MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

SUBJECT: Three Rivers, Arkansas, Navigation Feasibility Study and Environmental Assessment - Final USACE Response to Independent External Peer Review


2. The IEPR was conducted by Logistics Management Institute and Analysis Planning and Management Institute. The IEPR panel consisted of four panel members with technical expertise in civil works planning/economics, biological resources and environmental law compliance, civil/geotechnical engineering, and hydrology and hydraulics engineering.

3. The enclosed document contains the approved final written responses of the Chief of Engineers to the issues raised and the recommendations contained in the IEPR report. The IEPR Report and the USACE responses have been coordinated with the vertical team and will be posted on the internet, as required in EC 1165-2-214.

4. If you have any questions on this matter, please contact me or have a member of your staff contact Kathleen Williams, Deputy Chief, Southwestern Division Regional Integration Team, at 202-761-0315.

TODD T. SEMONITE
Lieutenant General, USA
Commanding
Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of WRDA 2007, EC 1165-2-209, and the Office of Management and Budget’s Final Information Quality Bulletin for Peer Review (2004).

The goal of the U.S. Army Corps of Engineers (USACE) Civil Works program is to always provide the most scientifically sound, sustainable water resources solutions for the nation. The USACE review processes are essential to ensuring project safety and quality of the products USACE provides to the American people. Logistics Management Institute (LMI) and their subcontractor, Analysis Planning and Management Institute (AMPI), was engaged to conduct the IEPR of the Three Rivers Southeast Arkansas Feasibility Study and Integrated Environmental Assessment (EA), Arkansas and Desha Counties, Arkansas.

The LMI/AMPI IEPR panel reviewed the Draft Feasibility Report (DFR) and integrated Draft EA, as well as supporting documentation. The Final IEPR Report was issued on 23 June 2017. A final back-check review was completed on the Final Feasibility Report (FFR) and EA dated June 2017.

Overall, 14 comments were identified and documented by LMI/AMPI. Of the 14 comments, one was considered significant, 3 were medium high significance and 10 were medium significance. No comments were deemed of low significance. The following discussions represent the USACE Final Response to the 14 comments.

Based on the technical content of the Three Rivers review documents and the overall scope of the project, LMI/AMPI identified candidates for the panel in the field of Economics/Civil Works Planning, Biological Resources and Environmental Law Compliance, Hydrology and Hydraulic Engineering and Geotechnical/Civil Engineering Four panel members were selected for the IEPR.

1. High Significance - All of the alternatives considered in the report include costly provisions to address concerns related to assumed under-seepage, which do not have a demonstrated technical basis.

This comment includes two recommendations, which were adopted.
1. Conduct a geotechnical evaluation including one or more borings to determine the cause of the sinkholes and to provide a reliable basis for remedial measures to be included in the proposed alternatives.

**USACE Response: Adopted.**  
**Action Taken:** During the Preliminary Engineering and Design (PED) phase of the project, a formal Geotechnical evaluation will be performed at the Historic Cutoff Structure. Its mission will be to determine the failure mechanism by which sinkholes occur in the area. This will include a study of how subsurface seepage through the structure affects the sinkhole process. Evaluation of whether the decay of buried organic material or other non-seepage related phenomena affects the sinkhole issue. The new information gleaned from the Geotechnical evaluation will be used to refine the design for each alternative to resolve the sinkhole issue and to insure that sub-surface seepage will not create a failure mechanism for the new Historic Cutoff Structure.

2. Revise the estimated costs of the alternatives to reflect the results of the evaluation.

**USACE Response: Adopted.**  
**Action Taken:** During the Preliminary Engineering and Design (PED) phase, the cost estimates for Alternatives 1 and 2 will be revised to reflect any changes to the project’s design that result from the Geotechnical evaluation.

2. Medium/High Significance - The time period used to estimate operational and maintenance (O&M) sunk costs for the study area is too short.

This comment includes one recommendation, which was adopted.

1. Update the O&M costs: (a) review O&M records and federal investments from 1971 to 1989 for the project, (b) add these costs to the totals from 1989 to 2017, (c) recalculate the average annual O&M costs spent during the entire period of record from 1971 to 2017, weighing more recent costs more heavily if USACE believes that is appropriate, (d) using revised costs calculated in Item “c”, project O&M costs forward in time for the “without project condition” and alternatives 1 and 2, and (e) revise report text and tables as appropriate, including Tables 10 to 13.

**USACE Response: Adopted.**  
**Action Taken:** Although review of USACE district records indicate that there were no OMRR&R expenditures in the study area to address head-cutting prior to 1989, the USACE has revised the analysis to include years prior to 1989 recorded as zero in the array (see Table 1 in the main report). Per the panel’s suggestion recent values are weighted more than past values.

3. Medium High Significance - The hydraulics and hydrology analysis does not include a discussion of risk and uncertainty.

This comment includes three recommendations, which were adopted.

1. Inventory key sources of hydrologic uncertainty in the report due to model itself and natural conditions in the study area.
USACE Response: Adopted.
Action Taken: A sensitivity analysis in which reasonable likely combinations of upper and lower bound n-values will be used to obtain a range of headwater and tailwater stages will be performed during PED

2. Assess the effect these uncertainties have on proclaimed project improvements or benefits (e.g., reduction in flooding, increased inundation time, water velocities, potential for erosion or breach).

USACE Response: Adopted.
Action Taken: This analysis is included in Section 3.1 of Appendix B - H&H.

3. Add a summary of the risk and uncertainty evaluation to the Draft Report and a more detailed discussion in Appendix B: H&H.

USACE Response: Adopted.
Action Taken: Only a hydraulic model was developed for this study, not a hydrological, or rainfall-runoff, model therefore no uncertainty or sensitivity analysis will be done on the hydrology just the hydraulics.

An inventory of natural hydrologic variables and possible sources of errors that lead to increasing uncertainty are provided in section 2.4.2 in the H&H appendix. Even though all of these variables were held constant through the POR modeling effort, the resulting calibration was rated from good to very good using established statistical performance.

The uncertainties in the hydraulic model pertaining to both the containment structure at elevation 157 and the opening through the Historic Cutoff will be assessed during PED to determine the effects and risks associated with erosion, geomorphological changes, sedimentation, and navigation.

4. Medium/High Significance - The report should provide additional information regarding the USACE expert elicitation process used to determine the probability of a cutoff.

This comment includes one recommendation, which was adopted.

1. Include a discussion of the expert elicitation process used. The discussion and evaluation should provide information such as how the Panel was selected; the number, areas of expertise, and experience; the information, data, and analyses provided to the experts to elicit opinions; quantification of the opinions and statistical distribution used; interpreting the results of collective opinions of the experts; and a discussion of the uncertainty or confidence level analysis.

USACE Response: Adopted.
Action Taken: The following discussion is included in Section 2.2 of Appendix A – Economics: The expert opinion elicitation (EOE) process was incorporated into USACE risk protocol in the late 1990’s and was developed to assist in producing best estimate probabilities for complex engineering problems such as engineering reliability analysis for dams and levees, navigation locks and hydropower facilities. For the 3-Rivers Feasibility Study, the expert panel consisted of seven scientists and engineers who were selected based on
1) Strong relevant expertise through academic training (engineering, hydrology, geology and geochemistry), professional accomplishment and experiences, and peer-reviewed publications;
2) Familiarity and knowledge of various aspects related to the study area and the problem;
3) Willingness to act as proponents or impartial evaluators;
4) Availability and willingness to commit needed time and effort; and
5) Specific related knowledge and expertise of issues of interest.

Panel members consisted of four USACE Little Rock District employees and three external experts and included:

1) Dr. Leroy Arnold: Dr. Arnold is a registered civil engineer and geotechnical specialist with over 30 of experience with the Corps. He is the principle advisor and geotechnical engineer for all major geotechnical and civil engineering discipline aspects of the Engineering and Construction Division's Dam Safety evaluation and monitoring efforts. He also manages emergency response plans preparation, construction quality assurance for features of water resource projects consisting primarily of concrete gravity, earth and rock-fill dams, locks, channels and harbor facilities.

2) Dr. David Biedenharn Ph.D.: Dr. Biedenharn is a professional engineer with 30 years of experience in hydraulics, river engineering and fluvial geomorphology with the Corps Vicksburg District, Lower Mississippi Valley Division office, and the U.S. Army Engineer Research Development Center at the Waterways Experiment Station (WES). He is presently a research hydraulic engineer with the Rivers and Structures Division, River Sedimentation Engineering Branch at WES. He has authored over 50 technical papers and reports on hydraulic engineering, fluvial geomorphology, channel restoration, and sedimentation.

3) Mr. Mitch Eggburn: As a registered professional engineer, Mr. Eggburn has over 22 years of service with the Corps including 11 years in River Engineering and Hydraulic Design and seven years in Construction. He has worked on the analysis and design of several Melinda structure repairs and administered contracts on two Melinda structure repairs and on the Jim Smith Lake Headcut Control Structure. During his seven years of construction he was posted at Montgomery Point Lock and Dam, where he observed flow patterns through the Arkansas-White River corridor during high water events as they happened.

4) Dr. Steve Haase Ph.D.: Dr. Haase works for the Nature Conservancy, has a Ph.D. in Geology and Geochemistry, and more 30 years professional experience in basic and applied hydro-geologic research. Before joining the Nature Conservancy he conducted and managed a wide range of environmental cleanup and restoration projects, and water resource investigations for various public and private organizations. Since joining the Conservancy in 2002, Dr. Haase has served as the Project Manager for the Nature Conservancy’s Lower White River Basin Project and currently serves as a regional hydrologist and river scientist providing technical support to TNC projects throughout the South-eastern and South-central USA. His specific project responsibilities include hydrologic analysis and interpretation of discharge and stage data to determine natural flow regime characteristics for river systems and to determine the nature and extent of flow alteration associated with anthropogenic changes; development of ecologically sustainable flow prescriptions for application in water allocation and water resource management.
decisions; watershed geomorphologic assessments and channel stability analysis of riverine systems to support development of watershed-scale river restoration plans based on natural channel design principles; interpretation of chemical data for surface water and groundwater systems; and development and implementation of Site Conservation Plans for priority conservation areas.

5) Mr. Elmo Webb: Mr. Webb is a registered professional civil engineer with over 17 years of experience with the Corps, most of which has been in geotechnical services. One of Mr. Webb’s first projects was the Arkansas White River Cutoff project. While on the project delivery team, he was responsible for coordinating the subsurface investigation, sampling, testing, soil-cement mix design, and geotechnical design of the structures. Mr. Webb also has extensive knowledge of the area’s subsurface conditions and history of the project.

6) Mr. Nick Mitchell: Mr. Mitchell is a registered professional engineer and has over 24 years of experience with the Little Rock District. He’s held various positions in Construction and Operations Divisions. He’s worked extensively on bank stabilization, dredging and channel improvement projects. During his career with the Corps he served as Chief of the Contracts Support Branch in the Pine Bluff Project Office from 1995 to 1999. He returned to the District Office in 1999 and began working in the Navigation and Maintenance Section where he coordinates dredging and bank stabilization needs for the district on the MKARNS. Nick is also the chairman for the lock and dam operator training program.

7) Mr. Glen Raible: Mr. Raible is a registered professional engineer and has over 24 years of service with the Corps including 16 years as a hydraulic engineer, 5 years Arkansas River System Engineer, and 2 years as the Little Rock Districts technical expert hydraulic engineer. Glen has experience applying hydraulic and hydrologic principles and methodologies to HEC-1, HMS and HEC-2, -RAS numerical models. He has designed many projects and structures, including the Table Rock Auxiliary Spillway, flood control channels, drainage structures, weirs, drop structures, and erosion and bank failure protection structures. He’s planned and performed detail phases of the Little Rock Districts water quality program, worked with WES (ERDC) in physical modeling of a selective withdrawal structure for Table Rock Lake, and worked with A/E’s on physical fixed and movable bed models for the North Little Rock Hydropower Plant at the Murray Lock and Dam.

The expert elicitation took place at the USACE Little Rock District office, and included a technical facilitator, several observers and the expert panel. Prior to the workshop, USACE provided experts with background materials including fact sheets, a historical overview of the study area including past damages to containment structures, engineering design materials for existing containment structures, and other studies or information related to head cutting and hydrologic and geologic issues related to the study. These included a contract study completed in 2000 by FTN Associates entitled the “Arkansas-White River Cutoff Analysis,” which modeled and analyzed historic flow regimes (dis-charge elevation frequency) in the study area using hydraulic models.

The workshop lasted three days with the first day focusing on discussions of background materials and study objectives, a description of the study area including hydrology and geomorphic processes affecting head-cutting and containment structures, and the overall elicitation process. The group also discussed potential sources of bias such as overconfidence, wanting to influence decisions and funding allocations, or preconceived notions that they would
be evaluated by superiors as a result of their answers. Day 2 consisted of a field trip to the study area where the panel inspected the Jim Smith, Owens Lake and Melinda structures and observed and discussed other geophysical and hydrologic conditions in the study area.

The elicitation, which involved an undisclosed (blind) tally, took place on the third day of the work-shop. Before providing estimates, the facilitator led a technical discussion of the issue such as the condition of containment structures, head-cutting in the isthmus (past, present and expected), head differential and duration frequencies for the Arkansas and White rivers, and hydrologic events that impact the Mississippi River in conjunction with the Arkansas and White. The panel were also given the assumptions that: 1) more than one cutoff would not occur in any given year, 2) any cutoff that formed would be 1,100 feet wide with a bottom elevation of 110 feet (mean sea level), and 3) containment structures were in a fully rehabilitated and repaired state. Then, matrices showing head differentials and duration combinations were provided to the panel, who then provided conditional probabilities of a breach of containment structures, and subsequent cut-off formation. Presenting the elicitation in terms of conditional probabilities had the benefit of simplifying the question by decomposing the problem. Experts were also asked to provide their level of confidence in their estimates, and each had high confidence in their respective values. Results for the panel were aggregated across all head differential and duration combinations to arrive a baseline (i.e., year 1 of the period of analysis) probability estimate along with descriptive statistics (mean, median, standard deviation, maximum, and minimum). Descriptive statistics were reviewed and discussed, and the panel was given an opportunity to revise their initial estimates.

As shown in Table 1 below, and as noted by the IEPR panel, there was considerable variance in the responses provided for the baseline year 1 probability. Opinions ranged from a low of 0.005 percent to a high of 2.30 percent with a mean of 0.81 percent, a median of 0.30 percent, and standard deviation of 0.87 percent. In the NED analysis, the USACE relies on the mean across all experts that includes the exceptionally low value of expert number 5 (0.005 percent). Other than being much lower than the other experts, there is no apparent basis to disregard expert no. 5’s low value even though it appears to be an outlier. It would be arbitrary to dismiss the value without some reasonable justification such as the expert had strong bias, which did not appear to be the case. If the lowest opinion value is eliminated, the mean and median for the baseline converge, but do not change drastically (the mean becomes 0.95 versus 0.87, and the median is 0.59 versus 0.31).

While it is true that a different panel of experts, assuming the USACE could assemble one with individuals with similar credentials and experience, it is unlikely that the responses would fall significantly outside the current ranges. However, it is possible that the responses might cluster around values in the current range resulting in less variation in the estimates. For example, three experts reported value ranging from 0.22 percent to 0.30 percent, and two reported values of 1.71 and 2.30 percent. If a different expert panel estimated values with less variation, but within a similar range (perhaps 0.10 to 0.50 or 1.00 to 3.00 percent), the baseline values would be higher or lower, but on average over the 50-year period analysis values tend to converge to around 7 to 8 percent regardless of the base-line. For instance, as shown in Table 1, a baseline value of 0.29 percent averages to 7.85 percent over the period of analysis and a value of 1.71 percent averages to 8.34 percent. The key point is that potential results of another panel would have to differ significantly in order to substantially impact the magnitude of NED benefits.
Table 1: Expert Panel Results for baseline and Mean over the Period of Analysis

<table>
<thead>
<tr>
<th></th>
<th>Baseline (year 1)</th>
<th>Mean over Period of Analysis</th>
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<tbody>
<tr>
<td>Expert 1</td>
<td>2.30%</td>
<td>8.50%</td>
</tr>
<tr>
<td>Expert 2</td>
<td>0.87%</td>
<td>7.79%</td>
</tr>
<tr>
<td>Expert 3</td>
<td>1.71%</td>
<td>8.34%</td>
</tr>
<tr>
<td>Expert 4</td>
<td>0.30%</td>
<td>7.89%</td>
</tr>
<tr>
<td>Expert 5</td>
<td>0.005%</td>
<td>3.61%</td>
</tr>
<tr>
<td>Expert 6</td>
<td>0.22%</td>
<td>7.75%</td>
</tr>
<tr>
<td>Expert 7</td>
<td>0.29%</td>
<td>7.83%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>0.87%</td>
<td>1.69%</td>
</tr>
<tr>
<td>Mean</td>
<td>0.81%</td>
<td>7.39%</td>
</tr>
<tr>
<td>Median</td>
<td>0.30%</td>
<td>7.83%</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.005%</td>
<td>3.61%</td>
</tr>
<tr>
<td>Maximum</td>
<td>2.30%</td>
<td>8.50%</td>
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As discussed in the economics appendix of the study, selection of the recommended alternative (Alternative 1) was based on costs. Given that Alternative 1 was very similar to Alternative 6 (157 foot levee) from the Ark-White analysis with exception of location and the addition of a passive weir at the historic cut-off (which would have a synergistic effect in reducing head differentials), USACE assumes that Alternative 1 has the same risk of failure as Alternative 2A from the Ark-White study (average annual risk of 0.08 percent over period of analysis). The Ark White study did not analyze an alternative similar to Alternative 2 of the Three Rivers study; however, the USACE opted not to re-convene an expert panel to estimate the failure risk of Alternative 2 under the following rationales: 1) the financial costs of Alternative 2 are substantially higher than Alternative 1 – annualized $5.7 million versus $8.3 million; and 2) it is very unlikely that the risk would be lower than Alternative 1, and even if it were, it would not come close to affecting USACE’s preferred plan (Alternative 1) given the large cost differential between the two alternatives.

5. Medium Significance - There is no supporting evidence/rationale for how USACE determined that the integrity of the structures should not fall below 70 percent for either the Jim Smith or Melinda Corridors, or for concluding that the Owens Lake structure is structurally sound.

This comment includes two recommendations, which were adopted.

1. Provide analysis and rationale for why USACE determined that it should not allow the integrity of the structures to fall below 70 percent for either the Jim Smith or Melinda Corridors.

**USACE Response: Adopted.**

**Action Taken:** Assuming that the USACE would let containment structures deteriorate indefinitely is unrealistic as is presuming that the USACE would rehabilitate the structures on annual basis. Although a value higher than 70 percent is likely unrealistic; it could be lower depending upon resource availability such as funding. Changes to this parameter affect the
probability of cutoff, timing and costs of assumed structure rehabilitation and thus NED benefits. If the USACE assumed rehabilitation at 80 percent, the probability of cutoff decreases to 5.92 percent and NED benefits decline approximately 15 percent, and at a 60 percent the probability increases to 8.91 percent and NED benefits rise about 15 percent.

Deterioration rates of containment structures are based on the expert panel’s assessment of the level of structural integrity of each structure shortly after construction (i.e., circa 1990) and their condition when the team toured and assessed the study area in 2004. This was not a formal voting process as was the case for the probability of structural failure and subsequent cutoff formation, but was determined through discussion and a consensus among both the expert panel and USACE engineers. As is the case with the degradation threshold, it involved professional engineering judgment. The condition of the structures shortly after their construction was compared to their condition in the field in 2004 and after taking into to account the number and nature of repairs, the team came up with a reasonable rate of annual degradation (0.15 per annum for the Melinda Structure and about 0.045 for the Owen’s Lake structure). At the time of the field visit, the Jim Smith structures were still under construction, but given the structures’ location and the hydrologic forces they endure, the USACE and expert panel agreed that these structures would degrade at a rate similar to the Melinda structure. Today, this has proved to be a reasonable assumption given that the Jim Smith structures have suffered frequent damages and have required substantial repairs. This discussion is included in Appendix A - Economics of the final report.

2. Expand and clarify the process that the expert team used to assess and quantify the degree to which the Owens Lake structure is sound.

**USACE Response: Adopted.**

**Action Taken:** The probability of a cutoff is not wildly sensitive to moderate changes in the degradation rates. For example, if one assumes that the degradation rate for Jim Smith and Melinda is 0.10 per year, the average annual probability over the period of analysis is 6.55 percent versus 7.38. Assuming a degradation rate of 0.20 results in an average annual probability of 7.82 percent. This discussion is included in Appendix A - Economics of the final report.

6. Medium Significance - The *Civil Engineering* appendix provides no design basis in support of armor stone size selection, thickness, or slope.

This comment includes two recommendations, which were adopted.

1. Revise Appendix C to include preliminary engineering calculations supporting armor stone size, thickness, slope, and foundation requirements.

**USACE Response: Adopted.**

**Action Taken:** Appendix C – Engineering, Attachment B, has been revised to include preliminary engineering calculations supporting the stone sizes selected, the thicknesses they will be placed at, the slopes they will be installed up-on, and the foundation requirements necessary to support them.

2. Revise cost estimate as necessary if calculations result in change in quantities or median armor stone size.
USACE Response: Adopted.
Action Taken: During the Preliminary Engineering and Design (PED) phase, the cost estimates will be revised to reflect any changes to the median stone size and quantity of required by the alternatives.

7. Medium Significance - There is no discussion of the potential error embedded in the HEC-RAS 2D mesh resulting from stitching together 12 different topographic elevation and hydrographic elevation datasets.

This comment includes two recommendations, which were adopted.

1. Provide a discussion of the “terrain data stitching” methodology in Appendix B, including estimation of vertical elevation errors in each dataset and the resulting errors included in the 2D mesh.

   USACE Response: Adopted.
   Action Taken: The error is expected to be minimized by calibration to gage data and the fact that the flooding is induced by backwater from the Mississippi. The area of most concern is through the proposed opening in the Historic Cutoff Containment Structure where the headwater and tailwater stages will have the greatest impact to velocities. Since velocity is the driving force for scour potential and cross-currents in the navigation channel, the 2011 discharges down the Mississippi and the White Rivers will be increased by some factor and the Arkansas River discharges will be decreased. This will induce an artificial worst case scenario with the greatest head differentials and therefore increase velocity through the proposed opening. The change in the velocity will help determine the significance in stitching together 12 different topographic elevation and hydrographic elevation datasets. The modeling effort to induce an artificially worst scenario for the greatest head differentials and subsequent cross current will be done during the PED Phase.

2. Assess the model derived stages and velocities to determine if the survey errors result in any significant uncertainty in the model output. Discuss the range of these uncertainties in Appendix B.

   USACE Response: Adopted.
   Action Taken: See the following section of Appendix B – H&H: Section 2.3.1 LiDAR and Bathymetry. Calibration to several elevation gages in the study area will “drown” the static errors induced by stitching different types of elevation data into one.

Section 3.1: Hydraulic Model Statistical Performance Evaluation

Section 4: Hydraulic Model Sensitivity and Uncertainty:

8. Medium Significance - The discussion of HEC-RAS model calibration is incomplete.

This comment includes four recommendations and three of the four were adopted.

1. Calculate goodness-of-fit statistics for model stage hydrographs as compared to actual stage hydrographs and present them in Appendix B.

   USACE Response: Adopted.
Action Taken: A goodness-of-fit statistics for model stage hydrographs as compared to actual stage hydrographs will be computed for the gages that have complete records. Gages that have large intervals of missing data that would require in-depth statistical analysis to estimate will not be included. This analysis is included in Section 3.1 of Appendix B - H&H.

2. Compare the simulated conservation of mass (water flow) to the actual conservation of mass for available stream gauges and present that data in Appendix B.

USACE Response: Not Adopted.
Action Taken: Conservation of mass would require all water in the system to pass through a single cross-section. This is a 2D hydraulic model with internal 2D area connections that only measures water surface elevation and discharge that passes through the length of the connections. The entire study area is submerged during the POR simulation and the majority of water mass falls outside of the 2D area connection sections. If water surface elevations are not exactly the same as observed, then it would logically follow that discharge will also be off and subsequently conservation of mass. Mass of water falling outside of the internal 2D area connections would not be captured. This type of calibration analysis does not provide more insight than the goodness-of-fit statistics in “Recommendation 1”. The only location where this analysis will be done would be at the most downstream boundary condition, the Mississippi gage at Greenville.

3. Provide an extended discussion of the calibration process and the results, including summary tables of all calibration criteria.

USACE Response: Adopted.
Action Taken: An extended discussion of the calibration process and the results, including summary tables of all calibration criteria, will be completed on MPLD: White River, Yancopin: Arkansas River, Rosedale: Mississippi River. When this effort is completed, this analysis is included in Section 3.1 of the H&H appendix of the final report.

4. In areas of the model where calibration criteria are low, provide a discussion of model weaknesses.

USACE Response: Adopted.
Action Taken: A discussion of model weaknesses is included in Section 3.1 of the H&H appendix.

9. Medium Significance - The overall quality and readability of the report should be improved to ensure a clear understanding of analyses, assumptions, and results.

This comment includes one recommendation, which was adopted.

1. Improve the overall quality and readability of the documentation by providing additional information, correcting editorial errors, and facilitating navigation of the documentation.

USACE Response: Adopted.
Action Taken: As USACE proceeds through the feasibility level analysis and progresses toward completion of the report, additional technical and editorial reviews will be completed. These
additional reviews should ensure that the document is of the highest quality with minimal to no typographical errors - including references to algae blooms not present in a riverine system which were included in error. USACE will ensure the document is easy to read and understand even where there is significant technical discussion regarding the assumptions and results of analyses. In so doing, an explanation of the role of NED and environmental considerations were included in the selection of the recommended plan. Additional information has been added concerning anticipated water quality post construction, the relevant basis for conclusions concerning the presence/absence of HTRW in the project area and public safety concerns related to Benzal Road.

10. Medium Significance - There is no supporting evidence for the methods used to elicit opinions and measures from the shipping industry.

This comment includes one recommendation, which was adopted.

1. Discuss the methods used to survey the shipping industry and justification for the validity of the responses.

**USACE Response: Adopted.**

**Action Taken:** The following discussion is in Appendix A – Economics pages 19-21. With respect to sampling frame and sample selection, the USACE was not able to extract a random sample from the population of MKARNS shippers due to the fact that it is extremely difficult, if not impossible, to identify the entire population of MKARNS shippers. Relatively lower volumes of cargo on a tributary waterway to the Mississippi River System such as the MKARNS compared to larger volumes on Mississippi River main-stem often results in multipurpose users of particular ports and terminals. Except for a few large shippers with private access to particular docks such as at Tulsa Port of Catoosa, many MKARNS shippers use docks and terminals of third party providers. While third party port and terminal operators can attest to the cargoes they transport, they often have limited information regarding origins, destinations and freight rates other than port handling costs. Without a random sampling frame, we are restricted to a less satisfactory form of sample that cannot be randomly selected because not all individuals within that population will have the same probability of being selected for the sample. Thus, the sample of shippers is a non-probability sample, which is not suitable for statistical inference (e.g., confidence intervals and margins of error). There is no scientific way of analyzing or justifying the “validity” of the sample or responses.

Despite the difficulty, GEC was able to identify 49 firms that ship on the MKARNS. Of these GEC was able to establish contact with 38 firms. Interviews were conducted via phone or in person. Three of the contacted firms provided limited if any information, and two were not currently shipping on the MKARNS. Thus, in total representatives of 33 companies agreed to provide information to GEC representatives. Notwithstanding assurances of confidentiality, respondents were often reluctant to discuss proprietary business matters in any degree of detail other than a qualitative response regarding alternatives to a long-term unplanned disruption of MKARNS navigation, types and volumes of cargo shipped and rough estimates increased shipping costs for alternative routes and mode of transportation.

With respect to response to a closure, most shippers agreed that an extended closure would be a problem. When asked how they would handle a long-term unplanned closure of the MKARNS, 25 respondents (76 percent) reported that they would ship via alternative routes and modes
through existing suppliers and or use alterative supply sources at a higher cost, one firm reported that they would cease operation after existing stockpiles depleted, and wait until the waterway reopened before commencing operations, and the remaining seven firms did not have contingency plans in place and did not know what they would do.

As noted previously, responses are based on a non-probability sample of the population, and the validity of the findings based on them is unknown and cannot be established, but it is the best available information. Without an extended study schedule and resources, the USACE believes that the results are suitable for planning purposes. Even with an extended schedule and additional re-sources, it would be very difficult to identify the universe of shippers and participation would still be voluntary. Regardless, the 33 firms that provided information move almost 40 percent of tonnage through the study area each year. While there is uncertainty in the variable in question, model in-puts and outputs in the overall model and resultant NED benefits are expressed in stochastic ranges to account for the inherent uncertainty in many of the model’s inputs and outputs. USACE will add a section to the economics appendix with sensitivity matrices in the final report that shows how benefit to cost ratios for alternatives vary with different diversion rates of cargo, and other model inputs (i.e., at a 50 percent diversion rate the benefit to cost ratio for the USACE Tentatively Selected Plan is 2.8, at 75 percent it is 3.8, and at 90 percent it is approximately 4.4). While changes to the assumed diversion rate affect the magnitude of NED benefits and thus the benefit to cost ratio, changes do not impact the selection of the preferred alternative. The survey indicates that in the event of a cut-off forming between the Arkansas and White rivers, navigability through the study area would become unreliable, and not conducive large-scale and regular movements of commercial cargo. If this happens, people that pay to move commodities would have to find an alternative mode of transportation, or cease operation of their businesses until the waterway was repaired. This discussion has been added to the final feasibility report.

11. Medium Significance - The 2009 Ark White study, which provides the basis for much of the analysis performed and conclusions made in the current report, and a few other important reports, are not adequately summarized, referenced, or made available to the reader or public.

This comment includes three recommendations, which were adopted.

1. Summarize the 2009 Ark White study and its major findings in more detail at the outset of the current report.

   **USACE Response: Adopted.**
   **Action Taken:** A summary of the Ark-White Study has been added to Chapter 1 to provide background information and rationalization for analyses and assumptions presented in the Three Rivers draft report.

2. Adequately reference the 2009 Ark White study and incorporate sufficient information to provide context when the information in that study is used to perform additional analysis or draw conclusions and findings in the current study.

   **USACE Response: Adopted.**
   **Action Taken:** Information that is drawn from the Ark White study is now referenced as such to clarify how the previous work is incorporated into the current analysis.
3. Reference and adequately describe the information extracted from all other externally relied-upon reports. For example, the shipping study discussed on the bottom of page 52 needs proper reference.

**USACE Response: Adopted.**
**Action Taken:** References throughout the report have been added or edited to clarify source information and the references section has been updated accordingly.

12. **Medium/Low Significance - It is not clear how the USACE arrived at the conclusion that 75 percent of commercial barge traffic will choose least-cost alternative modes and routes during a cutoff event.**

This comment includes one recommendation, which was adopted.

1. Provide description, clarity, and justification in the text for the percentage of commercial barge traffic that will choose least-cost modes and routes during a cutoff event in the study area.

**USACE Response: Adopted.**
**Action Taken:** See Appendix A- Economics, pages 19-21 for the following discussion. GEC was able to identify 49 firms that ship on the MKARNS. Of these GEC was able to establish contact with 38 firms. Interviews were conducted via phone or in person. Three of the contacted firms provided limited if any information, and two were not currently shipping on the MKARNS. Thus, in total representatives of 33 companies agreed to provide information to GEC representatives. Notwithstanding assurances of confidentiality, respondents were often reluctant to discuss proprietary business matters in any degree of detail other than a qualitative response regarding alternatives to a long-term unplanned disruption of MKARNS navigation, types and volumes of cargo shipped and rough estimates increased shipping costs for alternative routes and modes. With respect to response to a closure, most shippers agreed that an extended closure would be a problem. When asked how they would handle a long-term unplanned closure of the MKARNS, 25 respondents (76 percent) reported that they would ship via alternative routes and modes through existing suppliers and or use alternative supply sources at a higher cost, one firm reported that they would cease operation after existing stockpiles depleted, and wait until the waterway reopened before commencing operations, and the remaining seven firms did not have contingency plans in place and did not know what they would do.

USACE will also add a section to the economics appendix with sensitivity matrices in the final report that shows how benefit to cost ratios for alternatives vary with different diversion rates of cargo, and other model inputs (i.e., at a 50 percent diversion rate the benefit to cost ratio for the USACE Tentatively Selected Plan is 2.8, at 75 percent it is 3.8, and at 90 percent it is approximately 4.4). While changes to the assumed diversion rate affect the magnitude of NED benefits and thus the benefit to cost ratio, changes do not impact the selection of the preferred alternative.

13. **Medium/Low Significance - It is not clear in the report how filled and impacted wetlands will return to their previous hydrological state.**
This comment includes one recommendation, which was adopted.

1. Re-write the paragraph under the subsection Clean Water Act to provide clarification and more detail on which wetlands are expected to return to their previous hydrologic state and which are to be mitigated to compensate for permanent wetlands loss.

**USACE Response: Adopted.**

**Action Taken:** The following additional information has been added to section 4.6.31 Clean Water Act: “Impacts to wetlands and water quality may include increased turbidity, decreased clarity, increased temperatures, and potential contamination of wetlands and waters if mechanical issues occur were to occur with construction equipment. A stormwater pollution prevention plan would be prepared prior to construction to address and mitigate potential contamination of wetlands and WOTUS. The hydrology of the area may be temporarily disrupted by placing barriers around the construction site in order to construct in drier conditions. These barriers would be removed immediately after construction is complete.” As well, additional clarification and detail has been added to the Executive Order 11990 section. The following information has been added: “Implementation of Alternative 1 would adversely impact vegetated wetlands, specifically bottomland hardwood forests. Long-term direct impacts of approximately 25 acres include filling in wetlands to construct the containment structure. Wetland vegetation would be removed throughout the length of the containment structure and converted to impervious surface. An additional 25 acres are anticipated to be temporarily impacted through removal of wetland vegetation, decreased hydrologic flow into the wetlands; and altered water temperature, pH, nutrient levels, oxygen, and carbon dioxide, as a result of construction activities. The water quality and hydrologic flow into the wetlands are expected to return to baseline conditions after construction activities cease. Herbaceous wetland vegetation is expected to return within one growing season. Woody wetland vegetation is anticipated to return; however, by the end of the planning horizon, the wetlands would be an earlier successional stage of bottomland hardwood forest than under the existing condition.

As well, additional clarification and detail has been added to Chapter 4, Section 4.6.3.4 Executive Order 11990. The following information has been added: “Implementation of Alternative 1 would adversely impact vegetated wetlands, specifically bottomland hardwood forests. Long-term direct impacts of approximately 25 acres include filling in wetlands to construct the containment structure. Wetland vegetation would be removed throughout the length of the containment structure and converted to impervious surface. An additional 25 acres are anticipated to be temporarily impacted through removal of wetland vegetation, decreased hydrologic flow into the wetlands; and altered water temperature, pH, nutrient levels, oxygen, and carbon dioxide as a result of construction activities. The water quality and hydrologic flow into the wetlands are expected to return to baseline conditions after construction activities cease. Herbaceous wetland vegetation is expected to return within one growing season. Woody wetland vegetation is anticipated to return; however, by the end of the planning horizon, the wetlands would be an earlier successional stage of bottomland hardwood forest than under the existing condition.

The HGM model results were used to calculate the mitigation requirements for the 25 acres of long-term direct impacts. In summary, 4.0 functional capacity units must be mitigated in-kind. An analysis of mitigation alternatives and cost was conducted, resulting in a recommended action to purchase mitigation credits from an approved mitigation bank. Details on mitigation can be found in Appendix N.
Alternative 2 would adversely impact 15 acres of WOTUS from construction of new structures in Owens Lake (and possibly Jim Smith and in the historic cutoff). Adverse impacts to 20 – 50 acres of forested wetlands would occur from new permanent roads needed for construction, inspection and maintenance of the structures. These permanent impacts would degrade Owens Lake, remove BLHs and fill wetlands for the roads. An additional 25 - 50 acres are anticipated to be temporarily impacted through removal of wetland vegetation, decreased hydrologic flow into the wetlands, altered water temperature, pH, nutrient levels, oxygen, and carbon dioxide as a result of construction activities. The water quality and hydrologic flow into the wetlands are expected to return to baseline conditions after construction activities cease. Herbaceous wetland vegetation is expected to return within one growing season. Woody wetland vegetation is anticipated to return; however, by the end of the planning horizon, the wetlands would be an earlier successional stage of bottomland hardwood forest than under the existing condition.

Alteration of the Historic Closure Structure elevation under both alternatives would have permanent indirect impacts to forested wetlands. The elevation change in Alternative 1 would impact 100 acres by increasing the flood frequency. This hydrologic change is not expected to result in any change in forest species composition or relative abundance. The elevation change with Alternative 2 would impact 4,822 acres in a similar fashion, although there could be a change in the relative abundance of some wetland tree species on higher elevation ground. Details on these changes can be found in Section 4.7.2.1. There would also be a minor change in flood duration on a limited number of acres. These sites would experience up to 8 days per year of drier conditions. This 8-day total would be spread out over several flood events, with water receding from these acres a few hours to perhaps a day sooner. While the change in flood frequency and duration that would be experience with Alternative 2 is not considered significant, or even measurable in some instances, the PDT and resource agencies felt that this level of change may cumulatively have a much greater impact to the immediate area and could result in a gradual shift in BLH species (relative abundance) over time in some areas.

Permanent, direct wetland impacts from either alternative would be mitigated with coordination from state and Federal agencies. These impacts, while permanent, are considered insignificant. Impacts to wetlands related to construction from either alternative would be temporary. These wetlands would return by the end of the period of analysis; however, they would be at an earlier successional stage of bottomland hardwood forest and not fully mature. These impacts would be insignificant.

14. Medium/Low Significance - The recreational and ecological benefits and costs are not integrated into the NED analysis.

This comment includes one recommendation, which was adopted.

1. Provide rationale and justification for the exclusion of recreational and ecological benefits in the NED analysis.

**USACE Response: Adopted.**

**Action Taken:** Additional information justifying why net ecological benefits were not calculated has been added to Chapter 4 in section 4.16 Environmentally Preferred Alternative: “The ecological benefits are not monetarily significant because of the high quality existing BLH system throughout the study area. If costs could be calculated, which is questionable due to the sensitivity of the HGM model, inclusion would not change the BCR or net benefits of either alternative to sway selection of a different plan.”
Recreational benefits and costs were not accounted for in the NED analysis because there is a significant amount of land that could be accessed in the event of a breach of the existing containment structure and closure of the area, as described in Chapter 2—Section 2.20 Recreation and Aesthetics. It is assumed that recreationists would access the other available areas adjacent to the possible breach areas; therefore, there would be no benefit to or loss of recreation resulting in a monetary value of $0.