



REPLY TO  
ATTENTION OF

DEPARTMENT OF THE ARMY  
U.S. ARMY CORPS OF ENGINEERS  
441 G STREET, NW  
WASHINGTON, DC 20314-1000

JUN 25 2013

CECW-ZB

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (CIVIL WORKS)

SUBJECT: Pine Creek Lake, McCurtain County, Oklahoma, Dam Safety Modification Report and Environmental Assessment – Final USACE Response to Independent External Peer Review

1. Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of the Water Resources Development Act of 2007, EC 1165-2-214, and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004).
2. The IEPR was conducted by Battelle Memorial Institute. The IEPR panel consisted of five members with technical expertise in economics/planning, geotechnical engineering, civil/structural engineering, engineering geology, hydraulic/hydrology engineering, and environmental/NEPA impact assessment.
3. I approve the final written responses to the IEPR contained in the enclosed document. The IEPR Report and 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 Ms. Sandy Gore, Deputy Chief, Southwestern Division Regional Integration Team, at 202-761-5237.

Encl

STEVEN L. STOCKTON, P.E.  
Director of Civil Works

**Pine Creek Lake Dam Safety Modification Study**  
**FINAL**  
**U.S. Army Corps of Engineers Response to**  
**Independent External Peer Review**  
**June 2013**

Independent External Peer Review (IEPR) was conducted for subject project in accordance with Section 2034 of the Water Resources Development Act of 2007, EC 1165-2-214, 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 resource solutions for the nation. The USACE review processes are essential to ensuring project safety and quality of products USACE provides to the American people. Battelle Memorial Institute (Battelle), a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to conduct the IEPR for the Pine Creek Dam Safety Modification Report (DSMR) and Environmental Assessment (EA).

The Battelle IEPR panel reviewed the Draft DSMR and the Draft EA, as well as supporting documentation. The final IEPR Battelle Report was issued on 29 March 2013.

Overall, 15 comments were identified and documented. Of the 15 comments, 2 were identified as having high significance, 8 had medium significance, and 5 had low significance. The following discussions present the USACE Final Response to the 15 comments.

Based on the technical content of the Pine Creek Dam review documents and the overall scope of the project, Battelle identified candidates for the panel in the field of geotechnical engineering, engineering geology, civil/structural engineering, hydraulic/hydrology engineering, economics/planning, and environmental/NEPA impact assessment. Five panel members were selected for the IEPR from more than 25 candidates identified.

**1. IEPR Comment – *High Significance*: The length of the proposed cutoff wall of 44 feet may not be long enough to cover the area of potential hydraulic fracturing or embankment defects.**

This comment includes two recommendations for resolution; both were adopted based on comments made in prior reviews and further evaluation, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) conducting an analysis during final design of the stresses within the embankment overlying and adjacent to the concrete plug to evaluate the possibility that hydraulic fracturing has occurred and to define the zone of fracturing. The limits of the analysis should be sufficient to define the limits of any potential hydraulic fracturing and thereby

provide a basis for the length of the cutoff wall. In response, sufficient analyses were performed to obtain a cost estimate for comparison of Risk Management Plans. Completion of the final design is an iterative process through completion of the plan, design, and construction sequencing. The iterative process will continue with additional analyses as recommended during the Planning, Engineering, and Design (PED) Phase. The IEPR Panel recommended (2) extending the limits of the cutoff wall to incorporate the entire length of the embankment fill, which was placed and compacted against the steep, irregular surface of the sloping excavated sidewalls of the trench for the outlet works. Consideration should be given regardless of the results of the analysis described above in the previous recommendation and occur during the final design phase. In response, the DSMR was revised to extend the length of the Element 5A Modified Cutoff Wall to 64 feet. Revisions have been made where applicable to Appendix III Formulation of Risk Management Plans Report; Appendix IV 65% Engineering Design Drawings, As-built Drawings and Construction Photographs; and Appendix VI Cost Estimating Background. The revision resulted in an increased cost of approximately \$500,000 for Structural Plan 7. Although the cost of Structural Plan 7 increased, Structural Plan 7 remains as a component of the selected alternative.

**2. IEPR Comment – High Significance: The current schedule for completing remediation does not correspond to the apparent urgency of actions needed to prevent failure as implied by Dam Safety Action Classification (DSAC) I.**

This comment includes four recommendations for resolution; three were adopted and one was not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) clarifying the starting time for the estimated construction period durations of the risk management alternatives listed in Table 50. In response, tables 50 and 51 of the DSMR were revised to reduce the construction period durations of Structural Plans 6 and 7 each from 6 years to 4 years. Final design will be expedited and construction is planned to start in October 2014. The IEPR Panel recommended (2) making every effort to expedite required reviews, funding, and finalization of repair procedures and contracts in order to begin remedial construction at the earliest possible date. In response, the DSMR, Section 4.6 Recommended Risk Management Plan was revised to reflect intent to expedite final design and construction of the project. The IEPR Panel recommended (3) modifying the sequencing to expedite the installation of the most critical remedial measures involving the drain and cutoff wall. The construction of the cutoff wall and installation of the new drain will require specialized equipment and contractor expertise. The installation of the steel liner and downstream drain system will involve more-routine type construction that does not require significant specialized equipment. Consider utilizing a separate contract to install the secant wall and chimney filter before implementing the downstream filter and conduit liner system. This sequencing may expedite the installation of the most critical remedial measures involving the

chimney drain and cutoff wall. In response, the DSMR, Section 4.6 Recommended Risk Management Plan and the construction schedule were revised to reflect the intent to expedite the project by adjusting sequencing. Expediting project completion requires final sequencing of construction of risk management measures (elements) during the PED Phase.

**USACE Response: Not Adopted**

The IEPR Panel recommended (4) including Structural/Non-Structural Plan 4 in Tables 50 and 51. As explanation, the USACE did not include the Structural/Non-Structural Plan 4 in Tables 50 and 51 because this plan was eliminated from consideration. The plan was eliminated because it delays the implementation of the complete structural plan and resolution of the issues within the embankment. The current condition of the embankment is considered to be critical and expedient remedial actions are necessary.

**3. IEPR Comment – Medium Significance: Pertinent hydrologic and hydraulic calculations, modeling, and mapping are not fully presented in Appendix 12 of the Baseline Risk Assessment Report; therefore, the full extent of the breach routing and resulting downstream flood hazards could not be determined.**

This comment includes three recommendations for resolution; two were adopted and one was not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) providing more information on HEC-RAS modeling and mapping in Appendix 12 in order to understand the mapped flood hazards used to determine dam breach consequences, and (2) including the storage curve calculation used for level pool routing and incorporate this information in Appendix 12 of the Baseline Risk Assessment Report. In response, the recommendations were adopted by taking an alternate approach to strengthen the information provided to the IEPR Panel and in the DSMR as follows. Hydraulic models, mapping, and computed inundations were provided to the IEPR panel prior to completion of the IEPR. Appendix I Baseline Risk Assessment and Appendix 12 Initiating Event: Hydrologic and Hydraulic Analysis have been revised to include a discussion of the maximum PMF used for the analysis, a schematic of the HEC-RAS model, discussions of the engineering parameters used in analysis, summary of peak discharges/stages and discharges for applicable pool elevations, storage curve calculations, and inundation maps.

**USACE Response: Not Adopted**

The IEPR Panel recommended (3) verifying that physical changes within the storage/reservoir area (i.e., sediment accumulation, vegetation growth) that have occurred since dam construction do not necessitate an update of the Pine Creek Lake storage curve that is provided in the Water Control Manual. If significant reservoir storage has been lost, develop a revised Pine Creek

Lake storage curve. As explanation, the USACE determined that an update is not necessary because a bathymetric study of the conservation pool was conducted in late 2011 and adopted in the current stage- storage curves since June 2012. Extreme event routings are not expected to impact pool routing since the topography of the watershed is very steep and does not facilitate significant sedimentation in the flood pool.

**4. IEPR Comment – Medium Significance: The breach formation time of three hours, associated with each of the six antecedent pool elevations, may not be in accordance with dam breach analysis guidelines and criteria.**

This comment includes three recommendations for resolution; none of which were adopted, as discussed below.

**USACE Response: Not Adopted**

The IEPR Panel recommended (1) providing rationale for the use of a fixed three-hour breach formation time within the Baseline Risk Assessment Report, (2) updating hydraulic modeling and flood hazard mapping, if it is decided that a breach matrix of possibilities is appropriate for use, and (3) modeling breach characteristics with the BREACH model and compare results as a quality control check. In consideration of this comment, the USACE conducted a sensitivity analysis, which indicated there was minimal to no impact on the inundation areas downstream. Initial breach parameters were within limits of current practice for breach inundation mapping. Additionally, a breach parameter sensitivity analysis was conducted as part of the base model to provide confidence in the parameters. Therefore, no revision to the hydraulic modeling, flood hazard mapping, or Dam Safety Modification Study is required.

**5. IEPR Comment – Medium Significance: Coincidental flood releases from Broken Bow and DeQueen Lakes were not considered during hydraulic modeling, which could result in increased flood stage and the inundation area on the Little River in the vicinity of the subject tributaries.**

This comment includes three recommendations for resolution; none of which were adopted, as discussed below.

**USACE Response: Not Adopted**

The IEPR Panel recommended (1) discussing and, if necessary, fully evaluating the downstream boundary conditions associated with the Broken Bow Dam and DeQueen Lake Dam tributaries, (2) revising the dam breach modeling and map associated flood hazards, if downstream boundary conditions other than low-flow conditions are deemed appropriate, and (3) re-evaluating consequences based on remapped flood hazards. As explanation, the USACE determined that further evaluation of the downstream boundary conditions and revision to the dam breach modeling was not necessary for the following reasons. The sensitivity study of PMF pool non-

failure and failure simulations at Pine Creek Lake with discharges from Broken Bow Dam and DeQueen Dam resulted in little change in the computed stage and inundation along the Little River. Additionally, revision of the dam breach modeling and re-evaluation of the consequences was not necessary as differences in the computed stage and inundation showed little change along the Little River.

**6. IEPR Comment – Medium Significance: There are discrepancies between reported maximum high pool elevations associated with the Probable Maximum Flood (PMF), which could significantly increase the flood volumes, flow depths, and inundation area.**

This comment includes three recommendations for resolution; one was adopted and two were not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) verifying breach modeling use of 503.6 feet as maximum high pool elevation. In response, the current Potential Failure Mode Analysis (PFMA) conducted in May 2012 resulting in the Maximum Pool of 503.6 is the most current value and has been included in the hydraulic breach modeling and consequence analyses. Reasons for having “discrepancies” in the PMF are the context of when analyses were performed and the level of accuracy used. The recommendation was adopted by taking an alternate approach to strengthen information provided in the DSMR as follows. The DSMR, Section 4.2.3 Dam Break Analysis and Inundation Maps, was revised to acknowledge and include the reason for the variations in the maximum pool. In addition, Appendix I Baseline Risk Assessment Report, Appendix 12 Initiating Event: Hydrologic and Hydraulic Analysis was revised to reflect a maximum pool elevation of 503.6 feet.

**USACE Response: Not Adopted**

The IEPR Panel recommended (2) performing revised modeling of the breach and map the resulting downstream flood hazards if the modeled pool elevation of 503.6 feet was not used as the maximum high pool elevation. In consideration of this comment, the USACE determined that a change in the DSMR was not required as the most current PMF data was reflected in the hydraulic breach modeling and consequence assessment. The IEPR Panel recommended (3) using remapped flood hazards as the basis for determining breach consequences. As explanation, the USACE determined that a change in the DSMR was not required as inundations were computed with the most recent PMF data (May 2012) and used for development of the consequence assessment model.

**7. IEPR Comment – Medium Significance: Standard Penetration Tests (SPTs) do not appear to correspond to the shear strength parameters used for the stability analysis conducted in the Seismic Safety Review (USACE, 2003), which could constitute a change in the stability of the critical dam cross section.**

This comment includes four recommendations for resolution; all were adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) performing a revised stability analysis using data correlated from the SPT testing from Phases I through IV. Specifically, model the localized loose and soft filter material below approximately El. 405 feet and model the localized soft zones, (2) iterating the layer and shear strength to achieve a Safety Factor between 1.0 and the previously calculated 1.6 (steady seepage) to reflect current embankment conditions in the model, (3) modifying the model to verify the interim construction conditions for the planned alternative to confirm that the improvements result in a Safety Factor exceeding the minimum required factors shown in Table 3-1 of the U.S. Army Corps of Engineers' Engineer Manual (EM) 1110-2-1902 (USACE, 1992), and (4) modifying the model with the final recommended alternative improvements and analyze to confirm that the improvements result in a Safety Factor exceeding the minimum required factors shown in Table 3-1 of USACE's EM 1110-2-1902 (USACE, 1992). In response, Appendix III Formulation of Risk Management Plans, Section 2.6 Element 8 was revised to describe the basis for the parameters used in the analysis. Additional analyses will be performed during the PED phase of the project using information provided in the Pine Creek Dam, Seismic Safety Review, November 2003, U.S. Army Corps of Engineers, Tulsa District as well as laboratory testing performed for geotechnical explorations performed after the November 2003 Seismic Review. DSMR, Section 4.6 Recommended Risk Management Plan was revised to indicate that complete stability analyses of the embankment and excavation slopes will be performed during the PED phase to ensure that required Factors of Safety are met using data correlated from the SPT testing from Phases I through IV and model the localized soft zone, specifically below and any soft zones below approximately El. 405 feet. Completion of the final design is an iterative process through completion of the plan, design, and construction sequence. The iterative process will continue with additional analyses during the PED Phase.

**8. IEPR Comment – Medium Significance: Bedrock erosion and embankment foundation stability due to uncontrolled spillway discharge under Probable Maximum Flood (PMF) conditions have not been addressed, and their importance as a credible failure mode cannot be evaluated.**

This comment includes two recommendations for resolution; both were adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) providing a copy of the full Potential Failure Modes Analysis (PFMA) Report as an appendix to the BLRA Report to document what failure modes have been considered and evaluated. In response, the Appendix I Baseline Risk Assessment Report was revised to include Appendix 13 Potential Failure Mode Discussion providing discussions of all

the potential failure modes considered by the Risk Cadre. Additionally, the DSMR, Section 8.1 Consequence Assessment Overview was revised to reference Appendix 13.

The IEPR Panel recommended (2) providing additional information with regard to uncontrolled spillway discharge velocities, susceptibility of foundation soils and bedrock to erosion under spillway design conditions, and the potential effects of erosion and head-cutting to embankment foundation stability. In response, during the PFMA, potential failure modes were classified as not credible or credible and significant. The potential failure modes that were credible and significant were carried forward through the risk assessment process. PFMS3-Erosion Downstream of Spillway was not considered to be credible nor carried forward through the risk assessment process for several reasons indicated in Section A.4.4 PFMS3 Erosion Downstream of Spillway in the Baseline Risk Assessment Report, Appendix 13. The recommendation was adopted by taking an alternate approach to strengthen information provided in the DSMR. The DSMR, Section 4.2.1 Baseline Condition was revised to clarify that five potential failure modes were considered as significant and credible. All other potential failure modes were not considered to be Significant and Credible for reasons described in the Appendix 13, potential failure mode discussion.

**9. IEPR Comment – Medium Significance: The cause of the minor pin-boils observed at station 30+00 under higher pool levels has not been fully evaluated and could pose a long-term concern for the integrity of the dam, especially under high-pool conditions.**

This comment includes two recommendations for resolution; both were adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) monitoring the outflow of the pin-boils for flow and transported sediment when flowing under high-pool conditions. In response, the Appendix I Baseline Risk Assessment Report, Section 9.1.2.2.2 SRP Estimate for PFME3 – Foundation-Embankment interface piping in the vicinity of Station 30+00, was revised to include that the outflow of the pin-boils will be monitored for flow and transported sediment during high-pool conditions. The IEPR Panel recommended (2) providing a quantitative evaluation (seepage analysis) in the supporting documentation that supports the probability estimates for PFME3. In response, the USACE determined that Appendix I, Baseline Risk Assessment Report incorrectly indicates PFME3 – Foundation/Embankment Interface Piping at Station 30+00 of the Main Embankment as a significant potential failure mode. PFME3 was initially considered as a potential failure mode, but ultimately discounted as a credible and significant potential failure mode after further review. In addition to the reasons cited in Section 9.1.2.2.2 SRP Estimate for PFME3 – Foundation-Embankment interface piping in the vicinity of Station 30+00, the cadre concluded that the pin boils were a result of inadequate drainage at a low point in the blanket drain, where water would naturally drain and exit. Inadequate drainage due to silting at the

exterior face of the blanket drain would not allow for drainage to occur above the low point contributing to an increase in pressure and pin boils to occur. The probability of failure caused by erosion at Station 30+00 was relatively low and within tolerable risk guidelines. The recommendation was adopted by taking an alternate approach to strengthen information provided in the DSMR. Appendix I, Baseline Risk Assessment Report has been revised to include further discussion of PFME3 and the reasons for discounting as a significant and credible potential failure mode, where applicable.

**10. IEPR Comment – Medium Significance: Eleven threatened and endangered species were reported, yet a description of the specific species, the probability of them being found in the project boundary area, and potential impacts on these species were not provided.**

This comment includes four recommendations for resolution; two were adopted and two were not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) including a list of individual threatened and endangered species and their potential to occur within the project area in Section 4.2.4.5.8 Threatened and Endangered Species of the document, including identifying the unnamed endangered mussel, and (2) defining the species of concern with regard to the statement in the DSMR that “this area contains one of the greatest concentrations of imperiled or critically imperiled, aquatic and terrestrial species in mid-North America”. In response, Appendix VIII Draft Environmental Assessment (EA), Appendix E Public Comments has been revised to include a list of individual threatened and endangered species and their potential to occur within the project area and has also been revised to define the species of concern and its concentration. Appendix VII Draft Environmental Assessment (EA), Section 4.6 Threatened and Endangered (T&E) Species was revised to include a listing of the 11 T&E species in Table 4.6. Appendix VII Draft Environmental Assessment (EA), Section 4.6 Threatened and Endangered Species, has been revised to include a description of each T&E species with a potential to be present within the project area, as well as the more generally defined “Ouachita Mountains of Southeastern Oklahoma”.

**USACE Response: Not Adopted**

**Recommendation:** The IEPR Panel recommended (3) identifying potential impacts to the endangered mussel, and include impacts on construction scheduling and costs and the benefits forgone if construction time is extended due to the presence of the mussel or *Harperella*. As explanation, it was determined that no significant impact to T&E plant and mussel species will result from DSM activities associated with the selected Risk Management Plan. Surveys for the American burying beetle will be conducted in accordance with USFWS guidelines prior to soil disturbing activities associated with the DSM and woody vegetation removal along the dike. The USACE will comply with requirements of the Biological Opinion in effect at the time

construction activities start and prudent avoidance measures will be implemented. The IEPR Panel recommended (4) defining mitigation measures for these species if needed. For example, a mitigation measure for this project may read: “Prior to initiation of soil-disturbing activities along the dike and the embankment, the Tulsa District will coordinate survey efforts and data collection under the conditions of the most current Biological Opinion in effect at that time for the American burying beetle, Harperella and endangered mussel. All avoidance measures within the USFWS biological opinion should be implemented”. As explanation, at present, the environmental assessment concludes there would be no significant impacts to T&E species with a potential to be present on federally managed lands adjacent to Pine Creek Reservoir and Pine Creek Dam or downstream of the Project. Coordination with the USFWS is ongoing and, if necessary, this recommendation may be adopted in the future based upon additional recommendations provided in compliance with the Fish and Wildlife Coordination Act. This coordination is not anticipated to adversely impact the construction activities or schedule.

**11. IEPR Comment – Low Significance: The U.S. Geological Survey (USGS) 10-meter Digital Elevation Model (DEM) topographic data used to develop hydraulic models, map downstream flood hazards, and ultimately determine dam breach consequences may not be commensurate with the vertical accuracy as stated in the Baseline Risk Assessment (BLRA).**

This comment includes three recommendations for resolution; none of which were adopted, as discussed below.

**USACE Response: Not Adopted**

The IEPR Panel recommended (1) discussing the potential impacts of the low resolution mapping on the study results. In consideration of this comment, the USACE confirmed that modeling used for the risk assessment incorporates the best available topographic data for the reach under study. For risk assessment hydraulic modeling and inundation mapping, USACE typically uses USGS 10 meter DEM topographic data as a base layer for model development and inundation mapping. USACE typically includes checks to verify the legitimacy of the results. Checks have been incorporated into the Pine Creek model and include: 1) a flow calibration of discharges below the dam at representative locations to verify that channel capacity flows do not cause flooding outside of the channel bounds, 2) a sensitivity test on breach parameters and resulting flow hydrographs to determine if downstream water surfaces vary greatly based on extreme inundation levels, and 3) a sensitivity of roughness values to determine sensitivities of immediate overbank areas. These checks generally expose DEM inconsistencies which may cause varied results. Revisions to the DSMR were not required as the model was calibrated to channel capacity discharges based on downstream gage data and real time water control management. The IEPR Panel recommended (2) investigating potential sources of additional mapping data (for example, mapping used for Federal Emergency Management Agency [FEMA] detailed studies). In consideration of this comment, the USACE determined that revisions to the

DSMR were not required as searches for supplemental topographic data revealed Flood Insurance Study (FIS) data was not available in the area. The IEPR Panel recommended (3) if deemed necessary after further consideration, obtaining detailed channel cross-section(s) for each reach of the Little River conveying a significant portion of the flood flow. The number of cross-sections could be limited to the number necessary to verify that the templates used to “cut” the river channel in the HEC-RAS model were representative of the existing channel conditions. In consideration of this comment, the USACE determined that the model was calibrated to channel capacity discharges based on downstream gage data and real time water control management. Thus, it was not necessary to obtain any more channel cross-section data and no revisions to the DSMR were required.

**12. IEPR Comment – Low Significance: The operation, maintenance, repair, replacement and rehabilitation (OMRR&R) efforts are not adequately described, and it could not be determined if the proposed costs are reasonable.**

This comment includes one recommendation for resolution; it was adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended providing details supporting the O&M costs associated with the various risk reduction alternatives that clearly support the reported values and documenting the differences. In response, additional information has been included in the DSMR, Section 4.4.1 Operations, Maintenance, Repair, Replacement, Rehabilitation (OMRR&R) to explain how OMRR&R was determined. The section includes the detailed description of the OMRR&R assumptions for the risk management plans.

**13. IEPR Comment – Low Significance: Piezometer PZ17 appears to be very responsive to high pool conditions and may indicate an undesirable seepage condition.**

This comment includes one recommendation for resolution; it was adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) providing an evaluation of the PZ17 readings that establishes the significance of its response to high pool conditions and its relevance to dam safety. In response, the DSMR, Section 3.5.4.6.2 Pool Rise Versus Piezometer Response Time in 2012 was revised to reflect that a rise in piezometer PZ17 level prior to rise in pool level is likely caused by influence of pool on the piezometer as well as other groundwater sources unrelated to pool. A revised plot is included in Appendix I Baseline Risk Assessment Report, Additional Geotechnical Explorations and Studies, Instrumentation, “Piezometer Plots”. PZ17 will continue to be monitored and evaluated as part of the USACE Dam Safety Program.

**14. IEPR Comment – Low Significance: Various key inputs to the economic analyses, such as including the cost of repairing damage to the dam as a potential direct loss, were not provided or explained and could result in an inaccurate final cost analysis.**

This comment includes four recommendations for resolution; three were adopted and one was not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) providing a concise description of how HEC-FIA works as applied to this study, defining the inputs and the uncertainties associated with the input data and output data. In response, Appendix II Economic Consequences, Section 4.1 Property Damage has been revised to include a concise description of how the HEC-FIA model is employed to analyze potential economic consequences, a discussion of the models and input data, and an explanation of the uncertainties associated with the input and output data. In addition, the DSMR, Section 4.1 Identify Dam Safety Issues and Opportunities and Appendix II - Economic Consequences, Section 9 Agriculture have been revised to describe how HEC-FIA works. The IEPR Panel recommended (2) clarifying the importance of agriculture in the project area and justify eliminating agricultural impacts from evaluation. In response, Appendix II Economic Consequences, Section 9 Agriculture has been added. The section includes a discussion of the land use affected by a dam failure at Pine Creek. The area impacted by inundation of a PMF event is primarily forested with minimal impacts to agriculture and cattle operations. The IEPR Panel recommended (3) evaluating dam costs for repair, assessing the forgone benefits during the three-year dam repair, and providing revised estimates. In response, it was determined during the Risk Assessment that a dam repair was estimated to take three years and cost \$40 million. This estimated amount is within the range of the various structural alternatives examined by USACE. Historical flood damages prevented were used to determine Flood Risk Management benefits. This value is considered conservative in nature. The area downstream of Pine Creek has seen limited growth and development over the years. Between the years 2000 and 2010, the area saw a population decline. The recommendation was adopted by taking an alternate approach to strengthen information provided in the DSMR as follows. Appendix II Economic Consequences, Section 6 Repair Costs has been revised to indicate that the assumed repair cost would be approximately 25 percent of the updated construction cost. As the study moved forward, the Risk Management Plan closest to the repair (Structural Plan 5), had a construction cost of approximately \$96.3 million dollars.

**USACE Response: Not Adopted**

The IEPR Panel recommended (4) calculating depth-damage percentage losses based on USACE guidance for vehicles. In consideration of this comment, the USACE clarified that USACE EGM No. 04-01 and EGM No. 09-04 are guidance for studies dealing in Flood Risk Management (i.e Flood damage reduction studies). These studies deal with justifying the level

of protection for a storm event (e.g. 100 year and 500 year event or 1 percent and 0.2 percent exceedance event) and these curves would be used in a flood damage reduction analysis model such as HEC-FDA. The DSMR is not a flood reduction study in which the project alternatives are assessed on the level of protection they provide. In a DSMR, the project alternatives are assessed on how the probability of dam failure is lowered. Therefore, in the “without project” condition, the assumption is a failure at a certain pool level and the consequence of it (i.e. a singular event). These depth damage curves for structure, content, and vehicle were assumed to be sufficient to capture the estimated economic consequence resulting from a dam failure which is a singular event.

**15. IEPR Comment – Low Significance: The chemical composition of the grouting material and sealant is not described, and the potential for short-term impacts on aquatic species has not been considered.**

This comment includes three recommendations for resolution; one was adopted and two were not adopted, as discussed below.

**USACE Response: Adopted**

The IEPR Panel recommended (1) identifying potential impacts on down gradient natural resources from grout mobilization or from degradation over time, or demonstrate that no impacts are likely to occur. In response, Appendix VII Environmental Assessment (EA), Section 5.2.2.2 Aquatic Resources, was revised to include information regarding the general impacts associated with grouting activities on water quality and aquatic resources.

**USACE Response: Not Adopted**

The IEPR Panel recommended (2) providing information regarding the chemical composition of grout and sealant. In consideration of this comment, the USACE will further assess any additives incorporated into grout mix designs for grouting purposes, with regard to aquatic resources impacts, during design and specifications phase prior to construction. If additives incorporated into grout mix designs during construction are shown to result in impacts to aquatic resources, a supplement to the existing Environmental Assessment will be prepared by USACE at that time. In addition, consideration for grout mixes without impact to aquatic resources will be given in the PED Phase. The IEPR Panel recommended (3) preparing and implementing a water quality monitoring program, including pH and electrical conductivity (EC), immediately prior to and during grouting. Continue monitoring through initial set of the grout. As explanation, while a Section 404 permit has been issued by the Tulsa District Regulatory Office (NWP 3), coordination with the Oklahoma Department of Environmental Quality (ODEQ) is still ongoing. If chemical additives used in grouting and sealant mixes are determined to result in possible significant impacts to aquatic resources, requirements for water quality monitoring would be incorporated into a Section 401 Permit issued by ODEQ (if required). As an

alternative approach, this recommendation will be adopted, if required, by USACE in the future following assessment of chemical additives used in grouting and sealant mix designs.