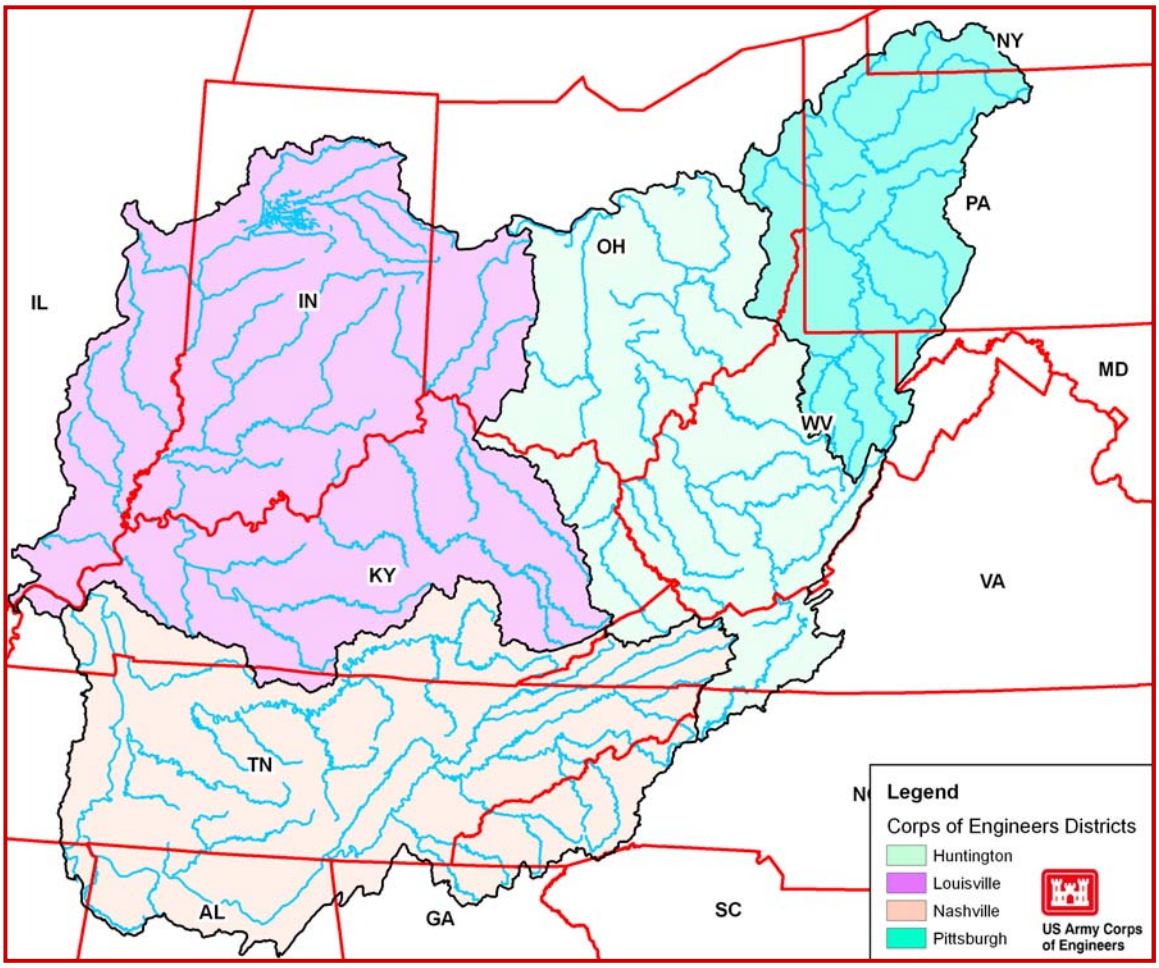
December 2009

Ohio River Basin Comprehensive Reconnaissance Report



US Army Corps of Engineers

Pittsburgh–Nashville–Louisville–Huntington
Great Lakes and Ohio River Division

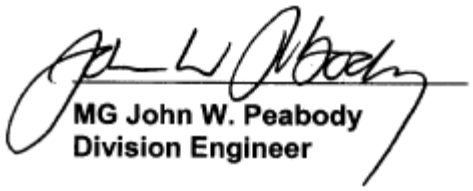
COMMANDER'S SIGNATURE PAGE

This *Ohio River Basin Comprehensive Reconnaissance Report* has been prepared generally in accordance with prescribed procedures found in Engineer Regulation 1105-2-100, for 905(b) expedited reconnaissance reports, and in concert with the requirements of *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (dated 1983).

The concerns and issues related to water resources in the Ohio River basin that were raised by key stakeholders, the general public, and USACE staff (through various media) have been identified in this report and have been analyzed by processing available data through geospatial technology. Alternatives addressing the issues have been formulated, and each alternative has been evaluated qualitatively as to its anticipated outputs, benefits, costs, and performance under various future conditions as well as its potential ecosystem, socioeconomic, and cultural impacts. For those alternatives that could be addressed through USACE missions, a determination of Federal Interest has been completed.

Based on the evaluation of the alternatives and the determination that certain alternatives have a defined Federal Interest, a series of recommended actions have been included that could address the most pressing issues in the basin. Opportunities for collaborative actions with stakeholders, Federal and state agencies, NGOs, and other willing and financially capable non-Federal sponsors have been clearly defined in the report.

In view of the technical proficiency of the report, confirmed by an agency technical review and policy compliance reviews by the MSC, I hereby approve this *Ohio River Basin Comprehensive Reconnaissance Report* for the purposes of proceeding with more detailed planning of the formulated alternatives and development of basinwide strategic plans.



MG John W. Peabody
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EXECUTIVE SUMMARY

The Ohio River basin is a culturally diverse and productive region of the United States. The basin has a rich mixture of indigenous and foreign cultures which through historical clashes, assimilations, and blending resulted in a combination of human and natural resources that has become an engine of growth in the nation. The basin's abundant resources of fresh water, minerals, petroleum, natural gas, timber, and productive soils, forged with home-bred innovation and hard work have generated national benefits and supported the population that lives in the region.

The character of the region's natural and man-made systems is captured in this reconnaissance study through analyses of geospatial data collected at the watershed level. The existing conditions and systems were thrust forward into several uncertain futures to see what conditions of climate, economics, resources and extreme events may challenge the residents and the sustainability of their constructed systems.

The basin's productivity and beauty belie a myriad of problems confronting the region while offering wonderful opportunities for the future. Through several communication venues, the study team reached out to the public and stakeholders in search of their concerns for the region's future. That outreach effort was successful in capturing their concerns about the state of water and land resources in the basin. Their insightful comments are included within this report and its appendices. Also, the team looked inward to its own organization to discover what long-standing water and land issues have been identified within the agency. That introspection revealed practical concerns for the future health of the basin's natural resources and for the sustainability of its aging infrastructure.

In response to those concerns and issues, the study team formulated a series of alternative plans that address the issues and take full advantage of the opportunities that the resources offer. There are multiple opportunities for collaboration in the further planning and implementation of many of the alternatives and sharing of the financial responsibilities that attend several of the plans. Some of these plans can be deployed by Federal agencies, several by the fifteen basin states and others by the many county and municipal jurisdictions within the region.

Specifically the plan recommends proceeding with development of three basinwide system plans; a strategic water management plan, a strategic infrastructure reinvestment and plan, and a plan to assess the prospects of a multi-state forum through strategic collaboration between the basin states. In addition, sub-basin level watershed assessments are recommended to evaluate development-related threats to aquatic and riparian habitat, water supply needs and at-risk floodplain development. Also, reviews of existing operating projects are recommended that address sedimentation, nutrient-capture, storage reallocation and flow releases where changed conditions indicate the need. Additional watershed and project or local jurisdiction planning initiatives are identified in the report to address public, stakeholder, and agency concerns for stormwater, water quality, recreation, aquatic and terrestrial resources, navigation, and water supply issues.

1. INTRODUCTION

Historically, the nation's river corridors were used as transportation pathways for moving people and supplies through beautiful yet often treacherous terrain. Native Americans enjoyed the food, clean water, and transportation that the streams and rivers provided. Later, those same corridors became locations for subsistence agriculture, settlements, and eventually villages, towns, and cities with growing indigenous and foreign immigrant populations. The abundance of natural resources in the corridors' surrounding landscape supported employment, production, and wealth that helped the new nation grow. Today, the major river basins in the United States represent the hydrologic circulatory system of the nation, providing:

- resources for drinking water, recreation, industrial processing, and energy production;
- habitat for countless thousands of aquatic species, birds, and animals; and
- a fluid highway for transporting products and commodities.

Over the centuries, interwoven with the beneficial uses of rivers, abuses of this valuable resource also have occurred. Municipal and industrial pollutants; sedimentation from land disturbances; extraction of sand, gravel, and valuable minerals; and embankments that encroach into river channels all have had negative impacts on the resource and the environment. In addition, the large volumes of water extracted for drinking water, industrial cooling, materials processing, resource exploration, and irrigation threaten the volume and quality of the water resources. Billions of dollars are spent annually to treat surface water extracted for municipal and industrial uses. During times of reduced precipitation, droughts continue to occur in the region. Man's intervention into the river corridors also caused recurring losses, through flood damages to property and loss of life during flood events.

The Ohio River basin is no stranger to population growth, the conversion of land cover, or misuse of water resources. Many acres of land cover have been converted for extraction of energy resources, tilled and fertilized for agriculture, and cleared for new residential, commercial, and institutional development. Many basin cities and towns have Combined Stormwater Overflow (CSO) issues that are being addressed through Federal and state programs but continue to exacerbate deteriorated water quality. Numerous abandoned mine sites, scattered throughout the region, continue to degrade water quality.

Agriculture and livestock production continue to produce nationally significant volumes of food and their share of both point-source and non–point-source pollutants that threaten water resources. Agricultural land cover generates non–point-source sedimentation, agricultural chemicals and fertilizers (nutrient loading), and water withdrawals for irrigation. Livestock production generates point-source contamination from feedlots and non-point contamination from grazing areas. Notwithstanding the use of best management practices, harvesting timber from the Appalachian forests has degraded aquatic habitat through erosion of haul roads. Accumulation of woody debris (e.g., slash) in harvesting reduces hydraulic efficiency in river channels during high flows.

Dispersed industrial centers and energy production facilities withdraw large quantities of water for cooling and processing of materials and products. Numerous municipal areas (Columbus, Pittsburgh, Charleston, Cincinnati, etc.) withdraw drinking water. Not only operating industrial centers but also abandoned brownfield sites can release toxic chemicals and other contaminants into the river system.

Since the 1930s, when the US Army Corps of Engineers (USACE) began to construct flood protection works, flood damages have increased in step with the basin's population growth and associated floodplain development. Although agency records of deaths due to flooding do not extend back to the 1930s, more recent flooding statistics show that flooding has claimed numerous lives. Local protection projects for major cities have reduced the probabilities of loss of life and flood damages, while other flood risk reduction facilities protect thousands in river corridors. Despite these improvements, many unprotected communities and their residents remain at risk.

This report documents the Existing Conditions of the basin, the many problems that plague the basin, and opportunities for improving the water resources that service the region and the nation. This report generally follows the standard template of the 905(b) expedited reconnaissance report, with several supporting appendices.

2. STUDY AUTHORITY

The authority for this report is based on the U.S. Senate Committee on Public Works Study Resolution, dated 16 May 1955, as displayed below:

> "Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors created under Section 3 of the *River and Harbor Act*, approved June 13, 1902, be, and is hereby requested to review the reports on the Ohio River published in House Document No. 306, Seventy-fourth Congress, First Session, House Committee on Flood Control Document No. 1, Seventy-fifth Congress, First Session and related reports, with a view to determine whether any modifications in the present comprehensive plan for flood control and other purposes in the Ohio River Basin is advisable at this time."

The study associated with this report is being conducted in accordance with the legal procedures and technical requirements of ER1105-2-100, *Planning Guidance*, and according to the concepts, objectives and guidance included in EC1105-2-411, *Watershed Planning*. Other guidance regarding watershed planning efforts was derived from USACE *Planning Guidance Letter # 61* and other USACE regulations and engineering circulars. Additional authorities that support formulated alternatives and recommendations are discussed throughout this report.

3. STUDY FUNDING AND BUDGETING HISTORY

During the development of the initial proposal for this *Ohio River Basin Comprehensive Reconnaissance Study*, a preliminary study plan was prepared by USACE staff. That study plan identified preliminary work tasks that were used in the Project Management Plan and associated costs for labor, travel and other expenditures to complete the study. Given the size of the basin, the number of operating projects and the number of potential

stakeholders, the standard reconnaissance study limits for cost ($100,000) and study period (12 months) were quickly identified as too limiting to successfully accomplish the work tasks identified for the study. An additional issue identified in the study cost development was the agency's division of the basin among four USACE districts – a division that could further complicate the planning process and lead to greater costs. Initial costs for the study were estimated to be $980,000, with a study period that was limited by law to 18 months. Being classified as a reconnaissance level study, the full costs of the initial study would be borne by the Federal government.

Initial funds ($374,000) for the execution of this study were received by the Huntington District in 2008. Obligation and expenditure of funds were restricted until July 2008 when the district received headquarters authorization to exceed the 905(b) reconnaissance study limit of $100,000. Funds in the amount of $594,000 were provided in the 2009 appropriations bill for completion of the study (scheduled for the end of December 2009). Study funding was shared by all four districts, but management of the funds was the responsibility of the Huntington District.

4. STUDY PURPOSE

A detailed comprehensive study of the Ohio River basin was completed by USACE in 1969 through a multi-agency, multi-district study process. The study identified issues of that period and made recommendations to proceed with several basin study initiatives. Some of those recommendations did result in further feasibility level studies culminating in specific actions. However, since that 1969 study, there have not been any USACE comprehensive studies of the basin.

During the past 40 years, changes in water resources policy and planning procedures (including publication of the *Principles and Guidelines for Land and Water Resources Development* in 1983), enactment of the *National Environmental Policy Act* in 1970, enactment of new USACE water resources authorities (i.e., Aquatic Ecosystem Restoration), substantial land cover conversions, and further aging of critical infrastructure all pointed toward the need to look at the basin through a holistic planning process (emphasizing watershed principles) and a systems approach, with a view toward sustainability. As a result of these changes, the Great Lakes and Ohio River Basin Division, in cooperation with the four Ohio River districts, determined that a basin reconnaissance study was necessary.

The purposes of a traditional 905(b) Expedited Reconnaissance Phase Study are to:

1. determine whether the basin's water-resource problems warrant Federal participation in feasibility studies,
2. determine whether there is a Federal Interest in pursuing such studies,
3. complete a 905(b) analysis or a reconnaissance report,
4. prepare a Project Management Plan and assess the level of interest and support from non-Federal entities in pursuing feasibility studies, and
5. negotiate and execute a feasibility cost-sharing agreement.

In the case of this study, whose scope is the entire Ohio River basin, identification of traditional feasibility studies for defined project or watershed areas for the purpose of preparing a Project Management Plan and a feasibility cost-sharing agreement is unrealistic. The potential exists for identifying follow-on studies out of this report, but they may be conducted at a level of detail less than a traditional feasibility study level.

A reconnaissance study does not recommend projects for construction or programs for implementation; the reconnaissance study identifies subsequent actions that must be undertaken to justify expenditure of Federal funds and to satisfy environmental documentation for construction or implementation of potential alternative actions. Those actions can be in the form of feasibility studies, detailed project reports, specially authorized studies, or any one of a number of studies prepared through an existing continuing authorities program (i.e., Section 205, "Small Flood Control Projects"; Section 206, "Aquatic Ecosystem Restoration"; Section 22, "Planning Assistance to States"; or Section 216, "Review of Completed Projects").

In addition to the standard required elements of the 905(b) reconnaissance study, this comprehensive document includes a number of additional features identified in the approved Project Management Plan as objectives of the study (see below).

5. STUDY OBJECTIVES

In addition to the standard requirements of an expedited reconnaissance study, a number of additional objectives were defined in the Project Management Plan for this comprehensive study of the basin.

- Complete an infrastructure inventory of all USACE flood control projects in the Ohio River basin showing authorized purposes, facilities, and storages;
- Develop alternatives that address flood risk reduction including rehabilitation, modernization and revitalization of existing projects, and construction of new projects as needed;
- Investigate various sources of funding, including Federal operation and maintenance (O&M) and congressional appropriations as well as non-Federal sources, to ensure the most efficient use of resources available to maintain Ohio River basin projects;
- Support formation of a coalition of state government officials that can provide political and non-Federal financial support for the existing infrastructure as well as potential future projects;
- Identify key basin sponsors and stakeholders to include Federal and state agencies, regional organizations such as watershed association and conservation districts, and local sponsors for local protection projects (LPPs);
- Develop a comprehensive database of all available and useful GIS data layers in a GIS Atlas that can be available for all Division users; and
- Develop the framework of a basinwide reinvestment plan for ensuring the continued, reliable operation of USACE-operated facilities and for assisting non-Federal sponsors in O&M of sponsor operated projects.

6. LOCATION OF PROJECT AND CONGRESSIONAL DISTRICT(S)

This reconnaissance level study has been defined by the study authority geographically as the entire Ohio River basin, including the mainstem of the Ohio River and a number of major sub-basins (including the Little Kanawha, Kanawha, Guyandotte, Big Sandy, Licking, Kentucky, Salt, Green, Cumberland, and Tennessee from the south and the Allegheny, Monongahela, Beaver, Muskingum, Hocking, Scioto, Little Miami, Great Miami, and Wabash from the north). In total, the basin covers approximately 204,000 square miles in portions of 15 states. There are 152 eight-digit Hydrologic Unit Code (HUC) watersheds in the basin as defined by the United States Geological Service (USGS).

In all there are 30 Senators and 66 members of the House representing the 27 million people living in 15 states, 548 counties, and 2,600 municipal areas within the Ohio River basin. Additional information on the congressional districts is included in Section 8 (see Figure 28) and in Appendix O.

7. DISCUSSION OF PRIOR STUDIES, REPORTS AND EXISTING WATER PROJECTS

Initial attempts at flood risk reduction in the Ohio River basin began in the early 1800s when landowners built levees along the lower Wabash River to protect farm land. Later, local authorities built levees and walls to protect Shawneetown, Illinois and some other communities along the Ohio River. Following the great flood of 1913, the Miami Conservancy District was formed by local interests and it constructed five flood control impoundments and several LPPs in the Miami basin. This constituted the initial efforts for coordinated flood risk reduction in the Ohio River basin.

The first extension of Federal flood control activity into the Ohio River basin was enabled by passage of the *River and Harbor Act of 1917*. This Act stipulated that existing laws relating to improvements of rivers and harbors for navigation should also apply if applicable to flood control, and placed flood control activities under USACE jurisdiction. More comprehensive programs for flood control and water resource development were made possible by the *River and Harbor Act of 1927*, which authorized USACE to conduct river basin studies known as “308 Surveys.” The purpose of these surveys was to formulate and execute general plans for improving the nation’s rivers for navigation, flood control, hydropower, and irrigation.

The results of the “308 Surveys” in the Ohio River basin were submitted to Congress in 1935 and are published in *House Document Number 306*, 74th Congress. That document presented a comprehensive plan for alleviation of floods on the Ohio River and was under consideration by Congress when the great floods of 1936 and 1937 occurred. That document, which was slightly modified because of these floods, recommended a comprehensive plan for flood control and other purposes in the Ohio River basin and was the basis for the landmark *Flood Control Act of 1938*.

The Muskingum River was the first in the Ohio River basin to develop a basinwide system of reservoirs for flood control. To help address flooding problems in Ohio, the Muskingum Watershed Conservancy District (MWCD) was formed as a separate political sub-division of the State of Ohio in 1933. The purpose of the MWCD was to develop and implement a comprehensive plan for flood control in the 18-county Muskingum River basin. The MWCD completed a basinwide reservoir plan and submitted it to the Public Works Administration (PWA), which granted funds to USACE in 1933 to design and construct the MWCD reservoir plan.

Construction of 14 of the dams and reservoirs was completed in 1938, and these were turned over to the MWCD for operation. Several of the reservoirs had conservation pools (lakes) that provided water supply, recreation, and flow augmentation in addition to flood control storage. The *Flood Control Act of 1939* incorporated the completed 14 MWCD reservoirs as elements in the Ohio River basin flood control plan that had been authorized by the *Flood Control Act of 1938*.

The Tygart Reservoir in the Monongahela River basin, which was authorized by the *River and Harbor Act of 1935* and completed in 1938, is a special project. It was the first Federal reservoir in the Ohio River basin, providing storage for multipurpose use that is flow augmentation for navigation as well as for flood control.

The *Flood Control Act of 1936* authorized 14 reservoirs, including nine in the Allegheny and Monongahela River basins and five in the Kanawha and Licking River basins, and incorporated the previously authorized Tygart Reservoir. This Act also authorized 20 local protection projects in the Wabash River basin and two in the Cumberland River basin. Pursuant to this Act and later amendments, survey reports for the Green and Licking Rivers in Kentucky and the Scioto River in Ohio were completed in the 1950s.

The original Ohio River flood control plan (referred to as the “1938 Plan”) consisted of 79 reservoirs and 235 local protection projects. This plan has been modified, of course, as a result of detailed studies of various projects as they were progressively developed.

Many of the flood control structures in the Ohio River basin were constructed in the late 1930s and 1940s and are approaching 70 years of age. Although most of the projects continue to function for flood risk reduction, many are in serious need of major repair or rehabilitation.

The last Ohio River basin comprehensive study was authorized by congressional resolution in 1955 and was published in 1969. This comprehensive basin report included an updated Ohio River plan, designated the “1965 Flood Control Plan.” This plan consisted of 98 dams and reservoirs, 263 major LPPs, and 56 small flood control projects (channels, etc.). Until the advent of the current comprehensive planning effort, there had not been any major review of the basin infrastructure as a system for preventing flood damages or for generating any other major public benefit stream.

The current Ohio River basin system consists of 83 reservoirs (including 5 single-purpose reservoirs), 95-plus major local protection projects, and numerous small flood control projects. Although these projects were justified economically and analyzed for effectiveness in reducing flood damages, they were not regarded as components of a

system during their individual formulation. In the case of the reservoirs, each facility has been afforded some portion of the flood protection monetary benefits that accrue due to reduced damages on the mainstem Ohio River during regional flooding events.

In times of major regional flooding events, this system operates through individual operating plans that address local, watershed, and basin flood risk management objectives. Local protection projects (floodwalls and levees) do not accrue any direct benefits outside of the protected interior area and generally are operated by non-Federal sponsors to reduce damages within the protected area. Appendix F contains a comprehensive list of USACE's completed, operating water resources projects by type and by responsible operating entity.

Recent flood events in January 2005 and May 2008 have highlighted some of the deficiencies in the existing infrastructure. During the January 2005 flood in the Muskingum basin, 13 reservoirs reached record pools, and emergency repairs were required at several projects to prevent catastrophic failures. The record floods in the White River sub-basin in May 2008 highlighted the need for flood risk reduction measures in the highly populated areas of central Indiana.

At time of publication, a number of planning studies and projects were underway in the basin. Appendix L lists all of the current USACE authorities for water resources development projects, programs, studies, design, and construction in the basin.

8. PLAN FORMULATION

> ***"Creativity is the ability to see relationships where none exist."***
>
> *—Thomas Disch* [1]

The plan formulation process requires a thorough understanding of the problems, needs and opportunities (collectively referred to as "issues") within the study/project area and recognition of the water resources planning process. In the reconnaissance phase, in-depth technical analyses and generation of new planning data are secondary to holistic and comprehensive identification and analysis of the important issues, effective public involvement and stakeholder interaction, and formulation of creative solutions that address the issues. In addition, this reconnaissance study considers the more generalized issue of sustainability with respect to the existing infrastructure as well as any potential alternatives formulated. Unsustainable solutions (in whatever metrics sustainability is measured) should not be favored during evaluation of alternatives.

Plan formulation at the reconnaissance level requires a comprehensive airing of possible plan alternatives and activities that could be applied and an indication of the relative effectiveness of those alternatives. Evaluation of alternatives can be accomplished using both qualitative and quantitative measures. At least one feasible alternative plan should be formulated that can address the issue(s) being considered. Other plans/solutions that could be implemented through various authorities or levels of

[1] Thomas Disch (1926–2006) was a writer and poet. His quote expresses the need to look creatively at the array of seemingly unrelated conditions as systems of related and interconnected elements.

government can be displayed and evaluated qualitatively as well. In view of the fact that the study addresses the entire basin – with its 152 distinct watersheds, 18 sub-basins, 548 counties, and 2,600 plus municipal areas– alternatives were formulated that applied to at least four geographic areas: basinwide, sub-basin/state, watershed, and local/project area.

For ease in navigating the study process and report text, the basin has been divided into distinct hydro-geographic categories for analysis. The term "basin" has been used exclusively to refer to the two-digit HUC code 05 in this plan. For the purposes of this study, the Tennessee River basin normally coded separately as 06 has been included. The term "sub-basin" in this plan refers to the four-digit HUC coded hydrologic units (15) such as the Muskingum, Scioto, Green, Cumberland, and Wabash tributaries of the mainstem Ohio River. The term "watershed(s)" in this plan refers to the eight-digit HUC coded watersheds (152), which are the smallest coded units for which data were collected and analyzed in the plan. The term "project" relates to individual site-specific infrastructure (existing or proposed), and the term "local" refers to issues and activities in municipal and county jurisdictions.

Since this reconnaissance report covers the entire Ohio River basin, most of the data collected, analyzed, and mapped through the GIS framework are displayed at the eight-digit watershed or four-digit sub-basin level. Throughout the study, data and information collected at the municipal and county level (such as US Census data) were rolled up into the watersheds so that comparisons between the watersheds could be performed and system-level alternatives could be formulated. In most cases, the data included in the appendices are listed at the watershed, county, and municipal level where available.

Using a watershed planning approach requires consideration and understanding of systems within the study area. Those natural and cultural systems are interrelated and interconnected at many nodes and along their individual pathways. Discovering the relationships between those systems allows the planner to formulate creative solutions that can affect multiple systems positively without significant adverse effects. Creativity, as part of the plan formulation process is the ability to recognize and understand relationships among systems where none are currently visible.

8.1 EXISTING CONDITIONS

The Ohio River basin is an exciting and vibrant region of the nation. With awe-inspiring scenery, a rich assortment of cultures, and a fascinating history, the basin is both a key component of our nation's economy and one of the most diverse ecoregions in the world. The Ohio River basin is essentially "water-rich" and sports a complex water storage and control system managed by several Federal agencies. Larger than California in geographic size, home to about 8% of the nation's population, and supplying a majority of the water that flows in the Mississippi downstream from Cairo, Illinois, the basin's future economic and environmental health has national implications.

8.1.1 Geographic

The Ohio River basin covers portions of 15 states and encompasses approximately 204,000 square miles (approximately 130.5 million acres). The basin is shown in Figure 1 (USACE districts, states, and county boundaries are shown). The perimeter distance of this unique geographic region is 2,874 miles. Geospatially, the basin spans 570 miles in the north/south direction and 622 miles in the east/west direction. The Ohio River basin is larger in geographic size than any of the 50 states except Alaska and Texas. The basin is bounded by the Great Lakes drainage to the north, the Appalachian Mountains to the east, the upper Mississippi River drainage to the west, and several river basins to the south and southeast that discharge to the Atlantic and Gulf coasts.

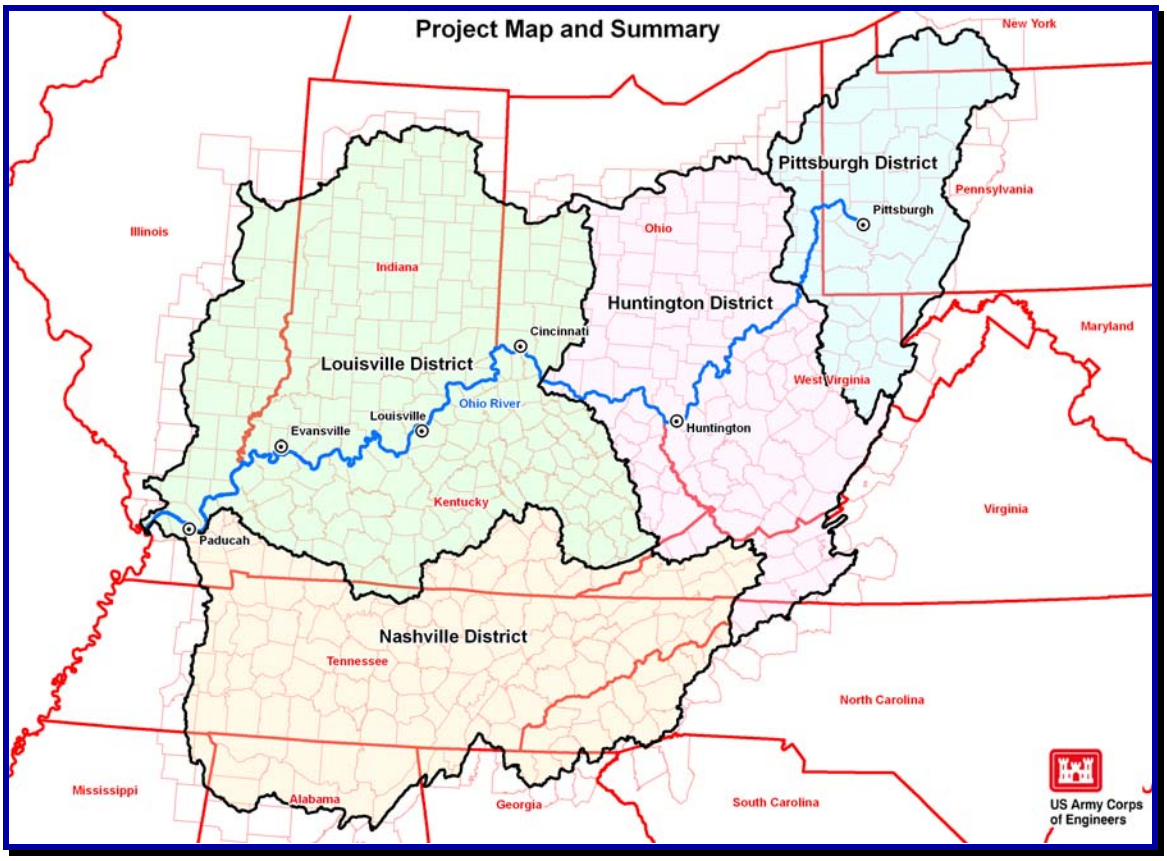


Figure 1 – Ohio River Basin Map

There are 548 counties located either wholly or partially within the boundary of the basin and 2,631 municipal jurisdictions (classified as 1,131 cities, 846 towns, and 654 villages), which govern the activities of more than 27 million basin residents. In addition, there are 408 Census-defined places (unincorporated communities) and 394 areas defined as boroughs. Many of the municipal areas operate their own sewer and water systems as well as solid waste facilities and security systems (police, fire, and emergency services). The majority of these jurisdictions also participate in the National Flood Insurance Program (NFIP) in an effort to reduce the financial impacts of flooding and to manage floodplain development. As shown in Appendix H, a great number of

these communities are also protected by LPPs that require local financial resources for O&M of aging infrastructure.

Figure 2 shows the basin's array of distinct physiographic regions, the characteristics of which are very diverse. At least seven distinct physiographic regions are present, providing a varied landscape that is home to a complex hydrologic system and equally diverse ecosystems (see Figure 19). The terrain of the basin ranges from moderate rolling hills and flat plains to very rugged mountainous areas. The eastern and southeastern edges of the basin are characterized by rugged terrain, with the Appalachian Mountains rising as high as 6,684 feet msl at Mt. Mitchell in North Carolina. In contrast, the northern and western edges of the basin are more moderate to essentially flat in slope, with northern portions of Pennsylvania, Ohio, Indiana, and Illinois being affected by past glacial activity. The basin's low point is Cairo, Illinois, at 310 feet msl.

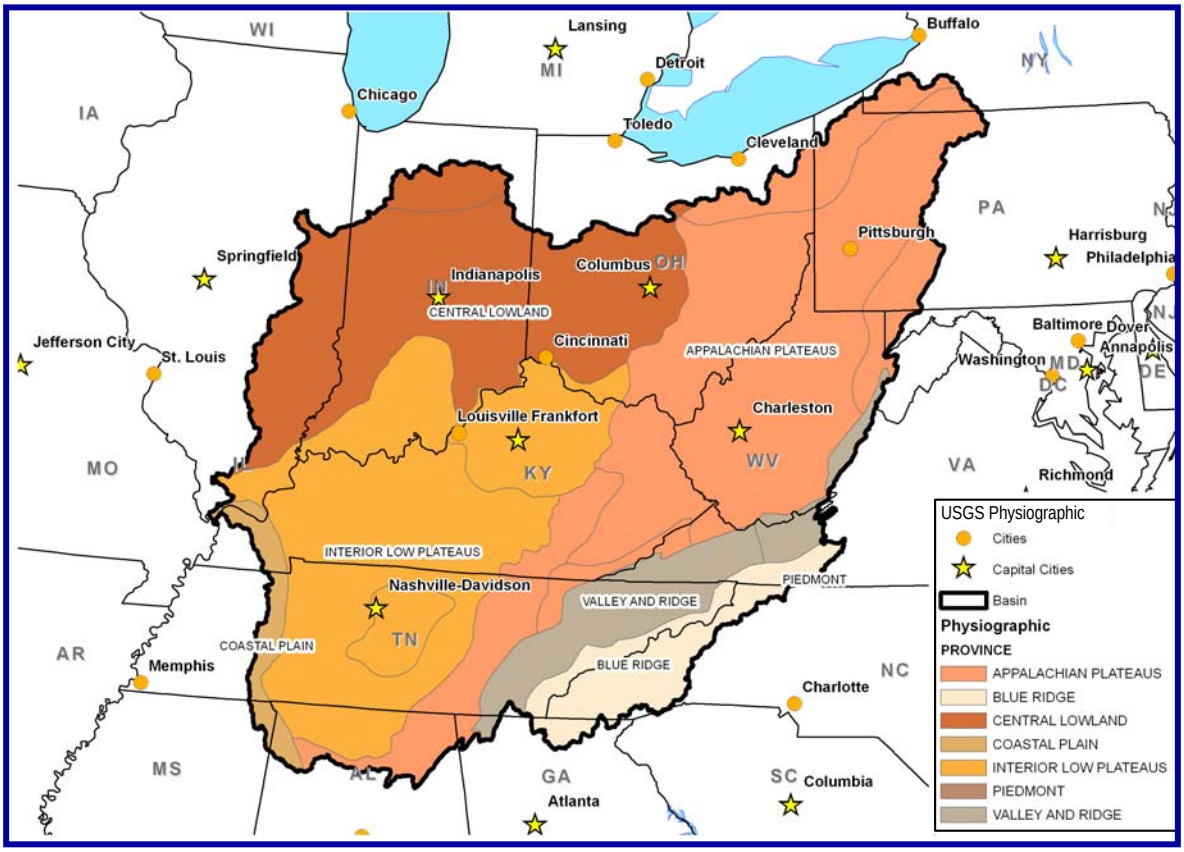


Figure 2 – Physiographic Regions (USGS Data)

Figure 3 shows the average basin elevation by HUC 8 watersheds, and Figure 4 shows the average slopes across the basin by HUC 8 watersheds. These figures show the basic topographic differences between the relatively flat terrain of the northwestern portion of the basin and the steepness of the terrain in the eastern and southeastern portions of the basin. These terrain differences have resulted in diverse land cover types across the basin that provide a kaleidoscope of flora and fauna and an aesthetic

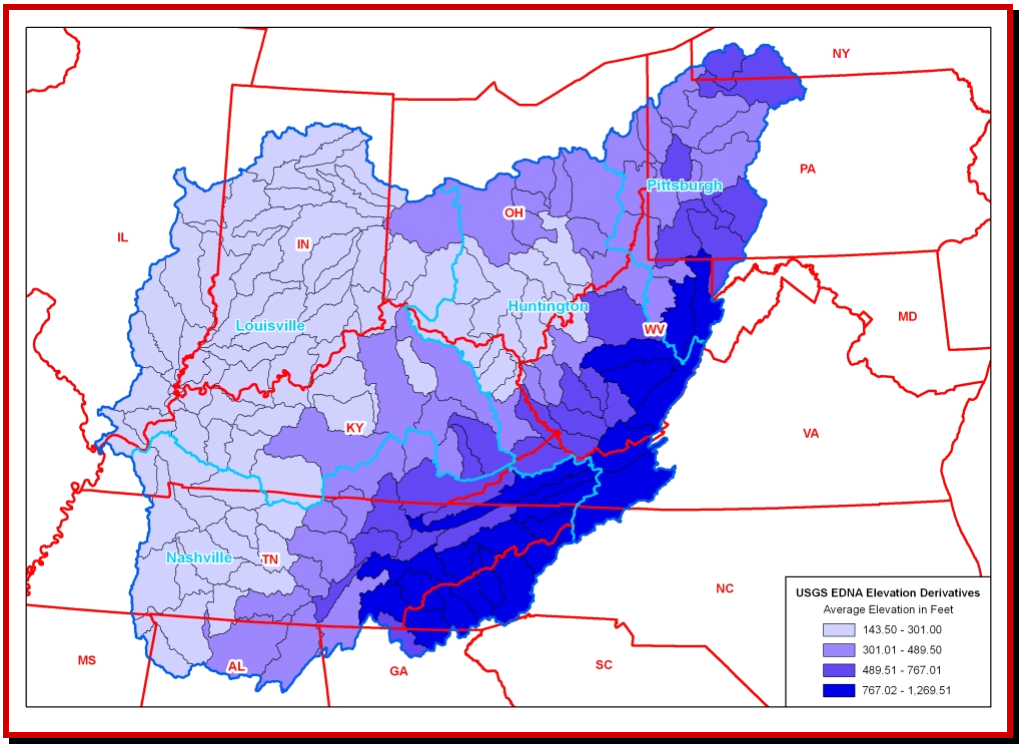


Figure 3 – Average Elevations in Feet

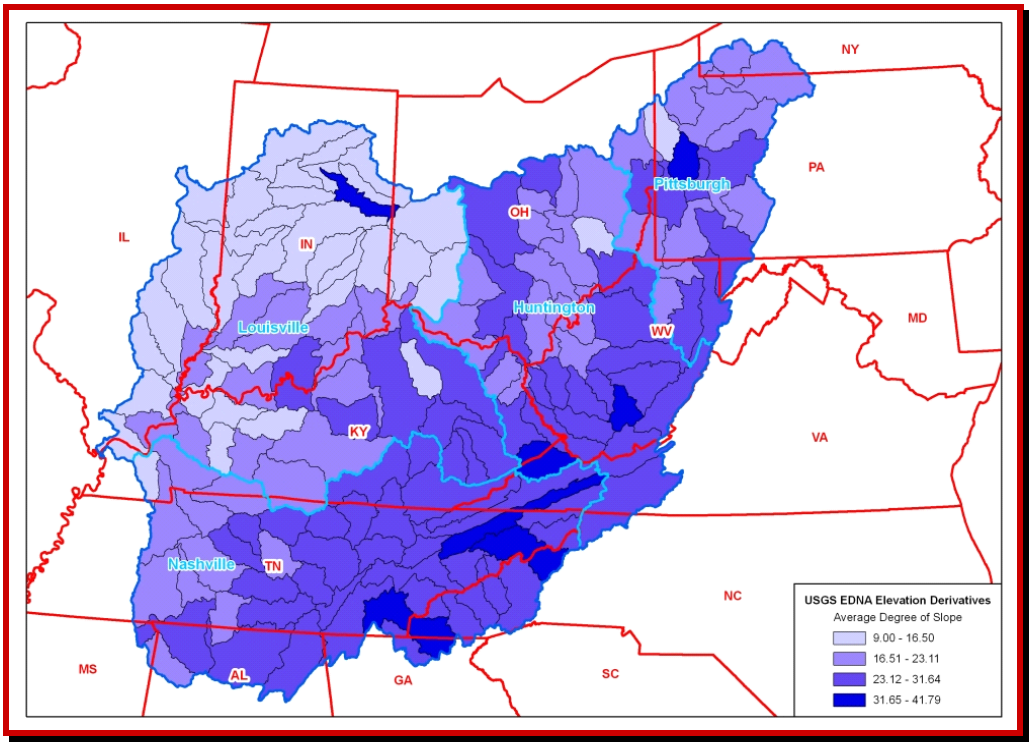


Figure 4 – Average Degree of Slope

richness found in few other river basins in the nation; this richness generates a variety of opportunities for recreation and tourism. The varied surface terrain is also emblematic of the underlying geological features of the region that have generated productive soils for agriculture, contain rich deposits of minerals and petroleum products, and are carpeted with millions of acres of valuable hardwoods and softwoods for market and wildlife habitat.

8.1.2 Land Use and Land Cover

By economic and topographic necessity, the diverse terrain generates a corresponding diversity of land uses throughout the basin. The relatively moderate to flat terrain has been dedicated to land uses that can take advantage of the flatter slopes and efficient transportation opportunities. Uses such as intensive agriculture, sprawling urban and suburban development and expansive industrial complexes populate this flatter terrain. Due to the geological variability of the eastern and southern portions of the basin; a condition that has resulted in more severe terrain, scattered urban and sub-urban land cover types have occupied the region primarily in the floodplains of river valleys. Concentration of development within the hazardous floodplains and the damages and losses of life associated with this land use pattern have been one of the basin's enduring issues.

Information on land cover types was extracted from the USGS published Anderson Level I land cover classes for both the 1992 and 2001 data. The following paragraphs describe the land cover types found in the basin and the approximate spatial extent of the types in square miles. To put the square mile figures for the land cover types into perspective for comparison sake, Connecticut is 5,544 square miles, the state of Washington is 71,303 square miles, Colorado is 104,100 square miles, and Rhode Island is 1,545 square miles in size. The entire Ohio River basin itself (204,429 square miles) is geographically larger than California.

8.1.2.1 Urban Land Cover

Urban cover constitutes approximately 6,200 square miles of the basin land surface. This category includes all areas defined by the land classification system as urban in character including incorporated and incorporated cities, towns, and villages. It also includes all industrial and commercial lands dedicated to heavy industry and intensive transportation uses (rail yards) and commercial uses such as shopping districts and malls. Although the majority of the population of the basin lives within this land cover type, the predominance of impervious surfaces in this type generates substantial amounts of excess precipitation runoff causing damages and impacting urban stream corridors. Generally the land use subcategories that comprise this cover type have between 20% and 100% impervious cover. The dichotomy of this patchwork of rural and urban areas is that 107 out of the 548 basin counties do not contain any areas defined by the US Census as an "urban area" with respect to population density – an amazing land use fact for a region with 27 million people.

8.1.2.2 Forest Land Cover

Forest lands cover approximately 103,500 square miles (50.6% of the total land cover) within the basin. Forested lands typically cover steep terrain and are home to a multitude of plant, animal and bird species as well as the birthplace of many of the tributaries that form the HUC 8 watersheds. Forested areas usually cover relatively thin layers of soil but are capable of absorbing and transpiring great amounts of rainfall without significant runoff. Besides the economic benefits generated by the production of timber and wood products from these forests, carbon sequestration is a major benefit of the great forested areas of the basin. Several National Forests (managed by the US Forest Service) and many state forests operated by the individual states are located in this region. This land cover type is subject to silviculture practices (timber harvesting) for the production of timber and wood products as well as enhancing wildlife habitat.

8.1.2.3 Cultivated

Cultivated or agricultural lands cover approximately 71,100 square miles (34.7% of the total land cover) in the basin. Figure 5 shows the extent of the cultivated land cover against the HUC 4 sub-basin outlines. Primarily this land cover type is located in Indiana, Kentucky, Ohio and Illinois with a scattered pattern in the other basin states. These lands are categorized by production of various row crops; livestock, poultry, and dairy products; orchards; and other agricultural products. This cover type has limited

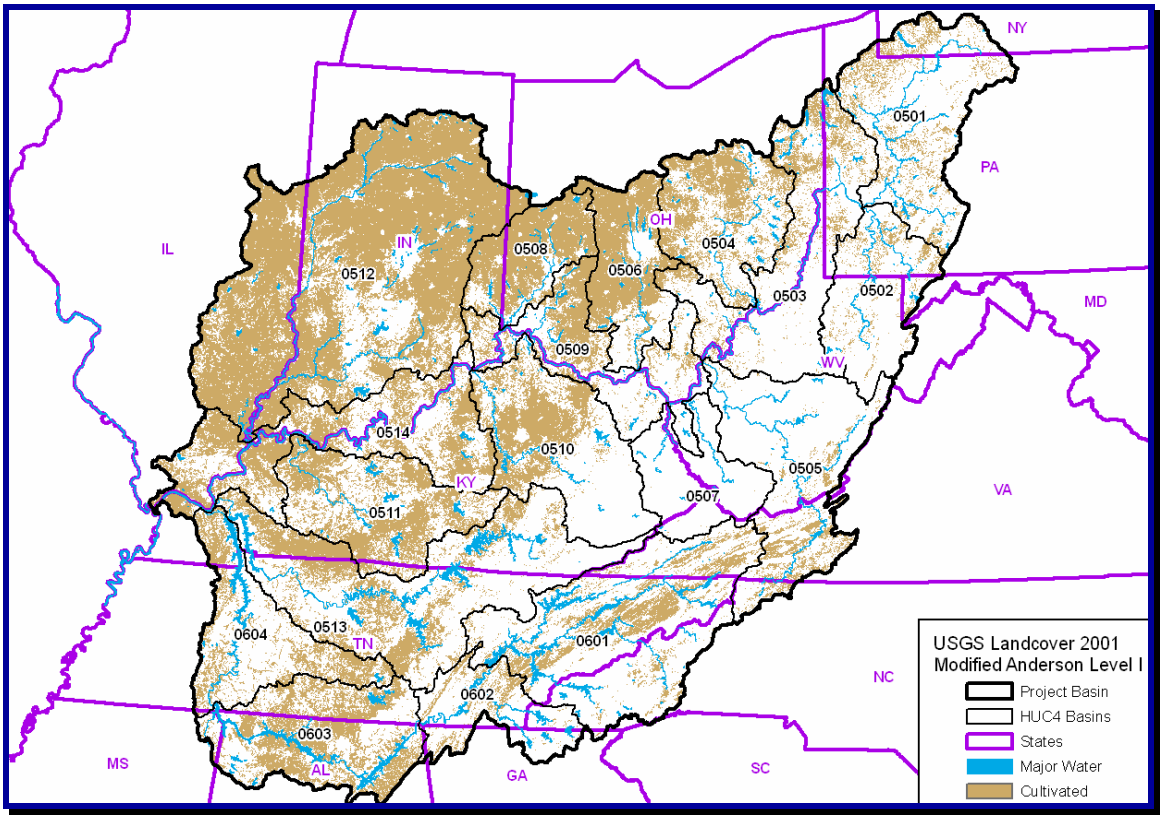


Figure 5 – Cultivated Land Cover Type

impervious surfaces as a percentage of the total land surface but is a source of point and non-point pollutants (i.e., sedimentation, herbicides, pesticides, chemical fertilizers, and *E. coli*). Portions of this cover type are highly dependent upon irrigation by surface and groundwater resources (see Figures 38 and 39).

8.1.2.4 Open Water

The land cover type described as open water covers approximately 3,000 square miles of the basin. This land cover type includes lakes, rivers, streams, ponds and any other water surface which would include all USACE, TVA, and NRCS reservoirs, recreation lakes and the Ohio River and its tributaries.

8.1.2.5 Barren

The land cover type described as barren includes 499 square miles of the basin's land surface. This land cover type includes all exposed rock, clay, soils and other mineral surfaces.

8.1.2.6 Wetlands

The land cover type described as wetlands account for approximately 1,500 square miles of the basin's land surface. These highly sensitive, diverse, and productive ecosystems are inextricably tied to the basin's aquatic habitat and water quality issues. According to the data from the 1998 and 2001 land cover mapping by NRCS, approximately 781 square miles (500,000 acres) of this land cover type were converted to other land cover types during that 10 year period (USGS data).

8.1.2.7 Shrub/Grassland

This land cover type occupies approximately 18,400 square miles of the basin. It includes successional vegetation types in previously cultivated land, golf courses, parks, low-density residential (greater than 1 unit per acre) and other uses that have predominantly pervious surfaces and relatively lower precipitation runoff.

Detailed land cover for 2001 is shown in Figure 6 against the HUC 8 watershed outlines. Figure 7 shows the distribution of land cover types in 2001 by percentages in a pie chart format. The preponderance of forest and cultivated cover is noteworthy.

Based on the comparison of USGS land cover areas in 1992 and 2001, the land cover type classified as urban increased by over 10,937 square miles (7.0 million acres), while the land cover type classified as forest decreased by 8,593 square miles (5.5 million acres) and the land cover type classified as cultivated decreased by 7,812 square miles (5.0 million acres). These land cover changes indicate a significant increase in impervious surfaces across the basin, loss of food production capability to suburban sprawl and natural succession of abandoned farmland and loss of forested areas so important to aquifer regeneration, carbon sequestration and wildlife habitat. Also of concern is that during this 10 year period, the data indicate that 781 square miles (500,000 acres) of land cover classified as "wetland" were converted to other land cover

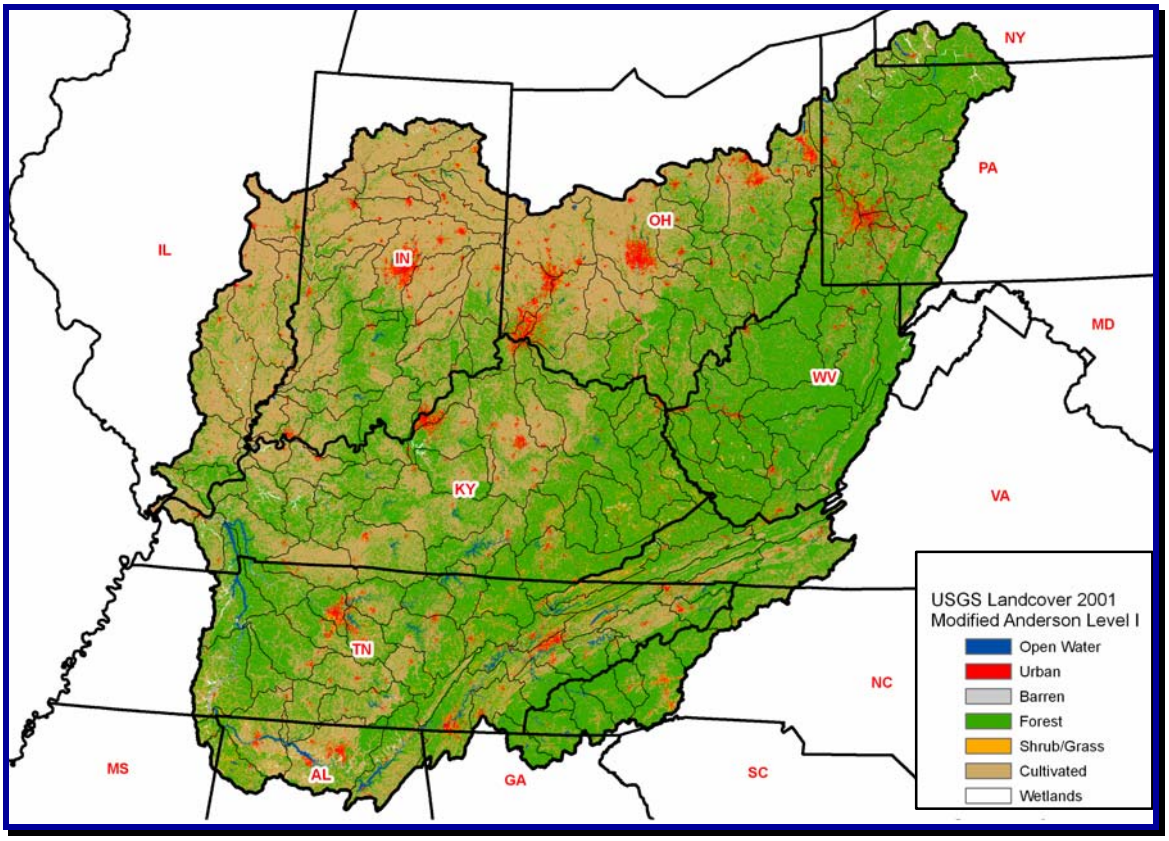


Figure 6 – ORB Land Cover Types – 2001

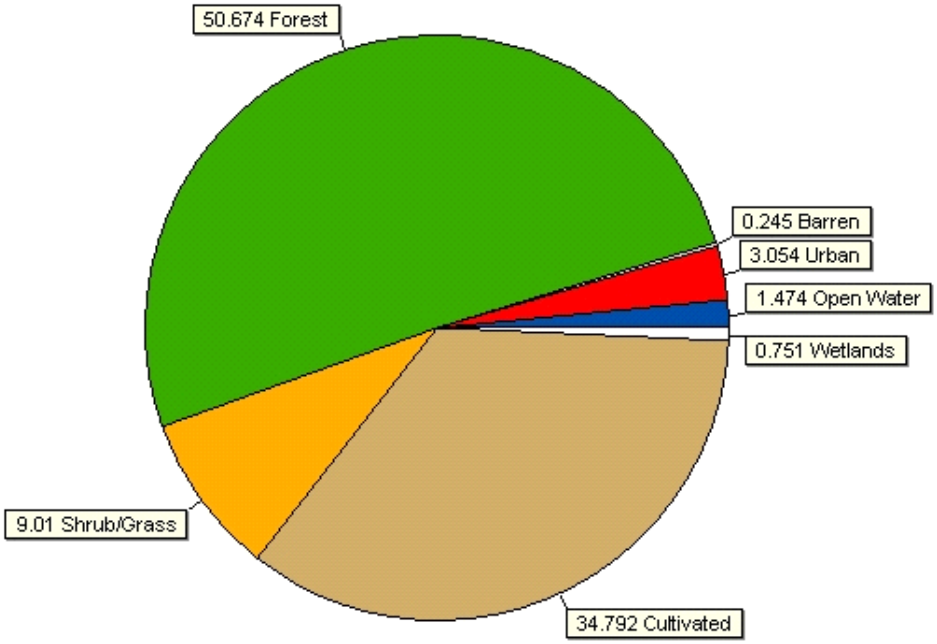


Figure 7 – Land Cover Distribution in 2001

types (i.e., open water or shrub/grass) – a significant loss of that productive, water-based basin habitat.

The land use conversion process is constrained in many urban areas through land use controls such as zoning and subdivision ordinances where such controls are in effect. Generally speaking, these controls are not in place in many of the rural areas of the basin. Federal regulatory programs maintain some control over the loss of jurisdictional wetlands and the basin states administer the National Pollution Discharge Elimination System (NPDES) permitting system.

Under the *Clean Water Act* requirements, the NPDES can control the quality of runoff from construction sites and other disturbed land areas. Although this system does reduce in-stream pollutants from some land conversions, it does little to control increased volume of stormwater runoff. Only those urban and rural areas with storm-water management ordinances can effectively control the amount of runoff by onsite storage and other methods. A database search of all basin communities and counties indicates that only a small number have stormwater control ordinances.

8.1.3 Demographics

8.1.3.1 Population

Based on the 2000 Census data, approximately 27.0 million people live in the basin. Table 1 shows distribution of that population among several statistical categories, including children less than 5 years, mature adults, educational attainment, and Native Americans. The basin is home to several resident tribes of Native Americans and historically was the home of at least eight Native American tribes. This indigenous culture yet today influences the region through its historical legacy, geographic nomenclature, basin population (91,215 in 2000 Census data), and deep appreciation for the natural environment. Consultation with existing tribes on aspects of the study will be ongoing.

Figure 8 shows the population distributed among the basin's HUC 8 watersheds. Pockets of dense population converge in the more urban areas of the basin where most of the major Interstate Highways also converge. According to the land cover data, these urban areas generally expanded by 10,937 square miles (7.0 million acres) between 1998 and 2001. It is likely that between 2001 and the present the same population expansion process has been steadily at work in the sprawling urban areas.

Projections from the US Census indicate that the basin's population is likely to increase through 2030. Table 2 shows the approximate basin population projections through 2030. The projections are based on county population trend analyses and proportional county shares of the overall state population growth rates listed by the US Census. Those projections show a potential 10.7% increase in population for the basin. This anticipated population growth signals potential increases in impervious cover, increases of non-point pollutants that impair water quality, increased stormwater runoff that affects aquatic ecology, and potential accelerated losses of sensitive habitat. Population growth also indicates future needs for expanded infrastructure, public services, and transportation capacity.

Table 1 – Population Characteristics (2000 Census)

State	Estimated Population	Less than 5 years	65 years and Older	Percent Graduates		Native Americans
				% High School	% College	
AL	863,025	59,413	126,800	71	15	7,721
GA	114,842	7,811	22,470	73	13	454
IL	659,680	39,289	97,992	79	13	1,764
IN	4,257,217	301,059	562,428	81	15	12,913
KY	3,986,376	275,049	540,310	68	12	10,418
MD	29,846	1,559	4,920	79	14	23
MS	19,163	1,150	3,399	65	9	58
NC	643,855	38,568	124,556	75	17	10,730
NY	223,705	11,703	33,270	81	16	3,055
OH	7,302,935	490,630	978,636	80	14	18,679
PA	3,392,486	169,025	564,969	82	15	5,512
SC	0	0	0	0	0	0
TN	4,299,964	306,439	631,287	69	12	15,535
VA	480,835	24,573	78,762	67	12	770
WV	1,595,861	88,271	248,658	72	12	3,583
Totals	*27,869,790*	*1,814,539*	*4,018,457*	*NA*	*NA*	*91,215*

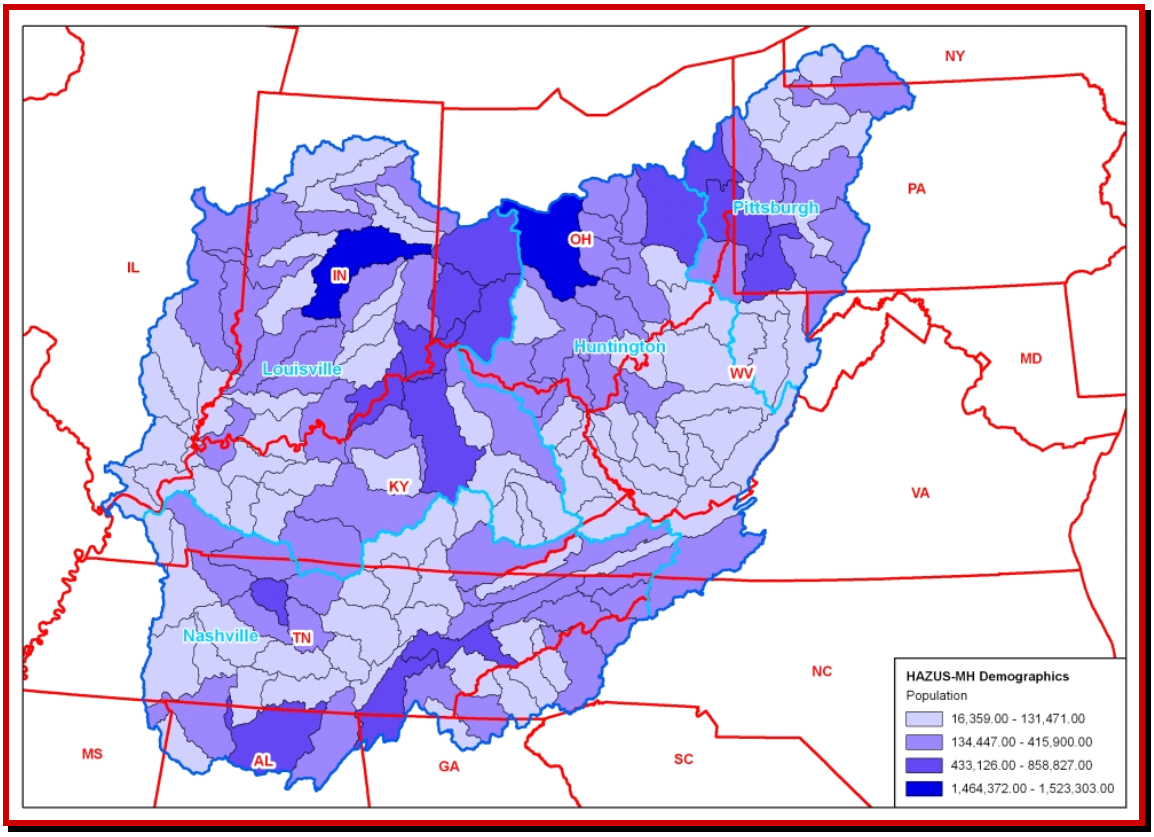


Figure 8 – Population Distribution by HUC 8 Watersheds

Table 2 – Basin Population Projections to 2030 (Based On Basin County Data)

State	2000	2005	2008	2030
AL	863,025	892,861	930,495	1,024,576
GA	114,842	127,374	133,978	163,338
IL	659,680	659,226	661,224	640,937
IN	4,257,217	4,388,320	4,482,729	4,826,863
KY	3,986,376	4,111,364	4,214,805	4,507,165
MD	29,846	29,660	29,698	31,153
MS	19,163	18,867	18,947	18,183
NC	643,855	674,856	700,681	848,160
NY	223,705	216,519	213,477	172,128
OH	7,302,935	7,459,917	7,542,606	7,993,245
PA	3,392,486	3,308,116	3,274,718	2,906,250
SC	0	0	0	0
TN	4,299,964	4,579,380	4,797,376	5,930,877
VA	480,835	475,081	477,418	477,168
WV	1,595,861	1,565,849	1,561,895	1,376,014
Totals	*27,869,790*	*28,507,390*	*29,040,047*	*30,916,057*

The basin's population density varies widely due to the presence of many heavily populated urban areas interspersed among vast areas of topographically challenged rural landscape. The presence of vast acreages of corporately and publicly owned forested and mineral-laden lands, Federally managed lands (e.g., National Forests, Wilderness Areas, Wildlife Refuges, National Parks), or state parks and forests significantly reduces the density of population across several watersheds.

Figure 9 shows the basin's population densities displayed in the HUC 8 watersheds. Evident within the graphic is the location of the basin's densely populated urban centers such as Pittsburgh, Pennsylvania; Columbus, Ohio; the Cincinnati/Dayton, Ohio, complex; Nashville, Tennessee; Indianapolis, Indiana; and Louisville, Kentucky (in the darker blue color). These major centers of population are the economic engines for the basin and their needs for reliable water supply, flood protection, energy and recreation represent significant demands upon the basin's water resource development. Much of the basin's recent expansion of urban land cover has occurred in and around these centers. Urban sprawl continues to affect the basin's natural resources, water resources and increases pressure on public infrastructure (sewer and water systems and transportation network). Projected population increases through 2030 can only further exacerbate these issues.

Another indicator of the economic strength of the basin is the numerous Metropolitan and Micropolitan Statistical Areas (MSAs) that represent the primary urban economic engines of the region. The Combined Statistical Areas (cross-hatched areas) are an amalgamation of the Metro- and Micro-Areas, showing more intensive economic ties between urban areas. These densely populated centers connected by the Interstate Highway System and complete with higher education facilities, financial institutions, governmental agencies and industrial facilities provide the surrounding population with

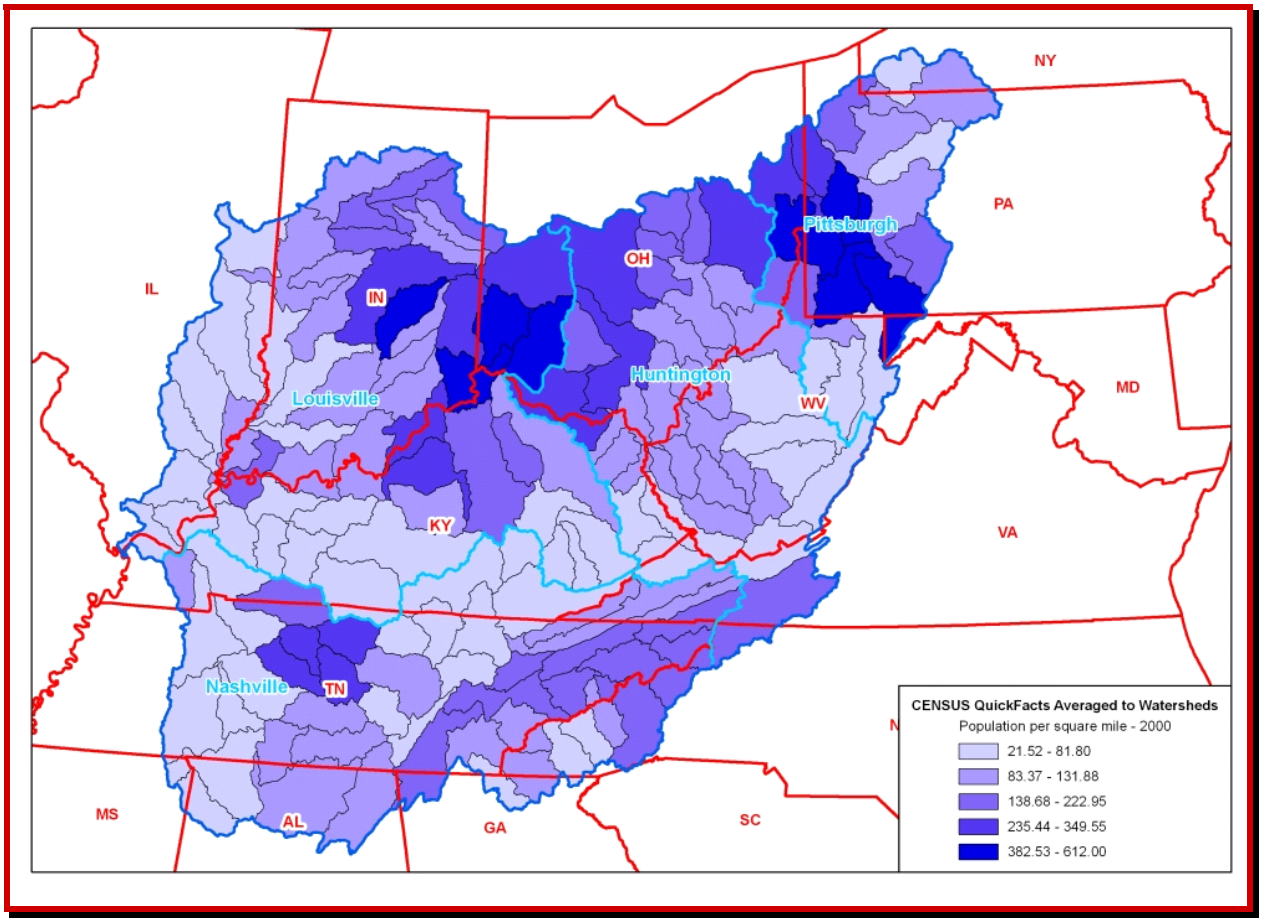


Figure 9 – Population Densities within the HUC 8 Watersheds

the financial, legal, educational and employment support necessary to sustain the region. These critical masses of globally connected production, innovation, and both financial and human capital imbedded within the region symbolize the significance of the basin to the nation. A number of the MSAs shown are protected from flood damages by the existing USACE protection system (reservoirs and LPPs). Figure 10 shows the distribution of the Combined Statistical Areas, and both Metropolitan and Micropolitan Statistical Areas within the region.

With the advent of the upcoming 2010 Census, data on the basin's population are likely to show an increase if recent projections are correct. This increase will place even greater demands upon the basin's infrastructure and water resources. As the rate of household formation increases in the basin and along its boundary, demands for municipal and industrial (M&I) water supply, sewage collection and treatment, land cover conversion, placing additional acres of impervious materials for new residences, commercial, institutional, and industrial development, and recreation facilities will soar. Each of these demands will further strain the existing infrastructure already in place and may support demands for additional infrastructure and facilities.

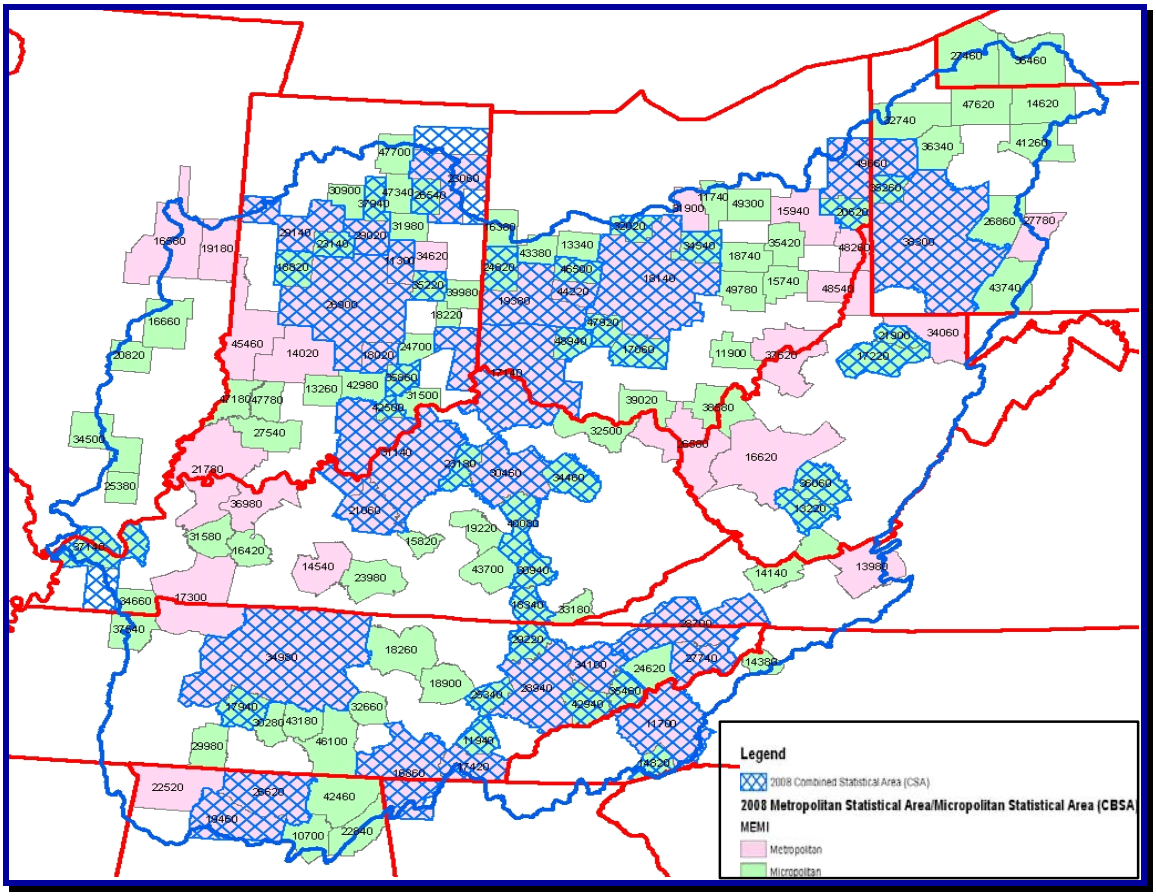


Figure 10 – Metropolitan Statistical Areas

8.1.3.2 Household Development and Residential Housing

Population growth has several secondary effects within the basin, one of which is the social formation of households. Whether as a result of marriage, singles moving away from home, or separations and divorces, household formation is a process that generates demand in the housing market – a demand that eventually results in construction of new dwelling units of several types (see single-family construction permits below). Although Census data indicate that household formation may be slowing recently (more singles are moving in with each other and young adults are returning to live with their parents), the demand for new housing units continues in the basin despite the housing mortgage woes.

Existing residential housing in the basin is a mixture of both aged and relatively new housing units scattered across the rural landscape in dense urban areas, small villages and towns as well as rural farmland areas. Significant concentrations of housing units are located within the urbanized areas as high-density development while more single-family and medium density multi-family units populate the suburban areas extending (sprawl) outwards from most of the major cities. Table 3 shows the distribution of housing units by type and age across the basin states.

Table 3 – Households and Housing Characteristics

State	Households	Persons per Household	Dwelling Units	Unit Types		Unit Age	
				Single Family	Multi-Family	<1970	>1970
AL	327,559	2.52	208,514	207,001	1,513	123,867	250,410
GA	67,336	2.54	45,152	44,904	248	24,119	60,008
IL	234,434	2.52	144,263	143,260	1,003	104,638	122,490
IN	1,669,372	2.57	1,098,001	1,086,103	11,898	642,435	903,370
KY	1,568,250	2.54	942,217	923,529	18,688	592,669	1,059,554
MD	9,391	2.58	6,382	6,335	47	4,192	10,256
MS	8,852	2.45	5,893	5,872	21	3,763	7,958
NC	257,646	2.41	153,457	150,465	2,992	100,705	228,897
NY	62,718	2.55	39,613	37,816	1,797	22,411	24,947
OH	2,850,342	2.56	1,842,864	1,795,602	47,262	1,205,974	1,371,003
PA	1,373,090	2.47	927,976	905,631	22,345	616,631	480,739
SC	0	0.00	0	0	0	0	0
TN	1,701,816	2.52	1,053,126	1,035,809	17,317	623,400	1,273,496
VA	211,589	2.49	122,781	122,033	748	83,382	150,047
WV	652,511	2.44	402,835	399,070	3,765	277,791	384,431
Totals	*10,994,906*	*NA*	*6,993,074*	*6,863,430*	*129,644*	*4,425,977*	*6,327,606*

Of note is the presence of a large number of housing units constructed before 1970 – the year when the National Floodplain Insurance Program was enacted. A portion of these pre-1970 units were likely located within what are now identified as flood hazard areas by FEMA. These units remain subject to frequent flooding even though many have flood insurance to offset the costs of flood damages. Many of these units also were constructed before the current building standards for energy efficiency and fire safety were enacted in the basin.

Although the recent downturn in the US economy and the prevalence of home mortgage foreclosures have likely slowed the number of new housing starts in the basin, housing construction had been on a steady pace within the basin prior to this reversal. Table 4 shows the numbers of construction permits issued for single-family dwelling units across the states in the basin in 2007. Figure 11 shows the distribution of the building permits for 2007 across the basin by HUC 8 watershed. At a modest third of an acre of land per single-family unit (1/3 acre per lot accounts for roads and open space), this number of permits amounts to an additional 35,400 acres (55 square miles) of land occupied by single-family residences. This additional development does not account for expansion of school facilities, new retail development or transportation improvements to serve the residents and children of these new homes.

Table 4 – Construction Permits for Single-Family Homes in 2007

State	Permits Issued in 2007
NY	345
PA	6,244
WV	2,110
OH	19,053
VA	1,588
KY	14,925
TN	30,651
IL	1,938
IN	16,681
NC	6,757
MS	3
AL	5,847
GA	1,344
SC	0
Total	*107,486*

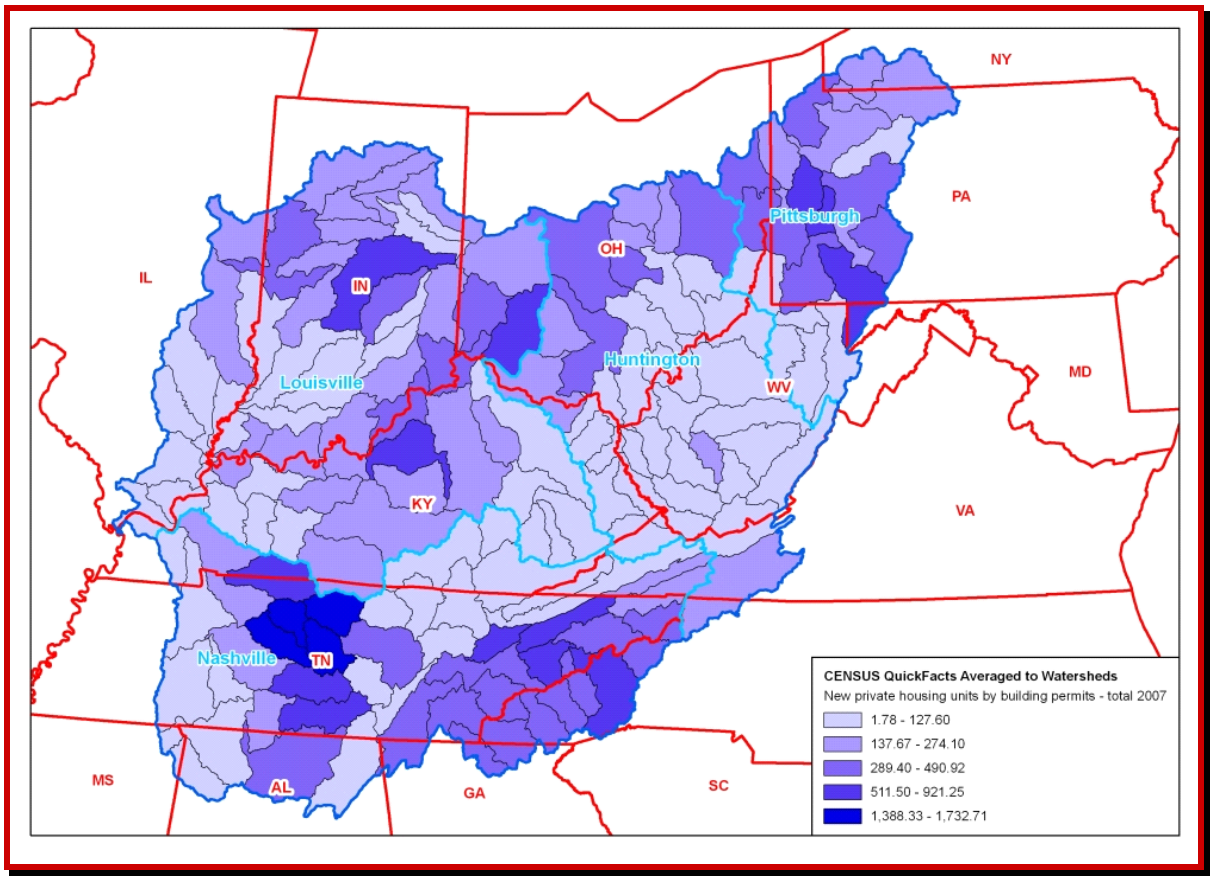


Figure 11 – Building Construction Permits in 2007

This historical pattern of residential growth in the basin is indicative of the growing issues of environmental impacts due to land conversion (especially sprawl surrounding urban centers) and increased and largely uncontrolled stormwater runoff from these new developments. Growth of new rural subdivisions prompted by extensions of sewer and water systems developed by public service districts has further fragmented wildlife habitat and either diverted stream channels or submerged many streams in pipes during subdivision construction. In some urban locations of the basin this sprawl pattern has been stemmed through strategic land use zoning and purchasing of development rights programs.

The City of Lexington, Kentucky and Fayette County, Kentucky (known as the Lexington-Fayette Urban County Government) have operated a Purchase of Development Rights (PDR) program since 2000. Under this program, development rights have been purchased from numerous land owners located within the county outside of the city's incorporated limits for the purposes of reducing costs of extending public service infrastructure, and protecting the scenic resources (horse farms and agricultural lands) that surround the city. Over 20,000 acres of land have been placed in permanent conservation easements through this program. In addition to protecting valuable natural resources (stream courses, riparian corridors and forests), this PDR program reduces the placement of additional impervious surfaces leading to increased storm-water runoff while maintaining a portion of the taxable land value for the county.

Duplication of this program as either a TDR (Transfer of Development Rights) or a PDR program such as used in the Lexington-Fayette Urban County Government example could be an effective local solution to increased urban sprawl and its effects on natural resources and waterways within the basin. Considering the substantial increase in urban land cover within the basin between 1992 and 2001 – a trend that has likely been maintained or increased since 2001, use of these land conservation measures could help to reduce the negative effects of new development. Additional information on this effective PDR program and the benefits associated with land conservation can be found at http://www.lexingtonky.gov/index.aspx?page=497.

In addition to an active housing construction market, the basin households exhibit a tendency for home repairs, remodeling and owner expansion. Based on the number of successful major home repair and construction materials retail and wholesale centers that reside in the basin, this is a profitable sector of the economy. One national home improvement store chain has over 200 locations within the basin providing employment.

8.1.3.3 Basin Economics and Employment Characteristics

The basin has a long history of both commercial and basic industrial sectors that support the regional and national economy. Historically the basin has included significant manufacturing, fabrication, materials processing, mining, chemicals, petroleum products, construction, transportation, timbering, agriculture and livestock, and service industries. In addition to these basic sectors of the economy there are major employment categories in educational services (K-12, community colleges, 4-year colleges and universities and vocational schools); financial, real estate and insurance services; professional services; health care; and thousands of public service jobs at the Federal, state, and local levels of government.

Major commercial and industrial complexes are scattered throughout the basin, but many are clustered around the metropolitan statistical areas where multimodal transportation, population and communications merge. Several specialty sectors locate nearby raw material sources (mineral processing and wood products) or alongside relatively inexpensive transportation routes like the inland waterway navigation system. Many coal-fired power plants locate along the navigable waterways to take advantage of the relatively inexpensive transportation of coal by barge and the presence of vast quantities of cooling water.

Despite decades of losses in manufacturing employment to other regions of the US and foreign locations, the basin maintains a formidable presence in several basic-sector employment categories. Commercial and industrial sectors within the basin are exporters of coal, natural gas, timber, grain, machinery, vehicles and vehicle components, steel, aggregates, manufactured goods, fabricated metals, specialty metals and alloys, cement, and prepared foods. The expanding and improving transportation routes of several modes (highway, airway, railway and waterway) continue to make the region a profitable one for manufacturers, wholesale distributors and big-box retail warehousing. Transportation of freight on the region's railways, highways and waterways has been growing rapidly. Table 5 shows the estimated numbers of individuals employed in various commercial, industrial and government sectors of the basin economy.

To exemplify the strength of the basin economy in several employment sectors, the location quotients for the basin counties were calculated using US Bureau of Labor Statistics data and compared with the nation and among the counties in the basin. Figures 12 through 14 show the location quotients for several sectors.

A location quotient equal to or greater than 1.00 shows that the county is an exporter of production in a certain good or service and contrariwise a location quotient less than 1.00 (0.99 or less) shows that the county is an importer of a certain good or service. For the employment sectors shown, there are several counties (and groups of counties) that are not only exporters of that particular good or service, but are several orders of magnitude greater than all counties in the nation. In these particular economic sectors of employment and production, the basin shows to be a powerful engine within the American economy as an exporter of several primary goods and services including natural resources and mining, construction and manufacturing.

8.1.3.4 Personal and Household Incomes

Of the many measures of wealth and purchasing power within a population is the statistic of personal and household incomes. The income statistics (personal and household income) are shown in Table 6 for the basin area. Although the basin still has pockets of poverty and economic need, the basin as a whole possesses great wealth and purchasing/investment power. The percentages of the national medians for personal and household incomes in each state indicate the relative economic ranking of the basin within the nation.

Table 5 – Employment by Commercial, Industrial and Government Sectors (2007 Census Data)

AL	GA	IL	IN	KY	MD	MS	NC	NY	OH	PA	SC	TN	VA	WV	Totals
Construction															
17,097	1,493	9,043	99,884	75,750	1,068	232	21,549	2,347	144,252	67,326	0	98,752	6,765	28,609	574,167
Education and Health Services															
30,750	4,906	33,009	239,564	220,177	1,602	635	43,766	12,014	468,471	276,669	0	254,987	18,918	99,153	1,704,621
Financial Activities															
13,610	1,444	10,536	98,122	90,751	442	176	9,869	2,238	185,523	79,838	0	105,633	4,602	25,352	628,136
Goods-Producing															
104,902	5,900	54,789	466,041	362,308	2,468	2,454	53,744	19,071	620,781	243,812	0	409,798	44,074	108,873	2,499,015
Information															
4,064	216	4,820	25,459	28,512	137	36	3,330	1,034	56,871	25,974	0	39,080	1,625	8,900	200,058
Leisure and Hospitality															
34,047	4,368	24,408	196,926	170,691	1,598	319	38,872	8,641	320,365	136,441	0	211,833	14,626	63,174	1,226,309
Manufacturing															
85,763	3,717	37,961	350,434	251,134	927	2,155	28,706	15,771	461,322	160,316	0	298,417	29,514	49,499	1,775,636
Natural Resources and Mining															
2,038	193	4,654	15,137	28,491	473	68	2,774	953	15,257	16,499	0	8,245	7,088	26,299	128,169
Other Services															
8,192	789	6,780	57,722	44,881	306	87	6,941	3,520	101,589	51,861	0	52,421	3,742	18,818	357,649
Professional and Business Services															
56,877	2,142	18,301	199,863	175,064	951	153	23,185	4,501	417,500	169,000	0	220,242	11,700	51,019	1,350,498
Service-Providing															
216,678	22,720	148,954	1,214,341	1,103,701	7,629	2,373	179,899	47,236	2,214,562	1,024,397	0	1,297,656	91,368	388,423	7,959,937
Trade, Transportation, and Utilities															
69,006	8,792	50,727	393,329	370,592	2,588	968	52,664	15,207	662,693	284,603	0	411,985	33,655	122,877	2,479,686
Unclassified															
	18	45	105	1,777	5		1,229	82	769	16	0	637	2	149	4,834
Federal Government															
37,716	531	8,695	60,811	75,024	152	134	8,334	1,282	103,798	45,699	0	66,536	3,993	36,211	448,916
Local Government															
96,291	9,295	60,060	365,360	242,576	1,331	1,553	58,659	31,993	594,603	172,766	0	202,636	27,099	123,917	1,988,139
State Government															
15,085	750	0	111,283	145,441	221	85	16,019	3,821	154,780	24,793	0	56,532	5,605	32,382	566,797

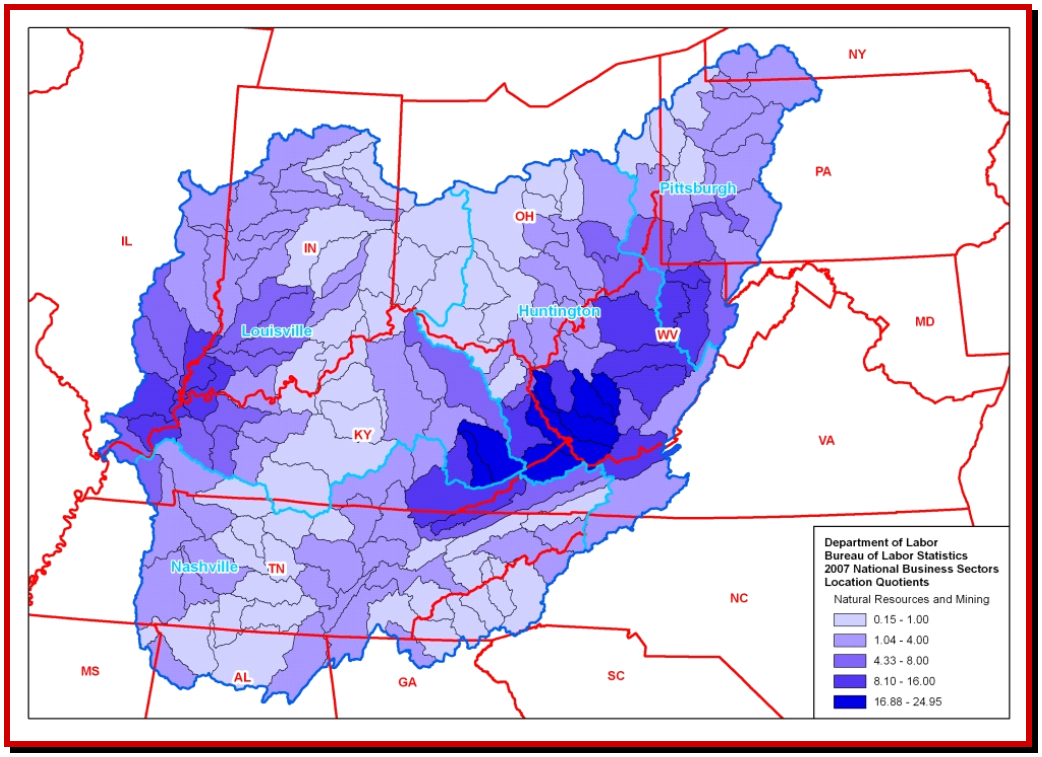


Figure 12 – Location Quotient for Natural Resources and Mining

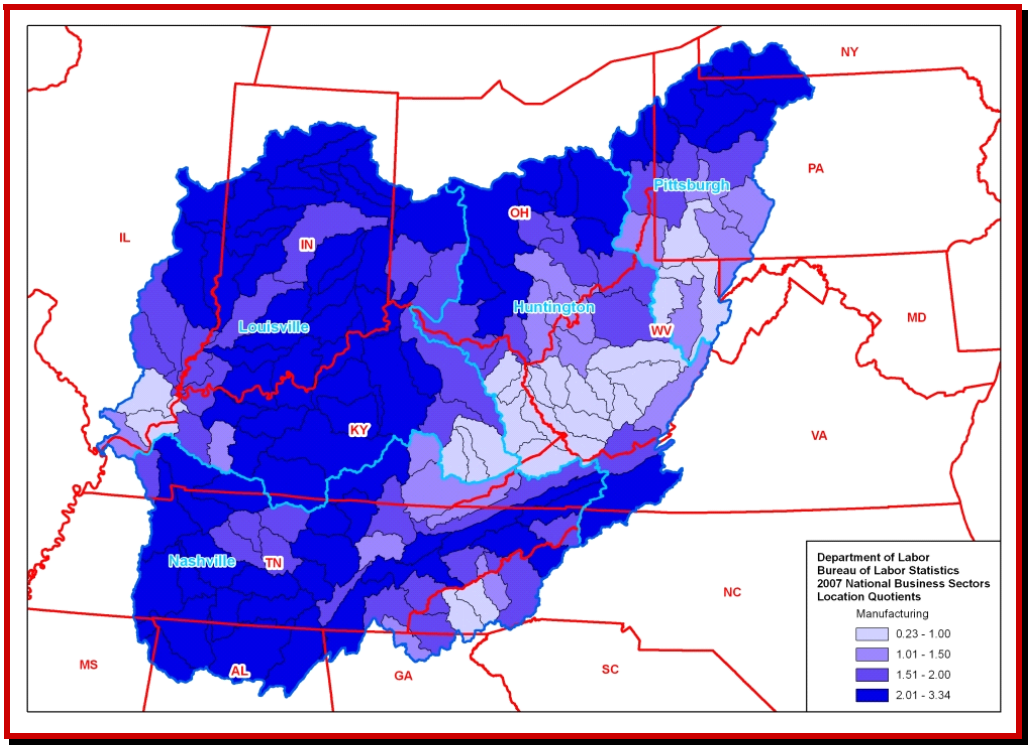


Figure 13 – Location Quotient for Manufacturing

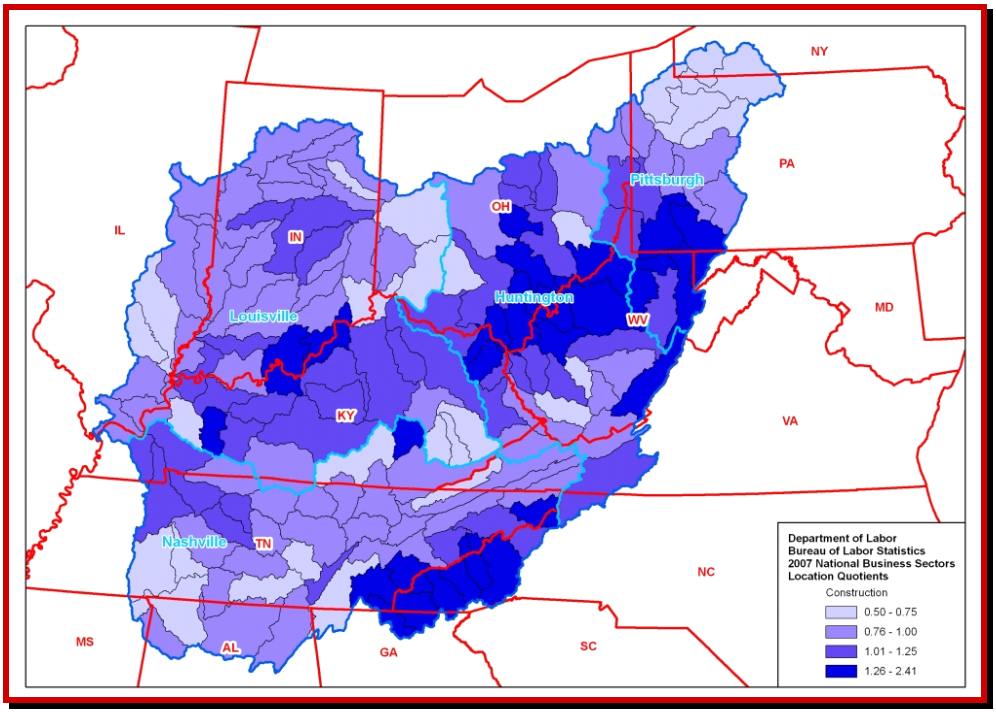


Figure 14 – Location Quotient for Construction

8.1.4 Hydrology

8.1.4.1 Surface Waters

The Ohio River basin is classified by USGS as a two-digit "Hydrologic Unit Code" (HUC) watershed. The Tennessee River basin is normally classified as a separate two-digit HUC, but for the purposes of this reconnaissance study has been added as a portion of the Ohio River basin. This complex hydrologic region drains approximately 130.5 million acres. The mainstem of the Ohio River originates at Pittsburgh, Pennsylvania, at the confluence of the Allegheny and Monongahela Rivers, and flows 981 miles to its mouth on the Mississippi River at Cairo, Illinois.

The Ohio River basin is composed of 15 four-digit HUC sub-basins, including the Allegheny, Monongahela, Muskingum, Upper Ohio, Scioto, Great Miami, Wabash, Kanawha, middle Ohio, Guyandotte/Big Sandy, Licking/Kentucky, Green, Cumberland, Lower Ohio, and Tennessee rivers. Figure 15 shows the sub-basins that drain into the Ohio River mainstem, and Table 7 lists the sub-basins with key characteristics, including population (estimated from US Census data), size in square miles, and total existing retention structures (USACE, TVA, and NRCS). Appendix I has detailed descriptions of each four-digit HUC sub-basin.

The basin is further divided into 152 eight-digit HUC watersheds, from which data were extracted to support the report. Figure 16 shows the array of the 152 eight-digit HUC watersheds in the basin (see the detailed listing of eight-digit HUC watersheds in Appendix I).

Table 6 – Personal and Household Incomes

State	Personal Income	National Median	% of National	Household Income	National Median	% of National
AL	$27,909	$36,714	76%	$39,743	$50,740	78%
GA	$26,455	$36,714	72%	$41,214	$50,740	81%
IL	$26,217	$36,714	71%	$40,014	$50,740	79%
IN	$29,437	$36,714	80%	$46,698	$50,740	92%
KY	$24,674	$36,714	67%	$37,290	$50,740	73%
MD	$28,310	$36,714	77%	$42,041	$50,740	83%
MS	$21,365	$36,714	58%	$33,123	$50,740	65%
NC	$26,163	$36,714	71%	$37,871	$50,740	75%
NY	$27,168	$36,714	74%	$39,878	$50,740	79%
OH	$27,959	$36,714	76%	$44,767	$50,740	88%
PA	$29,571	$36,714	81%	$39,650	$50,740	78%
SC	NA	$36,714	NA	NA	$50,740	NA
TN	$26,312	$36,714	72%	$38,785	$50,740	76%
VA	$19,805	$36,714	54%	$34,419	$50,740	68%
WV	$25,199	$36,714	69%	$34,530	$50,740	68%

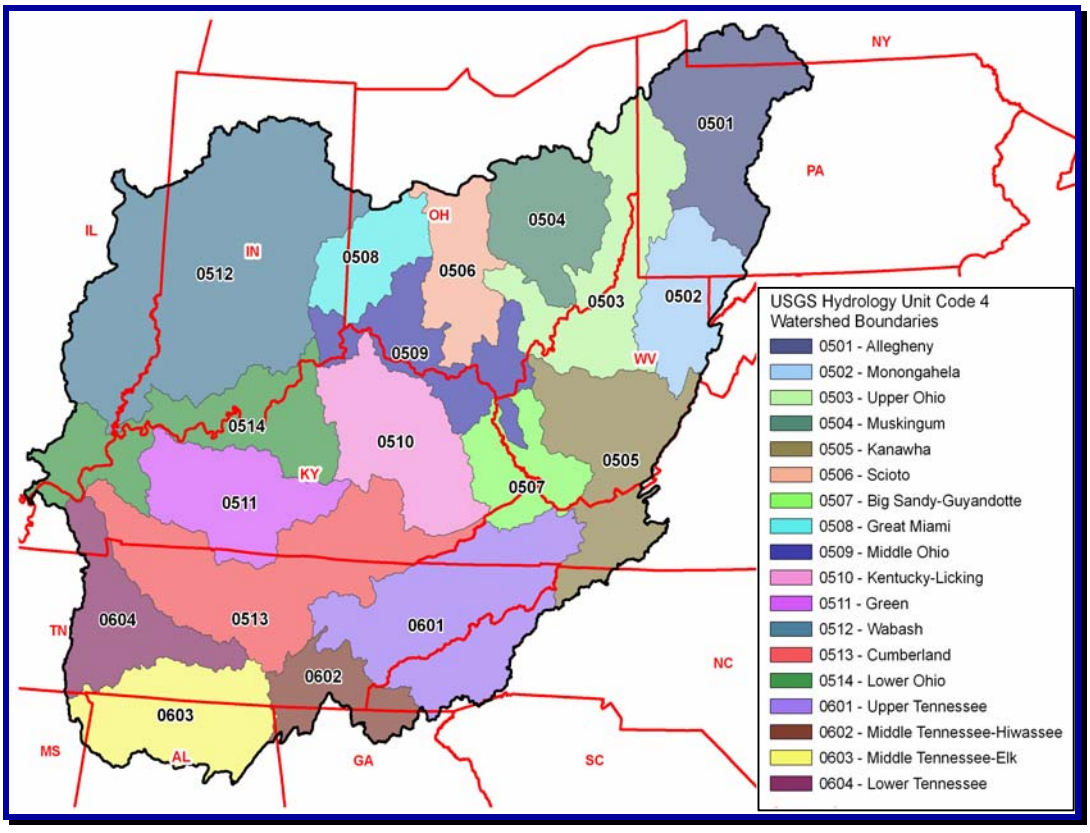


Figure 15 – Four-Digit HUC Coded Sub-basins

Table 7 – Four-digit HUC Coded Sub-basins

Sub-basin Name	Size (Square Miles)	Estimated Population	Number of FRR Projects
Allegheny River	11,655.8	1,419,772	46
Monongahela River	7,370.6	1,431,075	58
Upper Ohio	13,344.8	2,516,806	129
Muskingum River	8,095.4	1,491,110	49
Kanawha River	12,278.0	904,947	40
Scioto River	6,506.5	1,739,786	22
Big Sandy/Guyandotte Rivers	5,965.8	439,664	14
Great Miami River	5,409.6	1,537,932	25
Middle Ohio	8,941.3	2,103,595	51
Kentucky/Licking Rivers	10,687.2	1,111,117	92
Green River	9,276.1	623,048	99
Wabash River	33,166.3	4,066,268	266
Cumberland River	17,941.8	2,108,403	61
Lower Ohio	12,698.9	1,866,845	118
Upper Tennessee River	17,303.3	2,307,194	71
Middle Tennessee/Hiwassee	5,228.7	731,389	48
Middle Tennessee/Elk	10,429.9	1,028,885	26
Lower Tennessee	8,130.0	478,601	45
Totals	*204,429.9*	*27,906,440*	*1260*

8.1.4.2 Precipitation and Runoff

Annual precipitation amounts testify to the abundance of water in the basin and the humid climate of the region. Figure 17 shows the average annual rainfall across the basin between 2000 and 2007. Although there is variability in the rainfall distribution across the basin over several years, the recent trend has been rainfall in the southern watersheds and less precipitation in the northern watersheds. Future projections indicate a potential reversal of this trend. Precipitation gages operated through the Integrated Flood Observing and Warning System (IFLOWS) by the National Weather Service (NWS) are shown in Appendix R. Runoff is a function of the terrain (flatter to the west and north and steeper to the east and south), the soil associations and geology and the percentages of land cover in each watershed that feature more or less impervious surfaces. Generally, about 80% of the land surface of Ohio and 85% of the land surface of Kentucky drains into the Ohio River. Runoff from the Ohio River basin generates 60 percent of the flow in the Mississippi River at Cairo, Illinois.

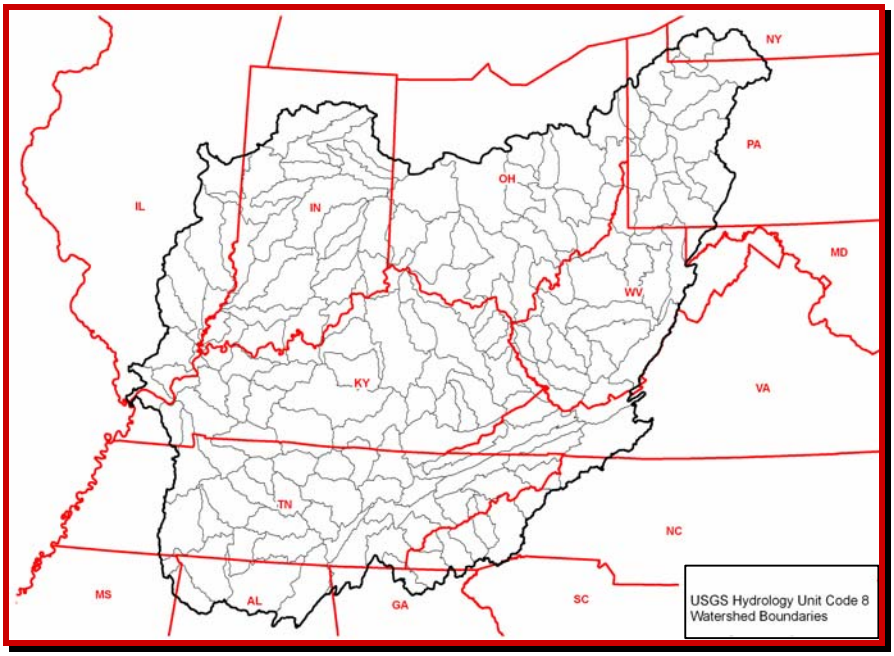


Figure 16 – Eight-Digit HUC Coded Watersheds

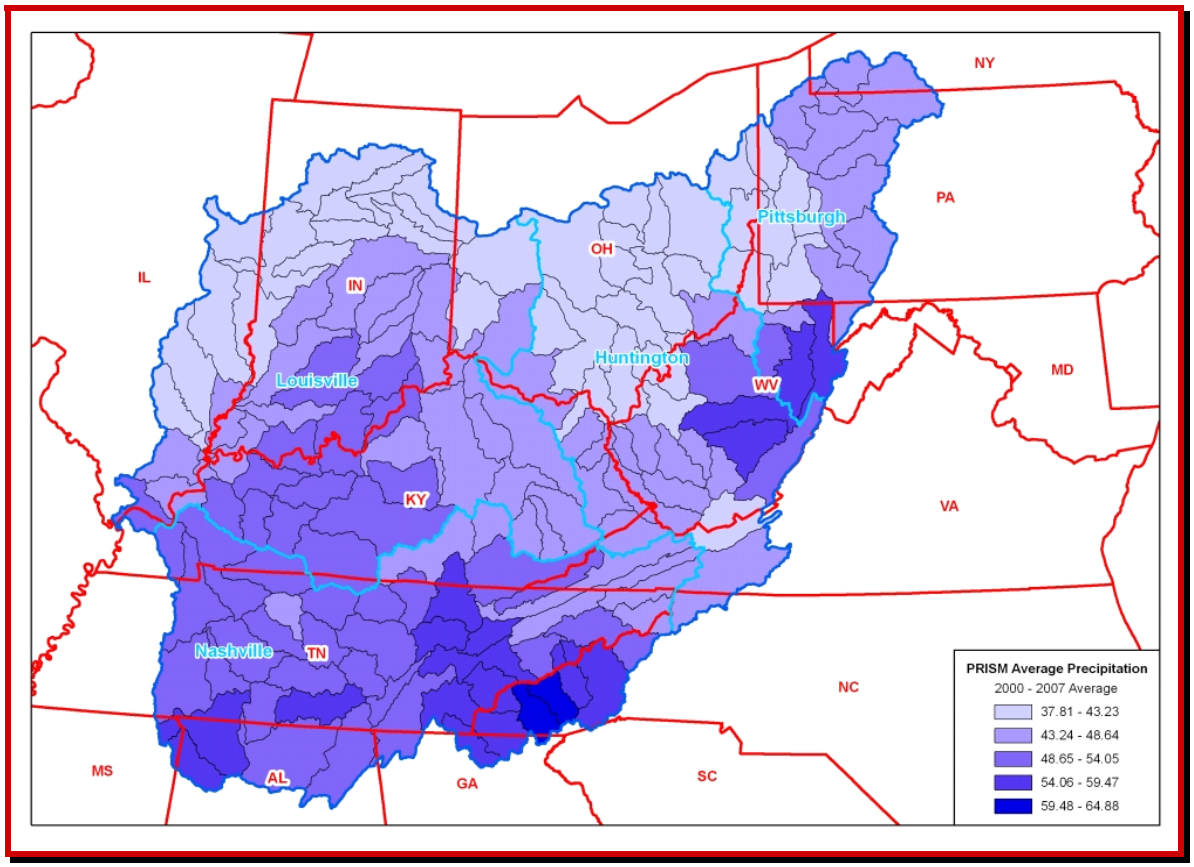


Figure 17 – Average Annual Precipitation (2000–2007)

8.1.4.3 Groundwater

Another key feature of the basin's hydrology is the presence of numerous underground aquifers that provide substantial sources of groundwater throughout the region. Figure 18 shows the major groundwater aquifers in the basin. With the exception of several areas of karsts topography and other geologic anomalies, most of the basin has access to some groundwater supplies. A majority of rural communities and rural residential units derive drinking water from individual wells (or well fields) – a fact that emphasizes the importance of reliable rainfall amounts and avoidance of groundwater contamination.

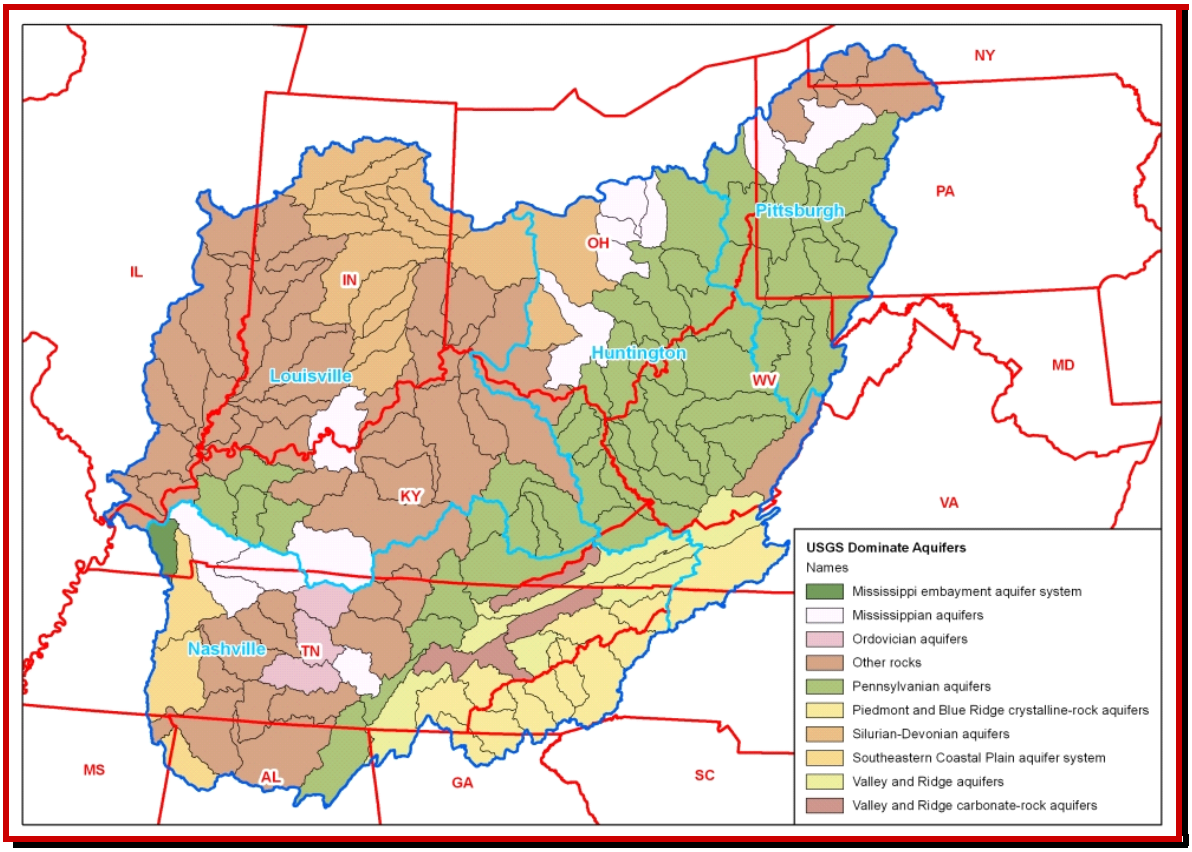


Figure 18 – Groundwater Aquifers

Surface water and groundwater supplies are inextricably linked and activities that adversely affect surface waters may have similar adverse effects on the groundwater supplies as well. In the mountainous areas, surface waters including rivers and artificial lakes comprise a significant proportion of the water supply opportunities due to the extreme depths of groundwater. Generally groundwater resources are adequate for low-density rural residential use, but due to iron content and other groundwater quality issues in well water, provision of potable water through public service districts is required in many rural areas of the basin. The dense urban areas of the basin require substantial water supplies that are available from both subsurface aquifers and major rivers or man-

made lakes. Figure 36 and 37 show the geographic extent and volumes of water being extracted (surface and groundwater) for public supplies.

There are a number of recognized threats to groundwater supplies including contamination by wastewater treatment facilities (septic systems and inadequate treatment plants), hazardous and toxic waste sites, minerals extraction processes, dewatering through excavation, leaking underground storage tanks (petroleum and other stored materials), acid mine drainage, pesticides and herbicides, landfills, injection wells, impervious material placement, and many others. These various land uses locate contaminates (liquids or solids) in close proximity to aquifer recharge areas where surface contamination can easily percolate into the aquifer and affect drinking water supplies. Land use disturbances such as deep excavations and channeling of rivers can dewater shallow aquifers that may supply local drinking water. The USGS monitors groundwater quality through a system of wellhead gages. Over 20,500 groundwater monitoring gages are present in the basin. Figure 44 and 45 in Appendix R show the distribution of these gages.

Several of the basin states have established Wellhead Protection Programs approved by USEPA in accordance with the *Safe Drinking Water Act of 1974* (as amended). These programs attempt to protect groundwater that supports individual wells and well fields used for drinking water supplies.

8.1.4.4 Water Quality

Among the many regional water quality monitoring programs, the monitoring system that supports the USEPA “Impaired Waters” program is one of the most comprehensive systems. Based on Sections 303(d) and 305(d) of the *Clean Water Act* (as amended), this system monitors numerous parameters of water quality used by the states to fulfill their reporting requirements in these two sections of the Act. Data from the monitoring gages is fed into the “Storage and Retrieval” (STORET) and “Water Quality Exchange” (WQX) data storage systems that can be accessed by the public and agencies through the internet. Although ORSANCO is the primary organization monitoring the water quality of the mainstem Ohio River, the USEPA “Impaired Waters” program includes stream and river water quality data on all basin surface waters.

The impaired waters program includes a comprehensive database with information on the location and miles of streams and rivers having impaired water quality, and specifies (based on state reports) what pollutants may be responsible for the impairment designation. Both point and non-point sources of pollutants (e.g., bacteria, sediment, ammonia, PCBs, etc.) are identified in the database. Land uses from which uncontrolled and untreated surface water runs off into the rivers are a major contributor to the listing of so many streams with impaired water quality; only one watershed out of the 152 HUC 8 watersheds in the basin did not include any designation of “impaired water” in its streams.

USEPA and ORSANCO are currently working with the states and communities along the Ohio River mainstem to develop Total Maximum Daily Limits (TMDL) for a range of pollutants. The TMDL standards would support and better define the requirements to address the many CSOs along the mainstem Ohio River. Additional information on the

water quality monitoring and improvements championed by ORSANCO and other challenges in the Ohio River mainstem is included in the Aggregated Issues Section of this report.

The USGS also operates approximately 17,000 water quality monitoring gages in the region. Several water quality parameters for surface and groundwater are monitored at hundreds of well sites by the USGS. Table 17 in Appendix R shows the distribution of these gages and Figure 42 and 43 display the geographic extent of the water quality gaging system.

8.1.4.5 Streamgage Network

There is an extensive basin streamgage network operated by USGS, USACE, NWS, and other Federal and state agencies. Streamgages are used for forecasting flood conditions (including flash flooding), gathering historical streamflow data, and monitoring water quality. Key components of the flood risk reduction system, stream flow (discharge) and stage elevation streamgages are the primary sources of information upon which many other flood response decisions are based.

According to the Hydrometeorological Automated Data System (HADS), there are more than 1,400 streamgages in the basin, with more than 520 continuously recording streamgages. These gages provide real-time readings of flow and stage elevation, which are observable online and also are transmitted to NWS to support flood warnings and river-stage forecasts. USGS uses the gaging system to collect historical data on stream discharges (to monitor long-term flood and drought conditions). More information on the USGS streamgage system can be found at www.usgs.gov. USACE maintains a number of streamgages for the purpose of operating its 83 reservoirs.

The IFLOWS (Integrated Flood Observing and Warning System) operated by NWS provides continuous stage data through a network of 112 stream gages in seven states. IFLOWS also collects data from 948 precipitation gages in this same region. These data support flood-warning and -forecasting information distributed by NWS. Figures 39 and 40 in Appendix R show the geographic extent of the IFLOWS gaging system.

O&M of the gaging system is funded through a number of cooperating agencies including USGS, NWS, USACE, NRCS, TVA; Department of the Interior, Department of Agriculture, and the individual states. A number of reporting streamgages have been discontinued throughout the basin due to a lack of funding from one or more sources. Loss of the gages represents a gap in the flood warning detection system, and loss of real-time data could imperil any number of floodplain residents within that particular watershed. Ongoing O&M funding for streamgages is a pervasive problem throughout the basin. As one crucial component of the overall flood risk reduction system in the basin, the flow (discharge) and stage information provided by the gaging system; information that supports flood forecasting needs to be reliable and uninterrupted.

8.1.5 Ecological

The Ohio River basin is nationally and internationally renowned for its array of eco-regions with a diversity of flora and fauna species that distinguishes it from other basins

within the nation. Portions of at least 16 separate and distinct Level III ecoregions can be identified within the basin. Figure 19 shows the Level III ecoregions that compose the basin landscape. The Tennessee River and Cumberland River sub-basins are two of the richest ecological regions in the nation and are reportedly two of the richest in terms of species diversity in the world. Several Threatened and Endangered (T&E) fish and mussel species inhabit their waters. Table 8 shows the list of T&E species by state divided between vertebrates, invertebrates and plants. A vast array of aquatic species inhabit the waters of the basin making it one of the most diverse and productive ecoregions in the nation. There are at least 625 species within the 15 states that fall under the protection of the *Threatened and Endangered Species Act*. Figure 20 shows this distribution among the states. Although numerous T&E fish and mussel species still exist in the basin, numerous mussel species have been extirpated from the basin.

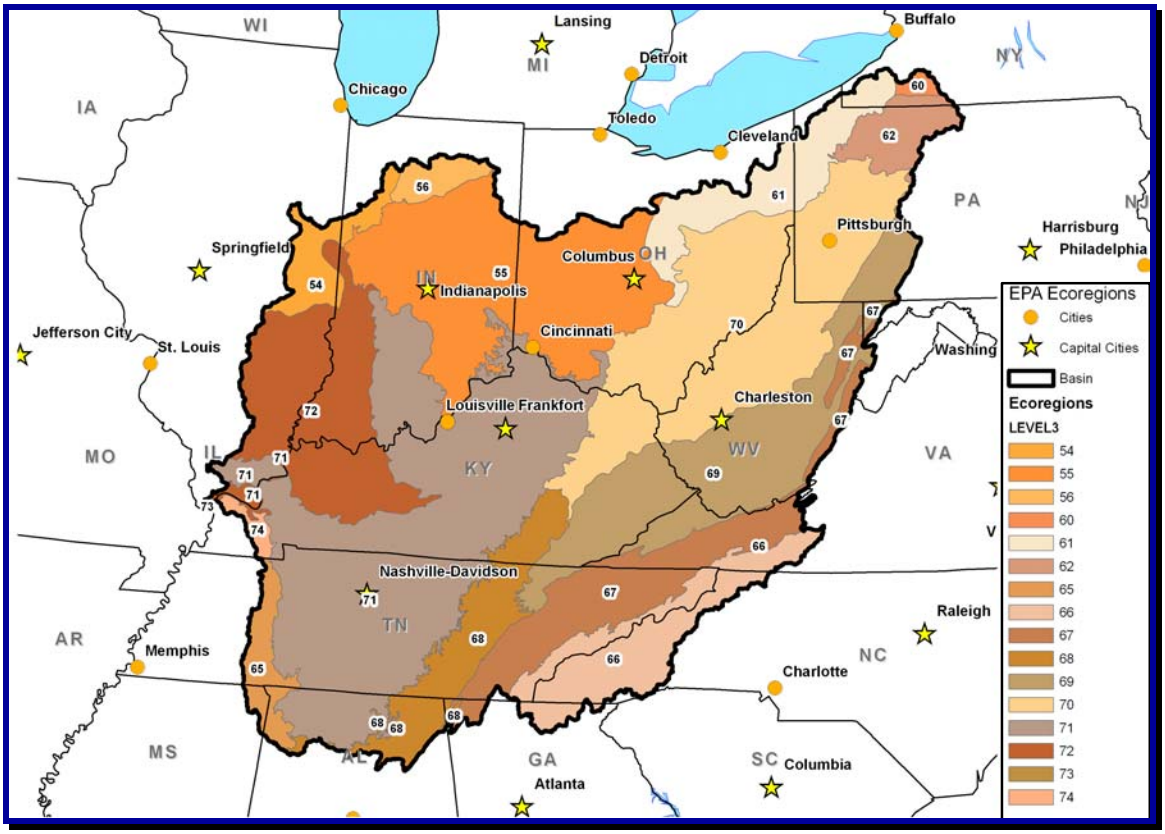


Figure 19 – Level III Ecoregions (USEPA Data)

8.1.6 Climate

The broad geographic expanse (latitude and longitude) of the basin coupled with the wide differences in elevation make for a variety of climatic conditions throughout the basin. Generally the climate can be characterized as being temperate, but based on the Köppen classification of climates in North America, the Ohio basin lies within two major climate sub-zones – the humid continental climate and the humid subtropical climate. Figure 21 shows the distribution of climatic regions across the basin.

Table 8 – Threatened and Endangered Species by Basin State

State	Vertebrates	Invertebrates	Plants	State Totals
AL	33	47	17	97
GA	26	14	24	64
IL	6	12	9	27
IN	6	15	5	26
KY	10	20	8	38
MD	14	3	7	24
MS	25	9	4	38
NC	22	9	27	58
NY	14	3	6	23
OH	6	9	6	21
PA	3	8	3	14
SC	18	1	19	38
TN	19	41	19	79
VA	22	23	15	60
WV	4	8	6	18
Totals	*228*	*222*	*175*	*625*

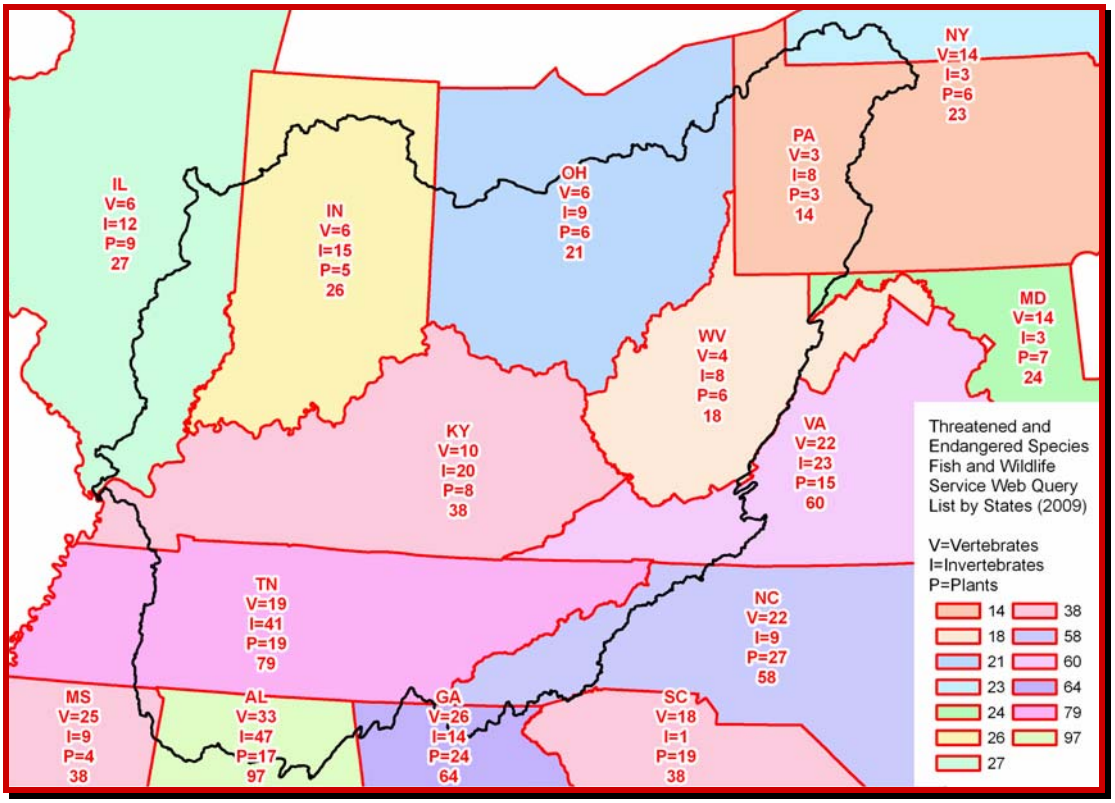


Figure 20 – Distribution of Threatened and Endangered Species

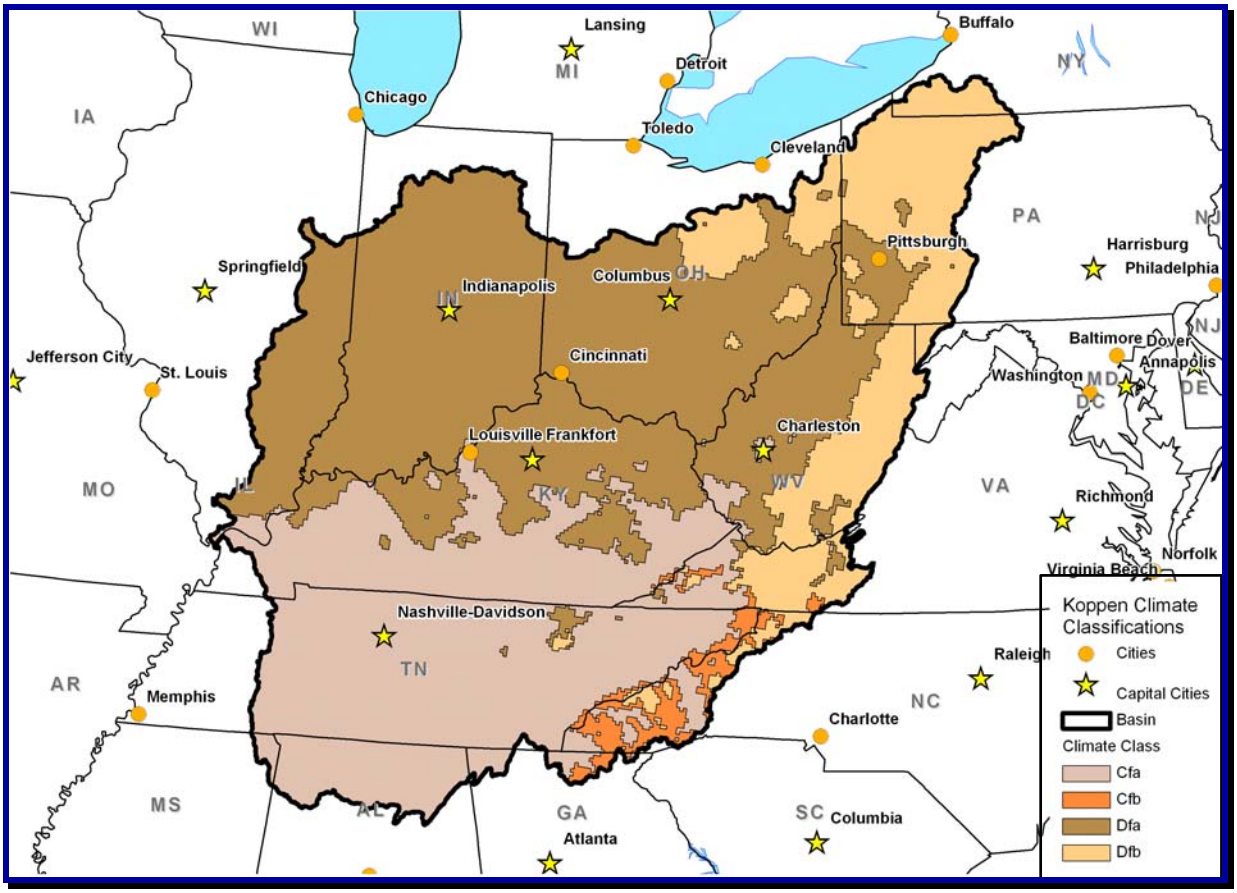


Figure 21 – Climatic Regions

The humid continental climate (Köppen *Dfa* or *Dfb*; see Figure 21) is a climate found over large areas of landmasses in the temperate regions of the mid-latitudes where there is a zone of conflict between polar and tropical air masses. The humid continental climate is marked by variable weather patterns and a large seasonal temperature variance. The seasonal temperature variance can be as great as 33° Celsius, but is typically about 15–22°C (59–72° Fahrenheit). The temperature differences between the warmest and coldest months increases as one moves further inland and away from the moderating influence of the ocean. This climatic sub-zone is found in the northern portions of the basin, in portions of Pennsylvania, New York, West Virginia, and Ohio.

The humid subtropical climate (Köppen *Cfa* or *Cfb*; see Figure 21) is a climate zone characterized by hot, humid summers and chilly to mild winters. This climate type covers a broad category of climates, and the term "subtropical" may be a misnomer for the winter climate. Significant amounts of precipitation occur in all seasons in most areas. Winter rainfall (and sometimes snowfall) is associated with large storms that the westerlies steer from west to east. Most summer rainfall occurs during thunderstorms and an occasional tropical storm, hurricane or cyclone. This sub-zone is present in portions of Kentucky, Tennessee, North Carolina, South Carolina, Alabama, and Mississippi in the basin.

The climate of the basin has a significant effect on the character, productivity, and diversity of the ecosystems in the region. In a like manner, the land cover and economic viability of the basin are largely determined by the availability and quality of water. From municipal and industrial water supply users to agricultural irrigation and recreation users, any future threats to the present abundance of water must be taken seriously. Potential future changes in the climate characteristics of the basin could threaten supplies of water that would be available to support the many users within the basin. Likewise temperature changes could threaten agricultural and silvicultural production as well as flora and fauna associations common in the basin. More emphasis on the potential impacts of climate change is addressed in the issues section.

8.1.7 Historical, Archaeological, and Cultural Resources

The Ohio River basin has a rich history of past settlements, cultures and archeological resources. Since the earliest explorers and settlers ventured into the basin in the late 1600s, there has been an ongoing social process of confrontation, assimilation, cooperation and ethnic blending that has resulted in the rich diversity of folklore, heritages, stories and regional personalities that can be seen today in the architecture, speech, music, customs and values of the people.

Information gleaned from the archaeological work prepared for the US Fish and Wildlife Service for the Ohio River Islands National Wildlife Refuge indicates that a number of Native American groups populated the Ohio River basin since at least 10,550 BC. At that time the Paleo-Indian society inhabited portions of the basin and thrived as a highly mobile, hunter-gatherer culture. Evidence of their culture is found through portions of Kentucky, Ohio, and Pennsylvania in stone tools and the classic fluted “Clovis” projectile points. This group was followed by Native American groups in the Archaic period in the basin. This period of habitation spanned about 7,000 years and the culture was primarily small bands of mobile hunters and gatherers although the society utilized river corridors and adopted a “patch” methodology of mobile sustenance. The late Archaic Period is characterized by the introduction of some horticultural practices and societal changes. Neither of these two early habitations had much permanent effect on the landscape because of their highly mobile nature and failure to create any permanent settlements – only their artifacts remain.

The next periods of Native American habitation, starting about 2,500 BC, were more community based and established settlements and forts that are part of the evidence of their existence today. The Woodlands period lasted for about 4,000 years and included the Adena culture in the Ohio River valley. Known for their burial mounds, extensive trading practices, and other earth-moving ventures within the basin, the Adena culture thrived within the basin and began the first substantial settlements that we see evidence of today. The later stages of the Woodland period saw densely occupied settlements on terraces of major rivers. Significant, protected archaeological sites of this type abound throughout portions of the basin.

This “Hopewell” assemblage of artifacts from this period spans an area from western New York to Kansas City and from the Gulf of Mexico to Lake Huron. This cultural pattern of existence clearly overlaid much of the basin. The Late Prehistoric period of Native American culture lasted about 700 years during the Woodland period and was in

place when the first European contacts were made. Within this Late Prehistoric period, the Fort Ancient and Mississippian and locally the Monongahela cultures inhabited portions of the Ohio River basin. These cultures established great settlements with forts and community plazas and burials moved from mounds to cemeteries and within homes. Some permanent settlements were arranged in circular patterns around central courtyards with stockades for protection.

The Seneca, the Cherokee, the Chickasaw, the Creek, the Shawnee, the Iroquois, the Miami, and the Catawba nations encountered the first adventurous elements of European culture. At this time some of the native cultures were based on well-established settlements with sophisticated societies and productive agriculture. Despite the devastating effects of diseases introduced by Europeans, wars between the new invaders and indigenous peoples, and other societal differences, the Native American cultures endured well into the 18th century, and many live within the basin today.

As early as 1669, La Salle (a French explorer) led an expedition of fur traders into the Ohio River corridor and became the first recorded Europeans to see the river. La Salle's expedition was halted, ironically, at the Falls of the Ohio, where today the McAlpin Lock and Dam operates and where one of the larger metropolitan cities within the basin now stands (Louisville, Kentucky).

The "forks" of the Ohio (Monongahela and Allegheny) were recognized early on as being of strategic military importance. Thanks to La Salle, the French claimed the Ohio River until 1763, when the river was ceded to Great Britain after the French and Indian war. Prior to that transfer of ownership, the Ohio Company with a land charter from King George II (Great Britain) established a settlement at the "Forks" (now Pittsburgh), and soon Fort Prince George was under construction. Prior to its completion, the French gladly recaptured the site and named the military outpost Fort Duquesne in 1754. Not to be denied, the British recaptured the site in 1758 and renamed the site Fort Pitt. Following the French and Indian war, the British were in firm control until 1783, when the fort and the Ohio River were turned over to the United States. Shortly afterward, the Ordinance of 1787 was passed, and the Northwest Territories were opened for development. Figure 22 shows the locations of historical places and structures within the basin (US Department of Interior data).

The march westward for many colonists and settlers started with a trip south along the Ohio River (one of the major waterways in the region), to points such as Marietta and Cincinnati, and as far as St. Louis on the Mississippi, where wagon trains launched overland to new settlements in the mid-west and west. Due to the unimpeded current of the Ohio, many river boats were left or deconstructed for basic building materials, and new boats were built in Marietta and Pittsburgh. Eventually the Ohio River became a part of a larger commercial waterway system that stretched to New Orleans and other foreign ports. The Louisiana Purchase in 1803 secured the rights to this important waterway system and made the Ohio River an important part of the young nation's economy.

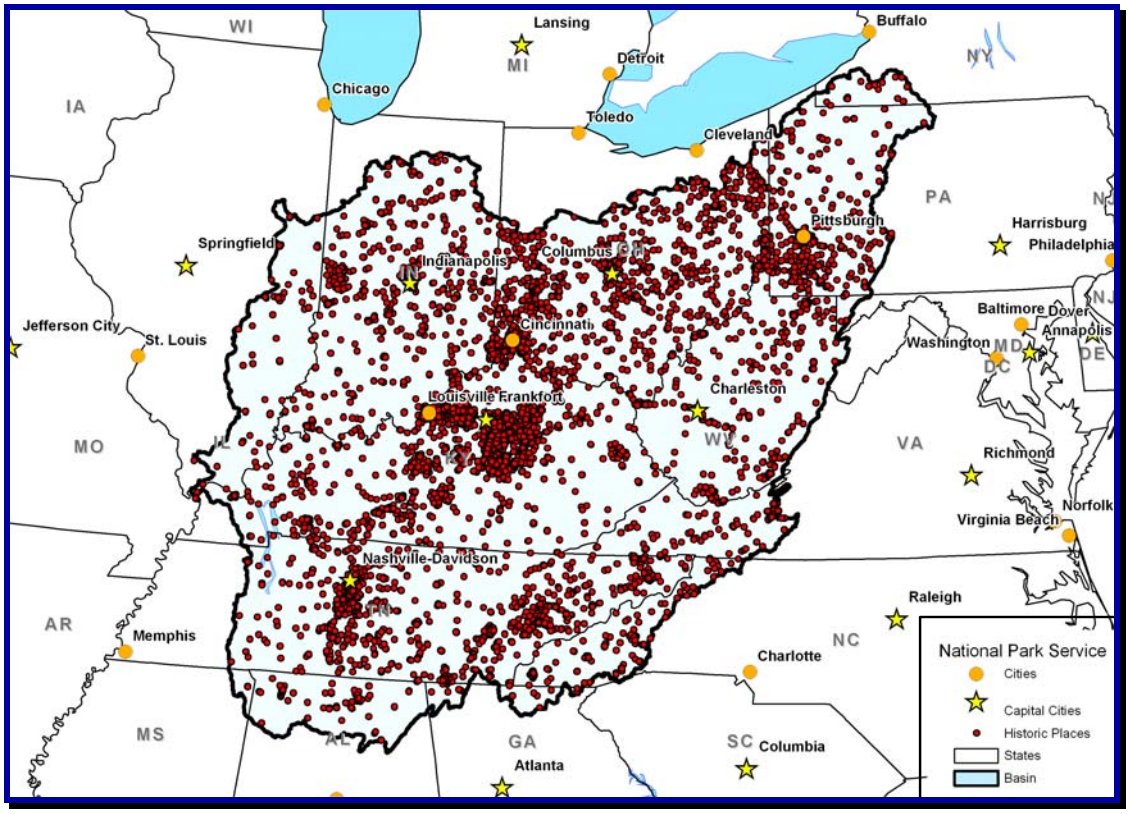


Figure 22 – Historic Places and Structures

Because it is the southern border of Ohio, Indiana, and Illinois, the Ohio River was a part of the border that divided Free states and slave states in the years before the Civil War. More escaping slaves made their perilous journey north to freedom across the Ohio River than anywhere else in the north-south frontier. Today, numerous historical structures throughout the Ohio River valley still owe their significance to the Underground Railroad that transported so many slaves to freedom.

Today, the Ohio River basin is a blending of cultures, races, ethnicities, and backgrounds – including many foreign-born immigrants, indigenous Native Americans, and the progeny of the first European settlers who arrived in the 1700s and 1800s. The historical structures and landmarks within the basin attest to the rich history of the region and the people who helped form its heritage.

8.1.8 Transportation and Public Infrastructure

8.1.8.1 Transportation

Of the many attributes of the basin that support the welfare and productivity of the 27 million residents, the multi-faceted transportation system is a key component. This system composed of highways, railways, pipelines, airports, river ports/terminals, and urban transit systems provides a relatively safe, efficient and at times intermodal connectivity that supports the productivity and growth of the region. Aided by years of

Federal, state, regional, local, and private investments, the basin's transportation system has supported (1) thousands of basic manufacturing industries, (2) energy-resources extraction, (3) processing and movement of raw materials and food products, and (4) safe and convenient passage of workers (to and from their places of employment).

The highway network composed of the Federally supported national interstate system, national and state routes, and the Appalachian Regional Highway system has facilitated the dispersal and strategic location of many industries throughout the basin. Figure 23 shows the current Federal Interstate Highway network, and Figure 24 shows the current network of Appalachian regional highways. In addition to the ability to move vast quantities of raw materials and finished products, this network enables the residents both within and outside of the basin to visit and enjoy the many recreational opportunities provided at USACE reservoirs.

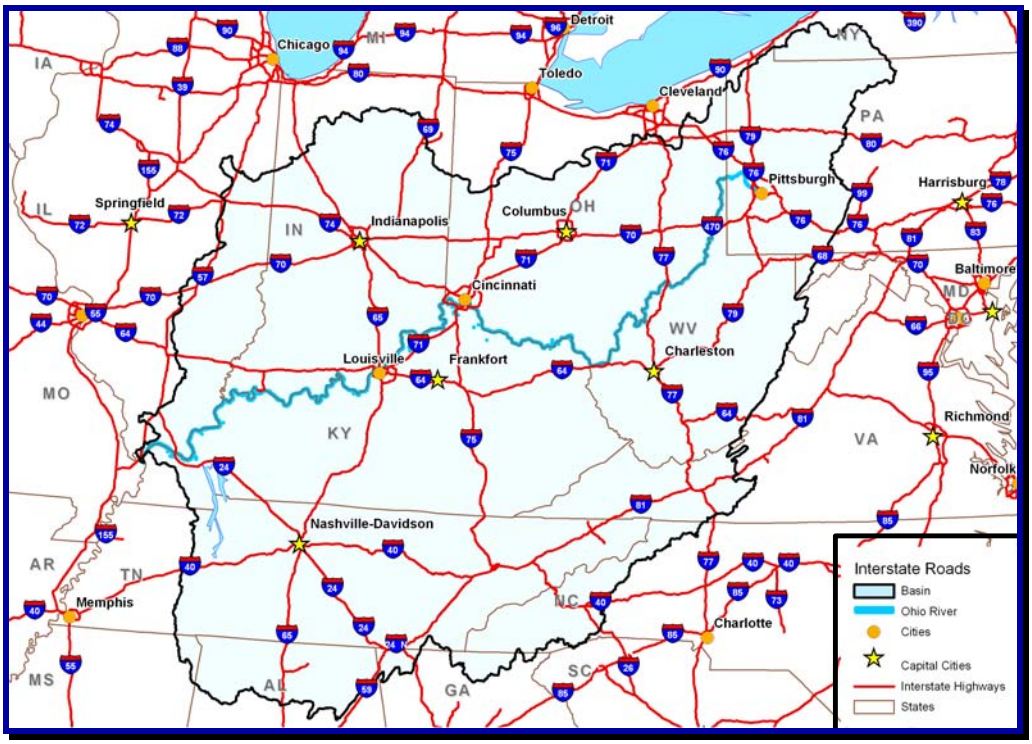


Figure 23 – Federal Interstate Highways

Recreational visitation at USACE lakes and reservoirs is due in large measure to the network of highways and byways that allow movement of recreational vehicles, boat trailers, and campers that fill USACE recreational areas and state parks located at USACE projects within the basin. Although rising energy prices indicate potential lessening of this recreational traffic, those same price increases point toward more "staycations" within the region's resident recreational centers. The day-trip location of several major USACE lakes with respect to the major cities within the basin provides a unique variety of recreational opportunities to millions of potential visitors that are not available in most city, county, or regional parks.

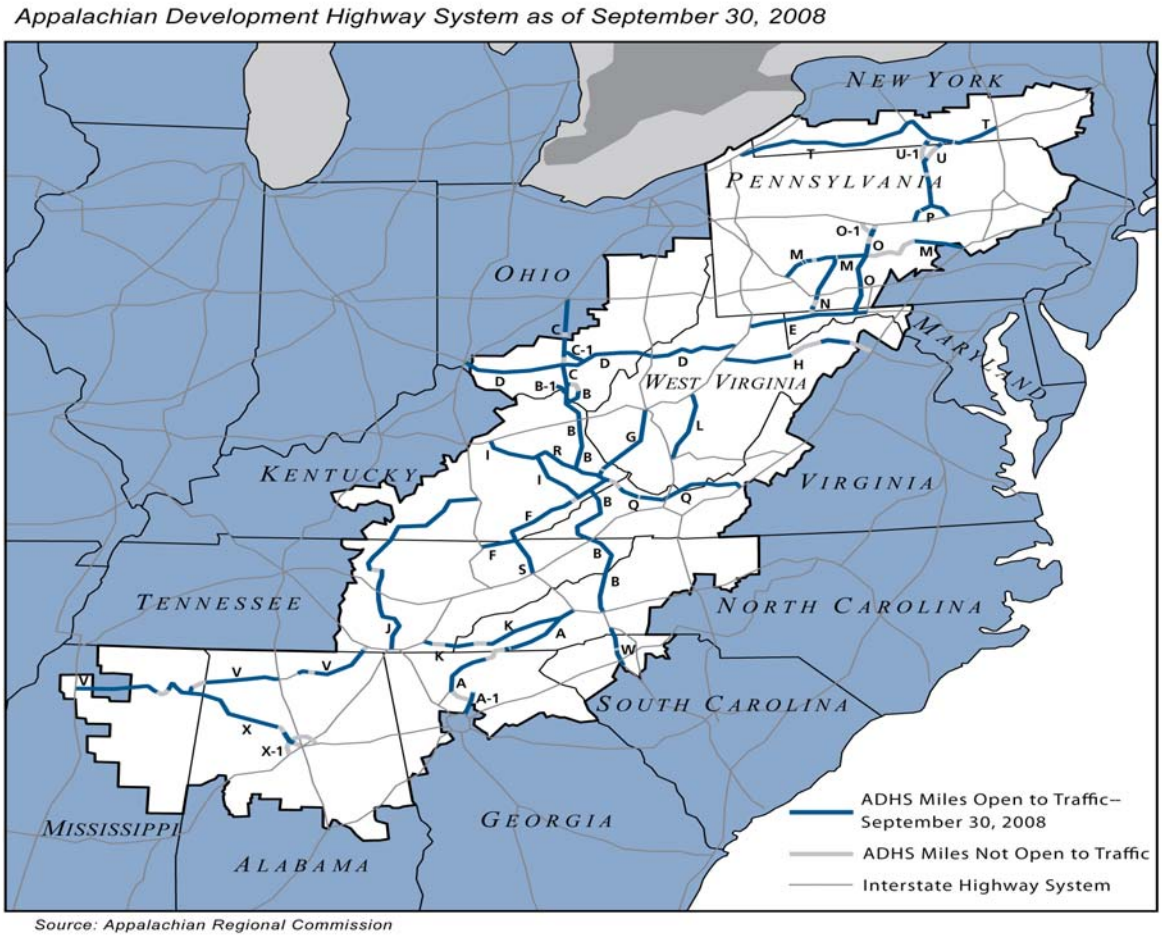


Figure 24 – Appalachian Development Highway System

The other components of the transportation system (railways, airports, water ports, and pipelines) although somewhat less prevalent visually as the highway system, provide the means of moving vast quantities of raw materials (ores, wood, cement, aggregates, and sand) and energy resources (coal, gas, oil, and oil shale) within and outside of the basin. Generally (with the exception of airports that are partially supported by Federal funds), these modes are privately funded and operated and maintained by private transportation companies.

Several Class I railroads are shown in Figure 25. The major railroads shown include the CSX system, the NS system, and the Union Pacific. These lines carry millions of tons of coal, wood products and other valuable commodities generated regionally to national and international markets thus attracting industry and business growth. Planned railway improvements will open opportunities for more enhanced freight service and shipping opportunities. The planned "Heartland Corridor," authorized in the 2005 *Transportation Act*, will link Norfolk, Virginia, with Columbus, Ohio, and make connections onto Chicago through an improved Norfolk Southern railway line. This enhanced corridor would enable the regular use of double-stack container trains from the ocean intermodal ports at Norfolk, Virginia, to intermodal terminals at Columbus and Chicago and new

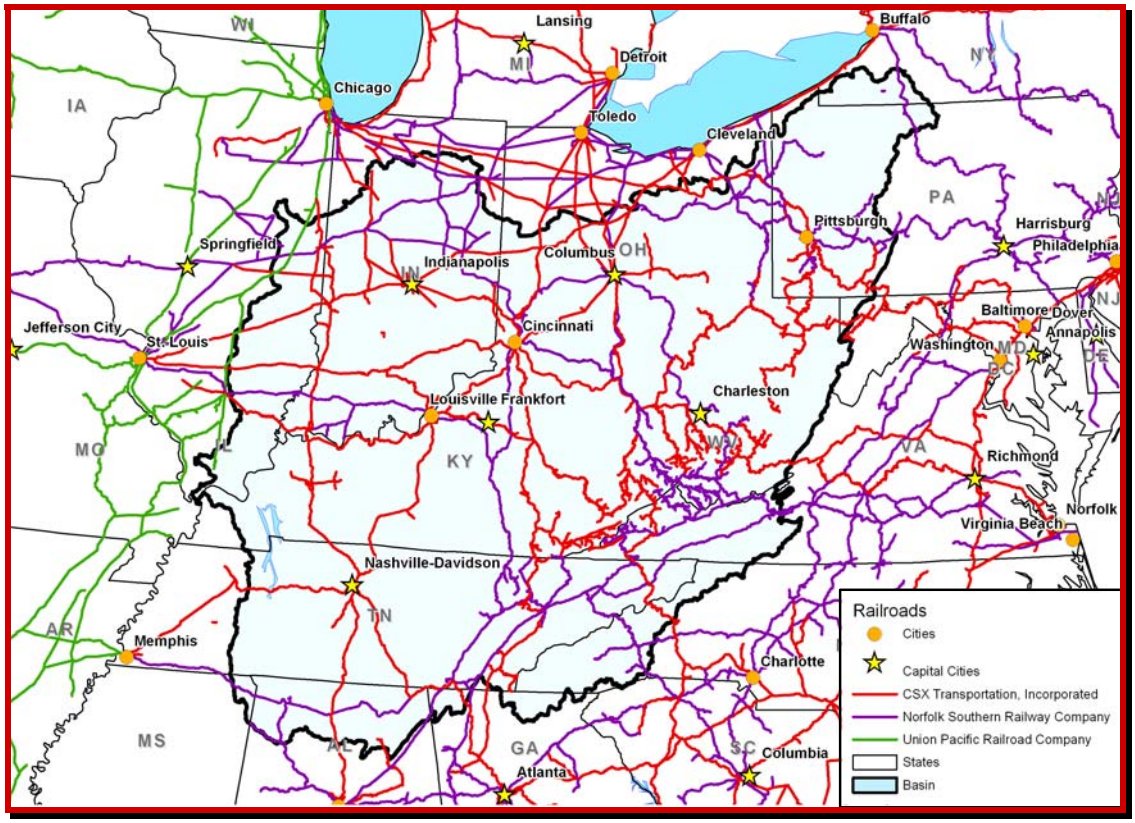


Figure 25 – Class I Railroads

intermodal ramps at Roanoke, Virginia, and Prichard, West Virginia. This transportation improvement will likely attract significant warehouse and commercial development in the vicinity of the intermodal ramps.

The basin's spider web of major natural gas and oil pipelines are shown (as red lines) in Figure 26. Their concentrations indicate the major exploration and production fields in the basin (northeast and west portions of the basin). The miles of maintained gas line easements extending across the basin represent thousands of acres of terrestrial habitat and miles of "edge" vegetation community for wildlife use. Millions of cubic feet of natural gas are located in as yet untouched reserves affording substantial fuel resources for an energy-based national economy. Exploration and drilling of the Marcellus Shales under New York, Pennsylvania, West Virginia, and Ohio may generate substantial quantities of gas, but issues concerning water needs for hydraulic fracturing and water quality issues associated with drilling discharge water surround its production.

Figure 27 shows the locations of the major airports providing regularly scheduled airline services. The presence of regularly scheduled regional airline services provides an additional attraction to businesses and industries for growth. Express mail and air freight services facilitated by major air carriers attract international business ventures to the region. This airway network also allows vacationers and recreation users from the national market to enjoy the many leisure pursuits at Federal and state facilities.

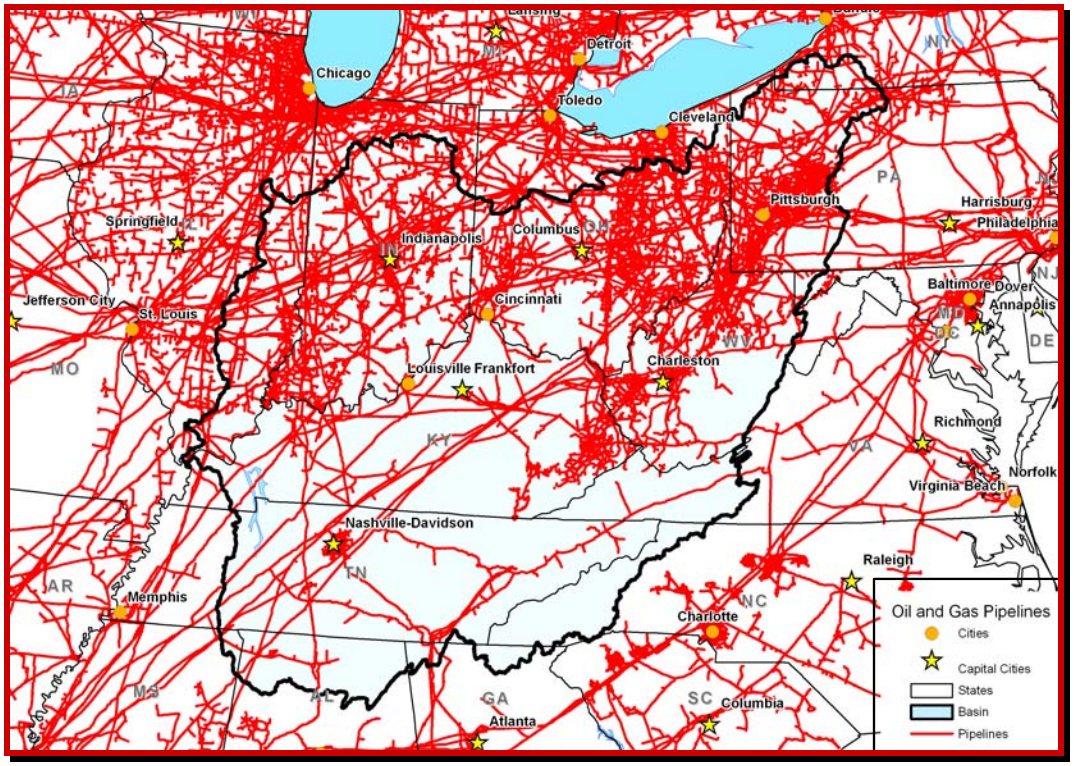


Figure 26 – Major Oil and Natural Gas Pipelines

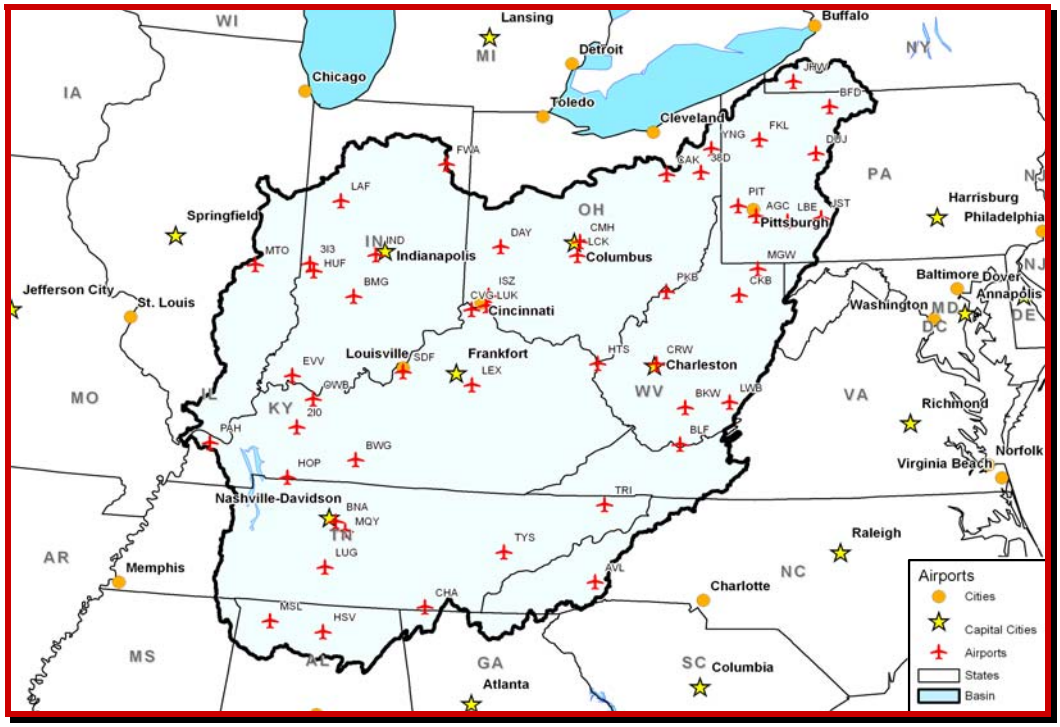


Figure 27 – Commercial Flight Airports

Figure 28 shows the network of approximately 2,800 miles of commercially navigable rivers in the basin. This navigation system provides safe, energy efficient, environmentally friendly and cost-effective transportation of large volumes of raw materials, energy resources and finished products throughout the basin and beyond. In 2007 this system moved over 260.1 million tons of commodities valued at more than $30.3 billion. Due in large part to the inland waterway system and its cost effectiveness in moving bulk coal and petrochemical products, the basin is home to numerous power plants and petrochemical facilities that depend upon large-volume, low-cost shipping opportunities.

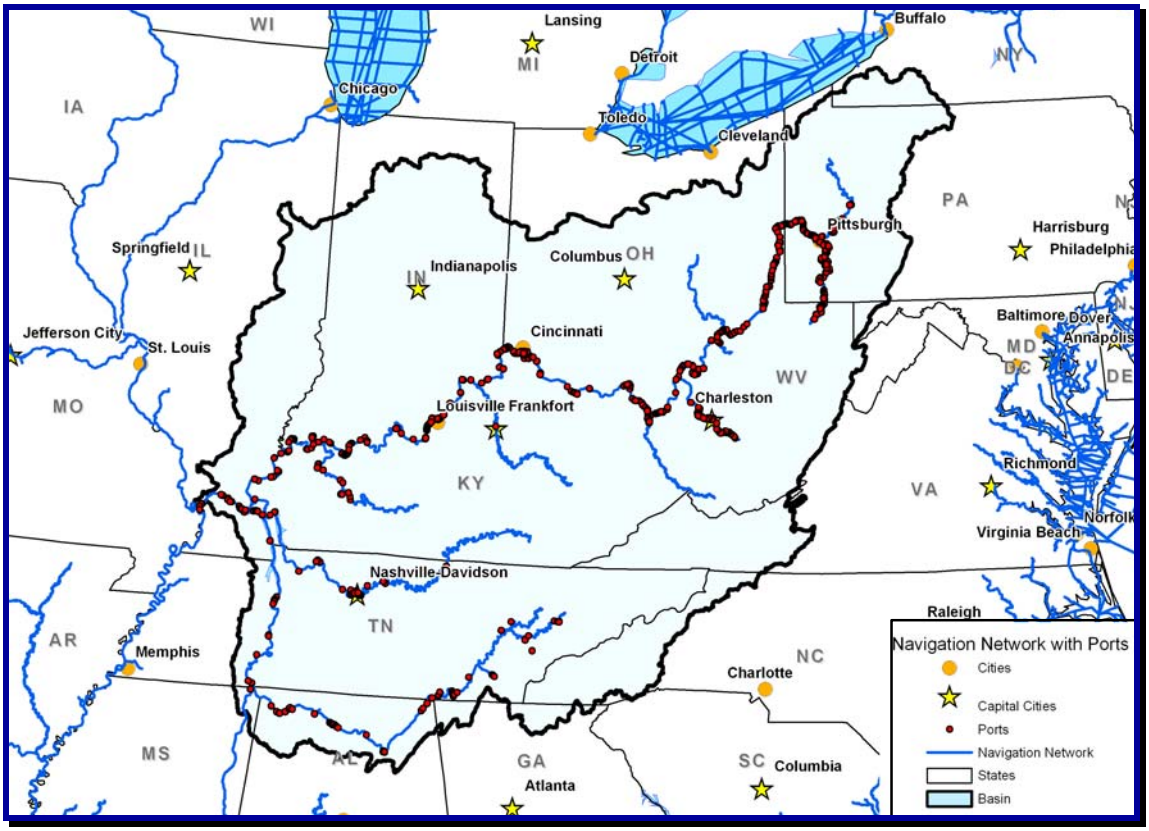


Figure 28 – Commercially Navigable Waterways

This system also feeds bulk commodities into the Mississippi River and Tennessee-Tombigbee (Tenn-Tom) inland navigation systems, with connections to the Gulf Coast terminals. Through this north-south waterway connection, industries within the basin have efficient freight connections to South America, Central America, Europe, and Asia (through the Panama Canal). The navigation system's stable pools also provide opportunities for M&I water supply and recreational (boating, fishing, water skiing, etc.) use throughout the navigable river system. There are numerous public access sites along the navigable waterways, but additional recreational and emergency access to the navigation pools has been an issue raised by state natural resources agencies and state security offices.

8.1.8.2 Public Water and Sewer Infrastructure

The basin's public infrastructure consists of Federal flood risk reduction facilities; state financed public works; and county and municipal water-treatment and -distribution systems, stormwater-collection systems, and sewage-collection and -treatment systems. There are privately owned and operated infrastructure systems, and some corporate facilities along the waterways operate their own infrastructure systems. Many of the municipal areas extend services into the surrounding suburban portions of counties, while rural areas are serviced by individual public service districts. There are 49 communities with a total of 1,045 Combined Sewer Overflows (CSOs) discharging into the Ohio River (ORSANCO data), accounting for over 10% of all CSOs in the nation. Table 9 shows the cities and towns (ORSANCO data) along the Ohio River having CSOs, and the number of discharge points at each location.

A great number of stormwater and sanitary systems were designed and constructed prior to the *Clean Water Act* and other water quality legislation. For reasons of cost and reduced right-of-way requirements, these two systems were combined into one pipe that conveyed both stormwater and sewage to the treatment plants. During heavy rainfall events, the excess stormwater flow causes the combined sewage and stormwater volumes to exceed the inflow capacity of the treatment facilities; the resulting overflow is discharged into the receiving streams and rivers. These overflow situations allow repeated surges of bacteria-laden water to enter the aquatic ecosystem, endangering downstream municipal water supply intakes. The majority of these combined sewer and stormwater systems are located in older cities in Pennsylvania, West Virginia, Ohio, Indiana, and Illinois, with several in Kentucky. In addition to the larger cities' CSOs, numerous smaller communities within the basin are without adequate sewage collection and treatment systems and have minimal stormwater controls.

Federal programs for upgrading and expanding sewer system infrastructure provide opportunities to address some of the problems encountered by these systems. The USACE Environmental Infrastructure Assistance Program, authorized under various congressional actions (and designations), covers several areas within the Ohio River basin. The various authorities address both sewage collection and treatment and water treatment and distribution. Table 10 shows the authorities (by section number) and the states covered by those authorities. Table 17 in Section 8.4.10 provides available data on the number of environmental infrastructure projects completed and the types of infrastructure in place (water, sewer, other).

Numerous municipal, county, and rural water-treatment and -distribution systems are scattered throughout the basin. Components of those aging infrastructure systems require rehabilitation and upgrading to address new threats to the quality of drinking water supplies. A more detailed discussion of these local systems and the problems that confront them is included in the section on water supply and water quality.

Table 9 – Cities/Towns (Discharger) on the Ohio River with Active CSOs

COMBINED SEWER OVERFLOWS ALONG THE OHIO RIVER							
NPDES #	River Mile	Discharger	State	WWTP Flow (MGD)	Permitted CSOs	Lat/Long	CSO Plan
PA0025984	3.1	ALCOSAN	PA	250	21	Yes	Approved
NA	3.1	Pittsburgh	PA	N/A	217	Yes	Required
NA	3.1	Emsworth	PA	N/A	1	Yes	Required
NA	3.1	McKees Rocks	PA	N/A	3	Yes	Submitted
NA	3.1	Stowe Township	PA	N/A	7	Yes	Submitted
PA0026352	10.2	Coraopolis	PA	3.0	6	Yes	Submitted
PA0020681	12.3	Sewickley	PA	0.9	4	Yes	Approved
PA0024589	14.2	Leetsdale	PA	0.775	6	Yes	Submitted
PA0021640	25.0	Rochester	PA	1.4	3	Yes	Submitted
NA	25.0	Freedom	PA	N/A	3	Yes	Required
PA0026140	25.6	Monaca	PA	1.15	6	Yes	Submitted
PA0023701	37.3	Midland	PA	1.25	1	Yes	Submitted
OH0020214	60.1	Toronto	OH	1.0	8	Yes	Submitted
OH0027511	68.0	Steubenville	OH	6.0	17	No	Submitted
WV0020273	70.5	Follansbee	WV	0.5	4	No	Approved
OH0026565	71.6	Mingo Junction	OH	0.6	6	Yes	Submitted
WV0026832	74.7	Wellsburg	WV	1.25	10	Yes	Approved
WV0023230	90.8	Wheeling	WV	15.0	211	Yes	Approved
WV0020648	93.2	Benwood	WV	0.3	14	Yes	Approved
OH0049999	94.0	Eastern Ohio RWA	OH	6.1	47	No	Approved
WV0020141	96.5	McMechen	WV	0.3	3	Yes	Approved
WV0023264	102.4	Moundsville	WV	2.34	5	Yes	Approved
WV0027472	128.7	New Martinsville	WV	2.3	10	Yes	Approved
OH0021725	250.4	Pomeroy	OH	0.345	13	No	Submitted
OH0026514	251.2	Middleport	OH	0.3	13	No	Reviewed
WV0022039	265.7	Point Pleasant	WV	0.7	2	Yes	Approved
WV0023159	313.2	Huntington	WV	17.0	23	Yes	Approved
WV0035912	313.2	Kenova	WV	N/A	2	Yes	Approved
KY0035467	317.1	Catlettsburg	KY	0.5	17	No	Submitted
KY0022373	322.5	Ashland	KY	11.0	8	Yes	Approved
OH0025852	327.4	Ironton	OH	1.7	9	Yes	Submitted
KY0022926	328.9	Worthington	KY	0.2	3	Yes	Suspended
OH0020613	351.8	New Boston	OH	N/A	2	Yes	Approved
OH0027197	356.0	Portsmouth	OH	5.0	10	Yes	Submitted
KY0021512	378.4	Vanceburg	KY	0.41	5	Yes	Required
KY0020257	411.8	Maysville	KY	3.4	11	Yes	Approved
OH0025453	464.5	Cincinnati	OH	200	234	Yes	Approved
KY0021466	477.4	N. Kentucky SD#1	KY	46.5	97	Yes	Approved
IN0050903	493.0	Aurora	IN	N/A	3	No	Approved
IN0025666	558.8	Madison	IN	3.6	7	No	Approved
IN0023302	604.1	Jeffersonville	IN	5.2	16	Yes	Approved
KY0022411	612.0	Louisville	KY	105	117	Yes	Approved
IN0021016	726.6	Tell City	IN	2.063	5	Yes	Approved
IN0021067	746.2	Rockport	IN	0.50	1	Yes	Approved
KY0073377	754.6	Owensboro	KY	18.8	12	Yes	Approved
IN0033073	792.5	Evansville East	IN	18.0	8	Yes	Approved
IN0032956	794.0	Evansville West	IN	20.6	15	Yes	Approved
KY0020711	806.0	Henderson	KY	15.0	13	Yes	Approved
IN0035696	829.0	Mt. Vernon	IN	4.1	3	No	Approved
KY0022799	936.0	Paducah	KY	9.0	10	Yes	Approved
IL0029874	944.0	Metropolis	IL	2.05	1	Yes	Approved
IL0023825	979.0	Cairo	IL	1.5	3	Yes	Approved

"N/A" applies when the discharger does not directly discharge to the Ohio River, but does discharge to an Ohio River discharger.

Table 10 – Environmental Infrastructure Programs

Program Name	State Location
Section 313	South-central PA
Section 340	Southern WV
Section 531	Southern and eastern KY
Section 571	Central WV
Section 594	OH (statewide)
Section 502	Southwest VA
Section 219 (amended)	Northern WV
Section 219	National program
Section 592	MS (statewide)
Section 5130	TN
Section 5082/5085	LA
Section 5113	NC
Section 5065	GA

8.1.8.3 USACE-Constructed Flood Risk Reduction Infrastructure

The complex system of runoff retention and flood protection infrastructure in the basin represents several decades of planning, engineering, and construction by USACE and other Federal and state agencies. Stretching from the farthermost northeastern headwaters of the basin in New York, Pennsylvania, and Ohio (where flood risk reduction may be provided by only a single component such as a reservoir or LPP) to the lower Ohio River (where a multitude of upstream reservoirs, local flood warning systems, flood insurance, and even floodproofing of structures may be providing multiple layers of redundant flood protection), this aging system represents a regional investment similar in scale to the Interstate Highway System – both foster growth and security.

Components of USACE's flood risk reduction system, consisting of 83 reservoirs (78 multi-purpose and 5 single-purpose projects) and 97 local protection projects designed by USACE (levees and floodwalls operated by third parties), have been in place since the 1930s and have produced an estimated $19.0 billion in flood risk reduction benefits through 70 years of continuous operation. Although an effective system for reducing flood damages and reducing threats to human life from flooding, components of the system are experiencing problems associated with aging equipment and materials. Many of the problems are due to deterioration of materials, aging/outdated equipment, and limited O&M funding to accomplish the needed repairs and rehabilitation work.

Generally, all earthen embankment dams within the basin are constructed with similar components, including:

- an embankment structure (composed of various layers of soil and rock materials) that adjoins two abutments;
- an intake structure and outlet works that permit the passage of normal flows and restrain high flows;

- an emergency spillway that allows passage of extremely high flows (which would otherwise crest the dam embankment, causing damages to the embankment); and
- various other appurtenances and equipment that are particular to the dam design and site conditions.

In some cases, earthen dams are covered with concrete on the upstream face (or, for reservoirs, on the lake side face), to limit erosion and underseepage.

There are several concrete dams that function in a similar manner to the earthen embankment dams, but the water-retaining embankment is a concrete structure and the intake and outlet works are integrated into the concrete structure (i.e., Bluestone Dam, Tygart Dam, and Sutton Dam). Normally the dam has an integrated spillway or separate spillway that allows extremely high flows to bypass the dam or overtop the dam without endangering the structure. Concrete dams are adjoined to the adjacent abutments using sophisticated anchoring and grouting systems. Generally the concrete dams depend upon their massive weight to resist the tremendous forces of water pressure.

Failures of the Buffalo Creek Dam in West Virginia and the Canyon Lake Dam in South Dakota in 1972 contributed to Congress' passing the *National Dam Inspection Act* in 1972. Passage of the *Reclamation Safety of Dams Act* in 1977 followed failure of the Teton Dam in Idaho in 1976. Subsequent failure of the Laurel Run Dam in Pennsylvania and the Kelly Barnes Dam in Georgia in 1977 set in motion the development of the Federal Guidelines for Dam Safety, issued in 1979 by the Federal government. The USACE dam-safety program has been in operation since 1979.

The program has completed investigations of each of the 83 USACE dams in the basin. A complex but technically sound methodology for assessing the condition of the dams and appurtenances and the risks of partial or total failure (with associated loss of life, property damages, power loss, etc.) was used to rank each of the dams into one of four categories. The Dam Safety Action Category (DSAC) quantitatively and qualitatively indicated the combined severity and criticality of the deficiencies with respect to the operational reliability of the structure and the risks associated with its ongoing operation. Assessment factors such as potential for loss of life, induced flood damages downstream due to structure failure, loss of power generation (at hydropower installations), loss of municipal and industrial (M&I) water supply, loss of water-based recreation, and other key factors associated with structure failure were combined into the risk-informed evaluation process.

Table 11 shows the flood risk reduction dams currently being rehabilitated (under construction) or scheduled for construction to address deficiencies identified in the dam safety inspections.

In addition to this system of dams, there are 97 USACE-designed local protection projects (levees and floodwalls) within the basin that are in varying states of operational readiness. These structures protect over 400 square miles of urban area, approximately 248,000 structures valued at over $14.0 billion, and an estimated 498,000 night-time residents. Appendix H provides more detailed data on the public and private assets protected by these structures.

Table 11 – Dams Scheduled for Rehabilitation in the Dam Safety Program

Name	River Name	Sub-Basin	DSAC	Construction Start
Center Hill Dam	Caney Fork River	Cumberland	1	2008
Wolf Creek Dam	Cumberland River	Cumberland	1	2006
Zoar Levee Dam	Tuscarawas River	Muskingum	1	2013
Bolivar Dam	Sandy Creek	Muskingum	2	2011
Dover Dam	Tuscarawas River	Muskingum	2	2010
Beach City Dam	Sugar Creek	Muskingum	2	2013
Mohawk Dam	Walonding River	Muskingum	2	2013
Bluestone Dam	New River	Kanawha	2	2000
Brookville Dam	Whitewater River	Great Miami	2	2012
Green River Dam	Green River	Wabash	2	2012
J. Edward Roush	Wabash River	Wabash	2	2011
Nolin Dam	Nolin River	Green	2	2012
Patoka Dam	Clarion River	Wabash	2	2013
Rough River Dam	Rough River	Green	2	2011
Salamonie Dam	Salamonie River	Wabash	2	2011
J. Percy Priest Dam	Stones River	Cumberland	2	2012
East Branch Dam	Clarion River	Allegheny	2	2010

8.1.9 Water Supply

The Ohio River basin is a water-rich region with abundant sources of both surface and groundwater. Rainfall amounts vary but the average rainfall across all of the 15 states is approximately 43 inches per year. Surface waters include over 50,000 miles of rivers and streams and over 1,300 lakes. A number of ground water aquifers provide water supply to millions of residents. Figure 14 shows the primary aquifers located within the basin. USGS data indicate that groundwater supplies are available in many rural areas of the basin, but there are pockets of karst topography and other geologic formations that limit economical access to groundwater supplies for municipal and private use. Several instances of drought situations requiring emergency supplies of drinking water be trucked into communities have been recorded (West Virginia and Kentucky).

There are 29 public water distributors withdrawing water from the mainstem Ohio River, serving an estimated 5 million people. Within the USACE navigation pools on the Ohio River and its tributaries, there are 388 raw water intakes servicing both industrial and municipal demands. Table 12 shows a general listing of the number of raw water intakes within the various navigation pools and the volumes of water extracted in millions of gallons per day (mgd). This dependence upon the Ohio River and its navigable tributaries as a reliable source of water stresses the seriousness of water quality and water management issues.

USACE reservoirs provide a dependable water supply in the basin through 31 water supply contracts on 16 reservoirs. Other agencies, such as TVA and NRCS, likewise provide water for municipal and industrial users through the operation of reservoirs. Municipal and industrial (M&I) water supplies are available from USACE reservoirs in accordance with the *Water Supply Act of 1958*. Available storage capacity within the reservoir may be used for water supply (through executed agreements), provided that

Table 12 – Raw Water Intakes and Volumes within Navigation Pools

River Name	Number of Raw Water Intakes	Withdrawals (mgd) *
Allegheny	18	524.0
Clinch	10	1,850.8
Cumberland	46	3,188.8
Green	13	298.2
Kanawha	44	788.8
Kentucky	6	29.4
Monongahela	24	1,028.4
Ohio	129	12,510.6
Tennessee	98	3,036.5
Totals	*388*	*23,253.5*
Municipal use	172	2,266.5
Industrial use	216	20,989.0
Power plants	74	19,882.7
Other plants	142	1,106.3

* *mgd = millions of gallons per day.*

such usage does not endanger other authorized purposes (e.g., flood control, recreation, low-flow augmentation, fish and wildlife habitat, etc.). Water supply facilities at USACE lakes and reservoirs are funded solely by non-Federal funds with all water service revenues dedicated to O&M of those facilities.

8.1.10 Energy Resources and Production

The Ohio River basin drapes across rich deposits of low-sulfur, high BTU bituminous coal and extensive natural gas and oil fields. These energy resources have generated much wealth within the basin and still represent a substantial proportion of the revenues that support several states in the basin. Coal and natural gas reserves in the basin are substantial and represent a significant proportion of domestic production of these energy commodities. Figure 29 shows the extent of the coal fields across the basin.

Due to the quality of the basin coal reserves, millions of tons of this resource are annually excavated, processed and transported via rail and barge to eastern and Gulf ports for shipment to European markets and to the array of coal-burning power plants along the Ohio River. The increased use of scrubbers and other coal-blending techniques that maintain air quality standards within acceptable limits in the region has kept the basin's coal reserves in high demand. The inland waterway navigation system (locks and dams and navigational aids) has provided a relatively Inexpensive, fuel-efficient, safe, and environmentally friendly mechanism for moving vast tonnages of coal for an electricity-hungry nation. Extraction, processing, and transportation of coal

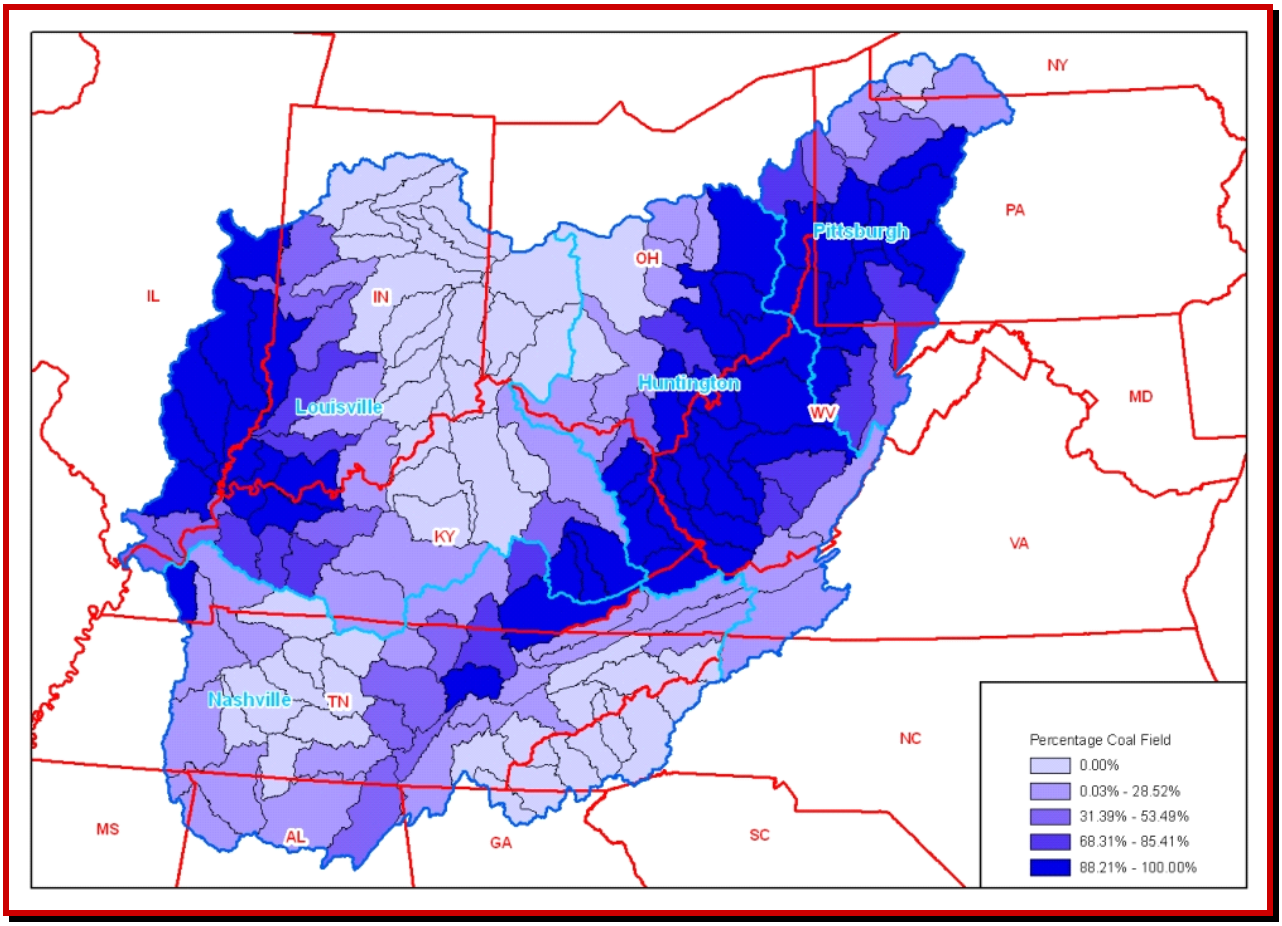


Figure 29 – Coal Fields in Eight-Digit HUC Watersheds

requires significant investments of private capital and to a certain extent Federal investment in the inland waterway navigation system – a major mover of coal in the region. The number of coal-fired power plants listed in Table 13 is a testament to the cost effectiveness of moving heavy, bulk commodities short distances and especially by barge and justification to locate plants near these massive reserves.

Natural gas is a major energy commodity as well. Natural gas reserves are substantial and gas production in the region ranks high among all producing regions in the nation. Numerous gas wells can be found throughout the basin and many millions of cubic feet of gas are stored in underground sites throughout the region. Recently, the Marcellus Shale gas fields that underlay portions of New York, Pennsylvania, Ohio and West Virginia have been identified as a future major source of natural gas. Figure 30 shows the extent of the Marcellus Shale complex and the extreme depths of the gas-bearing shale. A 2008 estimate of the Marcellus shale field suggested that as much as 500 million cubic feet of gas may be trapped in the shale of which about 10% would be recoverable. Drilling and extraction of this extensive field is currently underway in West Virginia, Ohio, and Pennsylvania.

Table 13 – Coal-Fired Power Plants at Waterside Locations

Plant Name	State	River	Annual Tons (in Thousands)	Output (KH)
Colbert	AL	Tennessee River	853.47	7,644,226
Widows Creek	AL	Tennessee River	4359.48	9,629,059
Joppa Steam	IL	Ohio River	5453.9	8,338,903
Brown (SIGE)	IN	Ohio River	1816.47	3,353,983
Clifty Creek	IN	Ohio River	4213.7	9,122,736
Culley	IN	Ohio River	1202.28	2,313,986
Gallagher	IN	Ohio River	1208.21	2,493,274
Rockport (INMI)	IN	Ohio River	11903	20,325,589
Tanners Creek	IN	Ohio River	2990.8	5,863,476
Warrick	IN	Ohio River	476.71	4,441,041
East Bend	KY	Ohio River	2119.3	4,966,967
Ghent	KY	Ohio River	5631.84	12,190,952
Grand Rivers Terminal	KY	Tennessee River	13793.1	0
Mill Creek (LGEC)	KY	Ohio River	4424.62	9,769,828
Paradise (TVA)	KY	Green River	5011.12	14,535,145
Shawnee (TVA)	KY	Ohio River	4422.5	9,500,755
Spurlock	KY	Ohio River	3463	7,604,526
Trimble County (LGEC)	KY	Ohio River	1625.53	4,229,643
Beckjord	OH	Ohio River	2897.61	6,131,507
Cardinal	OH	Ohio River	4837.9	11,454,665
Gavin	OH	Ohio River	7404.5	16,632,444
Killen	OH	Ohio River	1755.26	4,145,349
Kyger Creek	OH	Ohio River	3564.4	7,336,698
Miami Fort	OH	Ohio River	3447.1	6,641,949
Richard H. Gorsuch	OH	Ohio River	708.12	928,803
Stuart (DP&L)	OH	Ohio River	6178.4	14,661,346
W.H. Zimmer	OH	Ohio River	3870.65	9,547,198
Hatfields Ferry Power Station	PA	Monongahela River	827.12	9,336,588
Cumberland (TVA)	TN	Cumberland River	7517.2	18,690,180
Fort Martin (MONG)	WV	Monongahela River	623.98	8,030,378
John E Amos	WV	Kanawha River	8260.2	20,052,905
Kammer	WV	Ohio River	1392.2	3,452,794
Kanawha River	WV	Kanawha River	891.4	1,995,027
Mitchell (OPC)	WV	Ohio River	2969.3	7,576,850
Mountaineer	WV	Ohio River	3080.9	7,162,930
Pleasants	WV	Ohio River	741.27	8,639,197
Rivesville	WV	Monongahela River	93.59	0
Sporn	WV	Ohio River	2165.5	5,045,885
Willow Island	WV	Ohio River	370.26	650,590
Totals			*138565.89*	*304,437,372*

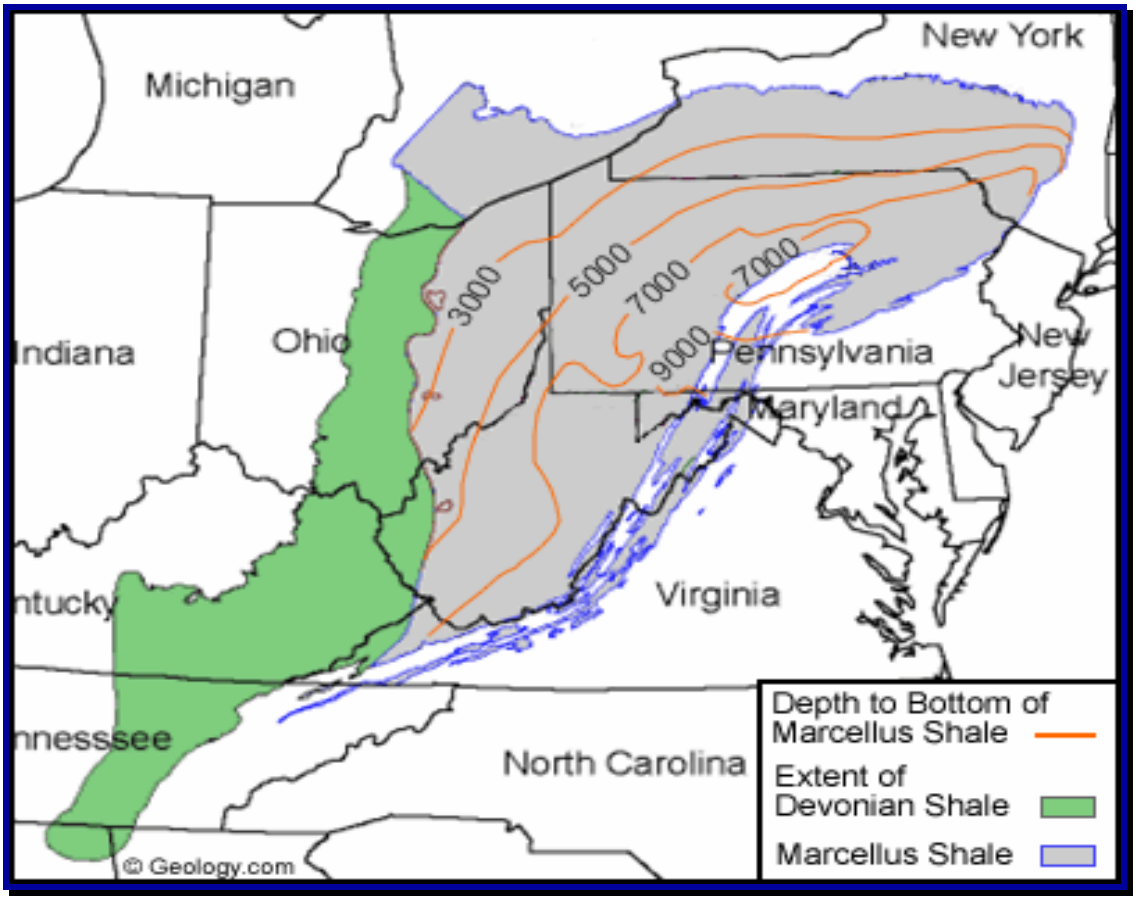


Figure 30 – Marcellus Shale Complex

The natural gas recovery process in this large shale field requires hydraulic fracturing of the gas-bearing shale at extreme depths, using huge quantities of water, sand, and other soluble chemicals. Also, the gas recovery process can generate substantial amounts of discharged, contaminated water during the - fracturing process that could affect land and water resources and local drinking water supplies in the drilling region.

From an energy production standpoint, the basin is home to approximately 400 power plants that supply an estimated 688.8 million kilowatts annually (2007 data). Table 13 includes a listing of all of the basin coal fired power plants that are located waterside on the Ohio River or a tributary stream. Among this power generating infrastructure there are 109 coal-fired plants, 103 oil-fired plants, 92 natural gas-fired plants, at least 4 nuclear-powered plants, 51 hydroelectric power plants, and 41 power plants of various other fuel types including wind turbines and bio-fuels. Table 1 in Appendix P shows the total number and types of plants within the basin.

As the table shows, 39 plants are located waterside to a commercially navigable river and 36 of the 39 plants receive all or much of their fuel via the inland waterway system. Over 1,800 kilowatts of electrical energy are generated annually through hydropower plants at USACE reservoirs and navigation locks and dams. Table 14 shows those USACE facilities providing commercially marketed hydropower energy.

Table 14 – Hydropower at USACE Reservoirs and Navigation Dams

Dam Project Name	State	River Name	Plant Output
Summersville Lake	WV	Gauley River	80 megawatts
Lake Cumberland	TN	Cumberland River	270 megawatts
Dale Hollow Lake	TN/KY	Obey River	48K kilowatt hours
J. Percy Priest Lake	TN	Stones River	46K kilowatt hours
Wolf Creek Lake	KY	Wolf Creek	610K kilowatt hours
Cordell Hull Lake	TN	Cumberland River	350M kilowatt hours
Cheatham Lake	TN	Cumberland River	160M kilowatt hours
Center Hill Lake	TN	Caney Fork River	351M kilowatt hours
Laurel River Lake	KY	Laura River	67M kilowatt hours
Old Hickory Lake	TN	Cumberland River	497K kilowatt hours
Lake Barkley	TN/KY	Cumberland River	641K kilowatt hours
Conemaugh Lake	PA	Conemaugh Creek	15.0 megawatts
Youghiogheny Lake	PA	Youghiogheny River	12.2 megawatts
Hannibal Locks and Dam	OH	Ohio River	35.7 megawatts
Allegheny River L&D 5	PA	Ohio River	9.5 megawatts
Allegheny River L&D 6	PA	Ohio River	8.5 megawatts
Allegheny River L&D 8	PA	Ohio River	13.6 megawatts
Allegheny River L&D 9	PA	Ohio River	18.0 megawatts
Greenup Lock and Dam	WV	Ohio River	70 megawatts
Racine Lock and Dam	WV	Ohio River	48 megawatts
Belleville Lock and Dam	WV	Ohio River	42 megawatts
Winfield Locks and Dam	WV	Kanawha River	14 megawatts
Marmet Locks and Dam	WV	Kanawha River	14 megawatts
London Locks and Dam	WV	Kanawha River	14 megawatts

In addition to use of the inland waterway system to move coal and other fuels to regional power plants, many power plants along the basin's rivers use millions of gallons of water annually for system cooling purposes. Circulated cooling water is released back into the rivers at a somewhat higher temperature that must be monitored to protect spawning fish and other aquatic species. Loss of a reliable water volume provided by the stable navigation pools during drought conditions or navigation dam failure can significantly reduce power plant efficiency or result in plant shut-downs.

Renewable energy sources are being developed in various basin locations. Solar, wind, geothermal (limited), hydropower, hydrokinetic, bio-mass and other renewable energy types can be generated using the unique geographic, geologic, hydrologic and vegetative characteristics of the region. Several arrays of wind turbines and 51 hydroelectric plants currently generate power within the basin. Considering the basin's geographic and land cover characteristics, the generating capabilities for these types of renewable energy in the basin vary greatly, but there are opportunities for

expansion of these systems nonetheless. Notwithstanding the aesthetic and environmental quality impacts of their development, large expanses of Federal and state owned land could be considered for siting renewable energy sources in the future.

8.1.11 Politics and Political Subdivisions

The Ohio River basin overlays portions of 15 states, each with its own suite of senators and congressmen/congresswomen who represent the best interests of those states in the legislative branch of the US government. In addition to their activities (voting, legislation, and debate) on the floor of their respective branches, this array of political interests serves on numerous committees and sub-committees in the Senate and House of Representatives. Among those groups are an array of authorization and appropriations committees and sub-committees that provide the legal and financial means for USACE and other Federal water resources agencies to study, design, and implement water resources development programs and projects within the basin and the nation. Those committees and sub-committees include the following:

- Senate Appropriations Committee (Appropriations) – Subcommittee on Energy and Water Development
- Senate Committee on Environment and Public Works (Authorizations) – Subcommittee on Water Resources and Environment
- House Committee on Appropriations (Appropriations) – Subcommittee on Energy and water Development
- House Committee on Transportation and Infrastructure (Authorizations) – Subcommittee on Transportation and Infrastructure

There are 30 senators representing the basin population and 66 congressmen and congresswomen. Among these 96 congressional public servants are many long-term, experienced politicians who continue to serve our nation and the basin's population. They are distributed among the committees and subcommittees listed above and can support the ability of USACE and other Federal agencies to work with key stakeholders to address the issues identified in this report. Table 14 of Appendix O lists the basin's congressional interests by state and also lists current committee and subcommittee members assigned to the four groups shown above. Figure 31 shows the distribution of the congressional districts and the political party of the current representative.

In addition to congressional members representing the interests of their constituents, there are 15 state governors and a countless number of state senators and delegates that populate state executive and legislative branches. The current governors of each state are shown in Appendix O, with the congressional interests. These public servants compose a large portion of the decision-making process that underlies the basis for determining whether willing and capable non-Federal cost sharing partners can be identified for further studies or project implementation. In conjunction with the heads of water and natural resources agencies and departments within state governments, this cadre of politicians must be fully informed and made aware of the basin issues and potential solutions.

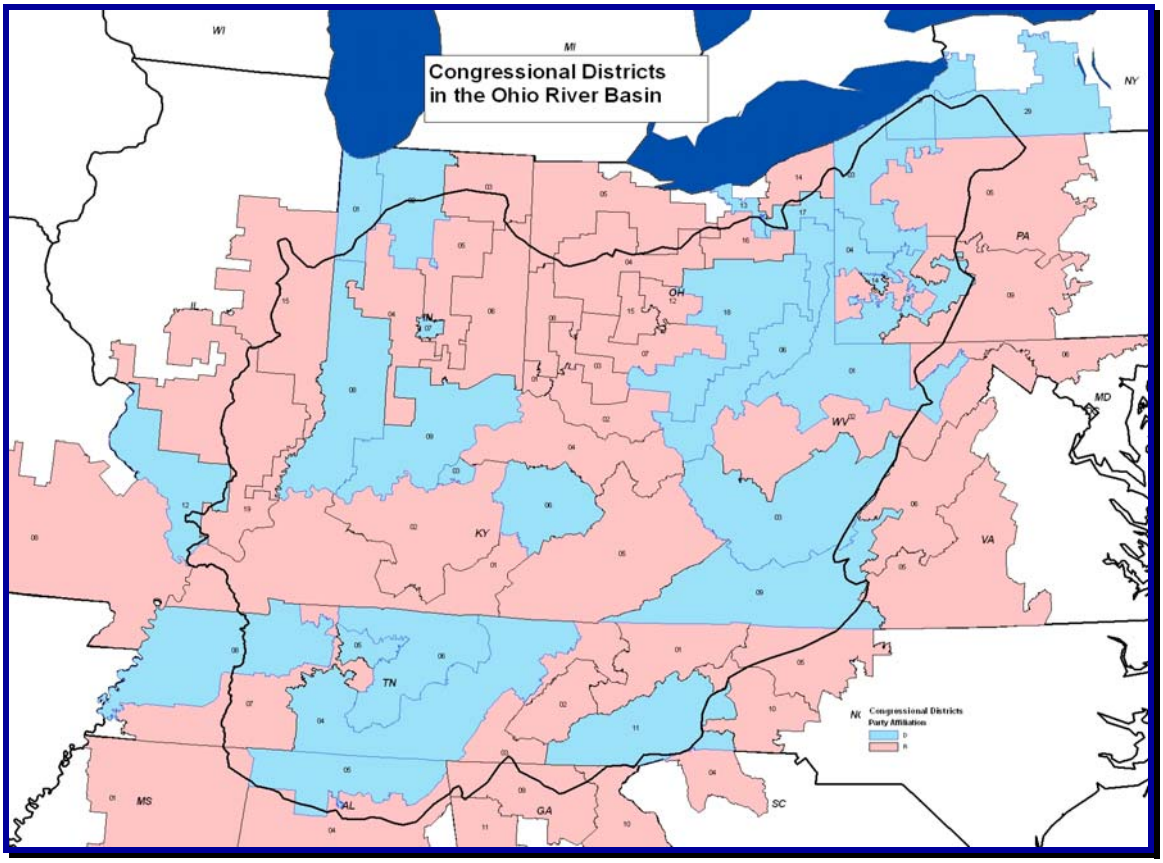


Figure 31 – Congressional Districts

In addition to the Federal and state layers of political activity working to improve the basin there are 548 county governments and 2,600 municipal jurisdictions within the basin that carry on the day to day activities of governing at the local level. Besides maintaining facilities and infrastructure that service the land uses within their jurisdictions, these units of government provide security and safety through police, fire and emergency services and collect various property taxes and user fees to support these activities. Additionally, these local units of government are empowered by the state government with certain "police powers" that allow them to establish ordinances and regulations that control land use (land use zoning, subdivision ordinances, and building codes) and its development. These local land use controls can be effective components of any structural or nonstructural alternatives formulated by USACE or other Federal agencies for reducing flood damages. Among the many issues that have surfaced during the development of this reconnaissance report, local jurisdictions have expressed concerns about reducing flood damages, operating and maintaining existing local protection projects (levees and floodwalls), maintaining adequate M&I water supplies, and upgrading recreational facilities at USACE reservoirs.

Through an Executive Order in 1971, the Ohio River Basin Commission was created to provide a basis for collaboration between dozens of diverse Federal agencies, state departments, stakeholders, and water users in the basin and to provide a cohesive voice for addressing issues and problems. In 1981, by Executive Order, this basin

commission (along with several others) was officially abolished. Since 1981, there has not been a single governing body that speaks on behalf the 15 states and there has not been an organizational forum for discussing common water resources issues confronting the states.

Other agencies, such as the Ohio River Sanitary Commission (ORSANCO), and several Federal agencies (USACE, NRCS, TVA, and USGS) have taken up the role of speaking on water management issues, but their individual missions are narrowly focused on a handful of objectives and their Federal roles limit their ability to speak on behalf of the 15 state governors whose individual and collective economies depend in part upon the water resources of the basin. This basin collaborative "vacuum" and lack of an interstate forum for discourse on water resources issues opens the door for future individual state decisions on water use or individual state agreements for out-of-basin water transfers that could impact other basin states and threaten availability of M&I supplies or navigation access. Whether through reestablishment of a basin commission, establishment of an advisory Council of Governors, or some other regional organization, the future of the basin and wise use of its precious water resources may depend upon a regional forum for discourse of the issues and common understanding of the ramifications of individual state actions. Investigating the options for various regional forums and collaboration networks may be the first step in avoiding future conflicts over water issues.

At a more local level, but just as important to the management and protection of the many watersheds are the numerous watershed associations. An online search of the USEPA database uncovered an estimated 452 functioning watershed associations within the basin. These organizations vary in the sizes of watersheds that they represent from HUC 8 sized watersheds to HUC 12 or HUC 16 sized watersheds.

Their primary objectives vary depending upon the array of issues being faced in each watershed. In most cases, the watershed associations are represented at the state level through a state water resources or environmental quality office. During implementation of any recommended watershed assessments, these local watershed associations would be a valuable source of local information on watershed issues and must be engaged in a collaborative planning effort. Figure 32 shows the distribution of the USEPA-listed watershed associations.

8.1.12 Research, Technology and Communications

The Ohio River basin is home to over 500 colleges and universities that comprise a significant research and technology-based resource for the states and region. Research in bio-medical, bio-technology, communications, both fossil fuel and renewable energy systems, engineering/industrial processes, transportation, aerospace and aeronautics, environmental sciences, and other social and public issues provide a foundation for the basin's continued growth and advancement. In addition to the higher education research system, there are numerous public and private research facilities for industry, technology companies and the military in the region. It is the presence of these local and national institutions that drives innovations in technology and industry. Many of the research institutions located in academia, private industry, and the public sector are provided protection by existing USACE flood risk reduction facilities. Many colleges and

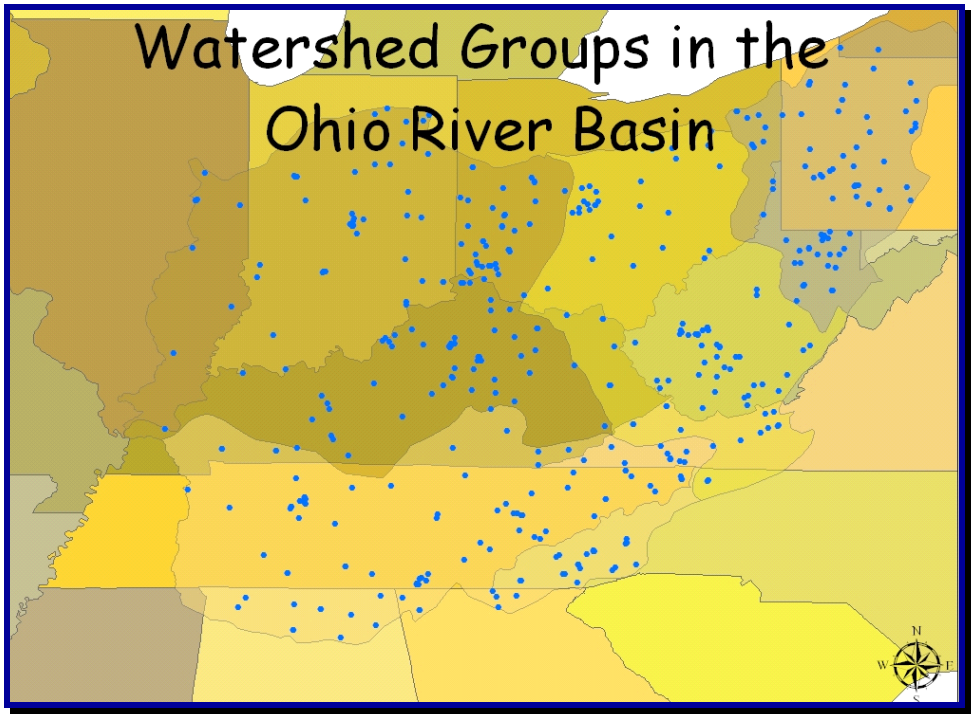


Figure 32 – Watershed Associations (USEPA Data)

universities are located within the protected footprint of local protection projects or downstream from a USACE reservoir that reduces the risks of flood damages. Without such protection, these centers of innovation could not invest in the expensive and flood intolerant equipment, testing systems, telecommunication systems, and computer systems necessary to develop new technologies.

8.1.13 Summary

As described in the text and graphics above, the Ohio River basin is a geographically large, culturally diverse, environmentally rich and productive region. Encompassing more than a quarter of the states in the nation and nearly 8% of its population, the basin generates significant domestic energy resources, forestry and mineral resources, agricultural products and substantial foreign exports. The diversity of the ecological resources of both national and international significance emphasizes the environmental value of the basin to the nation. A wide variety of recreational pursuits and beautiful landscapes attract millions of visitors to National Parks, National Scenic Areas, National Wildlife Refuges, Federally managed recreational areas, state parks, and commercial resort facilities. Tourism is a major sector of each of the 15 basin states' economies.

The basin is "water-rich" in comparison to other major water basins in the nation and provides drinking water supplies to over 5 million residents. Industry and agriculture extract significant amounts of water and each use the transportation efficiencies of the waterway system to provide relatively inexpensive products and services. The volume of water from the Ohio River entering the nationally significant Mississippi River at Cairo, Illinois, comprises 60% of that waterway's capability to support navigation, recreation,

and water supply for several states (from Illinois to the Gulf of Mexico). Not surprisingly, this energy- and water-rich region has attracted much historical growth, leading to significant expansion of urban and suburban areas in past decades – with associated impacts to natural resources and valuable ecosystems.

Water demand from both subsurface aquifers and surface waters is substantial and growing as the population of the region swells. Population projections promise a future with at least 3.0 million new basin residents. The development of residential, commercial, industrial and institutional land uses has supported past increases in population and will likely respond in a similar fashion to any growth in population. Such development unless controlled will generate more impacts to the environment as well as increasing demands for water and treatment of wastes.

Finally, the basin is represented by a cadre of political stewards at the national, state, and local levels who have guided and supported the development of the basin's resources and have protected its citizens. Merging those diverse political interests into a single forum to discuss and deliberate common issues and to formulate strategies for sustainable use and conservation of the basin's resources may be a key component of the region's future.

Having identified and analyzed the exiting conditions of the basin, the planning process turns its attention to the future of the basin and a study of the socioeconomic and cultural driving forces that inexplicably direct the activities of the population, corporations and governments.

8.2 EXPECTED FUTURE CONDITIONS IN THE OHIO RIVER BASIN

8.2.1 Forecasting Future Conditions

As Mr. Crosby states, our current plans will be for a world yet to be realized and one that only can be imagined at this point in time. Where the Existing Conditions provide a snapshot of the basin's characteristics taken from the most current data and information available, Expected Future Conditions elicit educated guesses of what the characteristics of the basin may be in an uncertain future.

> ***"If anything is certain, it is that change is certain. The world we are planning for today will not exist in this form tomorrow."***
>
> *—Philip Crosby* [2]

For the purposes of this study, the "future" will be defined as a period of time spanning the next 50 years. Numerous methods can be used to forecast what future conditions may be, but the underlying forces of societal, cultural, political, environmental, and technological change known as "driving forces" are potential keys to imagining any number of possible basin futures.

These driving forces have brought the basin from its early archaic beginnings to the current economic and diverse cultural powerhouse that supports more than 27 million

[2] Philip Crosby (1926–2001) was a businessman and author known for his theories of management and quality management practices. His quote expresses the uncertainty of the future and its ever-changing character – facts that suggest caution and diligence in forecasting future conditions.

people and literally and figuratively helps to fuel the nation's economy. These underlying change processes have shaped the basin's current character for more than 200 years, and unless there are dramatic shifts in those forces, they will continue to drive changes in the landscape, ecology, culture, and regional productivity. In addition to identifying and describing those forces, this section describes four separate future scenarios (Appendix B contains the full text of the scenarios). The scenarios are not meant to predict or project what the future may indeed be but rather are meant to expose what environmental, societal, and economic conditions may be in effect within this 50-year span of time and how existing system components and organizations may perform within those conditions.

8.2.2 Driving Forces

Driving forces are commonly referred to as a series of internal and external natural and human forces or influences (not specific events) that cause changes in an organization, culture, process, or material. Driving forces can be global, national, or local in nature and can result in change over long periods of time in a very subtle and methodical way or in a very dramatic and sudden way. These forces are frequently and broadly categorized into general arenas such as social, technological, environmental, political, and economic.

Of the driving forces that appear to have historically generated and continue to generate the majority of the demands on the present infrastructure and natural resources, five forces stand out: (1) population growth, (2) energy demand and production, (3) transportation technology, (4) Federal investment, and (5) increased concern for and appreciation of our environment – a factor that has generated interest in outdoor recreation, tourism, and environmental activism. These five forces are related and have acted both separately and in unison during different time periods to change the face of the basin since the mid-1800s. Unless there is a radical departure from the present nature of these forces and the influences that they have, they will continue to drive the regional economy, the landscape aesthetic, the environmental health and basin culture toward an uncertain future.

Post civil war activity in the basin increased dramatically as the rich resources of coal, timber and gas attracted thousands of immigrants to employment opportunities (initiating population growth). The subsequent wealth created by the extraction and processing of those resources fueled development of thousands of new floodplain communities. Economic and politically motivated Federal and state actions that improved access into the region to extract energy-related resources, generate economic opportunities and enable tourism created a landscape ripe for land cover conversion and environmental impacts. Improvements in transportation technology paved the way for the region to become more nationally and recently more globally connected. The beauty, solitude, and leisure pursuits that the basin offers further exacerbate the ecosystem pressures through resort and recreational development.

8.2.2.1 Population Growth

Population growth through a combination of natural increase (basin births minus deaths) and net-migration (in-migration minus out-migration) has simultaneously resulted in

greater economic productivity, social opportunities, and cultural diversity, while placing ever-growing demands on the basin's natural resources and aging infrastructure. Population growth translates into formation of households, needs for additional housing (single-family and multi-family), commercial and industrial development, institutional development (schools, hospitals, and public services), water supply, waste collection and treatment and energy demands. Each of these land use development components requires a form of land cover conversion from an otherwise natural state (vegetated natural contours) to a more impervious, unnatural state and requires that certain public or private infrastructure be in place to support its operation.

Due to the topographic restrictions within the eastern portions of the basin, much of the historical development in that area is concentrated within floodplain zones. Census data from 2000 indicate that over 2.0 million residential structures alone (not accounting for commercial, institutional or industrial structures) may have been constructed prior to the advent of the national flood insurance program in 1970 and its flood hazard zones mapping system. A substantial number of those residential structures (and other types) built before 1970 were likely located within what is now considered to be a hazardous floodplain and were "grandfathered" into the National Flood Insurance Program (NFIP) as each community and county entered the flood insurance program.

The basin's annual flood damages are a testament to land development processes executed in ignorance of the inherent natural hazards. It is this inventory of "grandfathered" structures and attendant infrastructure for which the existing flood risk reduction system was constructed and has been operated since the late 1930s. After the advent of the NFIP, new development (where the NFIP is active) has been constructed largely outside of the identified hazard areas. However, the existing flood protection system remains in place and operates to provide protection from flood damages. Any significant changes in the frequency or amounts of rainfall associated with regional storms due to climatic changes or increases in impervious land cover could increase the numbers of structures and infrastructure at risk.

The land conversion process (with limited regulation in rural settings) has placed ever-growing stresses on the land and water resources and the resident flora and fauna habitat. The continuation of residential building evidenced by new building permits (107,486 permits in 2007) for single-family units ensures that more habitat and sensitive environments are being threatened. Loss of habitat, point and non-point water pollution, generation of air pollutants, threats to T&E species, and increased stormwater runoff all have emerged from the conversion of forests and other natural areas to impervious paved surfaces and building roofs. Until recently, this historical conversion process had little concern for the adverse effects on the surrounding natural resources or adjacent residents. The result has been impaired water quality, loss of indigenous species, degraded air quality, loss of productive soils, loss of natural environments, more at-risk development, and loss of scenic areas.

In future terms, the population projections from the US Census Bureau indicate that the basin's total population will increase through 2030. Although this increase is not uniform across all of the basin states, overall the population could rise by approximately 10.7 percent – or roughly 3.0 million people. Table 2 shows the projected increases by state within the basin. This projected increase indicates that many of the same

environmental and infrastructure problems associated with past population growth will continue and could, without intervention, worsen. Continuing population growth will exacerbate existing issues of stormwater runoff management, combined sewer overflows, point and non-point water pollution sources, sewer and water collection and distribution systems capacity and losses of habitat and scenic areas.

Although the trends and projections in population growth indicate an increase, there are a few events that could limit or reverse growth – for instance, an accident at one of four existing nuclear power plants in the basin or a toxic chemical release that would render substantial portions of the land area unlivable for extended periods of time. Also, a major pandemic episode could dramatically reduce the population especially in the densely populated urban areas (26 plus MSAs in the basin). Other natural events could reduce the population, such as a major earthquake or an unusually large flood event that would surpass the protection limits of many of the existing facilities (dams and LPPs), resulting in massive loss of life and property damages. In addition to these natural events, global climatic changes that would adversely affect the basin's natural productivity (agriculture and timber) or significantly reduce the abundance of water would seriously limit the basin's economic health and perhaps limit the anticipated population growth.

8.2.2.2 Energy Demand and Production

The second driving force in the basin is a combination of the external and internal demands for energy. In addition to national energy demands, the region itself requires substantial amounts of energy to fuel the many steel, chemical, and manufacturing facilities dotting the landscape. This energy demand in turn drives the historical process of extracting, processing, and moving vast qualities of coal, gas, and timber from the region. Substantial amounts of coal extracted from the basin are exported to foreign markets through the railways and inland waterway systems.

The region has strategic stores of high-BTU coal and natural gas (Figures 29 and 30 show some of these resources). Coal and gas reserves appear to provide a source of employment and tax revenues for the basin states. The rich reserves of coal, gas and water have attracted many power generating plants, a number of which have located in the floodplain areas and use both water for cooling and transportation of fuels. Although now not a primary energy resource, hardwood timber resources of the Appalachian region are a significant resource commercially and harvesting of that renewable resource will continue to fulfill international and national market demands for high quality wood products. Extraction and processing of wood products provide some employment opportunities, but those processes also may create problems with water quality (erosion of thin forest soils) and water quantity (excessive runoff).

To a more limited extent, the extraction of aggregates, sand, ores, and other minerals has been a factor as well, but coal, gas, and timber have been the primary commodities. To support these extractive processes, the existing highway system, railway system, and inland navigation system (all requiring heavy investment and land conversion) have spread throughout the basin. In addition, an extensive system of water resources infrastructure (dams/reservoirs, levees, and floodwalls) has been constructed to protect this development and supporting facilities from flood damages and to help move

extracted and processed resources. Many of the smaller towns and settlements within the region either were historically or are currently involved in the coal mining, natural gas or timbering industries or are supported to some extent by these industries.

Forecasting the effects that continued energy development could have depends upon global energy resources, energy demands by third-world countries, market prices of coal, oil and other fossil fuels; national energy strategies that could depend upon more renewable resources (water, wind, bio, wave, and solar); more stringent *Clean Water Act* and *Clean Air Act* regulations and other geo-political events in the world. Should the demand for coal and natural gas as energy and industrial materials remain high over the next 50 years, their extraction, processing and shipping will continue to place demands on the natural resources and man-made systems in the basin. As water resources play an important role in the processing and movement of these resources the volume of water available for industrial and transportation remains important through that period of time. Likewise the extraction and processing of these energy resources in the future will continue to affect the quality of water.

8.2.2.3 Transportation/Communication Technology

In a region that is topographically challenged and was separated from the eastern shores by what must have looked to explorers like insurmountable ranges of steep peaks, the basin's development has been significantly impacted by transportation and historical technological improvements to its various modes. The story of the basin has been a story, in part, of transportation improvements with all of their attending impacts.

Early westward incursions into the basin by foreign immigrants were largely by foot and horse and mainly confined to the river corridors due to rugged terrain. River travel by canoe and flat boats allowed bulkier and heavier cargoes to be brought inland although river-wide cataracts impeded much up-river travel on the James, Potomac and New Rivers. As explorers reached the headwaters of the Ohio River, they were able to travel by flat boats and eventually powered vessels farther south and west into the lower basin. Abundant building materials (especially wood) allowed a substantial boat-building industry to emerge along the Ohio River.

Initially the Ohio River provided a relatively inexpensive mode of moving people and materials on the way to populating the mid-west and western states. As boat building technology improved and eventually combined with steam engine technology, river travel expanded aggressively. The early economic opportunities that emerged along the Ohio River corridor in boat building and agriculture soon attracted a growing population of settlers that formed what today are the major centers of population along the mainstem Ohio River. These "landings" soon became the industrial centers for an array of natural resource materials (wood, salt, and hides) to enter the river system.

The first major land-based transportation route into the basin was the Federally funded national road. Originally envisioned between Cumberland, Maryland, and Jefferson City, Missouri, the road was started in 1811. The road extended through the basin in southwestern Pennsylvania, portions of western Virginia (now West Virginia), and through Ohio into Indiana. Completed to Vandalia, Illinois, in 1893, the national road was abruptly ended when Federal funding stopped. This first major road provided

passage for many thousands of westward-bound travelers and its right of way is now largely occupied by US Route 40.

Penetration of the basin by railroads was led by the Chesapeake & Ohio railway locating its western terminus in Huntington, West Virginia, on the Ohio River in 1873. The expanding capability to move tons of lumber, coal and other commodities from this region to eastern markets skyrocketed the importance of transportation as a primary driver in the development and expansion of the region. As with many other cities along the Ohio River and elsewhere in the basin, connections between transportation modes (much as today with intermodal terminals) caused exponential growth in productivity and community development. As engine technology progressed and both heavier track and railcar capacity increased, the region's vast natural resources began to move by rail. This capacity expansion was aided in large part due to improvements in earthmoving equipment, bridge engineering, and tunneling technology as well. Unfortunately, expansion and improvement of the basin rail system is still hindered by topographic and right-of-way challenges.

In time, more "turnpikes" like the National Road made their way into the basin emanating from the east coast. Many of the turnpikes followed old explorer or Native American trails into the basin. These early "expressways" enabled travel by horse-drawn wagons (people and materials) and eventually powered vehicles into and through the basin. The1958 emancipation of the American highway and automobile in the form of the Interstate Highway System truly opened the doors to the basin markets in ways never before imagined. Technological improvements in diesel engines, the increasing load capacity of tractor trailers and most recently intermodal freight have truly opened the basin economy to global markets. This capability has induced growth in industrial and commercial development with "freight hubs" in several major basin cities. Intermodal terminals are located throughout the basin, with a new regional intermodal corridor (i.e., Heartland Corridor) opening up between the eastern and Midwest markets through the basin.

As early as the 1940s, commercial air travel began to move mail, passengers, and some commodities within the basin. Through the efforts of the Federal government and states, major airports handling passenger and cargo aircraft were constructed, allowing both national and international movement of cargo and people. Improvements in both aircraft and airport capacity have allowed the region to ship cargo world-wide and entertain foreign travelers within the region's dramatic landscape. Several air traffic hubs have emerged at major cities (i.e., Pittsburgh, Columbus, Cincinnati, Nashville, and Indianapolis), with many of the remaining airports being served by regional air service into these central hubs.

In addition to the technological improvements in transportation, quantum leaps in communications technology have also fueled the rise of the region to a global player. Through investments in fiber-optic telephone networks, microwave and satellite communication stations and corporate investments in cell phone and internet service, the basin population and its business sectors have been able to connect to national and global markets. Through the internet system alone, terabytes of information on the basin's natural resources, commerce and industry, Federal programs, state resources, have been made instantly available to investors and interpersonal communications have

more closely knitted together the social and cultural fabric of the basin. Interactive computer systems have facilitated remote high school and college level instruction to scattered satellite institutions. Many regional media companies provide outlets for dissemination of information and opportunities for regional employment and organizational partnering.

Satellite and microwave communications technology has enabled real time data transmission of precipitation rates and flow and stage elevation data from hundreds of basin rain gages and the 520 recording streamgages that support flood warnings. This communications system has also facilitated the capability for remote operation of isolated flood risk reduction facilities. Satellite weather information available online to personal computers through NOAA/NWS has allowed individual households the ability to see approaching storms and receive flood warnings from the National Weather Service.

The basin culture and economy has shifted from a relatively isolated, home-bred market to a global partner through technological improvements in transportation and communications. Enhancement of the multi-modal and intermodal transportation system now being planned and initiated will continue to broaden the basin's commercial and industrial markets and allow fuller access to the global economy. More powerful and capable communication systems now being considered in the region will enable improved reliability during all types of weather and emergency situations. Transportation and communications technology improvements have been a major driving force in the development of the basin.

8.2.2.4 Appreciation and Concern for the Environment

Although remote areas have long been popular with fisherman, hunters, and campers, the environmental awakening of the 1960s and 70s ignited a flurry of private and public investment within states for outdoor recreation and tourism. Aided by the development of the Interstate Highway and Appalachian Development Highway corridors, recreation and tourism have become major components of the states' tax revenues. The popularity of these recreational pursuits has attracted thousands of commercial and private entrepreneurs to the region for construction of overnight accommodations, dining, recreational facilities, and recreation-related products and services. Major outdoor recreational outfitters (commercial and private) have established basin locations to take advantage of the economic benefits of this driving force. This sector of the basin economy has extended its seasonal nature through mixture of winter sports resorts with summer recreational facilities. There are approximately 1,200 golf courses within the basin and 215 state parks, some featuring skiing, fishing, golfing, camping, and hiking in the same location.

State Parks Departments, State Departments of Natural Resources, and a host of similar agencies have lured millions of tourists annually to natural and man-made attractions. Millions of visitors are attracted each year, not only by the rich history of the region and its dramatic scenery, but by the development of recreation at 2 National Parks, 2 Wild and Scenic River Segments, 33 National Forests, 9 National Parkways, 7 National Recreation Areas, 22 National Wildlife Refuges, and 36 National Wilderness Areas. Between 2004 and 2008, more than 100 million people visited National Park Service (NPS) facilities in the basin. As an example of the spatial extent of this development,

NPS owns and operates over 800,000 acres in the basin; the National Forest Service, 12.9 million acres; and USFWS, over 214,000 acres. In addition, the 15 states have constructed and operate 215 state parks in the basin, attracting millions of annual visitors. This influx of seasonal visitors generates millions of dollars for the regional economy but brings with it many impacts. Figure 33 shows the distribution of other Federally owned lands (other than USACE lands) and the spatial array of the state parks. The extent of National Forests, National Parks, and state parks expresses the extent of non-USACE recreational pursuits and protective management of ecosystem habitat.

Added to this legion of Federal and state recreational resources are the 83 reservoirs constructed by USACE where day-use and overnight recreational facilities have been provided. Total combined visitation at these Federal reservoirs for the last 5 years has averaged approximately 19 million visitors per year. Estimated public benefits derived from visitation/recreation during that same five year period exceed $200.0 million.

As in the case of both population growth and energy production, the tourism force has resulted in additional land cover changes and intrusions into natural areas. Although less land-intensive than either of the other forces, the tourism trade has ventured farther into more sensitive natural areas, where poorly planned and designed development can

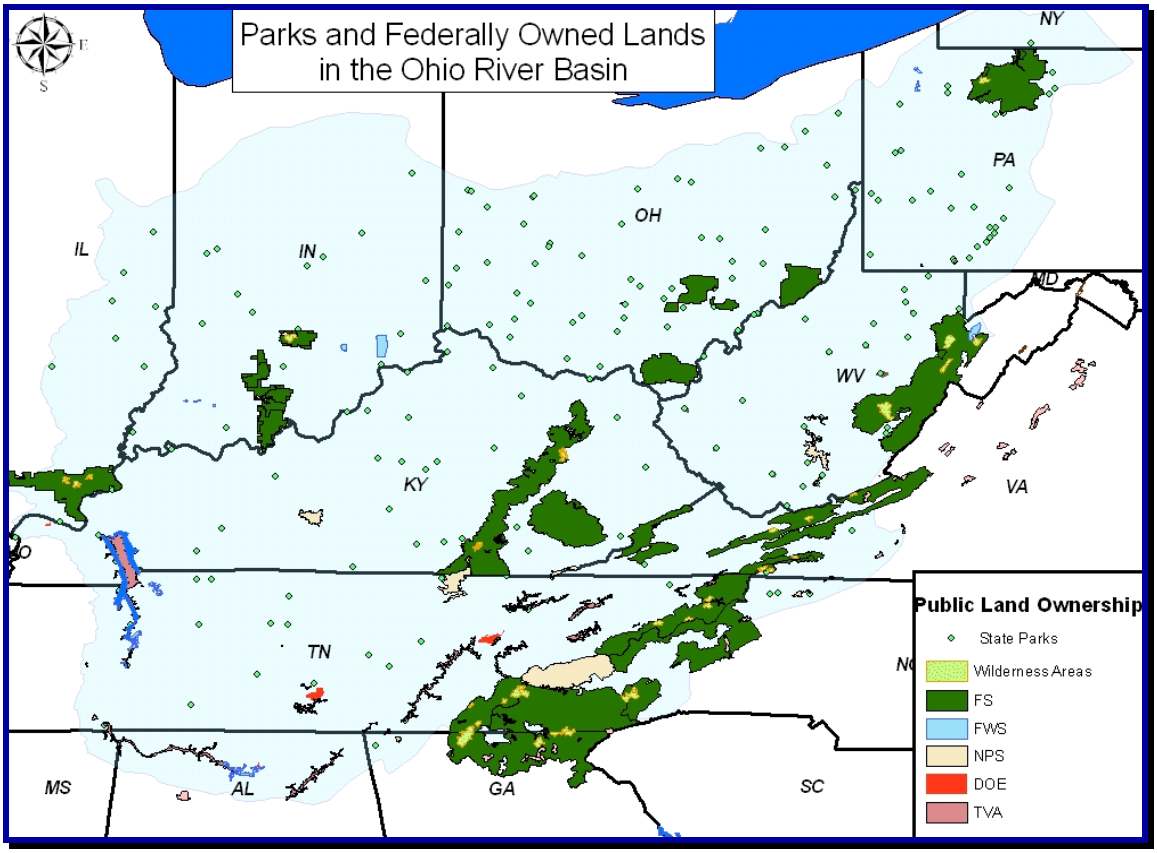


Figure 33 – Federally Managed Lands and State Parks

have profound consequences. Of these tourism-driven, privately funded forays into natural areas, second-home or vacation home development and exclusive resorts can have lasting effects on water quality, terrestrial and aquatic habitat, and aesthetic resources. The emergence of eco-tourism has further exacerbated this incursion into the natural areas. Construction of access roads/parking, water and sewer infrastructure, and buildings in more pristine areas have impacted the natural resources of the region.

8.2.2.5 Federal Investment

Although the economic wealth produced through development of rich natural resources and abundance of water has been substantial, much of the infrastructure within the basin that supports economic growth and a relatively high standard of living has been fueled by Federal investments. From highways, military bases, research institutions and inland navigation systems, to airports, schools, health care facilities and Federal loan-guaranteed housing, Federal investments have provided billions of dollars of support structure for the basin economy and society.

The programmatic forces described below are but a small percentage of the programs and projects financed largely by Federal funds that have driven change in the basin. This onslaught of Federal funds has enabled the basin to change from a more rural agricultural economy to a more industrialized region that helps support the nation's economy while containing its most diverse and productive ecoregions. A significant reduction in the flow of Federal assistance and program/project funding into the basin could have a substantial effect on the economy and the living standards of the region.

In particular, four major Federal programs outside of USACE's civil works program have had dramatic effects on the basin landscape. The Tennessee Valley Authority (TVA), the Federal Interstate Highway Program (FIHP), and the Appalachian Regional Commission (ARC) have injected billions of dollars of Federal investment into portions of the basin that have promoted growth in population, access, agriculture, energy development, and tourism.

The TVA was initiated in 1933 to generate inexpensive energy for the region through hydropower facilities, and fossil fuel plants as well as manufacturing fertilizer for agriculture. Figure 34 shows the footprint of the TVA program and the location of their facilities in the Tennessee River Valley (red squares designate reservoirs, purple squares designate nuclear power plants, and yellow squares designate fossil fuel plants). The TVA operates, in addition to hydropower (29 plants) and fossil fuel power plants (11 coal-fired and 83 combustion turbine generators), three nuclear power plants. TVA stands as a major employer, water manager and energy producer in the basin. Additional information can be found at their web site, http://www.tva.gov.

The FIHP began in 1958 and quickly improved the highway access both within and through the basin from eastern and mid-western commercial markets. Freight truck traffic capacity on the interstate system has favorably influenced many industrial and commercial location decisions within the basin. Improved access to the rich history and natural resources of the basin has made the tourism industry a major revenue producer.

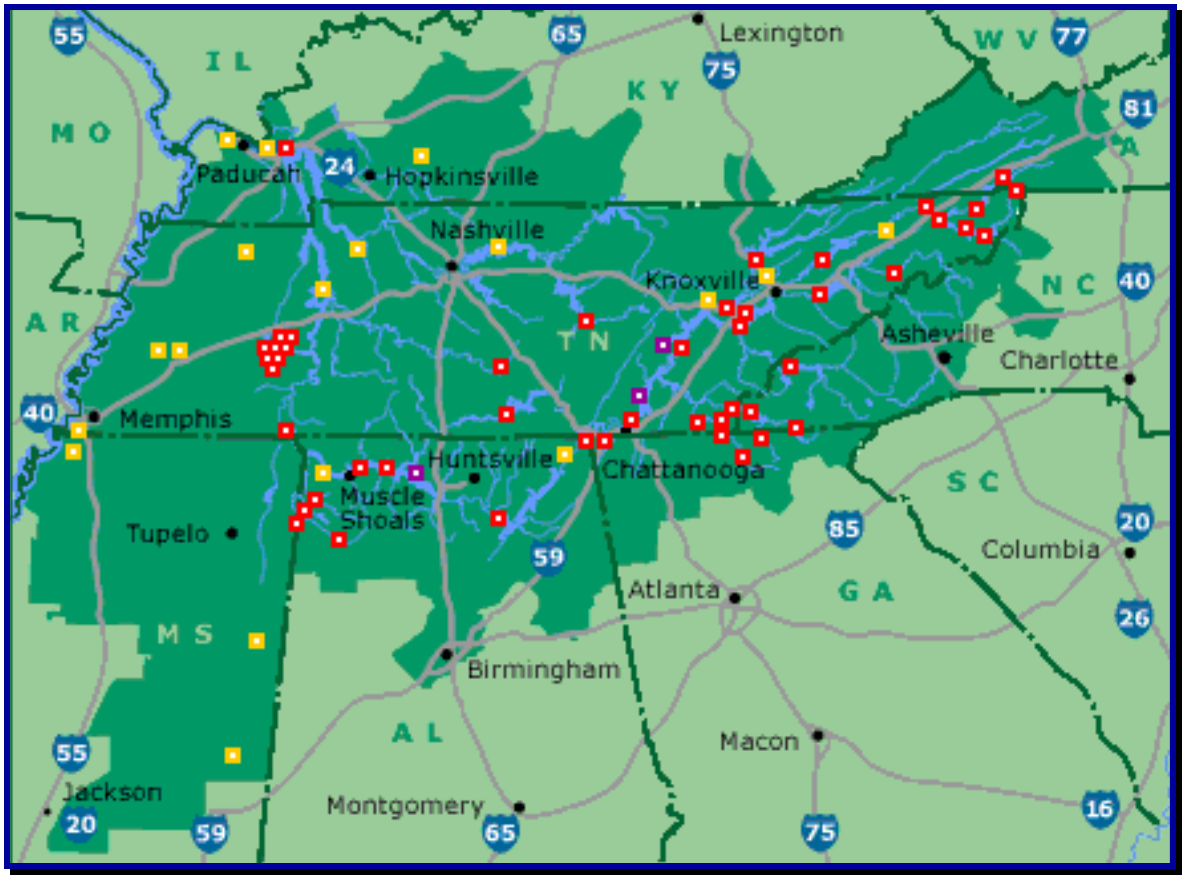


Figure 34 – TVA Footprint and Power Facilities

Major east-west and north-south routes through the basin that provide access to the ocean/gulf ports and Great lakes have opened up economic opportunities for major employers to move products internationally. Prime locations for intermodal terminals where the Interstate Highways intersect major railway lines and the inland waterways provide commercial and industrial opportunities for foreign trade and investment. Figure 23 shows the components of the Interstate Highway System in the basin.

With the advent of the Appalachian Regional Commission in 1965, Federal funds flowed into portions of the basin bringing improved access (3,090 mile long Appalachian Development Highway System [ADHS]), education, health-care, housing, infrastructure, and social services. This injection of public funds provided the population with new sewer and water service, improved access and upgraded basic health and public services that helped to both improve and sustain the population base.

The Commission is composed of the governors of each of the 13 states included in the ARC footprint and other appointed members. In relation to the Ohio River basin boundary, the ARC authorized footprint only excludes two states (Indiana and Illinois) within the basin. Funding for regional highway improvements is provided through the Federal Highway Administration to each of the 13 states to support the ADHS and amounts to about $450.0 million annually. Figure 24 shows the extent of the ADHS.

In addition to highway funding, annual funds are provided by Congress for area development. These funds are used for enhanced health care facilities, public infrastructure, education, and social services. Anticipated funding in 2009-2010 for the region is approximately $76.0 million. In collaboration with the states in the ARC region (West Virginia, Pennsylvania, Virginia, Maryland, Kentucky, Ohio, Tennessee, South Carolina, Georgia, Mississippi, New York, Alabama, and North Carolina), the ARC has vastly improved the health, safety, welfare and well-being of the residents. Figure 35 shows the geographic footprint of the ARC program.

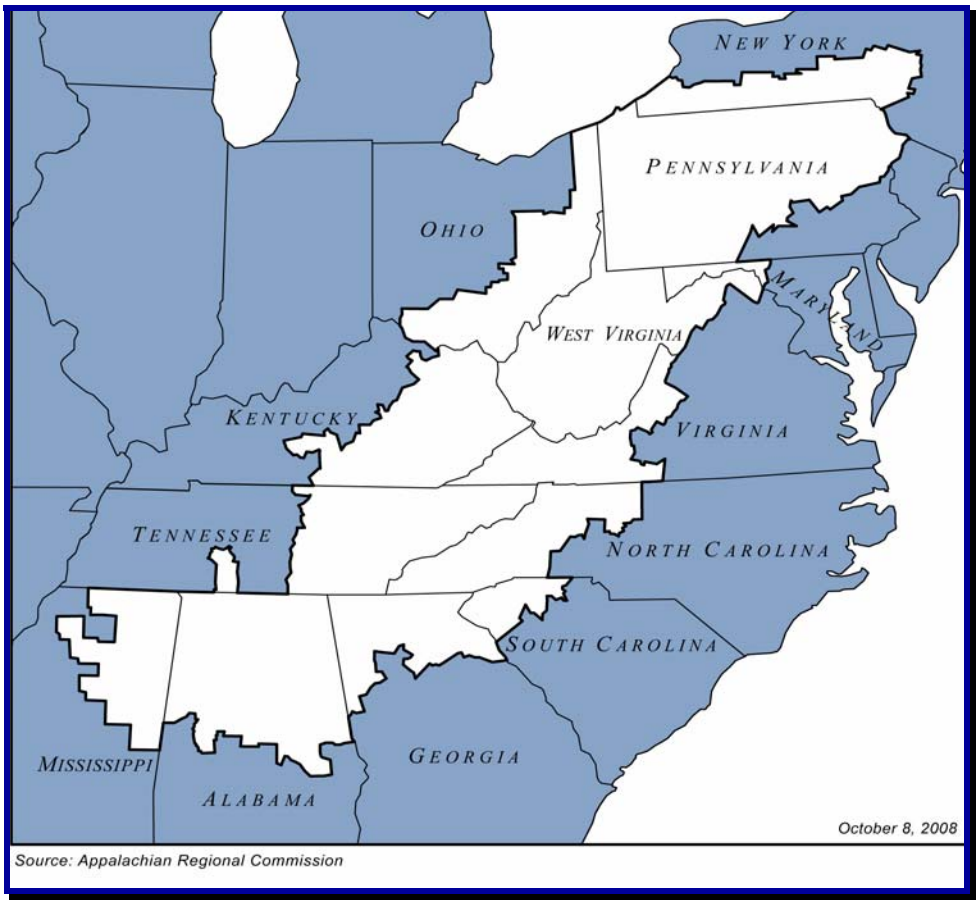


Figure 35 – Appalachian Regional Commission Footprint

8.2.2.6 External Driving Forces

The forces described above are primarily internal to the basin itself, but there are external forces that could significantly affect the basin and the protection of the residents and natural resources within it. Of the many global and national forces that may affect the basin's future, demand or lack thereof for the basin's energy resources; international agreements or national policy changes in energy production; climate change and air quality; global climate change; pandemic episodes; regional wars that affect the world's supply of energy resources and food; and global economic health and increasing population growth through immigration are a few that could seriously affect the basin population and natural resources.

International agreements on reduction of emissions of carbon and other air-borne pollutants within the US could significantly affect the basin's economy with its massive reserves of coal and multitude of coal-fired power plants (Table 13). Reductions in emitted gases and other particulate matter below levels that would be financially prudent for power companies to address could stifle future industrial growth in the region and drastically reduce revenues from coal production and utilities that power several states. Under such restrictive conditions, the cost effectiveness of shipping steam-coal by inland waterway compared to other modes may drive more use of the waterways.

Each of these external forces could affect the basin and the operation of existing infrastructure, but climate change, as discussed in the issues section of this report, is probably the most threatening to the future sustainability of the population, productivity and the environment. Major shifts in the climate with regard to amounts of precipitation, temperature extremes, higher evaporation rates, intensity and duration of storms and extreme weather related events (blizzards, tropical storms, heat waves) could have disastrous effects on the region's economy, society, and ecology in the future. Should the predicted changes occur, the shifting climate and the weather anomalies that are produced may become the primary driving force for change. More in-depth discussion on the potential effects of climate change is included in Section 8.4 – Aggregated Problems, Needs, and Opportunities.

8.2.3 Basin Future Scenarios

Having identified the "driving forces" that have been and continue to be at work, this section describes a series of four future scenarios of the basin that use the internal and external driving forces as their foundation. The scenarios represent only a fraction of the possible plausible futures that could be developed and that actually may occur. Using varying trends (upward, static, and downward) of the five internal forces described, a great many separate scenarios could be developed. Since many of the potential trend lines would defy current logic or accepted projections (i.e., a dramatic reduction in national energy demand or dramatic reduction in population growth) when used as combinations to support scenarios, the number of scenarios presented was limited to four. The four scenarios presented describe a logical array of plausible conditions that could subtly or dramatically affect the existing infrastructure as well as the management and sustainability of water resources.

Scenarios do not attempt to predict any particular future or even project trends as a method of determining an "official" future. Scenarios provide plausible descriptions of future conditions in which the driving forces, extended at varying degrees, merge to form an environment that is or is not conducive to certain existing activities or planned actions. Issues of sustainability, diversity, prosperity, and either socioeconomic cacophony or harmony can be explored through these different "narrative stories or myths" of the future. The four preliminary scenarios have been titled: (a) No Action, (b) Changed Climate, (c) Changed Economy, and (d) New Paradigm.

The scenarios are described in detail in Appendix B but are summarized below:

(a) In "No Actions" the same driving forces now at work in the basin continue on with little or limited basinwide planning or attempts to address growing issues of water

resources through a strategic collaborative process. Most agency responses to local or regional flood events such as major floods or emergency operations at dams or local protection projects are handled through single project initiatives funded over several years. Water quality improves in the basin although there remain areas of ongoing non-point pollution, nutrient loading and sedimentation that continue to hamper efforts to clean the rivers beyond their "impaired" listing. Several endangered species maintain a tenuous existence as aquatic habitat remains marginal due to altered flow regimes, sedimentation and altered water chemistry. Stormwater controls only occur in the major cities with limited application in smaller communities and growing counties. A number of CSOs remain unresolved due to lack of local financing to address them.

Land use controls such as zoning, building codes and subdivision regulations are not widely used to control the adverse effects of land conversion or to protect stream corridors. Climate change does occur and agencies and states work independently with limited regional information to address the impacts of those changes. More intensive rainfall events result in sporadic urban flooding, losses of life in high-gradient stream corridors and losses of in-stream habitat due to uncontrolled stormwater runoff. Growing regional water shortages are handled on a case by case basis through state emergency services. Several endangered species teeter on extirpation from the basin due to reduced water flow caused by less precipitation. In short most new water resources challenges are met by the agencies and states in an independent, largely uncoordinated fashion with short-term successes and questionable future sustainability.

(b) In "Changed Climate" the agencies and states involved with water resources take a largely laissez-faire approach to problems and through a lack of collaborative planning allow many outstanding problems to go unresolved or address them as single, uncoordinated project solutions. Local land use regulations that would address effects of intense storms and drought conditions continue to be managed in a sporadic fashion and only as a result of mandatory Federal requirements. Water quality improves in the Ohio River and its tributaries, but non-point issues such as nutrient loading and bacterial contamination abound in many watersheds. A number of streams classified as "impaired waters" continue to be degraded as does the productivity of the aquatic species that they support. Demands for water continue to grow, and water providers respond through rate changes and uncoordinated conservation efforts.

Climate change takes place, and the worst effects of those changes – in terms of precipitation and larger, more powerful Atlantic/Gulf cyclones – eventually result in a heretofore unseen convergence of floodwaters within the basin. Years of underfunded rehabilitation work at dams and local protection projects result in several catastrophic events featuring loss of life and significant damages. The more intense precipitation events take their toll on small stream aquatic habitats as uncontrolled stormwater runoff destroys in-stream structures and riparian vegetation. Past sporadic drought issues take on another perspective as prolonged drought conditions in the western portions of the basin threaten agricultural production and both surface and subsurface water supplies upon which irrigation depends.

(c) In "Changed Economy" the basic employment sectors of the basin suffer dramatic losses through changes in national energy priorities, international agreements over greenhouse gases, climatic changes, heightened tensions in the major oil producing regions of the world and deeper losses of manufacturing and basic sector employment. Due to shifts in national priorities, funding for water resources programs in the basin and the nation are significantly reduced. These employment and investment losses ripple through the entire economy causing many smaller communities based on regional employment sectors to approach insolvency.

Larger cities and towns in the basin that are protected from flooding by local protection projects and upstream dams are suddenly faced with severe shortages of tax revenues with which to support the annual O&M of the LPPs or to address any significant rehabilitation of lingering deficiencies in the structures. Population in the smaller communities begins to shrink as people move into areas of better economic conditions thus exacerbating the shortages of operating funds. A positive aspect of the adverse economic conditions is an overall slowing of development sprawl at the urban fringes thus reducing impacts on terrestrial and aquatic habitat. Climatic changes do occur as forecasted and the basin witnesses more intense storms, regional droughts and much hotter weather with soaring evaporation and transpiration rates. Small streams are impacted by intense, uncontrolled stormwater runoff episodes that destroy remaining aquatic and riparian habitat. Regional water shortages become more pronounced, and several states begin emergency conservation measures in a largely uncoordinated fashion. Surrounding states propose to withdraw substantial portions of the remaining water from the basin, and conflicts over water-rights between the states begin to mount. The basin begins to spiral into a full-fledged water-rights dispute.

(d) In "New Paradigm," the agencies and states within the basin form a collaborative partnership in the beginning of the second decade of 2000, based on strategic objectives dedicated to more sustainable use of the basin's water resources. A Water Users' Council forms, comprising the 15 states and involving (in an advisory role) Federal agencies associated with water resources. This Council begins to formulate basinwide strategies to address the most pressing water issues and supports numerous initiatives with multi-state financing and contribution of human resources. Basinwide water management and infrastructure rehabilitation plans are formulated through collaboration of Federal, state, regional, local, and NGO partners. Basinwide agreements that fund strategic actions result in (1) optimization of water flows and water storage and (2) institution of conservation practices designed to buffer the system from future climatic and socioeconomic upheavals.

A number of operating reservoir projects are modified to permit greater flexibility in flow releases and transference of storage to balance downstream aquatic benefits and support downstream TMDL standards. Regional water supplies are managed in a more integrated fashion through strategic planning as climate changes threaten reservoir and groundwater capacities. Water management strategies and integrated, water-monitoring stations are implemented that facilitate adaptive management of reservoir operations in response to changes in climate and economic conditions.

After enactment of enabling legislation at state levels, many counties and smaller communities enact stormwater management regulations. Renewed emphasis on floodplain management programs results in greater participation in the Community Rating System resulting in not only safer communities but also less expensive flood insurance premiums. Point sources of water pollution due to construction are reduced through the NPDES permit program and communities identify and protect sensitive riparian corridors in their neighborhoods through transfer and purchase of development rights. Efforts are made by the Council and the Federal agencies to work closely with local communities to rehabilitate local protection projects where significant deficiencies were identified in the levee inspection program following the *Levee Safety Act* in 2007.

These wise infrastructure investments pay off in the later years of the planning period (2060) as climate change challenges the flood risk reduction system with more intensive rainfall episodes. Upgrades in the basin's streamflow gaging system aided in part by combined efforts of the Council and Federal agencies, reduce loss of life and economic losses of movable assets. Capital investments in local protection infrastructure buffer local jurisdiction O&M financial burdens associated with downturns in the energy-related sectors of the basin economy.

8.2.4 Summary

The benefit of considering the driving forces that have shaped the basin is that many of the issues being generated by the stakeholders and public are directly related to those ongoing forces. Whether perceived to be beneficial or adverse, these forces continue to shape the human and natural environment. Within this array of forces is a submerged level of uncertainty as to the degree of impact that these forces would have on one another as well as the water resources should there be any significant natural or man-made "hiccups" in the future. Any dramatic, relatively sudden climate changes in the region as suggested in the "Changed Climate" scenario or a major seismic event may have significant and adverse impacts on many systems and it is in these extreme events that uncertainty lies hidden.

The future scenarios (Expected Future Conditions), as plausible or implausible as they may seem, display conditions of anticipated climate change, projected population growth, energy market volatility and environmental concern within which the existing infrastructure would be operated and managed. It is also within these plausible futures that various water resources initiatives may produce more beneficial outcomes with fewer impacts to the basin population and its ecosystems. The discussion on basin problems needs and opportunities that follows will broaden the discourse on how the driving forces identified above have affected the basin and how their future trends may impact existing and proposed systems.

8.3 IDENTIFIED PROBLEMS, NEEDS AND OPPORTUNITIES

> ***"A problem well stated is a problem half solved."***
>
> *—Charles Kettering* [3]

The identification and preliminary analysis of the problems, needs and opportunities within the study area is one requirement of the reconnaissance study. As Mr. Kettering suggests, clearly stating the problem, not just the symptoms of the problem, goes a long way toward formulating good solutions. Considering the volume of issues that have been generated by the public, key stakeholders, and USACE staff, more in-depth analyses of the issues has been included in Section 8.4, "Aggregated Issues – Problems, Needs, and Opportunities." Many issues have been aggregated into general themes for analysis.

In this study, the term "issues" is used as a generic title for the collected and documented views and concerns of the public and stakeholders regarding water resources development and management within the basin. This study's web site (www.orboutreach.com) and multiple stakeholder meetings have been the primary mechanisms for (1) sharing basin information, (2) promoting understanding of USACE's role in water resources development, and (3) inviting agencies, stakeholders, and the public to share their concerns about the basin water resources.

The ability to formulate potential alternative solutions for further study is grounded in the accurate characterization and analyses of the issues. Some issues expressed were directly related to the waters and aquatic ecosystems of the basin (rivers, lakes, streams, wetlands and riparian zones) while others were related to associated land activities that affect the waters of the basin. Additional associated issues raised by the public and stakeholders that may be connected to water resources development and management or that may be addressed in part by an alternative solution were also considered in this report.

Initially all identified issues within the study area were characterized under the general headings of USACE's current business lines. From an organizational viewpoint, the issues and their potential solutions (alternative plans) easily could be categorized into USACE's annual budget process (as distinct budget items) for further planning. This strategy would enable a smooth transition between the reconnaissance planning phase and future feasibility, watershed, or basin studies and continuing authorities for implementation. However, this strategy appeared to waste the opportunity to address a broader variety of issues, unlimited by USACE's relatively narrow business lines.

A comprehensive study of the basin hasn't been completed since 1969 – a 40-year period in which the basin's demography and challenges have changed substantially. This time period also has seen changes in priority for the nation's water resources as well as updates to the planning methods applied to water-resources development. The more recent requirements in USACE's "environmental operating principals" demand that

[3] Charles Kettering (1876–1958) was an American inventor holding 140 patents and serving as head of research for General Motors for 27 years. His quote points out the benefits of accurately characterizing or expressing the problem being considered rather than merely considering the visible symptoms.

an integrated, systems approach be used in planning for such a large and complex region. Viewing the water resources system as only a collection of unconnected business lines seemed inappropriate in the current policy environment of watershed and basin planning.

The PDT further realized that by categorizing all issues by business lines many integral system problems may be dispersed into separate, small-scale concerns making comprehensive, strategic solutions and outcomes less likely. The synergistic opportunities contained within identification of connected issues and integrated solutions would be lost through a disaggregated issues method. The many years of project-focused planning and project development have conceivably masked many system-wide problems for which comprehensive studies and strategic solutions are the only realistic answer. In addition, issues of system sustainability, resilience, robustness and redundancy can be marginalized when the system is disaggregated into and evaluated as only component parts (or only as business lines).

USACE's environmental operating principals require that sustainability be addressed in its planning processes. Viewing the system and its inherent issues as a collection of integrated and inter-related processes allows the planning team to formulate alternatives that can be strategic in nature, can offer synergistic opportunities, and can be both sustainable and feasible.

Since this reconnaissance report addresses the entire basin area and ER1105-2-100 encourages planning for water resources development at the watershed scale, the water resources issues within the basin were initially categorized as being either basinwide, watershed or sub-basin wide, particular to individual projects, or significant at the municipal/county level.

At the basinwide level, issues were seen as affecting either all or a significant number of the watersheds to some identifiable level. These broader issues were identified by all four USACE districts and the majority of non-Federal stakeholders as being widespread throughout the basin. Many of the water-management, water-quality, and ecosystem issues expressed by the various organizations appeared to apply on a basinwide scale.

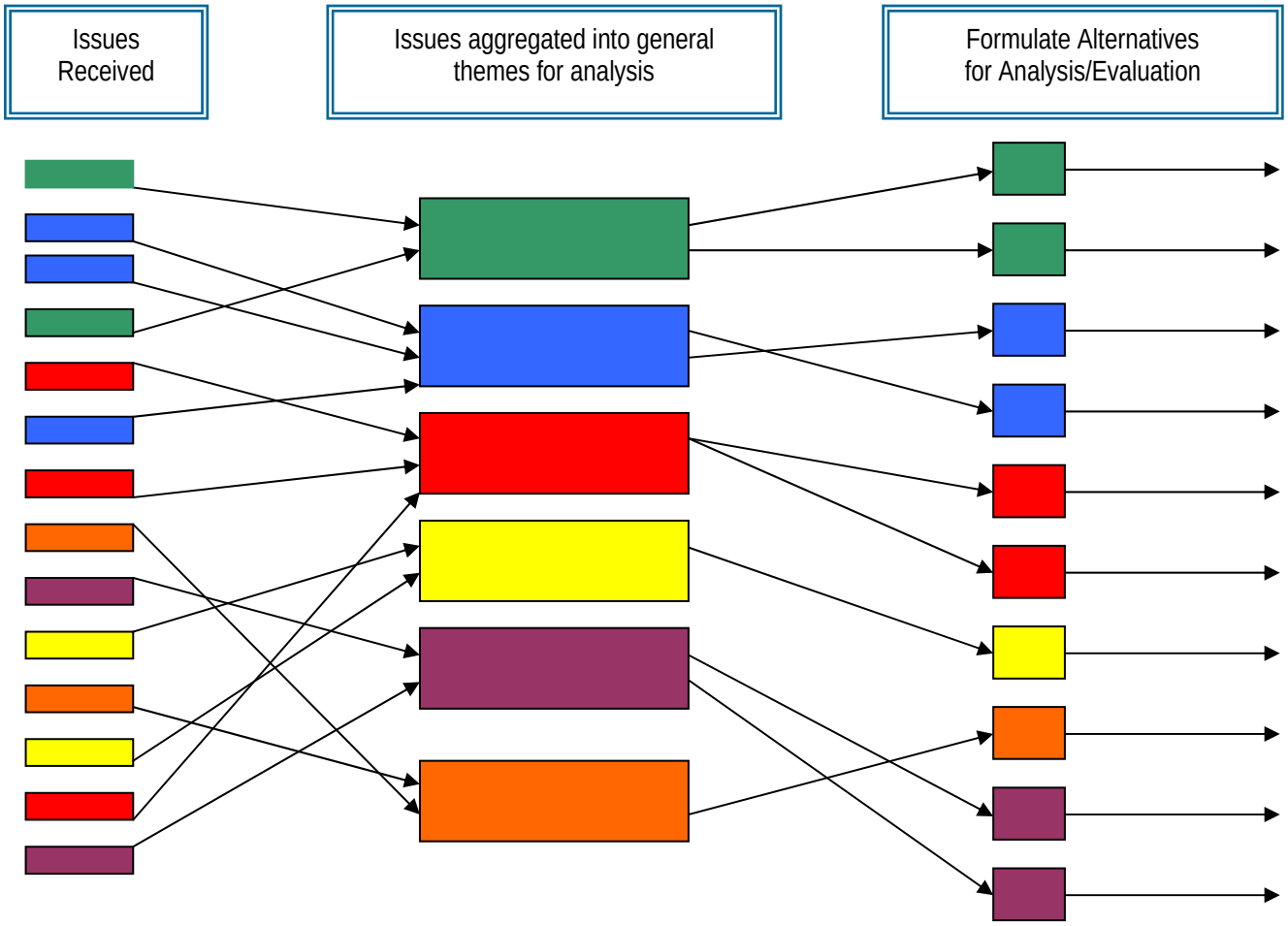
At the watershed or sub-basin level, some issues were seen as being particular to a distinctive geographic region of the basin because of specific regional demands or by virtue of some demographic, hydrologic, ecologic or economic anomaly within the basin. Concerns that water storage allocations among operating reservoirs had become outdated or obsolete points out potential needs for comprehensive reallocation studies within sub-basins where multiple-purpose reservoirs are operating. Likewise, issues surrounding one or two major water pollution sources (acid mine drainage or agricultural chemicals) could be located in a single watershed and therefore alternatives could be formulated and studies recommended for a particular region. Those issues that were expressed as being directly attached to a specific project (LPP or reservoir), city or county were categorized at a more local level – not equally important throughout the basin, but of particular interest at the community or project level.

By emphasizing these separate levels of concern, the PDT believed that more system-oriented, strategic solutions could be identified – systematic solutions that could resolve

outstanding risks, growing resources demands and aging infrastructure. At the same time, issues that are particular to one or more individual watersheds could be addressed by either standing or new authorities dealing with that level of planning and for which regional solutions (basinwide) were possible and supportable.

To bring the planning process full circle, the PDT cross-matched the many issues in the general categories of basinwide, watershed-level, and project/city/county level against the traditional business lines in a crosswalk or matrix table (to accommodate transition into the next planning phases and USACE's budgeting process). That cross-match table is included in Appendix C.

In addition to the categorization of issues at the basin, watershed or local level, the quantity of issues and concerns received, many with similar themes, suggested categorization by general themes so that alternatives of a more strategic nature could be identified. The issues/alternatives formulation process diagram shown below shows the process of sorting and aggregating received issues into general themes for further analysis, and formulation of alternatives to address the aggregated issues.



8.3.1 Issues – Key Stakeholders Perspective

Table 2 in Appendix C shows the list of water resources issues as viewed by the major basin stakeholders. This comprehensive array of stakeholders (a complete list of the major stakeholders from whom issues were solicited is provided in Appendix C) provided significant information to the PDT regarding state and regional problems, needs and opportunities in the realm of water resources. Primarily these comments were provided to USACE through letters and emails as response to USACE mailings to Federal agencies and departments within state governments as well as NGOs and other key stakeholders. A number of comments were received from the stakeholders at state/USACE meetings held either as regularly schedule annual meetings or specifically scheduled for the study. As can be seen in Table 4 in Appendix C, a significant number of common water resources issues were identified by both USACE personnel and major stakeholders.

8.3.2 Issues – General Public Perspective

In addition to the issues expressed by USACE personnel and the major stakeholders, the public was given the opportunity through the study web site and open forums to express their concerns for water resources development. Individual comments were received on the web site pertaining to the existing flood risk management infrastructure as well as environmental issues, recreational facilities, environmental issues, and the public's perceived gaps in the current protection system. Table 3 in Appendix C shows the public's comments.

8.3.3 Issues – USACE Perspective

Table 4 in Appendix C shows the range of issues by basin, watershed, and project levels, from USACE's perspective. This list of issues was developed through an iterative process involving multiple meetings and emails among the four USACE districts. Issues were solicited from several elements within each district (planning, real estate, engineering and construction, and operating field installations), and district personnel identified many basinwide, watershed, and project-level issues in several categories.

8.3.4 Summary

The collection, aggregation, and analysis of issues is one of the more important functions of the reconnaissance study process. Using the study's web site, email, meetings, and letters to known key stakeholders in the basin, the PDT has been able to gather comments from a wide variety of stakeholders, USACE personnel, and the general public. In view of the wide scope of the study and the full spectrum of comments received, the PDT gathered the comments into several major categories displayed in the following report section for the purpose of formulating strategic alternatives that could address the issues at several geographic and policy levels. The aggregation process also enables planners to identify inter-relationships between the issues and existing systems that can result in synergistic, sustainable solutions. Hopefully this airing of issues will energize many people and organizations both within and outside of the basin to collaborate on the implementation of some of the alternative strategies and actions described in Section 8.6.

Table 15 lists the top 30 concerns (by frequency of receipt) received on the web site, by letters, through feedback at meetings and conferences and by emails. They are not listed in any priority order. Appendix C provides the complete list of issues and concerns captured by the various communication methods.

8.4 AGGREGATED ISSUES – PROBLEMS, NEEDS AND OPPORTUNITIES

To analyze the many issues raised by key stakeholders, the public, and USACE personnel, several broader categories (or "themes") of issues were developed so that sustained analysis (thinking), as Voltaire suggests, could be applied to the issues at a more strategic and holistic level. Discovering casual relationships between issues through detailed analysis of data can lead to opportunities for synergistic solutions. The issues were aggregated into the general categories and themes below:

> ***"No problem can stand the assault of sustained thinking."***
>
> *—Voltaire* [4]

1. environmental and ecosystem;
2. water quality and flows;
3. water management;
4. development impacts from population growth;
5. water supply;
6. floodplain development, recurring damages, and loss of life;
7. aging flood risk reduction infrastructure;
8. public land stewardship and recreational facilities;
9. climate change;
10. environmental infrastructure;
11. water resources development policy;
12. energy/hydropower related; and
13. navigation.

The following issues are presented and discussed below in order of their frequency in responses to specific letter requests, responses to the study web site, and responses at stakeholder meetings. Opportunities are likewise discussed as they may pertain to specific actions at the basin, sub-basin, watershed, or project levels.

[4] Voltaire (1694–1778) was a French Enlightenment writer, essayist, and philosopher. His quote exemplifies the need for, and benefits of, sustained analysis and deliberate thinking when addressing difficult problems.

Table 15 – Top 30 Issues Received from Stakeholders, Public, and USACE

1. Water quality degradation from runoff by land use conversions and combined sewer overflows.
2. Water quality effects on Threatened and Endangered (T&E) species (especially mussels) in the Ohio River and tributaries.
3. Sufficiency of water supplies in view of projected population increases and potential climate changes.
4. Repair and rehabilitation of aging infrastructure in the basin (dams, levees, floodwalls, locks, and dams).
5. Needs for additional flood protection at basinwide major cities and smaller communities.
6. Fiscal sustainability of streamflow gages in the basin critical to flood warning systems and drought monitoring.
7. Water quality degradation from pharmaceuticals, bacteria, pesticides, nutrient loading, and sedimentation.
8. New commodities and freight prospects in the Ohio River navigation system and connections to Gulf Coast ports.
9. Necessity to upgrade recreational facilities and manage Federal lands for T&E species.
10. Assurance that stakeholders' input will be incorporated into the Ohio River basin report.
11. Bank erosion on rivers and lakes due to flow regulation at reservoirs, navigation locks, and dams.
12. Lack of basin stormwater management generates flooding conditions downstream and water-quality problems.
13. Effects of sedimentation on aquatic species including game fish and their food sources.
14. Lack of ecological connectivity between the rivers/floodplains and effects on riparian/aquatic species.
15. Conflicts among water users (i.e., water supply, hydropower, recreation, flood protection, fish and wildlife, and navigation) and better management of water storage and flows.
16. Need for updated floodplain mapping in developing communities to better manage floodplain development.
17. Invasive species effects on indigenous aquatic and terrestrial species in the basin.
18. Out-of-basin water transfers for water supply and other uses.
19. Needs for water treatment/distribution and sewage collection/treatment infrastructure to address basin health issues.
20. Regulated flow from reservoirs reduces aquatic species habitat diversity and productivity.
21. Potential impacts to water supplies and water quality from exploration and extraction of energy resources.
22. Lack of basinwide state forum for discussing common water resources issues and future strategies.
23. Potential effects of climate change on T&E species habitat, recreational use, water supplies and agriculture.
24. Need for a central library of water resources information and data accessible by agencies and citizens.
25. Federal policy changes regarding cost sharing, use of Federal lands, infrastructure rehabilitation.
26. Accelerated growth in areas of significant biological diversity and effects of uncontrolled sprawl.
27. Effects of winter drawdown on USACE reservoirs regarding erosion, recreational use, tributary head-cutting, etc.
28. Restricted access to fishing areas below reservoirs and locks and dams.
29. Concerns for the existing condition, burdens of maintenance (on financial and human resources), and safety of local community levees.
30. Issues are wetlands preservation, stormwater management, and drinking water shortages in some areas, as well as the capacity to store and share water.

8.4.1 Issues – Environmental and Ecosystem

The basin hosts a vast array of complex ecosystems that envelop and enrich the region. The ecoregions map Figure 15 shows the complexity and diversity of ecosystems that populate the basin. To a large extent the productivity and diversity of the ecoregions support a substantial amount of the economic activity for the 27 million people who live in the region. Besides the obvious commercial, recreational, and carbon sequestration contributions of the forested lands in the basin, the multiplicity of ecosystems provide food, store and cleanse rainwater, support outdoor recreation, and generate oxygen as well as many other monetary and non-monetary benefits.

Based on information presented at the Ohio River Summit in 2007, there are an estimated 80 species of fresh-water mussels in the Ohio River and its minor tributaries and about 154 species of fish in that same aquatic system. In addition, that information indicated the presence of between 35 and 39 species of freshwater snails in the river. Many of these aquatic species are on the Federal list of Threatened and Endangered species and a number of species (especially mussels) have already been extirpated from the Ohio River system. This aquatic species assemblage is a global resource worthy of preservation as demonstrated by the recent national certification of the Ohio River Basin Fish Habitat Partnership for this intended purpose.

The stressors placed on these species are regional, dynamic and intense requiring a comprehensive approach to attain sustainability of the resource. Among the stressors are the movement and settlement of the growing basin population. The development effects of population growth and household formation have taken their toll on the land and water resources of the region. Thousands of acres of quality terrestrial habitat are being consumed or so fragmented by a patchwork of residential and commercial development that they no longer function for wildlife uses. Quality aquatic habitat has been channeled into underground stormwater systems while riparian corridors have been submerged beneath asphalt and concrete paving. Federally protected wetlands are surrounded by impervious surfaces pouring volumes of polluted runoff into sensitive aquatic systems. Anticipated climatic changes that may generate more intense rainfall events would exacerbate the polluted runoff issues already being faced.

Many streams and rivers within the basin are identified by the states in the USEPA 303(c) and 305(d) programs as “impaired waters.” Water quality issues in these rivers and streams are such that certain aquatic species cannot be sustained within them. Both point and non-point pollution sources constantly attack the chemistry, temperature, nutrient levels, and oxygen content of the water, making that environment unsuitable or unhealthy for many aquatic species.

Of additional concern are the impacts to riparian zones from land development, agricultural practices, deforestation, transportation development and other land disturbances all of which further exacerbate impaired water quality and degraded aquatic habitat. The introduction of sediment, nutrients and agricultural chemicals (herbicides, fertilizers, pesticides) into riparian/stream corridors as non-point sources, threatens miles of aquatic habitat. Current USDA programs such as the highly successful Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP)

both being administered in West Virginia, Ohio, Pennsylvania, Indiana, Illinois, and Kentucky offer some relief from these non-point sources.

Of equal concern to impaired water quality is the continuing loss of wetlands in the basin. Both lacustrine and palustrine wetlands abound throughout the basin and support hundreds of aquatic and terrestrial species some of which are listed as Threatened and Endangered. Although they are protected by various laws and regulations, basin wetlands are under tremendous pressure from various forms of private development and land conversion processes. Loss of these wetlands has significant adverse effects on the entire water resource regime. The land cover analysis discussed in Section 8.1.2.7, "Shrub/Grassland," shows that approximately 500,000 acres of wetland cover have been lost between 1992 and 2001 (USGS data). It is highly likely that in the last 8 years more wetlands have been lost or adversely impacted.

The Ohio River basin aquatic ecosystems, including floodplains, have evolved with seasonal variability of hydrologic flows. Endemic species within the basin have also evolved specific adaptations to these changing flow conditions. USACE-built flood-control reservoirs within the watersheds are operated to reduce seasonal flooding. Additional authorizations allow low-flow augmentation in the summer. These artificial flow regimes affect habitat and species health downstream. Numerous reservoirs were constructed with single intake structures, restricting the operator's ability to mix waters of varying temperatures, oxygen, and nutrient levels in order to meet water quality parameters downstream for aquatic species. More recently constructed reservoirs in the system were designed with multi-level intake structures that facilitate the blending of reservoir waters of different temperatures and oxygen content. Modification of older single-level intakes could dramatically improve downstream water quality for aquatic species.

In addition to these modified stream effects, sedimentation, nutrients, and other pollutants have been captured in existing reservoirs thus reducing water quality and impacting aquatic habitat. Nutrient loading as a result of non-point runoff from agricultural and residential uses threatens many lake environments. This nutrient capture process also reduces levels of these important substances in downstream aquatic food chains.

Retention facilities reduce the ability of certain fish species to migrate and the loss of connectivity brought about by in-stream structures reduces the diversity and productivity of aquatic species. These in-stream structures range from low-head dams constructed to pool water for local water supplies and recreation to high-head dams constructed for flood control and hydropower. A number of low-head dams are being considered for removal to restore fish migration and pool connectivity.

In addition to the storage and release of water, USACE-operated reservoirs are home to thousands of acres of protected wildlife habitat. USACE management of these lands is dictated by Federal regulations, implemented through project master plans, and (in many cases) shared with state natural-resources agencies (that govern wildlife management as well as active and passive recreational uses). There are numerous ecosystems contained within these Federally owned lands including critical habitat for Threatened and Endangered (T&E) species. Management of these critical habitats is of paramount

importance to the sustainability of the T&E species in the region. Some migratory species using the Federal lands are likewise protected by national or international programs (Partners-in-Flight), thus adding to the complexity of USACE's land-management process.

Finally, the introduction of invasive aquatic and terrestrial species (flora and fauna) threatens indigenous species – in particular, T&E species. Invasive species present include zebra mussels, purple loosestrife, kudzu, and several other plant and wildlife species. Anticipated effects of regional climate change may exacerbate this problem as warming temperatures attract invasive species from southern regions of the nation. Addressing the effects of, and controlling, invasive species is a growing concern in the basin, as effects on species within Federally owned lands could be significant.

Based on the comments received, there are a number of opportunities for ecosystem restoration at the basin, sub-basin and watershed levels. Congress authorized the Ohio River Ecosystem Restoration Program in the *Water Resources Development Act of 2000*. Although restricted to the Ohio River mainstem and its adjacent embayments, this $306 million authorization (Federal and non-Federal funds combined) marks a significant turning point in recognition of the myriad of ecosystem challenges facing the river. A joint evaluation of hundreds of promising ecosystem projects by USACE, USFWS, and several state resources agencies along the Ohio River corridor has languished due to cost-sharing issues (see *Water Resources Policy Issues*) and lack of funding. Potential expansion of this current authorization to include the entire basin aquatic ecosystem and opportunities to cost-share projects with non-profit organizations could unleash a powerful eco-restorative force within the basin.

Among the 15 sub-basins in the region, the Green River is one of the most ecologically diverse in its aquatic habitat and it ranks among the top four river systems in the nation in this environmental category. With 151 species of fishes and 71 species of freshwater mussels, of which total, twelve are considered endemic and another 35 are considered imperiled, this sub-basin is a treasure house of aquatic species. Other known Threatened and Endangered species in the region (eastern hellbender, American Eel and both gray and Indiana bat) depend upon the river and its subsurface connection to the Mammoth Cave complex for their existence. Ongoing agreements and ecosystem project proposals between USACE and the Nature Conservancy show promise that future watershed ecosystem approaches would be successful.

An additional opportunity for ecosystem restoration is the Duck River watershed; a component of the Tennessee River sub-basin. This watershed is considered one of the premier aquatic and terrestrial ecosystems in the nation and is internationally known for the diversity and number of species residing there. Overall the Duck River supports 151 species of fish, 55 freshwater mussel species, and 22 species of aquatic snails. The Duck River is designated as a State Scenic River within the central sub-basin. The Duck River is the sole source of water for 250,000 people in middle Tennessee, including those in the cities of Columbia, Shelbyville, Manchester, and Tullahoma. Issues in the watershed include river flows to sustain aquatic species and water supply needs. The Nature Conservancy, USACE, TVA, and the Tennessee Department of Environment and Conservation have conducted studies of the ecosystem and water supply issues and have collaborated on some past projects. Other issues within the

Duck River include flooding problems in the cities of Columbia and Shelbyville. Further studies of the watershed would enable the various Federal, state, and local partners to optimize river flows to meet multiple purposes.

A number of other opportunities for ecosystem restoration and environmentally related programs and projects at various basin locations are discussed within each of the sub-basins in Appendix I, "Sub-basins and Watersheds."

Appendix M provides a comprehensive list of the individual issues surrounding ecosystem and environmental concerns.

8.4.2 Issues – Water Quality and River Flows

ORSANCO and USEPA are the lead agencies in the Ohio River basin with regard to monitoring and assessing water quality, establishing water quality (WQ) standards and implementing efforts to improve water quality on the Ohio River mainstem. Presently, the activities of ORSANCO do not extend beyond the immediate environs of the Ohio River corridor. Based on information from USEPA and ORSANCO, the water quality within the Ohio River has improved over the recent decades. Recent studies conducted by ORSANCO (2008) indicate that both water quality and the biological community have improved in several of the navigation pools in the Ohio River, but there are still challenges to be met in reducing certain pollutants.

Ongoing contamination through CSOs and frequent instances of “boil water” advisories within the basin indicates that sustaining good water quality is a continuing challenge. Similarly, water quality in many of the tributary rivers and streams in the basin is being steadily degraded by point and non-point pollution sources. The traditional contaminants of acid-mine drainage, petrochemicals, sewage effluent, livestock wastes, manufacturing wastes, agricultural chemicals, point and non-point nutrients, sediment, and biological and chemical oxygen demand contaminants are now being supplemented by an array of pharmaceutical and hormonal agents. Recent studies of the Ohio River water quality indicate that the inflow of pharmaceutical and hormonal agents may be increasing, with potential adverse genetic effects on aquatic species and potential effects on the millions using the river as a source for drinking water.

In addition to the ORSANCO and USEPA water quality monitoring and improvement efforts along the Ohio River mainstem, the USEPA water quality programs under Sections 303(d) and 305(d) of the *Clean Water Act* (as amended) require states to identify “impaired waters” within their jurisdictions that are contaminated by any number of point and non-point contaminants. Those contaminants include bacteria loading from untreated effluents and livestock feeding areas, sedimentation, nutrient loading, PCBs, acid-mine drainage, and CSOs. An online search of the USEPA database for these programs uncovered a wealth of data and GIS data on the location and extent of “impaired waters” within the basin. Generally with the exception of one eight-digit HUC watershed in the Tennessee River sub-basin, all other 151 HUC 8 watersheds had at least one stream labeled as being “impaired” by some contaminant.

Excessive nutrient loading from point and non-point sources of nitrogen and phosphorous (associated with fertilizers and detergents) can result in eutrophication of

water bodies as the high nutrients stimulate abundant growth of aquatic vegetation. The 'algae blooms" and other excessive growth of oxygen-demanding vegetation reduce oxygen supplies necessary for aquatic species. Added to the nitrogen and phosphorous loading can be introduction of sulfates and nitrates (air-borne and precipitation) that further alter the water chemistry so important to a healthy aquatic community. Control of nutrient sources is complicated by their widespread prevalence throughout the system and their largely non-point nature.

In a presentation at the Ohio River Summit in August 2008, ORSANCO staff stated that overall the water quality in the Ohio River had improved and many uses of the river previously limited by water quality were on the rise and improving. However, it was also noted that there were several outstanding water quality issues that had to be addressed. Those issues included:

- wet weather related bacteria, nutrients, and atrazine;
- air quality related mercury and nutrients; and
- legacy related chlordane, PCBs, and dioxin.

Additional data presented at the Summit indicated that several tributaries to the Ohio River were of concern regarding high levels of PCBs. Those tributaries included: the Alleghany, Monongahela, Beaver, Muskingum, Kanawha, Guyandotte, Scioto, Great Miami, Green, and Wabash rivers.

As a result of these various water quality issues, the following incidents occurred and/or water-related activities were limited due to impaired water quality:

- swimming and other water-contact recreational restrictions,
- consumption of certain fish species advisories,
- water temperatures exceeding limits at times and dissolved oxygen dropping below published standards,
- increased incidences of algae blooms,
- non-point pollutants impacting the Gulf of Mexico (hypoxia zone), and
- atrazine concentrations reaching action levels (springtime in the lower river reaches).

Several contaminants have shown indications of increases in their levels. ORSANCO has indicated that actions need to be taken to address these contaminants in the river. Those shown to be increasing at several monitoring stations were:

- chlorine,
- magnesium,
- total phosphorus, and
- sulfides/sulfates.

Issues related to bacteria (E. coli) contamination in all parts of the river have resulted in ongoing efforts (USEPA) to establish TMDL limits for the Ohio River and its tributaries.

Sources for bacteria entering the river include Combined Sewer Overflows (CSOs), point source inflow from animal feedlots, non-point manure fertilizing, failing septic systems, Sanitary Sewer Overflows (SSOs), sewage treatment plant effluent, meat processing wastes, tanning by-products, paper and pulp plants effluent, and textile manufacturing.

The exploration of the gas-bearing Marcellus shale complex underlying New York, Pennsylvania, West Virginia and Ohio (see Section 8.1, "Existing Conditions," and Figure 27) has raised serious concerns about water quality associated with this extraction process. In addition to the vast amounts of water required (a water supply issue) to hydraulically fracture the gas-bearing shale, numerous instances have been reported of discharge water from the wells entering local drinking water systems and adjacent streams, with disastrous effects on humans and wildlife. This fracturing process was exempted from Federal water laws in the 2005 *Energy Policy Act*, but concerns remain for the volumes of processing water needed and the quality of the discharged water.

In addition to the water volumes used in the fracturing process, large quantities of sand and other chemicals (industry trade secret) that are injected into the wells assist in releasing the trapped methane gas in the shale. Although well sites include waste water ponds for discharged water, accidental spills have been reported and local drinking water may have been impacted in some areas. Ongoing oversight of this extraction process by the states and Federal agencies responsible for water quality is needed. As an example of the benefits of a basinwide advisory entity, the Delaware River Basin Commission in May 2009 ruled that energy companies must gain approval through the Commission before further extraction of Marcellus shale gas in that river basin.

A number of comments from key stakeholders and the public addressed the impacts of modified flows on the downstream aquatic ecosystems, some including T&E species of mussels and fish. In addition to the impacts on ecosystem connectivity, species migration restrictions, and water quality issues generated by in-stream structures, the historical modification of river flows by retention structures is an oft-repeated concern. A myriad of low-head dams constructed by local communities and private corporations have maintained stable pools for water supply and recreation, but some of these structures are no longer required to fulfill their original purpose. A number of these “obsolete” low-head dams are being considered for removal where the ecosystem benefits would outweigh the socioeconomic considerations.

The high-head reservoirs and retention structures constructed by USACE, NRCS, TVA, and others have modified the flow regimes of many streams and rivers. The once-natural rhythms of stream flow attuned to the seasonal rains and extremes of flood flows and near–drought level low flows have been replaced in many cases by a more moderated series of structured flows. These structured flows reduce high peak flows (to reduce damages from overbank flooding) and result in longer bank full conditions as reservoir-retained waters are released. The longer, sustained bank full conditions can modify downstream channels and impact aquatic species habitat. In cases where retention structures are authorized for other purposes such as hydroelectric power generation or downstream whitewater recreation, the flow releases may be scheduled for peak power needs or seasonal recreational needs that are much different than the pre-project natural flow regime.

In a related matter, a number of older reservoirs were constructed with single-level intake structures that limit the water manager's ability to balance downstream water quality or aquatic habitat needs for water temperatures or oxygen content. More recent reservoir intake structures have multiple intake ports that allow mixing of both water temperature and oxygen content to facilitate compliance with downstream water quality and habitat needs. Addressing the single-port intake structures should be a component in any analysis of downstream flows or reviews of completed projects.

There are a number of opportunities for addressing water quality issues through existing and proposed programs. The USDA Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP) are active in watersheds and counties in Pennsylvania, Indiana, Illinois, West Virginia, Ohio, and Kentucky. These programs, dedicated to protection of riparian/stream corridors bordering viable cropland through conservation easements and stream buffer plantings, stem the flow of agricultural pesticides, herbicides, fertilizers, and sediment from productive fields into the adjacent streams. These have been successful programs in reducing non-point pollution sources and improving water quality. Expansion of these programs to other watersheds and sub-basins could produce significant benefits in terms of water quality, aquatic habitat improvements and safer water supplies.

In addition to the regulatory and land management efforts discussed above, a relatively new market-based approach is being considered for improving water quality by a coalition of public, private, academic and NGO participants. The Electric Power Research Institute is working closely with the American Farmland Trust, ORSANCO, the Great Miami Conservation District and other participants to establish a water quality trading program that would involve both electric power industries and agricultural interests (farmers) in the region. The purpose of the trading program would be to reduce the current volumes of nitrogen, phosphorous and other nutrients from entering the basin's rivers through trading of water quality credits. This is an innovative market program in its initial stages of development that may provide substantial water quality benefits throughout the Ohio River basin, the Mississippi River, and the Gulf of Mexico. Further information relating to the trading program and its participants can be found at www.farmland.org/programs/environment/solutions/ohio.asp.

USACE's Environmental Infrastructure Assistance Programs, discussed in Section 8.4.10, provide an opportunity to solve many of the basin's untreated-sewage discharge problems. This program provides opportunities through grants for local expansion of existing sewage collection systems and improved/upgraded treatment systems or development of new systems for underserved or un-served areas. Expansion of these programs to address Combined Sewer Overflows (CSOs) in cooperation with municipalities and counties would significantly reduce bacterial contamination and nutrient loading in streams/rivers and support efforts to maintain TMDL standards. Further expansion of the geographic coverage of the Environmental Infrastructure Programs to cover the entire basin would ensure opportunities to improve water quality.

There are numerous Federal installations and facilities located throughout the region. Many of those facilities or installations include constructed areas of impervious

pavement (parking lots, staging areas, esplanades, and roads) or building surfaces that generate stormwater runoff; runoff that can be contaminated with any number of petrochemical or organic compounds. Under Section 438 of the *Energy Independence and Security Act of 2007* (EISA), Federal agencies have new requirements to reduce stormwater runoff from Federal development and redevelopment projects to protect water resources. Federal agencies can comply using a variety of stormwater management practices often referred to as "green infrastructure" or "low impact development" practices, including for example, reducing impervious surfaces, using bio-swales, rain gardens, porous pavements, cisterns and green roofs. Use of these water-harvesting strategies to address stormwater runoff at Federal facilities should be a part of all future construction.

A comprehensive listing of water quality issues and flow issues is included in Appendix C.

8.4.3 Issues – Basin Water Management

The volume of flow, authorized storage, seasonal control and quality of the water are clearly issues that deeply involve each of the 15 basin states. Of the many issues considered, the management of water is truly an interstate issue worthy of ongoing Federal involvement. Recent legal conflicts between southern states over water flows for endangered aquatic species and sufficient storage for M&I water supply indicate the need to develop regional strategies for the management of water in the basin – strategies based on sound science and data and collaboration between the many users.

There are numerous water managers – including USACE, TVA, NRCS, and a litany of state, local, and regional governments – that manage facilities constructed for water supply, flood risk reduction, recreation, hydroelectric power, and other purposes. Each agency and manager operates their particular facility or facilities to meet certain authorized missions or objectives and when necessary can operate in concert with other facilities to accomplish common goals. However, operating all facilities as one system of sustainable water management has not yet occurred, and no plan for such a system has been prepared.

The formulation of storage requirements was determined largely on a project-by-project basis – not as an integrated system. Although there are some considerations for reducing flood risks along the mainstem Ohio River in the formulation of reservoir storage on tributaries to the Ohio River, the primary benefits derived from most projects for flood risk reduction and other purposes are more localized in nature. Generally, reservoirs operate individually to control out-of-bank flooding or to augment flows in drought conditions only within the watershed or the sub-basin.

In some sub-basins – such as the Muskingum, the Wabash, the Green, the Scioto, and the Kanawha – multiple reservoirs contain storage for a variety of authorized purposes. The acre-feet storage distribution within those facilities has not been analyzed since their initial operation for the purpose of addressing current needs or downstream flow issues. Also, many reservoirs were authorized for types of storage to address water needs in the

watershed that may now be obsolete or for which other alternative measures (not developed by USACE) have been instituted.

For example, some reservoirs in the system were authorized to maintain an increment of storage for flow augmentation to address downstream water quality issues that have been addressed by other non-USACE Federal agency programs such as USEPA. However, that increment of storage remains in the reservoir and the project is still operated to address a flow condition that may not be currently necessary. That increment of storage could be re-assigned to more beneficial uses (water supply, downstream recreation, altered flows for downstream fisheries, etc.).

In a related systems topic, concerns were expressed during the issues development phase of the study regarding a general lack of basinwide collaboration between the states and water resources agencies and no structured forum for basin states to discuss common issues or to formulate strategic programs or solutions to common problems. The varying political environment of the basin may not be conducive to development of a strong coalition that can support basin initiatives at this time. Current congressional initiatives to establish a Ohio River caucus notwithstanding, the absence of a multi-state structured forum for addressing current issues of water management – issues that are likely to become more contentious in the future is a key concern among several commenters. Options for such a collaborative forum or states-based advisory council should be explored with the states and cooperating agencies.

Other issues relate to local requests for water uses that cannot be complied with due to lack of project authority and the outdated nature of datum/surveying information on many reservoirs – a condition that can lead to inaccurate monitoring of reservoir operations. Additionally, the accumulated volume of sediments within many reservoirs (for which an increment of storage has been reserved) has not been analyzed for many years thus casting doubt on the true volumes of storage available for other uses such a flood risk reduction. A comprehensive analysis of the reservoirs including systems modeling could provide important data for decision-makers managing water resources.

As stated previously, the Ohio River basin is water-rich when compared with other basins in the US. Providing 60% of the flow in the Mississippi where the Ohio meets the Mississippi at Cairo, Illinois, the Ohio River basin is one of the prime providers of flow to support many activities in the Mississippi, not the least of which is commercial navigation. Despite the abundance of water within the basin and the many retention structures available for storing and releasing that flow into the mainstem Ohio, there have been major shortages of water in areas of the basin in the past.

In 1989, drought conditions in parts of the basin threatened USACE's ability to maintain several authorized uses at reservoirs and the needs of the navigation industry. In terms of future issues, the potential effects of climate change on the management of water in the basin (given all of the competing users) may become one of the most critical issues of the region. Adaptive management measures notwithstanding, extreme drought conditions could become commonplace. Recent judicial decisions on the operation of reservoirs in the southeastern United States for water supply and support of critical aquatic habitat give testimony to the urgency of formulating basinwide water management strategies in collaboration with the states and users.

A number of existing reservoirs in the basin may be producing unmitigated ecosystem impacts downstream or are being operated (flow releases) in such a fashion that downstream ecosystem benefits cannot be optimized. There are a number of reservoirs with single-portal intakes that limit operations to meet downstream water quality and ecosystem needs in terms of temperature and oxygen levels. In addition, there are increasing conflicts between water users at many reservoirs (water supply, recreation, flood storage, hydropower) – conflicts that may increase in light of future climate changes and increased population.

In addition, current operation of the basin reservoirs provide opportunities for integrated management for other water uses such as water supply, supporting establishment of and maintaining standards for TMDL, low-flow augmentation to support downstream water quality requirements and in-stream aquatic habitat. A strategic plan for water management that optimizes the benefits of these separate needs provides a valuable tool for decision-making.

Appendix C provides a comprehensive list of water management issues received from key stakeholders, the public, and USACE personnel.

8.4.4 Issues – Local Development Impacts on Water Resources

The total population in the basin, according to 2000 Census data, was approximately 27.0 million (Table 2 shows population by state). The projected population figures for each of the states (proportioned to the counties), again based on US Census data, show some substantial increases across the basin. In total, an additional 3.0 million people may be living in the basin by 2030. As the baby boomers' children and grandchildren begin establishing new households, the rate of population increase could accelerate.

As discussed previously, increases in population generate additional households and new development to accommodate the housing need. Based on the persons-per-household data in the 2000 Census, the projected population increases could result in formation of an additional 1.3 million households. Using modest figures for acreage per dwelling unit (0.33 acres per house) and accounting for unit vacancy rates from the Census, the anticipated household formation could require between 650 and 750 additional square miles of land dedicated to residential use to accommodate the projected population growth. The increase of urban land cover between 1999 and 2001, based on the USGS data (7.7 million acres), indicates the seriousness of the potential effects that increased population could have on basin resources.

Increases in commercial development and service-oriented employment centers will further add to the existing square miles of paved roads, parking areas and roof area. Land cover conversions that generate more impervious surfaces and increased uncontrolled runoff add to already overburdened stormwater collection systems and stream/river channels. Further intrusions into wildlife habitat areas and floodplain development add to the impacts to ecosystems. In addition, the increased population will by necessity increase water supply demands, needs for energy and additional capacity for liquid and solid waste collection and treatment/disposal. The same burdens now being placed on the man-made and natural systems by the current residents and visitors could be greatly increased in the future. The potential impacts on the water

resources due to population growth could be significant when viewed in context with other factors such as climate change.

Notwithstanding any major national or basinwide calamities or further significant economic turndowns that might lessen population projections, the increased growth in numbers of people and households cannot be solved through any USACE mission or program. However, the manner in which people, new households, and attendant land uses are accommodated can be modified to reduce incursions into sensitive natural areas, reduce impervious surfaces, and control stormwater runoff from impervious areas.

Generally, these controls are the purview of the states and individual county and municipal jurisdictions. Land use development and runoff controls at the local level are enabled through state legislation and fall under the general term “local police powers.” Strategies that reduce sprawl can (1) help limit flooding and threats to life, (2) reduce riparian and stream habitat damages, and (3) reduce the growing costs of transportation. Such strategies include:

- "Smart" land use zoning that directs development away from riparian stream corridors;
- subdivision regulations;
- stormwater-retention and -management ordinances;
- promotion and enforcement of the NFIP;
- strict adherence to the NPDES permitting process;
- property tax strategies to protect agricultural and forested lands;
- enactment and enforcement of building codes;
- application of TDR and PDR programs that limit new development in sensitive habitat, productive farmland, or hazardous locations (i.e., the Lexington, Kentucky, PDR program); and
- urban infill strategies and financial incentives (i.e., Tax Increment Financing [TIF]).

Purchase (by fee or scenic easement) and management of the basin's sensitive environments can protect them from future development, reducing development pressure on those areas. Local strategies for more dense urban development using new urbanism concepts and infill financing (Tax Increment Financing) would assist in reducing suburban sprawl. Increased application of these controls and strategies at the local and state levels can begin to slow the adverse effects of population growth on the basin’s water resources and ecosystems.

Continued application of sustainable land- and water-stewardship practices on USACE-managed lands, and cost effective use of flood-damage reduction measures at authorized projects, can educate the public and raise awareness of the benefits of these land management strategies locally. USACE's efforts to increase the sustainability of projects and to use “green” technologies can serve as examples of wise stewardship of

public land and can demonstrate to the visiting public the benefits of such local efforts, which can be implemented in county and municipal jurisdictions.

Of the many potential impacts generated by increased population growth, needs for additional fresh water may be the greatest concern for the existing water management system. The current ORSANCO estimate of 5 million people using the mainstem Ohio River alone for drinking water could be substantially increased in the future due to population growth. Current development trends show that the new growth may occur at the fringes of existing urban areas – areas now supplied drinking water by surface waters (rivers and lakes).

8.4.5 Issues – Water Supply

Information from ORSANCO reveals that at least 5 million people depend upon the water resources of the mainstem Ohio River alone for municipal drinking water. There are at least 33 public water systems withdrawing 257.4 million gallons of water daily from the Ohio River navigation pools. Considering the number of large urban areas located on the major tributaries of the Ohio River (the four-digit HUC sub-basins), the total number of people using surface water resources for drinking water is likely much higher than 5 million.

Many hundreds of small communities (rural public service districts) withdraw water from various tributary streams/rivers or rely on groundwater aquifers that are hydraulically connected to the surface waters. In the case of the larger cities, the reliable source of water provided by the mainstem Ohio River, its major tributaries or water supply lakes are the only reasons that those communities are sustainable. Groundwater supplies in the basin are sufficient to supply rural low-density residential development, but limited in sustaining the much larger municipal and industrial needs. Figure 36 shows the groundwater withdrawals for public supplies by county. Figure 37 shows the surface water withdrawals for public water supplies by county. These maps show the vast amounts of water being extracted from the basin water system (surface and subsurface) to support public supplies for residential, industrial, commercial and institutional uses.

Needs for agricultural irrigation water using both groundwater and surface water resources are significant in areas of the basin. Table 16 shows the percentages of cultivated land with respect to total land area within each of the HUC 4 sub-basins. Cultivated land cover areas greater than 40% of the total sub-basin area are highlighted in yellow. Figure 38 shows the groundwater withdrawals by county and Figure 39 shows the surface water withdrawals by county being used for irrigation of agricultural lands. As the maps show, both groundwater and surface water withdrawals for irrigation are substantial. A number of reservoirs operated by USACE, TVA, and NRCS provide water for irrigation purposes. Any significant reduction in the available supplies of either surface or subsurface waters could have devastating effects on the region's socioeconomic wellbeing.

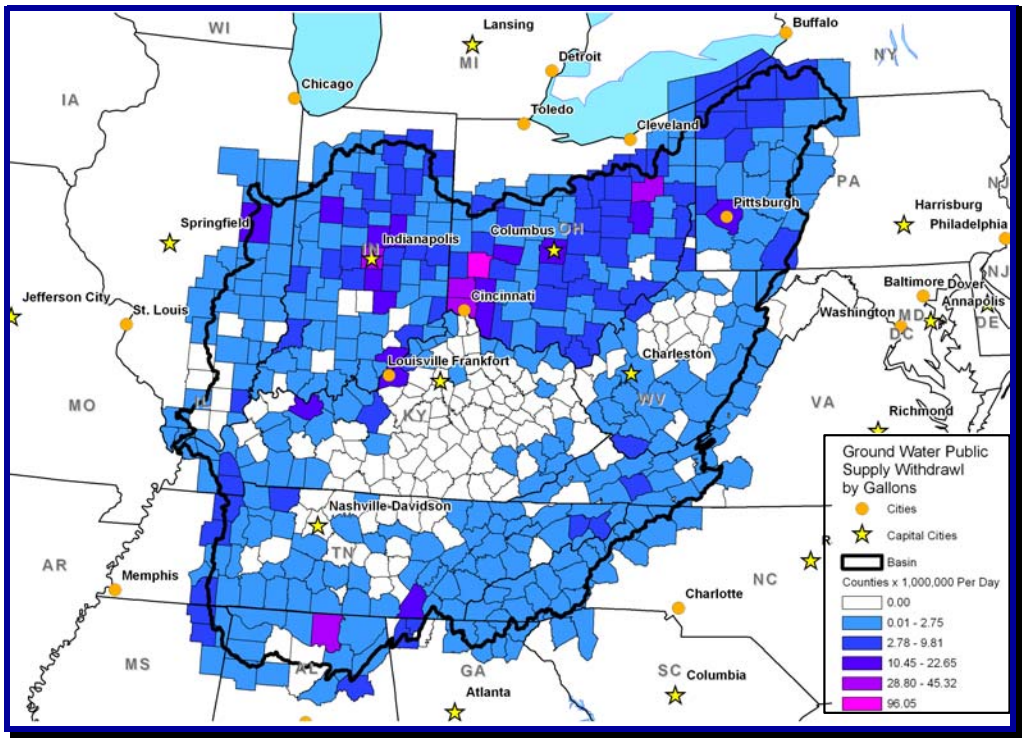


Figure 36 – Groundwater Withdrawals for Public Supplies

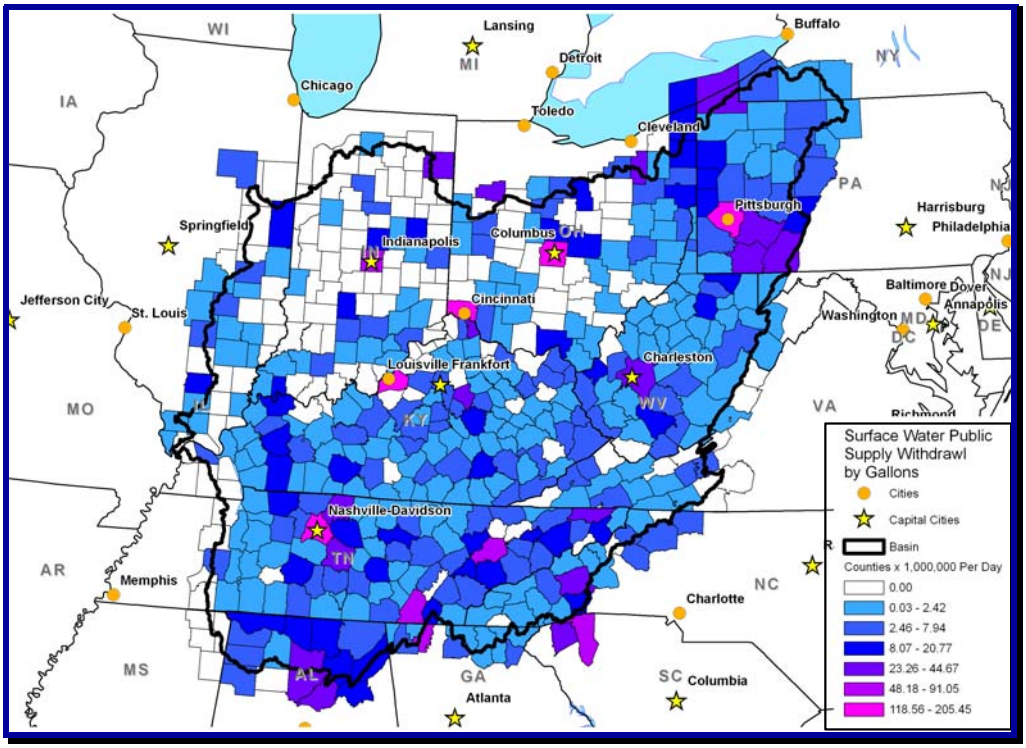


Figure 37 – Surface Water Withdrawals for Public Supplies

Table 16 – Percentage of Cultivated Land in Each HUC 4 Sub-basin

HUC ID #	Sub-basin Name	Total Land Area (sq mi)	Cultivated Land Area (sq mi)	Percent Cultivated
501	Allegheny	11,656	2,149	0.18
507	Big Sandy–Guyandotte	5,966	214	0.04
513	Cumberland	17,942	4,708	0.26
508	Great Miami	5,410	3,587	0.66
511	Green	9,276	3,942	0.42
505	Kanawha	12,278	1,691	0.14
510	Kentucky–Licking	10,687	3,338	0.31
514	Lower Ohio	12,699	5,303	0.42
604	Lower Tennessee	8,130	2,155	0.27
509	Middle Ohio	8,941	2,680	0.30
603	Middle Tennessee–Elk	10,430	3,692	0.35
602	Middle Tennessee–Hiwassee	5,229	855	0.16
502	Monongahela	7,371	1,139	0.15
504	Muskingum	8,095	3,261	0.40
506	Scioto	6,506	3,825	0.59
503	Upper Ohio	13,345	2,741	0.21
601	Upper Tennessee	17,303	3,256	0.19
512	*Wabash*	*33,166*	*22,590*	0.68

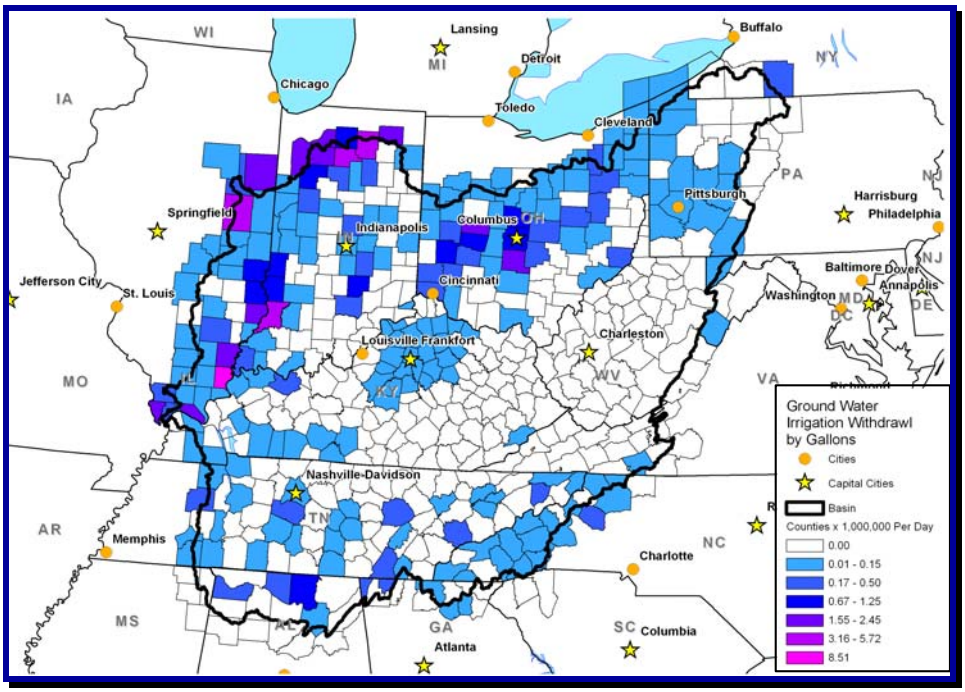


Figure 38 – Groundwater Withdrawals for Agricultural Irrigation

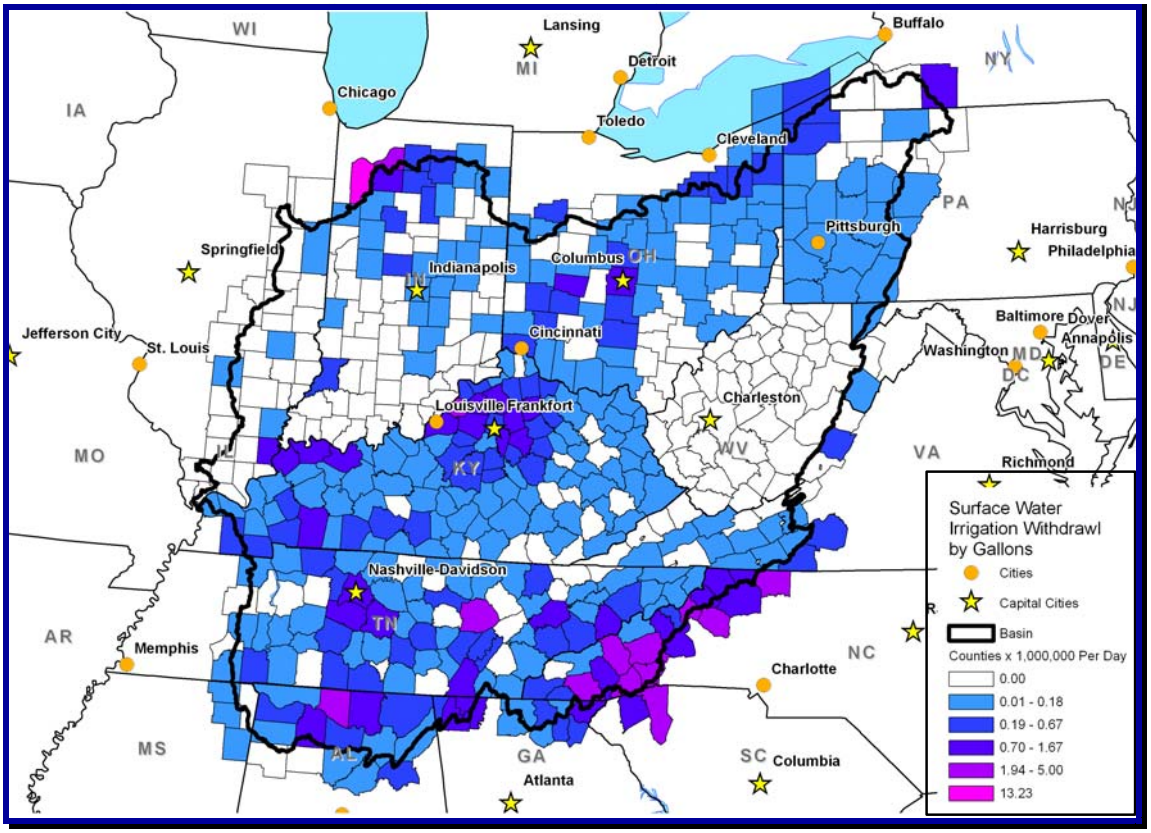


Figure 39 – Surface Water Withdrawals for Agricultural Irrigation

A USACE study (January 2009) on the numbers of raw water intakes and volumes extracted from within the commercial navigation pools in the basin (see Table 12) shows that municipal and industrial sectors are the primary water users along the mainstem Ohio River and its major tributaries. In fact, industrial uses – in particular, electric power plants – account for more than 85% of the water demand within the nine navigation pools listed. Considering the importance of the generating capacity of the power plants along the Ohio River mainstem and tributary rivers to the regional economy, maintaining a reliable flow of water is of paramount importance. In addition to ensuring reliable capacity for municipal water supplies from the system, management and protection of that capacity for water supply are critical components of the operating system.

Ongoing threats to water quality hinder the ability of cities using the mainstem and tributary rivers as a primary water source to cost-effectively treat raw water and provide a reliable, safe supply. The introduction of pharmaceutical and hormonal contaminants and multiple instances of bacterial loading from CSOs in the river exacerbate this problem. ORSANCO and USEPA are cooperating on an Ohio River Mainstem TMDL project that could result in more stringent standards for treatment of wastes among several major cities on the mainstem. The ability to sustain mean annual flows in the Ohio River mainstem through reservoir releases by USACE and other Federal agencies forms the basis for establishing the TMDL levels. Substantial reductions in downstream flows to maintain lake-based water uses could further restrict the TMDL standards.

Existing USACE Environmental Infrastructure Programs provide an opportunity to improve water treatment facilities and to expand water distribution systems through Federal grants to local communities. Expansion of the geographic coverage of those programs to the entire basin could significantly increase the provision of safe, potable water to underserved and un-served communities.

The *Federal Water Supply Act of 1958* provides opportunities to expand M&I water supplies through development of reservoirs having water supply as an authorized project purpose. In cases where water supply was not originally authorized at a reservoir, opportunities for use of reservoirs for M&I water supply still remain. However, the current hydrologic and environmental evaluation and decision-making process to permit M&I water supply withdrawals from USACE reservoirs is accomplished on a case-by-case basis. Minimal consideration has been given to potential watershed, sub-basin, or basin impacts from cumulative water supply actions at multiple reservoirs or impacts to other authorized purposes. Significant aquatic species habitat impacts resulting from extreme hydrologic conditions brought about by climatic change or land use changes in the watershed are also not typically considered.

In addition to these stressors on the available water supplies, the hydraulic processes used to recover methane gas from deep shale in the Marcellus gas shale field requires vast amounts of water. Information taken from the Internet on the hydraulic fracturing process indicates that millions of gallons of fresh water may be used in this process. As the hydraulic-fracturing wells can be scattered throughout extensive rural areas (see Figure 27), extraction of large volumes of processing water could be problematic for both residents (drinking water supplies) and aquatic species in some watersheds.

Population projections from the US Census through the year 2030 indicate a potential need for an additional 300 mgd (based on 100 gallons per day per person) unless water conservation measures are instituted. The anticipated future need, especially within metropolitan areas, would not likely be available in current aquifers. Political and economic pressure to secure that additional water supply may come to bear on surface waters (streams, rivers, lakes). These issues would become more urgent under certain climatic changes (reduced precipitation and increased evaporation) projected for the future.

8.4.6 Issues – Floodplain Development, Flood Risks, and Loss of Life

Floodplain development in some form has been ongoing since the early 1800s. Thousands of structures had been constructed in floodplains that since the advent of the National Flood Insurance Program (NFIP) in 1970 have been defined to be hazardous because of recurring and persistent out-of-bank flooding. The US Census figures show that over 1.0 million structures were constructed within the 548 basin counties before 1970. A proportion of those structures was located within the designated flood hazard zones and subsequently was grandfathered into the national flood insurance program following enactment of the ordinances by individual municipalities and counties. Ironically, many of these areas of the basin are continually flooded leading to recurring Federal disaster declarations, but current economic justification procedures deny opportunities for protection.

Most of the basin counties and municipal areas participate in the NFIP. As such, they are required to enact floodplain management ordinances that should limit most new development within the designated floodways of the jurisdiction and reduce damages to new construction in the flood fringe through elevation or wet or dry floodproofing. The efficacy of the ordinances is dependent upon local jurisdiction enforcement of the ordinance requirements and limited variances. Existing structures that were grandfathered into the NFIP when enacted locally are only required to comply with the new ordinance requirements if the value of damages due to flooding or other events is more than 50 percent of the value of the structure. Despite high participation in the NFIP, relatively few basin jurisdictions are participants in the Community Rating System (CRS) under the NFIP. Under this system, communities could enact local strategies, complete program documentation activities, and conduct public awareness programs that would decrease flood insurance rates within the jurisdiction.

Despite the development regulations and local programs in place, floodplain development still occurs within the basin. Some development occurs within watersheds where due to mapping costs and the lack of substantial development, floodplain mapping was not prepared when the community or county first entered the NFIP. Generally these areas are located in the upper headwaters of watersheds and the extent of the floodway and depths of the 1% chance flood are hard to estimate without accurate field surveys. As new development occurs in unmapped areas, more at-risk structures and especially at-risk structures located where flash flooding is prevalent will be constructed. Many of these new structures may not be protected from financial losses through the flood insurance program. The current Map Modernization Program through FEMA is attempting to capture these “orphaned” areas. The 2009 map modernization progress report indicates that the majority of the basin counties will have digital mapping completed in 2010.

In addition to floodplain development in heretofore unmapped areas, many topographically challenged communities faced with deciding whether to grant building variances to a potential developer must consider the potential local economic effects of denying permits to potential employers in the community. Given the growing economic challenges facing basin communities, refusing floodplain development variances to major employers and tax revenue producers (big box retail, mall development, multi-family residential and others) is tantamount to local economic and political suicide. In many situations the choice between economic stability or adverse ecosystem impacts and potential flood damages favors increased local employment and revenues.

With proper enforcement of the floodplain ordinances, damages to new structures (those constructed after enactment of floodplain management ordinances) should be minimal except for those occurrences when a flood event exceeds the base flood elevation used to establish first floor elevations of new structures. Through the efforts of USACE, FEMA, NRCS, and other Federal and state agencies, a substantial number of pre-NFIP and unprotected structures and facilities have been provided protection by various structural and nonstructural floodplain measures. However, a substantial remnant of this inventory of at-risk structures remains subject to flood damages.

Intense rainfall events in more mountainous regions of the basin frequently result in debris-filled stream channels and loss of channel capacity due to floodwater velocities and debris-laden floodways. Current responses to these damaged stream channels range from local efforts to re-establish the channel through in-stream excavation, to more carefully planned stream channel restoration efforts by state conservation agencies and Federal programs. Consideration of natural steam channel restoration using various ecologically based methodologies do result in more stable stream channel conditions with faster recovery of aquatic species and adequate channel capacity for future high-flow events. Basinwide use of these ecologically based methods of stream restoration could dramatically improve the aquatic health of the basin.

Of most importance to the reduction of flood damages is the ongoing operation of a reliable and accurate flood monitoring and warning system. The current system of rain and stream gages operated by the USGS, USACE, and various state agencies provides the early warning rainfall and streamflow data from which flood warnings are issued by NWS and state emergency management agencies. Several watershed and sub-basin flood warning systems are operational in the basin, but there are gaps in this system. Sustaining the existing gaging system through funding of O&M requirements and installation of gages to fill in "geographic gaps" is a basic component of the overall flood risk reduction system.

Several basin cities remain subject to flood damages (including Knoxville and Chattanooga, Tennessee), and several municipalities along the Ohio River also are subject to damages, lacking any protection (e.g., Marietta, Ohio). Some municipal areas contain industrial complexes that manufacture and store chemicals that are hazardous to humans. Since these municipal areas function as the centers of commerce, finance, education, and public services for surrounding county residents, their ongoing flood risks can affect a much larger population. Potential loss of life due to flooding is a continuing threat in these and other municipal areas. Methodologies such as LIFEsim that are used to predict potential loss of life due to flooding or structure failures could be used to determine the risks to large urban centers.

At the basin or watershed scale, a determination of total annual flood damages is beyond the financial and time limits of this study. However, there are two sources of information that can help to characterize the extent and severity of flood damages. One of those sources is the number, geographic extent, and location of Federally declared disaster areas. The disaster declarations are designated in accordance with procedures found in Title V, Section 501, of the *Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988* (P. L. 101-707) and are recorded on the FEMA internet site by event type, date of declaration, and location.

Figure 14 in Appendix N shows the geographic distribution of declared disaster areas. Table 14 in Appendix N displays the number of declarations that have occurred in counties between 2000 and 2008. Based on the geographic distribution of the disaster declarations, it is obvious that certain watersheds or groups of watersheds (sub-basin) have been significantly affected by flooding and flood damages. Numerous counties in West Virginia and Kentucky, and several counties in Indiana, have borne the brunt of severe rainfall events and storms leading to flood damages during the last 9 years.

Recurring flood events leading to declarations indicate a tendency for ongoing and future flood risks and repetitive losses.

The second source of information on flood risk faced by structures in the floodplain consists of insurance policy data from the FEMA flood insurance program. FEMA maintains a database of the number of flood insurance policies in force and their written value by state, county, and municipal jurisdiction within the US (current as of January 2009). Based on this information, it is possible to estimate the comparative flood risk down to the county and community level. Since structure owners are unlikely to acquire flood insurance in locations where it is unnecessary (flood insurance can be expensive), the number of policy holders in the database represents an accurate estimate of structures at risk from flooding, at least up to the 1% chance event.

Actuarial rate tables for flood insurance are based on the elevation of the structure, the structure value, and the probability of damage from certain frequencies of flooding. Thus, the policy coverage value represents a fair estimation of the risk in dollar terms and what the owner is willing to pay to offset the financial effects of future events. Reducing that risk (expressed in the amount of the policy value), through changing the elevation of the structure or through reducing the probability of certain flooding events, is also a key to reducing flood damages. The available NFIP data on insurance policies in force list approximately 152,000 insurance policies across the basin within the 1% chance floodplain.

FEMA also maintains within its database the number of claims attributable to those insurance policies and the amount paid out for those claims in the same categories of data collection (state, county, and municipal levels). Although these data provide an estimation of the flood risk in terms of insurance policy costs and claim payments, they do not address those structures in hazardous flood zones without flood insurance.

Fortuitously, the Rand Corporation completed a study of the National Flood Insurance Program for FEMA for the years between 2001 and 2006. Using a sampling of communities in the US (including 5 communities in Pennsylvania, Tennessee, and Ohio within the ORB), Rand determined the effectiveness of the insurance program and what percentage of structures located within the special flood hazard area (SFHA) had secured flood insurance. Those insurance “market penetration rates” indicate not only how many landowners have reduced their risk of flood losses, but also mathematically an estimate of those at-risk landowners who have not reduced that risk. The results of the study were categorized by region of the US and published by Rand in 2006. An internet link to the Rand report and its application to the determination of at-risk structures are found in Appendix A.

The Rand data show that the NFIP had managed a market penetration rate of 28% in the northeastern region (including Pennsylvania, West Virginia, Maryland, and Virginia), a penetration rate of 22% in the midwest region (including Ohio, Illinois, and Indiana), and a penetration rate of 61% in the southern region (including Kentucky, Tennessee, Alabama, Georgia, Mississippi, North Carolina, and South Carolina). Using these penetration rates and FEMA's list of current insurance policies, it is possible to estimate the number of potential at-risk structures in the flood hazard zones, by county. Based on the available NFIP information, as many as 489,000 structures may be at risk from a

1% chance flood event. The coverage value of those insurance policies based on average coverage values in each county may amount to $70.0 billion. Table 1 in Appendix A shows the numbers of potential at-risk structures in each basin county within the special flood hazard area (the 1% chance flood zone).

In addition to determining the number of at-risk structures, the dollar value of damages that could occur also can be estimated using FEMA policy claims data. Using average claim amounts paid out over the 31 years of FEMA-recorded data for the insurance policies in place, the estimated amount of damages can be determined for those insured as well as those estimated to be at risk yet uninsured. Table 1 in Appendix A shows the value of total insurance claims paid out by county. Using the average amount of those claims across each county and applying that amount to the potential at-risk structures gives an estimate of the amount of potential, insurable flood damages that exist by state and county. The estimated total of $6.3 billion indicates that, despite Federal, state, and local agencies' best efforts to reduce flood damages, a significant number of structures remain at risk. The damages indicated in the table represent only a fraction of the total damages that could occur, since the policies listed in the FEMA database do not include coverage or payment for structure contents (usually a separate FEMA policy) and do not account for other types of damages normally included by Federal agencies in the economic justification of flood risk reduction projects (i.e., utilities, transportation facilities, and public buildings).

In view of the recent emphasis on public safety in water resources plan formulation, it is notable that at least 10% of the potential at-risk structures in the floodplain may be located in the floodway zone, as designated by FEMA (West Virginia statewide Flood Protection Plan data – 2002). This high-velocity, high-frequency, deep-flow section of the floodplain is known for its destructive power, ability to move large volumes of battering debris, and history of loss of life and property damages. NFIP regulations normally limit any development within the designated floodway zone because of the dangers and adverse effects of structural blockages on the base flood elevation. However, many structures grandfathered into the flood insurance program still remain in this dangerous zone. Based on the NFIP data for at-risk structures in the 1% chance floodplain, as many as 48,000 structures and their occupants (estimated at 100,000 people) may be at risk. Measures and strategies for reducing the number of at-risk floodplain occupants could significantly reduce the potential loss of life in the basin.

On a watershed level, there are recently recorded instances of flood damages throughout the basin. Table 13 in Appendix N shows the watersheds where significant flood damages have been recorded in the last 10 years. Most recently (May 2009), heavy rainfall in southern West Virginia and Kentucky resulted in flash flooding that literally destroyed all structures and infrastructure within several watersheds. Federal disaster declarations were made on May 15th (West Virginia) and May 29th (Kentucky). FEMA assistance for individuals and public assistance for repair or replacement of public facilities (state, city, county facilities) has been approved for both areas in those declarations. Figures 7 through 12 in Appendix N show the parade of more recent disaster declarations (since 2000) for the areas displayed in Figure 6.

In relation to the ongoing efforts of agencies and local governments to curb flood damages and losses of life due to flooding, USACE's Silver Jackets program provides an

opportunity for collaboration between various agencies and levels of government. Formed in April 2005 by USACE and FEMA, Silver Jackets provides a forum for cooperation with other Federal agencies, states, and local governments to collaborate on flood hazard management strategies and programs that reduce damages and potential loss of life. Initial programs have been established in Ohio, California, Idaho, and Indiana and have led to improved communications and leveraging of agency funds to address flood hazard issues. Expansion of the Silver Jackets program to each state in the basin (expansion being an expressed goal of that program) would vastly improve the quality of interagency and inter-governmental communications regarding flood risks and would support data-sharing and leveraging of multiple programs. Additional information about the Silver Jackets program can be found at www.iwr.usace.army.mil/nfrmp/state.

Appendix C contains a more comprehensive list of issues associated with floodplain development and recurring flood damages.

8.4.7 Issues – Sustainability of Flood Risk Reduction Infrastructure

As discussed earlier in this report, the existing system of flood risk management (a.k.a. a flood risk reduction system) has numerous components, some of which are decades old and some of which are relatively new. Several sub-basins (four-digit HUC coded) feature multiple layers of redundant protection composed of retention structures, LPPs, flood warning systems, flood insurance, and floodproofing – each layer providing a higher level of protection for the property and lives of the structure occupants. In the downstream reaches of the Ohio River floodplain, flood risks are much reduced through the multiple layers of redundancy provided by operating upstream reservoirs, flood forecasting systems and LPPs. Likewise, the combined water storage of those multiple reservoirs when operated as a system could provide substantial support for other downstream uses such as water supply, navigation, recreation, and aquatic habitat.

Elements of the basin flood risk reduction system (a.k.a. the flood damage reduction system) have been operating continuously since the late 1930s. Over 70 years of operation through the extremes of weather and flood events have taken their toll on the equipment, materials and monitoring systems within these aging flood control structures. Seepage underneath and through earthen embankment dams and various forms of seepage at the dam abutments have caused great concern during extreme high water events. Deteriorated tunnel linings that connect intake structures with the outlet works and through which tons of water travel daily also are issues of growing concern. Despite ongoing O&M efforts by skilled staff and efficient use of limited O&M funds to sustain the projects, aging processes alone create issues of reliability and sustainability.

The *National Dam Safety Act*, authorized by Section 215 of the *Water Resources Development Act of 1996* (P. L. 104-303), required the director of FEMA and the National Dam Safety Review Board (authorized by that Act) to establish the National Dam Safety Program. The basic elements of that program were to carry out an inspection of dams in the United States (including the Ohio River basin) to assess their condition, distribute copies of the inspection reports to state governors where the dams were located (with suggested remedial measures upon request to address any deficiencies), determine what threats to human life and property the deficient dams may

present and establish an inventory of dams within the nation that would be periodically updated. In addition to these basic elements of the Act, the National Dam Safety Program established a number of objectives set forth below:

a. Ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction;

b. Encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, O&M, and emergency preparedness;

c. Encourage the establishment and implementation of effective Dam Safety Programs in each state, based on state standards;

d. Develop and encourage public education and awareness projects to increase public acceptance and support of state Dam Safety Programs;

e. Develop technical assistance materials for Federal and state Dam Safety Programs; and

f. Develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector.

As a part of this program, USACE has inspected all the dams in the Ohio River basin that it has constructed. As a result, dams were categorized according to engineering criteria that prioritized the critical nature of observed deficiencies. Those dams with critical deficiencies (potential embankment or abutment failures, undersized spillways, deteriorated intake and outlet structures, etc.) that could result in catastrophic failures and loss of life downstream received the highest priority in allocation of funding and rehabilitation design and construction. Other dams found to be less deficient during inspections have been scheduled for rehabilitation as funds become available. In some cases, high risk dams do not have updated emergency action plans. Table 11 lists dams that are currently being repaired through the Dam Safety Program.

There are 83 USACE-constructed dams in the basin that provide storage for various authorized purposes, such as retention of excess runoff, recreation, water supply, hydropower, fish and wildlife habitat, downstream flow augmentation, and navigation. Of those 83 dams, 78 are considered multi-purpose projects that maintain various pool levels to support recreation, water supply, and hydropower. Many of the projects provide substantial water surface acres for recreation and other uses. These Federal assets are managed through the Asset Management System by USACE. Use of the basic principles of asset management could be applied to future reinvestments in the operating system.

Of the many flood risk reduction projects of concern due to deficiencies, the cluster of 16 projects located within the Muskingum River sub-basin is unique because of age, authorization, and operation. Of the16 total projects, 14 were authorized and constructed in the late 1930s and have been operating continuously since that time. Table 7 in Appendix F lists the operating projects in that sub-basin, and dates of initial

operation. Figure 40 shows the Muskingum River sub-basin with the array of dams, watersheds, and major urban areas. An additional two reservoirs, Dillon and North Branch of Kokosing River lakes, also part of the sub-basin system, were constructed later in 1961 and 1971, respectively.

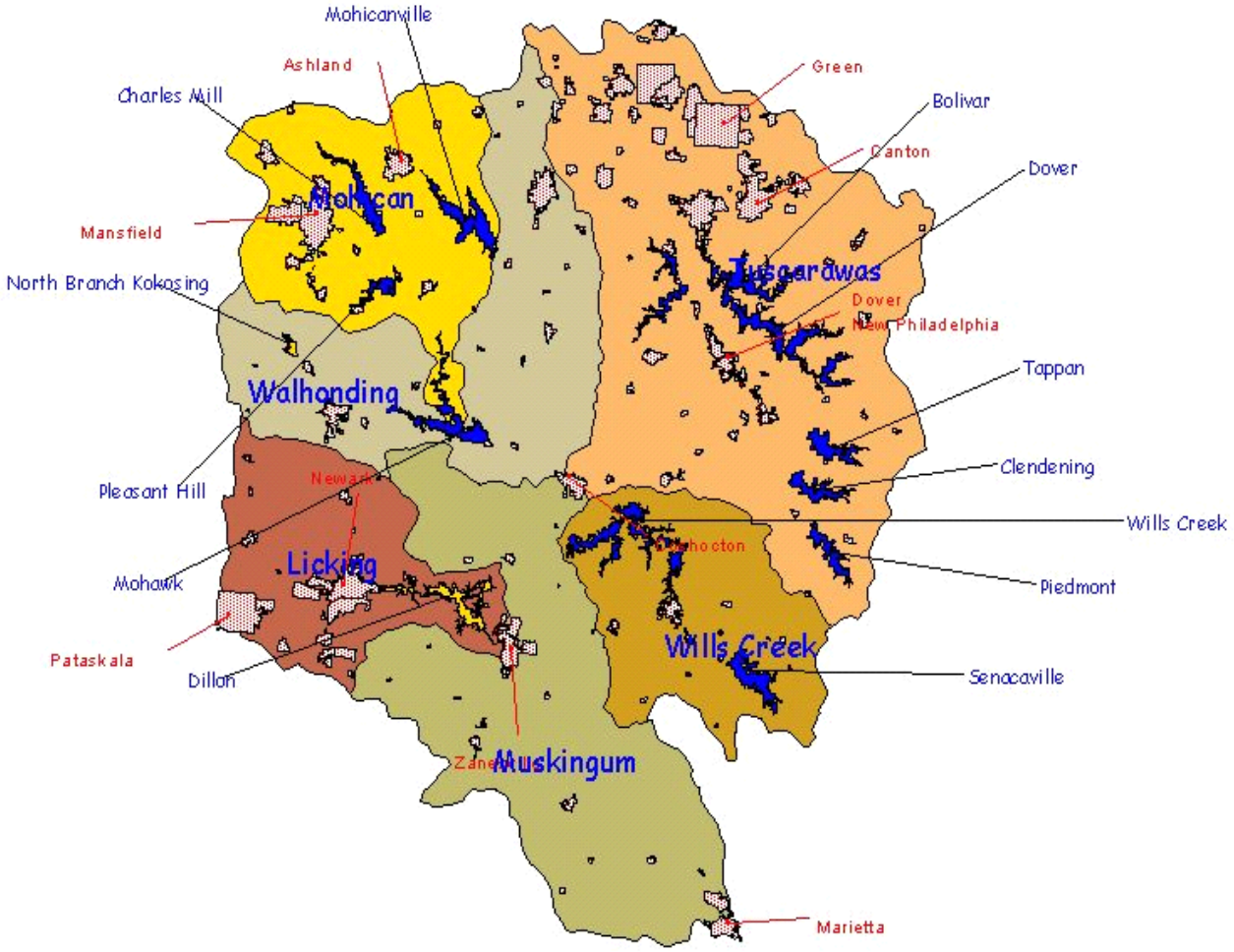


Figure 40 – Muskingum River Sub-basin

The original 14 dams are operated by USACE, and the lands are managed by the Muskingum Watershed Conservancy District (MWCD). Four of the original dams are dry dams, only operated for flood risk reduction; the remaining ten maintain conservation pools for recreation, water supply, and fish and wildlife habitat. The original 14 projects control 4,267 square miles of the 8,051 square miles in the sub-basin area and have reduced damages to downstream communities since their initial operation. In addition to recreational facilities constructed at the dam sites, MWCD has invested in millions of dollars of parks and recreational facilities in the system. Lodges, golf courses, cabins, campgrounds, and swimming beaches have been constructed by MWCD at several lakes; visitation in 1998 exceeded 4.0 million visitors. Alternatives to operation of this infrastructure system to maintain current levels of flood risk reduction in the Muskingum

sub-basin would be prohibitively expensive. However, there may be components of the system that could be replaced with other flood risk reduction options.

Dam safety inspections have uncovered many deficiencies throughout this system in need of immediate repair to reduce the risks of catastrophic failure. Flooding in 1969 in the Muskingum River sub-basin exposed numerous issues at the aged lakes, resulting in major rehabilitation at several lakes. In 2005, heavy downpours in the region resulted in record-setting pool levels and emergency repairs at 13 of the 16 dams in the system. There has been an explosion of growth surrounding urban areas resulting in increased uncontrolled stormwater runoff. Other conditions in the sub-basin related to water quality deterioration due to agriculture non-point sedimentation, urban and rural floodplain development and stormwater runoff, and deterioration of aquatic ecosystems point to the need for an assessment of this large watershed and its many issues.

In addition to the national Dam Safety Program, USACE was authorized under Title IX of the *Water Resources Development Act of 2007* (*National Levee Safety Act*) to undertake, in cooperation with FEMA and the states, a review of all levees in the nation (including the Ohio River basin) to conduct inspections, develop an inventory of all levees, and provide a one-time “consequences assessment” based on the conditions of the structures. The National Committee on Levee Safety submitted their draft report to Congress in January 2009. That preliminary report was a comprehensive review of the safety and reliability issues confronting the thousands of local protection projects across the nation and included 20 separate recommendations. USACE's inspection and evaluation of levees and floodwalls in the Ohio River Basin is ongoing at this time.

There are 97 existing levees and floodwall projects in the basin designed by USACE that protect riverside communities and facilities. Based on data collected by USACE districts for the local protection projects, more than 400 square miles of urban area are contained within the protection limits of the LPPs, approximately 500,000 night-time residents are protected by the existing LPPs, and the estimated total value of property protected by the LPPs exceeds $14.0 billion. Appendix H provides additional detailed data on the assets protected by the LPPs.

The local protection projects depend on local O&M under formal agreements with USACE (Section 221 of the *Flood Control Act of 1970* [P. L. 91-611]) and more recent project partnering agreements) to ensure reliable and safe operation during normal conditions and extreme flooding events. Local taxing of protected properties and establishment of operating organizations (floodwall or levee boards) provides support for the continued O&M of these local projects. In some cases, changes in upstream development runoff rates or updated hydrologic data may have reduced the original level of protection at some local protection projects. In other areas of the basin, the preponderance of private and agricultural levees calls into question the accuracy of current non-Federal levee inventories and their condition. Concerns identified through early inspections include substantial amounts of mature vegetation growing on levee embankments, deterioration of pump station discharge culverts and other piping imbedded in levee embankments, and deterioration and obsolescence of operating equipment in pump stations. Each of these features could either separately or in combination under the worst conditions contribute to failure of the project.

Using information gathered from each existing protection component of the FRR system, an estimate of the total basin damages prevented on an annual basis can be determined. USACE infrastructure for reducing flood risk is estimated to prevent, on average, $733.0 million in annual damages. Appendix F includes damages prevented for individual projects.

8.4.8 Issues – Public Land Stewardship and Recreational Facilities

In total, USACE projects provide more than 1.4 million acres of public land and water for public uses. USACE lakes combined have averaged more than 19 million total recreational visits per year during the past 5 years. At least 78 USACE multi-purpose reservoirs with a full array of day- and overnight-use recreational facilities are located within a 3-hour drive of 15 major cities in the basin. During times of high fuel costs and shrinking household budgets, convenient day- and overnight-use USACE facilities offer families opportunities for “staycations.”

Land-use management conflicts at USACE reservoirs are increasing as many more users compete for finite land and water resources. Conflicts between human recreational uses and sensitive habitats will increase in the future. These “carrying capacity” issues have arisen as visitation and impacts on project resources have increased; future population increases can only exacerbate these conflicts. Expansion of existing recreational facilities and increased hunting and fishing pressure on finite natural resources could have detrimental effects.

In addition to requests for exploration of energy resources on and beneath USACE lands (i.e., coal and gas exploration) that have been ongoing for many years, the growing national trend toward development of renewable energy sources (besides hydroelectric power) such as wind turbine fields, solar arrays, and bio-fuels production may also affect USACE-managed lands. In view of USACE's Environmental Operating Principles, current project purposes and land management criteria need to be re-evaluated and perhaps modified to meet potential land use demands and changing conditions.

Recent Federal mandates to address stormwater runoff at Federal facilities and installations (Section 438 of the *Energy Independence and Security Act*) will result in use of water-harvesting and green technologies during new construction and redevelopment at USACE projects and other Federal installations. The effects of capturing precipitation through use of pervious pavements, rain gardens, bio-swales, roof gardens, and other design techniques could have measurable benefits to water quality and local aquifers.

In addition, many USACE-managed lands include critical habitat for T&E species that have regional and, in some cases, national and international significance. Project habitat that supports migratory waterfowl and other species of concern requires special management considerations that can be coordinated with UFWS, organizations such as Partners-in-Flight, and state DNRs during the updating of project master plans. Concerns for managing USACE lands to address sustainability of T&E species have been raised as an issue by natural resources agencies.

Additional requests from the public have included demand for upgraded recreational facilities and different facilities than those planned in the 1960s and 1970s, when many of the projects were constructed. Many USACE recreational facilities are aging and in need of repairs and rehabilitation. Improvements in camping equipment (RVs) have superseded the ability of many USACE facilities to accommodate these new technologies.

Changes in regional demographics with respect to population characteristics and changing values have impacted USACE projects. User diversity has increased, with many new cultural groups using USACE facilities and expecting recreational experiences more in tune with their ethnic and cultural backgrounds. USACE methodologies for determining the necessary array of recreational facilities do not account for such demographic changes. Reliance on State Comprehensive Outdoor Recreation Plans (SCORPs) for this updated information can be sporadic among the several basin states. Opportunities for Federal or joint studies with the states on appropriate types and numbers of recreational facilities need to be considered.

Allied with the many requests for new and upgraded facilities are issues of sustainability of the existing facilities where balancing user needs against current funding and manpower restrictions approaches a “no-win” situation for USACE-project land managers. Current user fee schedules and the Federal policies regulating disposition of collected fees for reuse at projects have been raised as issues and need to be re-evaluated in view of the increasing recreational pressures being exerted on USACE facilities.

In order to accommodate a growing visitor population while protecting the projects’ ecosystems and maintaining their operational status for authorized purposes, strategies for reinvestment in visitor facilities and management of public lands to meet the demands must be developed. In addition to meeting the needs and demands of the recreating public is the issue of public safety at USACE operating projects. Although great strides have taken place in public safety at USACE reservoirs during the last 20 years, accidents still do occur. Fatalities and injuries requiring medical attention are occurrences at USACE reservoirs that should be reduced to an absolute minimum within practical means. USACE safety offices and reservoir managers and rangers continually stress boating and recreational safety to visitors through ongoing education programs, project signage, and project surveillance. The prospect that basin project visitation may increase as a function of population growth and rising fuel costs makes visitor safety programs of paramount importance.

Although not directly related to USACE reservoir projects where most recreational facilities have been located, recreational access to the many tributary streams and navigation pools on the Ohio River and its tributaries by fisherman, boaters, and swimmers was raised as an issue. Adequate access for first responders (emergency personnel, HAZMAT teams, and security services) to the navigation pools also is an issue of concern. Many new riverfront facilities have been constructed as joint ventures between local communities and USACE within the past 30 years. Additional requests for these facilities are expected to rise, and issues have been raised regarding the current methodologies for determining expected annual visitation, determining user needs, and addressing potential competition between riverfront facilities. Potential impacts to

aquatic resources (especially mussels) as a result of construction of additional riverfront sites also need to be addressed in development criteria and project decision-making. Opportunities to accommodate waterway tourism as a source of revenues for river communities were also suggested in the issues.

Another long-term issue for recreational resources could be the effects of climate change on the viability of outdoor recreation at USACE lakes and other projects. If changes in the regional climate result in less precipitation within the watersheds of reservoirs and demand for other storage uses such as water supply and hydropower stay at current levels or grow, pool levels that sustain certain types of water-based recreation could be in jeopardy. Additionally, should mean summer temperatures rise substantially, certain day-use activities (picnicking, hiking, boating, water skiing, etc.) at USACE facilities may not be as popular to the public, thus reducing visitor use. Higher evening temperatures (predicted in some climate change models) could stimulate more demand for electrified campsites to support air conditioning in campers and trailers.

8.4.9 Issues – Climate Change

Of the many issues raised during the preparation of the recon report, climate change and how such fundamental changes may affect the basin resources and operation of the existing infrastructure was frequently posited. Many studies and scientific analyses on the causes and potential effects of global climate change have been accomplished by NOAA, the National Science Foundation, and many other national and international agencies. Notwithstanding the geopolitical or socioeconomic aspects of the whys and wherefores of the global climate change debate, climatic changes could have significant and adverse impacts with regard to M&I and irrigation water supply, flooding, drought conditions, agricultural productivity, economic viability, energy needs, recreational use, commercial and recreational navigation, and sufficient flow to support aquatic species.

Among the many studies and reports published on climate change and its effects on the earth, the published science-based work by NOAA, *Weather and Climate Extremes in a Changing Climate*, concentrates its focus on possible effects on North America. This report, published in June 2008, includes numerous findings of what may be experienced as the anticipated climate changes occur. Similar findings have been included in the more recently published (June 2009) version of a study titled *Global Climate Impacts in the United States*. Those findings indicate that the following climate and weather conditions may occur in the future:

a. Abnormally hot days and nights, along with heat waves, are very likely to become more common. Cold nights are very likely to become less common.

b. Sea ice extent is expected to continue to decrease and may disappear in the Arctic Ocean in summer within coming decades.

c. Total precipitation on average is likely to be less, but rainfall may be more intense. Northern regions of the basin may receive more precipitation in winter and spring, while more southern regions will receive less precipitation.

d. Droughts are likely to become more frequent and severe in some regions.

e. Evaporation and transpiration rates are likely to increase.

f. Hurricanes will likely have increased precipitation and wind.

g. The strongest cold-season storms in the Atlantic and Pacific are likely to produce stronger winds and higher extreme wave heights.

Although some of the projected changes in the North American climate do not appear to directly affect the Ohio River basin, many of those listed could dramatically affect the regional population as well as the O&M of the basin's existing flood risk reduction infrastructure. Of particular note regarding the basin are the anticipated climate and weather changes listed in items a, c, d, e, and f.

Since the basin depends on an ample supply of fresh water to support the population, its economic production, and ecosystems, any climatic circumstances that would significantly reduce that supply would be a threat to the basin. Prolonged periods of drought (with the associated heat and increased evaporation rates) would affect supplies of drinking water (both groundwater and surface waters), industrial processing and cooling water, commercial navigation, water-based recreation, and agricultural and livestock production and would increase demands for energy (air conditioning). Prolonged drought could threaten many aquatic and terrestrial species, especially endangered fish and mussel species.

In addition to drought conditions would be the effect of warmer water temperatures on sensitive aquatic species such as trout (a major recreational fishing species) and on power plants dependent upon the intake of cool water to maintain power generation efficiencies. Water management agencies may be faced with outflow water quality challenges. Current balancing of outflow water temperatures with sufficient oxygen levels to accommodate downstream water quality targets is challenging – added to that challenge would be increased amounts of warmer lake water and warming air temperatures.

In contrast to drought conditions would be the threat of more intense storms bringing heavier amounts of rainfall into portions of the basin with steep terrain and high-gradient streams. In steep headwater areas where the forest soils are thin and forests continue to be harvested for timber and other uses (residential, commercial and resort development), sudden increases in uncontrolled runoff combined with high water velocities in the streams generate the potential for loss of life and severe damages to private property, public property and infrastructure (roads, utilities, etc.).

In addition, sudden intense rainfall events can impact the ability of local communities to operate local protection projects to reduce damages (gate closures), and USACE reservoirs could experience sudden and dramatic increases in pool heights that would threaten recreation users in lakeside facilities. Were these intense storms to occur at nighttime, the chances for loss of life would be much higher. Also, more intense rainfall events in the steeper, high-gradient streams may result in losses of aquatic habitat and stream-bank stability and may initiate stream armoring due to frequent recurrences of extreme water velocities.

The threat of abnormally hot days and nights could result in significant evaporation at USACE lakes, further exacerbating the water supply issues and possibly affecting hydropower operations due to water shortages. Hotter days and evenings could result in losses of recreational opportunities, as the comfort index for outdoor activities reached unbearable levels. Reducing pool seasonal storage to meet downstream needs (water supply intakes or navigation) would likely drop otherwise stable pool levels leaving some access facilities (boat launching ramps) in the lake unreachable by water and reduce many acres of otherwise attractive shoreline into mudflats. A generalized heating of the region combined with fewer very cold nights could significantly increase the insect population. Besides the crop and forest devastation and potential for disease vectors that could be wrought by an overabundance of insects, the effects of more insects on recreation users could reduce visitation at USACE-owned facilities.

Terrestrial and aquatic ecosystem components could begin to degrade as warmer temperatures and reduced water availability would affect riparian zones, wetlands, and other water-dependent plant associations and the fauna that depend upon them. Based on a USGS report done in cooperation with NOAA in January 2009, titled *Thresholds of Climate Change in Ecosystems*, it is conceivable that certain ecosystems (especially those that are particularly sensitive to changes in moisture and temperature) could, if impacted by sudden climatic changes, reach a threshold condition where dramatic and irreversible adverse changes could occur. Certain ecosystems already under some type of man-made stress (water quality, disease, habitat loss) may be more susceptible to threshold change.

That report defines an ecological threshold as “the point at which there is an abrupt change in an ecosystem quality, property, or phenomenon, or where small changes in one or more external conditions produce large and persistent responses in an ecosystem.” Should climatic changes occur over time as suggested by the NOAA report, there could be irreversible and catastrophic changes in the basin ecosystems. Climatic changes (warmer winter temperatures) that favor the productivity of and increase resistance to eradication techniques of existing invasive species could have serious impacts on the indigenous species of the basin.

One other factor of climate change noted in the NOAA report that could adversely affect the basin is the prospect of hurricanes especially those that manage to drift into the basin from the Gulf or move inland from the Atlantic coast bringing longer-duration, heavier rain events. In recent years hurricanes that have degraded into tropical storms or tropical depressions and have moved into the basin have produced significant amounts of rainfall over several days. There have been a number of basin flood events that were a direct result of a tropical storm or depression that ventured into the basin after impacting the Gulf or Atlantic coasts as a hurricane. The potential of these storms to become more powerful over the ocean environment and maintain their wind strength and rainfall potential inland threatens existing basin infrastructure and residents.

In addition to changed climatic factors that would directly impact the management of basin water resources by USACE and other agencies, impacts to the economic resources of the region could result in a significant decline in population and financial resources. Wholesale abandonment of fossil fuel sources for energy production could

significantly impact the basin - an impact which may ease pressure on ecosystems, but may result in fewer financial resources at the local level to support existing flood risk reduction infrastructure such as floodwalls and levees. A lack of financial capability could eventually result in local operational and maintenance deficiencies with potential catastrophic results during extreme weather events.

Information available online through the Center for Climate Change Strategies (http://www.climatestrategies.us/) indicates that several of the basin states have either completed a climate action plan or are currently working on their plan. Those basin states with plans include New York, Illinois, Virginia, North Carolina, South Carolina, and Maryland. Those currently working on action plans include Pennsylvania and Kentucky. The number of basin states having climate action plans further indicates the significance of the issues surrounding anticipated climate changes that could affect the Ohio River basin, although the primary impetus for the basin states also having coastlines may be the threat of sea-level rise as well.

Adaptive management is one of the many strategies that could effectively mediate the effects of climate change on water resources. Adaptive management in its passive form relies heavily on monitoring of management decision outputs to enable ongoing adjustments to management strategies – a process of learning by doing. Adaptive management techniques have been applied to water resources, ecological resources, hydrology and hydraulics and many other complex systems to address future uncertainties. Models are usually employed in development of adaptive management processes so that alternative strategies can be tested, outcomes evaluated and management strategies modified. This iterative process leads to “active learning” and identifying gaps in one’s knowledge of the system and its variables (such as climate change).

As climate prognosticators suggest, changes in climate are likely to result in significant consequences for the seasonal temperatures and precipitation patterns of the region. Both of these changes can have impacts on the management of USACE water and land resources. Developing adaptive management strategies through modeling and collaborative engagement of stakeholders may help to reduce the adverse effects of climate change on management of land and water resources. Development of adaptive management strategies could be coordinated with modeling efforts required for the basin water management plan.

8.4.10 Issues – Environmental Infrastructure

For the purposes of this study, the term “environmental infrastructure” is defined as either municipal or county structures, buildings and facilities associated with the collection and treatment of sewage and disposal of sludge or the extraction, treatment and distribution of potable water. In some cases depending upon the authorizing language supporting the infrastructure program, environmental infrastructure can include protection of surface waters including limited stormwater facilities that are associated with preventing stormwater infiltration into sewer systems.

Generally, the major basin cities have functional sewer and water systems and stormwater systems that comply with USEPA requirements except for combined sewer

overflow issues that are discussed below. However, that level of public services is not consistent across all communities and is sporadic in rural towns, villages and unincorporated areas. Where such facilities are lacking, threats to health and safety through contaminated drinking water supplies and disease can be significant. Lack of sufficient system capacity or level of treatment can limit growth or enhancement of other essential public services such as fire suppression, schools, hospitals, etc. As is the case in all other issues, projected basin population growth in the further exacerbates the issue of the capacity and efficiency of existing infrastructure systems and without use of conservation measures, threatens urban and rural water-treatment and -distribution systems and wastewater-collection and -treatment systems.

Through Federally authorized programs, existing sewer and water systems can be upgraded (capacity and treatment levels), and both collection and distribution lines can be extended to address heretofore un-serviced areas of communities. USACE's Environmental Infrastructure Program, which was authorized for several areas of the basin through multiple congressional acts, can help local communities to upgrade, enhance, and expand sewer- and water-treatment and -collection/distribution systems through a state-controlled prioritization process. Table 17 shows the currently authorized USACE Environmental Infrastructure Programs in the basin (detailed program data were not available for cited programs in Tennessee, Louisiana, Georgia, and North Carolina).

Table 17 – Authorized Environmental Infrastructure Programs

Program Name	State	Completed	Water	Wastewater	Other
Section 340	S. West Virginia	9	3	5	1
Section 594	Ohio	30	8	22	0
Section 571	C. West Virginia	4	2	2	0
Section 531	Kentucky	45	1	44	0
Section 502	SW Virginia	0	0	0	0
Section 313	SW Pennsylvania	53	16	35	2
Section 219 (amended)	N. West Virginia	0	0	0	0
Section 5130	Tennessee	0	0	0	0
Section 5082/5085	Louisiana	0	0	0	0
Section 5065	Georgia	0	0	0	0
Section 5113	North Carolina	0	0	0	0
Section 592	Mississippi	0	0	0	0
Section 219	National Program	1	0	1	0
Totals		*142*	*30*	*109*	*3*

Issues associated with the current programs include the limited geographic extent of the current authorizations as not all areas of the basin are covered by the programs. From a programmatic standpoint, funds appropriated for design and construction under the various programs also are used for public outreach and management of the program data; this necessary administrative use of limited design and construction funds remains

an issue throughout the program. In addition, given the basinwide water quality concerns associated with combined sewer overflows (CSOs), the general lack of authority to address stormwater flows in the Environmental Infrastructure Programs hinders agency efforts to support separation of these combined systems. With over 1,000 CSOs along the Ohio River alone (many which are municipal sources), expansion of the current environmental infrastructure authorities to address the stormwater components of these systems in partnership with municipal jurisdictions alone could substantially improve basin water quality. In recognition of anticipated intense rainfall as a result of projected climate changes, a condition that exacerbates CSO events, addressing stormwater issues through the current infrastructure programs may be a beneficial strategy.

8.4.11 Issues – Water Resources Development Policy

The development of the Ohio River basin flood risk reduction system has occurred over a 70 year period in which numerous water resources policies have been developed, revised, and re-revised. Supported by many congressionally authorized acts, Presidential Executive Orders, Department of Army regulations, and policy guidance memoranda, these policies provide guidance on the plan formulation, design, construction and operation of civil works water resources projects. Changes in policy have occurred to address new law, new and unique project or program situations, court decisions and heretofore undiscovered physical, social or economic conditions.

As the Ohio River basin infrastructure continues to operate and provides various public benefits to the region and the nation, and as new basinwide challenges (climate change, etc.) confront USACE, existing policies may need to be re-evaluated to determine whether the changed conditions warrant consideration of policy change to address the new issues or water resources conditions.

Among the policy issues submitted for consideration in the plan were the re-evaluation of current policies/procedures for determining eligible navigation benefits that should consider measurable external benefits such as reduced carbon emissions per ton mile of barge over other modes, highway maintenance costs, highway congestion costs and delays in major traffic corridors and benefit measures of increased highway safety. Also identified was re-evaluation of policies that limit use of environmental compliance and stewardship funds in certain business lines such as navigation impact monitoring.

Regarding flood risk reduction policies, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* and also ER 1105-2-100 could be re-evaluated to consider other benefit measures as well as justification for rural and economically depressed areas that are subjected to recurring damages. There are numerous examples of this project justification situation across the basin. The comment indicated that current policies tend to favor the wealthier communities in benefit calculations. An associated comment on current policies concerned the lack of consideration for loss of life in economic benefit calculations for flood risk reduction projects.

An issue raised concerned the policy/methodology for computing flood damages for structures in watersheds with steep gradients and debris-laden flood flows. The current

methodology using the FDA damages program assumes that 100% damages to a structure occur when the rising waters attain a certain elevation in the structure. In truth, structures located along steep gradient streams can be totally demolished by the high-velocity flood flows and debris long before the water depths approach the maximum damage level on standard flood damage curves. Therefore 100% loss of the structure can occur at much higher flood frequencies (5, 10, 20 year frequency) than the standard curves indicate. The result is loss of significant FRR benefits in the economic analysis of these types of projects.

An additional issue on current policies concerned the high cost sharing rates for ecosystem restoration projects. The current rates are 65% Federal share and 35% non-Federal share for ecosystem projects implemented through the Section 206 CAP program or through the normal authorization and budgetary process.

Issues on policies regarding water supply studies and storage costs concerned limitations on water supply management studies that restricted changes to current water supply permits forcing management to use legal mandates rather than a holistic process. The policy issues also pointed out inconsistent approaches to calculating water supply storage costs and annual O&M fees.

Issues with policies for O&M of current projects included the disparity of shoreline management costs and collected user fees (user fees are too low), the need to consider the return of project user fees to the project for rehabilitation of recreational facilities addressed in updated master plans and that project encroachments on USACE project lands hinder proper maintenance of the project. An additional policy issue concerned permitting future use of project lands for renewable energy development such as wind turbines, solar arrays and bio-fuels production.

An additional issue, although not directly related to water resources development policy, but a major component of USACE's mission was a request for a more transparent and better understood regulatory permit process for the general public.

8.4.12 Issues – Energy Production and Resources

As described above, the basin is a nationally strategic source of energy fuels and an annual generator of significant kilowatts of electric power - electric power that is relatively inexpensive due to the cost effective transport of fuels to generating stations by the inland waterways. In addition there are 51 hydropower facilities in the basin that provide 14.8 million kilowatt hours per year of electric power without carbon emissions.

Other renewable energy options may be feasible and USACE-operated lands may be able to accommodate some of those optional facilities or provide lands for supporting bio-fuels production, wind turbines or solar arrays provided that current USACE policies for use of managed lands can accommodate these uses (see *Water Resources Policy Issues*). In addition, the thousands of acres of USACE-managed forested land provide massive amounts of carbon sequestration. Management schemes that could increase the effectiveness of sequestration or storage capacity for air-borne carbon in the forests on USACE lands may be worthy of consideration.

Issues that emerged during the planning process included the lack of a basinwide strategy to cumulatively assess the impacts of individual, non-Federal hydropower retrofits being requested. In addition, the number of current hydropower units needing retrofits to increase generating efficiency and allow adjustments of downstream flow to benefit downstream species and meet water quality targets was raised as an issue. Related to issues of hydroelectric power generation was an issue of competition for stored water for uses other than hydropower that could endanger current generating capacity (e.g., water supply, recreation, etc.).

Other issues raised during the process involved increased threats to water quality and recreational use of USACE projects due to increased minerals and natural gas extraction within and around USACE projects. Many USACE projects are surrounded by or underlain with rich deposits of coal, natural gas and other energy related materials not purchased during project development. Extraction of those energy fuels on Federal lands could endanger the reservoir and potentially present hazards to the visiting public. In a related issue of concern to a large part of the basin is the exploration and extraction of gas from the Marcellus Shale deposits that underlay portions of Pennsylvania, West Virginia, Kentucky, and Ohio. Figure 27 shows the extent and depths of this massive energy resource. The issues surrounding extraction of this gas include significant water withdrawals from streams and the potential for water quality problems from drilling discharge water.

A general concern raised by USACE staff and key stakeholders was the lack of a clear strategy to address the cumulative impacts of exploration, extraction, processing and transportation of energy fuels on water quality, aquatic habitat, flood risk, and ecosystem health. Considering the massive scale of energy development and the integration of this process within the ecosystem, human environment and water resources system, a well conceived basin strategy formed through a collaborative process may help to address a multitude of issues.

8.4.13 Issues – Navigation

The collection of issues affecting the inland navigation system and formulation of alternatives to address issues were not considered the primary focus of the *Ohio River Basin Comprehensive Reconnaissance Study*. The ongoing Ohio River Mainstem System Study (ORMSS) has been considered to be the primary driver in making future decisions on navigation improvement investments. However, since the recon study is addressing water management issues in the existing system and since one of the primary beneficiaries of an adequate flow of water is the navigation industry, navigation issues were accepted for consideration in the planning effort.

The management of water resources, if truly based on an integrated basin approach, must include one of the major benefit producers and one which depends solely on a reliable volume of water within the navigable channels of the system to operate. Although not especially dependent upon water quality to operate, commercial navigation must consider its potential effects on the quality of its liquid highway and the flora and fauna within and alongside it. Closely related to the conditions of the river system is the landside development that accompanies and is generated by relatively low cost transportation opportunities. Private and public development and Federal regulatory

permitting of commodity terminals and ports along the waterways can add significantly to water quality issues, stormwater runoff, habitat losses, and recreational-use conflicts.

Given the other competitors for existing water volume (M&I water supply, recreation, fish and wildlife, hydropower, etc.) and the public benefit streams that they produce, navigation's need for a reliable water flow must be considered in the larger context of the other users' needs. A dollar benefit from a commodity moved on the waterway is essentially equivalent to a dollar benefit of water supply or a recreation day; therefore, decisions on the available storage and distribution of water between the competing interests falls to trade-off analyses or other non-monetary procedures.

Navigation issues identified in the planning process included concerns for increased traffic and need/demand for new terminals to handle anticipated future movements of intermodal containers. Current efforts by economic development agencies to increase the use of intermodal containers (the current standard for much national and international commerce) have increased movements by truck and rail. Regional "double-stack" intermodal rail traffic (now through Tennessee and Pennsylvania) is anticipated to increase through development of the USDOT authorized Heartland Corridor crossing through Huntington, West Virginia, on Norfolk Southern track. As the volume of regional container usage increases, the potential for container movements by barge increases as well. Future volumes may demand use of the waterways to decrease movement costs along the Ohio River leading to new intermodal terminals along the waterway. This raises the issue of whether the level of transportation benefits associated with investments in public port development to handle intermodal containers could generate a Federal Interest (NED benefits) in joint development of these facilities.

In a related navigation comment from a key stakeholder, the respondent suggested a long-range investigation of Ohio River basin navigation connectivity to other waterways such as the Tenn-Tom and blue-water ports such as the Gulf. Given the growing interest by state port authorities in connecting ports along the Ohio River to a Gulf intermodal port at Mobile, Alabama, using the Tenn-Tom waterway, this issue has merit.

An additional issue raised during the process involved the impacts of maintenance dredging for navigation access on aquatic species and their habitat. Especially important in this issue are the potential effects on mussel species in rivers where commercial navigation is prevalent. Given the numbers of Threatened and Endangered mussel species in the basin and the annual needs for navigation dredging, limiting the sources of sedimentation into the river system over and above natural processes is an equally important issue.

In a related issue, a concern was raised whether deepening the navigation channel to increase traffic volumes could generate enough NED benefits to confirm Federal cost sharing involvement. The currently authorized channel depth for navigation on the Ohio River is 9 feet. Efforts to increase that authorized depth would require extensive analysis of anticipated navigation traffic, engineering feasibility, environmental impacts, infrastructure impacts and other issues. Several comments were received during the planning process regarding the potential loss of Lock and Dam #3 on the Lower Monongahela River and the threats to existing navigation, municipal water supply intakes (drinking water and fire suppression), cooling water intakes for industrial and

power generating facilities, and water quality due to existing sewage treatment effluent discharges in that navigation pool. The impacts on aquatic species especially mussel beds could be catastrophic. Other similar locks and dams navigation pool issues such as on the Kentucky River relate to maintenance of the stable pools for M&I water supply and sustaining mussel beds.

An operational issue was raised during the process that involved needs for rehabilitating current navigation aids and mooring structures. One additional comment was received regarding operating inefficiencies at the Wilson Lock and Dam. Among other issues related to USACE's regulatory permit program, an issue was raised regarding the permitting of fleeting areas that could potentially impact mussel beds using information supplied by the fleeting companies and a related concern that available information on mussel beds was outdated and should be updated for uses by permitting agencies, resources agencies and the navigation industry.

8.5 RELATED FEDERAL AREAS OF RESPONSIBILITY

Generally, several Federal agencies involved in water resources, flood damages, land conversion, and floodplain development have an interest in the wide spectrum of issues being raised during this planning effort. Each of these agencies has programs or provides services authorized by law that define the extent of their participation in solving water resources related issues. A short list of those agencies would include FEMA, USGS, NRCS, USDA, NWS, USFWS, and USACE. Where these various agencies intersect with a particular issue raised or alternative formulated by this study, that connection will be noted.

USACE's Federal Interest in water resources development is established by law. Further definitions of Federal Interest as it relates to specific issues or project types are described in ER1105-2-100. Specific Federal Interests have been identified for the following USACE missions: Navigation, flood risk management, ecosystem restoration, hurricane and storm damage abatement, water supply, recreation, and hydroelectric power generation. Although there has been a defined Federal Interest in the pursuit of these project types, certain requirements should be met in preliminary evaluation of the monetary and non-monetary benefits whether described quantitatively or qualitatively to proceed to more detailed planning phases, project partnership agreements, design and implementation of a project. That evaluation is not a rigorous determination at the reconnaissance level of this report, but indications of cost effectiveness using available data should be addressed.

In the case of a reconnaissance study such as this one, whose geographic scope includes the entire basin and whose framework is established at the watershed level, such an evaluation is complicated by the lack of detailed project information from which qualitative or quantitative data can be derived. Therefore, identification of a Federal Interest in alternatives of this study is based more appropriately on identification of flood damage risk, qualitative assessments of threats to public safety, agency assessments on biological/ecosystem health and water quality of watersheds, sub-basins or the entire basin, and information from dam and LPP inspections.

Within the array of issues, problems, needs and opportunities that have been identified by USACE personnel, basin stakeholders and the public and have been described herein, there are several that may qualify as being in the Federal Interest and worthy of further study and analyses.

8.5.1 Reinvestment in Existing Flood Risk Reduction Projects

A key item on the list of issues is the continuation, rehabilitation and revitalization of the existing flood risk reduction facilities that have been constructed by USACE and either are operated and maintained by USACE or a non-Federal sponsor. Although these facilities were initially constructed under the determination of a Federal Interest in reducing flood risks their continuing operation and potential rehabilitation/revitalization must meet some minimal test. The annual reduction of flood damages at each of these facilities is shown in Tables 3 and 4 of Appendix F. Annual operating and maintenance (O&M) costs are shown for projects(where available) in the same tables. As the tables show, these projects despite their age and condition still generate significant flood risk reduction benefits over and above (nearly 9 to 1) annual operating and maintenance costs. Other Federal agencies (such as NRCS) and Federally established regional agencies (like TVA) also have aging infrastructure and are faced with many of the same problems challenging USACE.

8.5.2 New Investments in Flood Risk Reduction

In accordance with established USACE water-resources procedures and regulations, alternative plans qualify as being in the Federal Interest if they reduce flood damages or flood risks (and risks to loss of life) and are determined to be cost effective. Using both monetary and non-monetary metrics, flood risk reduction (FRR) benefits derived from alternative plans can be supportive of further detailed studies with willing and capable non-Federal sponsors.

Watershed Assessment Plans that indicate the potential for addressing a multitude of watershed issues (which include flood damages and risks to human life, water quality, floodplain encroachments, water supply, riparian impacts, and ecosystem degradation) can be initiated in cooperation with a willing non-Federal sponsor without identifying a cost effective alternative or a specific Federal Interest in the planning effort. ER1105-2-100 and EC1105-2-411 provide guidance for development of Watershed Assessment Plans.

Both NRCS programs and the FEMA Hazard Mitigation Grant Program (HMGP) are designed to address mitigation of flood risks both pre and post-disaster. The HMGP program is funded at the Federal level and distributed to states, counties and municipal areas for implementation of mitigation measures such as acquisition and structure elevation. The NRCS watershed planning programs such as the P. L. 566 program is similar to USACE programs for the planning, design and construction of flood risk reduction measures.

8.5.3 Ecosystem Restoration

In accordance with USACE regulations and policies, ecosystem restoration alternatives that show cost effective incremental benefits are in the Federal Interest. Such alternatives could be pursued through the Continuing Authorities Program (Sections 206 or 1135) or through projects specifically authorized by a Water Resources Development Act (WRDA) for ecosystem restoration on the watershed or sub-basin scale.

The currently authorized $300.0 million Ohio River Ecosystem Restoration Program, although not currently funded, does provide opportunities along the mainstem Ohio River and its adjacent embayments for substantial enhancements of the corridor's aquatic ecosystem. Modification of that authority in a WRDA, to address ecosystem restoration basinwide, would be a method of addressing many issues expressed by responders.

NRCS also has programs for the restoration of floodplains and stream corridors (Section 382 of P. L. 104-127) and wetlands (Wetlands Reserve Program) that can be used to restore damaged floodplain and wetland ecosystems.

8.5.4 Navigation

A number of navigation issues have been identified by various industry and shipping interests. Generally speaking navigation alternatives that indicate transportation efficiency benefit streams in excess of costs are found to be in the Federal Interest. The national benefits associated with increased efficiencies in moving commodities both within and outside of the basin via the inland waterway system can form the basis for those interest determinations. Addition of new commodities to the basin waterways in the form of intermodal containers would certainly expand the current array of bulk and break-bulk commodities being transported. Although containers can be loaded onto barges with minimal alterations of existing terminals (addition of a crane and spreader bar to the hardstand and storage areas) it is possible that new container dedicated facilities could emerge in the future. Some of the new facilities could be constructed and operated by the myriad of existing public port authorities and port districts along the basin waterways.

8.5.5 Water Supply

In accordance with the *Water Supply Act of 1958*, water may be withdrawn from USACE reservoirs for multiple purposes, USACE reservoirs may be authorized for construction with M&I water supply as a project purpose, and storage within an operating reservoir may be reallocated to facilitate withdrawals for M&I water supply purposes. The *Water Supply Act* allows for reallocation of storage without congressional approval provided that other project purposes are not adversely affected. Non-Federal cost sharing for any improvements to a project needed to facilitate water withdrawal is 100% for M&I purposes and 35% for agricultural irrigation.

Although the basin is considered by many to be "water-rich," there have been past instances of drought in the region. The drought of 1988–1989 and more recent droughts in the southern portion of the basin have shown that regional drought conditions can and may occur at any time. Numerous basin communities have been provided water by

tanker-truck (state agency actions) in the past due to reduced flows in rivers from which municipal water supplies are extracted. In some cases local water supply issues are associated with lack of adequate pumping and treatment facilities and distribution systems, but many others are due to the lack of a reliable water source. Local water supply and wastewater treatment can be addressed through the various environmental infrastructure authorities already in place for several basin states. Expansion of these authorities throughout the basin could provide an avenue for addressing these issues.

The 2005 navigation pool loss at the Belleville Lock and Dam on the Ohio River due to a navigation accident highlighted the number of industries that extract water from the Ohio River for cooling and processing and the great number of effluent discharge locations into the river that depend upon a reliable water discharge to meet regulatory requirements. In that same incident, numerous mussel beds along the Ohio River were in danger of being de-watered a situation that could have led to substantial loss of some nationally protected species. Such losses within rivers containing T&E mussel species would be devastating to the basin aquatic ecology.

In addition to shortages of water, water quality has been a basin issue that affects communities' ability to treat water for human consumption and impacts aquatic species diversity, productivity, and survival. More than 5 million people in the basin receive their household water supplies from the mainstem Ohio River alone (ORSANCO data). Many millions more live in basin communities that extract water from reservoirs or from rivers that are tributaries of the Ohio River. The growing concern over introduction of hormonal supplements and pharmaceuticals into rivers raises issue for drinking water safety and aquatic species impacts. Forty-five USACE-operated reservoirs within the basin have M&I and irrigation water withdrawals.

Both TVA and NRCS can provide water supply out of their reservoirs and have constructed numerous basin reservoirs that feature water supply as a project purpose.

8.5.6 Hydroelectric Power

The generation of hydropower at USACE multi-purpose reservoirs by non-Federal sponsors has been authorized by Congress through numerous statutes.

Among the operating renewable energy sources, generation of electricity through hydroelectric facilities located at USACE and other agency reservoirs is a significant resource of the basin. USACE's generating capacity is approximately 1,800 megawatts, with TVA hydroelectric plants and other facilities adding significant generating capacity as well. Eleven USACE-operated basin reservoirs provide lake storage for hydropower and six locks and dams have hydropower facilities as well.

Previous studies have determined that additional hydropower facilities could be installed at other USACE-operated basin projects given the availability of non-Federal sponsors and funding. The Great Lakes and Ohio River Division is engaged in the hydropower modernization initiative as a component of USACE's regional initiatives. This initiative will establish a programmatic approach for hydropower major rehabilitation projects and be used as a ranking model to prioritize hydropower major rehabilitation projects.

8.5.7 Recreation and Land Stewardship

Both day use and overnight use at USACE reservoirs is recognized as a legitimate public purpose. USACE operates 83 reservoirs, of which 79 are multi-purpose installations that include public lands and water and land-based recreational facilities. Approximately 1.1 million acres (1,733 square miles) of public lands at these reservoirs are devoted to various managed uses such as recreation, hunting, hiking, fish and wildlife management, and leases for public uses. Total combined annual visitation at USACE-operated basin reservoirs over the past 10 years has averaged 19 million visitors. In addition, many of the constructed local protection projects now being operated and maintained by non-Federal sponsors also have walking paths, fishing and boating access points, and incidental recreational facilities for day use.

As visitation increases (and perhaps continues to grow in the future as a result of anticipated, basin population growth), there are increasing conflicts between user groups at the reservoirs. Some reservoirs located within a short distance of larger urban centers could reach or exceed a theoretical carrying capacity for water-based recreation in a few short years. Issues of new equipment use on reservoir lakes and public lands (jet skis and four-wheelers) and the potential ecological damage they generate continue to grow in many areas of the basin. Issues of sustainability regarding land and facilities management, funded personnel levels and annual funding continue to grow.

Many of the operating reservoirs were constructed between 1950 and the late 1970s with recreational facilities that addressed visitor needs and demands of that time. In the intervening 30–40 years, the cultural diversity of visitors at USACE facilities has changed, and their outdoor recreational demands have changed as well. Recreational vehicles have increased in size, the variety of recreational pursuits demanded by the public has expanded, recreational equipment has improved, and people’s expectations of outdoor adventure and leisure have changed. In many cases, the current recreational facilities have not been upgraded to the level of visitors' expectations, and many are in need of rehabilitation. Current policies requiring cost sharing of expanded recreational facilities at USACE reservoirs has limited the rehabilitation and expansion of these facilities.

Both NRCS and TVA have developed numerous basin reservoirs that include recreational facilities for day-time and overnight use.

8.5.8 Summary

Given the wide range of issues identified by USACE, the key stakeholders and the general public and the categories of issues that appear to fall within the boundaries of past Federal involvement, there should be a wide spectrum of strategic plan alternatives that may address the issues. Both the NRCS and TVA agencies have programs and missions that can address several of the issue themes identified as well, and their existing structures provide streams of public benefits – as do those of USACE. Considering the driving forces discussed in Section 8.2 and the four basin scenarios presented, the formulation of alternatives must be sensitive to the vagueness of the future and mindful of the systems that will be impacted by those changes. Certainly the

option of formulating more robust and sustainable alternatives - alternatives that can weather a multitude of challenges in a constantly changing environment may be the key to a safer and more productive future.

Although not raised as a specific issue by many responders, sustainability of the existing water resources system is of paramount importance to the people of the basin who reap the benefits of that system. In light of potential future fiscal, resource and climatic challenges, continuing operation, management and maintenance of the existing system while attempting to meet new requests for local and regional assistance will be daunting. Many of the alternatives described in the following section attempt to meet the agency goals of system sustainability through sound planning and wise investments made in collaboration with key basin stakeholders. Sustainability is not attained by accident or chance; sustainability happens through strategic, intentional actions formulated in a collaborative environment.

8.6 ALTERNATIVE PLANS

The words of Mr. Burnham certainly ring true in formulating alternative plans for the Ohio River basin. Based merely on geographic size and the array of issues received, alternative plans meant to address basin issues would likely be large in scope and spatial extent. Alternative plans for this study were formulated at four levels: Basinwide, sub-basin/state, watershed, and municipal/county or project level so that Federal agencies, stakeholders, NGOs, and local entities with varying levels of jurisdiction and financial capability could engage in the process of further planning and potentially implementation of the more beneficial alternatives. In some cases, alternatives were formulated that could potentially be implemented regionally depending upon the willingness of multiple partners to participate in implementation and the flexibility of the program partnering procedures.

> ***"Make no little plans; they have no magic to stir men's blood and probably will themselves not be realized. Make big plans; aim high in hope and work, remembering that a noble, logical diagram once recorded will not die."***
>
> *—Daniel H. Burnham* [6]

The alternatives were also targeted toward the issues and concerns generated by stakeholders, the public and agency personnel through the various communication methods. Many of the concerns and issues have fundamental system relationships allowing formulation of alternative plans that may have synergistic results. Although there are certain constraints that must be observed during plan formulation, the great number of stakeholders, the preliminary nature of the study and the wide range of issues expressed by those stakeholders, suggested that a large number of alternatives and strategies could be developed at several program levels.

[5] Daniel Burnham was an American architect and urban planner and author of city plans for Chicago, San Francisco, and Washington, DC (1846–1912). His quote plays to the inherent characteristic of large-scale, holistic solutions that capture the human imagination and generate popular support – both keys to successful implementation.

Some of the alternatives fall within the legal purview and interest of Federal and state agencies to implement and others will be more appropriate for local jurisdictions to implement. Those regulatory alternatives within the local police powers of counties and municipal jurisdictions can be implemented in a timely fashion, provided that the political will to act in the best interest of the citizens is present. Education of the public in the nature of the issues and engagement in determining what appropriate local actions may be taken is an effective grassroots pathway toward generating local, state, and national political support. Raising public awareness of water resources issues at the basin level through strategic communications and collaborative discourse, two key elements of the reconnaissance study process, can lead to holistic solutions.

This section of the reconnaissance report describes an array of potential alternative measures that may be effective in addressing the issues identified by the stakeholders, the public and USACE staff. In the face of so many future unknowns, more robust, strategic alternatives characterized by flexibility and resiliency with an eye toward sustainability may be an effective pathway to the future. The anticipated outputs of each alternative, its geographic scope and the unknowns associated with the outputs are described below. In pursuit of an orderly formulation process and discussion of the alternatives, the alternatives are displayed in Table 18 by category of issue/theme.

Alternatives are designated by a letter/number code that is carried forward into the evaluation in Table 19. The color coding designates the scale/scope of the alternative: Orange = basinwide; green = state/sub-basin/watershed; yellow = local or project scale.

8.7 PRELIMINARY EVALUATION OF ALTERNATIVES

This section of the report describes the evaluation of the various alternatives using several parameters. Among those parameters are public safety, economic efficiency, environmental effects, and social effects. Recently, heightened concerns for public safety that may be threatened by structure failures or unmitigated flooding events have relegated that criterion (a.k.a. potential loss of life) to a position at least equal in stature to the national economic benefit measures normally used in alternatives evaluation.

Since this reconnaissance study is exceptionally large in geographic scope and addresses a great number of issues identified by basin stakeholders, specific detailed data to evaluate the formulated alternatives could not be developed. For this reason, much of the evaluation of alternatives is qualitative in nature. Information on possible public safety impacts was included where that data could be estimated. Despite the lack of specific benefit and cost data, historical benefits and costs generated by current projects were used to illustrate the potential value of certain alternatives in addressing the identified issues. Alternatives are assessed in the order they were identified in Section 8.4. Table 18 lists the alternatives, their scope, public safety impacts, qualitative benefits and costs, outputs and their anticipated environmental impacts.

8.7.1 Environmental/Ecosystem Restoration Alternatives

As is the case with all environmental/ecosystem restoration alternatives, benefits are not measured in monetary terms but rather rely on qualitative improvements or enhancements to ecosystem types or quantitative increases in acreages or miles of a

specific high quality habitat type (i.e., wetlands, riparian zones, and in-stream aquatic habitat). Alternatives that would result in cost effective improvements or increases to habitat acreages would be deemed to generate positive benefits at some determined incremental cost. Alternatives are presented at the basin, sub-basin, state, watershed, and project levels, to provide opportunities for several scales of potential projects that would appeal to multiple sponsors (states, regional agencies, NGOs, etc.). Certain USDA programs for protecting stream corridors and riparian habitat can be evaluated by reduced volumes of chemicals and sedimentation in protected streams and additional acres of high-quality riparian habitat.

8.7.2 Water Quality Alternatives

Similar in some respects to ecosystem restoration, alternatives that address positive changes in water quality are not measured in monetary units unless reduced costs for water treatment can be accounted for and displayed as benefits. Since the alternatives are described at the larger basin, sub-basin and watershed levels, reduced treatment costs were not available for this stage of reporting. However the benefits of improved water quality in terms of increased recreational access (permitted water contact), removal of limitations on consumption of fish, reduced health risks and quantitative improvements in fish diversity and productivity can be estimated in future studies.

There are a large number of potential alternatives that can be taken to improve water quality which would typically be expected at the local or watershed level in comparing pre-action and post-action conditions. These positive impacts may translate, depending on the action, into measurements such as increases in fish and wildlife habitat units; improved attainment and compliance with established Federal and state water quality standards; or targeted reductions in sedimentation to streams in the region.

In some cases, the costs associated with potential alternatives may be limited to re-evaluation studies of existing USACE reservoirs to evaluate possible changes in release schedules to achieve downstream water quality improvements, authorized by Section 216 of the *Flood Control Act of 1970* ("Review of Completed Projects"). Other kinds of studies, through watershed evaluations or storm water management plans, could lead to recommendations for uniform ordinances across multiple jurisdictions that would improve water quality, leading to, for example, subsequent design and construction separating combined sanitary and stormwater overflow systems in urban areas, supported by state and/or Federal Environmental Infrastructure Programs. In other cases, costs of design and construction to modify intakes at USACE dams to more flexibly release waters from reservoirs at various depths and temperatures to improve downstream water quality may be worthy of consideration.

Energy resources in the region are recognized for their importance to the regional economy, but impacts to water quality from extraction activities are a potential threat. In September 2009, the aquatic life in Dunkard Creek, a 38 mile tributary to the Monongahela River straddling the West Virginia and Pennsylvania state line, was extinguished, with evidence still under evaluation but with suspicion that a golden algae bloom toxic to aquatic life and previously unknown in this part of the country was the cause. This bloom survives only in water with a high level of salinity, indicating that the

Table 18 – Formulated Alternatives, Scope, Outputs, and Output Unknowns/Challenges

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Ecosystem and Environmental (E)				
E.1	Attainment of new authorization for or modification of the existing Aquatic Ecosystem Restoration Program authorization to address ecosystem restoration (i.e., wetlands) within the entire Ohio River basin.	Basinwide	Authorization to plan, design and implement cost-shared aquatic ecosystem restoration projects throughout the basin.	Levels of state, resources agencies, NGOs support to modify current authorization and accept current cost sharing requirements and congressional support to modify authorization or initiate new authorization.
E.2	Development of comprehensive invasive species assessment and control strategies in coordination with Federal and state agencies, NGOs and academia.	Basinwide	Identification and analysis of existing and anticipated invasive species in the basin and recommendations for control strategies to eradicate or mitigate for invasive species.	Appropriate lead agency, number of participating agencies and funding sources in developing comprehensive invasive control strategy. Public awareness of significance of invasive species.
E.3	Modify current USACE regulatory permitting process and the nationwide permit process to promote use of natural stream restoration techniques/processes.	Basinwide	Wider use of natural stream restoration techniques in the basin by private developers and local jurisdictions such that aquatic diversity and productivity can be restored.	Agency willingness to modify current practices associated with regulatory permitting procedures. Willingness of private citizens and developers to accept natural stream restoration.
E.4	Preparation of Section 216 studies (review of completed projects) to determine potential for modification of reservoir storage and downstream flows from reservoirs.	Sub-basin or watershed	Reallocation of storage within individual projects or among projects to optimize benefits and modified flows to support downstream aquatic species habitat.	Levels of financial support for studies beyond the initial appraisal study or implementation of any constructed facilities to adjust flows. Adequate certified flow models for aquatic species.
E.5	Update existing USACE reservoir land use master plans to reflect other resources agency objectives regarding T&E species habitat management.	Sub-basin	Project master plans that address management within current budget limits of critical habitats on USACE managed land that support T&E species.	Levels of state or resource agencies staff support to collaborate on T&E species habitat management plans. Potential conflicts between USACE regulations and T&E species habitat needs, and funding needs for management.
E.6	Installation of stream-bank vegetation and riparian buffers through USACE Section 206 Aquatic Ecosystem Restoration CAP program projects to protect aquatic species habitat.	Watershed	Vegetated riparian zones with adjacent vegetative buffers that limit introduction of sedimentation, agricultural chemicals, fertilizers and other non-point pollutants from entering streams and rivers.	Limitations of Section 206 program with respect to riparian/floodplain buffers and limitations on funding for projects and Section 206 program.
E.7	Restoration of river corridors/greenways through state and Federal programs (watershed associations, interior/National Parks programs).	Sub-basin or watershed	Restored greenways along stream and river corridors within the basin providing protection for riparian, wetland and aquatic habitats that may support T&E species.	Levels of commitment to restoration of greenways and river corridors by Interior Dept. and sufficiency of funding to support programs. Local sponsor responses to acquired easements and potential O&M costs.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Ecosystem and Environmental (E) (continued)				
E.8	Development of Initial Watershed Assessments, followed by a Watershed Assessment and Management Plans, through USACE or NRCS programs at the sub-basin or watershed level.	Sub-basin or watershed	Assessments of the existing condition and anticipated future conditions of watershed systems and natural and man-made features including non-point pollution, nutrient loading, and TMDL issues. Strategic management actions and programs to address watershed issues and needs.	Levels of financial commitment to Watershed Assessment Plans beyond the Federally funded Initial Assessment study. Sufficiency of current certified modeling capability to address multiple parameters within watersheds.
E.9	Expansion of the USDA CRP and CREP programs into all watersheds of the basin to reduce impacts on riparian/stream corridors.	Sub-basin/state	Protection of riparian/stream corridors from agricultural practices, chemicals and sedimentation and enhancement of the corridor vegetation/habitat.	Levels of support from states and landowners for CRP and CREP programs expansion in watersheds. USDA funding support.
E.10	Restore lacustrine and palustrine wetlands in collaboration with USFWS, DNRs, and the Nature Conservancy (TNC) using CAP and WRDA authorities.	Sub-basin and watershed	Restored wetland habitat that absorbs floodwaters without damages and replenishes existing aquifers.	Congressional and state funding support for regional ecosystem restoration projects targeting basin wetlands. Land availability for projects.
E.11	Initiate Section 22 PAS studies with states to identify stable streams for use as reference streams for channel restoration projects and to protect identified streams from degradation.	State	Identification (and protection) of stable stream sections that can be used as reference streams for stream restoration projects.	State financial support for Section 22 PAS studies for stable streams. Ability to protect stable streams through acquired easements.
E.12	Implementation of aquatic and terrestrial ecosystem restoration projects using existing USACE Continuing Authority Programs 206/1135/204.	Project	Variety of aquatic and terrestrial ecosystem restoration projects justified through incremental cost effective analysis.	Levels of demand for ecosystem restoration through the CAP programs. Federal and non-Federal funding availability to support projects.
E.13	Modify reservoir intake/flow release structures by installing multi-level intakes to address downstream water quality and aquatic species requirements (temperature and oxygenation).	Project	Modification of existing USACE projects that do not have multi-level intakes to facilitate blending of temperatures, oxygen levels, sediment and nutrient levels to benefit downstream species.	Engineering and economic feasibility of modifying current intakes to provide multiple level outflows and ability to meet downstream aquatic needs post-modification.
E.14	Establish project-wide partnering agreements at USACE reservoir projects with resource agencies and NGOs based on updated master plan recommendations for ecosystem restoration activities on project lands or on tributaries that affect water quality and aquatic habitat within the project.	Project	In-place partnering agreements for ecosystem restoration projects, based on master plan update information that facilitates expedient implementation of restoration efforts with resources agencies and NGOs.	Presence of administrative limitations to executing pre-project agreements based on master plan update recommendations. Available funding to support executed agreements.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Water Quality (WQ)				
WQ.1	Implementation of the Environmental Infrastructure Programs basinwide to address deteriorated sewer systems or lack of basic collection and treatment systems.	Basin by state	Reduction of point-source pollutants from individual residential and commercial structures (bacterial contamination) TMDL loading.	Congressional support for expansion of environmental infrastructure authorities. Available funding to support additional programs.
WQ.2	Conduct basinwide sedimentation assessment that addresses sources and potential effects on reservoirs, navigation, and aquatic ecosystems.	Basinwide	Updated sedimentation transport and storage assessment data for water management decision-making.	Available sedimentation modeling capability to accurately identify sediment movements and describe effects on systems. Funding support for modeling process.
WQ.3	Basin/regional perspective on compliance with water quality requirements and resolution of water quality issues.	Basinwide	Opportunities to address water quality and compliance issues from a coordinated, strategic standpoint.	Willingness of water quality organizations and agencies to collaborate on common compliance standards and monitoring processes.
WQ.4	Establishment of a market-based water quality credits trading program in the Ohio River basin.	Basinwide	Water quality credits trading program that would result in reduced nitrogen, phosphorous and nutrient loadings in basin rivers.	Economic uncertainties of valuing water quality credits for the trading process and willingness of participants to enter the program.
WQ.5	Initiate compliance with Section 438 of the *Energy Independence and Security Act* regarding stormwater runoff management at Federal facilities and installations.	Basinwide	Improved water quality through stormwater runoff management using water-harvesting, pervious pavements, rain gardens, green roofs, etc.	Availability of Federal funds to design and construct stormwater runoff controls. Willingness of project sponsors to cost-share techniques.
WQ.6	State compliance with USEPA requirements for non-point implementation plans (USEPA 303/305) for impaired streams including issues of nutrient loading.	State	Impaired streams implementation plans for addressing non–point-source pollutants and reductions in pollutants.	Availability of state financing to maintain stream monitoring system and execute plans to address non-point sources.
WQ.7	State-based programs for unused pharmaceutical and hormonal drugs recovery and disposal.	State	Removal of a portion of pharmaceuticals and hormonal drugs from drinking water sources and aquatic habitat.	Public willingness to surrender unused prescription drugs and issues with drugs collection and safe disposal.
WQ.8	Expansion of the USDA CRP and CREP program into all watersheds in the basin to reduce impacts from nutrient loading and non–point-source pollution.	Sub-basin or watershed	Protection of streams/rivers from agricultural chemicals and sedimentation to improve water quality.	Willingness of landowners to dedicate portions of farmland to the program and capability of states to participate in program.
WQ.9	Implementation of voluntary nonstructural measures where applicable and economically feasible to eliminate straight-pipe systems and reduce floatable debris in floodplains.	Watershed or project	Reduction of point -source pollution from individual residential and commercial structures (bacterial contamination) TMDL loading and reduce debris in reservoirs.	Technical and economic feasibility of nonstructural measures in lieu of structural actions to reduce flood risks. Willingness of landowners to participate in buyout programs.
WQ.10	Installation of multi-level intake structures at USACE dams to enhance flexibility and resiliency in meeting downstream parameters of temperature and oxygen.	Project	Flexibility in meeting downstream water quality parameters and aquatic ecosystem needs for temperature, nutrients and oxygen.	Effectiveness of multilevel intakes in addressing each project's downstream aquatic and water quality demands. Sufficient funding support.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Water Quality (WQ) (continued)				
WQ.11	Facilitate nutrient releases downstream from dams to meet aquatic ecosystem needs and reduce nutrient effects on lakes (eutrophication).	Project	Restore nutrient levels in downstream aquatic ecosystem habitat and reduce effects of eutrophication in lakes.	Technical and environmental feasibility of providing nutrient flows from dams and probability of positive results on aquatic habitat and lake quality.
WQ.12	Apply best practices in natural stream restoration design during ecosystem restoration projects and FRR projects.	Watershed or project	Restore stream ecosystem habitat during implementation of flood risk reduction projects that involve stream disturbances.	Cots effectiveness of using natural stream restoration design in ecosystem and flood risk reduction projects in lieu of other methods.
WQ.13	Ensure compliance with NPDES design requirements through USACE engineering QA/QC and monitor implementation of NPDES permit requirements by USACE contractors.	Project	Meet or exceed NPDES permit requirements for offsite runoff pollution control during USACE construction.	Sufficiency of QA/QC process and project construction inspections to ensure NPDES compliance.
WQ.14	Local actions to address USEPA and state laws regarding compliance with CSO violation requirements.	Local	Resolution of combined sewer overflows point pollution issues and improved water quality.	Sufficient municipal and county funding to address USEPA compliance requirements for CSOs.
Basinwide Water Management (WM) (continued)				
WM.1	Prepare basinwide water management plan that addresses authorized reservoir water storage, flow releases and user demands through H&H systems modeling and stakeholder collaboration. Supports adaptive management strategies.	Basinwide	Improved management of water resources taking into account needs of all users, resources limitations, future conditions, and Federal agencies and states requirements. Increased benefits in several categories.	Agency administrative support and congressional funding support to accomplish a basinwide management plan. Sufficient modeling expertise and capability to incorporate all parameters.
WM.2	Development and certification of system-wide H&H models to address Ohio River basin water management demands and adaptive management strategies.	Basinwide	A revised regulation system based on new modeling of reservoir releases and user needs. This activity may be included in a basin water management plan.	Agency capability to certify basinwide H&H models for technical sufficiency and duplication in other basins.
WM.3	Formulation of a basinwide communication forum and collaborative network for interstate and interagency dialogue on common water management issues and action strategies.	Basinwide	A multi-state, structured water resources forum for addressing common water management issues and formulating regional strategies.	Willingness of the basin states to engage in a forum on water management issues and to consider formation of a basin collaboration structure.
WM.4	Develop basinwide infrastructure reinvestment strategy plan for rehabilitating and sustaining existing USACE reservoirs .	Basinwide	Infrastructure reinvestment plan based on sound planning and engineering principles.	Administration support and congressional funding support to accomplish basinwide reinvestment plan. Inability to prioritize needed actions objectively with supporting data.
WM.5	Evaluate climate change effects during assessment of basinwide water management alternatives.	Basinwide	System strategies for addressing anticipated climate change effects on water management activities such as water supply, hydropower, ecosystem flows, recreation ,etc.	Availability of reliable/credible climate change information at the basin level to use in water management alternatives. Flexibility of basin H&H models to accept changing predictions.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Basinwide Water Management (WM) (continued)				
WM.6	Prepare updated reservoir management plans for storage reallocation (Section 216 – Review of Completed Projects).	Project	Reallocation (if recommended) of storage within one project or among several projects in sub-basin to optimize public benefits and address Environmental Operating Principles.	O&M funding support of initial appraisals, positive results of appraisals indicating further study and funding support (Federal and non-Federal) for follow on detailed studies.
WM.7	Conduct sedimentation studies both upstream and downstream of and within reservoirs.	Project or watershed	Project-specific or sub-basin system sediment management strategies that would address sediment loading and transportation within and downstream of reservoirs.	Technical sufficiency of current sediment movement modeling to address current issues, and funding support of modeling process.
Local Development Effects on Water Resources (LDA)				
LDA.1	Individual basin states' enabling legislation that promotes enactment and enforcement of stormwater management ordinances by counties and municipalities through financial and technical assistance.	State	Local counties and municipalities empowered to enact and enforce stormwater management ordinances that control the volume of excess runoff on newly developed property based on pre-development conditions. Less excess site runoff in adjacent streams.	State executive administration and political support to enact legislation requiring stormwater management planning. Public and private resistance to regulations. Local financial capability to administer and enforce stormwater regulations.
LD.2	Prepare initial Watershed Assessments and Watershed Assessment Plans for each sub-basin in the Ohio River basin.	Sub-basin	Fully coordinated assessments of sub-basin natural and man-made resources, driving forces, issues and systems leading to local management strategies and opportunities to leverage Federal and state funds.	Agency administrative approval and legislative appropriations to support Watershed Assessments and willingness of non-Federal sponsor to cost share in assessments.
LDA.3	Local enactment and enforcement of stormwater management ordinances by counties and municipalities that encourage use of pervious pavements, retention on-site and other water harvesting strategies to complement the state NPDES program.	Local	Reductions in generation of site runoff for new construction, regeneration of aquifer storage, reductions in stream channel impacts (stream armoring, species eradication, erosion) and conservation of water resources.	Local government willingness and financial capability to enforce stormwater management ordinances. Local resistance to regulation of private property runoff.
LDA.4	Enactment and enforcement of the National Flood Insurance Program for all documented and suspected (obvious floodplain areas heretofore unmapped in the NFIP) floodplain areas.	Local	Future development in floodplain areas more resistant to flood damages and future development in regulatory floodways largely eliminated; fewer future flood damages and less risk to life.	Willingness of local communities and counties to participate in the NFIP. Willingness and financial capability of landowners to participate in program. Sufficiency of flood mapping to identify flood hazard zones.
LDA.5	Enactment and enforcement of land use zoning that identifies and protects urban, suburban and rural stream/riparian corridors and both forested and agricultural land as well as promoting housing densities (with incentives) that preserve undisturbed ecosystems.	Local	Future growth directed away from sensitive habitats such as stream corridors and riparian habitat. Increased urban density reducing future sprawl development into untouched ecosystems.	Willingness of communities and counties to enact and enforce land use zoning ordinances that protect ecosystem habitats and preserve farmland.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Local Development Effects on Water Resources (LDA) (continued)				
LDA.6	Enactment and enforcement of building codes specifying construction methods and materials that promote water and energy conservation (green strategies) as well as safe building methods for flood prone areas.	Local	Future new building construction and rehabilitation of buildings based on national codes for fire safety, reduction of flood damages, and energy conservation reducing peak hydroelectric power flows.	Willingness of local communities and counties to enact and enforce building codes.
LDA.7	Enactment and enforcement of subdivision ordinances that require developers to preserve stream/riparian corridors, to manage stormwater runoff through onsite retention and promote housing densities that preserve undisturbed ecosystems.	Local	Future development designed and constructed in accordance with ordinances protecting stream corridors, riparian habitat and requiring stormwater runoff controls.	Willingness of local communities and counties to enact and enforce subdivision regulations that include stream corridor preservation and stormwater management.
LDA.8	Application of property tax strategies that allow owners of undeveloped, forested or agricultural property to maintain the land in an undeveloped state without undue tax burdens and discourage floodplain development.	Local	Redirection of development away from undisturbed forest and agricultural property and floodplain land. Could be used to promote more dense development and less sprawl.	Willingness of communities and counties to adjust property taxes for owners of vacant, forested or farmland.
LDA.9	Promoting urban infill (vacant lots) growth with tax and zoning density incentives and Tax Increment Financing (TIF) that reduces pressures for sprawl development.	Local	Redirection of development into urban areas and away from undisturbed forest, agricultural property and floodplain land. Could be used to promote more dense development and less sprawl.	Willingness of local communities to accept and promote urban infill strategies and establish TIF zones enabled by state legislation.
LDA.10	Promoting and instituting TDR and PDR programs that transfer or acquire development rights on property located outside urban areas and within floodplains.	Local	Redirection of development into urban areas and away from undisturbed forest, agricultural property and floodplain land. Could be used to reduce sprawl without tax revenue losses.	Willingness of local communities and counties to initiate and administer TDR programs and financial capability to administer PDR programs. Landowners' willingness to participate in TDR or PDR programs.
Water Supply (WS)				
WS.1	Basinwide water supply/demand analysis including consideration of appropriate conservation measures in view of potential water shortages due to climate change.	Basinwide	Updated information on water supply needs within the basin under varying climatic conditions and identification of water conservation measures for use by states and local jurisdictions.	Agency administrative and congressional funding support for basinwide water supply and demand analysis. Willingness of population to accept water conservation measures.
WS.2	Basinwide level drought impact analysis and emergency response strategies with regard to existing reservoir operations, navigation, T&E species and M&I water supplies.	Basinwide	Strategic response options to future drought conditions that address user needs, capacities and conservation measures based on regional data.	Administration support and legislative funding support to prepare impact analysis and establish agency response strategies.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Water Supply (WS) (continued)				
WS.3	Policy review/update of Federal water supply guidance and laws due to changes in basin conditions and future climate change (see water resources policies below).	Basinwide	Revised guidance/policies to address potential future changes in basin water supply or M&I water needs.	Administration and legislative support to modify existing laws and policies to address anticipated but unconfirmed water shortages in basin.
WS.4	Uniform basin-state policies to protect water quality that ensure adequate water supplies through sustainable treatment systems.	Basinwide	Adequate supplies of potable water to meet needs through protection of water quality at existing storage locations.	Willingness of various agencies to collaborate on uniform water quality policies and funding support to maintain adequate water treatment.
WS.5	Continued appropriations under Environmental Infrastructure Programs for local and regional water treatment and distribution systems.	Basinwide	Installation of individually authorized new water treatment and distribution systems to un-served or underserved basin residents.	Administration program support and sustained legislative funding support for the Environmental Infrastructure Program. State and local support for improved water systems.
WS.6	Expand coverage of or enact additional environmental infrastructure authorities to cover all states in the Ohio River basin.	Basinwide	Regional application of new and upgraded water treatment and distribution systems to un-served and underserved basin residents.	Administration and legislative support to expand number of environmental infrastructure authorities. State and local support for programs.
WS.7	Study/analysis of increased requests for water withdrawals from navigation pools in view of competing interests and future climate change.	Basinwide	Better-informed, equitable decisions on requests for water withdrawals from the navigation pools considering capacity under varying conditions.	Administration support for study and legislative funding support to conduct study. Ability to capture all potential users in study.
WS.8	Individual basin states' Section 22 (Planning Assistance to States – PAS) water supply studies for future demands and conservation measures.	State	Basin/agency strategies and planned initiatives for allocation of water supply storage in existing reservoirs.	Continuing Federal support (administrative and funding) for the Section 22 PAS program and states' willingness and fiscal capability to support PAS studies.
WS.9	Conduct Section 216 (Review of Completed Projects) studies at individual existing reservoirs for future water supply potential.	Project	Reallocation (or not) of existing reservoir storage to increase capacity for water supply purposes.	Administration and legislative support for Section 216 program and local sponsor fiscal capability to support Section 216 studies.
Floodplain Development and Recurring Damages (FDRD)				
FDRD.1	Implement a basinwide flood warning system through special congressional authorization that addresses system O&M needs.	Basinwide	Timely, reliable, basinwide flood warnings facilitating evacuations of hazardous areas and reductions in flood damages and loss of life.	Administration and legislative support for basinwide flood warning system and state/local capability to support gaging system O&M costs.
FDRD.2	Support the ongoing FEMA Floodplain Map Modernization Program on a basinwide level.	Basinwide	Production of updated and reliable floodplain mapping to support efforts of local floodplain managers to reduce potential risks to new development.	Agencies' willingness to support Map Modernization Program with available data and information.
FDRD.3	Initiate research efforts through IWR on the use of permanent acquisition as a method of reducing threats to life using data from LIFEsim modeling techniques.	Basinwide	Reliable data and information to support recommended alternatives for permanent acquisition as a viable measure for reducing loss of life and property damages.	Funding support for modeling loss of life benefits of permanent acquisition through LIFEsim and other available programs.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.4	Apply asset management principles as part of the basinwide reinvestment framework and plans for the basin.	Basinwide	Basinwide reinvestment plan using asset management principles that would emphasize the systems approach to management, funding and sustainability.	Applicability of asset management principles to basinwide infrastructure reinvestment planning.
FDRD.5	Initiate recon level studies that address flood warning, structural and nonstructural measures for Ohio River mainstem and tributary (basinwide) communities that are at risk by flooding.	Basinwide	Flood risk reduction for at-risk structures and reduction of threats to life for floodplain occupants along the mainstem Ohio River and its tributaries.	Administrative and legislative authorization and appropriations support for study of at-risk Ohio River mainstem and tributaries communities. Necessity for and mechanics of study cost sharing.
FDRD.6	Cessation of flood risk reduction operations at dams in need of rehabilitation and application of alternative FRR strategies downstream (see REHAB.6 below).	Sub-basin	Long-term reliable, sustainable flood risk reduction for communities requiring cost-shared projects and local O&M.	Agency willingness to cease dam operations in lieu of flood risk reduction alternatives. Outcome of economic comparison analysis of alternatives between dams and downstream measures.
FDRD.7	Support NRCS P. L. 566 watershed protection projects that could provide flood risk reduction (FRR) benefits.	Watershed	Construction (or not) of PL 566 projects that provide flood risk reduction benefits.	Agencies' willingness to support NRCS efforts in P. L. 566 watershed protection projects with available data and information.
FDRD.8	Participate jointly with FEMA and local emergency management personnel to educate the public on the merits of the NFIP and CRS through FPMS program.	Sub-basin or state	Increase in participation in the NFIP thus reducing financial losses due to flooding and reducing development in the hazardous floodway.	Agency funding support through FPMS to participate with FEMA and local agencies in public education on NFIP and CRS.
FDRD.9	Provide state-based financial assistance for low-income landowners to enable purchase of flood insurance through NFIP.	State	Wider participation in flood insurance program by low-income population and reduction in financial losses due to flooding.	States' fiscal capability and political willingness to provide financial assistance to low-income landowners to purchase flood insurance.
FDRD.10	Expand implementation of the Silver Jackets collaborative program for flood hazard mitigation planning to each basin state and groups of basin states.	Basin/state	Collaborative efforts among Federal and state agencies and NGOs to reduce flood risks and loss of life on basinwide scale.	Agency's willingness to expand Silver Jackets program and legislative funding support for larger program. States' willingness to collaborate on flood risk reduction issues.
FDRD.11	Implement planning, design and installation of flood warning systems for each sub-basin through Section 205 CAP.	Sub-basin	Timely, reliable, regional flood warnings facilitating evacuations of hazardous areas and reductions in flood damages and loss of life.	Willingness of local sponsors to request assistance to address flood risks through CAP program and financial capability to support installation and O&M costs.
FDRD.12	Initiate Section 22 PAS studies in all 15 states to determine the numbers and types of structures and facilities located within the regulatory floodway.	State by sub-basin	Regional identification of potential floodway acquisitions by USACE, NRCS, or FEMA (HMGP) programs to reduce flood risks.	Willingness of states to financially share in costs of Section 22 PAS study and legislative funding support for the program.
FDRD.13	Initiate voluntary, permanent acquisition program of developed properties within the regulatory floodway through USACE, NRCS and FEMA programs.	Sub-basin or watershed	Sustainable, regional, or watershed scale reduction in flood risks and potential loss of life, reduction in community flood profiles, reductions in floatable debris.	Sufficient funding support to acquire floodplain properties and landowners willingness to participate in voluntary program.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.14	Prepare Watershed Assessment Plans in sub-basins that have exhibited ongoing flood damages and have numerous presidential declarations for flooding.	Sub-basin	Strategic options for reducing flood risks and loss of life that are systems-based and regional in design. Address strategies for water quality (TMDL and nutrient loading), floodplain development and floatable debris.	Administration support and legislative funding support for preparing initial assessments and willingness of local sponsors to financially support more detailed assessments.
FDRD.15	Initiate Section 22 PAS studies within each of the 15 states that address the current application of stormwater management practices and their effectiveness in reducing damages and ecosystem deterioration.	State	Regional, reliable data on the extent of local stormwater management upon which basinwide or regional strategies for stormwater retention could be based.	Willingness of the basin states to financially support Section 22 PAS studies of stormwater application. Legislative support of the Section 22 program.
FDRD.16	Initiate Section 22 PAS studies within the 15 states to determine where updated floodplain mapping and H&H data are needed.	State	Regional, reliable data on needs for updated mapping and H&H information to support initiatives for mapping upgrades.	Willingness of states to financially support Section 22 PAS studies to identify needs for updated floodplain mapping and H&H work.
FDRD.17	Upgrade existing stream and rain gages in each state or sub-basin with satellite transmission hardware and software to support the "Storm Ready" and "IFLOWS" NWS programs.	State by sub-basin	More timely and reliable flood warnings basinwide from the National Weather Service.	Agency funding support for stream and rain gage hardware and software enhancements.
FDRD.18	Install additional rain and stream gages where necessary to fill in NWS/USGS data and flood warning gaps through Section 205 CAP program.	State	Comprehensive and reliable flood warnings, post-flood data, and drought data records to support future projects.	Willingness of local sponsors to request assistance through CAP program to reduce flood risks through upgraded gaging system and share in project costs.
FDRD.19	Initiate Section 22 PAS studies with each basin state to determine levels of loss of life risk from infrastructure failures or flooding using the LIFEsim modeling platform.	State	Regional, reliable data on the risks of loss of life from infrastructure failure and flooding events.	Willingness of states to financially support Section 22 PAS studies to determine potential losses of life due to infrastructure failure or flooding.
FDRD.20	Prepare HAZUS-based risk assessment for the 1% chance event for individual HUC 4 sub-basin areas using GIS technology – maintain GIS databases and make flood data and information available to state mitigation offices and communities in an electronic library.	Sub-basin	HAZUS level flood risk data on potential monetary damages at the 1% chance event for each sub-basin, damages to critical facilities and potential loss of life estimates. Requires H&H modeling of 1% chance profiles and maintenance of GIS basin databases.	Agency administrative and funding support to conduct HAZUS evaluation for sub-basins including H&H modeling. Technical proficiency of GIS capability within districts and Division offices.
FDRD.21	Initiation of state site-development loan programs (industrial/commercial) that would offset high costs of local construction outside of the floodplain.	State	Reduced floodplain development by residential and commercial uses and more local compliance with NFIP ordinances (fewer variances).	Willingness of states to financially and politically support loan programs for industrial and commercial site development that limit floodplain development.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.22	Encourage basin communities to participate in the Community Rating System (CRS) program and investigate opportunities under Section 22 PAS and Section 205 CAP to assist communities in CRS improvements.	Local	Reductions in flood insurance costs for policy holders and potential reductions in flood risks due to small projects development.	Willingness of basin communities to participate in CRS processes and willingness to request assistance through Section 22 PAS and Section 205 CAP and support funding for studies and implementation of recommended actions.
FDRD.23	Local initiation of NFIP, local land use zoning, building codes, subdivision regulations, property taxes, urban infill, and TDR/PDR to reduce future flood damages in flood hazard zones (see alternatives LD.3–LD.9 above).	Local	Future growth directed away from hazardous floodplains and floodway to flood-safe land.	Willingness of basin communities and counties to enact and enforce local regulatory ordinances and programs and commit funding that reduces local flood risks.
FDRD.24	Support FEMA pre and post-disaster HMGP efforts to acquire floodway structures.	County/local	Acquisition (or not) of floodway properties reducing flood risks, loss of life, community flood profiles and floatable debris.	Agency support to FEMA HMGP program with data and information to acquire floodway structures.
FDRD.25	Initiate Section 205 CAP projects through local sponsor requests for assistance that can use permanent acquisition of structures in the regulatory floodway as a justifiable measure.	Project	Sustainable, project scale reduction in flood risks and potential loss of life, reduction in community flood profiles, reductions in floatable debris.	Willingness of local communities to request assistance under Section 205 program and financially support program studies and implementation of recommendations. Economic feasibility of acquiring floodway structures.
FDRD.26	Support upstream retention basin projects to control stormwater under the Environmental Infrastructure Program where that authority does now or may exist in future authorizations.	Watershed or project	Watershed scale reductions in site stormwater runoff volumes reducing potential for downstream overbank flooding.	Agency administrative and legislative support and financial support for upstream retention basins. Economic feasibility of upstream retention in lieu of other measures.
FDRD.27	Enforcement of requirements for floodplain management plans at USACE developed nonstructural projects.	Project	Better local enforcement of NFIP and reduced risks for future exceedance of flood protection levels in project.	Agency willingness to enforce local sponsor O&M requirements in PPA for nonstructural projects and sponsor's financial capability to prepare and administer management plan.
Existing FRR Infrastructure (REHAB)				
REHAB.1	Develop strategic reinvestment/rehabilitation plan for all dams and local protection projects that considers the components as one holistic system of flood risk reduction.	Basinwide	Basinwide strategy for rehabilitation of flood risk reduction infrastructure as a system operating to reduce flood damages and risks to life.	Agency administrative support and legislative funding support for strategic basinwide reinvestment plan including all system components.
REHAB.2	Rehabilitation of LPP system components (e.g., obsolete pump station electronics) in a basinwide program based on LSA inspection recommendations.	Basinwide	Reliable, sustainable flood risk reduction for a population of 489,000 people and $14.0 billion of development.	Agency administrative support and legislative funding support of component rehabilitation in LPPs and willingness/capability of local sponsors to share in costs of rehab.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Existing FRR Infrastructure (REHAB) (continued)				
REHAB.3	Rehabilitation of key common components of dams based on findings of Dam Safety Program inspections (this would be a project rehabilitation program implemented on a component basis).	Basinwide	Systematic removal of identified high-risk deficiencies at all dam projects reducing overall system risk to large downstream populations.	Agency willingness to accept a component-based rehabilitation strategy in lieu of project-based rehabilitation. Capability of funding support to component-based program.
REHAB.4	Implement flood risk reduction alternatives in lieu of rehabilitating existing flood storage operations at existing reservoirs. Reservoirs may continue operations to support other authorized purposes with non-Federal O&M.	Sub-basin or watershed	Relocate flood risk reduction facilities downstream using justified LLPs and nonstructural measures with non-Federal O&M. Reservoirs continue to operate for other authorized uses w/O&M by non-Federal sponsors.	Economic feasibility of downstream flood risk reduction measures in lieu of anticipated reservoir rehabilitation and long-term O&M costs. Local sponsors' willingness to support cost sharing for downstream measures.
REHAB.5	Ongoing project-based rehabilitation of flood risk reduction system infrastructure dams and appurtenances determined to be deficient.	Project	Continuance of current program of rehabilitation of identified deficiencies on a project by project basis.	Maintenance of appropriations for ongoing rehabilitation efforts at identified basin dams.
REHAB.6	Provide high-quality plans and specifications for local rehabilitation of LPPs through the "Work for Others" Program.	Project/local	High-quality plans and specifications with reliable quality control and risks assessment factors embodied in the design for sponsors' implementation.	Willingness of local sponsors' to request assistance from agency for high-quality P&S and capability to fund the production.
REHAB.7	Breach existing local protection projects and provide alternative FRR measures to reduce damages and threats to life.	Project/Local	Reliable, sustainable flood risk reduction for a population of up to 489,000 people and $14.0 billion of development.	Economic feasibility of alternative measures behind line of protection in comparison to needed rehabilitation and ongoing O&M costs.
Public Lands Stewardship and Recreational Facilities (SRF)				
SRF.1	Preparation of a basinwide recreation demand analysis for USACE reservoirs.	Basinwide	Regional recreation demand information to support sustainable facilities rehabilitation at USACE reservoir projects and cost-shared riverfront projects.	Agency administrative approval and legislative appropriations for demand analysis to support USACE recreation.
SRF.2	Project user fees reinvested in rehabilitation of recreational facilities (see water resources policies as well).	Basinwide	Sustainable, consistent financial resources for rehabilitation and maintenance of project recreational facilities in a safe manner.	Administration and legislative willingness to modify current policies regarding use of user fees to fund recreation rehabilitation.
SRF.3	Basinwide strategic riverfront recreation study addressing existing and planned facilities and appropriate formulation processes.	Basinwide	Regional strategies for planning riverfront recreational facilities that address USACE project formulation requirements and multiple project conflicts.	Agency administrative approval and legislative appropriations to fund strategic study and update formulation processes of riverfront development.
SRF.4	Prepare basinwide strategic plan/management policies for use of USACE project lands for renewable energy development.	Basinwide	Regional strategies for assimilating renewable energy projects on USACE project lands developed through collaborative effort with project users, stakeholders and the public and mindful of the project resources.	Agency administrative approval and legislative appropriations to support plan development and administrative approval of new policies. Public acceptance of renewable energy facilities on project lands.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Public Lands Stewardship and Recreational Facilities (SRF) (continued)				
SRF.5	Partner with states on development of SCORP documents that address needs of USACE recreational facilities and land use.	States	Regionally based recreation-demand data and information that support USACE recreation rehabilitation in the context of state-owned and -operated park management and development.	States' willingness to collaborate with USACE on Statewide Comprehensive Outdoor Recreation Plans (SCORPs) and legal capability of USACE to contribute funds to development of plan that benefits USACE projects.
SRF.6	Initiate state-based, cost-shared Section 22 "Planning Assistance to States" (PAS) studies of public and first responder river/pool access and alternatives for development and financing.	States	Strategic plan for development of river and navigation pool access sites to address needs for public access and first responder emergency access.	Willingness of states to share in costs of Section 22 PAS studies on public access and first-responder access to navigation pools.
SRF.7	Prepare sedimentation studies for USACE projects that address tributary sources, head-cutting and depletion of sediment storage in reservoir.	Watershed	Watershed scale operational strategies for eliminating or reducing sources of sediment, reduction of head-cutting on tributaries and slowing loss of sediment storage capacity.	Agency administrative approval and legislative appropriations to support project/watershed studies of sediment movement sand storage in USACE reservoirs.
SRF.8	Incorporate analyses of regional T&E species and critical habitats in the preparation and coordination of updated project master plans for all projects within a 4-digit HUC code sub-basin.	Sub-basin	Regional recommendations for projects' land use management techniques that sustain habitat needs for T&E species supporting multiple projects funding requests.	Agency administrative approval and legislative appropriations to support analysis of T&E species habitat on multiple project lands. Users' (hunters/hikers) willingness to share public lands with T&E species habitat.
SRF.9	Incorporate analyses of impacts of climate change and sustainability of T&E species and critical habitats in the preparation and coordination of individual updated project master plans.	Project	Master plan recommendations for project land use management techniques that sustain habitat needs for T&E species under different climate change scenarios and which can support project funding requests.	Agency administrative approval and legislative appropriations to support analysis of T&E species habitat on individual project lands. Users' (hunters/hikers) willingness to share public lands with T&E species habitat. Effects of climate change.
SRF.10	Rehabilitation/expansion of dated recreational facilities included in project master plan updates through cost sharing process.	Project	Expansion and/or improvements in recreational facilities and land management practices that would meet user needs, address safety concerns, and meet expectations of natural resources agencies.	Agency administrative approval and legislative appropriations support for rehabilitation of USACE recreational facilities. Necessity of local sponsor cost sharing of USACE operated facilities.
SRF.11	Partner with state DNRs and USFWS for joint preparation of T&E species and wildlife management plans for USACE lakes.	Project	Jointly prepared recommendations for project land use management techniques that sustain habitat needs for T&E species and other wildlife which can support projects USACE funding requests and support state DNRs wildlife management action plans.	Federal and state agencies willingness to collaborate on joint T&E species management plans on USACE lands. Potential for land use management policies modification to address T&E species on USACE lands.
SRF.12	Federally funded rehabilitation of dated recreational facilities (those constructed using USACE funds) based on updated master plans.	Project	Improved recreational facilities that meet the changing needs and demands of the public that are sustainable, and are safe.	Agency administrative approval and legislative appropriations to support Federal rehabilitation of USACE owned and operated recreational facilities.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Public Lands Stewardship and Recreational Facilities (SRF) (continued)				
SRF.13	Develop partnering agreements with natural resources agencies and NGOs for USACE reservoir projects to address ecosystem restoration projects based on master plan recommendations.	Project	More expedient approval and development of jointly developed restoration projects on or near project lands that have been identified in updated master plans.	Agency willingness to execute project partnering agreements for ecosystem restoration on project lands based on master plan updates.
SRF.14	Compliance with Section 438 requirements to address stormwater runoff at Federal facilities and installations using water harvesting technologies.	Project	Reduction in stormwater runoff from pavements, building surfaces and impervious surfaces that may contaminate impoundments and streams on Federal property.	Legislative appropriations that support deployment of stormwater runoff management technologies at Federal facilities and installations.
Climate Change (CC)				
CC.1	Basinwide study of potential effects of climate change on sustainability of water resources management, water supply, hydropower, navigation, and recreation.	Basinwide	Strategic contingency plans for water resources operations and lands management under array of adverse climatic conditions; coordination with NOAA.	Agency administrative approval and legislative appropriations to support system sustainability study under climate changes.
CC.2	Establish basinwide water resources climatic monitoring system for emergency operations.	Basinwide	Installation of automatic project water and weather conditions monitoring stations allowing emergency or pre-emptive actions in response to sudden climate changes.	Agency administrative approval and legislative appropriations to support installation of basinwide projects climatic monitoring system for emergency operations.
CC.3	Develop adaptive management strategies for USACE facilities based on system modeling and collaboration with stakeholders.	Basinwide	Adaptive management strategies that address climate change uncertainties based on sound modeling, learning through doing and collaboration with stakeholders.	Agency administrative support and legislative appropriations to support development of adaptive strategies. Willingness of stakeholders to engage in discourse. Modeling capabilities.
CC.4	State or sub-basin level cost-shared Section 22 PAS studies on effects of climate change on sustainability of water resources management.	State or Sub-basin	Regional, reliable information on potential effects of climate change and collaboratively formulated strategies for mitigating the effects on water resources management.	Willingness of states to financially support PAS study of water resources system sustainability under climate change.
CC.5	Sub-basin level studies on sustainability of aquatic habitat and species during climate change conditions and potential USACE facilities operational changes to offset impacts.	Sub-basin	Regional strategies for mitigating the effects of climate change on species habitat through operational and land management changes on USACE property.	Agency administrative approval and legislative appropriations to support study of aquatic species sustainability under climate change and USACE mitigative operations.
CC.6	Statewide level cost-shared Section 22 PAS studies to determine strategies for addressing climate change impacts on recreational usage at USACE and state facilities.	State	Regional strategies for mitigating the potential effects on recreational usage at USACE and state recreational areas due to climate change.	Willingness of states to financially support PAS studies on recreational use impacts from climate change and mitigation activities.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Environmental Infrastructure (INF)				
INF.1	Expand geographic coverage of the INF program to address areas of the basin where documented needs for sewer and water that affect health and safety and water quality are not covered by existing authorizations.	Basinwide	Geographic expansion of authorities to fund water and sewer infrastructure for improvement of regional water quality, reduced health risks, and economic development.	Administration and congressional support to expand INF program to cover more basin states. Willingness of additional states to accept INF program.
INF.2	Revise current authorizations and prepare any new authorizations for environmental infrastructure to address stormwater issues associated with CSOs involving municipal sources.	Basinwide	Separation of combined stormwater and sewer systems that reduce bacteria loading in Ohio River and tributaries, improve water quality, increase efficiency of treatment plants, improve stormwater conveyance, and reduce health risks.	Administration and congressional support to expand INF program to cover stormwater issues arising from CSOs. Willingness of states to accept INF program expansion and cooperate in CSOs resolution.
INF.3	Establish programmatic funds for public outreach, workshops, and data management covering all existing basin Environmental Infrastructure Programs.	Basinwide	Increased proportion of available funds directed to design and construction of priority sewer and water projects and improved data management and more effective public outreach.	Agency administrative and legislative approval and legislative appropriations support to establish separate programmatic funds under INF.
Water Resources Policies (WRP)				
WRP.1	Re-evaluate USACE policies regarding reuse of project user fees to rehabilitate project recreational facilities and land management activities.	Basinwide	Change in USACE policy to redirect user fees to rehabilitate aging and dated recreational facilities and land management activities.	Agency administrative and political willingness to modify current policies regarding current disposition of collected user fees.
WRP.2	Re-evaluate current policy/program guidelines for application of the Silver Jackets program to address multi-state organizations.	Basinwide	Revised program guidelines facilitating multi-state collaboration efforts for flood risk reduction through the Silver Jackets program.	Willingness of agency administration to modify current Silver Jackets policies regarding multiple collaborative engagements.
WRP.3	Re-evaluate cost sharing policies regarding ecosystem restoration projects.	Basinwide	Increase (or not) in opportunities for cost-shared ecosystem restoration projects with state agencies and NGOs that improve species habitat and generate public benefits.	Agency administrative and legislative political support for modifying current cost sharing rates for ecosystem restoration projects. States' positions on cost sharing rates.
WRP.4	Re-evaluate cost sharing policies and program authorizations with regard to rehabilitation of existing LPPs.	Basinwide	Increase (or not) in local sponsor's ability to participate No adverse environmental impacts anticipated in rehabilitation of local protection project that reduces potential for loss of life, flood damages, and economic development of the region.	Agency administrative and legislative political support for modifying current cost sharing policies and program authorizations for rehabilitation of LPPs. Sponsors' willingness to accept cost sharing options.
WRP.5	Re-evaluation of USACE policies regarding use of USACE lands for renewable energy development projects by third parties.	Basinwide	Acceptance (or not) of corporate requests to construct renewable energy facilities on USACE project lands in view of other users and habitat management.	Agency administrative and legislative approval to permit development of renewable energy facilities on project lands. Public acceptance of renewable energy facilities on project lands.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Water Resources Policies (WRP) (continued)				
WRP.6	Re-evaluate USACE policies and regulations governing the computation of flood risk reduction benefits in steep gradient watersheds.	Basinwide	Revised flood damage curves for steep gradient streams accounting for total structure loss at higher frequency floods.	Agency administrative approval to modify current regulations and procedures for calculating flood damages and benefits thereof.
Hydropower Generation and Energy Production (H&EP)				
H&EP.1	Prepare assessment of potential hydropower generation at USACE projects and cumulative effects of future implementation.	Basinwide	Regional, reliable data on hydroelectric power capacity at USACE projects and potential cumulative effects on aquatic ecosystems of additional power development.	Agency administrative and legislative approval and legislative appropriations support to prepare assessment of hydropower capability and potential impacts.
H&EP.2	Programmatic analysis of alternative or renewable energy development on USACE-managed lands (solar, wind, bio-fuels, etc.).	Basinwide	Regional, reliable data on benefits and impacts of renewable energy development on USACE project lands and mitigation options with respect to project users and managed habitat.	Agency administrative approval and legislative appropriations support to analyze programmatic effects of renewable energy development on USACE managed lands. Public (users) concerns about new land uses on project lands.
H&EP.3	Oversight/regulation of water withdrawal and disposal permits and water quality pertaining to Marcellus Shale and other energy developments.	Sub-basin	Improved management of water withdrawals and water quality in areas of drilling for Marcellus Shale gas and other energy production.	Agencies' willingness to enforce current regulations on water withdrawals and water quality in light of energy resource potential. Public's opinion on new energy resources extraction affecting water supply and quality.
H&EP.4	Programmatic analysis of mineral/gas extraction effects on USACE operated lands and water resources.	Project	Regional data on cumulative impacts and benefits of mineral/gas extraction on or beneath USACE project lands that could support decision-making on leasing requests.	Agency administrative approval and legislative appropriations support to analyze programmatic effects of mineral/gas extraction activities on USACE operated lands.
Inland Navigation (NAV)				
NAV.1	Extend Ohio River Mainstem System Study to include periodic updates on traffic projections and extension of ecosystem restoration opportunities to navigable tributaries.	Basinwide	Current and reliable data and information on Ohio River navigation traffic projections and additional opportunities for restoration of deteriorated aquatic habitat.	Agency administrative and legislative approval and legislative appropriations support to extend Ohio River mainstem authorities to navigable tributaries.
NAV.2	Basinwide, cumulative analysis of corridor landside and river use impacts of public and private intermodal port development through Section 22 PAS program.	Basinwide	Regional, reliable data on river and landside cumulative impacts from expanded intermodal container traffic on the basin waterways that would support regulatory permit analyses.	Probability of agency administrative approval and legislative appropriations support to conduct basinwide analysis of landside and river user impacts from port development.
NAV.3	System-wide evaluation of mooring facilities and navigation aids including latest traffic monitoring and management technology.	Basinwide	System-based data on conditions of current mooring facilities and navigation aids that could support funding requests for rehabilitation of current facilities.	Agency administrative and legislative approval and legislative appropriations support to evaluate needs for upgrading navigation aids and mooring facilities. Navigation industry views.

ID Number	Alternative Description	Scope	Outputs	Output Unknowns/Challenges
Inland Navigation (NAV) (continued)				
NAV.4	Evaluation of the NED benefits that may be generated by joint (Federal/non-Federal) development of public ports on the basin's inland waterways.	Basinwide	Acknowledgement (or not) of the NED benefits from joint development of public port development on the inland waterways that could lead to a Federal Interest determination for such projects in the future.	Agency administrative and legislative approval and legislative appropriations support to evaluate potential NED benefits from public port development.
NAV.5	Initiate new vessel design development to accommodate nontraditional commodities on the river system such as containers.	Basinwide	New vessel designs that facilitate transitions between inland waterway and Short-Sea shipping lanes for container use and other commodities.	Agency administrative support and legislative appropriations support to pursue new vessel designs jointly with academia. Navigation industry views on new vessels.
NAV.6	Rehabilitation of navigation structures (dams) that maintain stable pools used for M&I water supply and sustain mussel beds and aquatic species.	Basinwide	Sustain stable navigation pools for M&I water supply, mussels and other aquatic species habitat.	Administration approval and legislative appropriations to support evaluation process and implementation of recommendations.

underlying water quality in Dunkard Creek at the time of this event was extremely degraded. The coal ash spill near Harriman, Tennessee earlier in 2009 due to failure of a retention basin levee is another case where a considerable cost may need to be incurred to prevent similar devastating impacts at other sites in the future. The human and financial consequences of such a failure overwhelm the high cost of prevention of a low probability event. Challenging questions emerge from such catastrophes in attempting to assess not just the environmental values in the loss of aquatic resources and degradation of water quality, but the economic impacts from loss of use of such resources and the long term costs associated with restoration of the resource to protect human uses of the water and to ensure that public health, safety, and property are protected.

In each case, water quality benefits will need to be compared to the costs of studies, project designs and construction, or implementation costs of alternatives that may not involve construction but introduce other actions and standards such as land use planning, zoning, or changes in agricultural, mineral extraction, and drilling practices, with an understanding of associated costs. Detailed evaluations are needed to determine what actions will lead to significant water quality improvements, at what cost.

The important premise resulting from a number of comments received during the conduct of this reconnaissance study is that many of the factors contributing to degraded water quality are being observed in widespread areas of the Ohio River basin. Even though many of the alternatives to seek improved water quality will be initiated at the local level and within watersheds, important lessons can be learned, and practices shared, by examining water quality and developing measurement indicators for improvement from an Ohio River basin–wide perspective.

8.7.3 Basinwide Water Management Alternatives

The evaluation of alternatives that address the needs for better management of the water resources relies on the experience-based notion by many stakeholders and USACE staff that the existing water storage allocations may not be efficiently distributed among the many authorized uses under the current mode of operation. As shown in Table 10 of Appendix I several of the sub-basins have multiple reservoirs that have not been analyzed as a system since their initial operation. The various storages and regulated flows at the reservoirs in the system may not be balanced in such a way as to realize the optimum public benefits that may be available. Existing annual benefits attributable to the various storage uses across all of the existing 83 USACE reservoirs may be far short of the optimum benefits available.

Reservoir storage types such as flood control, water supply, low-flow augmentation, hydropower, recreation, and fish and wildlife habitat may have differing values per acre-foot of storage. The current benefit streams accruing to individual operating reservoirs can be determined; then, those benefit streams can be maintained as is (in the individual reservoir's current mode), redistributed (within the individual reservoir), or transferred (to other reservoirs, either in the sub-basin or in the larger system). Identifying the range of reservoir storage amounts within the system and valuing those amounts can be accomplished through a system-wide study.

In addition to storage analysis, numerous comments received from key stakeholders were concerned with flow releases from operating reservoirs and their impacts on downstream aquatic species, especially mussels. A number of the basin's indigenous aquatic species are on the Threatened and Endangered species list and some of those species have been impacted to various degrees by the changes in natural flow regime due to reservoir operations. The water management plan could begin to address in a systems-framework what level of aquatic impacts may be occurring and use the anticipated modeling development to simulate various flow releases that may reduce those species impacts.

8.7.4 Population Growth and Development Effects Alternatives

Many of the alternatives described to address the development effects on water resources as a result of population growth are regulatory in nature and are applied at the local jurisdictional level. Local land use zoning, application of building codes, enactment of stormwater management ordinances, enforcement of the NPDES permitting system, subdivision regulations, and purchase or transfer of development rights being a few of the potential local alternatives. Normally the effects are incremental and become realized as individual properties are developed or rehabilitated. Benefits are in the form of reduced floodplain development, reduced damages, and reduced threats to life, reduced loss of habitat, reduced erosion and reduced sedimentation in streams.

Regional building-permit data for 2007 show that more than 100,000 units of single-family housing were permitted for construction. Without application of the alternative regulatory restrictions on that development, potential future damages and financial losses could be significant and acres of valuable habitat could be lost. Assuming that the 2007 construction permits covered residences located on ¼ acre lots, over 25,000 acres of land cover were modified to uses generating potentially more nutrient-rich stormwater flow in adjacent streams.

Costs to implement these largely regulatory alternatives are minimal, administrative and local. The anticipated environmental impacts of enactment and enforcement of the alternatives are generally positive since many of the regulatory actions offer increased protection for streams, riparian areas and critical habitat. The outputs of the alternatives are more resilient communities that can develop without generating ecosystem impacts and can better withstand flood events.

8.7.5 Water Supply Alternatives

Water supply benefits are based on the differences in the costs of supplying water through an existing or new reservoir versus other methods of supply (wells, importing water, etc.) available to the user. Another benefit measure can be the current market value of water supplies from existing reservoirs or stretches of river/stream regulated by the reservoir system and measured through annual payments for water by the users.

According to information from ORSANCO sources, there are an estimated 5.0 million persons using the Ohio River alone as a source of drinking water. This number does not include all of the persons being provided potable water from USACE lakes or who receive drinking water from tributaries of the Ohio River. The populations of Charleston,

West Virginia; Columbus, Ohio; Indianapolis, Indiana; and Frankfort, Kentucky, all take water from the major tributaries of the Ohio River or lakes on those tributaries. Data from the USACE study of water withdrawals from navigation pools suggests that more than 23.0 million gallons of water for M&I uses are being extracted from the basin's navigation pools. At a modest price per gallon, the value of the water being extracted exceeds billions of dollars.

Indicators of positive water supply impacts may be measured in such ways as an increase in the number of people receiving improved supply of potable drinking water in areas not currently serviced by public distribution systems; an increase in the number of local water utilities who have secured arrangements for emergency water supply in anticipation of future periods of drought; an increase in the number of water treatment plants and water distribution systems which have developed improved levels of protection from future flood events to enhance reliable operations; and an increase in the number of water supply intakes from navigation pools and other surface water bodies that achieve an improved level of resilient operations through intake pipe extensions or relocations in anticipation of future drought conditions.

Water supply is an authorized Federal purpose at USACE reservoirs under the *Water Supply Act of 1958*, as amended. The Section 216 authority from the *Flood Control Act of 1970* ("Review of Completed Projects") can be used to conduct cost-shared water reallocation studies to evaluate opportunities to execute water supply contracts with public utilities, so long as existing authorized project purposes are not impaired. There may be little additional cost other than conducting such a study to increase potential water supply for public utilities, if existing utility infrastructure for water withdrawal is already in place at the reservoir or at a withdrawal point downstream.

Environmental Infrastructure Programs have been authorized (beginning in 1990) for USACE to assist local communities with design and construction of water-treatment and -distribution systems, with the requirement that the least costly plan be determined in the construction of the water system improvement. Tens of millions of dollars' worth of construction projects for water-supply improvements have been completed in cost-sharing partnerships with local communities over the past 20 years, using a number of environmental infrastructure authorities that apply to geographically designated areas within the Ohio River Basin. The U.S. Department of Agriculture's Rural Utility Service has been a partner in a number of these projects in western Pennsylvania and elsewhere, and the Appalachian Regional Commission supports water supply infrastructure investment under its programs. More projects can be pursued, pending annual appropriations from Congress and the financial ability of local communities to help cover local cost-sharing requirements.

Pennsylvania has recently completed a state water plan, with one important element being the identification of watersheds at risk of having water deficits under future drought conditions. Several vulnerable watersheds are located in the upper Ohio River Basin. Such planning is extremely useful for identifying priority target areas, evaluating the costs and benefits of alternative actions, and securing an improved water supply in anticipation of future droughts. This kind of approach could be pursued elsewhere in the Ohio River basin, or for the basin as a whole, with the benefits and costs methodologies

developed as part of such evaluations. Technical hydrologic studies, including consideration of a broader range of future conditions reflecting climate change scenarios, would be a necessary component in the determination of potential water supply problems and needs for areas within the Ohio River basin.

8.7.6 Flood Risk Reduction Alternatives

In standard expedited reconnaissance studies where one municipal or county jurisdiction could be protected by various alternatives (structural or nonstructural) reductions in risks of flooding (benefits) can be estimated for those various alternatives. At the basin, sub-basin or watershed level damage estimates for thousands of at-risk properties are beyond the boundaries of time and funds allotted for this study. However, other existing data sources (such as FEMA flood insurance data) can be used to describe the extent and level of risks in both numerical and monetary terms.

Flood insurance policy data and insurance claim data can be used to characterize the level of risks and economic losses being avoided through insurance coverage and agency claim settlements. FEMA data for the basin indicate that an estimated 150,000 active flood insurance policies are in force. Using the market penetration data developed by the Rand Corporation, one can estimate the potential number of at-risk basin structures as well. Based on that calculation, there could be as many as 489,000 structures located within the 1% chance floodplain – some with flood insurance, some without. The estimated value of the insurance policies for this at-risk population may approximate $70.0 billion. This numerical measure indicates the level of risk existing throughout the basin, to which flood risk reduction alternatives could be applied. The potential number of at-risk structures also indicates that as many as 1.0 million people (based on 2.1 persons per structure) may be at risk from flooding. More detailed information on the number of potential at-risk structures can be found in Appendix A.

Considering possible alternatives, there are 83 USACE reservoirs that provide average annual flood risk reduction benefits of over $900.0 million while annual O&M costs are estimated to be $130.0 million. In addition, there are 97 USACE-designed LPPs that protect an estimated 234,000 structures and 500,000 people living within the protection limits. The average annual flood risk reduction benefits accruing to LPP structures (where data are available) totals over $170.0 million.

Although not as prevalent as structural measures at this time, nonstructural measures are being used more frequently to reduce flood risks. In several sub-basins and watersheds, nonstructural measures have proven to be more cost effective on a per-unit-protected basis than structural measures where development is scattered along river corridors. Nonstructural measures have been shown to be less damaging to the riparian and aquatic ecosystems of floodplain corridors than some structural measures and can produce positive ecosystem benefits through restoration of floodplain and riparian properties. These historical projects and their continuing streams of benefits indicate that flood risk reduction alternatives can produce positive benefits.

8.7.7 Floodplain Development Alternatives

Like other local administrative and regulatory management activities, discussed above, enforcement of local floodplain management ordinances can reduce flood damages, prevent development of high-hazard flood zones and reduce threats to life. Restrictions against development within the regulatory floodway also reduce opportunities for point-source water pollution, floating debris storage in the floodplain and losses of riparian habitat due to land cover changes.

Benefits from effective floodplain management are largely incremental and depend upon the rates of local development (housing or commercial construction). The single-family house permitting data indicate that approximately 100,000 permits were issued in the basin during 2007. Although the data do not indicate where those structures may have been constructed, past trends suggest that a percentage of the new construction would occur in the regulated floodplains. Enforcement of the floodplain management regulations would ensure that the flood risks would be lessened and that financial losses would be reimbursed. In the absence of the regulations, flood damages and potential loss of life would be higher.

8.7.8 Existing Flood Risk Reduction Infrastructure Alternatives

The array of alternatives displayed to address the sustainability of the current flood risk reduction system is primarily directed toward ongoing and future rehabilitation of those existing structures. In some alternatives, cessation of components of the current protection system and development of alternative flood risk reduction measures is implied. Benefits of the alternative measures to the current system are not quantifiable at this time, but such measures used throughout the basin in lieu of dams, levees and floodwalls have proven to be cost effective in comparison to the structural measures.

Flood risk reduction benefit data from the 83 operating reservoirs show that these structures have generated more than $19.0 billion in flood risk reduction benefits. Detailed data on reductions to threat of loss of life is not immediately available for the reservoirs, but several large urban areas are located downstream of many of the operating dams. In addition, the 97 USACE designed local protection projects have generated millions of dollars in flood risk reduction benefits. Data collected for the 97 projects indicate that more than 500,000 people live within the protection limits of the basin's LPPs, and the value of property protected exceeds $14.0 billion.

8.7.9 Public Lands Stewardship and Recreation Alternatives

Benefits attributable to recreational use and careful stewardship of public lands are based on one of several measurement types. The simplest (unit day value) quantifies benefits based on numbers of counted user days for day use and overnight use (camping). Visitor information is collected for each of the 83 reservoirs, and unit-day values can be applied for each type of recreational use, to determine associated benefits. Benefits attributable to stewardship of each project's resources can be measured in certain recreational use types (such as hunting, fishing, and hiking, which

are resource-based activities). Where available, monetary benefits have been used, but many benefit measures are described in qualitative units.

8.7.10 Climate Change Alternatives

The projected climatic change effects include increased temperatures, less precipitation, but more intense storms, increased evaporation, and the potential for large cyclonic storms in the Atlantic and Gulf to venture further inland with heavier rains and winds. One potential impact of climate change may be a slow migration of species (flora and fauna) northward as temperatures increase. Included within this migration could be numerous invasive species that would devastate indigenous populations.

Alternatives included in this evaluation are primarily studies of the potential impacts on the water resources system and development of pre-emptive, adaptive management strategies designed to mitigate the effects of climate change on that system. Monetary benefit estimations of those alternatives are unavailable at this time, but qualitative descriptions of possible benefits have been included.

8.7.11 Environmental Infrastructure Alternatives

The provision of new or upgraded sewer collection and treatment and the treatment and distribution of potable water generates substantial benefits in reducing health risks, improving water quality in streams and lakes that enhance aquatic species diversity and productivity, increased potential for water-based recreation, and reductions in water treatment cost. Opportunities to serve additional residential and commercial units with public sewers and water decreases the tendency for larger lot sizes to accommodate septic tanks and leach fields thus reducing development footprint size and sprawl, Where the existing infrastructure authority includes the protection of surface waters, benefits can include improvements in health and safety and water quality as well as reduction in flooding associated with stormwater runoff.

Benefit measures can be associated with reduced healthcare costs, reductions in lost work time, reduced chemical costs for water treatment, reduced deaths and economic losses due to structure fires (installation of water hydrants), reductions in CSOs, and reductions in school sick days.

8.7.12 Water Resources Policy Alternatives

Based on the comments received from the various sources, the primary water resources policy issues are related to cost sharing rates for studies and ecosystem restoration projects, collection and reuse of recreation user fees, calculation of flood damages, and use of USACE managed lands for alternative energy development. Monetary benefits associated with any changes in policy are unavailable at this level of reporting, but qualitative benefits and costs associated with changes in policy have been included.

8.7.13 Hydropower Generation and Energy Related Alternatives

Benefit measures are associated with the cost differences in provision of electrical power through hydroelectric generation versus other forms of electrical energy (coal-fired or

gas-fired generators) production. Current hydroelectric power generation by USACE facilities amounts to approximately 1,800 megawatts. The value of that energy on the market is dependent upon regional utility rates.

Alternatives included in this study address rehabilitation of the current facilities to increase the efficiency of those current facilities and opportunities for expansion of energy development (hydropower and other renewable options) on USACE projects by third parties. Monetary benefit estimations for those activities are not currently available, but qualitative benefits and costs have been included.

8.7.14 Inland Navigation Alternatives

Benefit measures for navigation alternatives can be measured as differences in costs per ton/mile for waterway shipping versus other modes of transportation. Other measurements of fuel efficiency, safety and reduced air pollution can be included as benefits of navigation alternatives. Adding additional commodities onto the waterways, especially those that are non-traditional waterway commodities, can add to the benefit measures and can justify construction of new loading facilities and multi-use terminals.

Alternatives that would expand the commodity base moving on the navigation system and add to landside development opportunities would generate benefit streams for additional employment, tax revenues from new commercial and industrial production and the difference in costs of moving on the waterway versus other modes. Containers can be and are currently being moved on trucks and rail as well as barge modes.

8.7.15 Summary

The evaluation of alternatives relies in large part on monetary measures, measures of public safety, environmental impacts and outputs at the reconnaissance level of study. A basinwide study challenges the availability of specific unit monetary data to support alternatives at any scales larger than a project level. The data for this study (other than individual operating USACE projects) were collected at the minimum size of the HUC 8 level watershed, the average size of which is approximately 1,300 square miles. Data collection at that scale defies collection of much detailed monetary benefit information. Similar problems plague measures of costs for the various alternatives included at the basin, sub-basin, and watershed levels. Where credible data on lives at risk or structures at risk were available, such data have been included in the evaluation.

Generally, the alternatives evaluation comprises qualitative descriptions of likely benefits and costs as well as anticipated social, cultural, economic, and ecosystem impacts. Table 19 provides an evaluation of alternatives (using the same alpha-numeric designations and color coding as Table 18).

8.8 IDENTIFICATION OF A FEDERAL INTEREST

In view of the great number of issues received and alternatives formulated to address the issues, determination of a Federal Interest in any alternative presented has been expedited by determining which issues and associated alternatives are clearly not within the defined Federal Interest for recommendation by USACE. In the alternatives

evaluation table, there are a great number of alternatives that fall outside USACE's current mission fields (or business lines); without specific authorization, USACE could not legally initiate any further planning activities for those alternatives.

Some alternatives (so marked in the table) are the primary responsibility of other Federal agencies such as FEMA, USDA (NRCS), USGS, NWS, USEPA, and USFWS. Although USACE may support those other agency missions from time to time with project data, or legislatively authorized personnel and funding, USACE would not recommend further studies or projects for those alternatives in a recon report based purely on USACE authorization and appropriations. Likewise there are a number of alternatives listed (so marked in the table) and evaluated that are clearly within the realm of state or local (county and municipal) jurisdictions. Although USACE may support these local actions (NFIP enforcement, land use zoning, stormwater ordinances, etc.) as being components of overall strategies to reduce flood risk or reduce deterioration of aquatic habitat, USACE has no legal capability to implement those local actions and therefore would not identify a Federal Interest in them. Table 20 lists alternatives that are clearly outside of the USACE mission areas or business lines or that are clearly a local responsibility.

The remaining alternatives may be categorized as being potentially within the Federal Interest to pursue, under certain conditions. ER 1105-2-100 and other USACE regulations provide guidance on the requirements for determining a Federal Interest in a particular alternative for recommendation. A preliminary appraisal of alternatives based on benefits, costs, outputs and environmental impacts at the basin, sub-basin and watershed level must rely on qualitative descriptions of potential benefits and costs.

Specific quantitative measurements (monetary units) to describe benefits and costs at these geographic scales of planning are beyond the capability of this report. Regulations prescribe that reconnaissance level studies rely on existing data and qualitative analysis when monetary measures are not available. Descriptions of outputs and environmental impacts are based on past project experiences and historical data derived from previous uses of similar alternatives in past projects or currently operating projects. Several of the alternatives screened in Table 18 appear to be consistent with Army policies regarding a Federal Interest determination and therefore could be pursued in further Federally funded studies.

8.8.1 Reinvestment in Existing Flood Risk Reduction Infrastructure

At the top of the alternatives list regarding a Federal Interest determination are the alternatives that address the entire system or components of the current system of operating USACE reservoirs. By virtue of their ongoing Federally funded operation and generation of multiple and measurable public benefit streams (flood risk reduction, recreation, water supply, fish and wildlife management, low-flow augmentation, hydropower, etc.) these projects meet the requirements of a Federal Interest. Recent decisions to rehabilitate aging reservoirs using Federal funds further support this assertion. Table 3 in Appendix F shows the average annual FRR benefits being generated by each of the basin USACE reservoirs. The benefits accruing to reductions in flood risks from these operating projects are nearly 9 times greater than the annual O&M costs. Other benefit streams from ancillary authorized project purposes (e.g.,

recreation benefits) further exemplify the determination of a Federal Interest in pursuing alternatives that continue this flow of public benefits.

Table 19 – Evaluation of Alternatives

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Ecosystem and Environmental (E)				
E.1 Scope = Basinwide. Lead agencies = USACE.				
Attainment of new authorization for or modification of existing Aquatic Ecosystem Restoration Authorization to address ecosystem restoration (i.e., wetlands) within the entire Ohio River basin.	Measurable increases in habitat quantity or quality of aquatic species and enhanced protection of T&E species habitat such as wetlands and riparian zones.	Cost of preparing a management plan and future costs of ecosystem restoration projects authorized by the legislation.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. All impacts would be beneficial by program design and long-term for aquatic species and riparian associated terrestrial species.	a. Not authorized b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits
E.2 Scope = Basinwide. Lead agencies = USACE.				
Development of comprehensive invasive species assessment and control strategies in coordination with Federal and state agencies, NGOs, and academia.	Measurable improvements in quality and quantity of indigenous species habitat through eradication of invasive species.	Costs would be limited to development of an invasive species management plan and control activities such as vegetation removal, chemical treatment, application of biological controls.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Removal of invasive species would enable increased productivity of indigenous species.	a. Not authorized b. Authorized and reducing effects of invasive species, but climate change impacts indigenous species c. Authorized but not funded d. Authorized, and reducing effects of invasives through collaborative effort with states and USFWS.
E.3 Scope = Basinwide. Lead agencies = USACE.				
Modify the current USACE regulatory permitting process and the nationwide permit process to promote use of natural stream restoration techniques/processes.	Measurable improvements to quality and quantity of aquatic species habitat at restoration locations.	Costs would be minimal for administrative changes. Costs to private and public sectors using stream restoration techniques may be less than alternative structural measures for stream stabilization.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long term to aquatic species and riparian associated terrestrial species.	a. Not authorized b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Ecosystem and Environmental (E) (continued)				
E.4 Scope = Sub-basin or watershed. Lead agencies = USACE.				
Preparation of Section 216 studies (Review of Completed Projects) to determine potential for modification of reservoir storage and downstream flows from reservoirs.	Measurable improvements to downstream water quality with respect to temperature, seasonal flow volumes and oxygen content benefiting aquatic species within sub-basins or watersheds. Benefits associated with support of USEPA TMDL standards for water quality.	Initial appraisal costs are $20,000 per project; Recon studies are $100,000 Federal cost with additional study costs shared with a non-Federal sponsor. Storage reallocation and operational costs for modified flows costs are minimal.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term to lake and downstream aquatic species and their habitat.	a. Not approved b. Approved and producing benefits c. Approved but not funded d. Approved and producing benefits
E.5 Scope = Sub-basin. Lead agencies = USACE.				
Update existing USACE reservoir land use master plans to reflect other resources agency objectives regarding T&E species habitat management.	Measurable improvements to habitat quality for T&E species on reservoir project lands and measurable benefits for preservation of critical habitat on reservoir lands.	Costs for master plan updates are $250,000 per project. Costs for modification of reservoir lands management to address agency T&E objectives would be dependent upon geographic extent and practices.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial to critical habitat for T&E species on USACE-managed lands. Some current uses of USACE land (e.g., recreation) could be limited through T&E species management.	a. Not approved b. Approved and producing benefits c. Approved but not funded d. Approved and producing benefits
E.6 Scope = Watershed. Lead agencies = USACE.				
Installation of stream bank vegetation and riparian buffers through USACE Section 206 Aquatic Ecosystem Restoration CAP program projects to protect aquatic species habitat.	Measurable improvements to existing habitat quality or increases in quantity of riparian habitat.	Costs for projects implemented under the Section 206 authority are limited to $5.0 million Federal share.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any construction impacts in the re-vegetating process would be local and short-term. Long-term impacts would be positive to the riparian and stream habitats.	a. Not approved b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Ecosystem and Environmental (E) (continued)				
E.7 Scope = Sub-basin or watershed. Lead agencies = Local watershed associations, NPS.				
Restoration of river corridors/greenways through state and Federal programs (watershed associations, interior/National Parks programs).	Measurable ecosystem, adjacent land value, recreation, and social benefits from restoring river greenway corridors.	Costs for restoration would be limited to purchase of scenic property easements, pedestrian and fisherman access and vegetative plantings.	No adverse ecosystem, socioeconomic or cultural impacts anticipated from greenway restoration process other than short term construction impacts from access development and plantings. Long term impacts to local economy and ecosystem health would be positive.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
E.8 Scope = Watershed. Lead agencies = USACE, NRCS.				
Development of Initial Watershed Assessments, followed by a Watershed Assessment and Management Plans, through USACE or NRCS programs at the sub-basin or watershed level.	Measurable increases in collaborative relationships, issues identification (nutrient loading, TMDL needs) and knowledge of complex systems within and between watersheds.	Costs would be limited to $100,000 for Initial Watershed Assessments and potentially high costs at the watershed assessment level. Plans may not include recommendations for further USACE project costs.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts from strategic management actions would be beneficial and long-term for watershed aquatic habitat, water quality (TMDL supportive) and resident living conditions.	a. Not authorized b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits
E.9 Scope = Sub-basin or state. Lead agencies = USDA Farm Service Bureau.				
Expansion of the USDA CRP and CREP programs into all watersheds of the basin to reduce impacts on riparian/stream corridors.	Measurable benefits in the quality and quantity of riparian habitat produced through cessation of agriculture along streams and benefits of improved water quality.	Cost would be limited to various vegetative plantings along riparian corridors and land rental payments – costs that are covered by USDA and the sponsoring states.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be positive for aquatic and riparian ecosystems.	a. Not authorized b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits
E.10 Scope = Sub-basin and watershed. Lead agencies = USACE with USFWS, DNRs, TNC.				
Restore lacustrine and palustrine wetlands in sub-basins or watersheds in collaboration with USFWS, DNRs, and TNC using CAP and WRDA authorities.	Measurable increases in acres of restored, quality wetland habitat in sub-basins and watersheds.	Costs would be limited to Federal share of CAP Section 206 program ($5.0 million per project) or limited under WRDA authorization based on expected incremental benefits, cost effectiveness calculation.	No adverse ecosystem, socioeconomic or cultural impacts anticipated from restoration of wetland habitat. Any impacts during construction would be local and short-term.	a. Not authorized b. Authorized and producing benefits c. Authorized but not funded d. Authorized and producing benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Ecosystem and Environmental (E) (continued)				
E.11 Scope = State. Lead agencies = USACE with states.				
Initiate Section 22 PAS studies with states to identify stable streams that can be used a reference streams for other channel restoration projects and to protect identified streams from degradation.	Quality assurance that benefits derived from regional stream restoration projects are based on local ecosystem, hydrologic, and hydraulic conditions, reducing risk of restoration project failure.	Costs to identify and document regional stable streams through GIS platforms are administrative and minimal and shared 50-50 with states. Protection strategies would be regulatory in nature.	No adverse ecosystem, socioeconomic or cultural impacts anticipated in identifying and documenting stable streams. Protection of stable segments would be environmentally beneficial to aquatic and riparian habitats.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing benefits
E.12 Scope = Project. Lead agencies = USACE.				
Implementation of aquatic and terrestrial ecosystem restoration projects using existing USACE Continuing Authority Programs 206/1135/204.	Measurable benefits in acres, miles or units of quality aquatic or terrestrial habitat restored or created.	Federal costs would be limited to authorized share of projects under program limits (Section 206, $5.0 million; Section 1135, $5.0 million; Section 204, $15.0 million) and initial study funds.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic and associated terrestrial ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits
E.13 Scope = Project. Lead agencies = USACE.				
Modify reservoir intake/flow release structures by installing multi-level intakes to address downstream water quality and aquatic species requirements (temperature and oxygenation).	Measurable benefits in acres, miles or units of downstream aquatic species habitat and measurable improvements in water temperature, oxygen content and other water quality parameters.	Monetary costs to convert single intakes to multi-level intakes may range between tens of thousands and millions per structure.	No adverse ecosystem, socioeconomic or cultural impacts anticipated, but some short term construction impacts to water quality could be expected. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits
E.14 Scope = Project. Lead agencies = USACE.				
Establish project-wide partnering agreements at USACE reservoir projects with resource agencies and NGOs based on updated master plan recommendations for ecosystem restoration activities on project lands or on tributaries that affect water quality and aquatic habitat within the project.	Measurable benefits in reducing administrative time to bring projects to construction and avoiding funding losses by non-Federal sponsors.	Reduced costs for executing pre-project agreements would be administrative and minimal based on master plan updates.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any subsequent construction impacts would be short-term. Long-term impacts would be positive for aquatic and terrestrial ecosystems on project lands.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Quality (WQ)				
WQ.1 Scope = Basinwide. Lead agencies = USACE.				
Implementation of the Environmental Infrastructure Programs basinwide to address deteriorated sewer systems or lack of basic collection and treatment systems.	Measurable improvements in regulated water quality, reduced local healthcare costs, improved water and sewage treatment and lessened development costs.	Monetary costs would be in Federal grants for design and construction of sanitary waste collection and treatment and potable water treatment and distribution.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits
WQ.2 Scope = Basinwide. Lead agencies = USACE, NRCS, TVA.				
Conduct basinwide sedimentation assessment that addresses sources and potential effects on reservoirs, navigation and aquatic ecosystems.	Identify potential for measurable reductions in sedimentation quantities generating improvements in aquatic habitat, reduced dredging costs, and maintaining benefits of authorized reservoir storage.	Costs related to establishment of natural riffle/pool sequences, stream sinuosity and natural stream-bank stabilization through vegetation plantings.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits
WQ.3 Scope = Basinwide. Lead agencies = USEPA, ORSANCO, states.				
Basin/regional perspective on compliance with water quality requirements and resolution of water quality issues.	Non-monetary benefits of consistent administration of water quality parameters and compliance.	Non-monetary costs of collaboration and cooperation among agencies.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing system benefits
WQ.4 Scope = Basinwide. Lead agencies = ORSANCO, Farmland Trust.				
Establishment of a market-based water quality credits trading program in the Ohio River basin.	Measurable benefits in reductions of nitrogen, phosphorous and other nutrients in basin rivers.	Minimal costs since reductions are realized through market-based trading of valued credits.	No adverse ecosystem, socioeconomic or cultural impacts. Program effects would be positive on aquatic ecosystems.	a. No local development b. Implemented and producing limited benefits due to climatic effects c. Approved and yielding some benefits d. Implemented and producing benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Quality (WQ) (continued)				
WQ.5 Scope = Basinwide. Lead agencies = USACE.				
Initiate compliance with Section 438 of the E*nergy Independence and Security Act* regarding stormwater runoff management at Federal facilities and installations.	Measurable benefits in water quality improvement at Federal impoundments and streams on Federal lands.	Costs associated with installation of stormwater management and water harvesting at Federal facilities and installations.	No adverse ecosystem, socioeconomic or cultural impacts. Compliance with Section 438 would be positive on aquatic ecosystems.	a. Compliance not systematic b. Compliance and producing limited benefits c. Compliance but limited funding d. Compliance and producing system benefits
WQ.6 Scope = State. Lead agencies = State, local, municipal, and county governments.				
State compliance with USEPA requirements for non-point implementation plans (USEPA 303/305) for impaired streams including issues of nutrient loading.	Measurable improvements in water quality, aquatic habitat, reduced costs for potable water treatment, and avoidance of regulatory fines.	Local public and private monetary costs for addressing both point and non-point pollution sources within watersheds.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts likely to be beneficial and long-term for aquatic ecosystems. Some financial impacts to local public and private land owners for pollution source cleanup.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing benefits
WQ.7 Scope = State. Lead agencies = State, municipal, and county governments; USFDA				
State-based programs for unused pharmaceutical and hormonal drugs recovery and disposal.	Measurable benefits in improved water quality, reduced effects on aquatic species endocrine systems, reduction of potential human effects.	Local monetary costs associated with collection and safe disposal of unused pharmaceuticals and hormonal drugs.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial for aquatic ecosystems and drinking water supplies.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
WQ.8 Scope = Watershed by state. Lead agencies = USDA Farm Service Bureau.				
Expansion of the USDA CRP and CREP programs into all watersheds to reduce impacts from nutrient loading and non-point pollution sources.	Measurable reductions in sediment loading and agricultural chemicals. In water, measurable quantity in additional acres of prime riparian habitat in watersheds.	Cost would be limited to various vegetative plantings along riparian corridors and land rental payments – costs that are shared by USDA and the sponsoring states.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be positive for water quality and aquatic ecosystems.	a. No Federal development b. Implemented and producing some benefits affected by climate changes c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Quality (WQ) (continued)				
WQ.9 Scope = Watershed or project. Lead agencies = FEMA, USACE.				
Implementation of nonstructural acquisitions where applicable to address flood damages that eliminate straight-pipe systems and reduce floatable debris in floodplains.	Measurable benefits in reduction of flood damages in floodway, improvements in water quality (reduced bacterial loading) and reduced volumes of debris in floodplain.	Monetary costs associated with property acquisition in floodways and relocations costs. Subsequent reductions in pollution and debris are by-products without costs.	No adverse ecosystem or cultural impacts anticipated but may have local social and financial impacts that can be mitigated. Any ecosystem impacts would be beneficial and long-term for aquatic ecosystems and beneficial for drinking water systems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WQ.10 Scope = Project. Lead agencies = USACE.				
Installation of multi-level intake structures at USACE dams to enhance flexibility and resiliency in meeting downstream parameters of temperature and oxygen.	Measurable benefits in acres, miles or units of downstream aquatic species habitat and measurable improvements in water temperature, oxygen content and other water quality parameters.	Costs to convert single intakes to multi-level intakes could range from tens of thousands to millions per project.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WQ.11 Scope = Project. Lead agencies = USACE.				
Facilitate nutrient releases downstream from dams to meet aquatic ecosystem needs and reduce nutrient effects on lakes (eutrophication).	Measurable benefits in increased high-quality aquatic habitat, species diversity and productivity through nutrient releases.	Non-monetary costs for determining seasonal operations based on USFWS and Department of Natural Resources (DNR) data.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WQ.12 Scope = Project. Lead agencies = USACE.				
Apply best practices in natural stream restoration design during ecosystem restoration projects and flood risk reduction (FRR) projects with channel modifications.	Measurable benefits in acres, miles or units of more productive and diverse aquatic habitat leading to greater diversity and productivity of species.	Monetary costs of incorporating best practices in natural stream restoration normally less than more structural solutions to stream channel modification. Construction costs will depend upon scope.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts to aquatic habitat during in-stream restoration construction would be local and short term. Long term impacts are positive.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Quality (WQ) (continued)				
WQ.13 Scope = Project. Lead agencies = USACE, State Water Quality Dept.				
Ensure compliance with NPDES design requirements by USACE engineering and NPDES permit requirements by USACE contractors.	Measurable improvements in runoff receiving stream water quality during construction and reduction in possible regulatory fines.	Monetary costs associated with staff QC/QA of project design of NPDES features and installation of erosion protection devices and runoff retention facilities.	No adverse ecosystem, socioeconomic or cultural impacts anticipated, but construction costs slightly increased for retention and diversion features. Any impacts would be beneficial and long-term for aquatic ecosystems.	a. Not approve b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefit
WQ.14 Scope = Local. Lead agencies = Municipal and county governments.				
Local actions to address USEPA and state laws regarding compliance with CSO violation requirements.	Measurable reductions in water quality parameters such as fecal coliform, metals, organic materials, phosphorus, and pesticides.	Monetary costs associated with separation of stormwater and sanitary sewer systems and treatment plant modifications.	Some potential impacts to aquatic ecosystems during construction of separate systems. Any impacts would likely be beneficial to aquatic ecosystems and would be long-term.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
Basinwide Water Management (WM)				
WM.1 Scope = Basinwide. Lead agencies = USACE.				
Prepare basinwide water management plan that addresses authorized reservoir water storage, flow releases and user demands through H&H systems modeling and stakeholder collaboration under ranges of climate change impacts.	Measurable benefits in optimal operation of the reservoir system balancing user needs while producing sustainable public benefit streams through future scenarios of climate change and economic conditions. Measurable benefits in response to emergency flood or drought conditions and support of USEPA's TMDL standards.	Cost for developing, certifying, and deploying models of the basin H&H system is estimated at $20.0 million. Costs to adjust operations and reallocate storage at reservoirs are minimal, but trade-offs in some benefit streams may be possible.	Adverse ecosystem impacts are unlikely, but possible depending upon trade-off analyses; social and economic impacts to reservoir users or basin water users could occur. Support of USEPA TMDL standards through strategic flow releases would provide significant water quality and aquatic species habitat improvements.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WM.2 Scope = Basinwide. Lead agencies = USACE.				
Development and certification of system-wide H&H models to address Ohio River basin water management demands.	Benefits would be associated with use of certified and reliable models for water management decision-making.	Monetary costs for developing and certifying models would be administrative and contained within the agency.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Basinwide Water Management (WM) (continued)				
WM.3 Scope = Basinwide. Lead agencies = USACE.				
Formulate a basinwide communication forum and collaborative network for interstate and interagency dialogue on common water management issues and action strategies.	Non-monetary benefits of basin states collaboration on common issues and development of coordinated strategies for future water management and cooperation.	Monetary costs for collaborative exploration with the states of various basin water resources forums.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WM.4 Scope = Basinwide. Lead agencies = USACE.				
Develop basinwide infrastructure reinvestment strategy plan for rehabilitating and sustaining existing USACE reservoirs.	Measurable FRR benefits in ongoing protection of downstream assets and sustaining benefit streams from authorized water storage (F&W, water supply, hydropower, low-flow, etc.).	Costs for reinvestment plan development estimated to be $5.0 million, including extensive H&H modeling and collaboration with other Federal, state, and regional authorities and agencies.	No adverse ecosystem, socioeconomic, or cultural impacts anticipated provided that all rehabilitation of infrastructure is contained within existing footprint. Some short-term recreation and water quality impacts possible during rehabilitation construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WM.5 Scope = Basinwide. Lead agencies = USACE.				
Evaluate climate change effects during assessment of basinwide water management alternatives.	Monetary benefits in maintaining balance of authorized benefit streams in spite of climate changes.	Monetary costs of evaluation of climate effects during water management study.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WM.6 Scope = Project. Lead agencies = USACE.				
Reservoir management plans updated/ through reallocation (Section 216) studies.	Measurable public benefits in balancing and optimizing storage for authorized project purposes.	Monetary costs for plan development ($20,000 initial appraisal) and all other costs shared with sponsor.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Basinwide Water Management (WM) (continued)				
WM.7 Scope = Project or watershed. Lead agencies = USACE.				
Sedimentation studies upstream and downstream of reservoirs.	Measurable benefits in preserving sedimentation storage capacity in reservoir and not infringing on flood, water supply, or hydropower storage.	Monetary costs associated with modeling sedimentation transport, reservoir storage and stream sediment monitoring and measurements.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts are likely to be beneficial to riparian and aquatic habitat.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
Local Development Effects on Water Resources (LDA)				
LDA.1 Scope = State. Lead agencies = State, municipal, and county governments.				
Individual basin states enabling legislation that promotes enactment and enforcement of stormwater management ordinances by counties and municipalities through financial and technical assistance.	Measurable statewide benefits in reduced stormwater runoff and local flooding damages. Measurable benefits in reduced damages to urban stream aquatic habitat.	Costs for preparing and enacting stormwater management enabling legislation would be administrative and state funded. States' assistance to qualifying communities and counties would be state funded.	No adverse ecosystem or cultural impacts anticipated, but some social and economic impacts associated with additional land development requirements for stormwater retention and stream protection.	a. Not enacted b. Enacted and producing limited benefits c. Enacted but not funded by state d. Enacted and producing systems benefits
LDA.2 Scope = Sub-basin. Lead agencies = USACE.				
Prepare Initial Watershed Assessments and Watershed Assessment Plans for each sub-basin in the Ohio River basin.	Non-monetary local benefits of assessing water resources issues and systems integration upon which to based management strategies.	Monetary costs of preparing Initial Watershed Assessment ($100,000) and cost-shared Watershed Assessment Plan.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
LDA.3 Scope = Local. Lead agencies = Municipal and county governments.				
Local enactment and enforcement of stormwater management ordinances by counties and municipalities that encourage use of pervious pavements, retention on-site and other water-harvesting strategies to complement the state NPDES program.	Measurable local reductions in stormwater runoff, local flood damages and losses of urban stream aquatic species habitat.	Costs would be administrative and minimal for enacting and enforcing stormwater ordinances at the municipal and county level. Local building inspectors or county engineers cost to inspect sites.	No adverse ecosystem or cultural impacts anticipated, but some social and economic impacts associated with additional land development requirements for stormwater retention and stream protection.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Local Development Effects on Water Resources (LDA) (continued)				
LDA.4 Scope = Local. Lead agencies = Municipal and county governments.				
Enactment and enforcement of the National Flood Insurance Program for all documented and suspected (obvious floodplain areas heretofore unmapped in the NFIP) floodplain areas.	Measurable local benefits in reductions in economic losses due to flooding, measurable benefits in reduced development in hazardous floodways leading to loss of life and property damages. Estimated at-risk basin damages are $70.0 billion.	Monetary costs to enact and enforce NFIP are minimal and covered by permit fees. Local development costs higher from required elevation of new structures and retrofits.	No adverse ecosystem or cultural impacts anticipated, but some social and economic impacts due to regulatory requirements to elevate structures and carry flood insurance (economic costs of insurance).	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
LDA.5 Scope = Local. Lead agencies = Municipal and county governments.				
Enactment and enforcement of land use zoning that identifies and protects urban, suburban and rural stream/riparian corridors and both forested and agricultural land as well as promoting housing densities (with incentives) that preserve undisturbed ecosystems.	Measurable local benefits – e.g., in reduced loss of riparian, field, and forest habitat acreage through site development. Measurable benefits in reduced energy use through increased development densities. Increase in "community walkability."	Monetary costs to enact and enforce zoning ordinances are minimal, local and administrative.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts are likely to be beneficial to riparian and aquatic habitat. Some social and economic impacts due to regulatory development requirements of zoning, but protection of land values offset economic impacts over time.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
LDA.6 Scope = Local. Lead agencies = Municipal and county governments.				
Enactment and enforcement of building codes specifying construction methods and materials that promote water and energy conservation (green strategies) as well as safe building methods for flood prone areas.	Measurable local benefits in reduction of loss of life due to structure fires, storms and flooding, reductions in flood damages, energy use, and water conservation.	Cost to enact and enforce building codes is minimal and local. Costs are recovered through building permit fees.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Any impacts are likely to be beneficial to floodplain, riparian and aquatic habitat. Positive social impacts through reduced loss of life due to fires and adverse economic impacts due to building regulations increasing structure costs.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Local Development Effects on Water Resources (LDA) (continued)				
LDA.7 Scope = Local. Lead agencies = Municipal and county governments.				
Enactment and enforcement of subdivision ordinances that require developers to preserve stream/riparian corridors, to manage stormwater runoff through onsite retention and promote housing densities that preserve undisturbed ecosystems.	Measurable local benefits in reduction of acres of riparian and aquatic habitat lost to development, reduction in stormwater runoff and reduced energy use.	Costs to enact and enforce subdivision ordinances would be minimal, administrative and local.	No adverse ecosystem or cultural impacts anticipated, but social and economic impacts possible due to regulation of subdivision development design and construction.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
LDA.8 Scope = Local. Lead agencies = Municipal and county governments.				
Application of property tax strategies that allow owners of undeveloped, forested or agricultural property to maintain the land in an undeveloped state without undue tax burdens and to discourage floodplain development.	Measurable local benefits in preservation of natural, pervious undeveloped habitat, food production, carbon sequestration, and reduced losses of life and property damages due to flooding.	Monetary costs to apply new property tax strategies are minimal, administrative and local.	No adverse ecosystem, socioeconomic or cultural impacts anticipated, but some social and economic impacts are possible through reductions in local higher taxes for more valuable land uses (residential and commercial).	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
LDA.9 Scope = Local. Lead agencies = Municipal and county governments.				
Promoting urban infill (vacant lots) growth with tax and zoning density incentives and Tax Increment Financing (TIF) that reduces pressures for sprawl development.	Measurable local benefits in reduced energy use, more reliance on public transit, and less highway construction and reduction in losses to sensitive habitat.	Costs to apply urban infill strategies are administrative, minimal and local.	No adverse ecosystem or cultural impacts anticipated, but increased density of urban development could increase social impacts.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
LDA.10 Scope = Local. Lead agencies = Municipal and county governments.				
Promoting and instituting TDR and PDR programs that transfer or acquire development rights on property located outside urban areas and within floodplains.	Measurable local benefits in reduction of potential loss of life and flood damages in floodplain development and reductions in loss of habitat outside urban areas.	Costs to apply TDR are minimal and local. Costs to apply PDR relate to estimated future development potential of land and are local or state level.	No adverse ecosystem, socioeconomic or cultural impacts anticipated but costs for the PDR program could result in some economic impacts to local government (reduced tax revenues and land costs).	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Supply (WS)				
WS.1 Scope = Basinwide. Lead agencies = USACE, states.				
Basinwide water supply/demand analysis including consideration of appropriate conservation measures in view of potential water shortages due to future climate change.	Measurable benefits in identifying reliable water supplies and water supply strategies that would avoid loss of M&I water supplies and withstand potential future drought conditions. Conservation measures would reduce water demand and costs of water supply development.	Monetary costs for the supply and demand analysis study and implementation of water conservation measures (e.g., costs to install reduced water demand appliances and facilities).	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Impacts resulting from water conservation measures would be positive on aquatic habitat.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.2 Scope = Basinwide. Lead agencies = USACE, USGS, NOAA.				
Basinwide level drought impact analysis and emergency response strategies with regard to existing reservoir operations, navigation, T&E species and M&I water supplies.	Measurable benefits in drought readiness that avoids loss of adequate M&I water supplies, navigation on waterways and loss of T&E aquatic species habitat (mussels).	Monetary costs for preparing drought impact analysis and response strategies. Costs for response would be operational modifications.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Drought readiness would have positive impacts on basin residents.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.3 Scope = Basinwide. Lead agencies = USACE.				
Policy review/update of Federal water supply guidance and laws due to changes in basin conditions and future climate change (see water resources policies below).	Non-monetary benefits in USACE's ability to address future requests for water supply that may exceed current water supply laws and guidelines.	Monetary costs for policy, legal and guidance review.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Water supply policies flexibility would have positive impacts on basin residents.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.4 Scope = Basinwide. Lead agencies = USEPA, ORSANCO, states.				
Uniform state policies to protect water quality that ensure adequate water supplies through sustainable treatment systems.	Measurable benefits in reductions in water pollutants, adequate water supplies and reduced water treatment costs.	Non-monetary costs of ensuring uniform policies among agencies and regulators.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Positive benefits of water supply.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Supply (WS) (continued)				
WS.5 Scope = Basinwide. Lead agencies = USACE, states.				
Continued appropriations under Environmental Infrastructure Programs for local and regional water-treatment and -distribution systems.	Measurable local benefits in adequate and reliable water supplies for municipal and county development that maintain tax base and support growth in urban infill locations.	Monetary costs for environmental infrastructure design and construction assistance of local communities through state prioritized program.	Potential for short term adverse ecosystem impacts anticipated during construction of infrastructure. Positive social and economic impacts to communities.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.6 Scope = Basinwide. Lead agencies = USACE, states.				
Expand coverage of existing or enact additional environmental infrastructure authorities to cover all states in the Ohio River basin.	Measurable benefits from improvements in water quality, less health care costs, maintain community tax base, and support growth in urban infill locations.	Monetary costs associated with design and construction of new or improved sewer and water infrastructure through USACE programs.	Potential for short term adverse impacts on ecosystems during construction of infrastructure. Positive social and economic impacts.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.7 Scope = State. Lead agencies = USACE.				
Study/analysis of increased requests for water withdrawals from navigation pools in view of competing interests and future climate change.	Measurable benefits from maintaining navigation pool channel depths while providing benefits of M&I water supply during potential climate change.	Monetary costs for study/analysis of the water withdrawals from navigation pools.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.8 Scope = Basinwide. Lead agencies = USACE, states.				
Individual basin states' Section 22 (Planning Assistance to States – PAS) water-supply studies for future demands and conservation measures.	Measurable benefits from maintaining M&I water supplies that avoid loss of tax base and support urban infill growth. Conservation measures reduce demand and development of new water supply resources.	Monetary costs associated with studies through Section 22 are cost-shared 50-50 with state sponsors with limitation of $2.0 million per state; maximum cost for basin would be $30.0 million	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Social and economic impacts due to implementation of study recommendations would be positive.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
WS.9 Scope = Project. Lead agencies = USACE, Sponsor.				
Conduct Section 216 (Review of Completed Projects) studies at individual existing reservoirs for future water supply potential.	Measurable benefits in identifying future sustainable M&I water supplies that avoid losses in tax base and reductions in aquatic habitat.	Monetary costs for study are $20K initial appraisal with any additional study costs shared with non-Federal sponsor.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD)				
FDRD.1 Scope = Basinwide. Lead agencies = USGS, NWS, USACE.				
Implement a basinwide flood warning system through special congressional authorization that addresses system O&M needs.	Measurable regional benefits in reducing potential loss of life and property damages due to flooding and sustaining a reliable system.	Monetary costs for installation of new stream and rain gages, computer systems, and data communication facilities as well as annual O&M costs.	Potential for short-term, site development ecosystem impacts due to installation of gages and communication facilities. Social and economic impacts would be positive.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.2 Scope = Basinwide. Lead agencies = FEMA.				
Support the ongoing FEMA Floodplain Map Modernization Program on a basinwide level.	Measurable benefits in reducing economic losses due to flooding and potential to reduce loss of life in new development.	Monetary costs to update H&H and digitize revised floodplain mapping.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.3 Scope = Basinwide. Lead agencies = USACE Institute of Water Resources (IWR).				
Initiate research efforts (through IWR) on the use of permanent acquisition as a method for reducing threats to life (using data from LIFEsim modeling techniques).	Measurable benefits in identifying potential nonstructural options for reducing loss of life.	Monetary costs for IWR research and modeling of loss of life through LIFEsim.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Potential adverse impacts to communities through application of nonstructural acquisitions.	a. Not approved b. Approved and producing limited benefit c. Approved but not funded d. Approved and producing systems benefits
FDRD.4 Scope = Basinwide. Lead agencies = USACE.				
Apply asset management principles as part of the basinwide reinvestment framework and plans for the basin.	Non-monetary benefits in application of principles featuring systems sustainability and risk-based decision-making.	No monetary costs in application of asset management principles.	No adverse ecosystem, socioeconomic or cultural impacts anticipated in breeching the local protection project, but alternative flood risk reduction activities could generate adverse impacts.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.5 Scope = Basinwide. Lead agencies = USACE.				
Initiate recon level studies that address flood warning, structural and nonstructural measures for Ohio River mainstem and tributary communities that are at-risk by flooding from regional events.	Measurable benefits in reducing potential damages and loss of life in Ohio River mainstem and tributary communities.	Monetary costs of the unprotected Ohio River mainstem and tributaries communities studies.	Potential for adverse ecosystem, social, and economic impacts depending on the selection of alternative protection measures for Ohio River mainstem and tributary communities.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.6 Scope = Basinwide. Lead agencies = USACE.				
Cessation of flood risk reduction operations at dams in need of rehabilitation and application of alternative FRR strategies downstream (see REHAB.6 below).	Measurable benefits in reducing flood damages and potential for loss of life in communities downstream of aging reservoirs while reducing future O&M and rehabilitation costs at Federal reservoirs.	Monetary costs associated with application of nonstructural and structural measures downstream of aging infrastructure to be cost-shared at 65-35 rate with non-Federal sponsor; local O&M costs.	Potential for adverse ecosystem, social and economic impacts depending upon downstream measures selected to reduce damages and loss of life. Positive impact to Federal annual O&M expenditures.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.7 Scope = Watershed. Lead agencies = NRCS.				
Support NRCS P. L. 566 watershed protection projects that could provide FRR benefits.	Measurable benefits in reducing flood damages and potential losses of life through NRCS programs.	Monetary costs for design and construction of watershed protection measures. O&M costs are local responsibility.	Potential for adverse ecosystem, social and economic impacts depending upon measures selected by NRCS to reduce damages and loss of life. Local O&M costs.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.8 Scope = Sub-basin or state. Lead agencies = FEMA, USACE.				
Participate jointly with FEMA and local emergency management personnel to educate the public on the merits of the NFIP and CRS through FPMS program.	Measurable benefits in reduction of economic losses due to flood damages and potential loss of life through communities' participation in NFIP and CRS.	Monetary costs for staff participation in FEMA-led community education and training sessions to promote NFIP and CRS.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.9 Scope = State. Lead agencies = States.				
Provide state-based financial assistance for low-income landowners to enable purchase of flood insurance through NFIP.	Measurable benefits in reduction of economic losses through participation in NFIP for low-income population.	Monetary costs in the form of states' subsidies for low-income participation in NFIP program.	Significant, long-term environmental impacts are possible requiring mitigation. Some impacts would be irreversible. Social impacts may be positive with reduction in flood damages and reduced threats to loss of life.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.10 Scope = State. Lead agencies = USACE, states.				
Expand implementation of the Silver Jackets flood risk reduction collaboration program to each basin state and groups of basin states.	Measurable non-monetary benefits in improved and expanded collaboration between agencies, states and communities for flood risk management.	Monetary costs for staff participation in Silver Jackets collaborative efforts throughout the basin states.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Positive social impacts through collaboration.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.11 Scope = Sub-basin. Lead agencies = USACE, states.				
Implement flood warning systems for each sub-basin through Section 205 CAP.	Measurable benefits in reduction of flood damages and potential loss off life through reliable flood warnings.	Monetary costs for installation of stream and rain gages, communication facilities and computers.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.12 Scope = Watershed. Lead agencies = USACE, states.				
Initiate Section 22 PAS studies in all 15 states to determine the numbers and types of structures and facilities located within the regulatory floodway.	Measurable non-monetary benefits in identification of floodway structures and facilities to support program efforts to reduce numbers of high-at-risk structures and reduce potential loss of life.	Monetary costs for Section 22 PAS studies limited to $2.0 million per state with 50-50 cost sharing. Maximum Federal share = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.13 Scope = Sub-basin. Lead agencies = FEMA, USACE, NRCS.				
Initiate voluntary, permanent acquisition program of developed properties within the regulatory floodway through USACE, NRCS and FEMA programs.	Measurable benefits in reduction of flood damages and potential loss of life through voluntary removal of high-at-risk structures.	Monetary costs for property acquisition and relocations payments.	No adverse ecosystem or cultural impacts anticipated. Clearing floodway would enhance riparian zones. Social and economic impacts are likely to occur during relocations. Mitigation for these impacts is available.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.14 Scope = Watershed. Lead agencies = USACE.				
Prepare Watershed Assessment Plans in sub-basins that have exhibited ongoing flood damages and have numerous presidential declarations for flooding.	Measurable benefits in reducing flood damages and losses of life through flood risk reduction measures. Measurable benefits in water quality improvements, aquatic habitat improvements and access to potable water supplies.	Costs for Initial Watershed Assessment = $100,000. Watershed Assessment Plan cost-shared at 75-25 rate with sponsor. Any follow-on feasibility studies would be cost-shared 50-50 with sponsor.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.15 Scope = State. Lead agencies = USACE, states.				
Initiate Section 22 PAS studies within each of the 15 states that address the current application of stormwater management practices and their effectiveness in reducing damages and ecosystem deterioration.	Non-monetary benefits in determining the regional application of stormwater management practices from which state actions can be taken to address stream ecosystem damages and flood damages.	Monetary costs for conducting Section 22 PAS studies limited to $2.0 million per state with 50-50 cost sharing of study costs. Maximum Federal outlay = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.16 Scope = States. Lead agencies = USACE, states.				
Initiate Section 22 PAS studies within the 15 states to determine where updated floodplain mapping and H&H data are needed.	Non-monetary benefits in determining needs for updated or new floodplain mapping and H&H work to support the NFIP program and local enforcement.	Monetary costs for conducting Section 22 PAS studies limited to $2.0 million per state with 50%-50% cost sharing. Maximum Federal outlay = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.17 Scope = State by sub-basin. Lead agencies = NWS, USGS.				
Upgrade existing stream and rain gages in each state or sub-basin with satellite transmission hardware and software to support the “Storm Ready” and “IFLOWS” NWS programs.	Measurable benefits in reduced structure content damages, vehicular damages and reduction in potential loss of life.	Monetary costs for purchasing and installing hardware and software on gages for StormReady and IFLOWS systems. Annual O&M costs.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.18 Scope = Sub-basin. Lead agencies = USGS, NWS, USACE.				
Install additional rain and stream gages where necessary to fill in NWS/USGS data and flood warning gaps through Section 205 CAP program.	Measurable benefits in reduced structure content damages, vehicular damages and reduction in potential losses of life.	Costs for installation of flood warning systems contained within the Section 205 CAP Federal funding limitations ($7.0 million per project). Future O&M is local cost.	Some short-term and local ecosystem, impacts possible through gage installation, no adverse social or economic impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.19 Scope = State. Lead agencies = USACE, states.				
Initiate Section 22 PAS studies with each basin state to determine levels of loss of life risk from infrastructure failures or flooding using the LIFEsim modeling platform.	Non-monetary benefits in determining the potential levels of loss of life due to infrastructure failure or flooding events through modeling with LIFEsim. Data can support other FRR and REHAB initiatives.	Monetary costs for conducting Section 22 PAS studies limited to $2.0 million per state. Study costs are cost-shared 50-50 with states. Maximum Federal outlay = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.20 Scope = Sub-basin. Lead agencies = USACE, FEMA, states.				
Prepare HAZUS-based risk assessment for the 1% chance event for individual HUC 4 sub-basin areas using GIS technology – maintain GIS databases and make flood data and information available to state mitigation offices and communities in an electronic library.	Non-monetary benefits in determining the potential flood damages and loss of life that could occur during the 1% chance event in each HUC 4 sub-basin. Using GIS technology ensures consistent and accurate results that can be duplicated within basin.	Administrative costs of H&H model runs, HAZUS data runs, and GIS technology upgrades. Costs for each sub-basin could be shared between states and FEMA.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.21 Scope = State. Lead agencies = States.				
Initiation of state site-development revolving-loan programs (industrial and commercial) that would offset high costs of private site development outside of the floodplain.	Measurable reductions in flood damages for new commercial and industrial floodplain construction.	Monetary costs for state loan program startup and administration.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Social and economic local impacts may be positive.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.22 Scope = Local. Lead agencies = FEMA, USACE.				
Encourage basin communities to participate in the CRS program and investigate opportunities under Section 22 PAS and Section 205 CAP to assist communities in CRS improvements.	Local monetary benefits in reducing flood insurance premiums through CRS initiatives. Potential monetary benefits in reducing flood risks and potential loss of life through Section 205 CAP and avoiding future floodplain development through PAS studies.	Monetary costs for projects or activities recommended in Section 205 CAP study. Section 22 PAS studies limited to $2.0 million per state, cost-shared 50-50 with state. Maximum Federal outlay = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated. Socioeconomic impacts from CRS rating could be positive.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.23 Scope = Local. Lead agencies = Local, municipal, and county governments.				
Local initiation of NFIP, local land use zoning, building codes, subdivision regulations, property taxes, urban infill, and TDR/PDR to reduce future flood damages in flood hazard zones (see alternatives LD.3 - LD.9 above).	Local, measurable monetary benefits in reduction of flood damage losses and potential loss of life, improvements in riparian and aquatic habitat and housing quality.	Monetary costs for regulatory and tax actions are local and administrative. Costs for PDR depend upon size of program and land prices.	No adverse ecosystem or cultural impacts anticipated, but some socioeconomic impacts possible.	a. No local development b. Implemented and producing some benefits c. Approved but not funded d. Implemented and producing many benefits
FDRD.24 Scope = Watershed or Project. Lead agencies = FEMA, USACE.				
Support FEMA pre and post-disaster HMGP efforts to acquire floodway structures.	Measurable benefits in reduction of flood risks, reduced threat to loss of life, ecosystem restoration of evacuated property, reduced flood heights, reduced point and non-point pollution sources.	Costs are dependent upon local real estate costs, and opportunities for relocation housing and commercial space. Relocations costs are dependent upon public facility type and size and availability of suitable redevelopment sites.	No adverse ecosystem or cultural impacts anticipated, but some socioeconomic impacts possible.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.25 Scope = Watershed or Project. Lead agencies = USACE.				
Initiate Section 205 CAP projects through local sponsor requests for assistance that can use nonstructural permanent acquisition as a justifiable measure.	Measurable benefits in reduction of flood risks, reduced loss of life, ecosystem restoration of evacuated property, reduced flood heights, reduced point and non-point water pollution and reduced floatable debris.	Costs are dependent upon local real estate costs, and opportunities for relocation housing and commercial space. Relocations costs are dependent upon public facility type and size and availability of suitable redevelopment sites.	No adverse ecosystem or cultural impacts anticipated, but some socioeconomic impacts possible.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Floodplain Development and Recurring Damages (FDRD) (continued)				
FDRD.26 Scope = Watershed or Project. Lead agencies = USACE, Local.				
Program support for upstream retention-basin projects to control stormwater under the Environmental Infrastructure Program where that authority does now or may exist in future authorizations.	Measurable benefits in reduction of flood damages, reductions in aquatic habitat losses, and in improvements in water quality. Potential ecosystem benefits in wetland development in retention basins.	Monetary costs for design and construction of retention basins through program. Local O&M costs.	Some adverse ecosystem impacts possible through basin construction, but limited adverse socioeconomic impacts.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
FDRD.27 Scope = Project. Lead agencies = USACE, FEMA.				
Enforcement of requirements for floodplain management plans at USACE developed nonstructural projects.	Measurable benefits in reduction of damages, potential loss of life and habitat improvements.	Local monetary costs for preparation of floodplain management plans and enforcement.	No adverse ecosystem or cultural impacts anticipated, but some socioeconomic impacts possible.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
Existing FRR Infrastructure (REHAB)				
REHAB.1 Scope = Basinwide. Lead agencies = USACE, Local Sponsors.				
Develop strategic reinvestment/rehabilitation plan for all dams and local protection projects that considers the individual components as one holistic system of flood risk reduction.	Measurable benefits in reduction of potential future infrastructure failures resulting in loss of life, property damages, economic losses and public services.	Monetary costs for Federal development of the strategic reinvestment and rehabilitation plan.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
REHAB.2 Scope = Basinwide. Lead agencies = USACE, Local sponsors.				
Rehabilitation of LPP system components (i.e., obsolete pump station electronics, embankments) in a basinwide program based on LSA inspection recommendations.	Measurable benefits in continued reduction of flood damages and potential loss of life. Current basinwide USACE-designed LPPs protect approx. 500,000 night-time residents and $14.0 billion in assets.	Monetary costs for rehabilitation work at LPPs determined to have significant deficiencies that could result in failure of the line of protection or significant interior damages due to interior flooding events.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Existing FRR Infrastructure (REHAB) (continued)				
REHAB.3 Scope = Project. Lead agencies = USACE.				
Rehabilitation of key common components of dams based on inspection findings of Dam Safety Program.	Measurable benefits in continued reduction of flood damages, potential downstream loss of life and benefits streams accruing from authorized purposes (recreation, F&W, water supply, hydropower).	Monetary costs for rehabilitation of common component features of multiple dams during Dam Safety inspections in one sub-basin or the entire basin. Ongoing Federal O&M.	Some adverse ecosystem impacts possible if construction outside of existing project footprint, limited socioeconomic impacts.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
REHAB.4 Scope = Project. Lead agencies = USACE, Local sponsors.				
Implement flood risk reduction alternatives in lieu of rehabilitating existing flood storage operations at existing reservoirs. Reservoirs may continue operations to support other authorized purposes with non-Federal O&M.	Measurable benefits in reduction of flood damages and potential loss of life at communities downstream of operating reservoirs. Measurable benefits accruing from ongoing purposes at reservoirs (e.g., recreation, fish and wildlife management).	Monetary costs for planning, design and construction of justifiable LPPs and nonstructural measures downstream of reservoirs. Local annual O&M costs.	Some adverse ecosystem and socioeconomic impacts possible from new construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
REHAB.5 Scope = Project. Lead agencies = USACE.				
Project-based rehabilitation of flood risk reduction system infrastructure dams and appurtenances determined to be deficient.	Measurable benefits in continued reduction of flood damages, potential downstream loss of life and benefits streams accruing from authorized purposes (recreation, F&W, water supply, hydropower).	Monetary costs for rehabilitation of deficiencies identified through the Dam Safety Program at individual dams in one sub-basin or the entire basin. Ongoing O&M of Federal dams.	Some adverse ecosystem impacts possible if construction outside of existing project footprint, limited socioeconomic impacts.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
REHAB.6 Scope = Project. Lead agencies = USACE, Local sponsors.				
Provide high-quality plans and specifications for local rehabilitation of LPPs through the "Work for Others" Program.	Non-monetary benefits in agency assurance that local sponsor's rehabilitation of LPP deficiencies is based on sound engineering principles and risk analysis.	Reimbursed monetary costs for preparation of plans and specifications. Construction costs and O&M costs are non-Federal.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Existing FRR Infrastructure (REHAB) (continued)				
REHAB.7 Scope = Project. Lead agencies = USACE, Local sponsors.				
Breach existing local protection projects and provide alternative FRR measures to reduce damages and threats to life.	Measurable benefits in reduction of flood damages and potential loss of life. Potential ecosystem benefits in restoration of obsolete project right-of-way.	Monetary costs of breach construction and construction of alternative FRR measures in lieu of LPP protection. Local annual O&M of constructed protection.	Some adverse ecosystem and socioeconomic impacts possible from new construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
Public Lands Stewardship and Recreational Facilities (SRF)				
SRF.1 Scope = Basinwide. Lead agencies = USACE.				
Preparation of a basinwide recreation demand analysis for USACE reservoirs.	Non-monetary benefits from determination of reliable recreation demand data upon which benefit calculations can be based.	Monetary costs for preparation of recreation demand analysis.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.2 Scope = Basinwide. Lead agencies = USACE.				
Project user fees reinvested in rehabilitation of recreational facilities (see water resources policies as well).	Non-monetary benefits in availability of funding sources to rehabilitate aging recreational facilities at USACE projects. Recreation rehabilitation may generate additional benefits.	No direct monetary costs to redirect user fees to projects for recreation rehabilitation. Indirect costs to other USACE programs may occur.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.3 Scope = Basinwide. Lead agencies = USACE.				
Basinwide strategic riverfront recreation plan addressing existing and planned facilities, appropriate formulation processes, and recreation demand methodologies.	Non-monetary benefits from regional riverfront development strategy as basis for response to project requests and data-based methodologies for calculating recreation demand for riverfront facilities. Data may better determine economic justification of future requests and inform USACE decision-makers on report recommendations.	Monetary costs for preparation of regional strategy for riverfront development.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Public Lands Stewardship and Recreational Facilities (SRF) (continued)				
SRF.4 Scope = Basinwide. Lead agencies = USACE, Project Users.				
Prepare basinwide strategic plan for use of USACE project lands for renewable energy development.	Non-monetary benefits of basin strategy/policy for addressing public and private requests to construct/install renewable energy projects on USACE property.	Monetary costs for preparing strategic plan for renewable energy projects' development on USACE property.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.5 Scope = State. Lead agencies = USACE, states.				
Partner with states on development of SCORP documents that address needs of USACE recreational facilities and land use.	Non-monetary benefits of having USACE recreational facilities and land uses managed and developed in coordination with state recreation objectives and facilities demands.	Monetary costs of USACE's contribution of recreation data and sharing in costs of state SCORP development.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.6 Scope = State. Lead agencies = USACE, states.				
Initiate state-based, cost-shared Section 22 PAS studies of public and first responder river/pool access and alternatives for development and financing.	Measurable benefits from increased public recreational access and reduced potential for loss of life through enhanced access for first responders in river emergency situations (e.g., navigation and recreational accidents).	Monetary costs limited to Section 22 PAS studies at $2.0 million cost-shared with state 50-50. Maximum Federal outlay in basin = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.7 Scope = Project. Lead agencies = USACE.				
Prepare sedimentation studies for USACE projects that address tributary sources, head-cutting and depletion of sediment storage in reservoir.	Measurable monetary benefits in preserving storage in reservoirs for authorized benefit-producing uses. Measurable improvements in lake water quality and aquatic habitat.	Monetary costs for sedimentation studies.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Public Lands Stewardship and Recreational Facilities (SRF) (continued)				
SRF.8 Scope = Sub-basin. Lead agencies = USACE, USFWS, state DNRs.				
Incorporate analyses of regional T&E species and critical habitats in the preparation and coordination of updated project master plans for all projects within a 4-digit HUC code sub-basin.	Measurable improvements in T&E species habitat quality and increases in habitat quantity (acres) at USACE-owned property within sub-basins.	Monetary costs for inclusion of T&E species data in development of several updated project master plans within a sub-basin.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.9 Scope = Local. Lead agencies = USACE, NOAA, USFWS, state DNRs.				
Incorporate analyses of climate change and sustainability of T&E species and critical habitats in the preparation and coordination of individual updated project master plans.	Measurable improvements in T&E species habitat quality and increases in habitat quantity (acres) at USACE-owned individual projects property, despite climate changes.	Monetary costs for inclusion of climate change impacts and T&E species data in development of updated individual project master plans.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.10 Scope = Project. Lead agencies = USACE.				
Recreational facilities improvements/expansion in master plan updates.	Measurable benefits from increased recreational visitation and fewer visitor accidents.	Monetary costs for improvements to and expansion of recreational facilities.	Some adverse ecosystem impacts possible during construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.11 Scope = Project. Lead agencies = USACE, USFWS, state DNRs.				
Partner with state DNRs and USFWS for joint preparation of T&E species and wildlife management plans for USACE lakes.	Measurable improvements in the quality and increases in the quantity (acres) of T&E species habitat at USACE owned property and improved collaboration with state DNRs and USFWS.	Monetary costs for collaboration activities with USFWS and state DNRs.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.12 Scope = Project. Lead agencies = USACE.				
Federally funded rehabilitation of outdated recreational facilities (those constructed with and operated and maintained by USACE funds) based on updated project master plans.	Measurable benefits in increased recreational facilities and land resource usage and benefits in reduced potential for visitor accidents.	Monetary costs for upgrading existing recreational facilities.	Some adverse ecosystem impacts possible during construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Public Lands Stewardship and Recreational Facilities (SRF) (continued)				
SRF.13 Scope = Project. Lead agencies = USACE, state DNRs, NGOs.				
Develop project partnering agreements with natural resources agencies and NGOs for USACE reservoir projects to address ecosystem restoration projects based on master plan recommendations and environmental assessments.	Non-monetary benefits from expediting ecosystem restoration projects with natural resources agencies and NGOs on USACE projects.	Monetary costs associated with preparation of partnering agreements with sponsors.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
SRF.14 Scope = Project. Lead agencies = USACE.				
Compliance with Section 438 requirements to address stormwater runoff at Federal facilities and installations using water-harvesting technologies.	Measurable benefits associated with improvements in water quality at Federal facilities and installations.	Costs to design and construct stormwater management facilities in new development or redevelopments.	No adverse ecosystem, socioeconomic or cultural impacts. Compliance with Section 438 would be positive on aquatic ecosystems.	a. Compliance not systematic b. Compliance and producing limited benefits c. Compliance but limited funding d. Compliance and producing system benefits
Climate Change (CC)				
CC.1 Scope = Basinwide. Lead agencies = USACE, NOAA.				
Basinwide study of potential effects of climate change on sustainability of water resources management, water supply, hydropower, navigation, and recreation.	Non-monetary benefits in developing data and information on potential effects of climate change to support future agency decisions on water management for authorized purposes.	Monetary costs for preparation of study.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
CC.2 Scope = Basinwide. Lead agencies = USACE.				
Establish basinwide water resources monitoring system to support emergency operations.	Reduction in risks of losing measurable benefits from authorized purposes due to sudden changes in system or environmental conditions.	Monetary costs in installation of monitoring equipment and long term O&M and replacement of equipment.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefit c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Climate Change (CC) (continued)				
CC.3 Scope = Basinwide. Lead agencies = USACE, NOAA.				
Develop adaptive management strategies for USACE facilities based on system modeling and collaboration with stakeholders.	Non-monetary benefits of in-place operating strategies that quickly adapt to climate changes and limit benefit losses.	Costs to perform modeling and conduct collaboration efforts that support adaptive management strategy development.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not implemented b. Implemented but not at strategic level c. Implemented but modeling not funded d. Implemented strategies that mediate climate change effects.
CC.4 Scope = Sub-basin. Lead agencies = USACE, states.				
State or sub-basin level cost-shared Section 22 PAS studies on effects of climate change on sustainability of water resources management.	Non-monetary benefits in obtaining data that could support decision-making for water system management due to climate change.	Monetary costs limited to $2.0 million per state, cost-shared with state 50-50. Non-Federal cost can be work in kind. Maximum Federal outlay = $30.0 million for basin.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
CC.5 Scope = Sub-basin. Lead agencies = USACE, USFWS, state DNRs.				
Sub-basin level studies on sustainability of aquatic habitat and species during climate change conditions and potential USACE facilities operational changes to offset impacts.	Measurable benefits in avoidance of losses of aquatic species habitat due to climate change that may be mitigated by modified project operations.	Monetary costs for studies on climate change impacts on aquatic habitat.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
CC.6 Scope = State. Lead agencies = USACE, states.				
Statewide level cost-shared Section 22 PAS studies to determine strategies for mitigating climate change impacts on recreational usage at USACE and state facilities.	Avoidance of lost recreation benefits at USACE projects through strategic mitigation measures to combat potential climate changes (temperature/rainfall).	Monetary cost of Section 22 PAS study limited to $2.0 million per state, cost-shared 50-50 with state. Maximum Federal outlay in basin = $30.0 million.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Environmental Infrastructure (INF)				
INF.1 Scope = Basinwide. Lead agencies = USACE, states.				
Expand geographic coverage of the program to address areas of the basin where documented needs for sewer and water that affect health and safety and water quality are not covered by existing authorizations.	Measurable local benefits in reduced healthcare costs, school-days lost, lost productivity in commercial and industrial sectors, reduced emergency costs.	Monetary costs in increased environmental infrastructure assistance for design and construction of sewer and water projects.	Some adverse ecosystem and socioeconomic impacts possible during construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
INF.2 Scope = Basinwide. Lead agencies = USACE, states.				
Revise current authorizations and prepare any new authorizations for environmental infrastructure to address stormwater issues associated with CSOs involving municipal sources.	Measurable benefits in improved water quality, reduced M&I water treatment costs, reduced municipal and city regulatory actions and costs, and reduced sewage treatment costs.	Monetary costs for separating combined stormwater and sewerage systems (CSOs) into two systems.	Some adverse ecosystem and socioeconomic impacts possible during construction.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
INF.3 Scope = Basinwide. Lead agencies = USACE, states.				
Establish programmatic funds for public outreach, workshops, and data management covering all existing basin Environmental Infrastructure Programs.	Non-monetary benefits in the application of greater percentage of program funds to design and construction of benefit-producing activities.	Monetary costs of separate program funds for data management and public outreach.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
Water Resources Policies (WRP)				
WRP.1 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluate USACE policies regarding reuse of project user fees to rehabilitate project recreational facilities and land management activities.	Non-monetary benefits of redirecting project user fees to originating projects for recreational facilities upgrades.	Monetary costs of redirecting funds from other non-project, non-USACE related uses.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Water Resources Policies (WRP) (continued)				
WRP.2 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluate current policy/program guidelines for application of the Silver Jackets program to address multi-state organizations.	Non-monetary benefits of expanding the Silver Jackets program to address multi-state organizations.	Monetary costs for additional staff time to expand program.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits
WRP.3 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluate cost sharing policies regarding ecosystem restoration projects.	Monetary benefits of greater number of successful executions of ecosystem restoration projects (additional ecosystem benefits).	Monetary costs of shifting greater proportion of the costs of ecosystem restoration projects to the Federal government.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits
WRP.4 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluate cost sharing policies with regard to rehabilitation of existing local protection projects.	Non-monetary benefits in ensuring continuation of flood risk reduction benefits at LPPs through shared rehabilitation.	Monetary costs of sharing LPP rehabilitation costs with non-Federal sponsor.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits
WRP.5 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluation of USACE policies regarding use of USACE lands for renewable energy development projects by third parties.	Non-monetary benefits in utilizing Federal lands for development of renewable energy sources.	Monetary costs in lost benefits of authorized purposes (recreation, fish and wildlife) in conflict with energy development.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits
WRP.6 Scope = Basinwide. Lead agencies = USACE.				
Re-evaluate USACE policies and regulations governing the computation of flood risk reduction benefits in steep gradient watersheds.	Non-monetary benefits in accruing flood risk reduction benefits for lower frequency events in steep terrain.	No monetary costs.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not reevaluated b. Reevaluated and approved with limited benefits c. Reevaluated but not funded d. Reevaluated and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Hydropower Generation and Energy Production (H&EP)				
H&EP.1 Scope = Basinwide. Lead agencies = USACE, FERC, USDOE.				
Prepare assessment of potential hydropower generation at USACE projects and cumulative effects of future implementation.	Non-monetary benefits in determining capacity for increased hydropower development and cumulative ecosystem impacts.	Monetary costs for the assessment.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
H&EP.2 Scope = Basinwide. Lead agencies = USACE.				
Programmatic analysis of alternative or renewable energy development within USACE-managed lands (solar, wind, bio-fuels, etc.) to support land management decisions.	Non-monetary benefits of developing data and information to support agency decision-making on requests for development of renewable energy on project lands.	Monetary costs of preparing analysis.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
H&EP.3 Scope = Sub-basin. Lead agencies = USACE, USEPA, state DNRs, and state Departments of Environmental Protection (DEPs).				
Oversight/regulation of water withdrawal permits and water quality pertaining to Marcellus Shale and other energy developments.	Monetary benefits of avoiding losses of recreation and navigation benefits due to water quality or insufficient volume.	Monetary costs of staff time devoted to regulatory actions and oversight activities.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
H&EP.4 Scope = Basinwide. Lead agencies = USACE, BLM.				
Programmatic analysis of mineral/gas extraction effects on USACE operated lands and water resources.	Non-monetary benefits of determining potential impacts to USACE authorized uses from mineral and gas extraction.	Monetary costs of preparing analysis.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
Inland Navigation (NAV)				
NAV.1 Scope = Basinwide. Lead agencies = USACE.				
Extend Ohio River Mainstem System Study to include periodic updates on traffic projections and extension of ecosystem restoration opportunities to navigable tributaries.	Non-monetary benefits from monitoring navigation traffic projections to support navigation improvements and measurable ecosystem benefits from expanded restoration program.	Monetary costs from navigation monitoring and ecosystem restoration projects.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Inland Navigation (NAV) (continued)				
NAV.2 Scope = Basinwide. Lead agencies = USACE, states.				
Basinwide cumulative analysis of corridor landside and river use impacts of public and private intermodal port development through Section 22 PAS program.	Non-monetary benefits of data and information to support agency decision-making on future regulatory actions for Section 10 permits.	Monetary cost for conducting analysis. Study costs limited to maximum $2.0 million per state, cost-shared with state 50-50. Total Federal outlay limited to $30.0 million in basin.	No long term adverse ecosystem, socioeconomic or cultural impacts anticipated. Recommended actions could result in short-term construction impacts at river access points; potential impacts to mussel populations would be assessed.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
NAV.3 Scope = Basinwide. Lead agencies = USACE, Coast Guard.				
System-wide evaluation of mooring facilities and navigation aids including latest traffic monitoring and management technology.	Measurable benefits in reducing traffic delays due to potential navigation accidents and increased navigation benefits from reduced lockage times.	Monetary costs of evaluation studies and potential installation of improved mooring facilities and navigation aids.	No adverse ecosystem, socioeconomic or cultural impacts anticipated, but habitat considerations would be paramount in project specific determinations of approval.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
NAV.4 Scope = Basinwide. Lead agencies = USACE.				
Evaluation of the NED benefits that may be generated by joint (Federal/non-Federal) development of public ports on the basin's inland waterways.	Non-monetary benefits of identifying potential opportunities for increased NED navigation benefits.	Monetary costs of conducting the evaluation.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits
NAV.5 Scope = Basinwide. Lead agencies = Navigation industry, Academia, USDOT.				
Initiate new vessel design development to accommodate expanded commodities on the river system such as containers.	Non-monetary benefits in identifying more efficient vessel designs for commodity movements. Potential navigation benefits in commodity modal shift to waterway, reduced energy use.	Monetary costs to vessel designers and builders.	No adverse ecosystem, socioeconomic or cultural impacts anticipated.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and producing systems benefits

Alternative(s)	Benefits	Costs	Ecosystem, socioeconomic, cultural and other impacts	Performance under future scenarios *a*, *b*, *c*, and *d*
Inland Navigation (NAV) (continued)				
NAV.6 Scope = Basinwide. Lead agencies = USACE.				
Rehabilitation of navigation structures (dams) that maintain stable pools used for M&I water supply and sustain mussel beds and aquatic species.	Monetary benefits of avoiding losses of availability of M&I water supply and aquatic species habitat.	Monetary costs to perform structure evaluations and costs to rehabilitate structures.	Adverse ecosystem, socioeconomic or cultural impacts may be possible during rehabilitation process.	a. Not approved b. Approved and producing limited benefits c. Approved but not funded d. Approved and avoiding losses of M&I and ecosystem benefits

The alternatives addressing the issues surrounding the deteriorating conditions of and apparent need to rehabilitate some older local protection projects (levees and floodwalls) operated and maintained by third parties, likewise appear to meet the requirements for determination of a Federal Interest. Each of the basin LPPs constructed using Federal funds was based on sound economic justification requirements and has continued to produce flood risk reduction benefits. Ongoing costs for operating and maintaining these LPPs have been the responsibility of a local non-Federal sponsor in accordance with provisions of executed cooperation agreements. Evidence that required local O&M has not been lacking is the foundation of USACE's determinations of a Federal Interest in participating in emergency repair/rehabilitation of these structures under the P.L. 84-99, "Flood Control and Coastal Emergencies," program. In addition, the current *Levee Safety Act* inspection program indicates a congressionally authorized and continued Federal Interest in the long term safety and reliability of these structures. Post inspection rehabilitation activities (should there be any authorized) would likely involve cost-sharing arrangements between USACE and the non-Federal sponsor – another indication of an ongoing Federal Interest.

8.8.2 Systems-based Water Management Plans

Alternatives that evaluate the systems-based control, storage and management of water for the purposes of enhancing and balancing existing benefit streams from USACE facilities are in the Federal Interest. Similar to the determination made above regarding the continuation of public benefits from operating reservoirs, optimizing that operation through hydrology and hydraulics (H&H) modeling and consideration of all users needs likewise is in the Federal Interest. Enhanced operations of 78 multipurpose reservoirs that support several USACE business lines based on systems modeling and collaboration with water users produces optimal system benefits at minimal costs.

Benefits accruing to the reservoir system through risk-informed, sustainable operations based on sound modeling and despite future changes in climate or water demand would far exceed the future costs (losses of system benefits) likely generated within a reactionary operating environment. Associated alternatives that facilitate management plan development through regional cooperation and provide ongoing collaboration with the basin states over water management issues also meet the Federal Interest test. Non-monetary benefits associated with states' participation, political support and avoidance of potential future water-rights conflicts outweighs the administrative costs of creating stakeholder participation forums.

8.8.3 Ecosystem and Environmental Improvement Studies

Benefits and costs accruing from improvements or enhancements of ecosystems or environmental resources at USACE projects or other locations are compared through a cost-effectiveness incremental benefits process. Where increases in specific habitat types' quantity (units) or quality can be identified from an action, those increases are deemed to be beneficial to the nation. Only the relative costs of providing the various levels of ecosystem benefit (cost effectiveness) determine which measures may be acted upon. Each of the ecosystem/environmental alternatives formulated in the study would generally provide some measure of ecosystem benefits not now being generated. Since there would be positive ecosystem benefits generated there is a Federal Interest

Table 20 – Alternatives That Fall Outside of USACE Mission Areas Or Are a Local Responsibility

Alternative ID #	Primary Federal Agencies	Primary Local Responsibility
E.7	National Park Service	Local watershed associations
E.9	United States Department of Agriculture – Farm Service Bureau	States
WQ.4	NA	American Farmland Trust, Conservancy Districts, private land owners.
WQ.5	United States Environmental Protection Agency	States, local municipalities, and counties
WQ.6	United States Food and Drug Administration	States, local municipalities, and counties
WQ.7	United States Department of Agriculture – Farm Service Bureau	States
WQ.8	Homeland Security – Federal Emergency Management Agency (HMGP)	
WQ.12	United States Environmental Protection Agency	Municipalities and counties
LDA.1	NA	States
LDA.2	NA	Municipal and county
LDA.3	NA	Municipal and county
LDA.5	NA	Municipal and county
LDA.6	NA	Municipal and county
LDA.7	NA	Municipal and county
LDA.8	NA	Municipal and county
LDA.9	NA	Municipal and county
LDA.10	NA	Municipal and county
LDA.11	NA	Municipal and county
LDA.12	NA	Municipal and county
WS.4	United States Environmental Protection Agency and ORSANCO	States
FDRD.1	United States Geological Survey, National Weather Service	
FDRD.2	Homeland Security – Federal Emergency Management Agency (HMGP)	
FDRD.8	Homeland Security – Federal Emergency Management Agency (NFIP and CRS)	
FDRD.9	NA	States
FDRD.13	Homeland Security – Federal Emergency Management Agency (HMGP)	
FDRD.17	National Weather Service and United States Geological Survey	
FDRD.18	National Weather Service and United States Geological Survey	
FDRD.20	Homeland Security – Federal Emergency Management Agency (HAZUS)	
FDRD.21	NA	States
FDRD.22	Homeland Security – Federal Emergency Management Agency (CRS)	Municipalities and counties
FDRD.23	NA	Municipalities and counties
FDRD.24	Homeland Security – Federal Emergency Management Agency (HMGP)	
NAV.5	United States Department of Transportation	Navigation industry and academia

in pursuing the alternatives – only the relative costs of the specific measures are in question.

8.8.4 Watershed Assessment Studies

ER1105-2-100 stipulates that proposed studies, such as watershed assessments, that do not recommend Federal water resources projects for construction are not required to meet more rigorous economic justification standards to determine a Federal Interest for the purpose of proceeding to the next planning step. In this document the proposed next planning step for each of the several prioritized watershed assessments (at the sub-basin level) is the Initial Watershed Assessment, similar in many respects to a standard reconnaissance report. In each case, the initial studies will be conducted in accordance with EC1105-2-411 and provided that eligible non-Federal sponsors can be identified (several have been), a cost-shared Watershed Assessment Plan can be prepared. Any number of additional spin-off studies and project initiatives can emerge from the more detailed watershed plan. In view of the reporting requirements and policy guidance regarding the conduct of both Initial Watershed Assessments and Watershed Assessment Plans found in ER1105-2-411 and ER1105-2-100, there is a Federal Interest in pursuing these system-based plans.

8.8.5 Recreation and Land Stewardship Studies

Although provision of new recreational facilities has not been considered an administration or agency budgeting priority for several years, the ongoing provision of high-quality, safe recreational opportunities at USACE dams and reservoirs continues to accrue significant public benefits. As the data described above assert, recreational visitation at the 83 USACE reservoirs over the last 5 years and the benefits that are generated merely based on application of unit-day values point toward substantial benefits greater than project O&M costs apportioned to recreation. Actions that would upgrade existing recreational facilities to meet new demands or address safety issues would likely generate even greater economic benefits above costs, thus meeting the Federal Interest requirements.

Actions taken during the updating of project master plans to address the habitat needs of Threatened and Endangered species on public lands would garner substantial ecosystem benefits (for T&E species) in excess of management costs by third parties. Avoidance of impacts to other land uses during the master planning efforts would ensure that benefits accruing to T&E species habitat management would not be offset by losses in other benefit measures.

In addition, executing partnering agreements for potential ecosystem projects based on master plan recommendations and environmental documentation would expedite those actions and avoid losses of non-Federal sponsor (state agencies and NGOs) funds. Conducting regional assessments of the effects of a growing interest in riverfront recreation development on ecosystem habitats (mussels and fish) and investigating alternative formulation and recreation demand analyses for these unique recreational opportunities would likewise fall within the larger determination of a Federal Interest in recreation development. In view of these assertions, recommendations associated with

upgrading recreational facilities, accommodating needs for T&E species habitat on USACE lands, and riverfront recreation development assessments would be in the Federal Interest.

8.8.6 Review of Completed Projects – Section 216 Studies

Section 216, “Review of Completed Projects,” is a standing authority of USACE that can be applied to operating projects when changing conditions indicate a need to re-evaluate current operations (e.g., to meet new demands or improve environmental quality). The requirements for identifying changed conditions or identifying new demands or opportunities for improving the quality of the environment depend upon either USACE personnel or other agency feedback on observance of those issues. Several comments received from natural resources agencies and environmental groups point to the need to address aquatic ecosystem issues below several basin dams and USACE staff notations of potential opportunities for reallocation of storage based on changed downstream conditions meet that program requirement.

That identification process (issues raised in this document by outside agencies) meets the requirements of the authority, ergo; there is a Federal Interest in initiating Section 216 initial appraisals at operating projects. Issues that could be addressed through the Section 216 authority would be downstream water quality and seasonal flow improvements for aquatic species, modification of single-port water intake structures, water supply demands, and reallocation of water storage from obsolete uses to meet new demands. Substantial reallocations would require special congressional authorization. Should the initial appraisal identify issues and options for improvement, approval to proceed with a standard reconnaissance study would be sought.

8.8.7 Planning Assistance to States – Section 22 Studies

Section 22, "Planning Assistance to States," is a standing authority offering USACE's technical expertise and resources to the basin states in the preparation of cost-shared water resources related studies. As a standing authority requiring only the request of the basin states to activate one or more studies within the guidelines of the authority, there is a standing Federal Interest in pursuing these studies. Studies on the effects of climate change on water resources management, identification of stable streams to support formulation of alternatives for aquatic ecosystem restoration projects, statewide water supply demand analyses (under conditions of climate change), existence of structures in the regulatory floodway, existence and effectiveness of stormwater management ordinances, needs for updated H&H and floodplain mapping, levels of loss of life from infrastructure failures and floods using LIFEsim modeling, and effects of climate change on USACE existing project lands and recreational usage would fall under this cost sharing-based authority.

8.8.8 Water Supply Studies

Although national policy states that the primary provision of water supplies are a state and local level responsibility, USACE guidance indicates that USACE is authorized to include storage in reservoirs for M&I and irrigation and that provision of municipal and industrial water supplies from USACE reservoirs is in the Federal Interest under certain

economic conditions. Allocation or reallocation of water supply storage in USACE reservoirs, development of water supply infrastructure, and infrastructure O&M constitute a 100% non-Federal responsibility; thus, USACE costs to provide M&I water supplies are minimal. Permanent reallocation of water supply storage may be considered at existing projects through preparation and approval of a Section 216 study.

8.8.9 Hydropower Studies

USACE is encouraged and has been directed by Congress through several statutes to consider the development of hydropower in any comprehensive water resources development plan. Only in limited circumstances where there is not an opportunity for non-Federal sponsor development of hydropower, would USACE become directly involved in development of the hydropower facilities and then all costs of that development would be a non-Federal sponsor responsibility. Although USACE does not construct single-purpose hydropower projects, USACE planning documents may consider such development in new or existing projects where a non-Federal sponsor has indicated capability to finance and maintain the facilities. Studies for new hydropower development at USACE facilities must be specifically authorized by Congress and non-Federal sponsors must agree to cost share in any feasibility studies. By virtue of past congressional statutes directing USACE to engage in both planning for hydropower and development of same with non-Federal interests, there is established a Federal Interest in hydropower development.

8.8.10 Navigation Studies

USACE has a long-standing Federal Interest in the provision of safe and efficient navigation including development of harbors, channels, waterways and inland waterway navigation facilities (locks and dams). The existing basin system of locks and dams is a testament to USACE's ongoing involvement in navigation. Costs for this development are shared with the waterway industry through the Inland Waterways Trust Fund.

Other associated elements of the navigation purpose such as navigation aids (signals, lights, markers, and buoys) are the general responsibility of the Coast Guard. The establishment of landside terminals and ports is considered to be primarily a non-Federal responsibility although under specific congressional authorization, USACE has become involved in reconnaissance studies and cost-shared public port master planning with non-Federal state sponsors. Generally, USACE's role in port and terminal planning and construction is limited to providing oversight and regulation of terminal development through Section 10 of the *River and Harbors Act* and the Department of the Army regulatory permit program. Recent cost-shared, port planning efforts between USACE and state port authorities have been authorized through specific legislation.

Where maintenance dredging (to maintain navigation channels) results in accumulation of clean materials, the costs of various disposal methods may be economically evaluated, and the material may be used for ecosystem restoration purposes (e.g., restoration of wetlands, reconnecting floodplains to channel ecosystems, etc.). Such re-use is accomplished through Section 204 of WRDA 1992 ("Beneficial Use of Dredged Material"). In addition, Section 107 of the Continuing Authorities Program ("Small Boat

Harbors") can be implemented along the Ohio River to establish recreational boat harbors (in cooperation with non-Federal cost-sharing sponsors).

8.8.11 USACE Authorities

The USACE active authorities are listed in Table 11 of Appendix K and Table 12 of Appendix L and are displayed geographically across the basin in Figures 25 through 31.

9. PRELIMINARY FINANCIAL ANALYSIS

During the formulation of this reconnaissance report, the PDT was made aware of specific watersheds and sub-basin areas that were of interest to basin stakeholders (state agencies, public interest groups, NGOs such as the Nature Conservancy, and other Federal water-resource and natural-resource agencies). Subsequent coordination with several of the stakeholders and groups indicated a level of interest that could result in a letter of intent for cooperation in a more detailed study.

Letters of intent are being pursued as the findings and recommendations of this approved reconnaissance report are coordinated with those groups. The financial capability of each potential non-Federal sponsor will be determined during preparation and negotiation of a feasibility-level agreement.

10. SUMMARY OF FEASIBILITY PHASE ASSUMPTIONS

Any feasibility phase and other types of planning studies that would emanate from this reconnaissance report would be further developed based on several basic planning assumptions including the following;

a. Any feasibility phase efforts would be developed in accordance with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation*, Engineer Regulation 1105-2-100, the *National Environmental Policy Act* (NEPA), and other applicable Federal laws, regulations, and water resources development policies as amended.

b. Any cost-shared feasibility phase efforts would involve a capable and willing non-Federal sponsor (state, local jurisdiction, or NGO) who has executed a Feasibility Cost Sharing Agreement and would contribute at least 50% of the cost of the feasibility study of which 100% of the non-Federal match may be contributed as in-kind work and services as identified in an approved Project Management Plan.

c. Any basinwide study approved through the reconnaissance report as being 100% Federally funded would require extensive collaboration with numerous Federal, state, local agencies, tribal councils, and NGOs to define the components of the study and expected outcomes.

d. In watersheds where a multitude of land and water resource issues have been raised by stakeholders and where the complex interaction of those issues defy resolution in this reconnaissance report (for the purpose of defining the

components of a traditional feasibility phase), an Initial Watershed Assessment would be the preferred method of further study in lieu of a feasibility study.

Any such watershed assessment would be carried out in accordance with ER1105-2-100 and EC1105-2-411 policies and procedures. The Watershed Assessment Plan would be cost-shared in accordance with Section 729 of WRDA 2000 as amended and the requirements in EC1105-2-411.

11. FEASIBILITY PHASE MILESTONES

Table 21 lists the standard milestones for a civil works water-resources feasibility study. Other "milestones" that may precede Milestone F1 include MSC approval/certification of the reconnaissance report, preparation of a basinwide Strategic Management Plan to identify study priorities, congressional authorization of a non-standard feasibility study (100% Federally funded), congressional appropriation of and receipt of Federal feasibility funds, preparation of a Project Management Plan, execution of the Feasibility Cost Sharing Agreement, and receipt of non-Federal sponsor matching funds. Should feasibility phases be initiated after this report is approved, a specific schedule will be developed in concert with sponsor resources (monetary and in-kind work).

Table 21 – List of the Standard Milestones for a Civil Works Water-Resources Feasibility Study

Milestone	Description	Duration (mo)	Cumulative (mo)
Milestone F1	Initiate Study	0	0
Milestone F2	Public Workshop/Scoping	2	2
Milestone F3	Feasibility Scoping Meeting	11	13
Milestone F4	Alternative Review Conference	9	22
Milestone F4A	Alternative Formulation Briefing	5	27
Milestone F5	Draft Feasibility Report	3	30
Milestone F6	Final Public Meeting	1	31
Milestone F7	Feasibility Review Conference	1	32
Milestone F8	Final Report to SPD	3	35
Milestone F9	DE's Public Notice	1	36
-	Chief's Report	4	40
-	Project Authoriztion	4	44

12. FEASIBILITY PHASE COST ESTIMATE

Before a Project Management Plan is developed (through collaboration between a product delivery team and the anticipated non-Federal sponsor), estimated costs are highly uncertain, due to unforeseen contingencies. The standard feasibility work tasks listed in Table 22 are included to offer a framework for capturing anticipated feasibility costs.

Table 22 – Standard Feasibility Work Tasks

WBS	Description	Cost
JAA00	Feas – Surveys and Mapping Except Real Estate	
JAB00	Feas – Hydrology and Hydraulics Studies/Report (Coastal)	
JAC00	Feas – Geotechnical Studies/Report	
JAE00	Feas – Engineering and Design Analysis Report	
JB000	Feas – Socioeconomic Studies	
JC000	Feas – Real Estate Analysis Report	
JD000	Feas – Environmental Studies/Report (Except USF&WL)	
JE000	Feas – Fish and Wildlife Coordination Act Report	
JF000	Feas – HTRW Studies/Report	
JG000	Feas – Cultural Resources Studies/Report	
JH000	Feas – Cost Estimates	
JI000	Feas – Public Involvement Documents	
JJ000	Feas – Plan Formulation and Evaluation	
JL000	Feas – Final Report Documentation	
JLD00	Feas – Technical Review Documents	
JM000	Feas – Washington Level Report Approval (Review Support)	
JPA00	Project Management and Budget Documents	
JPB00	Supervision and Administration	
JPC00	Contingencies	
L0000	Project Management Plan (PMP)	
Q0000	PED Cost Sharing Agreement	
Total		

13. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE

Relevant issues include:

a. Identification of a Federal Interest in one or more potential solutions to the identified issues or sufficient supporting information to initiate an Initial Watershed Assessment or other planning process.

b. Identification of willing and financially capable non-Federal sponsors to support feasibility studies and other recommended studies.

c. Availability of state or local discretionary funds to support feasibility studies.

d. Approval to initiate basinwide studies at 100% Federal cost that are clearly shown to be interstate in nature and where no single beneficiary can be identified.

e. Congressional appropriations.

14. VIEWS OF OTHER RESOURCE AGENCIES

Several letters have been received from other Federal and state agencies and organizations, regarding their views on the Ohio River basin study, their expectations and concerns for the basin, and their support for the plan.

The City of Henderson

P.O. Box 716
Henderson, Kentucky 42419-0716

August 17, 2009

S. Michael Worley, P.E., Project Manager
Department of the Army
Huntington District, Corps of Engineers
502 Eighth Street
Huntingburg WV 25701-2070

RE: Reconnaissance Study - Ohio River Basin

Dear Mr. Worley:

Pursuant to your request, the City of Henderson is pleased to be included in the referenced study. Both the City of Henderson and Henderson County border the Ohio and Green River basins and often are affected by the flooding of both rivers.

Canoe Creek tributary is the primary drainage way for Henderson County and efforts have been made over the past 50 years to reduce flooding issues. Significant efforts have been made over the past two years to reduce flooding along Canoe Creek by performing improved maintenance measures and restoring portions back to the original Corp of Engineers design of 1983. Henderson's Flood Mitigation Board has been working with the Louisville District to obtain planning assistance and the submittal of a Letter of Intent – 205 Request.

We are formally requesting that Canoe Creek and its tributaries be included in this study. We have performed extensive modeling studies of the Canoe Creek basin and would be happy to share any information we have with the Corp. In addition, Henderson prides itself on having an excellent GIS database system and has been complimented by FEMA during recent D-Firm map upgrades. Again, we are pleased to be included in this study and look forward to working with the Corp and its consultants.

Mr. S. Michael Worley, PE
August 17, 2009
Page Two

Should you have any further questions, you may reach me at (270) 831-1200 or by e-mail at bnewman@cityofhendersonky.org.

Sincerely,

William L. "Buzzy" Newman, Jr.
Assistant City Manager

/dmc

c: Mayor Thomas E. Davis

ONIS "TREY" GLENN, III
DIRECTOR

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adem.alabama.gov
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Montgomery, Alabama 36130-1463
(334) 271-7700
FAX (334) 271-7950

BOB RILEY
GOVERNOR

August 17, 2009

Mr. S. Michael Worley, PE
Project Manager, Ohio River Basin Comprehensive Study
US Army Corps of Engineers, Huntington District
502 Eighth Street
Huntington, West Virginia 25701

Dear Mr. Worley:

I am writing in response to your July 2, 2009 letter requesting my agency's input during the reconnaissance study of the Ohio River Basin, including the Cumberland and Tennessee River basins. The Alabama Department of Environmental Management (ADEM) has regulatory oversight for a number of programs related to water resources within the Tennessee River basin in north Alabama. These programs include development, issuance, and enforcement of National Pollutant Discharge Elimination System (NPDES) permits for municipal, private, and industrial wastewater treatment facilities, development, issuance, and enforcement permits for public drinking water treatment and distribution systems, development of water quality standards, and the development and implementation of Total Maximum Daily Loads (TMDLs).

The Corps activities relative to the major water resource categories mentioned in your letter can have significant implications for ADEM's regulatory programs. As such, we appreciate the opportunity to participate in the comprehensive study and look forward to providing our input during the process. Specifically, issues that are of most concern to ADEM include water supply, water quality, regulation of river flows for hydropower and navigation, hydrologic data availability, and changes in system operations.

Thank you again for soliciting this agency's input. If you have questions or need additional information, please contact Mr. Lynn Sisk, Water Quality Branch Chief, ADEM Water Division at 334-271-7826 or by email at ls@adem.state.al.us.

Sincerely,

Onis "Trey" Glenn III
Director

OTG/LS/ghe

Birmingham Branch
110 Vulcan Road
Birmingham, AL 35209-4702
(205) 942-6168
(205) 941-1603 (Fax)

Decatur Branch
2715 Sandlin Road, S.W.
Decatur, AL 35603-1333
(256) 353-1713
(256) 340-9359 (Fax)

Mobile Branch
2204 Perimeter Road
Mobile, AL 36615-1131
(251) 450-3400
(251) 479-2593 (Fax)

Mobile - Coastal
4171 Commanders Drive
Mobile, AL 36615-1421
(251) 432-6533
(251) 432-6598 (Fax)

Illinois Department of
Natural Resources
One Natural Resources Way Springfield, Illinois 62702-1271
http://dnr.state.il.us

Pat Quinn, Governor
Marc Miller, Director

August 24, 2009

Mr. S. Michael Worley, PE
Project Manager
Department of the Army
Huntington District, Corps of Engineers
Huntington, West Virginia 25701-2070

Dear Mr. Worley:

This letter is in response to your August 3, 2009 letter to Arlan Juhl of my staff requesting information on the most pressing water resources issues and needs of the Ohio River Basin in Illinois. The Illinois Department of Natural Resources has numerous interests in the Ohio River Basin, while this letter speaks specifically to the flood risks which exist, and the need for improvements to reduce those risks.

Illinois is uniquely positioned where the Ohio and Mississippi Rivers converge, and have unique issues related to these two major rivers. The State has documented numerous additional flood problems located within Illinois and the Ohio River Basin. These flood problems are documented in the pages attached hereto and labeled "Flood Stages in Illinois: Flood and Damage Data" (DRAFT dated August 2009).

The following four issues are of particular interest to the State of Illinois:

Karnak Levee

The Karnak Levee was completed in 1952 under an intergovernmental agreement executed by the Louisville District Corps of Engineers and the Cache River Drainage District. In 2002 this levee failed due to lack of maintenance of a drainage structure. This levee failure allows flows from the Upper Cache River, which is tributary to the Ohio River via the Post Creek Cutoff, to reenter the Lower Cache River and to discharge into the Mississippi River. In 2008, over 5,000 cfs was estimated to be flowing through the Karnak Levee breach from the Upper Cache and Ohio Rivers based on adjacent stream gages and highwater mark information collected during the 2008 event. Ohio River flood stages, starting at a 2-year frequency event, are capable of flowing westward through the breach to the Mississippi River via the Lower Cache River. The consequences of the failed levee have been experienced by the Villages of Karnak, Ullin, Sandusky and Alexander County. These flows outlet to the Mississippi River from the Lower Cache River across the river from a levee operated under the authority of the Mississippi River and Tributaries (MR & T) Project. The MR & T project must now handle an increased flow from the Lower Cache River as the Mississippi River flows past Cairo, Illinois. This poses threats to Cairo, Illinois and the MR & T levee system, while flooding significant communities and farmland in Illinois. Illinois believes this situation needs to be reassessed to determine if the decertified levee should be reestablished, and the benefits and costs of such action.

Old Shawneetown Levee

The Old Shawneetown Levee was completed in 1934 under an intergovernmental agreement between the Louisville Corps of Engineers and the Village of Old Shawneetown. The levee was overtopped in 1937 and federal and state agencies made a concerted effort to buy-out Old Shawneetown and to relocate the community in New Shawneetown on the bluffs overlooking the Ohio River. Several properties were unwilling to relocate and the levee system is maintained with minimal funding, equipment, and resources. As floods occur, emergency response funds are expended by local, state and federal units of government to provide emergency protection to the remaining portions of Old Shawneetown. The economics of these operations and the need for substantial upgrades to the levee for protection of industrial and historical structures needs to be assessed.

Brookport Levee

The Brookport Levee was completed in 1949 under an intergovernmental agreement between the Louisville District Corps of Engineers and the City of Brookport, Illinois. The levee has remained in service since that time; however the economy of Brookport has significantly declined. Brookport is currently unable to assess adequate taxation to provide funding to maintain the levee and appurtenant works to the satisfaction of the Corps of Engineers, and there are significant deficiencies in drainage structures through the levee. The Illinois Emergency Management Agency and the Department of Natural Resources now require the City of Brookport to implement an evacuation plan when conditions indicate the community could experience a levee failure. The future operations and maintenance of this levee system needs to be assessed under the economic conditions which prevail today and which can be reasonably forecast to exist into the future.

Ohio River/Wabash River/Saline River floodplains

Illinois has experienced numerous flood events where the Ohio River, Wabash River, and Saline River expand and join in the vicinity of Gallatin County. In 2008, this condition led to the failure of agricultural levees which provided marginal protection to large acreages of agricultural lands and the associated roadways, homesteads and grain storage facilities. The causes, circumstances and impacts of this condition need to be assessed.

The attached satellite imagery of the March 2008 flooding depicts many of these problem areas. The February 19, 2008 memorandum which is attached documents the vulnerability of these flood protection systems to storm conditions.

Acquisition of adequate streamflow records on Ohio River tributaries in Illinois has remained difficult to fund over the past several years. The Corps of Engineers has reduced its' data collection efforts in these streams, and other agencies have only provided limited data to fill these data gaps. Long term funding of streamgage data, along with acquisition of LiDAR derived digital elevation models, would assist with planning, emergency response, and floodplain mapping in Illinois.

The State of Illinois is aware of Ohio River Basin improvements (reservoirs) which have reduced the probability of reoccurrence of the 1937 flood, however, Illinois is also aware of numerous deficiencies in levees constructed to handle the 1937 flood stages and the impact climate change

Page 3: Mr. S. Michael Worley

can have on predicted flood flows and stages. These conditions, combined with the identified project issues listed above, suggest that Illinois would benefit from an assessment of these risks. This assessment could become the basis for development of an Ohio River Flood Hazard Mitigation Plan for Illinois, and would assist with the certification and accreditation of levees in the future.

Sincerely,

Gary R. Clark

Gary R. Clark, P.E.
Director, Office of Water Resources

GRC:ARJ:rc

Attachments

U.S. Department of Homeland Security
Region III
One Independence Mall, Sixth Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

AUG 1 2 2009

FEMA

S. Michael Worley, P.E.
Project Manager, Ohio River Basin Comprehensive Study
U.S. Army Corps of Engineers, Huntington District
502 Eighth Street
Huntington, West Virginia 25701

Dear Mr. Worley:

Thank you for your letter dated July 2, 2009, regarding U.S. Army Corps of Engineers' reconnaissance study of the Ohio River Basin (ORB) and the opportunity to provide feedback regarding our needs as a stakeholder within the ORB, to provide information for the study, and the opportunity to partner with the Corps in your current study efforts. I am writing to you on behalf of FEMA Region III's Mitigation Division and, as the ORB includes FEMA Regions IV and V, I encourage you to outreach to those FEMA regions as well if you have not already done so.

Your letter is very timely as the Federal Emergency Management Agency (FEMA), being the agency that manages the National Flood Insurance Program (NFIP), has just started a new five-year program – Risk Mapping, Assessment, and Planning (Risk MAP) – to help reduce loss of life and property due to flooding and other disasters. Further details about the Risk MAP program may be found on FEMA's website at http://www.fema.gov/plan/ffmm.shtm. I see great potential for achievement of common goals between the ORB reconnaissance study and Risk MAP.

As the name of the Risk MAP program implies, FEMA is placing focus on risk assessment and mitigation planning in addition to making quality improvements to flood hazard data and mapping. FEMA has spent the past five years under its Flood Map Modernization Program converting much of the nation's NFIP map inventory into Geographic Information System (GIS) format. Considering Risk MAP and the NFIP in general, many of the topics that you list in your letter as well as on the ORB reconnaissance website as crucial water resources issues within the ORB are of interested to FEMA; most notable is flood damage reduction. In general, any aspects of the study that focus on identification, assessment, or mitigation of natural hazard risks would be very valuable to FEMA and, from FEMA's perspective, to the citizens within the ORB. As such, subtopics listed on the website such as dam safety, aging infrastructure, and levee encroachments are of special interest.

FEMA does maintain and have access to data that may be of value to the Corps while working on the ORB reconnaissance study. A partial list of such information is included below.

- Flood hazard boundary and elevation information, in GIS format, for portions of the ORB as well as study reports on a county (and, in some cases, community) level regarding flood hazards within the respective ORB communities;

S. Michael Worley, P.E.
Page 2

- Hazard risk assessments for various regions and municipalities within the ORB and/or access to FEMA's HAZUS-MH risk assessment tool and methodology (http://www.fema.gov/plan/prevent/hazus);
- Hazard mitigation plans, prepared in accordance with Section 322 (Mitigation Planning) of the Robert T. Stafford Disaster Relief and Emergency Assistance, for the state and select communities within the ORB;
- Information on flood insurance claims, to include repetitive loss properties, within the ORB; and
- Information on local mitigation projects supported through FEMA grants.

FEMA Region III has a long-standing relationship with the Corps, including the Huntington District, and will continue that relationship as a partner in the ORB reconnaissance study. As a partner, FEMA Region III can provide the aforementioned data as well as additional input into or review of the study as it is developed. Further, FEMA has no concerns over the Corps including a link from the ORB website to FEMA's website (www.fema.gov).

Regarding statuary authority, FEMA, as you are likely aware, is part of the Department of Homeland Security. The NFIP was created by Congress in 1968 through the National Flood Insurance Act of 1968 (P.L. 90-448). The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1988 (amending the Disaster Relief Act of 1974, PL 93-288) constitutes the statutory authority for most Federal disaster response activities especially as they pertain to FEMA and FEMA programs.

Thank you for including FEMA Region III as a partner with the Corps on this effort. Please feel free to contact Jon Janowicz of my staff at (215) 931-5524 or via email at jon.janowicz@dhs.gov to further discuss Region III's involvement in the ORB reconnaissance study.

Sincerely,

Eugene K. Gruber, P.E.
Director, Mitigation Division

CONSOL ENERGY.

CONSOL ENERGY Sales Company
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MICHAEL W. HENNESSEY
Vice President
River Operations

August 12, 2009

Mr. S. Michael Worley, PE
Project Manager, Ohio River Basin Comprehensive Study
US Army Corps of Engineers, Huntington District
502 Eighth Street
Huntington, WV 25701

Dear Mr. Worley,

Thank you for your letter asking for the input of CONSOL Energy, Inc. for your reconnaissance study of the Ohio River Basin. From our company's standpoint, the most important water resources issue in the Ohio River Basin is the completion of the Lower Monongahela River Lock #2, #3 and #4 project. This project started in 1996 and was scheduled to be completed in 2004 at a cost of $844 MM. As of today, the Lower Mon #2, #3 and #4 project is scheduled to be completed sometime in 2018 at a new total cost of $1.2 billion. This delay and the associated cost over-runs are very troubling to CONSOL Energy on many points. Primarily, we are concerned about the imminent failure of the +100 year old dam at Lock #3. If this dam fails, the pool from Lock #4 (MP 41) through Lock #2 (MP 11) will drain out and render this 30 mile section of the Monongahela River unusable to the towing industry and industry in general. CONSOL Energy, Inc. has five coal mines (three in West Virginia and two in Pennsylvania) that rail CONSOL tonnage to the Monongahela River for loading into barges at our Alicia Dock facility. If the Monongahela River is not navigable, we can't ship our coal to our electric utility customers on the Monongahela, Allegheny and the Ohio Rivers. Obviously, this is not a scenario that CONSOL wants to see occur and would be catastrophic to our company and to our electric utility customers.

CONSOL is also worried about the effect a dam failure would have on the small towns along the thirty mile stretch on the Monongahela River. Each town would lose water for their water authorities, sewer systems and their respective fire departments. Industries and utility power plants would also be shut down due to lack of water. All in all, a very ugly and hazardous scenario.

Due to the financial consequences to CONSOL and our utility customers, and the pain small towns would endure on the Monongahela River, we consider completing the Lower Mon #2, #3 and #4 project as the most important river project in the three rivers area around Pittsburgh.

Thank you again for requesting our input.

Sincerely,

Michael W. Hennessey
Vice President – River Operations

KENTUCKY DEPARTMENT OF FISH & WILDLIFE RESOURCES
TOURISM, ARTS, AND HERITAGE CABINET

Steven L. Beshear
Governor

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Marcheta Sparrow
Secretary

Dr. Jonathan W. Gassett
Commissioner

August 12, 2009

Mr. S. Michael Worley, P.E.
US Army Corps of Engineers

RE: Comprehensive Ohio River Reconnaissance Study

Dear Mr. Worley,

We have several resource needs including habitat, recreations, and research questions that effect the Ohio River. Please review the following list for consideration in the proposed study.

1. Closure and/or surplus of recreational boat ramps by the US Army Corps of Engineers: boat ramp and public access has been identified by KDFWR as a priority. Based on economic models, fishing and boating related recreation provides significant contributions to the economy. Economic analysis of amp closures and ramp needs should be considered.
2. Minimum flow requirements below dams.
3. Winter pool levels: which projects can modify operations and discharges to modify winter pool levels for fisheries resources.
4. Restricted access below dams on tributary streams and rivers: restriction distances have been based on Ohio River limits which may not apply to tributaries.
5. Low head dams on tributaries: these dams present safety issues and/or fisheries impacts which may include fish passage or negative impacts to stream fish assemblages. Many of these dams create "drowning machine" hydraulic flows, some during high flow and some constantly. Several drownings have taken place over the years. Emergency situations including at least one drowning have taken place in the past year. The state of Illinois recently undertook a study to identify such dams out of safety concerns. Nationally, low head dams have become a hot issue because of safety, fisheries impacts, and because of failing infrastructure concerns. Research directed toward dam removal, retrofitting dams to eliminate the recirculating hydraulic, and identification of failing dams in the state would provide useful information.
6. Threats to aquatic habitat have been recognized as a national issue. The National Fish Habitat Initiative (http://fishhabitat.org/) is working with state, regional, and local fish habitat partnerships to prioritize aquatic habitats and restoration projects. KDFWR belongs to the Southeastern Aquatic Resource Partnership (SARP; see http://www.sarpaquatic.org/) which obtains aquatic habitat grants through this program to restore streams and aquatic habitat. The US Army Corps of Engineers needs to be more engaged with the national and local

partnerships because of the obvious overlap with resources and projects. Many habitat projects are needed on Corps' owned land and reservoir projects.

7. Many Corps reservoir have physically degraded tributaries that flow into the reservoirs, contributing abnormally high sediment loads. This not only impairs the tributaries but contributes to early senescence or alteration of reservoir habitat. At least some of these tributaries are within the Corps property boundaries. Identifying these impaired tributaries and allowing or funding restoration projects would provide aquatic resource benefits.
8. Aquatic nuisance species: many species of exotic-invasive aquatic plants threaten Corps reservoirs as well as other non-federal impoundments. KDFWR has developed an Aquatic Nuisance Species Plan which can be found on our website (http://fw.ky.gov/nuisancespeciesplans.asp). Funding for treatment and control options present a problem to KDFWR. Incorporating aquatic nuisance species control into Corps project funding, such as stewardship funding, would help address problems.
9. Recreational access at Corps dams with hydroelectric facilities needs to be evaluated or re-evaluated to ensure public access is not unnecessarily restricted. Access from Corps properties along the Ohio River should be provided and improved to allow controlled access that is ADA accessible.
10. A plan or list of potential funding partners and funding sources would be a beneficial part of this reconnaissance study. Historically, Corps funds require a non-federal match that is higher than other funding sources. The result is that many Corps' planned project do not get funded or that states must fund those projects separately. The Ohio River Mainstem Study identified many habitat restoration needs. However, the Ohio River continues to be developed without any funding going toward fish and wildlife resources of the river.
11. Habitat improvement on the Ohio River and main tributaries may require modeling of flows. It would be useful to identify habitat projects and undertake any modeling to determine which treatments are feasible. For example, large boulders could be used in tailwaters or larger rivers as a cost effective habitat improvement. It would be helpful for the Corps to determine viable treatments and/or locations.
12. Fleeting operations have caused some concern for resource agencies because of the potential negative effect on mussel beds. At least part of the concern is that at shallower depths, barge traffic causes scour which negatively impacts mussel beds. Because of this fleeting companies fund mussel surveys and biological assessments to site or modify fleeting proposals to avoid and minimize impacts to mussel beds. A research project that determines critical depths that pose threats to mussel beds in the vicinity of fleeting operations would benefit both resource agencies and barge companies.
13. Mussel beds in the Ohio River and major navigable tributaries: the mussel data on the Ohio River and tributaries need to be updated. Updated comprehensive mussel bed surveys would provide more current information on the location and health of mussel beds. This would be useful for resource agencies, the Corps of Engineers-Regulatory Offices, and private industries that use the river.

Please refer to our Strategic Plan available for viewing on-line at http://fw.ky.gov/ for more issues and goals that have overlap with your study. This plan was completed with KDFWR identified needs and input provided at public meetings across the state. Another source of information is our Comprehensive Wildlife Action Plan also on-line at our website. This plan identifies species with the greatest conservation need across the state and prioritizes geographic areas based on occurrence records, physiographic regions, and/or watersheds.

If you have any further questions please call me at your convenience at 502-564-7109 ext. 4471.

Sincerely,

Mike Hardin, Program Manager
Division of Fisheries

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Ohio River Basin Comprehensive Reconnaissance Study
Feedback Form

What organization do you represent? U.S. Department of Energy Southeastern Power Administration

Name and Contact Information: Herb Nadler, 706-213-3853, herb.nadler@sepa.doe.gov
Douglas Spencer, 706-213-3855, douglas.spencer@sepa.doe.gov

What are the most pressing water resource issues in the Ohio River Basin facing your organiztion?

Southeastern is the Federal Power Marketing Administration that has the responsibility to market the electric power generated at Laurel, Wolf Creek, Dale Hollow, Cordell Hull, Center Hill, Old Hickory, J. Percy Priest, Cheatham and Barkley projects in the Cumberland River Basin. The overall operation of the river basin is an integral part of power marketing in terms of the effect on power production and availability of generation to meet customer's schedules. Any operational changes to the river basin could dramatically affect peaking power production at the projects and result in a loss of revenue for the Government and/or an increase in the federal power rates that the preference customers must pay in future rate adjustments.

It is Southeastern's responsibility to ensure that the costs allocated to the hydro power purpose are repaid to the United States Treasury. Project repayment costs were developed and assigned based on authorized purposes receiving certain benefits from the projects and such costs are to be repaid by the purpose in the utilization of project features such as available storage. Typically, the costs allocated to hydropower account for a very high percentage of the reservoir project costs.

Southeastern would be concerned with any changes which adversely impact the operation of a project with respect to the production of hydro-power. Any changes which create operational restrictions or redistributes project benefits should be accompanied by a reallocation of project costs and compensation to the impacted purpose. It is neither fair nor equitable to expect an authorized purpose to be responsible for costs which do not correspond to the level of benefits received. Any reductions in the availability of power are an impact to Southeastern's preference customers. The municipalities and cooperatives which benefit from project generation are heavily dependent on their government allocation of capacity and energy to meet their peak loads. Many of them have been preference customers for fifty years. They have designed their electrical systems considering the government generation as an important part of their systems peaking resource. Any reductions in the level of benefits available to them should be accompanied by an appropriate level of compensation.

Are there additional questions about this planning effort? No.

Please submit form to Patty Coffey, Chief of Planning, US Army Corps of Engineers (email: Patricia.Coffey@usace.army.mil; phone: (615)736-7865) or Mitch Laird, Project Manager (phone: (615)736-7865; email: Mitchell.P.Laird@usace.army.mil) with any additional comments.

Thanks for your input!

Cumberland River Compact

September 24, 2009

S. Michael Worley, PE
Project Manager, Ohio River Basin Comprehensive Study
US Army Corps of Engineers, Huntington District
502 Eighth Street
Huntington, West Virginia 25701

Dear Mr. Worley,

Thank you for the opportunity to comment on the Ohio River Basin Comprehensive Study. Founded in 1997, the Cumberland River Compact is a nonprofit 501(c)3 organization with a mission to enhance the water quality of the Cumberland River and its tributaries through education and by promoting cooperation among citizens, businesses, and agencies in Kentucky and Tennessee. We believe that communities can have both a strong economy *and* a healthy environment. Our goal and reputation is to be a trusted source of information on water issues and to facilitate cooperation among all stakeholders to ensure that our rivers and streams continue to provide us with clean water, bountiful crops, healthy fisheries, and abundant recreational opportunities.

We have a long history of working with the Nashville District of the U.S. Army Corps of Engineers in our Basin which winds over 696 miles through Kentucky and Tennessee. The land through which our river flows is home to some of the greatest biodiversity in the United States and over 2,000,000 people. Many of the same problems that plague other watersheds (high levels of erosion, sedimentation, a variety of point and non-point issues) have gained a foothold here. We work throughout the 18,000 square miles of the Cumberland River Basin to address those problems through four major programs and other special initiatives.

The **Watershed Program** was the first initiative developed by the Compact. Its goal is to establish and nurture watershed organizations in each of the 14 sub-watersheds within the Cumberland River Basin. In addition to helping the seven organizations formed to date, we provide educational programs outreach for the general public in these areas as well.

The **Building Outside the Box (BOB) Program** promotes and teaches sustainable building practices that enhance water quality and quantity and has resulted in over 100 water and energy-friendly developments, which include better building practices and stream restoration. We have provided education to builders and developers both in the Basin and to several states outside the Basin at their request. In addition, we have measured economic impact and garnered recognition from the Governor's Green Building Awards and EPA with a visit by EPA's Administrator as well.

Our **Local Officials Community Water Education Program** seeks to bring high-quality water education to elected and appointed local officials and their staff as well as the general public. Through this program, we have worked with local officials and staff to cooperatively assess and expand their capacity to address water quality and supply concerns. After assessments, we provide classes to educate and assist communities with developing water-friendly policies and practices, including buffer zone and steep slope ordinances and green infrastructure demonstration sites.

P.O. Box 41721 Nashville, TN 37204 www.cumberlandrivercompact.org (615) 837-1151

Project Blue Streams attends to smaller headwater streams in the Cheatham Reservoir Watershed which are often neglected by area landowners. These streams often have great economic, social, cultural, and environmental value. Project Blue Streams works with the local landowners to preserve and improve small stream habitat on their properties.

Through the establishment and operation of these programs over the last twelve years, the Compact has gained thousands of stakeholders and a network of partners who have come to respect us for our even-handed style and our proficiency at organizing and holding stakeholder meetings – and making good things happen for watersheds.

In the context of who we are, our comments are born out of support for and enthusiasm to work with the Corps on this upcoming project.

Through the Ohio River Basin Comprehensive Study we would urge the Corps to include and actively engage the Compact in:

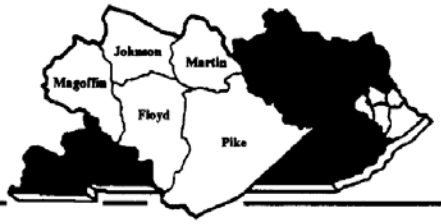
- Working together to develop and carry out a Tennessee-Cumberland River Basin Study for the purposes of addressing infrastructure needs together, studying, and working to enhance watershed ecology in impaired areas, and examining and utilizing mechanisms which aid in keeping ongoing objective historic measurements of river health, flows, and supply
- Seeking out and working cooperatively on Section 205 and Section 14 projects to enhance water quality and supply across the Basin to illustrate the transparency and inclusive nature of the modern Corps of Engineers
- Linking to each other's websites to better highlight both the water challenges of our Basin and the exciting work being carried out by both our organizations and other partners as well
- Building a data base of the knowledge and resources presented at meetings held regarding this effort, again displaying it on and linking it to and from both our websites and
- Providing a non-Corps presence and reporting function at meetings regarding this process as well as other Corps efforts in the Cumberland Basin.

We will look forward to keeping abreast of ongoing progress and thank you again for this opportunity to comment.

Best regards,

Doug Hausken, Executive Director

Cc: Shirley Caldwell-Patterson
Courtney Masters
BG John W. Peabody, Division Commander, Great Lakes and Ohio River Division
Pete Kopcsak
Margo Farnsworth
Mike Wilson
Patricia Coffey



BIG SANDY
AREA DEVELOPMENT DISTRICT, INC.
110 RESOURCE COURT
PRESTONSBURG, KY 41653

December 4, 2009

Colonel Robert Peterson
District Engineer
U.S. Army Corps of Engineers, Huntington District
502 Eighth Street
Huntington, WV 25701-2070

Dear Colonel Peterson:

The purpose of this letter is to express the Big Sandy Area Development District's (BSADD) support for the Big Sandy Watershed Re-evaluation Study. As you are aware, this study would evaluate a reallocation of water storage at Flannagan and North Fork of Pound Lakes in Virginia, as well as Fishtrap, Dewey, Paintsville, and Yatesville Lakes in Kentucky, and would address current watershed demands within West Virginia, Virginia and Kentucky. The results of such a study could provide positive impacts to industrial and economic development as well as tourism and recreation opportunities in all three states.

We fully support any legislation that would provide authority for the Corps of Engineers to perform a re-evaluation study and would gladly participate in coordination meetings associated with such an effort.

Sincerely,

Sandy Runyon

Sandy Runyon
Executive Director

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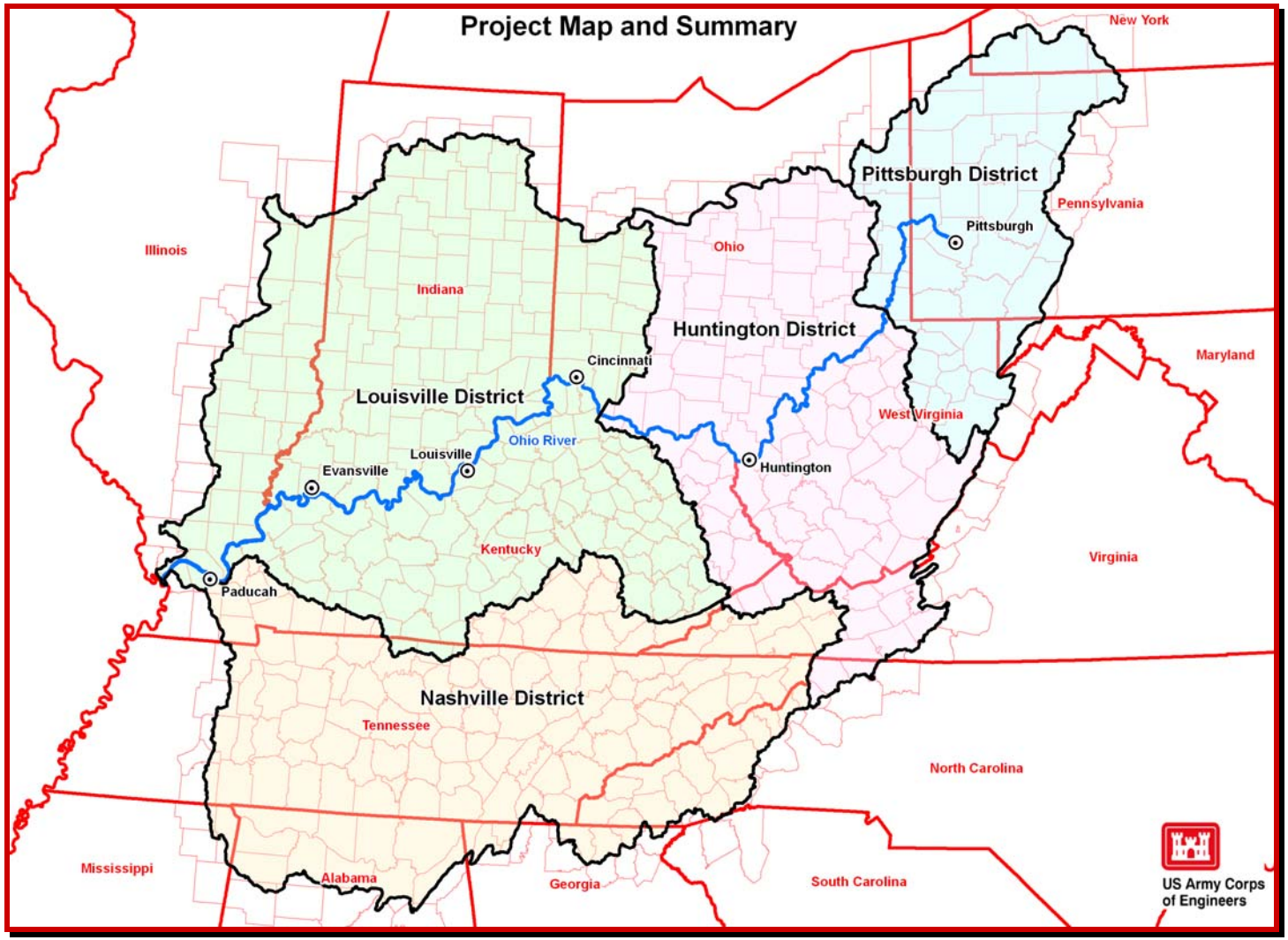
15. PROJECT MAP



16. RECONNAISSANCE REPORT RECOMMENDATIONS

> ***"We have a choice – we can plow new ground or let the weeds grow."***
>
> *—Jonathan Westover* [6]

This reconnaissance study has investigated a broad range of issues relating to the use and development of the land and water resources of the Ohio River basin. The issues were generated by current project sponsors, key stakeholders, and the general public and by USACE personnel. For the sake of report brevity and formulation of alternatives, the submitted issues were grouped into twelve distinct issue categories. Some of the categories fell within the authorities of USACE's authorized missions. Several appeared to be more appropriately addressed by other Federal agencies (such as FEMA, NRCS, USFWS, or USGS), and a number of issues fell within the purview of state, county, and municipal jurisdiction for administration, regulation, and management. Table 20 in Section 9 identifies those alternatives that are clearly not within the purview of USACE's missions or legal authority to pursue.

A brief analysis of the categories of issues using existing data led to the formulation of a number of alternatives with associated outputs, costs, and impacts that have been described in the report in tabular form. Many of the alternatives can be addressed through existing authorities of USACE and other agencies. In a few cases, the alternatives would require specific congressional authority. Some of the alternatives suggest a review of current water resources policies with the view of potential revisions to address unique problems and opportunities raised by the respondents.

A subsequent analysis of the benefits and costs of the alternatives revealed that many solutions indicate potential to generate substantial monetary and non-monetary public benefits in excess of costs. Other alternatives, although not promising substantial monetary benefits, offer generation of critical data to support future decision-making in both Federal and state agencies. For these reasons, a number of alternatives were determined to hold a Federal Interest in proceeding to more detailed planning with Federal and non-Federal resources. The following report recommendations have been arranged according to the geographic scope of the issues and alternative solutions. The alternatives brought forward into the recommendations were considered to be the most pressing in terms of addressing critical needs and most likely to garner political and financial support from the basin stakeholders and potential sponsors. As Mr. Westover suggests, we have a choice between new opportunities or accepting the weeds.

Several recommendations propose that specific plans or studies be completed at 100% Federal cost. This proposal has been made in recognition of several basic facts: (1) the primary activities, features, or elements considered in the recommended plans or studies are inherently interstate in nature, equally affecting all 15 basin states; (2) the elements or features of the basin being studied have been historically Federal in nature

[6] A quote attributed to Jonathan Westover and first included in a Virginia Department of Agriculture report in 1958–1959. The quote expresses the need to be future-oriented in our actions, lest inaction allow the current problems (weeds) to prosper and overtake us. Jonathan Westover was later found to be a fictitious person.

and current efforts regarding those features are being implemented at 100% Federal cost; (3) the basinwide emphasis of the plans or studies does not permit identification of one primary beneficiary with whom a study cost-sharing agreement could be executed; and (4) selection of one beneficiary out of the 15 states for the purpose of executing a study cost-sharing agreement could create the perception of favoritism during planning processes that require complete objectivity. Other recommended alternatives are clearly targeted at a specific region, watershed or issue where an eligible and financially capable non-Federal sponsor can and will be identified for cost-sharing purposes.

16.1 REPORT RECOMMENDATIONS

a. Prepare a basinwide water management plan at full Federal cost that addresses the full array of water user needs and current system of water control facilities. Estimated cost for the water management plan is $20.0 million over a 5-year period.

b. Prepare a basinwide reinvestment plan at full Federal cost that addresses the existing USACE-designed and -constructed flood risk reduction structures, including single-purpose dams and multi-purpose reservoirs as well as local protection projects operated by third parties. The estimated cost of the infrastructure reinvestment plan is $16.0 million over a 3-year period.

c. Prepare a basinwide study of current and future potential collaborative organizations for water resources management and development (at full Federal cost) that addresses the needs and expectations of the states, Federal agencies, and the public in a collaborative forum. The estimated cost of the collaborative forum study is $350,000 over 2 years.

d. Prepare Initial Watershed Assessments under the authority of Section 729 of WRDA 1986, as amended by Section 202 of WRDA 2000, for the following sub-basins or watersheds of the Ohio River:
   - Muskingum River,
   - Green River,
   - Monongahela River,
   - Duck River Watershed
   - Cumberland River,
   - Tennessee River,
   - Wabash River,
   - Great Miami River,
   - Scioto River,
   - Allegheny River,
   - Licking River,
   - Kanawha River, and
   - Big Sandy River.

e. Initiate sub-basin level, specifically authorized Section 216 (Review of Completed Projects) studies to identify opportunities for reallocation of authorized storage within and between existing multi-purpose USACE reservoirs for:
   - Muskingum River (16 reservoirs),
   - Wabash River (16 reservoirs),
   - Allegheny River (9 reservoirs),
   - Big Sandy River (7 reservoirs),
   - Kentucky/Licking Rivers (7 reservoirs),
   - Scioto River (6 reservoirs),
   - Green River (4 reservoirs),
   - Monongahela River 4 reservoirs),
   - Kanawha River (3 reservoirs),
   - Great Miami River (3 reservoirs), and
   - Cumberland River (2 reservoirs).

f. Collaborate with Federal and state natural resources agencies in the development of a basinwide, cost-shared, comprehensive "invasive species" assessment and control strategies plan.

g. Integrate needs of Threatened and Endangered species habitat in project master plans where such species or their habitat types are known to be resident within project lands.

h. Determine what land and water-use management and recreation mitigation strategies (including adaptive management strategies) may be appropriate in project master plans to reduce future impacts to authorized project benefits as a result of climate change.

i. Where appropriate, develop, negotiate, and execute partnering agreements with state natural resources agencies and NGOs for ecosystem restoration projects at USACE operating projects based on USACE updated master plan recommendations for ecosystem projects.

j. Support state and local efforts to expand the Environmental Infrastructure Programs to all basin states and support expansion of environmental infrastructure authorities to include stormwater facilities that assist in resolving municipal and county CSOs.

k. Support efforts by state and Federal natural resources agencies to expand through congressional action the geographic coverage of the existing Ohio River Ecosystem Restoration authority (Section 101 of the *Water Resources Development Act of 2000* [114 Stat. 2578]), to include all rivers/streams and associated riparian corridors of the basin (including the Tennessee and Cumberland sub-basins).

l. Collaborate with the Ohio River Basin Fish Habitat Partnership, the Southeast Aquatic Resources Partnership, and The Nature Conservancy in the further cooperative development of strategic aquatic restoration opportunities using existing (Sections 206 and 1135 of CAP) and future USACE ecosystem restoration authorities.

m. Collaborate with Federal and state agencies, and municipal and county jurisdictions (through USACE's floodplain management services program), to expand participation in NFIP and the associated Community Rating System (CRS). Such collaboration would include joint activities to educate and train local floodplain managers and administrators, as well as sharing of pertinent data and information on floodplain hazards and cost-shared FRR activities that reduce damages and support the CRS program (under Section 205, "Small Flood Protection Projects," of the Continuing Authorities Program [CAP]).

n. At the request of basin states, pursue cost-shared studies under the Section 22, "Planning Assistance to States" program that would address the following basin issues:

    1. Municipal and county stormwater management.
    2. Floodplain mapping and hydrologic/hydraulic data.
    3. Identification of, and strategies for protection of, stable streams.
    4. Current supply and future anticipated demand for M&I water supplies.
    5. Structures and facilities located within the delineated boundaries of the regulatory floodway.
    6. Assess potential impacts and benefits of expanding floodplain development to support growing use of the navigable waterways for manufacturing, fabrication, processing, storage and shipping of new commodities.
    7. Assess effectiveness and capability of current public access into the navigation pools for recreationists and emergency first-responders to support navigation security and accident-response programs.
    8. Assess (Pennsylvania, West Virginia, Ohio, and Kentucky) the potential impacts of exploration and extraction of natural gas from the Marcellus Shale formation on water supplies and water quality in the affected area.
    9. Assess, at the sub-basin level, sedimentation from point and non-point sources, sediment storage capacity at USACE reservoirs, sedimentation effects on lake and downstream outflow ecosystems, and effects of seasonal reservoir drawdown on tributary streams within project boundaries.

o. Re-evaluate current program and project policies and regulations regarding the following concerns:

    1. Return of user fees and charges collected at USACE reservoirs back to the originating projects (for use in upgrading and expanding recreational facilities).

2. Expansion of the Silver Jackets flood risk reduction program to address basinwide issues.
3. Cost-sharing rates on ecosystem restoration programs that support the goals and objectives of the Environmental Operating Principles.
4. Cost-sharing requirements for rehabilitation of local protection projects.
5. Land use management on USACE-managed lands for development of renewable energy sources.
6. Estimating flood risk reduction benefits where high-frequency flooding in steep-gradient stream watersheds results in total structure loss below flood depths indicating maximum structure economic losses.

p. Develop flood risk analyses for each sub-basin in cost-shared efforts with individual states using the FEMA HAZUS model and Geospatial Information Systems (GIS) technology.

q. Maintain and update the Ohio River basin GIS Atlas as an LRD Division-wide asset and make available to the public through an electronic water resources library.

r. Prepare a basinwide study of the potential hydropower capability of the basin reservoirs and locks and dams under various scenarios of climatic change.

s. Update and expand components of the current flood warning systems and explore alternatives for future system O&M financial support.

t. Prepare reconnaissance studies of unprotected, at-risk communities along the Ohio River mainstem and its tributaries.

16.2 CONCLUSION

Each of the recommendations would be effective in addressing one or more issues expressed by key stakeholders, the public and USACE staff at a level commensurate with the scope of the problem and with consideration of the characteristics of the current systems in place and the ongoing needs for collaboration between Federal, state, regional, and local partners. Implementation of the recommended actions as well as other alternatives identified could resolve many of the issues and concerns raised in the study. Identifying a strategic pathway forward that addresses prioritized implementation of the recommendations and other alternatives would be accomplished in a programmatic management plan as the final step in the reconnaissance phase.

17. OFFICE OF COUNSEL OPINION OF LEGAL SUFFICIENCY

USACE – Great Lakes and Ohio River Division

Chief Counsel: _____

US Army Corps
of Engineers