

## **CUMULATIVE EFFECTS ASSESSMENT AS THE INTEGRAL COMPONENT OF THE PROGRAMMATIC EIS**

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### **Abstract**

The cumulative effects assessment (CEA) process can serve as a useful integrating tool for addressing the impacts of proposed and other actions at the programmatic level. Further, the environmental sustainability (ES) of affected valued environmental components (VECs) can be used as a means of assessing the significance of cumulative effects. Because programmatic EISs are typically characterized by larger study areas, longer planning horizons, and numerous uncertainties related to future actions and environmental consequences, innovative methods and approaches are needed to accomplish CEA studies. Six needs-driven methods and approaches used in this case study include: (1) application of CEQ's 11-step CEA process for general and detailed planning of the study; (2) collaboration with an Interagency Working Group (IWG) during CEA planning and implementation; (3) utilization of a continuous scoping process during study conduction; (4) development and use of reasonably foreseeable future action (RFFA) matrices for identifying connections between actions and VECs, analyzing ES, and identifying follow-on ES needs, monitoring, and possible adaptive management (AM); (5) conduction of a VEC-based analysis of ES (AES) process involving identifying common effects from actions, relating these effects to indicators of ES over several time periods, and determining the relevant ES classifications; and (6) communicating the study findings based on a VEC-by-VEC presentation, coupled with a summary of cross-cutting findings. Key lessons derived from the use of these innovative methods and approaches are that they are all beneficial to planning and completion of a CEA study; the continuous scoping process is particularly necessary when dealing with a largely unprecedented impact study at the programmatic level; RFFA matrices provide a systematic tool that can be used for impact analysis and summarization of findings; and the AES approach encourages both relative and holistic thinking, and provides a basis for identifying ES needs and, possibly, a monitoring and AM program.

Descriptor words: cumulative effects assessment, environmental sustainability, valued environmental components, Interagency Working Group, RFFA matrices, continuous scoping, adaptive management

## Introduction

The U.S. Army Corps of Engineers (Corps) is conducting a cumulative effects assessment (CEA) study as one part of a system investment plan (SIP) for long-term navigation needs on the mainstem of the Ohio River. The overall study is referred to as the Ohio River Mainstem Systems Study (ORMSS). This strategic-level impact study provides a holistic review of the past, current, and anticipated environmental impacts from multiple actions and programs of the Corps; other federal, state, and local governmental agencies; and private industries and agricultural activities. The CEA serves as the technical basis and information integrator for a programmatic environmental impact statement (PEIS) that is being prepared for the SIP.

Cumulative effects (CEs) are an emerging issue, in general, in impact studies; the definition that follows is from the Council on Environmental Quality's (CEQ's) National Environmental Policy Act (NEPA) Regulations (Council on Environmental Quality, 1978):

“Cumulative impact” is the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The CEA study is in consonance with the above definition and with the policy of the Corps relative to addressing the cumulative effects of water resources plans such as the SIP. This policy is (U.S. Army Corps of Engineers, 1999):

The cumulative effects of the plan and other similar activities should be analyzed. Each proposed water resource development activity is but a piece of a large-scale program. The combined beneficial and adverse economic, environmental and social impacts of individual projects, each of which may be relatively minor, can have a significant regional or national impact. At each level of the evaluation and review process it is necessary to assess the cumulative beneficial and adverse effects of individual project impacts. Significant effects should guide the decisions.

Accordingly, the goal of the CEA study is to assess the full direct, indirect, and contributed impacts of further modernization of the Ohio River mainstem navigation system on resources, ecosystems, and human communities along the mainstem. The analysis addresses the accumulation of meaningful impacts to valued environmental components (VECs) from the modernization of the navigation system in concert with impacts from other past, present, and reasonably foreseeable future actions (RFFAs) by the Corps and others.

In addition to this introductory section, sections are also included on the situational context, and needs for innovative approaches to accomplish the CEA studies. Six developed methods or approaches are then described in further sections, they include:

application of the CEQ's 11-step process, an Interagency Working Group, a continuous scoping process, uses of RFFA matrices, a method for the analysis of environmental sustainability (ES), and communication of the study findings. Other innovative methods or approaches are addressed in companion papers related to the use of navigation traffic scenarios, incorporation of life cycle features of freshwater mussels in CEA, identification of ES needs, and monitoring and adaptive management. The final section of this paper includes the conclusions related to the above-mentioned six methods and approaches.

## **Situational Context**

In addition to the CEA, two other issues are related to the context of environmental studies for the SIP. The first involves the use of ES as an "ultimate test" for determining the significance of cumulative effects. ES is identified in the Corps' recently published Environmental Operating Principles (EOPs). The second is associated with the usage of programmatic-level impact studies where water resources plans are being addressed. Both of these context issues are highlighted in this section.

### Environmental Operating Principles

On March 26, 2002, General Robert Flowers, then Chief of Engineers of the Corps, announced seven EOPs for Corps planning and decision-making. Three of the principles are directly related to the ORMSS and have been incorporated in the CEA; they are (U.S. Army Corps of Engineers, 2002):

- Principle 1 -- Strive to achieve environmental sustainability. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.
- Principle 2 -- Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.
- Principle 5 -- Seek ways and means to assess and mitigate cumulative impacts to the environment; bring systems approaches to the full life cycle of our processes and work.

The foundation principle is number 1, which relates to sustainable development and environmental sustainability. An early definition of sustainable development was that it is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). Stated differently, sustainable development involves the search for a path of economic progress that does not impair the welfare nor destroy the environmental and natural resources of future generations; thus intergenerational equity is a fundamental premise (Pearce, Markandya, and Barbier, 1989).

The above-three principles are also addressed in an Engineering Circular (EC 1105-2-404) related to planning Civil Works projects consistent with ES considerations (U.S. Army Corps of Engineers, May, 2003). ES is defined as "a synergistic process whereby environmental and economic considerations are effectively balanced through the life cycle of project planning, design, construction, operation and maintenance to improve the quality of life for present and future generations" (U.S. Army Corps of

Engineers, 2002). While the EC indicates that it is applicable to feasibility and general reevaluation studies initiated after May 1, 2003, the concepts of ES were being used in the ORMSS prior to that date. It is important to note that the EOPs were also incorporated in Engineer Regulation (ER) 200-1-5 later in 2003 (U.S. Army Corps of Engineers, October, 2003).

### Programmatic EISs

Project-level environmental impact studies have been conducted for over 30 years in many countries. Since approximately 1990, there has been increasing attention directed toward strategic-level impact studies. Such studies in the United States are documented via the preparation of PEISs. These PEISs are focused on the environmental consequences of plans, programs, or policies of various governmental agencies. As noted above, a PEIS is under preparation for the SIP. Further, the Corps has completed or is involved in the preparation of PEISs for several other water resources plans or programs.

Strategic-level impact studies are typically characterized by larger geographical areas and longer future time frames than used at the specific project-level. Further, due to the paucity of consistent baseline data across the larger geographical area, and the possible complete absence of impact-related data on future projects and activities in the study area, the locational and quantitative specificity of impact predictions tends to be less than for project-level studies. However, despite these differences, strategic impact studies and associated PEISs provide the opportunity to more appropriately address cumulative effects from multiple actions and activities across space and time; to delineate geographical areas, habitat types, and plant and animal species which should be afforded more protection; and to require certain impact mitigation strategies and environmental restoration programs for enhancing ES. Further, the planning and implementation of adaptive management (AM) programs can be integrated into PEISs. Beyond these potential benefits, the opportunity also exists for introducing environmental issues and concerns at the decision level which is often driven only by traditional engineering and economic analyses, and related non-environmental policy choices.

More specifically, the PEIS for the SIP being developed via the ORMSS addresses the direct, indirect, and cumulative effects of the plan itself. The SIP is an official plan prepared by the Corps which will guide or prescribe alternative means to maintain an efficient, economically viable, and environmentally compatible navigation system, and which will provide information upon which future Corps actions will be based. However, it should be noted that future environmental assessments (EAs) or EISs will be prepared, as appropriate, on specific actions included within the SIP. Such future documentation will be tiered from the PEIS (Council on Environmental Quality, 1978).

Further, and as inferred above, it will be necessary to periodically review the SIP and PEIS in order to maintain current navigation and environmental information that can inform specific project-level decision-making. Such reviews can be aided by monitoring and policy information generated within an on-going AM program. Depending upon the types of modifications to the SIP, it may be necessary to issue one or more Supplemental PEISs at future dates.

## Needs for Innovative Approaches

During the early stages of the detailed planning for the CEA study, it was determined that these were no precedent-setting studies or comprehensive examples for large rivers involving waterway navigation. Accordingly, several new and innovative approaches were developed. The key needs being addressed and the approaches used are listed as follows:

- Need – a planning framework for the CEA study. Approach – applied CEQ's 11-step CEA process to each of the selected VECs to be addressed (Council on Environmental Quality, 1997).
- Need – achieve coordination across the large study area, numerous institutional boundaries, and overlapping responsibilities of various agencies. Approach – formed an Interagency Working Group (IWG) to provide advice and reviews during the conduction of the CEA study.
- Need – maintain flexibility due to numerous pragmatic uncertainties associated with how to accomplish the study. Approach – developed a multi-component continuous scoping process.
- Need – to consider multiple past, present, and RFFAs in relation to their individual and cumulative effects on the selected VECs. Approach – developed and used 22 RFFA matrices to delineate cause-and-effect relationships between the actions and the selected VECs and their subcomponents.
- Need – a method to assess the cumulative effects of multiple actions on the environmental sustainability of the selected VECs. Approach – developed an analysis of environmental sustainability method that combines the effects of actions on hierarchical indicators of ES so that sustainability classes can be designated.
- Need – to identify VEC-based actions that could be used to improve sustainability. Approach – utilized groups of experts to delineate sustainability needs for aquatic and riparian/floodplain resources. (Note: this approach is separately addressed in the companion paper entitled “Analysis of Environmental Sustainability Needs for the ORMSS”.)
- Need – to effectively communicate the findings of the CEA study. Approach – organized the CEA report on a VEC-by-VEC basis, with summary information from the report included, as appropriate, in the PEIS.

## Application of CEQ's 11-Step Process

The CEQ's 11-step CEA process was applied at both a general planning level and a detailed level for identified VECs. Steps 1 to 4 relate to scoping, Steps 5 to 7 to describing the affected environment, and, Steps 8 to 11 to determining the environmental consequences. The specific steps and descriptions of how they were addressed are as follows:

- Step 1 – Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals. This step was based upon the identification of the typical impacts associated with the construction and operation of navigation system locks and dams, and their repair and rehabilitation and periodic maintenance activities. Public scoping meetings were held along with several meetings of a 40-person IWG. The initial scoping in Step 1 provided the basis for the identification of 12 VECs of concern. The VECs included aquatic ecological resources (water and sediment quality, mussels, and fish), riparian and floodplain ecological resources (floodplain hydrology, terrestrial habitat, wetlands, islands, and soils and geology), threatened and endangered species (fish, mussels, mammals, birds, and plants), air quality, recreational uses of the River, noise, aesthetics, human health and safety, cultural resources, transportation and traffic, land use, and socioeconomic resources (including environmental justice).
- Step 2 – Establish the geographic scope for the analysis. The scope for the majority of the identified cumulative effects issues and related VECs consisted of the mainstem of the Ohio River along with its approximate 500-year floodplain. Due to data availability on actions, resources, and impacts, the geographic scope often focused on the mainstem and the contiguous counties in the six states along the mainstem.
- Step 3 – Establish the time frame for the analysis. The selected time frame was typically from 1920 to 2060 for most VECs. The earlier date coincides with the initiation of a system of locks and wicket dams on the Ohio River mainstem. The latter date reflects the economic study period for the SIP. One exception for this time frame was the inclusion of information on much earlier cultural properties for the cultural resources VEC.
- Step 4 – Identify other actions affecting the resources, ecosystems, and human communities of concern. As noted earlier, “other actions” include past, present, and reasonably foreseeable future actions (RFFAs). To facilitate these identifications and their potential effects, a series of 22 RFFA matrices were developed. The 22 matrices encompassed the 12 VECs and their subcomponents as delineated in Step 1. The RFFAs, which also included similar past and present actions, were defined as:

Actions identified by analysis of formal plans and proposals by public and private entities that have primary (direct) or secondary (indirect) impacts on VECs associated with the Ohio River. RFFAs also include potential actions that are beyond mere speculation when incorporated in plans or documents by credible private or public entities. RFFAs may also include events forecasted by trends, probable occurrences, policies, regulations, or other credible data that may have bearing on the VECs.

A total of 87 types of RFFAs were identified and considered in the analyses; the types were divided into six categories: navigation investment actions, other Corps actions, “but for” actions (actions that would not occur “but for” the existence of the navigation system), actions by others, natural disasters, and regulatory

environment. Each listed RFFA was characterized in terms of its anticipated time period of occurrence, probability of occurrence, and location on the River. The anticipated effects of each RFFA on each VEC or subcomponent were described in “smart cells” using Microsoft® Excel spreadsheets. Finally, the importance (high, medium, or low) of each RFFA relative to cumulative effects on each VEC or subcomponent was also described in “smart cells”.

- Step 5 – Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses. This step was based upon an analysis of ES (AES) for the pertinent VECs or subcomponents. The AES approach was comprised of four parts: (1) identification of “common effects” on the VEC or subcomponent thereof from the High and Medium importance RFFAs as delineated in the pertinent RFFA matrix (Step 4 above); (2) selection of indicators of ES for the VEC or subcomponent thereof, and their tiered grouping, as appropriate; (3) description of the “connections” between the common effects (and related High and Medium importance RFFAs) and the indicator groups; and (4) assignment of a “bottom line” category to the ES of the VEC or subcomponent, based on considering the past, present and future conditions. The ES categories included “not sustainable”, “marginally sustainable”, and “sustainable”. Specific ES definitions were developed for each VEC or subcomponent.
- Steps 6 and 7 – Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds; and define a baseline condition for the resources, ecosystems, and human communities. These two steps were addressed jointly for each VEC or subcomponent. The approach consisted of identifying historical and current laws, regulations, ordinances, and programs that contain regulatory thresholds and/or policies related to the VEC or subcomponent. Then, historical reference point and trends information, along with current conditions, were summarized for the indicators of ES for the VEC or subcomponent. Numerous information sources were reviewed for Steps 6 and 7. Further, the institutional information and environmental conditions and compliance with regulatory thresholds served as the basis for the categorization of the past and present ES for the VEC or subcomponent.
- Step 8 – Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities. This step was largely accomplished through the development of the RFFA matrices as described in Step 4. Further, peer-reviewed literature, various governmental studies and reports, and impact-study related and resource-management related books were used to more thoroughly document numerous relationships. Attention was also given to various relationships between VECs and subcomponents (e.g., what are the implications of changes in water quality on the populations of mussels in the River?).
- Step 9 – Determine the magnitude and significance of cumulative effects. Due to limited data on specific impacts from various actions, and to the system-wide focus of the CEA study, it was not possible to quantitatively determine the magnitude of the cumulative effects on the VECs and subcomponents. Rather, a qualitative

determination was made based on the AES approach described in Step 5. The significance of the cumulative effects was ascertained via compliance or noncompliance with regulatory thresholds, and the consideration of the connections between common effects and indicators of ES. The assigned categories of ES for the past, present, and future represent the composite significance determination for the cumulative effects on each VEC or subcomponent.

- Step 10 – Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects. This step has been addressed via the identification of generic mitigation measures for many of the analyzed actions, with particular attention being given to such measures for navigation investment actions by the Corps. In addition, various regulatory programs that have facilitated, or are expected to emphasize, generic mitigation measures for numerous actions have also been identified and incorporated in the analysis. A special approach was used to identify various mitigation and other ES needs for aquatic ecological and riparian/floodplain ecological resources; as noted earlier, this approach is described in the companion paper entitled “Analysis of Environmental Sustainability Needs for the ORMSS”.
- Step 11 – Monitor the cumulative effects of the selected alternative and adapt management. This step has been addressed in a systematic manner for each VEC and subcomponent. The key criteria that are being used to “trigger” Step 11 are the past, present, and future ES categories for the VECs and subcomponents. If the VEC or subcomponent is currently “sustainable”, and this is expected to continue into the future, only targeted additional monitoring over that currently being done is recommended, and no specific adaptive management strategy will be developed. For VECs or subcomponents that are currently categorized as “not sustainable”, or “marginally sustainable”, specific collaborate monitoring will be recommended along with an appropriate adaptive management strategy.

Both general and detailed planning for the CEA study was accomplished by a Central Planning Team (CPT). The CPT was primarily comprised of five members, including two persons from the Corps and three persons from an environmental consulting firm. The disciplinary backgrounds include two biologists, one environmental engineer, one landscape architect, and one political scientist/environmental planner. Regarding their experience with impact studies, one CPT member has over 30 years experience, two have from 15 to 25 years experience, and two have about 5 years experience each.

The CPT met every 2 to 3 months for the purposes of determining the timing and budgetary status of work-in-progress, conducting joint planning for specific future work elements and the overall connections between the CEA study and the SIP/PEIS, and jointly reviewing draft chapters, sections within chapters, and appendices. The need to develop a method or approach for completing a task or for transitioning from one task to another was frequently identified, and such methods or approaches were proposed, developed, tested, and refined during the meetings. These periodic meetings proved to be invaluable due to the broad nature of the SIP/PEIS, and the use of CEA as a means of integrating the effects of multiple actions on environmental features within the study area.

A steering committee also provided valuable inputs during the conduction of the CEA. For the ORMSS, the steering committee was named the Oversight Board (OB), which is a 14-person group comprised of Corps management-level professionals from the pertinent geographical Division and three involved Districts. The OB meets quarterly and conducts monthly teleconferences. It provides leadership direction relative to the overall ORMSS; such direction includes scheduling, budgetary approvals and adjustments, reviews of work-in-progress, and periodic policy decisions relative to topical issues and related intra- and inter-agency coordination and collaboration. The two Corps members of the CPT routinely interacted with the OB.

### **Interagency Working Group**

As noted above, the IWG consisted of approximately 40 members representing federal and state agencies with responsibilities for environmental management, as well as several ENGOs. Six members were from the U.S. Fish and Wildlife Service, with one serving as the coordinator for the USFWS group; two were from the U.S. Geological Survey; and one was from the U.S. Environmental Protection Agency. In addition, the Ohio River Valley Sanitation Commission (ORSANCO), a federally chartered compact among several states in the Ohio River drainage, had two representatives on the group. Members from ENGOs include one person from the Sierra Club, one from the Ohio River Foundation, and two from The Nature Conservancy. The remaining members were from natural resources or environmental management agencies in the six states bordering the Ohio River. The IWG had two to three meetings annually with the CPT. These one-day joint meetings included information dissemination and updates related to the status of the CEA study, status reports on specific research projects, and working sessions on integrative topics such as impact matrices for RFFAs, indicators for ES, and AES.

More specifically, the IWG has fulfilled the following purposes:

- Aided in identifying key issues and cumulative effects that should be addressed in the CEA study.
- Assisted the CPT in delineating and prioritizing key research needs relative to environmental issues and natural resources. Examples of completed research include fish passage studies at selected locks, determination of winter habitat requirements for selected fish species, and surveys of freshwater mussel populations at various river locations. In addition, the IWG has reviewed the completed research reports.
- Participated in the completion of RFFA matrices for VECs and their subcomponents related to aquatic ecological resources, floodplain/riparian ecological resources, and threatened/endangered/protected species.
- Reviewed work plans for addressing cumulative effects on VECs and their subcomponents; in addition, reviewed the identified methods and procedures relative to “best practice tools” for the specific issues and cumulative effects to be addressed. It should be noted that “best practice tools” infer both scientific validity and cost-effectiveness relative to their application.

- Conducted systematic reviews of draft chapters and appendices for the CEA study report and the SIP/PEIS.
- Provided periodic and continuing scientific information on emerging issues; examples include the incorporation of the ES analyses and the need to consider nonstructural measures for navigation traffic management, along with proactive repair and rehabilitation of existing locks and dams, and lock extensions.
- Participated in discussions related to a coordinated and collaborative long-term strategy for environmental monitoring and AM for the aquatic and floodplain/riparian ecological resources within and along the Ohio River mainstem. In fact, the IWG could become part of a long-term decision-making structure and process related to enhancing the ES of key resources.

In summary regarding the IWG, it provided the CPT with valuable scientific information and advice. Further, mutual education and continuing networking is occurring among the IWG and CPT. The “buy-in” of various governmental agencies and ENGOs to the study process was achieved via a healthy dialogue. Negative perceptions related to the role of committees are typically associated with the logistics and costs regarding meetings, the roles and limits of such committees in decision-making processes, and the creation of unmet expectations for all involved persons. However, these negative perceptions were greatly exceeded by the benefits noted above.

### **Continuous Scoping Process**

Scoping refers to an early and open process for determining the scope of the impact study and the significant issues to be addressed in an EIS or PEIS. This process was incorporated in the NEPA regulations promulgated by the CEQ in 1978 (Council on Environmental Quality, 1978 and 1981). “Early” suggests that the process will occur during the initial stages of planning a PEIS, although scoping can continue throughout a study, particularly for programmatic-level studies such as this navigation system study that incorporates new themes such as CEA and environmental sustainability (U.S. Army Corps of Engineers, 2002, and May and October, 2003). “Open” denotes that the process provides the opportunity for participation by affected federal agencies, state and local governments, Indian tribes, environmental nongovernmental organizations (ENGOs), development entities, and various other publics (stakeholder groups and individuals).

The scope of the study is related to the range of actions, alternatives, and impacts to be addressed in the PEIS (Council on Environmental Quality, 1978). Other than unconnected single actions, the range of actions can include “connected actions” to the original proposal, and “cumulative actions” and “similar actions” which can affect common environmental features. The range of alternatives are to include the “no action” alternative (this could be a continuation of current practices or a no project option), other reasonable courses of action to meet the identified needs, and the proposed action with add-on mitigation measures not included in the original concept and design. The range of impacts should include the direct and indirect impacts of the proposed action and alternatives, as well as the cumulative impacts of past, present, and future actions on common resources, ecosystems, and human communities.

An important principle related to the scoping process is that it should be uniquely designed for each impact study. The process itself can incorporate multiple features such as the conduction of a series of scoping meetings, telephonic and/or e-mail surveys of the perspectives of various agency and public stakeholders regarding the necessary scope, the solicitation of written comments from various stakeholders regarding the scope and significant issues to be addressed, and the completion of special research studies and literature-based policy/scientific reports on potentially affected resources, ecosystems, habitats, and protected species. Each of these features has been incorporated in the continuing scoping process for the CEA study.

The scoping process for the CEA and the SIP/PEIS for the Ohio River navigation study was characterized by multiple components, with several extending from the early planning stages to the completion of the SIP/PEIS. Table 1 provides a brief synopsis of the six components and their key functions in relation to the entire scoping process. Twelve public scoping meetings, along with the use of questionnaires, were accomplished early in the CEA study process. These early components were useful in prioritizing the 12 original VECs, and in identifying new issues and concerns that had not been previously identified.

The CPT and IWG were routinely engaged in study planning and continuous scoping throughout the conduction of the CEA study. To illustrate the continuous nature of the process, the following scoping emphases occurred over the time period of the CEA study:

- First quarter of study – identification and prioritization of the VECs, detailed planning for addressing the cumulative effects on each VEC, and establishment of the spatial and temporal scopes for the analysis of each VEC (encompasses Steps 1 to 3 of CEQ's 11-step process)
- Second quarter of study – development and usage of the RFFA matrices, and preparation of descriptions of affected environment conditions for the 12 VECs, including data assemblage and summaries of institutional requirements (encompasses Steps 4, 6, 7, and 8 of CEQ's 11-step process)
- Third quarter of study – development and usage of analysis of ES approach; determination of past, present, and future ES categories for the VECs; and incorporation of research and special study findings into the CEA report (encompasses Steps 5, 8, and 9 of CEQ's 11-step process)
- Last quarter of study – identification of ES needs via the conduction of expert group workshops for aquatic and riparian/terrestrial resources, report organization for information communication, and analysis of other potential usefulness of monitoring and AM as a follow-on program after completion of the PEIS (encompasses Steps 10 and 11 of CEQ's 11-step process)

One unstated thesis of the multi-component scoping process was that scoping does not refer solely to a single event or meeting; rather, it is a process that can include several mutually supportive and beneficial components. Further, and as demonstrated herein, the features of scoping can be beneficially extended throughout the planning and

**TABLE 1**  
**Components of the Scoping Process**

<b>Component</b>	<b>Key Functions</b>
Central Planning Team (CPT)	Provided leadership to the entire scoping process; including educational features related to CEA; interactions with the OB and IWG; development of VECs, RFFAs, methods, and AES; and analyses of received information.
Steering Committee --- Oversight Board (OB)	Provided policy advice and overall approvals for scheduling and budgetary matters for the entire ORMSS.
Interagency Working Group --- (IWG)	Provided scientific and/or policy advice to the CPT; aided in identifying research needs; participated in the completion of RFFA matrices, the identification of indicators for AES, and the delineation of ES needs; and reviewed various study documents.
Scoping Meetings --- Agencies and General Public	Provided input on the scope of the CEA study and related SIP/PEIS, including the identification of cumulative effects concerns and contributory actions to these concerns.
Questionnaires	Provided input on past actions and effects on aquatic and riparian ecological resources, the relative importance of the 12 VECs, and future concerns and management approaches.
Informational Website	Contained information on the ORMSS, public meetings, and the results of the scoping meetings; used by individuals to request further information on the issues of concern.

Notes:

CEA = cumulative effects assessment  
 VECs = valued environmental components  
 RFFAs = reasonably foreseeable future actions  
 AES = analysis of environmental sustainability  
 ORMSS = Ohio River Mainstem Systems Study  
 SIP/PEIS = system investment plan and programmatic environmental impact statement

conduction of a CEA study (i.e., scoping is an on-going and iterative process). Accordingly, the following conclusions and lessons learned can be articulated from this multi-component process:

- As illustrated by this example, scoping should be viewed as an important continuing, iterative process that can facilitate the integration of CEA within a large-scale SIP/PEIS. This “continuing process” is particularly important when dealing with largely unprecedented impact studies at the programmatic level. Further, such a process can provide a more robust input to the planning and conduction of a CEA study than a process comprised only of one to several public scoping meetings.
- Due to the relative newness of CEA within impact studies, particularly at the programmatic level, it is important that an educational component related to cumulative effects be incorporated in all components of the scoping process.
- An IWG can provide invaluable input relative to continuous scoping.
- The 11-step CEA procedure developed by the CEQ provided a useful framework for designing a unique scoping process for the CEA study. However, the designed process needs to include sufficient flexibility so as to facilitate adjustments over the period of time required for a SIP/PEIS to be prepared.

### **RFFA Matrices**

The term “RFFA” suggests that there should be some level of certainty related to the action, and that it should not be simply speculative or hypothetical. Further, RFFAs may be promulgated by Federal and non-Federal agencies, and by the private sector. In addition, such RFFAs could occur as a part of general population growth and economic development. Finally, another important implication of the above definition is that the RFFAs must impact the same resources, ecosystems, and human communities (i.e., VECs) that are being impacted by the proposed action, in this case, the navigation SIP (Council on Environmental Quality, 1997).

The original perception of the CPT was that one “overall matrix” could be developed. The overall matrix would have included all the identified RFFAs and the VECs and their subcomponents together. However, due to expediency relative to matrix completion, it was recognized that individual matrices would be needed for the 12 original VECs. For the three VECs with multiple components (Aquatic Ecological Resources, Riparian/Floodplain Ecological Resources, and Threatened/Endangered /Protected Species), additional matrix columns were envisioned. However, it was soon recognized that matrices focused on single subcomponents within VECs, or single VECs themselves, would be more useable. As a result, 22 matrices were used; the listing is in the left column of Table 2. Table 2 also indicates that several committees were involved in the preparation and review of the matrices.

**TABLE 2**  
**Summary of Process Features Related to Completion**  
**of the RFFA Matrices**

VEC	Preparation of Matrix	Review and Summarization of Matrix
AER – Water Quality/Sediment Qual	CPTC	CPT
AER – Fish	ERTC	CPT
AER – Mussels	IWGC (Note 1)	CPT
Air Quality	CPTC	CPT
RFER – Terrestrial Habitat	IWGC	CPT
RFER – Islands	IWGC	CPT
RFER – Wetlands	IWGC	CPT
RFER – Soils and Geology	IWGC	CPT
RFER – Floodplain Hydrology	IWGC	CPT
T/E/P Species – Fish	IWGC	CPT
T/E/P Species – Mussels	IWGC	CPT
T/E/P Species – Mammals	IWGC	CPT
T/E/P Species – Birds	IWGC	CPT
T/E/P Species - Plants	IWGC	CPT
Aesthetic Resources	CPTC	CPT
Noise	CPTC	CPT
Human Health and Safety	CPTC	CPT
Land Use	CPTC	CPT
Transportation and Traffic	CPTC	CPT
Socioeconomic Resources	CPTC	CPT
Cultural Resources	CPTC	CPT
Recreation	CPTC	CPT

Notes:

CPTC = central planning team committee (3-4 members)

CPT = central planning team

IWGC = interagency working group committee (3-4 members)

Note 1 = it was assumed that the T/E/P Species-Mussels RFFA Matrix is applicable to AER-Mussels

AER = aquatic ecological resources

RFER = riparian/floodplain ecological resources

T/E/P Species = threatened/endangered/protected species

Table 3 displays the first page only of the 5-page RFFA cumulative effects matrix used for the water and sediment quality VEC. The 87 RFFAs were divided into six categories: (1) navigation investment actions; (2) other Corps actions; (3) “but for” actions; (4) actions by others (could occur regardless of the Ohio River navigation system); (5) natural disasters; and (6) regulatory environment. “But for” actions refer to those actions by others which would not occur except for the existence and maintenance of the Ohio River navigation system. Natural disasters are included since floods, droughts, severe storms, and/or earthquakes can have major influences on many of the VECs and subcomponents. Definitions for each of the listed types of RFFAs were included in an appendix to the CEA report. Under the ORMSS, only “navigation investments actions” were evaluated programmatically for federal action. Finally, it should be noted that many of the RFFAs represented continuations of past and present actions.

The second column in Table 3 relates to sources of information that were the basis for the listed RFFA. Sources included plans, permits, census data, other EAs (environmental assessments) and EISs, surveys, map and/or navigation chart (Navchart) analyses, trends analysis data (TAD), and professional opinion. A summary of the utilized sources is included in an appendix to the CEA report.

The next three columns in Table 3 highlight relative characteristics of the listed RFFAs. The following definitions relate to the “codes” which were used for each of the characteristics:

- (1) Time Period-short, medium and long-term. Short-term is the initial 10-year period from the point of completion of the CEA study (2005) and is based upon the probability of occurrence, availability of information, status of funding, and other factors. The medium time frame is from 10 to 25 years beyond 2005. The long-term period is 25 to 55 years. The date of 55 years is based on the economic analysis period for the navigation investment plan (to 2060).
- (2) Occurrence Probability- high, medium, and low. High denotes substantial information exists and funding is already in place (already “on the books”). Medium denotes some information is available, and some funding possibilities exist. Low denotes minimal information and no identified funding or proponent.
- (3) Location on River- Three reaches of the River were routinely used (upper, middle, or lower); the upper reach was from Pittsburgh to approximately Huntington, West Virginia; the middle reach was from Huntington, to Louisville, Kentucky; and the lower reach was from Louisville to Cairo.

The final three columns relate to the effects on the VEC or sub-component thereof, and the overall importance of the RFFAs regarding cumulative effects. The key display information in the two VEC-related columns was associated with whether the RFFA exhibits negative or positive effects. Descriptive rationale for this determination was entered in “smart cells” as follows. The RFFA matrices were provided to each

**TABLE 3**  
**Portion of RFFA Matrix for Water and Sediment Quality**

RFFA	Sources	Time Period	Occurrence Probability	Location on River	Water Quality	Sediment Quality	Importance
Navigation Investment Actions							
Lock Extensions/New Locks/Replacement or Rehabilitation	Corps planning (districts); ORNIM study outputs						
L&D operation and maintenance	Corps O&M records, J.T. Myers & Greenup Locks Improvements EIS						
Non-structural navigation improvements	Examples from: Upper Mississippi -Illinois Waterway report, national park studies.						
Dam replacement and rehabilitation	(Category added by review team)						
Other Corps Actions							
Channel dredging/dredged material disposal	Corps (districts), J.T. Myers & Greenup Locks Improvements EIS						
Navigation aids - Construction and O&M	Corps historic records, trends related to GPS, 1980 Corps O&M EIS						
Flood damage reduction projects							
levees/floodwalls	EAs and EISs from individual communities, Corps O&M records, ERP projects list						
dry dams, other projects off mainstem	EISs in Corps planning offices (districts), projects planned on tributaries						
channel modifications	Point Pleasant project, projects planned on tributaries						
nonstructural measures (e.g. relocation)	FEMA, flood relocation reports, Corps planning, Mill Creek project						
Emergency streambank stabilization (Sec. 14)	Corps planning & operations (districts)						
Modification of Corps structures for environmental improvements (Sec. 1135)	Corps planning & operations (districts)						

committee as Microsoft® Excel spreadsheets. The “insert comment” function was used to access a detailed definition of each RFFA. Committee members were able to read each definition by moving their cursor over the RFFA cell. The committee was also encouraged to insert comments to expand upon coded entries. This proved most useful when the team was describing the effects on the VEC or subcomponent, and rating the relative importance of the RFFA’s impact. In so doing, the issues or values most important in the formulation of their entries were identified.

The final column in Table 3 is entitled “Importance”. In this case, the committee assigned an “importance rating” to all RFFAs identified as having effects. The rating code was H (high importance), M (medium importance), or L (low importance). Again, notes were added to the respective “smart cells” in the Importance column to denote the rationale used. Some things that were considered included: (1) the relative contribution of the RFFA to the cumulative effects; (2) the spatial and temporal extent of the anticipated effects; (3) the level of knowledge regarding the affected VEC or subcomponent, and the effects themselves, and (4) the possibilities for cost-effectively mitigating the negative effects. Although use of the comments function was optional, committees often provided comments for all of their high and medium importance entries.

The final results from the matrix analyses are depicted in Table 4 (the first page of a 3-page table) for the High and Medium ranked RFFAs. The shading codes in the table denote importance (darker is higher importance), and the “+ and – signs” denote positive or negative impacts. Detailed information which provides the bases for these codes are in the “smart cells” of the individual matrices.

To summarize the RFFA matrix approach, the following lessons have been identified relative to the value and uses of RFFA matrices in the CEA study:

- The RFFA matrix is a valuable tool that facilitated a systematic process for considering and evaluating RFFAs in a CEA study. For example, in traditional project-level impact studies, there is a tendency to consider the effects of the project in isolation. CEA requires the consideration of the effects of multiple past, present, and future actions. RFFA matrices force the users to consider multiple future actions that may impact a given VEC or subcomponents. Further, completed RFFA matrices provide a documented basis for “scoping” RFFAs and determining which should be addressed in a more detailed manner.
- Information extracted from completed RFFAs can be utilized to summarize a number of key points related to a CEA study. Examples of such information include expected time periods wherein given RFFAs are expected to occur; their occurrence probabilities; the locations or settings on or along the River wherein the given RFFAs are expected to occur; the RFFAs with anticipated negative effects, positive effects, and combinations thereof; and the importance categories for the RFFAs. Further, a composite picture of the effects of a given RFFA across all VECs can be drawn from an analysis of each of the 22 matrices.

**TABLE 4**  
**Portion of RFFAs Ranked High and Medium and their Effects by VEC**

RFFA	WQ & SQ	Fish	Mussels	Riparian	Health & Safety	Recreation	Air	Transportation & Traffic	Cultural	Socioeconomics
<b>Navigation Investment Actions</b>										
Lock Extensions/New Locks/Replacement or Rehabilitation		-	-	-	+	+	-	+	-	H/M+
L&D operation and maintenance	-	-	-		+	+		+	-	
Non-structural navigation improvements		+			+	+	+	+		
Dam replacement and rehabilitation		-	-	-	+	+		H/M+	-	
<b>Other Corps Actions</b>										
Channel dredging/dredged material disposal	-	-	-			-			-	
Navigation aids - Construction and O&M					+					
Flood damage reduction projects										
levees/floodwalls		-		-	+	-			-	+
dry dams, other projects off mainstem	-	-		-	+	+		+		
channel modifications		-	-	-	+					
nonstructural measures (e.g. relocation)		+	+	+		+				
Emergency streambank stabilization (Sec. 14)		-	-		+					
Modification of Corps structures for environmental improvements (Sec. 1135)		+	+	+		+			-	
Environmental restoration of aquatic ecosystems (Sec. 206)		+	+	+		+				
Recreation facilities - Construction and O&M					+	+		-		+
<b>Key to shading/symbols:</b>										
Indicates high importance ranking										
Indicates high-medium ranking	H/M									
Indicates medium importance ranking										
Effect on resource is primarily positive	+									
Effect on resource is primarily negative	-									
No symbol for mixed + and - impacts										

No shading indicates the RFFA is of low importance ranking or was not ranked.

- The RFFA matrix was used as an initial step in delineating the relative contributions of individual RFFAs to the overall cumulative effects. For example, RFFAs rated as having high importance would be expected to contribute more to the cumulative effects on a VEC than RFFAs rated as low importance. In certain cases, more detailed data gathering and analysis efforts were conducted to quantify (approximate) the relative contributions of an RFFA to the cumulative effects on a VEC.
- The majority of the RFFAs in the first five categories (4 in navigation investment actions, 13 in other Corps actions, 19 in “but for” actions, 26 in actions by others, and 4 in natural disasters) represent continuations of past and present actions. However, from an historical perspective, different actions were initiated in different time periods in the past. Therefore, effects information from the completed RFFA matrices were applied, as appropriate, to historical time periods and present actions, and utilized to qualitatively summarize the effects of past and current actions on the VECs.
- Information from the RFFA matrices can be used to examine the relationship between cumulative effects on a VEC or subcomponent thereof, and the ES of that VEC. The AES approach was briefly described in conjunction with Step 5. An example is in the following section.
- Necessary VEC sustainability needs and monitoring programs can be developed for “not sustainable” or “marginally sustainable” VECs or subcomponents determined to have significant cumulative effects. Such needs and monitoring can be focused on the indicators and the potential contributions of RFFAs identified as being in the high and medium importance categories. Further, mitigation measures can be identified for key RFFAs, thus forming an initial basis for interagency discussions related to appropriate mitigation and AM strategies for specific VECs.

Finally, the following generalized steps can be used to develop RFFA matrices for any CEA study:

- Develop a RFFA definition.
- Identify RFFAs based on a diversity of approaches, including the scoping process, review of planning documents, discussions with multiple public sector agencies and private sector groups, solicitation of information from a study steering committee, and use of the Internet.
- Categorize the RFFAs as appropriate.
- Develop matrices that relate the RFFAs to potentially affected VECs. Include appropriate RFFA codes within the matrices that delineate the time period and probability of their occurrence, and their location, effects, and relative importance.
- Complete the matrices via assignment of the codes and the inclusion of the rationale for each assignment.

- Summarize the results of the completed matrices and use them as appropriate in the CEA study documentation process.
- Develop “downstream uses” of the RFFA matrices as appropriate; examples include relating cumulative effects to ES, identifying and planning mitigation measures and AM, and implementing a focused cumulative effects monitoring program.

## **Analysis of Environmental Sustainability**

To illustrate the AES approach as described in CEQ’s Step 5 above, the water quality subcomponent of the aquatic ecological resources VEC will be used as an example. The same approach was used for all of the analyzed VECs. The first part of the AES for water quality involved the identification of four common effects of multiple High and Medium importance actions. As shown in Table 5, they include 8 actions causing turbidity and sedimentation, 5 actions contributing to point source pollution, 4 actions contributing to nonpoint source pollution, and 8 actions contributing to pollution reduction. Examples of actions from each common effects category include channel dredging/dredged material disposal and instream sand and gravel mining (turbidity and sedimentation), coal and related industries and marina operation (point source pollution), stormwater discharges and agriculture (nonpoint source pollution), and more stringent quality standards for environmental media and pollutant source control (pollution reduction).

Six indicators of ES had already been identified; and historical to current water quality information on them had already been summarized. Further, Table 6 displays the indicators for each of the six most important VECs. Regarding the relevance of the six indicators for water quality, the following rationale was used:

- measures of key water quality parameters
  - dissolved oxygen – related to the total organic loading from point and nonpoint sources at specific locations along the river; can also be used as a threshold indicator since the DO standard is 5.0 to 6.5 mg/l, depending upon several conditions
  - fecal coliforms – related to fecal matter contamination from humans or other animals, whether from point or nonpoint sources at specific locations along the river; can also be used as a threshold indicator since the standard is 2000 fecal coliforms/100 ml
  - turbidity and total suspended solids – related to solid material which can be attributed to point and nonpoint sources at specific locations along the river; can originate from both man-made wastewater discharges and natural erosional processes; no specific numerical standards exist for the Ohio River
  - nutrients such as nitrogen and phosphorus – related to the total nutrient loading from point and nonpoint sources at specific locations along the river;

**TABLE 5**  
**Actions Causing Four Common Effects on Water Quality**

<b>Effects</b>	<b>Actions</b>
Turbidity and Sedimentation	<ul style="list-style-type: none"> <li>• Channel dredging/dredged material disposal (H)</li> <li>• Instream sand and gravel mining (H)</li> <li>• Lock and dam maintenance and operation (M)</li> <li>• Port development and maintenance dredging (M)</li> <li>• Terminals and multimodal sites (M)</li> <li>• Fleeting areas/barge storage (M)</li> <li>• Increased traffic (M)</li> <li>• Marina development and operation (M)</li> </ul>
Point Source Pollution	<ul style="list-style-type: none"> <li>• Coal and other related industries (H)</li> <li>• Industrial river users, excluding coal-related (H)</li> <li>• Industrial discharges (M)</li> <li>• Accidents/spills (M)</li> <li>• Marina operation (M)</li> </ul>
Nonpoint Source Pollution	<ul style="list-style-type: none"> <li>• Stormwater discharges (M)</li> <li>• Agriculture (M)</li> <li>• Industrial development (M)</li> <li>• Floodplain sand and gravel mining (M)</li> </ul>
Pollution Reduction	<ul style="list-style-type: none"> <li>• More stringent quality standards for environmental media (H)</li> <li>• Pollutant source control (H)</li> <li>• ERP projects (M)</li> <li>• Phase 1 and 2 NPDES program (M)</li> <li>• TMDLs (M)</li> <li>• Effluent trading (M)</li> <li>• Control of agricultural resources (M)</li> <li>• Environmental awareness education (M)</li> </ul>

(H) = high importance  
(M) = medium importance

**TABLE 6**  
**Indicators of Environmental Sustainability by VEC**

---

**Indicators for Water & Sediment Quality**

- measures of key water quality parameters, including dissolved oxygen, pH, fecal coliforms, turbidity, total suspended solids and nutrients
- level of conformance with state and federal water quality standards, including attainment of permissible use designations
- TMDL (total maximum daily load) implementation
- effectiveness of specific point source control and nonpoint source control programs
- ability to sustain diverse, healthy populations of aquatic organisms, and
- effectiveness of spill response, monitoring programs and related precautionary measures

**Indicators for Fish**

- composition of fish communities, including numbers of intolerant and nonnative species, abundance and diversity
- amount of habitat with stable substrates, adequate depths, suitable currents, and sufficient food supplies
- reproductive viability as measured by amount of spawning habitat, genetic connectivity, and numbers of gravid females and larval individuals
- percent of population with abnormalities such as parasites, tumors, ulcers, and fin erosion
- water quality measurements such as levels of dissolved oxygen, and pH and
- level of disturbance from biotic stressors, such as invasive species and from abiotic stressors, such as river traffic

**Indicators for Mussels**

- amount of habitat with stable substrates, suitable depths, and currents and connectivity to other mussel populations
- measures of water quality parameters important to mussel populations
- extent of food supplies to help ensure good growth rates and reproduction
- availability of fish hosts to ensure reproductive success and maintain species diversity
- extent of disturbance from biotic stressors, such as invasive Asian clams and zebra mussels and from abiotic stressors, such as river traffic

**Indicators for Riparian/Floodplain Resources**

- adequacy of hydrologic connections between riparian areas and adjacent water bodies and uplands
- capacity for water storage in floodplain

- quality of soil structures
- adequacy of water table and groundwater recharge
- sustainability of sediment dynamics
- capacity of riparian areas to intercept pollution
- integrity of riparian habitats and
- measures of biodiversity

### **Indicators for Health & Safety**

- number and magnitude of spills of oil, fuel, and other hazardous or toxic materials
- potential sources of contamination associated with past or present activities
- number of accidents associated with commercial or recreational boating
- number and types of public advisories related to boating, swimming and fish consumption
- noise levels from construction activity, commercial transportation and other sources

### **Indicators for Recreation**

- types of recreation and associated opportunities
  - availability of recreational-related facilities (e.g. boat launch ramps, marinas)
  - quality of experience related to river conditions (e.g. density of watercraft, safety concerns)
  - number and types of public advisories related to boating, swimming and fish consumption
-

the nitrogen standard is 10 mg/l (for nitrite plus nitrate nitrogen); no standard has been adopted for phosphorus

- level of conformance with state and federal water quality standards, including attainment of permissible use designations – water quality standards are based on various use designations, with the level of conformance representing a composite indicator of a sustainable aquatic ecological resource
- TMDL implementation – the TMDL (total maximum daily load) program is for specific water quality parameters which may reflect an “overloaded” situation related to point and nonpoint sources at specific locations; implementation of the program reflects a coordinated effort to achieve appropriate water quality standards and promote a sustainable ecological resource
- effectiveness of specific point source control and nonpoint source control programs – such programs are focused on reducing pollutant discharges into the river, and thus they promote a more sustainable aquatic ecological resource
- ability to sustain diverse, healthy populations of aquatic organisms – an aquatic system which attains water quality standards while minimizing the effects of “legacy contaminated sediments” should sustain diverse populations of various organisms; further, it should attain permissible use designations
- effectiveness of spill response, monitoring programs, and related precautionary measures – these represent both direct and indirect programs which are focused on more effective management of water and sediment quality, and thus the promotion of a sustainable aquatic ecological resource

For the purposes of AES, the six indicators for water quality were grouped into three tiers as follows:

- first tier – “scientific measures of quality” -- water quality parameters (DO, fecal coliform bacteria, turbidity, total suspended solids, N and P); and conformance with water quality standards
- second tier – “positive actions related to source control” -- point source control and nonpoint source control programs; TMDL implementation; and spill response, monitoring programs, and related precautionary measures
- third tier – “composite indicators of aquatic ecosystem sustainability”; this includes two measures developed from several indicators -- attainment of permissible use designations; and sustain diverse, healthy populations of aquatic organisms

Finally, the indicators and tiers were displayed into four tables (not included herein), with each table coinciding with one of the four common effects and groups of related actions. Qualitative discussions of each table were then presented. For example, turbidity and sedimentation represent historical water quality concerns in the Ohio River, even with the absence of specific standards. Control programs for municipal and industrial point sources have been implemented within the last several decades, while

similar programs for nonpoint sources are largely in their first decade. Increased control programs, including operational measures, are expected in the future for channel dredging/dredged material disposal, and port and marine development and operation. Implementation of a TMDL program for turbidity could occur in localized reaches of the river. Further, spill-related programs and precautionary measures are expected to reduce accidental releases. As a result of these current and anticipated future source control efforts, for turbidity and sedimentation it is expected that permissible use designations will be more easily attained, thus increasing the sustainability of diverse populations of aquatic organisms.

Regarding point source pollution, of particular concern are industrial water users and dischargers who may introduce diverse chemicals and bacteria into the River. Existing point and nonpoint source control programs have already led to reductions in industrial discharges, thus increasing the possibilities for achieving conformance with water quality standards. Future source control programs may become more stringent, and TMDL requirements could be implemented for specific industrial pollutants in certain river reaches. Also, spill prevention and response programs are expected to reduce accidental point source pollution. As a result of these current and possible future point source control efforts, it is anticipated that additional river reaches will attain their respective permissible use designations, and the River itself will be able to sustain more diverse populations of aquatic organisms.

Nonpoint source control programs are being currently implemented for stormwater discharges from urban areas, and for runoff waters from industrial areas. Source control programs related to floodplain sand and gravel mining, as well as agriculture, are anticipated, although the specific requirements and their possible effectiveness are largely unknown. However, when considering the background of a minimal historical emphasis on controlling nonpoint source pollution, it does appear that the current efforts, when coupled with possible future emphases, are and will improve the ES of the aquatic ecosystem.

Finally, several of the 8 RFFAs expected to contribute to pollution reduction in the River represent continuations of existing pollution reduction efforts. Accordingly, the sustainability of the aquatic ecosystem is expected to improve over time

Regarding the three categories for ES of water quality, the following specific definitions were used (similarly structured definitions were used for each of the pertinent VECs and their subcomponents):

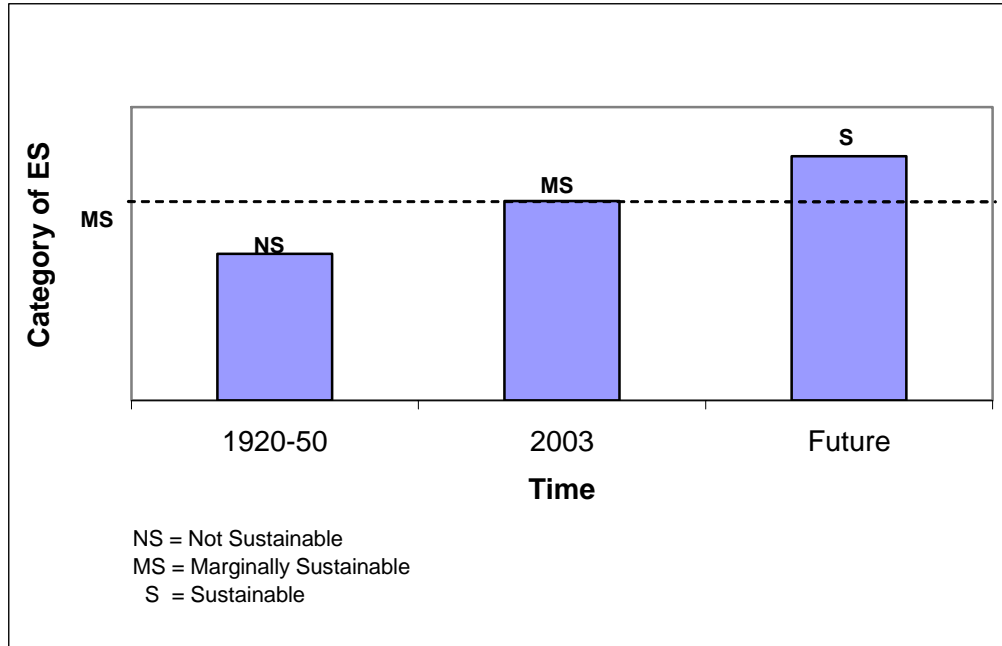
- Not sustainable -- the composite conditions for the selected indicators do not reflect conditions that would facilitate attainment of permissible use designations, nor would they sustain diverse populations of aquatic organisms.
- Marginally sustainable -- the composite conditions for the selected indicators are such that the attainment of permissible use designations is accomplished for the majority, but not all, of the river miles in the mainstem, and diverse populations of aquatic organisms are occurring along the majority of the River; however, the conditions of the indicators are somewhat tenuous both in location and likelihood of occurrences.

- Sustainable -- the composite conditions for the selected indicators are such that the attainment of permissible use designations is accomplished for essentially all of the river miles in the mainstem, and diverse populations of aquatic organisms are occurring along the majority of the River; further, the conditions of the indicators exceed regulatory thresholds and various governmental programs are in place to control point and nonpoint pollution sources and to emphasize pollution reduction.

Based upon the historical to current affected environment conditions for water quality, the multiple actions and effects, the tiers of indicators, and the ES categories, the ES of the water quality of the mainstem of the Ohio River can be characterized and depicted in Figure 1 as follows:

- In the time period prior to 1920, and continuing up to about 1950, the water quality of the mainstem was in a degraded state characterized by low DO concentrations, low pH levels in the upper River, high bacterial contamination, high nitrogen concentrations, and remobilization of potentially toxic chemicals that had become associated with River sediments. Essentially no pollution reductions or controls programs, or regulatory programs, were in place during this period. Further, declines in the diversity and health of fish communities in the mainstem also were experienced. Accordingly, the ES of the water quality VEC was classified as “not sustainable”. Primary contributors to these conditions were the largely untreated and uncontrolled point and nonpoint pollutant discharges from growing municipalities and various types of industries and land uses along the River.
- Due to the programs of ORSANCO, and the requirements of the Federal Water Pollution Control Act (and the amended Clean Water Act), the water quality of the River has shown a steady improvement in recent decades. For example, DO concentrations are typically above the 5.0 mg/L standard, pH levels are between the 7.0 to 9.0 standard, and nitrogen concentrations meet current water quality criteria. However, bacterial contamination primarily associated with NPS pollution is still problematic downstream of major urban areas. Further, legacy “contaminated sediments” are a concern in the upper River along with fish consumption advisories throughout the mainstem. In contrast, the results of algae (plankton) and aquatic macroinvertebrate biological surveys in the five most recent decades have demonstrated steady improvements in these aquatic ecological resources, with the improvements paralleling water quality improvements. Regarding the attainment of permissible use designations, as of 2001, 974 of 981 miles (99.3%) of the mainstem are “fully supporting” aquatic life, and 970.5 miles (98.9%) are “fully supporting” public water supply use. None of the mainstem was “fully supporting” fish consumption due to restricted or no consumption advisories along its total length. For contact recreation use, 804.3 miles (82.0%) are “fully supporting” this use. Finally, implementation of NPDES (National Pollutant Discharge Elimination System) permit programs for municipalities, industries, and stormwater has led to the reduction of discharges into the mainstem. Initiatives for increasing the use of BMPs (best management practices) have also been established. Also, information from the fish resources analyses has indicated that

**FIGURE 1**  
**ES of Water Quality**



the diversity and health of fish communities along the mainstem has considerably improved from the 1920 to 1950 period. Accordingly, at this time (2005), although there are many positive signs, the ES of the water quality VEC was classified as “marginally sustainable”. The primary concerns are associated with bacterial contamination and chemical remobilization from legacy-contaminated sediments.

- Regarding the future, it is expected that the water quality of the Ohio River mainstem will further improve as a result of the continuation of source control and other pollution reduction programs, and the implementation of an ecological restoration program (ERP) and other remediation efforts. Therefore, it is anticipated that the ES of the water quality VEC will achieve a “sustainable” condition. However, this characterization should not bring complacency; rather, vigilant efforts are still needed to continue effective water quality and aquatic ecological monitoring and management efforts. In this regard, it may be desirable to plan and implement source monitoring programs for selected RFFAs (actions) considered being of high importance relative to cumulative effects. Further, special surveys for legacy-contaminated sediments are needed along with site-targeted efforts to reduce bacterial emissions from CSOs (Combined Sewer Overflows). Furthermore, several actions are expected to be beneficial to the water quality resource in the future. For example, adverse impacts related to barge operation (e.g. queuing, dispersed traffic) will be alleviated to some extent through implementation of nonstructural navigation improvements, and through technological improvements related to communications and more environmentally-advanced barge design. Activities that support commercial navigation (e.g. port development and maintenance dredging) will continue to be scrutinized by both regulatory agencies and NGOs and may be more strictly regulated. Land disposal of in-stream dredged materials, for example, may become more common than is practiced today. Some development activity may revive or renovate underused urban space or industrial brownfields areas, with possible long-term water quality benefits related to surface and groundwater clean up. Much development activity, however, will involve conversion of existing floodplain lands (e.g. farmland, riparian woods, and wetlands) that now afford habitat protection, open space and ecosystems values. Once converted, such lands are unlikely to revert to their former more natural states. Increasing emphasis on pollution prevention, erosion control BMPs and implementation of the Phase 1 and 2 NPDES programs could counteract some adverse impacts, particularly in more urban areas. In general, several regulatory initiatives in recent years, including TMDL development, the national CSO policy, and Phase 1 and 2 programs should measurably improve water and sediment quality, but, at this time, it is not possible to predict the magnitudes of their beneficial effects.

In summary, the lessons learned regarding the application of the AES approach to the prioritized VECs include the following:

- The approach encourages the user to think about the connections between multiple actions and indicators in both a relative and holistic manner, thus encouraging the synthesis of a large body of information.

- The approach could be strengthened with quantitative information on each action, indicator, and tiers of indicators; however, in the absence of time-related information on each part, a qualitative discussion of the connections can still be useful.
- The structured framework of the approach can be useful for identifying current and future monitoring, mitigation, and sustainability needs, and for planning AM programs, as appropriate.

## **Communication of Findings**

The CEA report is currently organized into 14 chapters and five appendices. Following an introductory chapter, Chapter 2 delineates the key features of the process and special methods used to identify, analyze, and synthesize information related to this study. Chapters 3 through 12 focus on the CEs from past, present, and future actions on ten grouped VECs or subcomponents. Chapters 3 through 6 address the VECs related to aquatic and riparian ecological resources. For example, Chapters 3 through 5 relate to three subcomponents within aquatic ecological resources (water quality and sediment quality, fish, and mussels resources, respectively). Chapter 6 focuses on the riparian/floodplain resources VEC; including three functional categories involving hydrology and sediment dynamics, biogeochemistry and nutrient cycling, and habitat and food web maintenance. Threatened and endangered species are addressed, as appropriate, within Chapters 4, 5, and 6.

Chapters 8 and 9 are associated with human uses of aquatic and riparian ecological resources, with Chapter 8 addressing the health and safety VEC, including fish consumption advisories resulting from contaminant uptakes from the water and sediment phases. Chapter 9 highlights the river-based recreation VEC, with such recreation including boating, fishing, and multiple uses of the riparian zone. Because the focus of ORMSS is related to navigation investment actions, Chapter 10 addresses historical navigation traffic and projected trends under several scenarios. Chapters 7, 11 and 12 are broadly related to human uses of the Ohio River mainstem and its environs, with Chapter 7 addressing the air quality resources VEC. Chapters 11 and 12 encompass the socioeconomic and cultural resources VECs, respectively. Chapter 13 relates to the potential development of a monitoring and AM program, while Chapter 14 contains a comprehensive summary of the study findings.

The five appendices include a report on the public scoping process, detailed information related to the effects of RFFAs on the VECs and subcomponents, summaries of several fish-related research reports, the recreation mail survey instrument and analyses of the results, and a report on the Corps' policies regarding prospective mitigation and ecological restoration (retrospective mitigation).

A common topical outline was used for the six specific VEC chapters of greatest importance (Chapters 3, 4, 5, 6, 8, and 9). The generic outline was:

- Definition and Importance of this VEC and its Subcomponents
- Objectives and Scope of this VEC Study

- Issues from Public Scoping
- Indicators of Environmental Sustainability
- Laws, Regulations, Ordinances, and Programs
- Past to Current Baseline Conditions for the VEC and its Subcomponents
- Special Information Related to the Ohio River
- Interactions with Other VECs
- Relevant Actions Affecting this VEC and its Subcomponents
- Cumulative Effects and Environmental Sustainability
- Summary and Conclusions
- References

The summary chapter (Chapter 14) addresses all of the individual VEC chapters. Key sections in this chapter include:

- CEQ Methodology as Applied to the ORMSS CEA: description of CEQ's 11-step process and its application to the CEA study
- Special CEA-Related Studies: research studies – assessment of fish movement potential through locks and dams, winter habitat types used by fishes in an upstream and downstream pool, and an analysis of Corps policies regarding retrospective or prospective mitigation; database development for mussels, bottom substrates, and bathymetry; other special studies – recreational usage of the Ohio River mainstem, and an Endangered Species Act Section 7 biological assessment related to navigation system operational practices; and field studies related to fish movement and passage and life cycle issues
- Elements Common to all VECs: includes cross-cutting laws, regulations and programs; the RFFAs ranked high or medium and their effects by VEC; indicators of ES for the six higher priority VECs (water and sediment quality, fish, mussels, riparian/floodplain resources, health and safety, and recreation)
- Approach to Analyzing ES
- ES Conclusions by VEC: past, present, and anticipated future ES conditions for the 10 re-grouped VECs, including the six higher priority ones
- Interactions Between VECs

- ES Overview of All VECs
- Concerns and Opportunities Related to ES of VECs
- Concluding Comments

## **Conclusions**

The CEA process can serve as a useful integrating tool for addressing the impacts of proposed and other actions at the programmatic level. Further, the ES of affected VECs can be used as a means of assessing the significance of cumulative effects. Programmatic EISs are typically characterized by larger study areas, longer planning horizons, and numerous uncertainties related to future actions and environmental consequences. Accordingly, innovative methods and approaches are needed to accomplish CEA studies related to PEISs. The needs relate to a planning framework for CEA; coordination across multiple institutional boundaries; flexibility due to numerous pragmatic uncertainties; requirements for considering multiple past, present, and RFFAs; assessing cumulative effects on the ES of VECs; identifying ES needs and VEC-based actions; and effective communication of the findings.

Six needs-driven methods and approaches used in the ORMSS CEA study include: (1) application of CEQ's 11-step CEA process for general and detailed planning of the study; (2) collaboration with an IWG during CEA planning and implementation; (3) utilization of a continuous scoping process during study conduction; (4) development and use of RFFA matrices for identifying connections between actions and VECs, analyzing ES, and identifying follow-on ES needs, monitoring, and possible AM; (5) conduction of a VEC-based AES process involving identifying common effects from actions, relating these effects to indicators of ES over several time periods, and determining the relevant ES classifications (NS, MS, or S); and (6) communicating the study findings based on a VEC-by-VEC presentation, coupled with a summary of cross-cutting findings.

Key lessons derived from the use of these innovative methods and approaches are that:

- The CEQ's 11-step process, with appropriate study-driven modifications, provides a useful framework for study planning and implementation;
- An IWG can provide valuable scientific information and assistance throughout a large-scale and complicated CEA study;
- A continuous scoping process is particularly necessary when dealing with a largely unprecedented impact study at the programmatic level;
- RFFA matrices provide a systematic tool that can be used for impact analysis, summarization of findings, and as input for AES and related post-PEIS needs;
- The AES approach, while it could be strengthened with quantitative information, encourages both relative and holistic thinking, and provides a basis for identifying ES needs and, possibly, a monitoring and AM program; and

- Because of the scientific and institutional complexities of CEA studies at the programmatic level, it is very important to plan the written documentation so that the effective communication of information is accomplished.

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