.6. Change in model outputs over time are assumed to capture ecosystems changes that result from overstory tree species achieving a mature growth stage.

Table 9. Shoreline Restoration Model Output

	Shoreline Habitat	2017					
Habitat Variables	**Gray Squirrel**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
Food	Proportion of total tree canopy that is hard mast producing >= 25 cm dbh	1%	0.11	10%	0.19	50%	0.55
Food	Number of hard mast tree species 1 = hard mast species absent 2 = one species present 3 = two species present 4 = three species present 5 = more than 4 species present	2	0.20	2	0.20	5	1.00
Food	Percent canopy cover of trees for food (%)	15%	0.38	15%	0.38	50%	1.00
Cover/Reprod	Percent canopy cover of trees for cover/reproduction (%)	15%	0.38	15%	0.38	50%	1.00
Cover/Reprod	Mean dbh of overstory trees (inches)	4	0.00	6	0.10	10	0.50
	Habitat Suitability Index		**0.00**		**0.07**		**0.71**

Floodplain Forest Habitat Restoration:

The floodplain forest habitat was also modeled with the Gray Squirrel Habitat Suitability Index. The baseline was assessed in the field as well. FWOP were expected to improve passively, again similar to shoreline habitat. FWP were projected to improve based on the restoration action described in section 3.6. The same as the riparian modeling outputs, change in model outputs over time are assumed to capture ecosystems changes that result from overstory tree species maturing over time.

Table 10. Floodplain Forest Restoration Model Output

	Floodplain Forest Habitat	2017					
Habitat Variables	**Gray Squirrel**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
Food	Proportion of total tree canopy that is hard mast producing >= 25 cm dbh	5.00%	0.15	5.00%	0.15	50.00%	0.55
Food	Number of hard mast tree species 1 = hard mast species absent 2 = one species present 3 = two species present 4 = three species present 5 = more than 4 species present	2	0.20	2	0.20	5	1.00
Food	Percent canopy cover of trees for food (%)	85.00%	0.92	85.00%	0.92	85.00%	0.92
Cover/Reprod	Percent canopy cover of trees for cover/reproduction (%)	85.00%	1.00	85.00%	1.00	85.00%	1.00
Cover/Reprod	Mean dbh of overstory trees (inches)	7	0.20	7	0.20	12	0.70
	Habitat Suitability Index		**0.16**		**0.16**		**0.68**

Main Stem Fish Habitat Restoration:

The main stem fish habitat was modeled with the Smallmouth Bass Habitat Suitability Index (Smallmouth Bass), as described in section 3.4.3. The Smallmouth Bass model assesses the condition of rivers for suitable riverine fish habitat (USFWS 1983a). Scores range from 0 to 1. Baseline conditions were assessed in the field and in coordination with fish biologists familiar with this stretch of the Ohio River (Ohio River Valley Water Sanitation Commission). The FWOP conditions were assumed to remain static because of ongoing navigation activities that maintain hydrologic conditions and no known plans for any further degradation or active restoration plans. The FWP is projected to improve fish habitat as a results of the proposed restoration activities as described in section 3.6. Changes in model outputs over time are assumed to capture ecosystem changes that result from the installation of suitable structures and substrate types. FWP projections to parameters were based on best professional judgement of fisheries biologists, experts of the project area's stretch of Ohio River, however, there is a degree of uncertainty in judgement.

Table 11. Main Stem Fish Habitat Restoration Model Output

	Main Stem Fish Habitat	2017					
Habitat Variables	**Smallmouth Bass**	**Baseline Values**	**Baseline HSI Score**	**FWOP Values**	**FWOP HSI Score**	**FWP Values**	**FWP HSI Score**
Food/Cover/ Reprod	Dominant Substrate Type	A	0.20	A	0.20	C	1.00
Food/Cover	% Pools	90.00%	0.52	90.00%	0.52	80.00%	0.84
Cover	Avg. Depth Pools Midsummer (m)	8	0.90	8	0.90	8	0.90
Food/Cover/ Reprod	% Cover	5.00%	0.20	5.00%	0.20	25.00%	1.00
WQ	Avg. pH	7.4	0.89	7.4	0.89	7.4	0.89
WQ/Reprod	Min. Dissolved Oxygen (ppm)	6.4	1.00	6.4	1.00	6.4	1.00
WQ/Reprod	Max. Monthly Avg. Turbidity during Summer (JTU)	18.4	1.00	18.4	1.00	18.40	1.00
WQ	Water Temp. May-Oct. - Adults (°C)	25.3	1.00	25.3	1.00	25.30	1.00
WQ	Water Temp. Spawning + 45 Days - Embryo (°C)	26.3	0.35	26.3	0.35	24.20	1.00
WQ	Water Temp. May-Oct. - Fry (°C)	27.3	1.00	27.3	1.00	25.30	1.00
WQ	Water Temp. May-Oct. - Juvenile (°C)	27.3	1.00	27.3	1.00	25.27	1.00
Reprod	Water Level Fluctuations	A	0.30	A	0.30	A	0.30
Other	Stream Gradient (m/km)	0.05 m/km	0.07	0.05 m/km	0.07	0.05 m/km	0.07
	Habitat Suitability Index		**0.32**		**0.32**		**0.55**
	Habitat Units						

Habitat units (HU) are unit less measures of environmental benefits that are projected to occur as a result of proposed restoration activities. Habitat Units are calculated by multiplying the model score (HSIndex) by the area (acres) of restoration per habitat type per alternative. Habitat units are then averaged over the period of analysis (50 years) to calculate the Average Annual Habitat Units (AAHU) per alternative. Base year of analysis (2020) is the first year of implementation (ER-1150-2-100, Period of Analysis). AAHUs were calculated using the IWR Planning Suite's Annualization Calculator. FWOP AAHUs was then subtracted from the FWP AAHUs to produce NetAAHUs per alternative. NetAAHUs are the benefit input in the next phase of the planning process called Cost Effective/Incremental Analysis.

Calculation of HUs and AAHU per FWOP and FWP per habitat per alternative is presented in the appendix. Below (Table 12) are the total AAHU per habitat per alternative resulting in the NetAAHUs per alternative.

Table 12. Net Habitat Units

Description	Alts-Acronym	AAFWOPHU	AAFWPHU	NetHUs
1.Ft. Thomas - Stream Restoration	1-Stream	1.08	1.57	0.49
2.Ft. Thomas - Main Stem Fish Habitat	2-Fish	2.43	4.19	1.77
3.Dayton - Shoreline Restoration	3-Shore	0.15	1.54	1.39
4.a*.Bellevue - Shoreline Restoration A	4A-Shore	0.03	0.32	0.29
4.b*.Bellevue - Shoreline Restoration B	4B-Shore	0.03	0.32	0.29
5.Newport - Shoreline Restoration	5-Shore	0.07	0.66	0.59
6.Newport - Floodplain Forest	6-Forest	0.22	0.73	0.52
8.Covington - Floodplain Forest	8-Forest	0.66	2.24	1.58
11.a*.Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow A**	11A-MaxShore	0.47	4.68	4.20
11.b*.Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow B**	11B-MaxShore	0.47	4.68	4.20
12.Maximize Floodplain Forest Habitat Connectivity - Restore floodplain forest in Newport and Covington	12-MaxForest	0.87	2.97	2.10
13.Maximize Main Stem Fish Habitat Connectivity - All Study Reaches	13-MaxFish	6.32	10.91	4.59
14.a*.Maximize Habitat Connectivity - All Study Reaches A	14A-MaxAll	8.75	20.13	11.39
14.b*.Maximize Habitat Connectivity - All Study Reaches B	14B-MaxAll	8.75	20.13	11.39

*A – option A and B – option B. See section 3.6 Alternative Plan Description

**Includes Alt 3 (Dayton), Alt 4.a or b (Bellevue), Alt 5 (Newport), Alt 7(Covington), Alt 10 (Ludlow)

Planning Level Cost Estimation

Construction is projected to take 3 years for each alternative. Construction will include 1 year of actual earthwork or tree clearing and invasive species clearing. Then 2 years of follow up establishment activities to ensure all constructed features are persistent through different climatic events, such as flood events, and invasive species are controlled to a point that regular operations and maintenance will be able to sustainably maintain a low level of coverage. Operations and maintenance will commence once construction is complete. Note that initial alternatives, 7 (Covington Shoreline) and 10 (Ludlow Shoreline), which were eliminated as separate measures per Table 6 (see section 3.7), were rolled into an alternative that focused on maximizing specific habitat type, alternative 11 – Maximize Shoreline Connectivity (MaxShore). Construction for initial alternative 7 (Covington shoreline) was estimated at $690,000 and 10 (Ludlow shoreline) $1,156,000. The range of construction estimates for shoreline sections in alternative 11A-MaxShore was $362,000 - $1,723,000. Initial alternatives 7 and 10 are not considered excessive, or hidden costs of alternative 11, because their estimates were not outside of the range of expected shoreline restoration construction costs.

Table 13. Construction Costs

Alts	Construction
1-Stream	$3,488,997
2-Fish	$4,249,567
3-Shore	$433,066
4A-Shore	$362,067
4B-Shore	$14,996,812
5-Shore	$1,721,909
6-Forest	$404,195
8-Forest*	$1,908,697
11A-MaxShore	$4,363,016
11B-MaxShore	$18,997,761
12-MaxForest	$2,312,892
13-MaxFish*	$9,037,811
14A-MaxAll	$18,513,018
14B-MaxAll	$33,147,763

*Includes 2 options (a and b)

Real estate was based on total acres per alternative. Since main stem fish habitat is located in a submersed zone of the Ohio River, no real estate cost was calculated for that restoration feature. Note that acres calculated for environmental benefits will be slightly different from acres calculated for real estate estimation purposes (e.g., fish habitat).

Table 14. Real Estate Costs

Alts	Acres	Real Estate
1-Stream	3	$9,000
2-Fish	0	$0
3-Shore	6.75	$20,250
4A-Shore	1.25	$3,750
4B-Shore	1.25	$3,750
5-Shore	5	$15,000
6-Forest	1	$3,000
8-Forest	30	$90,000
11A-MaxShore	31.75	$95,250
11B-MaxShore	31.75	$95,250
12-MaxForest	30.75	$92,250
13-MaxFish	0	$0
14A-MaxAll	51.75	$155,250
14B-MaxAll	51.75	$155,250

Monitoring Costs were calculated based on the type of ecosystem features were the focus of the alternative. Alternatives that involved just shoreline features were calculated for 5 years post construction. Restored vegetation typically exhibits a high degree of variation in the first 3-5 years during restoration and then shows more stability after 5 years. Alternatives that involved fish habitat either along the main stem of the Ohio River or tributaries were calculated for 7 years of monitoring activities post construction. Fish response to restoration may exhibit a high degree of variation in the first year or 2 of restoration, but contrary to vegetation, fish may still exhibit greater variation for many years post construction. In order to detect accurate long-term trends of fish response to restoration activities, fish restoration projects should be monitored for longer periods.

Table 15. Monitoring Costs

Alts	Year1	Year2	Year3	Year4	Year5	Year6	Year7	Total
1-Stream	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$70,000
2-Fish	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000	$70,000
3-Shore	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
4A-Shore	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
4B-Shore	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
5-Shore	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
6-Forest	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
8-Forest	$5,000	$5,000	$5,000	$5,000	$5,000			$25,000
11A-MaxShore	$15,000	$15,000	$15,000	$15,000	$15,000			$75,000
11B-MaxShore	$15,000	$15,000	$15,000	$15,000	$15,000			$75,000
12-MaxForest	$10,000	$10,000	$10,000	$10,000	$10,000			$50,000
13-MaxFish	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$175,000
14A-MaxAll	$50,000	$50,000	$50,000	$50,000	$50,000	$25,000	$25,000	$300,000
14B-MaxAll	$50,000	$50,000	$50,000	$50,000	$50,000	$25,000	$25,000	$300,000

Operation and maintenance costs were calculated as a percentage of total construction costs. Ranging from 1 to 15% based on the type of features that are expected to be maintained for 50 years post construction by the Local Sponsor. Alternatives that were calculated with 10-15% were assumed to have potentially have larger efforts periodically over time.

Table 16. Operation and Maintenance Costs

Alts	Construction	O & M	Assumptions
1-Stream	$3,488,997	$34,890	Yearly inspection, some sections of habitat may need replacing 1x per 10 years
2-Fish	$4,249,567	$42,496	Yearly inspection, some sections of habitat may need replacing 1x per 10 years
3-Shore	$433,066	$6,496	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
4A-Shore	$362,067	$5,431	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
4B-Shore	$14,996,812	$74,984	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
5-Shore	$1,721,909	$17,219	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
6-Forest	$404,195	$4,042	Yearly inspections, yearly control of invasive species
8-Forest	$1,908,697	$19,087	Yearly inspections, yearly control of invasive species
11A-MaxShore	$4,363,016	$43,630	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
11B-MaxShore	$18,997,761	$94,989	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species
12-MaxForest	$2,312,892	$23,129	Yearly inspections, yearly control of invasive species
13-MaxFish	$9,037,811	$90,378	Yearly inspection, some sections of habitat may need replacing 1x per 10 years
14A-MaxAll	$18,513,018	$92,565	Yearly inspection, some sections of habitat may need replacing 1x per 10 years or rehabilitation 1x per 5 years, yearly control of invasive species
14B-MaxAll	$33,147,763	$165,739	Yearly inspection, some sections of habitat may need replacing 1x per 10 years or rehabilitation 1x per 5 years, yearly control of invasive species

The remaining costs of Engineering and Design (PED) and Construction Management (S&A) were calculated as a percentage of the total construction cost and added to the total project cost. The Interest during construction (IDC) was calculated with the cost annualizer in the IWR-Planning Suite Decision Support Software (IWR Planning Suite) for each alternative. The federal FY18 discount rate of 2.750% was used.

The IWR Planning Suite was developed by the Institute for Water Resources and certified for USACE planning use. Briefly, "IWR Planning Suite assists with plan formulation by combining user-defined solutions to planning problems and calculating the effects of each combination, or "plan." The program can assist with plan comparison by conducting cost effectiveness and incremental cost analyses, identifying the plans which are best financial investments and displaying the effects of each on a range of decision variables." More information about the IWR Planning Suite can be accessed on http://crbweb01.cdm.com/IWRPlan/default.htm.

Total project costs including: Initial costs (construction, real estate, monitoring, O and M (Operations and Maintenance)), PED (Engineering and Design) and IDC (Interest During Construction) per alternative were then annualized over the period of analysis with the cost annualizer in the IWR-Planning Suite (Table 17).

Table 17. Average Annual Costs

Alts	Total Cost	AA Cost
1-Stream	$4,943,154	$183,099
2-Fish	$6,020,298	$222,997
3-Shore	$653,423	$24,203
4A-Shore	$534,801	$19,810
4B-Shore	$19,432,760	$719,807
5-Shore	$2,447,072	$90,642
6-Forest	$594,923	$22,037
8-Forest	$2,769,360	$102,580
11A-MaxShore	$6,311,139	$233,770
11B-MaxShore	$24,825,182	$919,548
12-MaxForest	$3,394,736	$125,744
13-MaxFish	$11,957,572	$442,919
14A-MaxAll	$24,533,504	$908,744
14B-MaxAll	$43,284,103	$1,603,283

3.8.2 Introduction to Cost Effectiveness / Incremental Cost Analysis

The USACE's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (1983) direct Federal agencies to formulate alternatives that are economically and environmentally sound. A Cost Effectiveness/Incremental Cost Analysis (CE/ICA) is recommended for evaluating ecosystem restoration projects. For ecosystem restoration planning, CE/ICA analyses are conducted to ensure that the least cost plan is identified for each possible level of ecosystem restoration output; and that for any level of investment, the maximum level of output is identified. The results of such analyses are valuable tools to assist in decision-making. The results of the analyses permit decision-makers to progressively compare alternative levels of ecosystem restoration outputs.

Using a CE/ICA, the costs and non-monetary environmental outputs of alternatives are weighed against each other to identify the national ecosystem restoration plan. The environmental outputs are not expressed in monetary terms because there is currently no acceptable method for measuring many environmental outputs in monetary terms. The National Ecosystem Restoration

(NER) Plan is defined in ER-11105-2-100 as follows:

> *For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan.*

This CE/ICA follows the procedures specified by the USACE's *Ecosystem Restoration in the Civil Works Program* (1995) and the Institute for Water Resources (IWR) Report, *Evaluation of Environmental Investment Procedures Manual* (1995). The CE/ICA tool from the IWR Planning Suite was used for the evaluation. The *Ecosystem Restoration in the Civil Works Program* (1995) describes CE/ICA as follows:

> *A CE analysis is conducted to ensure that the least cost alternatives are identified for various levels of environmental output. After the CE of the alternatives has been established, subsequent ICA is conducted to reveal and evaluate changes in costs for increasing levels of environmental output. Its primary purpose is the explicit comparison of the additional costs and additional outputs associated with alternative plans or plan features.*

3.8.3 Cost Effectiveness

Next step in the planning process includes an analysis of the alternatives that requires all of the alternatives to be compared by assessing their respective benefits (NetAAHUs) and costs (AACosts). Cost Effectiveness is calculated using the IWR Planning Suite. AAHUs and AACosts are input for each alternative, the alternatives are then combined in a factorial design and each combination is called a plan. All plans that generate more benefits for less cost that other plans will be identified as cost effective. Table 18 is the inputs for the IWR Planning Suites.

Table 18. IWR Planning Suite Inputs

Description	Alts	Net AAHUs	AACosts
Ft. Thomas - Stream Restoration	1-Stream	0.49	$183,099
Ft. Thomas - Main Stem Fish Habitat	2-Fish	1.77	$222,997
Dayton - Shoreline Restoration	3-Shore	1.39	$24,203
Bellevue - Shoreline Restoration A	4A-Shore	0.29	$19,810
Bellevue - Shoreline Restoration B	4B-Shore	0.29	$719,807
Newport - Shoreline Restoration	5-Shore	0.59	$90,642
Newport - Floodplain Forest	6-Forest	0.52	$22,037
Covington - Floodplain Forest	8-Forest	1.58	$102,580
Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow A	11A-MaxShore	4.20	$233,770
Maximize Shoreline Connectivity - Restore shoreline in Dayton, Bellevue, Newport, Covington and Ludlow B	11B-MaxShore	4.20	$919,548
Maximize Floodplain Forest Habitat Connectivity - Restore floodplain forest in Newport and Covington	12-MaxForest	2.10	$125,744
Maximize Main Stem Fish Habitat Connectivity - All Study Reaches	13-MaxFish	4.59	$442,919
Maximize Habitat Connectivity - All Study Reaches A	14A-MaxAll	11.39	$908,744
Maximize Habitat Connectivity - All Study Reaches B	14B-MaxAll	11.39	$1,603,283

The plan generation process resulted in 422 plans (Figure 30). Out of the 422 plans, 29, including no action, were found to be cost effective.

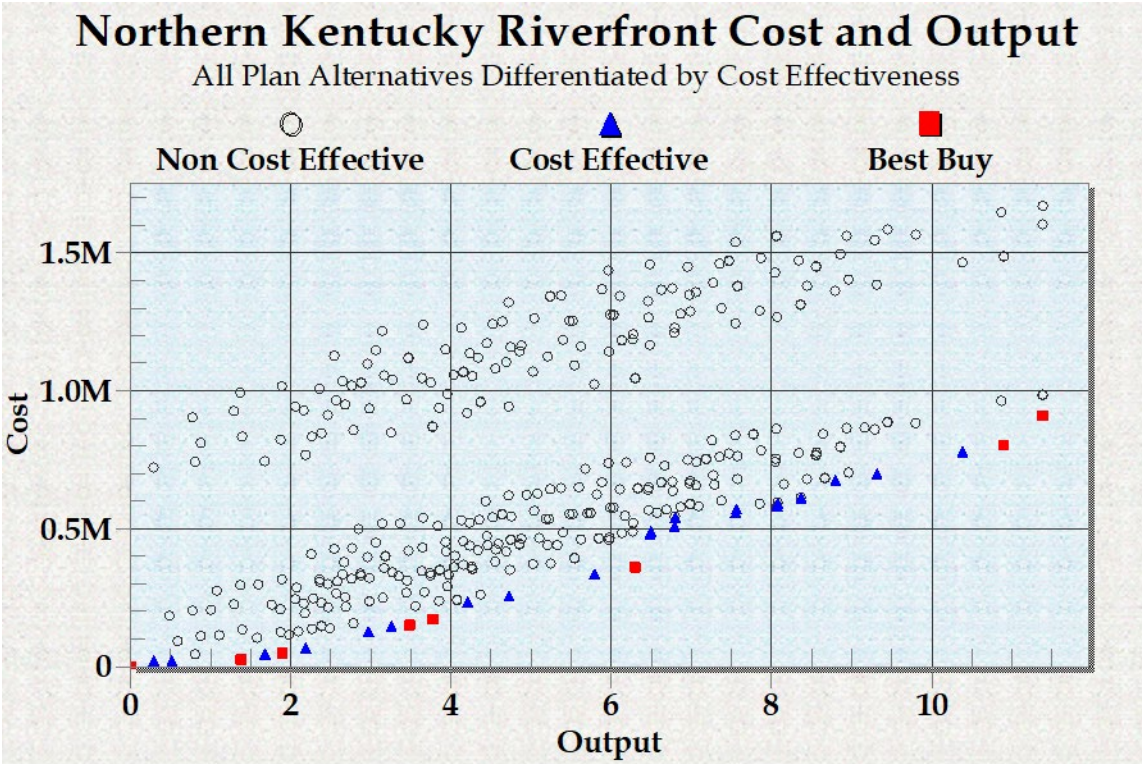

Figure 30. **Array of IWR Generated Plans**

3.8.4 Incremental Cost Analysis

Once cost effective plans have been identified the next step is to conduct an ICA. The ICA will incrementally compare increase in benefits and their associated increase in costs per plan. ICA will identify which plans produce the greatest amount of benefits for the least incremental increase in cost. These plans are called Best Buys. Out of the 29 cost effective plans, 8 were Best Buy plans (Table 19 and Figure 30).

Table 19. Best Buy Plans

Plans	Plan Alternatives	Output (HU)	Cost ($1000)	Avg Cost ($/HU)	Inc. Cost ($)	Incr. Output (HU)	Inc. Cost Per Output
1	No Action Plan	0.00	$0.00				
2	3-Shore (Dayton)	1.39	$24,203	$17,469	$24,203	1.39	$17,469
3	3-Shore and 6-Forest (Newport)	1.90	$46,239	$24,325	$22,036	0.52	$42,756
4	3-Shore and 6-Forest and 8-Forest (Covington)	3.48	$148,819	$42,717	$102,579	1.58	$64,804
5	3-Shore and 6-Forest and 8-Forest and 4A-Shore (Bellevue - Opt.A)	3.77	$168,629	$44,673	$19,809	0.29	$68,097
6	6-Forest and 8-Forest and 11A-MaxShore (All Shorelines)	6.30	$358,386	$56,863	$189,757	2.53	$75,065
7	6-Forest and 8-Forest and 11A-MaxShore and 13-MaxFish (All Main stem Fish)	10.90	$801,305	$73,540	$442,919	4.59	$96,423
8	14A-Max All (All Measures, Opt.A)	11.39	$908,743	$79,810	$107,437	0.49	$219,215

*HU – Average Annual Habitat Units, **Cost – Average Annual Costs

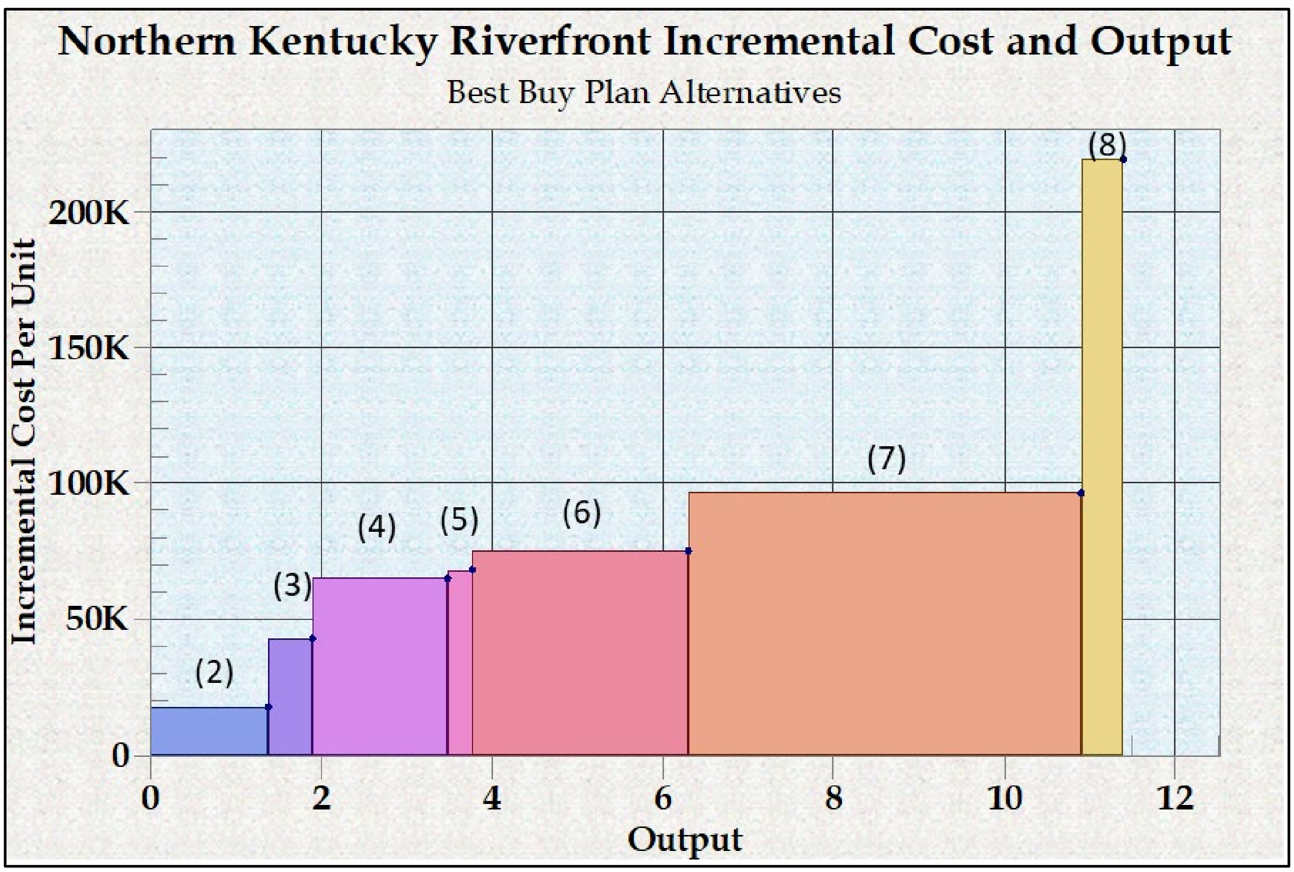

Figure 31. ICA Output - Best Buy Plans

3.8.5 Plan Comparison

Plan 1 is the No Action alternative. Plan 1 will result in no net environmental benefits and would not meet any of the planning objectives.

Plan 2 includes restoration of the shoreline in Dayton (6,300-linear feet) and has a net output of 1.39 HUs. This plan does not address significant issues of habitat fragmentation along various reaches of the study area and only addresses one habitat type. Because this plan does not address connectivity, limitedly addresses habitat quality and biodiversity, this plan is not recommended as the NER.

Plan 3 includes restoration of the shoreline in Dayton and just one floodplain forest reach (Newport) with a net output of 1.9 HUs, a 0.52 increase from Plan 2. Similar to Plan 2, Plan 3 fails to adequately address significant issues of connectivity and only limitedly addresses overall habitat quality and biodiversity throughout the study area. Plan 3 is not recommended as the NER plan.

Plan 4 includes restoration of the shoreline in Dayton and both floodplain forest reaches (Newport and Covington) and had a net output of 3.48, a 1.58 increase from Plan 3. Although Plan 4 adds another reach of floodplain forest, this plan does not address environmental issues in other study reaches. Plan 4 does a better job at addressing connectivity, because it does address all of the floodplain forest sections in the study area, but it fails to adequately address overall habitat quality and biodiversity in other study sections. Plan 4 is not recommended as the NER plan.

Plan 5 includes restoration of the shoreline in Dayton, both floodplain forest reaches (Newport and Covington) and the shoreline of Bellevue (option a) with a net output of 3.77 HUs, an increase of 0.29 from Plan 4. Plan 5 includes both reaches of floodplain forest and some portions of the shoreline, but is still missing significant portions of the study area, particularly those shoreline sections downstream of Bellevue. Plan 5 is not recommended as the NER plan.

Out of the Best Buy plans, plans 6 and 7 are stand outs. They represent the greatest incremental increases in benefits (+2.53 and +4.59 respectively) for relatively low incremental increases in costs relative to the other plans.

Plan 6 includes alternatives 6, 8 and 11A. These alternatives include restoration of Newport Floodplain Forest (Alt 6), Covington Floodplain Forest (Alt 8) and Maximized Shoreline (Alt 11a), which is the restoration of the shorelines of Dayton, Bellevue (option a), Newport, Covington and Ludlow. Plan 6 has a net output of 6.30 HUs, a 2.53 increase from Plan 5. Plan 6 will result in riparian restoration of around 6 miles (31,500 linear feet) of Ohio and Licking Rivers This plan reasonably maximizes the amount of shoreline and floodplain forest restoration in order to meet the planning objectives of restoring habitat connectivity, habitat quality and biodiversity throughout the majority of the study area sections with an average annual cost of $56,900.00 per Habitat Unit. Plan 6 is the recommended NER plan.

Plan 7 includes all those alternatives described in Plan 6 plus alternative 13, which is maximized fish habitat restoration, which includes main stem fish habitat restoration throughout the length of the study area, from Ft. Thomas to Ludlow. Plan 7 has a net output of 10.90, an increase of 4.59.from Plan 6. This plans is essentially plan 6 with the addition of main stem fish habitat restoration. Although this plan does offer additional habitat benefits directly associated with fish species, Plan 7 is also more costly than 6, with an average annual cost of $73,500.00 per Habitat Unit. Additionally, Plan 7 is double the total average annual cost at $801,300.00, compared with Plan 6 at $359,400.00. The additional costs combined with the risk and uncertainty (described below) of Plan 7 make this plan less suitable as the NER plan. Thus, Plan 7 is not recommended as the NER plan.

Plan 8 includes all alternatives, which includes the floodplain forest and shoreline areas, main stem fish habitat and Ft. Thomas tributary restoration. This plan results in a net output of 11.39, an increase of 0.49 from Plan 7. Although this plan represents the full realization of all possible environmental benefits, the increase in costs for the relatively small (0.49) increase in benefits from Plan 7 is not reasonable. Plan 8 is not recommended as the NER plan.

3.8.6 Risk and Uncertainty

A recommended plan will be selected by identifying the plan that reasonably maximizes ecosystem restoration benefits compared to costs to the extent it is practicable to do so. With National Ecosystem Restoration (NER) studies, in order to select a recommended plan, professional judgment must be used to capture what numbers alone cannot. For example, if two plans have similar outputs but one plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it is possible that the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs and using professional judgment to refine the selection process, that plan would have been excluded from further consideration.

Based on risks associated with regulatory hurdles and uncertainty in performance, Plan 7 is more riskyF and uncertain than Plan 6. Plan 7 includes the restoration of main stem fish habitat along the length of the Ohio River within the project area. Restoration measures would include installation of large quantities of stone, cobble, gravel and woody debris. First, there are state and federal regulations that are associated with the fill of our Nation's waterways (e.g., Clean Water Act). Because of the preliminary nature of the restoration measures, intensive coordination between the project partners and regulatory agencies have not yet commenced and it is unclear that the restoration of fish habitat along the main stem of the Ohio River would meet the ER 1150-2-100 policy[2] that states fish and wildlife mitigation should be avoided as the result of ecosystem restoration projects. There is a risk that this type of restoration feature would require mitigation if determined to result in fill of a waterway. Second, there is a degree of uncertainty associated with restoration of fish habitat along the Ohio River. As of today, there are no large-scale fish habitat restoration projects along the main stem of navigable rivers that can be used to demonstrate the efficacy and persistent nature of this proposed restoration feature. Although Plan 7 is projected to produce more benefits of Plan 6, Plan 7 is considered to be more risky and uncertain. With this consideration, Plan 6 is selected as the recommended NER plan.

[2] (page 3-24)(3) Mitigation. Ecosystem restoration projects should be designed to avoid the need for fish and wildlife mitigation.

3.9 RECOMMENDED PLAN

The recommended NER Plan 6 includes restoration of Newport Floodplain Forest (Alt 6), Covington Floodplain Forest (Alt 8) and Maximized Shoreline (Alt 11a), which is the restoration of the shorelines of Dayton, Bellevue (option a – pulled back bank), Newport, Covington and Ludlow. This plan reasonably maximizes all of the potential restoration possible within the study area, minus those that are considered either too expensive (e.g., tributary restoration) or risky and uncertain (main stem fish habitat).

3.9.1 Recommended Plan Description

Plan 6 (Table 20), based on preliminary planning level estimates, has a net AAHUs of 6.30 on 14.46-acres (average of 0.44-AAHUs per acre) with an average annual (AA) cost of $358,400.00 (based on Table 22 – revised AACost = $337,859). It is important to note that there are differences in acres between the preliminary planning estimate and final recommendation. The planning level AA costs and AAHUs were calculated using the same area approximation methodology, ensuring there was appropriate comparison between AA costs and AAHUs. Based on more refined measurements of the recommended plan areas, project benefits were revised with the average AAHUs per acre (0.44-AAHUs X 69.72-acres), for a total of 30.4 AAHUs. Recommended plan costs will include refined construction, monitoring and adaptive management, design and implementation and real estate estimates (Table 21).

Table 20. NER Plan - Plan 6 Description

Alternatives	Description	Features
Alt-6 Newport Floodplain Forest	Restore 2,700 linear feet of floodplain forest along Newport's OH River and Licking River	Remove invasive species with cutting and herbiciding, install native plant species (trees, shrubs, herbaceous)
Alt-8 Covington Floodplain Forest	Restore 9,000 linear feet of floodplain forest along Covington's OH River and Licking River	Remove invasive species with cutting and herbiciding, install native plant species (trees, shrubs, herbaceous)
Alt-11a Maximize Shoreline: Dayton, Bellevue (option a), Newport, Covington, Ludlow	Restore 19,100 linear feet of naturalized shoreline along Dayton, Bellevue, Newport, Covington and Ludlow	Regrade banks to more gentle slope (e.g., Bellevue) in some areas as appropriate, install heavy duty erosion control features where appropriate, remove invasive species with cutting and herbiciding, install native plant species (trees, shrubs, herbaceous)

<u>Description of Restoration Features:</u>

At this stage of the study process, only preliminary engineering and design work has been completed. More in-depth site investigations will be completed in the next stage of the study under engineering and design, which will assist in the location, scale and design of features. For example, the study team is aware that some areas of the shoreline need earth work (e.g., grading) to gentle the slope. Exact locations of these bank regrade areas will be assessed during engineering and design. However, in order to better understand what is being proposed as restoration the following is a discussion of features and how these tie back to overall project goals and objectives. Supplemental NEPA assessment and documentation may be necessary if design results in substantial changes to the project evaluated in this study phase.

Bank Regrading:

Earth will be excavated to lower the elevation and gentle the slope. Regrading could result in a smooth continual slope or with small terraces, depending on the condition of the area of concern. This will be carried out during appropriate climate (fall/winter) and weather (dry) conditions as to minimize possibility of movement of loose sediment during the process. Additionally, temporary sediment control measures will be implemented to further control movement of sediment, such as silt curtain, erosion control blankets, coir logs, etc. Earth will be disposed of in accordance with all federal, state and local laws and ordinances, if not reused on site for other purpose. Long term bank stability will occur through establishment of floodplain/riparian vegetation adapted to frequent flooding events and wave actions. Additionally, woody debris will be placed strategically along the toe of the shore in part to aid in stability. Bank regrading allows for greater hydrologic connectivity of the river with its floodplain, water is able to flow into lower elevations during flood events. Bank regrading is one component of the NER plan that increases quality of shoreline/riparian areas within the study area.

Erosion Control Features:

Erosion control features will be used in the short term (temporary) and as part a long term strategy. Temporary erosion control features will mostly be used in areas of bank regrading, but may be used in areas of excessive bare earth as well, which will be determined in the engineering and design phase. Temporary measures may include erosion control blankets (biodegradable coconut fiber), coir logs, silt curtains, etc. Long term measures may include woody debris to be placed along portions of the shoreline, most likely in areas that are inherently more vulnerable to erosive forces (e.g., wave action). Woody debris will most likely be sourced from areas of the shoreline that will be cleared in the course of bank regrading. Woody debris are typically medium to large trees that have the top half of the tree removed. A perpendicular trench is then dug in the area of installation, the trunk is then laid in trench, then filled in with the root ball extruding outward. Another possible erosion control feature is the use of gravel and cobble strategic placement, particularly in areas of small seeps that may become apparent during the course of construction. Gravel and cobble would be considered more of a longer term erosion control feature, if needed. Erosion control, short and long term, helps to improve the quality of the shoreline/riparian areas of the study by allowing establishment of diverse vegetation and associated ecosystem functions and processes supported by diverse plant communities.

Horner Park Restoration, USACE Section 206 Aquatic Ecosystem Restoration, Chicago, IL.

Horner Park restoration is an example of a shoreline that was graded to a more gentle slope, with a terraced area that has a wood chip trail, used temporary (erosion control blankets) and long term erosion control (woody debris) techniques, along with native vegetation establishment and invasive species control to result in a stable, reconnected, highly diverse riparian habitat. This is an example of the use of these techniques in an area that also experiences high levels of flood frequency, rapid increases and decreases in flood stages and boat wake (see Photo 7).

Woody Debris:

Use of woody debris for erosion control purposes is described above. In addition to erosion control, woody debris, placed at normal water levels, provides important fish habitat along the nearshore zone of a river. Woody debris provides shelter from predators for smaller fish, refuge during periods of high water, and because woody debris blocks sunlight from penetrating, allows water temperatures to stay cooler in areas of low to no current. Low or almost no current may occur within the study area during dry months of the year because of the lock and dam operations. Providing important fish habitat supports the fish hosts of area's mussel species of concern (threatened and endangered species).

Soil Amendments:

In areas with poor soil quality, in so far as to support native riparian vegetation, amendments may be needed. Amendments are additions to substrate that help to increase the suitability of the material to support desirable vegetation. Potential amendments include: organic carbon, pine saw dust, sand, native top soils. Suitable soil will improve establishment of native vegetation and thus improve quality and biodiversity of restoration areas.

Invasive Species Removal:

There are a variety of invasive plant species in the study area including woody (Japanese honeysuckle) and herbaceous (Reed canary grass) species. Techniques to control invasive species will be specific to the type of species needing removal. For example, woody species may be cut low on the stem and the stump treated with herbicide or may be treated around the stem with a basal bark herbicide treatment. The many techniques for invasive control will be reviewed and assessed during the engineering and design phase. Use of herbicides will follow all applicable EPA and manufacturer guidelines on things such as amount of active ingredient per acre, seasonal timing and weather (e.g., wind, rain, etc.) restrictions. Control of invasive species allows for a fully functioning and diverse native plant community, improving the quality of habitat and increasing the biodiversity of the restoration areas.

Native Plantings (Establishment):

Native plant seed and live material (e.g., herbaceous plugs, small shrubs and trees) will be installed in most areas of the NER plan. Specific mixes of species will be compiled during the engineering and design phase for each restoration area. Issues that will be accounted for in the compilation of specific mixes includes: diversity of functional groups (e.g., spring bloomers, milkweed, fruit vs. seed producers), diversity of species pre-adapted to changes in climatic conditions (e.g., heat tolerant, cold tolerant, tolerant of more or less wet conditions) and species known to do well in urban environments (e.g., rain gardens). Establishment of a diverse plant community improves the biodiversity and quality of the study area.

Compatible Access to River:

Continued maintenance and operations of the restored areas requires personnel and machinery to access restored areas in an efficient manner and without potential for accidental harm to restored native plant communities. Additionally, since these are open to the public, the public will endeavor to form their own desire trails if no set trail/path is made available to them. Unplanned desire trails have the potential to harm the newly restored areas by excessive trampling, killing of vegetation and creating areas of potential erosion through removal of vegetation. In order to maintain and allow intentional public access to restoration areas a combination of concrete/wood chip trails will be installed at appropriate locations. The exact nature (e.g., boardwalk, wood chip, with or without fences, etc.) and location of trails will be determined in the engineering and design phase. By reducing the risk of potential harm to restoration areas, the continued quantity, quality and biodiversity of the restoration areas will persist through time. At this time there are no recreational features planned.

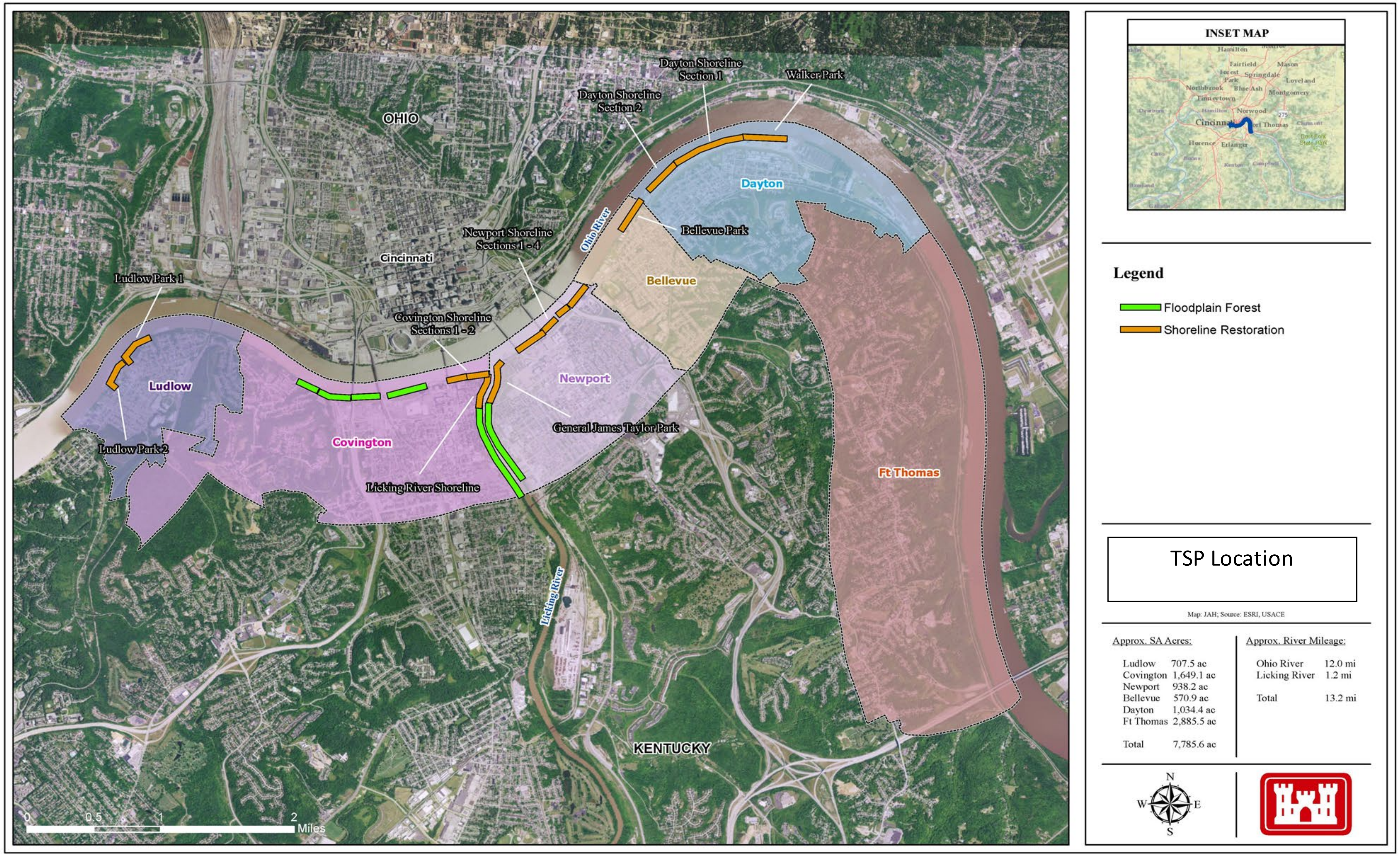

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Figure 32. TSP Location

3.9.2 Large River Restoration

The intent of this section is to provide more context on the probability of success of the proposed restoration project. This section will discuss issues regarding exposed substrate along the toe of the banks in some of the photos presented in the above sections. Then will present restoration projects that have been constructed in other areas along the Ohio River that provide evidence of restoration potential along large highly regulated rivers.

First, it should be noted that sections of exposed substrate located along the toe of the bank in many of the photos (Pg. 77 – Ohio River shoreline at Bellevue, Pg. 78 – Licking River shoreline near Newport/Covington, Pg. 78 - Ohio River shoreline at mouth of Licking River) is a natural occurrence during periods of ordinary low water levels (at their operational limit) that occur seasonally, typically in the summer/fall months of the year. Note that those photos referenced were taken during August/September months. Please refer to the example of a fully functioning floodplain below (A) (also located in section 3.4.1 Ecosystem Restoration Approach), provided by American Rivers. Above the exposed toe of the bank the floodplain (B) contains large swaths of vegetation, typically forested. Remnant floodplain forest is present along Covington (Pg. 34 Photo 5 of floodplain along Ohio River, Pg. 35 Photo 6 along Licking River - this photo taken early spring with higher water levels and vegetation is still in dormancy and Pg. 78 Figure 27). The green areas in the diagram below indicate the presence of floodplain forest.

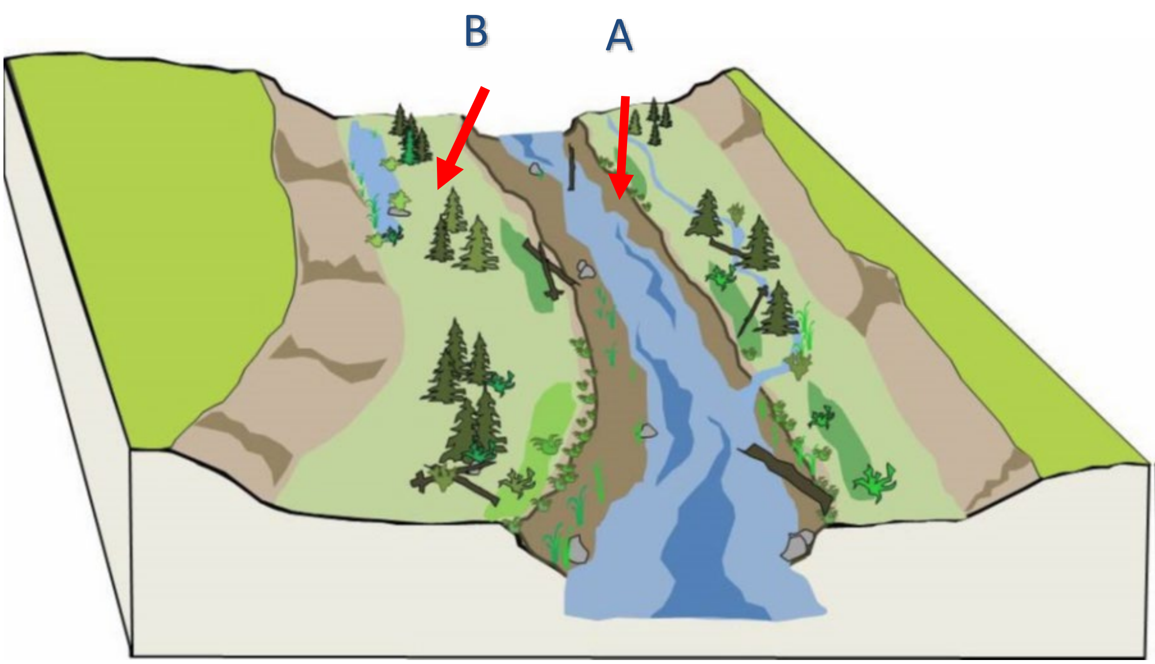

Figure 33. Functioning Large River Floodplain Diagram Provided by American Rivers.

Frank Veraldi, USACE Great Lakes and Ohio River Division Regional Technical Specialist (RTS), knowledgeable of study area, noted that this reach of the Ohio River is not fluviogeomorphically active, it is a regulated pool that has been in place for a long time relative to an unchecked river's movement (e.g., not meandering in and out channels). Subsequently all of the induced erosion from riverine hydraulics no longer occurs to effect bank degradation or point bar deposition. However, the Licking River puts sediment into the pool, and a small delta sand bar exists at the mouth (Figure 27, upper right photo); this point bar would be affected by riverine flows and sediment transport. Aside from this spot, the system in place only has erosion potential from over land flow down the bank face, wave erosion from wind or boating, with degrees of exacerbation by the lack of vegetation on portions of the bank.

Second, it also should be noted that in areas above the toe of the bank that are vegetated or sparsely vegetated are the result of past and on-going problems, as described on Pg. 31 section 2.4.

"Native plant recovery has been hindered by multiple factors. Local native plant species populations have been mostly destroyed or highly degraded from human activities with the remaining populations being small and fragmented. Recruitment (e.g. seed rain) from local native plant species populations is very low, resulting in low likelihood of native volunteers establishing in former habitat. Compounding low recruitment, if established in former habitat, native plant species volunteers are likely outcompeted by aggressive invasive and weedy plant species. Removal of invasive species, establishment of large numbers of native individuals, to provide buffering against disturbance, and other buffering agents like woody debris, will allow for the establishment of a diverse native plant community."

There is risk of plant mortality with longer than normal periods of inundation, however, most native Midwest floodplain forest species need periods of inundation coupled with dry conditions to successfully reproduce and out-compete plant species not adapted to long flood events. With proper native plant selection, species adapted to long periods of inundation followed by draw downs (e.g., black willow, river birch, etc.), and buffering from wave action, native plant restoration is likely to be successful. Although there is a good chance of success, there is always uncertainty, particularly during the early stages of establishment, when many young plant species are more susceptible to large swings in climatic variability (e.g., extreme floods or droughts). Adaptive management provisions will be placed in the construction contract that outline certain actions that will be triggered by adverse events. One mechanism to buy down risk is to require warranties on nursery supplied plant material. This helps to ensure that good quality plant material is used and if mortality is greater than expected, and not as a result of extreme weather events, the contractor/nursery is required to replace at their cost. This is a recognized risk reduction tactic that has been used successfully in many native plant restoration projects.

The Great Lakes and Ohio River Division RTS (Mr. Veraldi) offered the following opinion on the level of detail provided through this study relative to the potential of restoration success:

"The ecosystem restoration measures and features presented in the report are typical of restoration features across the Midwest. Providing detailed drawings aside from acres and quantities of materials during the feasibility phase is unwarranted, especially for planting schemes and large woody debris placement. Restoration measure detail is appropriate for feasibility level costs estimates, habitat outputs, and effects to the environment. Coordination with RTS Frank Veraldi confirmed that various DPRs have been approved and successfully designed and implemented that provided minimal design detail on drawings (usually only acres of planting, grading zones, woody debris locations) and in turn reducing feasibility costs by thousands of dollars. Sufficient feasibility level description of the features can be found in section 3.9.1. Concepts of bank grading, native plant establishment and the use of large woody debris in regulated systems are common place in LRD, coordination confirms sufficient detail for establishing feasibility level costs, outputs and effects."

3.9.2.1 Examples of riparian restoration of large regulated rivers

First, a limited literature search was performed to review published accounts of large river restorations. Results from the Sacramento River Project, suggest that it is feasible to re-establish native trees and shrubs along large, regulated rivers, at least at certain sites for an initial period of several years with appropriate management actions (Alpert et al. 1999). Additionally, Gore and Shields (1995) suggest there is considerable potential for rehabilitation, that is, the partial restoration of riverine habitats and ecosystems along large rivers, like the Ohio River.

Second, successful riparian restoration has occurred along the Louisville Ohio River shoreline, (see Photos 8-10). Louisville is located downstream of the study area and experiences very similar hydrologic regimes (see hydrograph in Figure 16 and 17).

Restoration of native vegetation along the Ohio River at Louisville, as evident in the photos, have resulted in thriving in native plant communities along the riparian zone that is influenced by the high and low pool elevations created upstream of McAlpine Locks and Dam.

Photo 8. Ohio River Shoreline at Louisville, Kentucky

Native black willow and honey locust saplings dominated the understory adjacent to the toe of the bank. Notice that the toe of the bank is not exposed at this time because the photo was taken during October, when the pool elevation was higher than the operational limit or ordinary low water level. Additional native species that were observed along the reach were river birch, sycamore, silver maple, cottonwood, and mulberry.

Photo 9. Riparian restoration along the Ohio River at Louisville, Kentucky

Photo 10. Native sycamore tree shown in right of frame with black willow saplings in understory

3.9.3 Estimated Project Costs and Schedule.

Table 21. Estimated Project Costs

Design and Implementation Costs	Total	
Planning, Engineering, and Design	$	1,306,000
Construction	$	7,251,000
Lands and Damages	$	612,000
Construction Management	$	653,000
Project First Cost*	$	9,822,000

*Note that project first costs include contingency

A detailed layout of the construction schedule and associated funding stream will be developed following the execution of the Project Partnership Agreement (PPA).

Table 22. Cost Share Requirements

Cost Share 75% FED/ 25% non-FED	FED Share	$7,366,500	non-FED Share	$2,455,500
Real Estate Administrative Cost	FED Share	$20,000	non-FED Share	-$20,000
Total Cost Share Requirements	FED Share	$7,386,500	non-FED Share	$2,435,500

Table 23. Implementation Schedule

NKY - P2# 471176			
Task	**Start**	**Finish**	**Duration**
Draft DPR	2-Apr-18	31-May-18	59
Draft DPR - DQC Review	1-Jun-18	15-Jun-18	14
Draft DPR - Legal / Policy Review	4-Jun-18	22-Jun-18	18
ATR	25-Jun-18	2-Nov-18	130
MSC / HQUSACE Review - Draft DPR	28-Jun-18	17-Sep-18	81
GI Study Termination Memo - Draft	15-Dec-18	20-Dec-18	5
GI Study Termination Memo - OC Review	20-Dec-18	14-Jan-18	25
GI Study Termination Memo - Front Office Review	14-Jan-18	28-Jan-18	14
GI Study Termination Memo - COL Gant Signature	28-Jan-18		
GI Study Termination Memo - LRL Transmit to MSC	28-Jan-18		
GI Study Termination Memo - MSC Review / Approval	28-Jan-18	19-Mar-19	50
GI Agreement Termination Complete	19-Mar-19		
CAP SEC 1135 FCSA - Draft / Negotiation	20-Mar-19	27-Mar-19	7
CAP SEC 1135 FCSA - Sponsor Signs	5-Mar-19		
CAP SEC 1135 FCSA - USACE Signs	3-Apr-19		
GI Study Cost Share Record Closeout	22-Aug-19	24-Oct-19	63
Receive federal funds	9-Apr-19		
Draft Final DPR - DQC Review	29-Apr-19	16-Sep-19	140
Draft Final DPR - Legal Review	6-May-19	5-Jun-19	30
Release Draft DPR for Concurrent MSC / Public Review	23-Sep-19		
Public Review	23-Sep-19	23-Oct-19	30
MSC Review	23-Sep-19	23-Oct-19	30
LRL Respond to Comments	24-Oct-19	7-Nov-19	14
MSC Back-Check Comments	8-Nov-19	22-Nov-19	14
Report Update / Draft Final DPR	24-Nov-19	9-Dec-19	14
Abbreviated ATR Draft Final DPR	10-Dec-20	6-Jan-20	27
Finalize Report	7-Jan-20	20-Jan-20	14
Submit Final DPR for MSC Approval	24-Jan-20		
MSC Approval of Final DPR	3-Feb-20		
PPA - Draft / Negotiation	4-Feb-20	4-Mar-20	30
PPA - Sponsor Signs	Apr-20		
PPA - USACE Signs	Apr-20		
Plans and Specifications - Start	May-20		
Real Estate Certification	Jun-20		
ATR Certified Construction Plans and Specifications	Aug-20		
Construction Contract Award	Nov-20		
Implementation Complete	Winter 2023		

4 ENVIRONMENTAL EFFECTS OF ALTERNATIVES

Coordination with all appropriate resource agencies is ongoing and their comments and/or concurrence of the EA will be included in the final NEPA document. Any significant changes to plan during design and construction phase may require additional analysis and a supplemental Environmental Assessment. If a supplemental assessment is needed, results will be provided to all appropriate agencies and study partners for their review and comment

4.1 CLIMATE

Climate vulnerability assessments are necessary to help guide adaptation planning and implementation so that USACE can successfully perform its missions in an increasingly dynamic physical, socioeconomic, and political environment. The VA Tool was used to examine the vulnerability of the Middle Ohio (HUC 0509) and the Kentucky-Licking (HUC 0510) river basins to fulfill their primary mission objectives given a changing climate; the mission business line considered for this analysis was ecosystem restoration.

The VA tool did not identify this business line as within the top 20% of vulnerable watersheds. While these basins were not identified as within the top 20% of vulnerable watersheds, that does not to imply that vulnerability to climate change does not exist within the watersheds. Of the vulnerability indicators examined by the VA tool, there was one that reliably drives the vulnerability of the ecosystem restoration business line-percentage of freshwater plant communities at risk (8). This was the dominant indicator for both basins for two climate scenarios (wet and dry) over two epochs (2050 and 2085). The next two dominant indicators for both basins were high elasticity between increasing precipitation and streamflow (277) and monthly coefficient of variation of runoff (221C). Factsheets that detail how each of these indicators are calculated are located in the Environmental Appendix.

The VA Tool was utilized to identify potential vulnerabilities in the Middle Ohio and Kentucky-Licking basins at the HUC-4 watershed level. Figure 34 shows dominant indicators of vulnerability for each basin as identified by the tool for two climate scenario (wet and dry) over two epochs (2050 and 2085). As indicated by the results, the percentage of freshwater plant communities at risk was the highest contributor to vulnerability for both basins. This indicator measures the percentage of wetland and riparian plant communities that are at risk of extinction based on remaining number and condition, remaining acreage, threat severity, etc.

All HUC-4 watersheds within the United States were assigned values for this indicator that ranged from 11.9 (not vulnerable) to 72.17 (most vulnerable). The VA Tool indicated the Middle Ohio and Kentucky-Licking watersheds had values of 50.49 and 43.48, respectively.

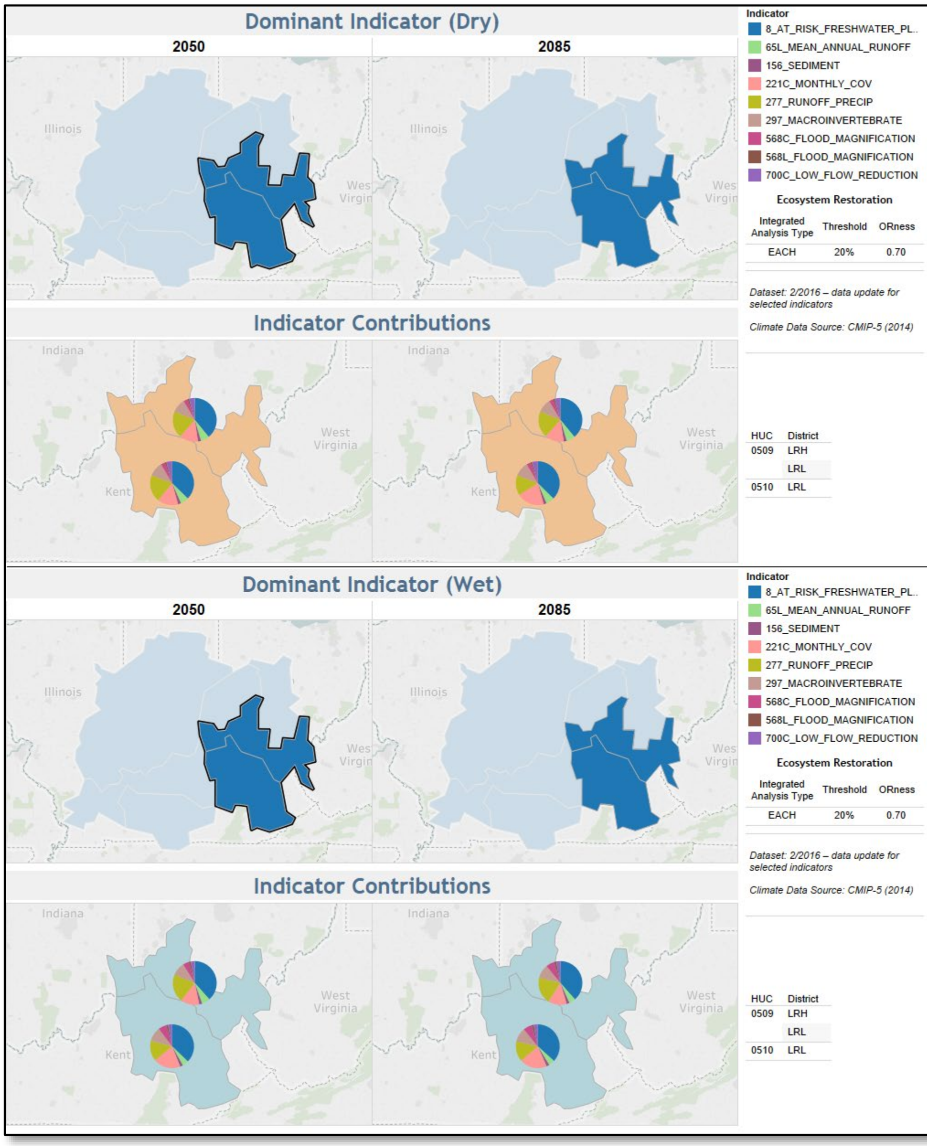

Figure 34. USACE Vulnerability Assessment Tool Results for the Middle Ohio HUC-4 watershed.

There is a majority consensus among scientific literature that air temperature is expected to increase in the future within the Southeast, to include the project area. Increases in air temperature over time can result in increases in water temperature, which may facilitate detrimental impacts to the watershed such as increases algal blooms and decreased dissolved oxygen. Algal blooms can produce toxins that can sicken or kill people and animals, and create dead zones in water bodies. They can also raise treatment costs for drinking water and become troublesome to industry that rely on clean water. Increased water temperatures may also affect fish spawning timing and/or success.

The projected trend among the literature for precipitation extremes, e.g. flooding and drought events, is variable and does not exhibit a consensus opinion. Any plan to restore ecosystem functions and processes should be designed to the extent possible, to be resilient to changes in hydrology and or temperatures.

The climate change assessment did not reveal significant barriers to restoring ecosystem structure, function and processes, which has been lost within the study area along the Ohio and Licking rivers. As indicated by the vulnerability assessment, at risk plant communities were the most significant indicator of climate change vulnerability in the surrounding watersheds. Restoration of the riparian plant communities along the rivers would act to improve resiliency of the watersheds against future changes in climate and restore important ecosystem processes. Further details of project design of the recommended plan in regards to resiliency to flooding and/or drought conditions will be addressed in the Design Phase of this study.

Recommended Plan

The vulnerability assessment for these two watersheds indicated that loss of native riparian and wetland plant communities is a major contributor to the vulnerability of the basins to future changes in climate. Implementation of the proposed project would directly increase native riparian plant abundance, diversity, and quality through reforestation of riparian zones, and streambank stabilization. Streambank stabilization would act to minimize soil erosion caused by potential increases in future precipitation and runoff into the Licking and Ohio rivers.

No Action Alternative

The benefits of improved quality of plant communities and reduction of erosion and storm water runoff would not be realized with the No Action Alternative. Degradation of the riparian corridor from invasive plants and eroded streambank would be expected to continue without intervention.

4.2 SOILS

Recommended Plan

Recommended shoreline (riparian) restoration activities would include removal of invasive plant species via cutting and applying herbicides and installation of native plant species (trees, shrubs, herbaceous). Maximization and restoration of shoreline riparian and aquatic habitat along Dayton, Bellevue, Newport, Covington and Ludlow would also involve regrading banks to create a gentler slope and installation of heavy duty erosion control features where appropriate. These restorative measures would ultimately result in a reduction in erosion as native plant roots take hold and erosion control features hold soil in place. Implementation of the recommended plan may result in short-term, temporary impacts to soils within the project area during construction of the project when vegetation is initially removed and streambanks are graded. Once the planted vegetation is established and streambanks are stabilized, positive impacts to the soils would be realized through improved stability. All appropriate erosion control measures and construction best management practices (refer to section 3.9.1 for further details) would be utilized during and immediately after construction to minimize soil erosion. No indirect effects to soils would be anticipated

Many nonnative plants are notoriously difficult to control with mechanical methods, making herbicide application an appropriate option. Any herbicides used for implementation of the recommended plan would be applied by trained and licensed operators in strict conformance with the requirements of the Environmental Protection Agency and the manufacturer's recommendations. No significant direct or indirect effects to soils would be expected from application of herbicides.

No Action Alternative

Implementing no action would result in the continued erosion of the river banks and loss of riparian habitat.

4.3 SURFACE WATERS AND OTHER AQUATIC RESOURCES

4.3.1 Surface Water

Recommended Plan

The recommended plan, is expected to have favorable long-term effects on water quality in, and downstream of, the project area by decreasing erosion and the subsequent turbidity introduced to the Ohio and Licking rivers following high water events. The removal of invasive plant species and planting of native species would result in a healthy community of native riparian and wetland vegetation which can act as an important buffer to filter and decrease runoff into the rivers. Implementation of the recommended plan may result in short-term, temporary impacts to surface waters within the project area during construction of the project when vegetation is initially removed and streambanks are graded. Once the planted vegetation is established and streambanks are stabilized, positive, indirect impacts to the surface water quality would be expected from reduction of runoff and improvement of filtering effects of runoff by the native vegetation. All appropriate storm water best management practices (refer to section 3.9.1 Description of Recommended Plan) would be utilized during and immediately after construction to minimize short-term adverse impacts to surface water quality by reducing run-off and turbidity.

Potential measures to improve in-stream habitat include strategically placed boulder clusters and woody debris complexes. Some materials such as woody toe protection could be implemented to provide both improved aquatic habitat and erosion protection. Installation of these measures may result in minor and temporary increases in turbidity at the project site, but would not result in significant detrimental impacts to surface waters. Further details of the any in-stream fill will be identified in the Design Phase of the project and compliance with the Clean Water Act will be ensured before the start of construction. If development of detailed designs results in the potential for increases in adverse effects to surface water quality, additional effects analysis will be carried out and supplemental NEPA documentation may be developed.

No Action Alternative

The no action alternative would result in the continued erosion of the streambank and subsequent long-term increases in turbidity and sedimentation downstream in the Ohio River.

4.3.2 Groundwater

None of the alternatives, including the No Action Alternative, would be expected to have any direct or indirect impacts to groundwater resources.

4.3.3 Flood Plains

Recommended plan

In compliance with Executive Order 11988, the recommended plan is expected to have positive long-term impacts on the floodplain within the project area, and any negative short-term effects would be minimal. Any proposed action within the established floodway/floodplain would comply with state/local floodplain protection standards. The proposed project would improve the ecological health of floodplains in Newport and Covington by increasing the number of native tree, shrub, and herbaceous species and reducing invasive plant presence. Implementation of the recommended plan would not significantly impact flood stage on neither the Ohio nor the Licking River because the majority of planted vegetation would replace existing nonnative vegetation. The area of channel cross section that would be newly planted with native vegetation would have little to no change to Manning's roughness coefficient and result in no impact to flood stage. Implementation of the recommended plan would not facilitate incompatible development within the floodplain and land use would not be expected to change after construction of the proposed project, therefore no indirect effects to the floodplains would be anticipated.

No Action Alternative

No impacts to the floodplain would be expected from the no action alternative. The Ohio and Licking rivers would continue to erode the streambanks at the proposed project sites and deposit the eroded material downstream.

4.3.4 Wetlands

In order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative, the USACE shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities. None of the alternative plans, including the no action alternative, would adversely affect wetlands or alter their function and would be in full compliance with Executive Order 11990 following completion of the NEPA process. Significant benefits to the quality and abundance of wetlands would be expected from implementation of the recommended plan. Any potential indirect effects of the proposed project would likely be positive as it may facilitate the creation of wetlands, or act to restore historical wetlands.

4.4 WILDLIFE HABITATS

4.4.1 Terrestrial and Aquatic Vegetation

Recommended Plan

Terrestrial vegetation would be drastically improved by implementation of the proposed plan. By removing invasive plant species through cutting and applying herbicide, native plants would have resources to flourish. Additionally, planting of native plants would ensure that riparian areas and forested wetlands are poised for developing healthy and dynamic functions that are resilient to climatic changes and sustainable over the long term. Implementation of the recommended plan would result in short-term, temporary impacts to terrestrial vegetation during construction of the project. Once the planted vegetation is established, positive impacts to habitats would be realized as the native vegetation matured into functional habitat for native fauna. No indirect effects would be expected from implementation.

No Action Alternative

The no action alternative would result in the continued erosion of the streambank where streambank protection is proposed, which would eventually result in the undercutting and the loss of terrestrial riparian vegetation and the habitat which it provides.

4.4.2 Fauna

Recommended Plan

The proposed project should greatly benefit native fauna due to increased quality and quantity of native plants and habitat. Native vegetation would boost the food web by providing habitat and food for native herbivorous insects and mammals. These effects would likely cascade up to higher trophic levels, resulting in healthier and more numerous fauna within the project area. Additionally, there would likely be a positive effect of the project on aquatic fauna from bank stabilization, which would reduce turbidity within adjacent waters, and from improved aquatic habitat near the shoreline. The creation and/or restoration of wetlands would be likely to increase both species richness and abundance in the project area due to improved habitat conditions. Implementation of the recommended plan would result in short-term, temporary impacts to fauna within the project area during construction of the project when vegetation is initially removed. Once the planted vegetation is established, positive impacts to the fauna would be expected. No indirect effects would be anticipated from the recommended plan.

No Action Alternative

The no action alternative would result in the continued erosion of the streambank and increase in abundance of invasive plant species. Continued erosion would eventually result in the undercutting and the loss of terrestrial riparian vegetation and, subsequently, the fauna that relies on that vegetation for habitat, food, and shelter. Invasive species would continue to outcompete native species and increase in the abundance, depleting functional habitat available to native fauna.

4.4.3 Existing Terrestrial and Aquatic Habitats

Recommended Plan

The project site lies within the Mississippi Flyway, through which more than 325 bird species make the round-trip each year, from their breeding grounds in Canada and the northern U.S. to their wintering grounds along the Gulf of Mexico and in Central and South America (Audubon). Increases in native riparian vegetation along the Ohio and Licking rivers and their floodplains would provide important habitat for which these birds could utilize for resting and feeding during their migrations.

Significant benefits to the existing aquatic habitats would be expected by implementing the recommended plan. Effects of the recommended plan would likely include reduced turbidity through installation of erosion control features and planting of native trees whose roots would also hold soil in place. As many species react negatively to high turbidity (Henley et al., 2000), this indirect effect would likely improve aquatic habitat within the Ohio and Licking Rivers adjacent to the project site. Forested wetlands would likely form in riparian areas that exhibit the appropriate soil and hydrologic conditions, which would also significantly improve the quality of both terrestrial and aquatic habitats. Implementation of the recommended plan would result in short-term, temporary impacts to the existing terrestrial and aquatic habitats within the project area during construction of the project when vegetation is initially removed. Once the planted vegetation is established, positive impacts to these habitats would be expected. No indirect effects would be anticipated from the recommended plan.

No Action Alternative

The no action alternative would result in the continued erosion of the streambank and increase in abundance of invasive plant species. Continued erosion would eventually result in the undercutting and the loss of terrestrial riparian vegetation and, subsequently, the fauna that relies on that vegetation for habitat, food, and shelter. Invasives would continue to outcompete native species and increase in the abundance, depleting functional habitat available to native fauna.

4.5 ENDANGERED AND THREATENED SPECIES

4.5.1 Federal

Recommended Plan

In general, the recommended plan would have a long-term, positive impact on federally threatened and endangered species that may occur within the project area. Any indirect effects would be expected to be positive as the planted native vegetation matures and provides habitat that is more suitable to terrestrial organisms than what currently exists. Construction best management practices would be implemented to minimize the potential for localized, short-term increases in turbidity during construction of the project.

High turbidity can have both direct and indirect negative effects on freshwater mussels. Direct effects include mortality and reduced physiological function. Indirect effects of high turbidity include reduced food and host fish availability. Decreases in primary production are linked to increases in sedimentation and turbidity, and can deplete food sources for multiple trophic groups, including mussels, through cascading effects. Additionally, high turbidity has direct negative effects on fish, which results in indirect negative effects on mussels (Henley et al., 2000), because freshwater mussel larvae must use gills of specific host fish species as sites of development before they can detach as juveniles and grow to adulthood in river/stream sediment (KDFWR, 2014). Although short term effects of the proposed project may include increased turbidity, the proposed plan— through increasing native plant roots and erosion control features that would hold soil in place along the river— would reduce erosion and, subsequently, turbidity, therefore benefitting federally threatened and endangered mussel species.

Photo 11. The logperch is a host fish for snuffbox mussels. ***Photo by Dr. Chris Barnhart, Missouri State University***

Removal of invasive plant species, specifically white clover, garlic mustard, and Japanese honeysuckle, in riparian areas and in the floodplain would potentially open up habitat for running buffalo clover, a federally endangered species. All three of these invasive species have been found in Kenton and Campbell counties and out-compete running buffalo clover for a variety of resources, including moisture, nutrients, space, and sunlight (EDDMapS, 2018; USFWS, 2015).

Improvement of riparian areas and floodplains should encourage increases in terrestrial insect populations that the three federally endangered and threatened bat species in the project area rely on for a food source. Invasive plant removal and native plantings would also increase summer roosting habitat for the endangered Indiana bat and the threatened northern long-eared bat, as they roost underneath tree bark and in cavities or crevices of live and dead wood. An increase in native riparian trees would presumably increase the number of potential roosting trees with exfoliating bark, overtime.

No Action Alternative

The no action alternative would result in the continued erosion of the streambank and continual increase in abundance of invasive plant species. Continued erosion would eventually result in the undercutting and the loss of terrestrial riparian vegetation and, subsequently, the potential habitat for threatened and endangered species. Invasives would continue to outcompete native plant species and increase in the abundance, depleting functional habitat available to native flora and fauna.

4.5.2 State

Recommended Plan

As with federally listed species, this ecosystem restoration project would have an overall, long-term, positive impact on state endangered, threatened, and special concern species, and potentially a negative impact in the short-term (while the project is being implemented).

The 22 bird species that are endangered, threatened, or of special concern in the state of Kentucky would undoubtedly benefit from riparian and floodplain restoration, which would increase nesting habitat and organisms on which they feed, through cascading effects stemming from increased native plant presence.

Eighteen mussels are listed as endangered, threatened, or of special concern by the state of Kentucky. As discussed in the impacts of the proposed projects on federally listed species, riparian and floodplain restoration would decrease erosion, which would reduce both indirect and direct negative effects of high turbidity on these mussels.

As discussed in section 3.5.1, removal of invasive plant species and planting of native flora in riparian areas and within the floodplain would benefit the Indiana Bat and Northern Long-Eared Bat, which roost in trees during the summer. All state listed bat species would benefit from increased insect numbers, resulting from increased native vegetation for habitat and food sources. In addition to the three federally listed bat species, the Virginia big-eared bat is also state listed (endangered). According to the Kentucky Department of Fish and Wildlife Resources, moths are their most important prey. Increases in native flowers would benefit moths, which rely on these plant parts for nectar.

State listed insects may be positively impacted by planting of native vegetation, depending on the plant species chosen. The state threatened six-banded longhorn beetle would benefit from planting of native trees, specifically sugar maple (primary host; Perry et al. 1974), basswood, beech, linden, and elm (secondary hosts; Solomon, 1995). Planting or seeding of roundleaf ragwort (the primary larval host plant), goldenrod, black-eyed Susan, and yarrow (nectar sources for adults) in riparian and floodplain areas would allow successful reintroduction of the state threatened Northern Metalmark (Vaughan and Shepard, 2005).

Increases in terrestrial and aquatic insect populations associated with improvement of riparian areas and floodplains, and subsequent reductions in turbidity, respectively, would not only benefit state listed bat species, but also state listed amphibians and the Eastern Spotted Skunk (of special concern in Kentucky), which also rely on insects as their main food source (Gompper and Jachowski, 2016). Furthermore, these positive effects on insects could cascade up the food chain, resulting in higher small mammal numbers, further benefiting the Eastern Spotted Skunk (Gompper and Jachowski, 2016). Positive impacts on terrestrial and aquatic insects due to decreased turbidity would have positive effects on state listed fish species that rely on insects for a food source. Because the state threatened Kirtland's Snake feeds on small fish and insects (USFWS, 2017), it would also benefit from restoration of riparian and floodplain areas.

No Action Alternative

Implementing no action would result in the continued erosion of the streambank and continual increase in abundance of invasive plant species. Continued erosion would eventually result in the undercutting and the loss of terrestrial riparian vegetation and, subsequently, the potential habitat for threatened and endangered species. Invasive species would continue to outcompete native plant species and increase in the abundance, depleting functional habitat available to native flora and fauna.

4.5.3 Critical Habitat

No federally designated critical habitat would be affected, directly or indirectly, through the implementation of the proposed project or the No Action Alternative.

4.6 RECREATIONAL, SCENIC, AND AESTHETIC RESOURCES

Recommended Plan

The recommended plan would be expected to increase quantity and quality of aesthetic and recreational resources in the long-term. While temporary increases in noise and/or minor decreases in air quality may occur, the proposed restoration work is an effort to increase quality and quantity of wildlife habitat, which in turn should increase organism numbers and diversity and thus opportunity for recreational fishing and wildlife observation. Indirect effects of the recommended plan may include an increase in passive recreational use of the project sites. Appropriate measures should be taken by the local sponsors to ensure recreational use does not inhibit the ecological success of the project.

No Action Alternative

Implementing no action would result in the continued streambank erosion, increase of invasive species, and consequently, the decline of the project area's recreational, scenic, and aesthetic resources.

4.7 CULTURAL RESOURCES

In accordance with 36 CFR 800.3(a)(1), the recommended plan has no potential to cause direct or indirect effect to historic properties to include prehistoric cultural resources. DPR and integrated EA will be provided to all appropriate agencies, including SHPO, for their review and comment in compliance with NEPA regulations. Coordination with SHPO is ongoing and their concurrence of the EA will be included in the final NEPA document.

Any significant changes to plan during design and construction phase may require additionally analysis and a supplemental Environmental Assessment. If a supplemental assessment is needed, the supplemental will be provided to all appropriate agencies and study partners for their review and comment.

4.8 AIR QUALITY

Recommended Plan

Air quality would be temporarily and insignificantly affected by the recommended plan. Emissions are expected from equipment used during restoration, and any other support equipment which may be on or adjacent to the proposed project area. Increases in dust emissions would occur during certain restoration activities such as bank regrading, but these impacts would be short-term, only occur while restoration is active, and not impact overall air quality. Any proposed project-related emissions are not expected to contribute significantly to direct or indirect emissions and would not impact air quality within the project area.

DPR and integrated EA will be provided to all appropriate agencies, including KY Air Pollution Control Board, for their review and comment during public comment period in compliance with NEPA regulations. Any significant changes to plan during design and construction phase may require additionally analysis and a supplemental Environmental Assessment. If a supplemental assessment is needed, results will be provided to all appropriate agencies and study partners for their review and comment.

No Action Alternative

No impacts to air quality would be expected from the No Action Alternative.

4.9 NOISE

Recommended Plan

Noise levels may be temporarily elevated during restoration activities. Expected duration of construction with earthwork, tree clearing, and initial invasive species clearing, is one year. Two years of follow up establishment to ensure constructed features are persistent through different climatic events, such as flood events, and invasive species are controlled to a point that regular operations and maintenance would be able to sustainably maintain a low level of coverage, is also expected. Construction contract is expected to be approximately 3 years total. However, all construction associated with the recommended plan is expected to comply with all published noise ordinances. No indirect effects to noise levels from the recommended plan would be anticipated.

No Action Alternative

No impacts to noise levels would be expected from the No Action Alternative.

4.10 HAZARDOUS AND TOXIC SUBSTANCES

Neither the recommended plan, nor the No Action Alternative, would directly or indirectly impact hazardous and toxic materials in the proposed project area, nor would it produce hazardous and toxic materials.

4.11 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

Recommended Plan

The recommended plan would not have the potential for disproportionate health or environmental effects on minorities or low-income populations and communities and would be in full compliance with Executive Orders 12898 following completion of the NEPA process.

The recommended plan would not have the potential to disproportionately affect the safety or health of children and will be in full compliance with Executive Order 13045 following completion of the NEPA process. No indirect effects of the socioeconomics of the project area from implementation of the recommended plan would be anticipated.

No Action Alternative

Implementing no action would maintain the status quo and would not disproportionately affect minorities, low-income populations, or children.

4.12 CUMULATIVE EFFECTS

The Federal Executive Branch's Council on Environmental Quality defines cumulative impact as "the impact on the environment [that] results from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7, National Environmental Policy Act of 1969, as amended). While the combined incremental effects of human activity may be insignificant on their own, accumulated over time and from various sources, they can result in significant impacts to the environment. The cumulative impact analysis must consider past, present and reasonably foreseeable actions in the study area. The analysis also must include consideration of actions outside of the USACE, to include other state and federal agencies. As required by NEPA, the USACE has prepared the following assessment of cumulative impacts related to the alternatives being considered in this integrated EA.

The proposed Section 1135 project is located between ORM 462 and 474. At this location along the Ohio River, construction of Markland Locks and Dam resulted in the minimum navigation pool being raised from elevation 441 to elevation 455, an increase of 14 feet along the Ohio River portion of the Section 1135 study area. There were similar impacts on the Licking River. At its confluence with the Ohio River the depth was increased by 14 feet, with the nine-foot minimum navigation pool on the Licking River extended from Mile 3 to Mile 7. As a result of this increase in pool elevation, many public infrastructure facilities along the shoreline of both rivers (e.g. water intakes, storm water discharge lines, boat docks, mooring facilities, roads and the like) had to be modified and the costs for these modifications were included as part of the implementation costs for the Markland Locks and Dam. However, during this same time, minimal consideration was given to the significant impacts by this change in the river on the ecology and/or physical scale of the riverine habitat at this location.

Some of the most significant detrimental impacts caused by the impoundment have occurred along the riparian corridor of the Ohio River and the lower reaches of its tributaries. Riparian processes have a crucial ecological role in most landscapes. Riparian ecosystems offer varied habitats for many species, function as filters between land and water, and serve as pathways for dispersing and migrating organisms. Riparian ecosystems can also have many economic and recreational values.

The construction of Markland Locks and Dam converted the free-flowing waters of the river into a more lake-like, lacustrine environment during low flow periods due to the increase in minimum pool level. Such modification has caused both the alteration of the natural erosion-transport deposition processes and the development of new riverbed and riverbank landforms. These hydrogeomorphic alterations of the river ecosystem have significantly affected the structure and distribution of the upstream riparian plant communities along the Ohio River. These disturbances, coupled with other anthropogenic influences, have also facilitated the spread of invasive plant species throughout the once-healthy riparian vegetative communities. Implementation of the proposed Section 1135 project will act to restore riparian and aquatic habitat that has been degraded from the alteration of the hydrologic conditions caused by the construction of the Markland Locks and Dam. At the time of this assessment, there are no other USACE projects scheduled from implementation in the Northern Kentucky area.

The Northern Kentucky Stream and Wetland Restoration Program is an in-lieu-fee program that provides compensatory mitigation for the loss of stream and wetland resources in northern Kentucky due to land development. The program was established in 1999, and operates under an Agreement among the Louisville District of the USACE, the Northern Kentucky University Center for Environmental Restoration (CER), and the Northern Kentucky University Research Foundation (NKURF). The program is informally known as the NKU Stream Restoration Program (NKU-SRP).

The NKU-SRP is responsible for 28 stream mitigation projects. These projects will generate over 83,000 stream credits, and encompass over 4,200 acres of conserved land, including approximately 82 miles of streams. As of November 2015, 24 mitigation projects were constructed and there were approved projects to satisfy nearly 30,000 credits (Northern Kentucky Stream and Wetland Restoration Program-Annual Report, 2017). A map from the NKU-SRP Annual Report showing locations of the stream mitigation projects is located in the Environmental Appendix.

Other past restoration projects in the project area include the Northern Kentucky Urban and Community Forestry Council's reforestation efforts, which have resulted in more than 36 acres of protected public park and school land being planted with native woodland trees since 2007. The Banklick Watershed Council acts to improve the Banklick Creek watershed (tributary to the Licking River) by implementing conservation measures within the watershed that include conservation land acquisition, storm water management, septic repair and replacement, and pasture management. The Boone, Campbell, and Kenton conservancies are also active non-profit organizations in their respective counties which act protect and conserve land with unique or significant recreational, natural, scenic, historical, and/or cultural value.

The combined effects of the proposed Section 1135 project which the known past present and future ecosystem restoration projects and conservation efforts would act to improve overall ecosystem health in the project area, increase in native habitat and food sources for fauna, and decrease in shoreline and floodplain erosion and runoff. Reduced erosion should result in higher quality aquatic habitat. These positive effects are likely to cascade throughout the food web, resulting in increases in native flora and fauna throughout the study sites.

Migratory birds and insects have a strong need for riparian corridors, even though they spend much of their time in the air rather than on the ground. Connected corridors provide habitat for resting and feeding, and ensure that species are able to continue on their migratory journey without encountering large gaps of unsuitable habitat. Implementation of the recommended plan, in conjunction with the aforementioned actions of other agencies and organizations, would act to enhance existing corridors and improve habitat connectivity along the Ohio and Licking rivers.

A large portion of the proposed project is along the Licking River, and the Licking River Greenway and Trails will run adjacent to the newly restored floodplain and riparian areas, the recommended plan would increase recreational wildlife and bird-watching opportunities for folks within the Greater Cincinnati Region as well as those travelling from farther away.

5 MITIGATION OF ADVERSE EFFECTS

No significant adverse impacts are expected from TSP, as such, no mitigation plan is needed. Impacts to surface water and physical substrates from placement of fill material would be minimized by using appropriate erosion control measures, such as sediment fences, turbidity curtains, and by constructing the project at low water, which would further reduce erosion potential.

Removal of invasive riparian and floodplain vegetation, although not an impact, would be mitigated by native plantings. All applicable permits would be obtained from Kentucky Division of Water before the initiation of construction.

6 IMPLEMENTATION REQUIREMENTS

6.1 PROJECT PARTNERSHIP AGREEMENT

This section describes the non-federal sponsor responsibilities in conjunction with the Federal government to implement the Recommended Plan. As established in PL 99-662, as amended, project costs are shared with the non-Federal sponsor. Northern Kentucky Port Authority has agreed to serve as the local cost-sharing sponsor for the ecosystem restoration project. The cost-sharing requirements and provisions will be formalized with the signing of the Project Partnership Agreement (PPA) between the local sponsor and USACE prior to initiation of contract award activities. In this agreement, the local sponsor will agree to pay 25% of the total project costs, as well as agreeing to comply with applicable Federal laws and policies, including but not limited to:

(1) Provide 25% of the project costs for environmental restoration as further specified below:

(a) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(b) Provide work for in-kind crediting as discussed in the Cost Sharing section following this section, and as defined in the PPA.

(c) Provide, during construction, any additional funds as necessary to make its total contribution equal to 25% of the project costs.

(2) For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project, or functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

(3) Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

(4) Assume responsibility for operating, maintaining, repairing, rehabilitating, and replacing (OMRRandR) the project or completed functional portions of the project without cost to the Government, in a manner compatible

with the project's authorized purpose and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRRandR manual and any subsequent amendments thereto.

(5) Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

(6) Hold and save the Government free from all damages arising from the construction or operation and maintenance of the Project and any Project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors. The phrase "operation and maintenance" includes repair, replacement, and rehabilitation.

(7) Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as would properly reflect total project costs.

(8) Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

(9) Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

(10) To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that would not cause liability to arise under CERCLA.

(11) Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

(12) Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

(13) Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well

as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

(14) The Government, as it determines necessary, shall undertake actions associated with historic preservation, including, but not limited to, the identification and treatment of historic properties as those properties are defined in the National Historic Preservation Act (NHPA) of 1966, as amended. All costs incurred by the Government for such work (including the mitigation of adverse effects other than data recovery) shall be included in construction costs and shared in accordance with the provisions of this Agreement.

(15) Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is authorized.

6.2 LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS AND DISPOSAL AREAS

A real estate appraisal was performed by the LRH appraiser that identified 69.73-acres (Kenton County = 32.25-acres and Campbell County = 37.48-acres) needed for the recommended plan. A breakdown of the acres owned and their appraised value is in the following table. The total real estate cost of the recommended plan is $600,000.

Table 24. NER Plan Real Estate Costs

	Acres	Cost/Acre	Total Cost
Sponsor-Owned Lands: Fee Simple Interest	61.68	$5,000	$308,400
Privately-Owned Lands: Ecosystem Restoration Easements	8.04	$7,500	$60,300
Incidental Acquisition Expenses - 54 individual acquisitions		$2,500	$135,000
Contingency (15%)			$76,000
Federal administrative Real Estate costs**			$20,000
Total RE Cost*			**$600,000**
TOTAL RE Cost Shared			**$580,000**

*Rounded, **Not cost shared

6.3 MONITORING AND ADAPTIVE MANAGEMENT

The Monitoring and Adaptive Management (MAM) Plan for the proposed ecosystem restoration alternative is located in the Environmental Appendix. All monitoring components of the MAM Plan would continue to be refined as project design progresses. The current version is based on feasibility level information.

The MAM Plan details the assessment of three components for an estimated 10 years after implementation:

1) structural sustainability of implemented features,
2) biological response of natural communities, and
3) planning goals and objectives.

Structural sustainability would be monitored by assessing erosion along restored shoreline and then by assessing changes in accessibility for maintenance and public use. The biological responses of natural communities would be monitored by assessing changes in native and invasive plant communities in all restored areas and macroinvertebrate and fish communities along Bellevue's shoreline. Planning goals and objectives would be assessed based on the performance standards outlined in the MAM Plan, quantitative flora assessments, and ability to maintain compatible access. Table 25 lays out an estimated schedule of monitoring tasks for the project areas. Monitoring should continue until ecological success criteria are met.

Table 25. Estimated Ten Year Scheudle of Monitoring Tasks for Restored Areas

Tasks	Baseline	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Component 1	E & A	E & A	E & A	E & A	E & A	E & A	E & A	E & A	E & A	E & A	E & A
Component 2	FQAI PCQM MFS	QI	QI	FQAI PCQM	QI	QI	FQAI PCQM MFS	QI	QI	QI	FQAI PCQM MFS
Component 3				G & O			G & O				G & O
Final Report											FR

Legend for Table 25

E & A	Visual assessment of erosion control and accessibility
FQAI	Quantitative assessment of native and invasive plants using line transects
PCQM	Point-centered quarter method (floodplain forest evaluation)
MFS	Macroinvertebrate and fish sampling
QI	Qualitative assessment/monitoring of invasive species
G & O	Success based on goals and objectives assessed using percent coverage metrics and FQAI
FR	Final report

6.4 OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

The non-federal sponsor will be responsible for the long-term operation and maintenance (OMRR&R) of this project once construction is completed. Total construction is expected to be three years for work to be completed (earthwork, invasive species clearing/treatment and native plant installation) several growing seasons to establish the appropriate vegetative cover. The primary goal of the OMRR&R is to maintain the structure and function of the project areas to facilitate increasing habitat quality after construction is complete. A detailed O&M Plan will be prepared near the end of the construction phase. This plan will be formulated in consideration to the non-Federal sponsor's and local stakeholders' capabilities. The feasibility level O&M costs of the project are estimated to total an average annualized cost of $92,600 at the 2.750% rate over 50-years. This plan would include activities listed in Table 26.

Table 26. OMRR&R Activities and Cost

NER Plan Area	O&M Activities	Yearly Estimated Cost
Newport Floodplain Forest	Yearly inspections, yearly control of invasive species	$5,000
Covington Floodplain Forest	Yearly inspections, yearly control of invasive species	$20,000
Shoreline - Dayton, Bellevue, Newport, Covington, Ludlow	Yearly inspection, some sections of habitat may need rehabilitation 1x per 5 years, yearly control of invasive species	$25,000
Average Annualized Cost		**$50,000**

Inspections will include walking restored areas along riverbank and along maintenance trails. Inspection will include looking for invasive species, areas of excessive erosion within planted areas and woody debris structures. Invasive species control includes removal and stump herbicide of shrubs and trees, follow up herbicide of resprouts and seedlings. Control of invasive species to occur throughout the OMRR&R. Assume 2 trees and 5 shrubs per acre, resprout once per year, treat herbaceous plant species 1X per year. Rehabilitation will include installation of fill if needed to repair washouts and native plant installation assumed to include installation of live material and seeds. Assume 5 lbs. seed per acre, 5 shrubs and 2 trees per acre, to include erosion control blankets and coir rolls to protect newly installed plant material. Inspections and invasive species control assumed to cover roughly 64 acres. Assumed one mile of walking trails throughout the areas. Per some guidance from Dept. of Interior/Fish and Wildlife, assume a width of 5 feet for trails. 93 woody debris structures assumed to be anchored to river bottom as structure and habitat. There is uncertainty associated with the O&M estimate due to the planning level of design this is based on. O&M activities will be updated and revised once design and construction is close to completion in order to better equip the local sponsor with a more accurate estimation of activities needed to maintain project area.

6.5 REGULATORY REQUIREMENTS

6.5.1 American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: The Project is being coordinated with federally recognized tribes to discern its impact to sacred sites and/or objects. All federally recognized tribes are included in the mailing list included in Appendix F.

6.5.2 Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.)

Compliance: The project is being coordinated with the KDFWRD and the USFWS. No impacts to bald or golden eagles are anticipated from project implementation.

6.5.3 Clean Air Act, as amended, 42 U.S.C. 7401 et seq. (CAA)

In compliance with the CAA (42 USC § 7401 et seq.) and the 1977 and 1990 amendments, the Environmental Protection Agency has promulgated ambient air quality standards and regulations to protect health and the environment. Areas that are below the standards are in "attainment," while those that are equal or exceed the standards are said to be in "non-attainment." The proposed project site is within an attainment area and none of the alternatives described would impact long-term ambient air quality standards (U.S. Environmental Protection Agency, 2017).

6.5.4 Clean Water Act of 1977, 33 U.S.C. 1251 et seq. (CWA)

Compliance with section 404 and 401 of the CWA is required for discharges of dredged or fill material in to waters of the United States, including adjacent wetlands. An evaluation and finding of its compliance with the Section 404(b)(1) Guidelines is located in the Environmental Appendix. Because bank stabilization would occur below the Ordinary High Water Mark of the Ohio and Licking rivers, Water Quality Certification would be obtained from the Kentucky Division of water for the proposed project. Likewise, if more than one acre of land is disturbed, a National Pollutant Discharge Elimination System (NPDES) permit would be obtained to comply with Section 402 of the CWA. All necessary permits will be obtained prior to start of construction.

6.5.5 Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq. (ESA)

The ESA requires the determination of possible harm or degradation to federally listed threatened or endangered species and critical habitat. The USFWS provided an official list of threatened or endangered species that may be present within the project vicinity. Based on available information compiled from mussel surveys conducted within the nearby vicinity, existing habitat conditions at the project site, and timing of construction, in so far as activities to offset potential adverse impacts to Indiana bats, the USACE made a determination of "may affect, but not likely to adversely affect" for the following species: clubshell (*Pleurobema clava*), rabbitsfoot (*Quadrula cylindrica cylindrical*), rayed bean (*Vilosa fabalis*), sheepnose (*Plethobasus cyphyus*), Indiana bat (*Myotis sodalis*), and northern long-eared bat (*Myotis septentrionalis*). This EA has been provided to USFWS for their review and comment with regard to their determination of compliance with the Endangered Species Act (ESA), 16 U.S.C. §§ 1531-1544 and the USACE determination of effects.

6.5.6 Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq. (FWCA)

In compliance with the Fish and Wildlife Coordination Act, coordination is ongoing with the USFWS regarding endangered species and other sensitive species and natural areas with the project area. This EA will be provided to USFWS and the KDFWR for their review and comment with regard to their determination of compliance with the FWCA. All correspondences will be found in the Environmental Appendix.

6.5.7 Historic and Archeological Preservation Act of 1974, as amended, 16 U.S.C. 469 et seq.

Compliance: Not Applicable. The project does not have an adverse effect to an archaeological site that will require the recovery, analysis, curation, or disposition of archaeological data.

6.5.8 Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-4 et seq.

Compliance: Not applicable. The project would not impact any land or resources that have been established by the Land and Water Conservation Fund.

6.5.9 Migratory Bird Treaty Act (16 U.S.C. 703 et seq.)

Compliance: No impacts to migratory birds are anticipated from project implementation. This report is being coordinated with the USFWS and the KDFWR. Any recommendations received from these agencies regarding the protection of migratory birds will be considered for implementation.

6.5.10 National Historic Preservation Act (NHPA)

Section 106 of the NHPA, as amended, requires federal agencies to consider the effects of their undertakings on historic properties. The implementing regulations at 36 CFR 800 detail the process that requires consultation with the SHPO, tribes, local governments, the public, and others. Suitable efforts to identify historic properties must be taken and consulting parties afforded an opportunity to comment on the area of potential effect and an undertaking's affect determination. Only sites, building structures, objects, or landscapes listed in or determined eligible for listing in the National Register of Historic Places (NRHP) are afforded the safeguards of the NHPA. Archival research for this project involved site visit to the Office of State Archaeology, University of Kentucky, consulting the KY-SHPO, and review of the National Register of Historic Places electronic As a result of this research, the USACE has determined, in accordance with 36 CFR 800. 3(a)(1), that there is no potential to cause effects on historic properties or other cultural resources eligible for listing to the National Register of Historic Places. Coordination with the KY-SHPO is ongoing. All correspondences can be found in the Environmental Appendix.

6.5.11 Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3000-3013, 18 U.S.C. 1170

Compliance: The project occurs on non-federal lands and does not involve human remains of Native American descent. However if human remains are discovered during the course of the project and are determined to be of Native American descent, regulations implementing NAGPRA and state cemetery laws will be followed to identify the patrimony of those remains and the proper course of action for their disposition with the State Historic Preservation Officer and all federally recognized tribes.

6.5.12 National Environmental Policy Act of 1969, as amended, 42 U.S.C 4321 et seq.

Compliance: Preparation of this EA signifies partial compliance with NEPA. Full compliance shall be noted at the time the Finding of No Significant Impact is signed by the District Engineer.

6.5.13 Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 et seq.

In compliance. The project would not include the creation of an obstruction to the navigable capacity of any of the waters of the United States.

6.5.14 Watershed Protection and Flood Prevention Act as amended, 16 U.S.C 1001 et seq.

Compliance: Floodplain impacts have been considered in project planning. The project will not result in the loss of floodplain.

6.5.15 Wild and Scenic Rivers Act, as amended, 16 U.S.C 1271 et seq.

Compliance: Not applicable. The project would not occur on a designated wild and scenic river.

Executive Orders

6.5.16 Executive Order 11593, Protection and Enhancement of the Cultural Environment, 13 May 1971.

Compliance: Not Applicable. This EO deals with historic properties on federal property or under federal control. This project will not occur on federal property or property under federal control.

6.5.17 Executive Order 11988, Floodplain Management

Executive Order (EO) 11988, Floodplain Management requires federal agencies to evaluate and minimize to the extent possible, impacts and modifications to the floodplain. Ecosystem Restoration within the stream, shoreline, and floodplain would inherently occur within the floodplain; therefore, there is no alternative to working in the floodplain. The proposed action does not conflict with applicable state and local standards concerning floodplain protection, nor would it have any impacts to the 1% Annual Chance of Exceedance floodplain. Proposed floodplain forest restoration efforts within Newport and Covington would improve the health of the forests and would not act to facilitate incompatible development within the floodplain. Furthermore, due to the small relative size of the ecosystem restoration project, impacts to flood stage along the Ohio and Licking rivers would be insignificant.

6.5.18 Executive Order 11990, Protection of Wetlands, 24 May 1977.

Compliance: Public notice of the availability of this report for public review fulfills the requirements of Executive Order 11990, Section 2 (b).

6.5.19 Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, 4 January 1979.

Compliance: This EO is not applicable to projects located within the United States geographical boundaries.

6.5.20 Executive Order 12898, Environmental Justice, 11 February 1994.

Compliance: The project will not have a significant negative impact on minority or low-income population, or any other population in the United States. See section 4.11 for more details.

6.5.21 Executive 13007, Accommodation of Sacred Sites, 24 May 1996.

Compliance: Coordination with the State Historic Preservation Office and all federally recognized tribes indicates that there are no known Sacred Sites in the project footprint.

6.5.22 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks. 21 April 1997.

Compliance: The project would not create a disproportionate environmental health or safety risk for children.

6.5.23 Executive Order 13061, and Amendments – Federal Support of Community Efforts Along American Heritage Rivers
Compliance: Not Applicable. The project is not along an American Heritage River.

6.5.24 Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, 6 November 2000.
Compliance: Coordination with the State Historic Preservation Office and all federally recognized tribes signifies compliance.

Executive Memoranda

6.5.25 Analysis of Impacts on Prime or Unique Agricultural Lands in Implementing NEPA, 11 August 1980.
Compliance: There are no prime agricultural lands under or on the project. The project would be located on a steep stream bank adjacent to major suburban development.

6.5.26 White House Memorandum, Government-to-Government Relations with Indian Tribes, 29 April 1994.
Compliance: Consultation with the tribes is ongoing.

7 PUBLIC INVOLVEMENT

7.1 PUBLIC VIEWS AND COMMENTS
All comments from the public received during the 30-day public and agency review period will be summarized in this section and placed in the Environmental Appendix.

7.2 STAKEHOLDER AGENCY COORDINATION

7.2.1 Federal Agencies
This report will be provided to the USFWS and the Environmental Protection Agency (EPA) for comment and review during the standard 30-day review period.

7.2.2 State Agencies
Coordination with the Kentucky Department of Fish and Wildlife Resources and the Division of Water and any other state interested state agencies will have opportunity to provide input on this project during the 30-day public and agency review period.

7.2.3 Local Agencies
Local agencies will have opportunity to provide input on this project during the 30-day public and agency review period.

7.2.4 Non-Governmental Organizations
Non-governmental organizations will have the opportunity to provide input on this project during the 30-day public review period.

8 FINDING OF NO SIGNIFICANT IMPACT

The Finding of No Significant Impact is located in the Environmental Appendix.

9 RECOMMENDATION

The plan that reasonably maximizes net National Ecosystem Restoration benefits and is consistent with the Federal objective, authorities and policies, is identified as the NER/Preferred Plan. The NER Plan was determined to be Plan 6.

Plan 6 has a net 160.36 AAHUs (revised based on preliminary estimate) and based on refined cost estimation, the recommended plan has an estimated total construction cost of $7,361,000 (including base and contingency), with construction management and monitoring it is $8,123,000.

An Environmental Assessment was completed for the proposed habitat restoration within the Northern Kentucky Riverfront project area, Campbell and Kenton Counties, Kentucky. The Environmental Assessment has concluded that there would be not be a significant effect on the human environment (no adverse effects), resulting from implementation of the NER Plan. A 30-day Public Review period was held from _______ to _____ 2018. Agency and public review comments will be addressed as they are received with pertinent comments incorporated into the document.

The non-federal sponsor fully supports the recommended NER plan. Once MSC approval of the recommended NER plan has been obtained, the sponsor is intent on executing a PPA to design, build, operate and maintain the project.

The Louisville District recommends the selected NER plan (Plan 6) to address environmental problems to the aquatic resources within the Northern Kentucky Riverfront project area. The NER plan includes the following ecosystem restoration activities, reduction of bank erosion, reconnect riparian function and structure, removal of invasive species and establishment of native plant species, along approximately 6 miles (31,500 linear feet) of the Ohio River and Licking River shorelines. The NER plan has a project Design and Implementation Cost of approximately **$9,822,000** (2019 price levels and with feasibility is $9,862,000), with the federal cost of **$7,386,500** and the non-federal sponsor cost of **$2,435,500.** This plan provides 30.4 net average annual habitat units over approximately 6 miles (69.73 acres) of the project area. The Louisville District recommends MSC concurrence with the recommended plan and approval to complete the feasibility phase.

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