Final Independent External Peer Review Report Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Risk Management Center (RMC)
Huntington District

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Executive Summary

PROJECT BACKGROUND AND PURPOSE

Mohawk Dam is one component of a system of flood risk management (FRM) projects located in the Muskingum River Basin in Ohio. This project was authorized and constructed through a cooperative agreement with the Muskingum Watershed Conservancy District (MWCD). The Flood Control Act of 1939 turned over ownership, as well as operations and maintenance, of the Muskingum Basin projects to the U.S. Army Corps of Engineers (USACE). This transition resulted in a partnership between USACE and the MWCD wherein USACE owns the dams and immediate land footprint of the dam, while the MWCD owns the land beneath the reservoir, stored waters, and surrounding lands.

Mohawk Dam is located on the Walhonding River, a tributary of the Muskingum River. The dam is located 17.4 miles above the mouth of the Walhonding River and approximately 129.8 miles above the mouth of the Muskingum River. The floodplain between Mohawk Dam and downstream at-risk population centers can generally be described as a broad, gently sloping valley. Development is relatively sparse downstream of the dam, being comprised primarily of small to moderate municipalities and incorporated communities, several industrial sites, and farmland.

Mohawk Dam is a "dry dam" and does not retain a permanent pool during any season of the year. Four other USACE FRM dams are located upstream of Mohawk Dam: the Mohicanville, Charles Mill, Pleasant Hill, and North Branch of Kokosing River Dams. Two non-USACE dams with permanent pools are located upstream of Mohawk Dam: Apple Valley Lake (22,485 acre feet maximum storage) and Knox Creek Lake (3,750 acre feet maximum storage). No other FRM dams are located downstream of Mohawk Dam, either on the Walhonding or the Muskingum River.

The project consists of a rolled earthfill embankment, an outlet works control tower with two 20-foot diameter conduits that transition to horseshoe-shaped tunnels, and an uncontrolled spillway. The embankment is composed of a central clay core flanked by pervious zones and outer rock fill shells. The outlet works consist of an approach channel, intake tower, horseshoe-shaped tunnel and conduit, stilling basin, and outlet channel. The intake structure consists of reinforced concrete substructure and a brick and block superstructure to house the gate-operating machinery for six 8-foot by 17-foot sluice gates and the auxiliary power unit. Access to the structure is by a service bridge extending from the left abutment. The outflow is directed through one of two 20-foot diameter concrete conduits that transition to concrete-lined horseshoe-shaped tunnels. The tunnels then extend through the left abutment from a transition section near the gates to the stilling basin.

Independent External Peer Review Process

Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analysis. USACE is conducting an Independent External Peer Review (IEPR) of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio (hereinafter: Mohawk DSMS IEPR). As a 501(c)(3) non-profit science and technology organization, Battelle is independent, free from conflicts of interest (COIs), and meets the requirements for an Outside Eligible Organization (OEO) per guidance described in USACE (2012). Battelle has experience in establishing and administering peer review panels for USACE and was engaged to coordinate this IEPR. The IEPR was external to the agency and conducted following USACE and Office of Management and Budget (OMB) guidance described in USACE (2012) and OMB (2004). This final report presents the Final Panel Comments of the IEPR Panel (the Panel). Details regarding the IEPR (including the process for selecting panel members, the panel members' biographical information and expertise, and the charge submitted to the Panel to guide its review) are presented in appendices.

Based on the technical content of the Mohawk DSMS review documents and the overall scope of the project, Battelle identified potential candidates for the Panel in the following key technical areas: plan formulator/economist, National Environmental Policy Act (NEPA)/environmental, engineering geologist, and geotechnical engineer. Battelle screened the candidates to identify those most closely meeting the selection criteria and evaluated them for COIs and availability. USACE was given the list of final candidates to confirm that they had no COIs, but Battelle made the final selection of the four-person Panel.

The Panel received electronic versions of the Mohawk DSMS IEPR review documents (2,067 pages in total), along with a charge that solicited comments on specific sections of the documents to be reviewed. Following guidance provided in USACE (2012) and OMB (2004), USACE prepared the charge questions, which were included in the draft and final Work Plans.

The USACE Project Delivery Team (PDT) briefed the Panel and Battelle during a kick-off meeting held via teleconference at the start of the review to provide the Panel an opportunity to ask questions of USACE and clarify uncertainties. In addition, a site visit to discuss the Mohawk DSMS project was held at the project site on October 20, 2016; all four panel members attended this meeting. As part of this meeting, USACE provided an in-depth presentation and led Battelle and the Panel on a site investigation of the Mohawk Dam. Other than Battelle-facilitated teleconferences and the site visit, there was no direct communication between the Panel and USACE during the peer review process. The Panel produced individual comments in response to the charge questions.

IEPR panel members reviewed the Mohawk DSMS documents individually. The panel members then met via teleconference with Battelle to review key technical comments and reach agreement on the Final Panel Comments to be provided to USACE. Each Final Panel Comment was documented using a four-part format consisting of (1) a comment statement; (2) the basis for the comment; (3) the significance of the comment (high, medium/high, medium, medium/low, or low); and (4) recommendations on how to resolve the comment. Overall, 14 Final Panel Comments were identified and documented. Of these, three were identified as having high significance, two were identified as having medium/high significance, four had a medium significance, two had medium/low significance, and three had low significance.

Results of the Independent External Peer Review

The panel members agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2012; p. D-4) in the Mohawk DSMS review documents. Table ES-1 lists the Final Panel Comment statements by level of significance. The full text of the Final Panel Comments is presented in Section 4.2 of this report. The following summarizes the Panel's findings.

Based on the Panel's review, the report is well-written, detailed, and provides excellent supporting documentation on engineering, environmental, economic, and plan formulation issues. In addition, the site visit conducted by USACE in Coshocton, Ohio was particularly thorough. USACE personnel answered the IEPR Panel's questions in detail, making the Panel's visit very useful in understanding the main issues of the project.

The report provides a balanced assessment of the economic, engineering, and environmental issues of the overall project; however, the Panel identified several elements of the report that should be clarified or revised, or elements of the project where additional analyses are warranted and places where clarification of project findings and objectives need to be documented or revised.

Engineering and Geology: The Mohawk DSMS review documents address the main engineering and geological issues and explain the assumptions and uncertainties involved in the analyses and models used. However, the Panel identified several issues that warrant additional consideration. Of primary concern (high and medium/high level comments) was that there is no documentation of the presence of a continuous, uniformly graded, fine to medium sand or silt layer directly beneath the confining layer, which is the most important requirement for potential failure modes (PFMs) 5K or 5E to initiate. This issue can be addressed by (1) revising Appendix A, relating PFMs 5K and 5E to boiling and unfiltered exits caused by vertical gradients exceeding the critical hydraulic gradients, not to conventional backward erosion piping (BEP); and (2) modifying the objective of the risk management plan (RMP) to reduce uplift pressure in order to minimize the potential for boiling and unfiltered exits, not to prevent BEP, as hypothesized in the review documents.

The Panel also noted a significant amount of uncertainty about modeling, analyses, assumptions, and geologic conditions used for evaluating spillway channel erodibility remains at the project site. One way to deal with this concern is to reevaluate the applicability of the WinDamB program for modeling spillway erodibility, and examine other case histories of open-channel spillways with similar geologic conditions. The Panel was also concerned that the risk of left abutment failure due to fractured rock instability and buildup of pore pressure, associated with high amounts of seepage during high pools, has either not been evaluated or not considered in sufficient detail. A slope failure of the left abutment is very likely to compromise the outlet works and pose overall potential risk to the dam. To help address this issue, USACE could evaluate the risk that high pore pressures may pose to rock slope instability of the left abutment and the potential risk to the dam as part of the RMP and the tentatively selected plan (TSP).

In addition, the Panel observed that the right bank downstream of the stilling basin does not appear to be in a condition to prevent scour under certain flows and significant flood events, which could result in damage to dam components and utilities. The Panel recommends adding riprap so that the entire right bank is uniformly covered with armor rock, meeting USACE specifications EM 1110-2-1601, and suggests that the risk of bank failure on the right bank, downstream of the stilling basin, be clarified in the Existing

Condition Risk Assessment (ECRA) and Future Without Action Condition (FWAC) Risk Assessment in Appendix A.

A final observation from the Panel is that, without a fully functional piezometer system, representative of uplift pressures in the critical areas of the project, the future performance of the TSP cannot be adequately evaluated. To help address this issue, USACE can replace all abandoned and unreliable piezometers with new piezometers, install additional piezometers in the vicinity of new relief wells, monitor piezometers more frequently during high pool events (daily or sooner, if needed), and evaluate relief well performance (discharge) in light of piezometric data.

Plan Formulation and Economics: The Mohawk DSMS project adheres to sound planning principles, thoroughly and rigorously covers USACE regulations and policies, and relies on up-to-date fiscal year dollar values and discount rates. However, the Panel has two concerns about plan formulation. First, the rationale for not identifying the National Economic Development (NED), the National Ecosystem Restoration (NER), or the combined NED/NER plan in the Dam Safety Modification Report (DSMR), as required by ER 1105-2-100, has not been presented in sufficient detail. While identifying these plans is unlikely to change the ranking of alternatives or selection of the TSP, it is still considered part of the alternatives formulation and evaluation process. The issue can be resolved by revising the documents to identify and briefly describe the NED, the NER or the combined NED/NER plan and explaining the why the NED, the NER, or the combined NED/NER plan was not selected as the TSP. Second, the DMSR and appendices do not present any Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) modeling results, making it difficult to determine if all impacts associated with the FWAC, RMPs, and the TSP have been adequately addressed. Performing a reconnaissance-level run of HEC-FDA for the communities downstream of, and protected by, the Mohawk Dam, along with a brief discussion of the HEC-FDA results, can address the issue.

Environmental: Assumptions and background information provided in the Mohawk DSMS are adequate to assess the project's impacts on environmental resources, comply with NEPA requirements, and are at the appropriate level of detail at this stage in the planning process. A great deal of work has gone into arriving at the TSP in a relatively short period of time and the PDT should be commended. The Panel noted a few places where additional clarification would add to the completeness of the review documents. For example, providing more details on wetland features (hydrology, dominant vegetation types, etc.) typically found in the wetland delineation report would help clarify project impacts and support report completeness. Revising the discussion in Appendix A to reflect current stormwater control regulations for retention/detention systems will improve the technical accuracy of the discussion of stormwater controls, but will not affect the conclusions of the FWAC. The description of the baseline environmental conditions and impacts on various resources is limited in some parts of the review documents, which could affect the technical quality of the report. Finally, the discussion of the inundation zone relative to the FWAC does not address the effects of forecasted climate change or the role of County Natural Hazards Mitigation Plans in mitigating future risks. Revising and clarifying the discussion of the inundation zone relative to the FWAC will aid in understanding the FWAC risk assessment and benefit local County Hazard Mitigation Planning efforts.

Table ES-1. Overview of 14 Final Panel Comments Identified by the Mohawk DSMS IEPR Panel

No.	Final Panel Comment
Significance – High	
1	The presence of a continuous, uniformly graded, fine to medium sand or silt layer directly beneath the confining layer, the most important requirement for PFMs 5K or 5E to initiate, has not been documented.
2	A significant amount of uncertainty about modeling, analyses, assumptions, and geologic conditions used for evaluating spillway channel erodibility remains at the project site.
3	The risk of left abutment failure due to fractured rock instability has either not been evaluated or not considered in sufficient detail.
Significance – Medium/High	
4	The right bank downstream of the stilling basin does not appear to be in a condition to prevent scour under certain flows and significant flood events, which could result in damage to dam components and utilities.
5	Without a fully functional piezometer system representative of uplift pressures in the critical areas of the project, the future performance of the TSP cannot be adequately evaluated.
Significance – Medium	
6	RMP 10 relies entirely on relief wells and effective performance of the seepage collection system to address PFMs 5K and 5E, and, without a backup, offers only moderate redundancy and low to moderate resiliency.
7	The use of coefficient of uniformity (C_u) values to evaluate the piping potential of broadly graded glacial outwash at the project site is not reliable.
8	The wind direction, wave height, wave run-up, and wave reflection, at various pool elevations, have not been sufficiently considered with respect to the operation of the intake structure, the potential for scour, and instability of the upstream slope of the dam.
9	The rationale for why the DSMR does not identify the NED, the NER, or the combined NED/NER plan, as required by ER 1105-2-100, has not been presented in sufficient detail.

Table ES-1. Overview of 14 Final Panel Comments Identified by the Mohawk DSMS IEPR Panel (Continued)

Significance – Medium/Low	
10	The DMSR and Appendices B and C do not present any HEC-FDA modeling results, making it difficult to assert that all impacts associated with the FWAC, RMPs, and the TSP have been adequately addressed.
11	The Category 3 wetland delineation report has not been included in the appendices, but inclusion would help document impact conclusions and the significance of this area since this was important to the screening of measures and the selection of the TSP.
Significance – Low	
12	Current stormwater control regulations for retention/detention systems in Ohio capture events higher than the 20-year storm, whereas the discussion looks at high-frequency stormwater events that are 20-year events or less.
13	The description of the baseline environmental conditions and impacts on various resources is limited in some parts of the report, which could affect the technical quality.
14	The discussion of the inundation zone relative to the FWAC does not address the effects of forecasted climate change or the role of County Natural Hazards Mitigation Plans in mitigating future risks.

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LIST OF ACRONYMS

AALL	average annual life loss
ATR	Agency Technical Review
BEP	backward erosion piping
COI	Conflict of Interest
C_c	Coefficient of curvature
C_u	Coefficient of uniformity
CL	Lean clay
CWL	Construction Work Limits
DrChecks	Design Review and Checking System
DSAC	Dam Safety Action Classification
DSMR	Dam Safety Modification Report
DSMS	Dam Safety Modification Study
EC	Engineer Circular
ECRA	Existing Condition Risk Assessment
ER	Engineer Regulation
ERDC	Engineer Research and Development Center
FERC	Federal Energy Regulatory Commission
FRM	Flood Risk Management
FWAC	Future Without Action Condition
GC	Clayey gravel
GRR	General Reevaluation Report
HEC-FDA	Hydrologic Engineering Center's Flood Damage Analysis
HEC-FIA	Hydrologic Engineering Center’s Flood Impact Analysis
HEP	Habitat Evaluation Procedure
IDF	inflow design flood
IEPR	Independent External Peer Review
IES	Issue Evaluation Study
IWR	Institute for Water Resources
ML	Silt
MWCD	Muskingum Watershed Conservancy District
NED	National Economic Development
NEPA	National Environmental Policy Act

NER	National Ecosystem Restoration
ODNR	Ohio Department of Natural Resources
OEO	Outside Eligible Organization
OEPA	Ohio EPA
OMB	Office of Management and Budget
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PFM	Potential Failure Mode
RMC	Risk Management Center
RMP	Risk Management Plan
SC	Clayey sand
SCM	Stormwater control measures
SFTA	Special Flood Hazard Area
SM	Silty sand
T&E	threatened and endangered
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
TSP	Tentatively Selected Plan
WQv	water quality volume

1. INTRODUCTION

Mohawk Dam is one component of a system of flood risk management (FRM) projects located in the Muskingum River Basin in Ohio. This project was authorized and constructed through a cooperative agreement with the Muskingum Watershed Conservancy District (MWCD). The Flood Control Act of 1939 turned over ownership, as well as operations and maintenance, of the Muskingum Basin projects to the U.S. Army Corps of Engineers (USACE). This transition resulted in a partnership between USACE and the MWCD wherein USACE owns the dams and immediate land footprint of the dam, while the MWCD owns the land beneath the reservoir, stored waters, and surrounding lands.

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Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analysis. The objective of the work described here was to conduct an Independent External Peer Review (IEPR) of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio (hereinafter: Mohawk DSMS IEPR) in accordance with procedures described in the Department of the Army, USACE, Engineer Circular (EC) *Civil Works Review* (EC 1165-2-214) (USACE, 2012) and the Office of Management and Budget (OMB), *Final Information Quality Bulletin for Peer Review* (OMB, 2004). Supplemental guidance on evaluation for conflicts of interest (COIs) was obtained from the *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports* (The National Academies, 2003).

This final report presents the Final Panel Comments of the IEPR Panel (the Panel) on the existing engineering, economic, environmental, and plan formulation analyses contained in the Mohawk DSMS IEPR documents (Section 4). Appendix A describes in detail how the IEPR was planned and conducted, including the complete schedule followed in executing the IEPR. Appendix B provides biographical information on the IEPR panel members and describes the method Battelle followed to select them. Appendix C presents the final charge to the IEPR panel members for their use during the review; the final charge was submitted to USACE in the final Work Plan according to the schedule listed in Table 1. Appendix D presents the organizational conflict of interest form that Battelle completed and submitted to the Institute for Water Resources (IWR) prior to the award of the Mohawk DSMS IEPR.

2. PURPOSE OF THE IEPR

To ensure that USACE documents are supported by the best scientific and technical information, USACE has implemented a peer review process that uses IEPR to complement the Agency Technical Review (ATR), as described in USACE (2012).

In general, the purpose of peer review is to strengthen the quality and credibility of the USACE decision documents in support of its Civil Works program. USACE has been directed by Congress to develop the Mohawk Dam DSMS. IEPR provides an independent assessment of the engineering, economic, environmental, and plan formulation analyses of the project study. In particular, the IEPR addresses the technical soundness of the project study's assumptions, methods, analyses, and calculations and identifies the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the Mohawk DSMS was conducted and managed using contract support from Battelle, which is an Outside Eligible Organization (OEO) (as defined by EC 1165-2-214). Battelle, a 501(c)(3) organization under the U.S. Internal Revenue Code, has experience conducting IEPRs for USACE.

3. METHODS FOR CONDUCTING THE IEPR

The methods used to conduct the IEPR are briefly described in this section; a detailed description can be found in Appendix A. Table 1 presents the major milestones and deliverables of the Mohawk DSMS IEPR. Due dates for milestones and deliverables are based on the award/effective date listed in Table 1. Note that the actions listed under Task 6 occur after the submission of this report. Battelle anticipates submitting the pdf printout of the USACE's Design Review and Checking System (DrChecks) project file (the final deliverable) on December 22, 2016. The actual date for contract end will depend on the date that all actions for this IEPR are conducted and subsequently completed.

Battelle identified, screened, and selected four panel members to participate in the IEPR based on their expertise in the following disciplines: plan formulator/economist, National Environmental Policy Act (NEPA)/environmental, engineering geologist, and geotechnical engineer. The Panel reviewed the Mohawk DSMS documents and produced 14 Final Panel Comments in response to 21 charge questions provided by USACE for the review. This charge included two overview questions added by Battelle.

Table 1. Major Milestones and Deliverables of the Mohawk DSMS IEPR

Task	Action	Due Date
1	Award/Effective Date	9/8/2016
	Review documents available	9/13/2016
2	Battelle submits list of selected panel members	10/4/2016
	USACE confirms the panel members have no COI	10/7/2016
3	Battelle convenes kick-off meeting with USACE	9/19/2016
	Battelle convenes webinar kick-off meeting with USACE and panel members	10/13/2016
4	Panel members complete their individual reviews	11/2/2016
	Panel members provide draft Final Panel Comments to Battelle	11/16/2016
5	Battelle submits Final IEPR Report to USACE	11/22/2016
6[a]	Battelle convenes Comment Response Teleconference with panel members and USACE	12/19/2016
	Battelle submits pdf printout of DrChecks project file to USACE	12/22/2016
	Contract End/Delivery Date	4/28/2017

[a] *Task 6 occurs after the submission of this report.*

Battelle instructed the Panel to develop the Final Panel Comments using a standardized four-part structure:

1. Comment Statement (succinct summary statement of concern)
2. Basis for Comment (details regarding the concern)
3. Significance (high, medium/high, medium, medium/low, or low; in accordance with specific criteria for determining level of significance)
4. Recommendation(s) for Resolution (at least one implementable action that could be taken to address the Final Panel Comment).

Battelle reviewed all Final Panel Comments for accuracy, adherence to USACE guidance (EC 1165-2-214, Appendix D), and completeness prior to determining that they were final and suitable for inclusion in the Final IEPR Report. There was no direct communication between the Panel and USACE during the preparation of the Final Panel Comments. The Panel's findings are summarized in Section 4.1; the Final Panel Comments are presented in full in Section 4.2.

4. RESULTS OF THE IEPR

This section presents the results of the IEPR. A summary of the Panel's findings and the full text of the Final Panel Comments are provided.

4.1 Summary of Final Panel Comments

The panel members agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2012; p. D-4) in the Mohawk DSMS IEPR review documents. The following summarizes the Panel's findings.

Based on the Panel's review, the report is well-written, detailed, and provides excellent supporting documentation on engineering, environmental, economic, and plan formulation issues. In addition, the site visit conducted by USACE in Coshocton, Ohio was particularly thorough. USACE personnel answered the IEPR Panel's questions in detail, making the Panel's visit very useful in understanding the main issues of the project.

The report provides a balanced assessment of the economic, engineering, and environmental issues of the overall project; however, the Panel identified several elements of the report that should be clarified or revised, or elements of the project where additional analyses are warranted and places where clarification of project findings and objectives need to be documented or revised.

Engineering and Geology: The Mohawk DSMS review documents address the main engineering and geological issues and explain the assumptions and uncertainties involved in the analyses and models used. However, the Panel identified several issues that warrant additional consideration. Of primary concern (high and medium/high level comments) was that there is no documentation of the presence of a continuous, uniformly graded, fine to medium sand or silt layer directly beneath the confining layer, which is the most important requirement for potential failure modes (PFMs) 5K or 5E to initiate. This issue can be addressed by (1) revising Appendix A, relating PFMs 5K and 5E to boiling and unfiltered exits caused by vertical gradients exceeding the critical hydraulic gradients, not to conventional backward erosion piping (BEP); and (2) modifying the objective of the risk management plan (RMP) to reduce uplift pressure in order to minimize the potential for boiling and unfiltered exits, not to prevent BEP, as hypothesized in the review documents.

The Panel also noted a significant amount of uncertainty about modeling, analyses, assumptions, and geologic conditions used for evaluating spillway channel erodibility remains at the project site. One way to deal with this concern is to reevaluate the applicability of the WinDamB program for modeling spillway erodibility, and examine other case histories of open-channel spillways with similar geologic conditions. The Panel was also concerned that the risk of left abutment failure due to fractured rock instability and buildup of pore pressure, associated with high amounts of seepage during high pools, has either not been evaluated or not considered in sufficient detail. A slope failure of the left abutment is very likely to compromise the outlet works and pose overall potential risk to the dam. To help address this issue, USACE could evaluate the risk that high pore pressures may pose to rock slope instability of the left abutment and the potential risk to the dam as part of the RMP and the tentatively selected plan (TSP).

In addition, the Panel observed that the right bank downstream of the stilling basin does not appear to be in a condition to prevent scour under certain flows and significant flood events, which could result in damage to dam components and utilities. The Panel recommends adding riprap so that the entire right bank is uniformly covered with armor rock, meeting USACE specifications EM 1110-2-1601, and suggests that the risk of bank failure on the right bank, downstream of the stilling basin, be clarified in the Existing Condition Risk Assessment (ECRA) and Future Without Action Condition (FWAC) Risk Assessment in Appendix A.

A final observation from the Panel is that, without a fully functional piezometer system, representative of uplift pressures in the critical areas of the project, the future performance of the TSP cannot be adequately evaluated. To help address this issue, USACE can replace all abandoned and unreliable piezometers with new piezometers, install additional piezometers in the vicinity of new relief wells, monitor piezometers more frequently during high pool events (daily or sooner, if needed), and evaluate relief well performance (discharge) in light of piezometric data.

Plan Formulation and Economics: The Mohawk DSMS project adheres to sound planning principles, thoroughly and rigorously covers USACE regulations and policies, and relies on up-to-date fiscal year dollar values and discount rates. However, the Panel has two concerns about plan formulation. First, the rationale for not identifying the National Economic Development (NED), the National Ecosystem Restoration (NER), or the combined NED/NER plan in the Dam Safety Modification Report (DSMR), as required by ER 1105-2-100, has not been presented in sufficient detail. While identifying these plans is unlikely to change the ranking of alternatives or selection of the TSP, it is still considered part of the alternatives formulation and evaluation process. The issue can be resolved by revising the documents to identify and briefly describe the NED, the NER or the combined NED/NER plan and explaining the why the NED, the NER, or the combined NED/NER plan was not selected as the TSP. Second, the DMSR and appendices do not present any Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) modeling results, making it difficult to determine if all impacts associated with the FWAC, RMPs, and the TSP have been adequately addressed. Performing a reconnaissance-level run of HEC-FDA for the communities downstream of, and protected by, the Mohawk Dam, along with a brief discussion of the HEC-FDA results, can address the issue.

Environmental: Assumptions and background information provided in the Mohawk DSMS are adequate to assess the project's impacts on environmental resources, comply with NEPA requirements, and are at the appropriate level of detail at this stage in the planning process. A great deal of work has gone into arriving at the TSP in a relatively short period of time and the PDT should be commended. The Panel noted a few places where additional clarification would add to the completeness of the review documents. For example, providing more details on wetland features (hydrology, dominant vegetation types, etc.) typically found in the wetland delineation report would help clarify project impacts and support report completeness. Revising the discussion in Appendix A to reflect current stormwater control regulations for retention/detention systems will improve the technical accuracy of the discussion of stormwater controls, but will not affect the conclusions of the FWAC. The description of the baseline environmental conditions and impacts on various resources is limited in some parts of the review documents, which could affect the technical quality of the report. Finally, the discussion of the inundation zone relative to the FWAC does not address the effects of forecasted climate change or the role of County Natural Hazards Mitigation Plans in mitigating future risks. Revising and clarifying the discussion of the inundation zone relative to the FWAC will aid in understanding the FWAC risk assessment and benefit local County Hazard Mitigation Planning efforts.

4.2 Final Panel Comments

This section presents the full text of the Final Panel Comments prepared by the IEPR panel members.

Final Panel Comment 1

The presence of a continuous, uniformly graded, fine to medium sand or silt layer directly beneath the confining layer, the most important requirement for PFMs 5K or 5E to initiate, has not been documented.

Basis for Comment

The 150 foot thick glacial outwash deposits underlying the dam are very heterogeneous in nature (Appendix A [Existing Condition Risk Assessment (ECRA) and Future Without Action Condition Report (FWAC)], p. 2-32). The heterogeneous nature of the glacial outwash is corroborated by the broad bands encompassing the grain size distribution curves (Appendix A, Addendum D, Figures 4 and 5; Appendix A, Figure 2.16). Where the outwash material is layered, the layers are cross-bedded and discontinuous (USACE IEPR Brief, Slides 21-23; Appendix A, Addendum B, Figures 15 and 16). Although many samples from drilling and auger borings were tested in the laboratory for grain size distribution and Atterberg limits, a significant amount of uncertainty still remains about the subsurface distribution of gravel, sand, silt, and clay at the project site. The USACE presentation during the kickoff briefing showed sections from a quarry (Slides 21-23) 3 miles upstream of the project site to illustrate the nature of glacial outwash. However, because of the heterogeneous nature of glacial outwash, the subsurface conditions at the project site are expected to be quite different and variable with respect to distribution and layering of materials of different size gradations.

Potential Failure Modes (PFMs) 5K and 5E are both related to backward erosion piping (BEP). However, considering the heterogeneity of geologic conditions stated above, there is considerable uncertainty regarding the possibility of failure modes 5K or 5E occurring at the project. As stipulated in the documents, there are three requirements for BEP (PFMs 5K and 5E) to occur: (i) an impervious confining layer is present on top of the foundation soil to serve as a roof for the pipe, (ii) a continuous layer of uniformly graded, fine- to medium-grained sand or non-plastic silt, susceptible to piping, is present directly beneath the confining layer, and (iii) defects in the confining layer are present either naturally or can be created by the uplift pressure of water seeping through the foundation, which, in turn, requires that the confining layer on the downstream side is thin enough to be heaved and cracked by the uplift pressure.

The geologic conditions at the project site meet requirements (i) and (iii), but not requirement (ii). The subsurface data provided in the Dam Safety Modification Report (DSMR) and the accompanying appendices document the presence of a confining layer of alluvium, consisting of a silty clay (CL-ML) or a sandy clay (CL), both upstream and downstream of the embankment. The confining layer is relatively impervious and has a maximum thickness of more than 8 feet and minimum thickness of 1.3 - 2.2 feet (Appendix A, Addendum C, p. C-656). The layer contains a few natural defects (e.g., large, uprooted trees). Also, the factor of safety values against uplift pressure is less than 1 for the thinner portions of the confining layer once the pool rises above elevation 840 - 850 feet (Appendix A, p. 2-56). However, the estimates of confining layer thickness are based on seven auger borings in the downstream area, which are concentrated in the previously observed seepage/boiling area (Appendix A, Addendum C, Figure 1, p. C-655). This limited number of borings does not provide sufficient data/information about the continuity and thickness of the confining layer downstream of the embankment, causing uncertainty.

The presence of a continuous, uniformly graded, fine to medium sand or silt layer, which is the most important requirement for PFMs 5K and 5E to initiate, has not been documented. Table 2.10 (PFM 5K Node 2 Likelihood Factors) in Appendix A (p. 2-31) states, “The complicated depositional environment (channel braiding, meandering, stream cutoff, bank and terrace area mantling) makes it unlikely a continuous pipe-able layer exists upstream to downstream.” On page 2-32, Appendix A states, “These

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heterogeneous samples lacking persistent uniform fine-to-medium sands indicate the existence of a continuous zone of erodible material extending beneath the dam and exiting into the seepage collection system outfall channel is very unlikely." Addendum D (p. D-4) states, "During the IES, Hoffmans (2013), Sellmeijer (2011), and Schmertmann (2000) methodologies were used to evaluate progression of backward erosion piping (BEP) failure modes. The probability of a continuous fine to medium grained sand was elicited to be very unlikely to virtually impossible." On page 2-38, Appendix A states, "Erodible material must be in contact with roof-forming material and no continuous erodible material has been found at within 40 feet of a roof bearing material (see Figure 2.17)." Yet the failure modes 5K and 5E both assume the presence of such a layer, contrary to the geologic findings. Considering this, there is a significant amount of uncertainty regarding the initiation and progression of failure modes 5K or 5E (i.e., the initiation and progression of BEP). The Panel is unable to understand the basis for PFMs 5K and 5E when the geological conditions for BEP, as hypothesized in the review documents, do not exist. The Panel is also unable to understand how the geologic uncertainty for these two failure modes, as part of the total uncertainty, as shown on the f-N plots for the three risk management plans, RMP 10, RMP 5, RMP 14 (DSMR, Figures 3.5, 5.1, 5.2, and 5.3), was estimated.

Significance – High

Assuming the presence of a continuous layer of uniformly graded sand or silt, directly beneath the confining layer, extending upstream to downstream, for evaluating BEP potential impacts the ECRA and FWAC Risk Assessment described in Appendix A as well as the RMP.

Recommendation for Resolution

1. Revise Appendix A to relate PFMs 5K and 5E to boiling and unfiltered exits, caused by vertical gradients exceeding the critical hydraulic gradients, not to conventional BEP requiring the presence of a continuous sand/silt layer beneath a confining layer and extending upstream to downstream.
2. Modify the objective of the RMP to reduce uplift pressure in order to minimize the potential for boiling and unfiltered exits, not to prevent BEP, as hypothesized in the review documents.

Final Panel Comment 2

A significant amount of uncertainty about modeling, analyses, assumptions, and geologic conditions used for evaluating spillway channel erodibility remains at the project site.

Basis for Comment

Based on recent investigations, the spillway report (Appendix A, Addendum E) states that (i) the unconfined compressive strength of bedrock is higher than previously thought and (ii) discontinuities are generally tighter than previously considered. The report concludes that the potential for spillway erosion (i.e., PFM 9) is much less than previously considered.

However, there is uncertainty associated with the modeling and analyses used for evaluating spillway erodibility (PFM 9). Both the WinDamB analysis for headcut erosion and the impingement and backroller erosion analysis are based on numerous assumptions, some of which may not be entirely valid. Both types of analysis have significant limitations. Addendum E states (pp. E-119 - E-120):

> "The limitations of the WinDamB program should be noted as related to runs completed for Mohawk. The overall analysis of the complex geometry used in the block soil model pushed the WinDamB program to its limits, several properties had to be adjusted and some smaller blocks had to be removed to finally produce accurate runs. In addition the program was unable to run a continuous weathered rock layer, thus this condition observed during the field exploration program was not accounted for. In addition the program isn't really built for modeling a concrete weir and rock conditions were very limited when developing the program. Several of the input properties such as representative diameter, percent clay, detachment coefficient are more geared towards the erosion of soil creating a limitation of determining the erodibility of rock. It is recommended that additional 1D analysis and case studies of the rock erosion be examined."

Regarding impingement and backroller erosion, the spillway report (Addendum E, p. E-129) states, "A significant assumption in this analysis is that stream power works across the entire spillway and the erosion of soil does not result in concentrations of the stream power that is acting on the rock." However, this assumption does not appear to be valid since, once the soil is removed, an eroding bedrock consisting of alternating layers of harder and softer strata is very likely to result in concentrations of stream power and stream velocity. The Panel was also unable to understand how the accuracy of the runs was determined.

The majority of the soils in the spillway channel are cohesionless silty sands (SM) or silts (ML), with zones of low plasticity material (CL, SC, and GC) (Addendum E, pp. E-42 and E-45). Despite the presence of grass cover and gravel, these soils are likely to erode rapidly under any pool above the spillway crest. The continuous 5 to 10 foot thick weathered rock layer that WinDamB could not model will offer little resistance. Once a few blocks from the sandstone layers in the underlying unweathered bedrock are removed, the alternating shale layers will erode rapidly, facilitating the erosion of the remaining portions of sandstone layers. Furthermore, joint spacing and joint orientations are much more important in influencing erodibility potential than rock strength. Joint orientations are based on only 51 poles (Addendum E, p. E-55), statistically, a very small population. Joint apertures, ranging from 0.19 inches to 4.15 inches (Addendum E, p. E-60), are large enough to erode a thinly bedded and closely jointed bedrock. Additional data on discontinuity orientations, spacing, and aperture will reduce the modeling uncertainty with respect to these parameters. Because of the assumptions, modeling limitations, and geological considerations stated above, there is a significant amount of uncertainty regarding spillway erodibility. The Panel agrees with the PDT recommendation that additional case histories regarding erodibility of open-channel

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spillways with similar geologic conditions be considered, applicability of WinDamB be re-evaluated, and other modeling software be examined.
Significance – High
The spillway is an integral part of the dam. Spillway erodibility was one of the failure modes (PFM 9) carried forward for further analysis and risk assessment.
Recommendation for Resolution
1. Re-evaluate the applicability of the WinDamB program for modeling spillway erodibility. 2. Examine other case histories of open-channel spillways with similar geologic conditions. 3. Collect and evaluate additional data regarding discontinuity orientations, spacing, and aperture for the bedrock underlying the spillway channel to reduce the modeling uncertainty associated with geologic conditions.

Final Panel Comment 3

The risk of left abutment failure due to fractured rock instability has either not been evaluated or not considered in sufficient detail.

Basis for Comment

The August 2012 Issue Evaluation Study (IES), completed in September 2014, describes (p. 9-2) primary risk drivers, one of which is PFM4A, “Internal Erosion of the embankment into open rock defects at the left abutment.” IES Section 9.2.2 describes Nodes 1 through 7 with key risk factors for failure from PFM4A and concludes the risk is acceptable.

During the site visit, USACE presented information on historic pool levels, as well as the 2005 Pool of Record. Drawing BG101 of Appendix A, Addendum F (p. F-1), describes the record pool level as rising to elevation 879.5, and five other historical pool levels from 1969 to the present that ranged from elevation 851.2 to 867.8.

USACE provided Battelle with historic photos for the Panel to review: 22 photos depicting the outlet works construction from 1936; photos of left bank seepage from the 2005 pool event; and photos of construction details and sections describing the concrete cut-off wall and grout curtain constructed to prevent seepage through the left abutment. The photo captioned “Profile on Center Line of Dam at East Abutment” shows a 10-foot concrete cut-off wall constructed from Station 23+00 to 25+40. The document also reveals a grout curtain was installed from Station 23+00 to 25+30, extending 20 feet beneath the cut-off wall and as far down as elevation 784 in some locations. The IES describes the potential source of leakage and concludes it is unknown. Since the photos depict the measures to cut off water flow and the IES indicates the source of leakage is unknown, it is unclear if the measures used are functioning as intended.

The photos of the historic pool event of 2005 reveal significant seepage occurred during the pool elevation of 879.5. The photos show a horizontal fractured zone exists where significant seepage exited the left abutment rock wall. Seepage appears to originate at approximately elevation 846. The fractured nature of the rock and unfiltered exits with pools exceeding elevation 851 indicate that either the grout holes and cut-off wall are not functioning as designed or that more fractured rock exists beyond the grout curtain and cut-off wall.

According to the IES (p. 9-39), “Concentrated leakage observed on downstream left abutment face at El. 844 when reservoir reached El. 851… .” It also states, “Leakage also observed at el. 848.6 with reservoir of El. 855… .” It is the Panel members’ experience, based on piezometer readings in rock slopes, that pore pressures can rise very quickly, either due to precipitation or to water in flow. In addition, pore pressures can also rise even higher in winter months when freezing temperatures have a tendency to freeze seepage and concentrate seepage flows. The photos from the 2005 record pool indicate that concentrated flow exists at the left abutment roughly at elevation 845. Should pore pressure rise significantly, there is a potential risk that the left abutment could fail and the slide material could be transported into the stilling basin. The potential for rock debris blocking the outlet works discharge is a risk factor that should be considered.

Significance – High

A slope failure of the left abutment is very likely to compromise the outlet works and pose overall potential risk to the dam.

Final Panel Comment 3
Recommendation for Resolution
1. Evaluate the risk that high pore pressures may pose to rock slope instability of the left abutment and the potential risk to the dam as part of RMP and TSP. 2. Revise the IES to include this risk factor.

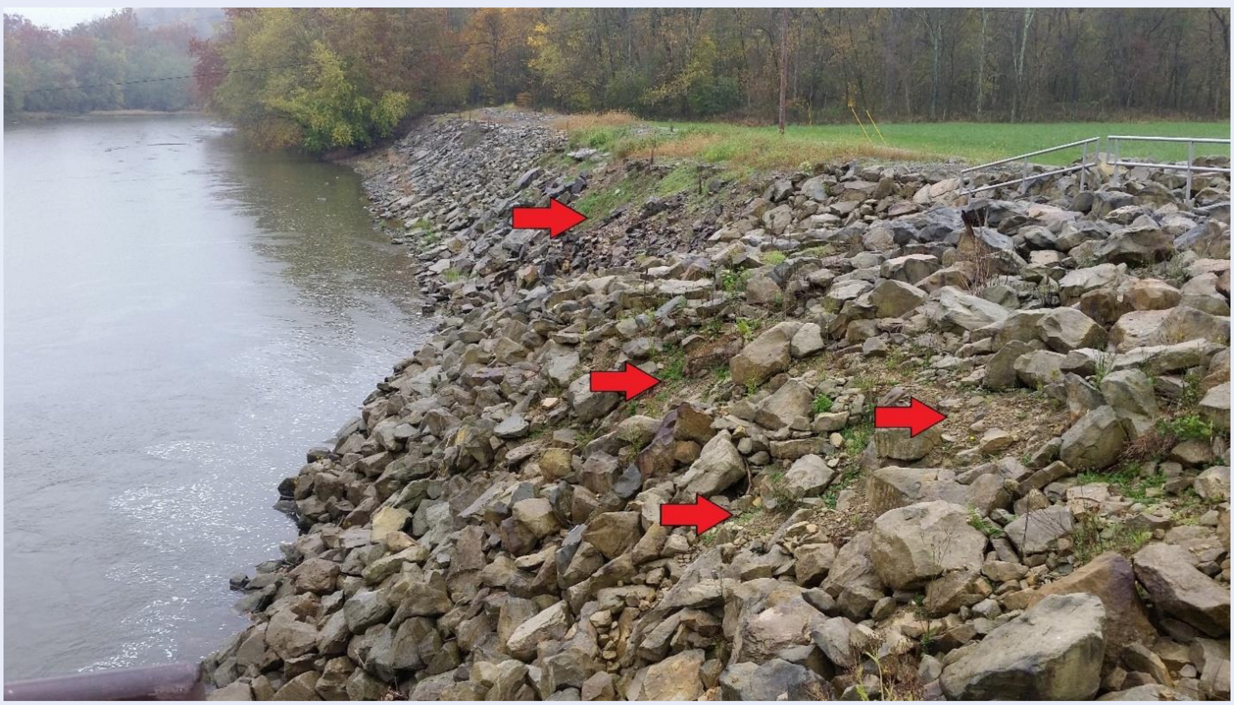
Final Panel Comment 4

The right bank downstream of the stilling basin does not appear to be in a condition to prevent scour under certain flows and significant flood events, which could result in damage to dam components and utilities.

Basis for Comment

Appendix A describes the outlet works as consisting of "an approach channel, intake tower, horseshoe-shaped tunnel and conduit, stilling basin and outlet channel" (p. 1-2). Potential failure modes are described, but the risk of bank failure on the right bank, downstream of the stilling basin, is not discussed.

During the site visit, the Panel observed the right and left bank downstream from the stilling basin. It appears the left bank consists of bedrock lined with armor rock and the right bank is lined with armor rock to prevent scour of the banks. The Panel reviewed the condition of the armor rock and concluded the left bank armor rock is in good condition, but the right bank armor rock either is missing riprap or it is partially covered. Per USACE EM 1110-2-1601 rock should be designed for the maximum discharge velocities. High discharge velocities, during high pool events, may lead to scour if the riprap is missing from the right side of the river bank. The locations observed by the Panel are shown in the photo below. The Panel did not perform a complete inspection, which is necessary to verify any other locations where armor rock is missing.



Significance – Medium/High

The current condition of the right bank armor rock could result in damage to the right bank of the outlet channel, scour of wetlands, loss of structural support for the concrete stilling basin, and loss of electric power (see photo depicting power pole behind revetment and power lines crossing river.).

Final Panel Comment 4
Recommendation for Resolution
1. Add riprap so that the entire right bank is uniformly covered with armor rock meeting USACE specifications EM 1110-2-1601. Clarify the risk of bank failure on the right bank, downstream of the stilling basin, in the ECRA and FWAC risk assessment in Appendix A.

Final Panel Comment 5

Without a fully functional piezometer system representative of uplift pressures in the critical areas of the project, the future performance of the TSP cannot be adequately evaluated.

Basis for Comment

The Mohawk Dam project has a total of 55 piezometers: 49 open tube and 6 fully grouted vibrating wire piezometers. These piezometers are monitored for uplift pressures in the foundation, in the embankment, adjacent to relief wells, beneath the filter blanket, and under the downstream alluvium. However, a number of these piezometers are either nonresponsive (P-48A; P-48B; CD-10-91A; CD-10-91B; CD-10-93; P-48) or result in erratic/unreliable data (P-16; P-23; CD-10-92A; CD-10-92B; P-10) (Appendix A, Addendum D, Section 4.2, pp. D-64 to D-67). Piezometers P-10, P-16, and P-23 have already been abandoned and other nonresponsive or unreliable piezometers are recommended for replacement. This shows that nearly 25% of the total number of piezometers at the project site are nonfunctional.

The main objective of RMP 10 is to minimize the potential for PFMs 5K and 5E by reducing the uplift pressure. The plan proposes to reduce the uplift pressure by increasing the number of relief wells and by improving the associated seepage collection system downstream of the embankment. In order to adequately evaluate the future performance of the tentatively selected plan (TSP), it is essential that all piezometers at the project are fully responsive and provide reliable data. The piezometer data will indicate whether or not the uplift pressures during high pools are low enough not to cause boiling or unfiltered exits. Therefore, for the TSP to meet its objective, it is important that all abandoned and unreliable piezometers be replaced by vibrating wire or other state-of-the-art piezometers. Furthermore, additional piezometers should be installed in the downstream seepage-berm area between the relief wells, especially the new relief wells, and monitored more frequently. The piezometer system at the project site needs to be upgraded so that future performance of the proposed RMP 10, the TSP, can be adequately evaluated.

Significance – Medium/High

Reliable piezometric data provide a direct measure of the effectiveness of relief wells (i.e., the proposed RMP). Without an up-to-date and properly functioning piezometer system, the success of RMP 10 cannot be evaluated.

Recommendation for Resolution

1. Replace all abandoned and unreliable piezometers with new state-of-the-art piezometers.
2. Install additional piezometers in the vicinity of new relief wells.
3. Monitor piezometers more frequently during high pool events (daily or sooner, if needed).
4. Evaluate relief well performance (discharge) in light of piezometric data.

Final Panel Comment 6

RMP 10 relies entirely on relief wells and effective performance of the seepage collection system to address PFMs 5K and 5E, and, without a backup, offers only moderate redundancy and low to moderate resiliency.

Basis for Comment

RMP 10, designated as the TSP, uses two improvements over the existing condition (DSMR, p. 4-18) to address PFMs 5K and 5E:

- A line of 11 new relief wells between Stations 7+50 and 15+00, located downstream of the existing relief wells (DSMR, Figure 4.2)
- Selective upsizing of the seepage collector system, i.e., removal or abandonment of some pipes and replacement or installation of new pipes (DSMR, Figure 4.2).

The proposed plan is appropriate because it reduces the uplift pressure and the associated hydraulic gradients, the basis for the initiation of PFMs 5K and 5E. It also results in PFMs 5K and 5E plotting on the f-N diagram below the tolerable risk limit for average annual life loss (AALL), including uncertainty (DSMR, Figure 5.1). According to the DSMR, the proposed plan ranks high in completeness, medium in robustness, medium in redundancy, and low to medium in resiliency (DSMR, Table 5.1). RMP 10 is also the most cost-effective plan.

However, among the three existing risk management measures at the project – the upstream impervious blanket, the downstream seepage berm, and the relief wells – the RMP 10 relies exclusively on increasing the number of relief wells. Improving the seepage collection system improves the effectiveness of the relief well system. If, during an unusually high flow event, some of the relief wells and their associated seepage collection systems do not perform as intended, there is no backup to count on. The past performance of relief wells indicates that, during the 2005 pool of record, the relief wells and their seepage collection system were overwhelmed (DSMR, p.1-10), hence the Panel's concern. Also, depending upon the ages of the wells and their levels of rehabilitation and maintenance, all wells may not be equally effective during high pool events. Furthermore, during high pools, tail water may reduce effectiveness. Therefore, it is the Panel's opinion that RMP 10 would benefit from additional redundancy and resiliency.

The DSMR states (p. 4-6): "Relief wells are an efficient measure at Mohawk because they reduce the likelihood of uplift and initiation of BEP for relatively low cost. This relief well extension would be marginally effective because it only targets a portion of the exit locations. For this reason, this measure may need to be combined with other measures." The Panel agrees with this statement, which suggests the need for additional redundancy and resiliency.

During the site visit, information was presented to the Panel describing the relief well system. It is the Panel's understanding that the new system will consist of the following:

- New relief wells will extend to 120 feet in depth.
- New concrete headwalls will be located downstream of the existing relief well discharge points.
- Both the existing relief wells and new relief well discharge pipes will be extended to the new concrete headwall.
- Existing relief well discharge scour aprons will have riprap removed and filled to the level of the new headwall.

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- New scour aprons will be added for both the existing and new relief well discharge points. Discharge will then flow into the 10 foot wetland buffer area and wetland for each discharge pipe.

Addendum E in Appendix D includes preliminary drawings for the TSP, which show the proposed relief well system described above. The Panel has the following comments on the design, design calculations, and assumptions made for the TSP. These comments pertain to the influence of the proposed design of the TSP on redundancy and resiliency.

- Addendum E, Sheet CU502 contains details on the design depths for the new relief wells with roughly 120 feet to the bottom of the well screen. Page B-6 of the Mohawk DSMS geomorphology indicates the foundation for the dam consists of highly permeable, predominately sands and gravels extending to bedrock. Bedrock is about 150 feet, with some variation. During high pool events, it is anticipated that significant pressure head may exist between the well screens and bedrock, resulting in significant flow that may not be intercepted. It is difficult to draw flow nets with any certainty due to the braided nature of the outwash material and variation in its permeability. It is the Panel's opinion that the relief wells do not extend to a sufficient depth to intercept flows closer to bedrock, thereby reducing the redundancy and resiliency.
- The headwall location, as shown in Addendum E design drawings for the TSP, depicts headwall with minimal allowance for discharge energy absorption. As shown in Drawings CS701 to CS706, the proposed headwall is in close proximity (in some cases within 10 feet) to the CWL setback from the limits of existing wetland. Calculations for design of the gabion stone blankets were not provided, therefore the discharge velocity, and its potential for scour of the blanket and adjacent wetlands, could not be assessed. The Panel discussed this issue with USACE personnel during the site visit and was told that part of the headwall could be relocated closer to the dam to provide sufficient energy absorption before allowing discharge to enter the wetland. It is the Panel's opinion that additional assessment of this issue may be needed for the TSP to be more effective.

Significance – Medium

The seepage collection system lacks sufficient redundancy and resiliency, and during high pool and high tailwater events, may not perform as intended, resulting in potential risks.

Recommendation for Resolution

1. Increase the thickness of the downstream seepage berm.
2. Increase the thickness of the filters/rock-covers in the outfall areas.
3. Increase the length of the seepage berm to the extent possible, without adversely impacting the wetland area.
4. Increase the depth of the relief wells, extending close to the bedrock.
5. Consider whether relocation of headwalls or extension of gabion stone blankets may be required to minimize relief well discharge scour of wetlands, potential scour under stone blankets, or potential for undercutting of concrete headwalls.
6. Use backflow preventers on the new as well as the existing relief well discharge pipes.

Final Panel Comment 7

The use of coefficient of uniformity (C_u) values to evaluate the piping potential of broadly graded glacial outwash at the project site is not reliable.

Basis for Comment

The ECRA and FWAC Risk Assessments Report (p. 2-32) states, “The physical nature of the valley outwash is highly variable due to its depositional nature and consists of sands and gravels with varying amounts of silts and cobbles.” On the same page, the report states, “BEP mostly occurs in sands and silts with a coefficient of uniformity (C_u) less than 3 based on the experience and laboratory testing in the United States and Europe (Bonelli, 2013).” The grain size distribution results reported in the ECRA and FWAC Risk Assessments Report (Figure 2.16, p. 2-33), in Addendum D of Appendix A (pp. D242-D245), and in the USACE presentation during the kickoff briefing (Slides 24 and 25) include gravel in addition to sand and silt. The presence of gravel in the samples tested would result in C_u values being >3 for most samples. The PDT confirmed via email in response to a panel member question submitted by Battelle that grain size distributions were performed on the samples that contained gravel in addition to sand and silt. Also, both C_u and C_c (coefficient of curvature) should be used to determine whether sand or silt is uniformly graded and susceptible to piping. Therefore, the C_u criterion for evaluating the piping potential of broadly graded outwash material, with fines filling the voids between larger gravel particles, cannot be considered reliable. Furthermore, under high head (pool), the seepage forces can migrate fines from the voids even when the C_u values are >3, with coarser particles providing bridges. The pipes formed in this manner can be irregular (tortuous) in shape. However, they serve the same purpose as the conventional BEP mechanism hypothesized in the documents but not supported by the geologic conditions present at the site.

The ECRA and FWAC report further states (p. 2-32), “The majority of the more uniform sand deposits were found below EL 750 in the outwash (> 30 foot depth), except for a few samples at the downstream toe, which had C_u values ranging between 3 and 6.” Regardless of the location of uniform sand, the individual particles can migrate upward due to the upwardly directed seepage forces associated with high heads. The small, localized, and temporary pipes that may form in uniformly graded sand and silt layers, without an overlying confining layer, collapse quickly, but the particle migration process goes on as long as the hydraulic gradients exceed the critical hydraulic gradient.

Under prolonged periods of high pool, migration of fine particles from the foundation outwash material can significantly undermine the foundation. In the Panel’s opinion, this type of particle migration under high uplift pressures and high gradients is a more plausible explanation/mechanism for the boils and any unfiltered exits observed at the Mohawk Dam site than the restrictive type of piping, which requires a sand layer underlying a clay layer, as described in the documents. There is ample evidence, based on case histories and experimental research, to support this argument (Sherard, 1979; Haq and Rehman, 1984; Shakoor, 1992; Shakoor, 2005; Holtz et al., 2011; Atallah et al., 2015).

Significance – Medium

The C_u criterion can underestimate the piping potential of a broadly graded and heterogeneous material such as glacial outwash.

Recommendation for Resolution

1. Use the C_u values of only sand and silt fractions to evaluate their susceptibility to piping.
2. Use a combination of C_u and C_c to determine if sand or silt samples are uniformly graded.

Literature Cited:

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Shakoor, A. (2005). Piping failure of the Upper Ivex dam, northeast Ohio. Abstract. Association of Engineering Geologists. p. 85.

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Final Panel Comment 8

The wind direction, wave height, wave run-up, and wave reflection, at various pool elevations, have not been sufficiently considered with respect to the operation of the intake structure, the potential for scour, and instability of the upstream slope of the dam.

Basis for Comment

Addendum A of Appendix A, dated February 2016, contains a study of the inflow design flood (IDF) for Mohawk Dam. This addendum contains an evaluation of wind speeds, fetch lengths for various wind orientations, and estimates of wave height and wave run-up for the maximum pools (125 percent and 150 percent hydrographs).

Section 8.1.2, Addendum A, states, “No indication was found in the manual about rock on the upstream face of the dam. However, under normal conditions, earthfill dams will have some type of stone protection on the upstream face. Based on this it was assumed that wave runup would be computed with a layer of rock on the upstream face.” The Panel reviewed photos of the original dam construction from 1935 contained in Addendum F of the site characterization drawings. These photos show a rock blanket was constructed on the upstream dam face. However, the same report provides a design section for remedial work conducted in 1986 indicating the rock fill was removed and “random and impervious fill” was added as part of the dam rehabilitation (Addendum F, pp. F-10 to F-12). During their site visit, the Panel saw that the current slope is grass-lined. Drawings F-10 to F-12 indicate “random fill” was placed beneath the grass-lined slope with unknown gradation.

Section 8.4, Appendix A, Table 8-1 (p. A-95) presents a sensitivity analysis with wind speeds ranging from 47 to 90 mph; Figure 8-2 considers the fetch lengths and wind orientation evaluated for wave height and wave run-up. The Panel believes the procedures used to evaluate wave height, run-up, and fetch orientation are suitable for the maximum pool events. However, the assumption that a rock layer is present leads to additional risk of scour and instability that has not been assessed for the maximum pool or lower pool levels. Research and assessment of actual materials present are necessary to evaluate the tractive forces, scour potential, and risk of instability.

In addition, the IDF study does not evaluate the risk of several important conditions. Of primary importance at lower pool elevations, risk of scour and slope instability have not been considered for various wind orientations, fetch lengths, wave heights, wave run-up, and wave reflection. These factors are described in more detail below:

- A blanket or toe berm exists on the upstream side of the dam according to Section 8.1.1 and is shown in Figure 8-1 of Addendum A. Section 8.1.1 indicates that, at maximum pool elevations, there is no berm influence on wave height. However, it is the Panel’s opinion that at lower pool levels a berm influence may exist. Although fetch lengths may be less, the potential for increased wave height, wave run-up, scour, and slope instability are not addressed. Additionally, the slope is grass-lined, with underlying random fill of unknown gradation. The potential for scour, slope instability, and shorter flow paths beneath the dam should be evaluated.
- At roughly Station 13+00 (Addendum F, p. F-1), there is a rock berm that was constructed in 1937. It begins near the toe of the upstream face and extends upstream roughly perpendicular to the dam. The Panel believes that at lower pool elevations, and with north to northwest wind, wave reflection should be considered. Wave reflection may result in a concentration of wave energy that produces larger waves and larger wave run-up in a concentrated area of the dam face. Consideration should

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be given to the risk of potential scour at lower pool elevations and whether there is any risk of toe scour, instability, and shorter flow paths beneath the dam.

The IDF study does not evaluate lower pools in which wind orientation from the west may be concentrated on the left bank of the Walhonding River between the outlet works intake structure and spillway. A significant number of trees are present on this slope, as shown in the photo below. During high and peak wind conditions and under variable pool elevations, the risk of slope instability under wave attack is high. This may lead to loss of trees and root balls that could potentially block or partially block the intake structure leading to risk to dam safety.

Significance – Medium

Scour may lead to instability of the upstream dam face with risks not considered in the DSMS and TSP. In addition, the outlet works may not function as intended should wind and waves result in loss of tree and root balls. This risk is not considered in the DSMS and TSP.

Recommendation for Resolution

1. Research specifications, from the 1986 upstream face reconstruction, to determine fill types placed during construction for material described as “random fill.”
2. Consider performing additional geotechnical work to assess the upstream slope geotechnical properties if sufficient information is not available for scour and stability evaluation.
3. Perform additional wind, wave run-up, and wave studies to evaluate the potential scour for lower pool levels on the dam face where the toe berm/blanket may impact wave height and wave run-up.

Final Panel Comment 8
4. Consider performing additional scour assessment and evaluate the potential slope instability risk for the dam face along with impacts on flow path under the dam. If analyses show risk for scour of upstream slope, consider using riprap, the standard measure against wave action. 5. Evaluate variable pool elevations and assess wave reflection from the upstream rock berm near Station 13+00. Determine whether wave reflection may cause increased wave height and run-up that could result in localized higher scour potential for the toe of dam and potential risk to instability and shorter flow paths beneath the dam. 6. Evaluate and document the risk of potential blocking of the intake structure from tree and root ball loss during high winds, at various pool levels, for the area between the spillway and outlet works as shown in photo above.

Final Panel Comment 9
The rationale for why the DSMR does not identify the NED, the NER, or the combined NED/NER plan, as required by ER 1105-2-100, has not been presented in sufficient detail.
Basis for Comment
The Planning Guidance Notebook (USACE, 2000) requires that the National Economic Development (NED) plan, the National Ecosystem Restoration **(**NER) plan, or the combined NED/NER plan be identified and the rationale for not selecting that plan be explained. This is a technical requirement imposed by existing policy. The Panel understands that NED and NER outputs do not drive Dam Safety Action Classification (DSAC) study recommendations, but the policy requirement exists nonetheless.
Significance – Medium
Identifying the NED, the NER, or the combined NED/NER plan is unlikely to change the ranking of alternatives or selection of the TSP, but is a technical matter imposed by policy that is considered part of the alternatives formulation and evaluation process.
Recommendation for Resolution
1. Revise the DSMR and Appendix C to identify and briefly describe the NED, the NER, or the combined NED/NER plan. 2. Explain the rationale as to why the NED, the NER, or the combined NED/NER plan was not selected as the TSP.

Literature Cited:

USACE (2000). Planning – Planning Guidance Notebook. Engineer Regulation (ER) 1105-2-100. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. April 22.

Final Panel Comment 10

The DMSR and Appendices B and C do not present any HEC-FDA modeling results, making it difficult to assert that all impacts associated with the FWAC, RMPs, and the TSP have been adequately addressed.

Basis for Comment

According to the DSMR, there are at least 11,347 people living downstream of the Mohawk Dam project. This would mean that there are a significant number of structures in the communities of Nellie and Coshocton that would be impacted by failure or removal of the dam. Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) software is specifically designed to capture the potential damages to property and should be included in the analysis of the FWAC, RMPs, and the TSP.

Significance – Medium/Low

Since this project is not formulated on the basis of net NED benefits, it is unlikely that addressing this issue will change the ranking of alternatives or selection of the TSP; however, a full accounting of all impacts, including flood risk management, would more clearly describe the full range of effects associated with the project.

Recommendation for Resolution

1. Perform, if even at the reconnaissance level, a run of HEC-FDA for the communities downstream of, and protected by, Mohawk Dam.
2. Display and discuss the results of the HEC-FDA model results.
3. Explain why the model results do not affect the selection of the TSP.

Final Panel Comment 11

The Category 3 wetland delineation report has not been included in the appendices, but inclusion would help document impact conclusions and the significance of this area since this was important to the screening of measures and the selection of the TSP.

Basis for Comment

The Category 3 wetland is mentioned at multiple locations in the DSMR and appendices as an important environmental control. However, additional details on the delineated wetland are needed to assess accuracy and completeness of impact conclusions.

There is no mention of the Category 3 wetland or any reference to the delineation report in Appendix H (p. 2). Nor is there a statement in Appendix H that the TSP will have no impacts on the Category 3 wetland. This is an important conclusion regarding overall impacts of plan formulation on environmental resources.

The DSMR indicates (p. 52) that this measure will not impact the Category 3 wetland. Based on the figure presented, it does appear that completion of this measure may result in temporary environmental impacts. Here and in Appendix H, some discussion of the project potential for temporary impacts on this wetland should be provided, or whether planned construction techniques will be used to avoid or minimize short-term impacts associated with earth disturbance.

Providing the delineation as part of the appendices will aid in understanding wetland hydrology and hydroperiod and dominant wetland vegetation types, clarify the potential impacts of measures evaluated, including the TSP, and help in assessing whether additional controls or mitigation measures such as enhanced sediment and erosion control measures may need to be incorporated during the preconstruction engineering and design (PED) stage.

Significance – Medium/Low

Providing more details on wetland features (hydrology, dominant vegetation types, etc.) typically found in the wetland delineation report will clarify project impacts and support report completeness.

Recommendation for Resolution

1. Add an overview section to the DSMR, Section 1.4, on existing environmental resources/controls and include a description of Waters of the U.S. and the Category 3 wetland.
2. Incorporate a wetland delineation report in the relevant technical appendices.
3. Add a brief discussion of construction sediment and erosion controls to prevent discharges to the Category 3 wetland in the DSMR, p. 52, 2nd full paragraph.
4. Discuss the Category 3 wetland and location of the delineation report in Appendix H, p.2.

Final Panel Comment 12

Current stormwater control regulations for retention/detention systems in Ohio capture events higher than the 20-year storm, whereas the discussion looks at high-frequency stormwater events that are 20-year events or less.

Basis for Comment

The discussion of future without action stormwater conditions in Appendix A, Section 3.2.1.3 (p.179), with stormwater facilities capturing high-frequency stormwater events (5-, 10-, and 20-year), does not reflect current State of Ohio and community quantity stormwater requirements.

Stormwater control measures (SCMs) generally must meet the following requirements (Ohio EPA, 2007; ODNR, 2014)

- The peak discharge rate of runoff from the critical storm and all more frequent storms occurring under post-development conditions is not to exceed the peak discharge rate of runoff from a 1-year, 24-hour storm occurring on the same development drainage area under pre-development conditions.
- Storms of less frequent occurrence (longer return periods) than the Critical Storm, up to the 100-year, 24-hour storm, shall have peak runoff discharge rates no greater than the peak runoff rates from equivalent size storms under pre-development conditions. The 1-, 2-, 5-, 10-, 25-, 50-, and 100-year storms shall be considered in designing a facility to meet this requirement.

Per Ohio EPA (OEPA), if the basin will serve the multiple functions of water quality and water quantity management, it is recommended that when designing structures for both water quality volume (WQv) and flood/peak discharge control, the flood/peak control volume be stacked on top of the WQv (use the top of the WQv as the base elevation for the flood control volume) (OEPA, 2007; question no. 21). Per OEPA, this will establish that there is ample storage when back-to-back storms occur. The actual rules vary by jurisdiction, but, in general, local flood control rules require capturing events higher than the 20-year storm.

Appendix A, Section 3.2.1.3 (p. 180), states that most on-site facilities are not designed with sufficient storage capacity to significantly reduce the total flow into Mohawk Dam associated with a 1 percent or 0.5 percent chance event occurring in the watershed. Based on Ohio and community stormwater quantity control requirements, retention systems designed for flood control will likely have localized flood control benefit up to the 100-year storm, but, in aggregate, total flows into Mohawk Dam will not be significantly reduced.

Significance – Low

Revising the discussion in Appendix A to reflect current stormwater control regulations for retention/detention systems will improve the technical accuracy of the discussion of stormwater controls, but will not affect the conclusions of the FWAC.

Recommendation for Resolution

1. Modify Section 3.2.1.3 (p. 179) to reflect current Ohio stormwater quantity requirements.
2. Clarify anticipated local benefits of onsite storage facilities in Section 3.2.1.3 (p. 180).
3. Review, and revise if necessary, the overall discussion in Sections 3.2.1.3 to ensure that the discussion is consistent with recommended changes.

Literature Cited:

Ohio Department of Natural Resources (ODNR) (2014). Rainwater and Land Development: Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection. Third Edition. Ohio Department of Natural Resources, Division of Soil and Water Conservation, Columbus, Ohio. November 6. Available online at: http://epa.ohio.gov/Portals/35/storm/technical_assistance/RLD_11-6-14All.pdf.

Ohio EPA (2007). Storm Water Post-Construction Questions & Answers. Guidance Regarding Post-Construction Storm Water Management Requirements of Ohio EPA's Storm Water Construction General Permit #OHC000002. March 20. Available online at: http://www.epa.ohio.gov/portals/35/storm/CGP-PC-Q&A2.pdf

Final Panel Comment 13

The description of the baseline environmental conditions and impacts on various resources is limited in some parts of the report, which could affect the technical quality.

Basis for Comment

The concise discussion of existing resources and several examples of impacts on various resources, both within the main report and the appendices, raise concerns about the completeness of the analysis of impacts and a full understanding of the environmental impacts of various measures screened in the selection of the TSP. Examples are as follows:

- DSMR, Section 1.4.1. Local and Regional Geology (p. 16): Add a discussion or a separate section that provides a concise overview of the natural/ecological resources, including a characterization of Walhonding status under Ohio WQ laws, wetlands, and threatened and endangered (T&E) species. It would be useful to add just enough detail to define the environmental controls/ environmental show stoppers, which will benefit the measure screening discussion and environmental impacts identified to screen measures.
- DSMR, Seepage Berm Extension (Screened Out) (p. 47, 2nd paragraph): Quantify relative impacts on wetland in acres, even approximately. This could be a challenge without having done much design work, but would help establish significance and the magnitude of impacts this measure would have on the Class III wetland.
- DSMR, Downstream Tailwater Weir (Screened Out) (p. 47, last sentence): Consider indicating how this measure would directly impact wetland hydroperiod, alter wetland vegetation composition over time, and provide an estimate of the acreage of wetland directly impacted due to construction of the weir.
- DSMR (p. 50, 2nd paragraph): Acknowledge impacts on cultural resources, loss of woodland habitat, and potential T&E impacts stemming from tree clearing, since any impact may require Habitat Evaluation Procedure (HEP) analysis and potential mitigation, which could increase costs to the project.
- DSMR - Replace and Augment Existing Relief Wells, Thicken Seepage Berm (Carried Forward) (p. 52, 2nd full paragraph, last sentence): While no adverse environmental impacts are anticipated, it appears there might be temporary construction impacts based on how close this is to the Category 3 wetland; however, it is hard to tell due to the scale. The primary concern with this alternative going forward is avoiding even temporary impacts, since Ohio State Certification Special Limitations and Conditions require an individual state water quality certification when temporary impacts are proposed on or in Category 3 wetlands.
- DSMR (p. 58, 6th paragraph): Acknowledge habitat impacts. Even if there are no T&E impacts, impacts on woodland vegetation may trigger need for HEP analysis and mitigation of woodland habitat loss per USACE policy.
- Appendix A, Table 3.17 (p. 178): Explain the substantial loss of wetlands over the reported time period, a rather significant loss in acreage. Is the loss associated with an increase in impervious cover or is this a typo?

Significance – Low

Addressing these comments on existing resources will improve the technical quality of the report, but not change the outcome or screening of alternatives.

Final Panel Comment 13

Recommendation for Resolution

1. Address the deficiencies as suggested by the bullets above.

Final Panel Comment 14

The discussion of the inundation zone relative to the FWAC does not address the effects of forecasted climate change or the role of County Natural Hazards Mitigation Plans in mitigating future risks.

Basis for Comment

Appendix A (p. 180-186) discusses forecasted population growth and anticipated land use changes, including uninformed school consolidations occurring outside the Special Flood Hazard Area (SFHA), but within the defined inundation zone. The DSMR, Section 3.3.6 (pp. 40 and 41), discusses climate change, but does not consider how the forecasted change in flows may affect the size of the inundation zone, which is not subject to local floodplain risk management regulations. In addition, Appendix A provides no information on the estimated relative difference in water height between the SFHA and the inundation zone, and does not discuss the role that the County Natural Hazard Mitigation Plans could play in preventing future risks associated with local school consolidations and other anticipated land use changes within the inundation zone. Specifically:

- Appendix A, Section 3.2.4.2 (p. 189): The sentence describing the differences between the SFHA and the inundation zone indicates that inundation zone depths would far exceed the depths associated with 1 percent chance flooding depths. Some quantification of the relative differences could help understanding of future risks and threats to population changes in the inundation zone.
- Appendix A, Section 3.2.3, 1st first paragraph (p. 183): This statement references the floodplain area and conversion from agriculture to developed areas. This development would need to be in accordance with County or community floodplain regulations to reduce flood risks and should be recognized to avoid any implication that future growth would occur without any controls. A brief statement is necessary about the likely future development in the inundation area, similar to the references to development likely to occur in the floodplain areas.
- Appendix A, Figure 3.9 (p. 188): The boundary of the inundation area is not clearly identified on this figure. Adding a distinct label to key or a label indicating the extent of inundation to show the difference in area impacted by the SFPA and the inundation area will help in understanding the differences between these two areas.
- Appendix A (p. 186, last statement on page): Referencing the role of County Natural Hazard Mitigation Plans could help address this issue and help mitigate future risks (OEMA, 2010; Muskingum County, 2010; ODPS, 2011). While the planning cycle for updating Hazard Mitigation Plans has generally been 5 years or more, adding this local planning mechanism will help in future discussions with communities downstream of the Mohawk Dam.
- DSMR, Section 3.3.6 (p 40 and 41) discusses climate change, but no discussion of how the forecasted change in flows may affect the size of the inundation zone, which is not subject to local floodplain risk management regulations.

Significance – Low

Revising and clarifying the discussion of the inundation zone relative to the FWAC will aid in understanding the FWAC risk assessment and benefit local County Hazard Mitigation Planning efforts.

Final Panel Comment 14

Recommendation for Resolution

1. Add narrative to Appendix A as to whether future forecasted base flow changes due to climate change discussed in the DSMR will result in any potential changes in SFHA areas relative to forecasted inundation zone due to Mohawk Dam breach scenario.
2. Clarify the relative difference in flood height between SFHA and inundation zone to understand risks (Appendix A, Section 3.2.4.2, p. 189)
3. Make a distinction between potential future floodplain development and changes in land use in the inundation zone (Appendix A, Section 3.2.3, p. 183)
4. Modify Figure 3.9 (Appendix A, p. 188) to clarify the boundary of inundation area relative to the indicated SFPA.
5. Add a brief discussion of the role that a County Natural Hazard Mitigation Plan can play in reducing future land use changes in the inundation zone.

Literature Cited:

Muskingum County (2010). Natural Hazard Mitigation Plan Five Year Update. Zanesville, OH. Available online at: https://ohiosharpp.ema.state.oh.us/OhioSHARPP/Search/Results/LHMPs.aspx?type=county&name=Muskingum.

ODPS (2011). Mitigation Planning. Ohio Emergency Management Agency, Department of Public Safety. Available online at: https://ohiosharpp.ema.state.oh.us/OhioSHARPP/Planning.aspx#plan.

OEMA (2010). Coshocton County Natural Hazard Mitigation Plan, 2010. Ohio Emergency Management Agency, Department of Public Safety. Available online at: https://ohiosharpp.ema.state.oh.us/OhioSHARPP/Search/Results/LHMPs.aspx?type=county&name=Coshocton.

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Ohio EPA (2007). Storm Water Post-Construction Questions & Answers. Guidance Regarding Post-Construction Storm Water Management Requirements of Ohio EPA's Storm Water Construction General Permit #OHC000002. March 20. Available online at: http://www.epa.ohio.gov/portals/35/storm/CGP-PC-Q&A2.pdf

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Shakoor, A. (1992). Remediation of landsliding and piping problems at a residential pond. Abstract. Proceedings, 35th Annual Meeting of the Association of Engineering Geologists. p. 175.

Sherard, J.L. (1979). Sinkholes in Dams of coarse, broadly graded soils. Transactions, Thirteenth International Congress on Large Dams, Volume 2. New Delhi, India. pp. 325-334.

The National Academies (2003). Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports. The National Academies (National Academy of Science, National Academy of Engineering, Institute of Medicine, National Research Council). May 12.

USACE (2012). Water Resources Policies and Authorities: Civil Works Review. Engineer Circular (EC) 1165-2-214. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. December 15.

USACE (2000). Planning – Planning Guidance Notebook. Engineer Regulation (ER) 1105-2-100. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. April 22.

APPENDIX A

IEPR Process for the Mohawk DSMS Project

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A.1 Planning and Conduct of the Independent External Peer Review (IEPR)

Table A-1 presents the schedule followed in executing the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio Independent External Peer Review (hereinafter: Mohawk DSMS IEPR). Due dates for milestones and deliverables are based on the award/effective date listed in Table A-1. The review documents were provided by U.S. Army Corps of Engineers (USACE) on September 13, 2016. Note that the actions listed under Task 6 occur after the submission of this report and are described in more detail at the end of this Appendix.

Table A-1. Mohawk DSMS Complete IEPR Schedule

Task	Action	Due Date
1	Award/Effective Date	9/8/2016
	Review documents available	9/13/2016
	Battelle submits draft Work Plan[a]	9/21/2016
	USACE provides comments on draft Work Plan	9/30/2016
	Battelle submits final Work Plan[a]	10/4/2016
2	Battelle requests input from USACE on the conflict of interest (COI) questionnaire	9/21/2016
	USACE provides comments on COI questionnaire	9/22/2016
	Battelle submits list of selected panel members[a]	10/4/2016
	USACE confirms the panel members have no COI	10/7/2016
	Battelle completes subcontracts for panel members	10/10/2016
3	Battelle convenes kick-off meeting with USACE	9/19/2016
	Battelle sends review documents to panel members	10/11/2016
	Battelle convenes kick-off meeting with panel members	10/11/2016
	Battelle convenes webinar kick-off meeting with USACE and panel members	10/13/2016
	USACE, Battelle, and Panel visit the site (travel day: October 19, 2016)	10/20/2016
	Battelle convenes Mid-Review Teleconference for panel members to ask clarifying questions of USACE	Not Applicable
4	Panel members complete their individual reviews	11/2/2016
	Battelle provides talking points for Panel Review Teleconference to panel members	11/3/2016
	Battelle convenes Panel Review Teleconference	11/4/2016
	Battelle provides Final Panel Comment templates and instructions to panel members	11/10/2016
	Panel members provide draft Final Panel Comments to Battelle	11/16/2016
	Battelle provides feedback to panel members on draft Final Panel Comments; panel members revise Final Panel Comments	11/16/2016 - 11/18/2016
	Panel finalizes Final Panel Comments	11/19/2016

Table A-1. Mohawk DSMS Complete IEPR Schedule (continued)

Task	Action	Due Date
5	Battelle provides Final IEPR Report to panel members for review	11/21/2016
	Panel members provide comments on Final IEPR Report	11/21/2016
	Battelle submits Final IEPR Report to USACE[a]	11/22/2016
	USACE Risk Management Center (RMC) provides decision on Final IEPR Report acceptance	**11/29/2016**
6[b]	Battelle inputs Final Panel Comments to DrChecks and provides Final Panel Comment response template to USACE	11/29/2016
	Battelle convenes teleconference with USACE to review the Comment Response process	11/29/2016
	Battelle convenes teleconference with Panel to review the Comment Response process	11/30/2016
	USACE RMC provides draft Project Delivery Team (PDT) Evaluator Responses to Battelle	12/13/2016
	Battelle provides draft PDT Evaluator Responses to panel members	12/13/2016
	Panel members provide draft BackCheck Responses to Battelle	12/16/2016
	Battelle convenes teleconference with panel members to discuss draft BackCheck Responses	12/16/2016
	Battelle convenes Comment Response Teleconference with panel members and USACE	12/19/2016
	USACE inputs final PDT Evaluator Responses to DrChecks	12/19/2016
	Battelle provides final PDT Evaluator Responses to panel members	12/19/2016
	Panel members provide final BackCheck Responses to Battelle	12/20/2016
	Battelle inputs the Panel's final BackCheck Responses in DrChecks	12/21/2016
	Battelle submits pdf printout of DrChecks project file[a]	12/22/2016
	Contract End/Delivery Date	4/28/2017

[a] *Deliverable.*

[b] *Task 6 occurs after the submission of this report*

At the beginning of the Period of Performance for the Mohawk DSMS IEPR, Battelle held a kick-off meeting with USACE to review the preliminary/suggested schedule, discuss the IEPR process, and address any questions regarding the scope (e.g., terminology to use, access to DrChecks, etc.). Any revisions to the schedule were submitted as part of the final Work Plan. The final charge consisted of 21 charge questions provided by USACE, two overview questions added by Battelle (all questions were included in the draft and final Work Plans), and general guidance for the Panel on the conduct of the peer review (provided in Appendix C of this final report).

Prior to beginning their review and after their subcontracts were finalized, all the members of the Panel attended a kick-off meeting via teleconference planned and facilitated by Battelle in order to review the IEPR process, the schedule, communication procedures, site visit logistics, and other pertinent information for the Panel. Battelle planned and facilitated a second kick-off meeting via teleconference/webinar during which USACE presented project details to the Panel (the site visit will be discussed in the next section). Before the meetings, the IEPR Panel received an electronic version of the final charge, as well as the review documents and reference/supplemental materials listed in Table A-2.

Table A-2. Documents to Be Reviewed and Provided as Reference/Supplemental Information

Report Title for IEPR Panel Review	No. of Review Pages	Subject Experts			
		Plan Formulation/ Economics	NEPA/ Environmental	Engineering Geologist	Geotechnical Engineer
DSMR Main Report	90	90	90	90	90
Appendix A – Existing Condition Risk Assessment and Future Without Action Condition Report	206	206	206	206	206
Addendum A – PMP/IDF Update	171	-	-	171	171
Addendum B – Glacial Geology & Geomorphology	21	-	-	21	21
Addendum C – Geotechnical Investigations - Embankment	796	-	-	796	796
Addendum D – Geotechnical Analysis - Embankment	248	-	-	248	248
Addendum E – Geotechnical Investigations & Analyses - Spillway	168	-	-	168	168
Addendum F – Site Characterization Drawings	19	-	-	19	19
Addendum G – Consequences	39	39	-	39	39
Addendum H – DAMRAE Inputs and Results	86	-	-	86	86
Appendix B – With Project Risk Assessment	38	38	38	-	38
Appendix C – Formulation	3	3	3	-	3
Appendix D – Engineering Analysis	33	-	-	-	33
Addendum A – Relief Well Design Calculations	41	-	-	-	41
Addendum B – Toe Drain Calculations	4	-	-	-	4
Addendum C – Seepage Collection System Analyses	13	-	-	-	13
Addendum D – Calculations for Further Design of TSP	7	-	-	-	7
Addendum E – Drawings for TSP	12	-	-	-	12
Addendum F – Abbreviated Constructability Review	3	-	-	-	3
Appendix E – Applicable Essential USACE Guidelines	10	-	-	-	10
Appendix F and Appendix G – Cost	35+	35+	35+	-	35+
Appendix H – Environmental Documentation	6	-	6	-	-
Dam Safety Action Decision Summary	18	18	18	18	18
Total # of Pages (Approximate)	**2,067**	**429**	**396**	**1,862**	**2,061**

In addition to the materials provided in Table A-2, the panel members were provided the following USACE guidance documents. A full list of USACE engineer regulations (ER) publications that panel members were provided for review can be found in the final charge listed in Appendix C.

- USACE guidance, *Civil Works Review* (EC 1165-2-214), December 15, 2012
- Office of Management and Budget, *Final Information Quality Bulletin for Peer Review,* December 16, 2004.

Before the review period ended, the Panel provided Battelle questions regarding the review documents or the project. Battelle submitted six panel member questions to USACE regarding pool levels, upstream slope, and relief well performance. USACE was able to provide written responses to all the questions prior to the end of the review. Because of this, Battelle determined and USACE confirmed that a mid-review teleconference was not necessary with USACE.

A.2 Participation in Site Visit

After the IEPR panel members started their review of the documents, Battelle planned and facilitated a site visit. On October 20, 2016, USACE, Battelle, and the Panel met on site at Mohawk Dam in Coshocton, Ohio. As part of the on-site meeting, USACE provided an in-depth presentation near the Mohawk Dam site. All four of the panel members and one Battelle staff member attended the site visit. A list of all attendees can be found in Table A-3. Two USACE staff members participated by phone.

Table A-3. Battelle, the Panel, USACE, and Mohawk DSMS Personnel Attending the Site Visit

Name	Affiliation	Role on IEPR
Thomas Denbow	Biohabitats, Inc.	IEPR – NEPA/environmental
Mike Hartley	PND Engineers	IEPR – Geotechnical engineer
David Luckie	Independent Consultant	IEPR – Plan formulator/economist
Abdul Shakoor	Independent Consultant	IEPR – Engineering geologist
Anne Gregg	Battelle	IEPR PM Representative
Adam Kays	Huntington District, USACE	Geotechnical PDT
Brian Lowe	Huntington District, USACE	USACE Project Manager
Karen Miller	Huntington District USACE	RMC IEPR Lead, Technical Point of Contact
Darin White	Huntington District, USACE	Lead Engineer PDT
Eric Smith	Maintenance Mechanic MKW	N/A
Eric Schreckengost	Walhonding Facility Manager	N/A

The meeting was conducted in two parts. The first part involved a detailed briefing by USACE. Panel members asked several questions during the presentation, and an open discussion ensued. The second part of the meeting was the site investigation. USACE led Battelle staff and the panel members on a tour of the dam, stopping at various points to observe key issues, including various geologic, geotechnical, and NEPA considerations.

Throughout the site visit, USACE staff pointed out specific project features to help the panel members better comprehend issues associated with the existing project features and the intent of the project.

USACE staff then answered questions posed by the panel members. This tour provided an opportunity for the panel members to see the project area and project features and to ask clarifying questions of the USACE PDT.

Following the site visit, USACE provided documents at the request of panel members. The following documents were provided to Battelle and then sent to the Panel to aid in their review:

- Latest version of the IES (Mohawk IES 9-26-14.pdf)
- Appendix F and Appendix G – Cost (Mohawk DSMS Baseline CSRA (post-DQC).xlsm; Basis of Estimate --- Federal Labor (Post QC).xlsx; Basis of Estimate --- Labor & Equipment.xlsx; Basis of Estimate --- Mohawk TSP Baseline (Post QC).xlsx; Mohawk DSMR FY17 Baseline TPCS (Post DQC).xlsx; Mohawk DSMS --- TSP Baseline Cost Estimate (Post DQC).mlp; Mohawk DSMS Appendix C - MCACES Estimate For Recommended Plan.docx; Mohawk DSMS Appendix G - Total Project Cost Summary.docx)
- Site visit pictures (Left Abutment Seepage 2005 Photos; Left Abutment Seepage 2008; Left Abutment Seepage Construction; Left Abutment Seepage 2011).

A.3 Review of Individual Comments

The Panel was instructed to address the charge questions/discussion points within a charge question response form provided by Battelle. At the end of the review period, the Panel produced individual comments in response to the charge questions/discussion points. Battelle reviewed the comments to identify overall recurring themes, areas of potential conflict, and other overall impressions. At the end of the review, Battelle summarized the individual comments into a preliminary list of overall comments and discussion points. Each panel member's individual comments were shared with the full Panel.

A.4 IEPR Panel Teleconference

Battelle facilitated a teleconference with the Panel so that the panel members could exchange technical information. The main goal of the teleconference was to identify which issues should be carried forward as Final Panel Comments in the Final IEPR Report and decide which panel member should serve as the lead author for the development of each Final Panel Comment. This information exchange ensured that the Final IEPR Report would accurately represent the Panel's assessment of the project, including any conflicting opinions. The Panel engaged in a thorough discussion of the overall positive and negative comments, added any missing issues of significant importance to the findings, and merged any related individual comments. At the conclusion of the teleconference, Battelle reviewed each Final Panel Comment with the Panel, including the associated level of significance, and confirmed the lead author for each comment.

A.5 Preparation of Final Panel Comments

Following the teleconference, Battelle distributed a summary memorandum for the Panel documenting each Final Panel Comment (organized by level of significance). The memorandum provided the following detailed guidance on the approach and format to be used to develop the Final Panel Comments for the Mohawk DSMS IEPR:

- Lead Responsibility: For each Final Panel Comment, one Panel member was identified as the lead author responsible for coordinating the development of the Final Panel Comment and submitting it to Battelle. Battelle modified lead assignments at the direction of the Panel. To assist each lead in the development of the Final Panel Comments, Battelle distributed a summary email detailing each draft final comment statement, an example Final Panel Comment following the four-part structure described below, and templates for the preparation of each Final Panel Comment.

- Directive to the Lead: Each lead was encouraged to communicate directly with the other panel member as needed and to contribute to a particular Final Panel Comment. If a significant comment was identified that was not covered by one of the original Final Panel Comments, the appropriate lead was instructed to draft a new Final Panel Comment.

- Format for Final Panel Comments: Each Final Panel Comment was presented as part of a four-part structure:

  1. Comment Statement (succinct summary statement of concern)
  2. Basis for Comment (details regarding the concern)
  3. Significance (high, medium/high, medium, medium/low, and low; see description below)
  4. Recommendation(s) for Resolution (see description below).

- Criteria for Significance: The following were used as criteria for assigning a significance level to each Final Panel Comment:

  1. **High:** Describes a fundamental issue with the project that affects the current recommendation or justification of the project, and which will affect its future success, if the project moves forward without the issue being addressed. Comments rated as high indicate that the Panel determined that the current methods, models, and/or analyses contain a “showstopper” issue.

  2. **Medium/High:** Describes a potential fundamental issue with the project, which has not been evaluated at a level appropriate to this stage in the Planning process. Comments rated as medium/high indicate that the Panel analyzed or assessed the methods, models, and/or analyses available at this stage in the Planning process and has determined that if the issue is not addressed, it could lead to a “showstopper” issue.

  3. **Medium:** Describes an issue with the project, which does not align with the currently assessed level of risk assigned at this stage in the Planning process. Comments rated as medium indicate that, based on the information provided, the Panel identified an issue that would raise the risk level if the issue is not appropriately addressed.

  4. **Medium/Low:** Affects the completeness of the report at this time in describing the project, but will not affect the recommendation or justification of the project. Comments rated as medium/low indicate that the Panel does not currently have sufficient information to analyze or assess the methods, models, or analyses.

  5. **Low:** Affects the understanding or accuracy of the project as described in the report, but will not affect the recommendation or justification of the project. Comments rated as low indicate

that the Panel identified information that was mislabeled or incorrect or that certain data or report section(s) were not clearly described or presented.

- Guidelines for Developing Recommendations: The recommendation section was to include specific actions that USACE should consider to resolve the Final Panel Comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed).

Battelle reviewed and edited the Final Panel Comments for clarity, consistency with the comment statement, and adherence to guidance on the Panel's overall charge, which included ensuring that there were no comments regarding either the appropriateness of the selected alternative or USACE policy. At the end of this process, 14 Final Panel Comments were prepared and assembled. There was no direct communication between the Panel and USACE during the preparation of the Final Panel Comments. The full text of the Final Panel Comments is presented in Section 4.2 of the main report.

A.6 Conduct of the Public Comment Review

There was no public comment period or review associated with this IEPR.

A.7 Final IEPR Report

After concluding the review and preparation of the Final Panel Comments, Battelle prepared a final IEPR report (this document) on the overall IEPR process and the IEPR panel members' findings (this document). Each panel member and Battelle technical and editorial reviewers reviewed the IEPR report prior to submission to USACE for acceptance.

A.8 Comment Response Process

As part of Task 6, Battelle will enter the 14 Final Panel Comments developed by the Panel into USACE's Design Review and Checking System (DrChecks), a Web-based software system for documenting and sharing comments on reports and design documents, so that USACE can review and respond to them. USACE will provide responses (Evaluator Responses) to the Final Panel Comments, and the Panel will respond (BackCheck Responses) to the Evaluator Responses. All USACE and Panel responses will be documented by Battelle. Battelle will provide USACE and the Panel a pdf printout of all DrChecks entries, through comment closeout, as a final deliverable and record of the IEPR results.

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APPENDIX B

Identification and Selection of IEPR Panel Members for the Mohawk DSMS Project

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B.1 Panel Identification

The candidates for the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio (hereinafter: Mohawk DSMS IEPR) Panel were evaluated based on their technical expertise in the following key areas: plan formulator/economist, National Environmental Policy Act (NEPA)/environmental, engineering geologist, and geotechnical engineer. These areas correspond to the technical content of the review documents and overall scope of the Mohawk DSMS project.

To identify candidate panel members, Battelle reviewed the credentials of the experts in Battelle's Peer Reviewer Database, sought recommendations from colleagues, contacted former panel members, and conducted targeted Internet searches. Battelle evaluated these candidate panel members in terms of their technical expertise and potential conflicts of interest (COIs). Of these candidates, Battelle chose the most qualified individuals, confirmed their interest and availability, and ultimately selected four experts for the final Panel. The remaining candidates were not proposed for a variety of reasons, including lack of availability, disclosed COIs, or lack of the precise technical expertise required.

Candidates were screened for the following potential exclusion criteria or conflicts of interest (COIs). These COI questions were intended to serve as a means of disclosure in order to better characterize a candidate's employment history and background. Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. Guidance in OMB (2004, p. 18) states,

> "…when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

Panel Conflict of Interest (COI) Screening Statements for the IEPR of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio, Huntington District
1. Previous and/or current involvement by you or your firm[1] in the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio and/or related projects such as the Mohawk Major Rehabilitation Study/Report.
2. Previous and/or current involvement by you or your firm[1] in dam safety and/or flood risk management projects/studies in the Muskingum River Basin in Ohio.

[1] Note: Includes any joint ventures in which your firm is involved and if your firm serves as a prime or as a subcontractor to a prime. Please clarify which relationship exists in the rows above.

Panel Conflict of Interest (COI) Screening Statements for the IEPR of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio, Huntington District
3. Previous and/or current involvement by you or your firm[1] in the conceptual or actual design, construction, or operation and maintenance (O&M) of any projects in the Muskingum River Basin in Ohio, or in Coshocton County, Ohio.
4. Current employment by the U.S. Army Corps of Engineers (USACE).
5. Previous and/or current involvement with paid or unpaid expert testimony related to the Mohawk DSMS, Coshocton County, Ohio or Mohawk Major Rehabilitation Study/Report.
6. Previous and/or current employment or affiliation with the non-Federal sponsor and/or any cooperating Federal, State, County, local and regional agencies, environmental organizations, and interested groups *(for pay or pro bono)*: • Muskingum Watershed Conservancy District (MWCD).
7. Past, current, or future interests or involvements (financial or otherwise) by you, your spouse, or your children related to the Muskingum River Basin in Ohio, or Coshocton County, Ohio.
8. Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, Engineer Research and Development Center (ERDC), etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Huntington District.
9. Previous or current involvement with the development or testing of models that will be used for, or in support of the Mohawk DSMS or Mohawk Major Rehabilitation Study/Report.
10. Current firm[1] involvement with other USACE projects, specifically those projects/contracts that are with the Huntington District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please also clearly delineate the percentage of work you personally are currently conducting for the Huntington District. Please explain.
11. Any previous employment by USACE as a direct employee, notably if employment was with the Huntington District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
12. Any previous employment by USACE as a contractor (either as an individual or through your firm[1]) within the last 10 years, notably if those projects/contracts are with the Huntington District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
13. Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning flood risk management or dam safety and include the client/agency and duration of review (approximate dates).

Panel Conflict of Interest (COI) Screening Statements for the IEPR of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio, Huntington District
14. Pending, current, or future financial interests in the Mohawk Dam in Coshocton County, Ohio or Mohawk Major Rehabilitation Study/Report and related contracts/awards from USACE.
15. Significant portion of your personal or office's revenues within the last three years came from USACE contracts.
16. Significant portion of your personal or office's revenues within the last three years came from MWCD contracts.
17. Any publicly documented statement (including, for example, advocating for or discouraging against) related to the Mohawk DSMS or Mohawk Major Rehabilitation Study/Report.
18. Participation in relevant prior and/or current Federal studies relevant to the Mohawk DSMS or Mohawk Major Rehabilitation Study/Report.
19. Previous and/or current participation in prior non-Federal studies relevant to the Mohawk DSMS or Mohawk Major Rehabilitation Study/Report.
20. Is there any past, present, or future activity, relationship, or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe:

Providing a positive response to a COI screening question did not automatically preclude a candidate from serving on the Panel. For example, participation in previous USACE technical peer review committees and other technical review panel experience was included as a COI screening question. A positive response to this question could be considered a benefit.

B.2 Panel Selection

In selecting the final members of the Panel, Battelle chose experts who best fit the expertise areas and had no COIs. Table B-1 provides information on each panel member's affiliation, location, education, and overall years of experience. Battelle established subcontracts with the panel members when they indicated their willingness to participate and confirmed the absence of COIs through a signed COI form. USACE was given the list of candidate panel members, but Battelle selected the final Panel.

Table B-1. Mohawk DSMS IEPR Panel: Summary of Panel Members

Name	Affiliation	Location	Education	P.E.	Exp. (yrs)
Plan Formulator / Economist					
David Luckie	Independent Consultant	Mobile, AL	B.A., Economics & Finance	N/A	28
NEPA / Environmental					
Thomas Denbow	Biohabitats, Inc.	Cleveland, OH	B.S., Zoology	N/A	40
Engineering Geologist					
Abdul Shakoor	Independent Consultant	Kent, OH	Ph.D., Engineering Geology	N/A	46
Geotechnical Engineer					
Michael Hartley	PND Engineers, Inc.	Seattle, WA	M.S., Civil/Geotechnical Engineering	Yes	37

Table B-2 presents an overview of the credentials of the final four members of the Panel and their qualifications in relation to the technical evaluation criteria. More detailed biographical information regarding each panel member and his area of technical expertise is given in Section B.3.

Table B-2. Mohawk DSMS IEPR Panel: Technical Criteria and Areas of Expertise

Technical Criterion	Luckie	Denbow	Shakoor	Hartley
Plan Formulator / Economist				
Minimum 10 years of demonstrated experience in public works planning	X			
Very familiar with USACE plan formulation process, procedures, and standards	X			
Familiar with evaluation of alternative plans for Dam Safety Modification Studies	X			
Familiar with USACE standards and procedures	X			
Experience related to evaluating traditional Civil Works plan benefits associated with Dam Safety Modification Studies, to include experience in USACE methodologies for determining the cost effectiveness of alternatives evaluations and consequence analysis	X			
NEPA / Environmental				
At least 15 years of experience directly related to water resource environmental evaluation or review and National Environmental Policy Act (NEPA) compliance		X		
Minimum M.S. degree or higher in a related field		W[1]		

Table B-2. Mohawk DSMS IEPR Panel: Technical Criteria and Areas of Expertise (Continued)

Technical Criterion	Luckie	Denbow	Shakoor	Hartley
Must be familiar with the habitat, fish and wildlife species that may be affected by the project alternatives in this study area		X		
An expert in compliance with additional environmental laws, policies, and regulations, including compliance in Fish and Wildlife Coordination Act and Endangered Species Act		X		
Familiar with United States Fish and Wildlife Service Habitat Evaluation Procedure (HEP) (USFWS, 1980)		X		
Sufficient expertise and knowledge regarding application of cultural resource rules, regulations and appropriate laws, including the National Historic Preservation Act, as amended, to ensure proposed project modifications are in compliance		X		
Engineering Geologist				
Senior level geologist or an engineer familiar with hydrologic, hydraulic, and geologic design of spillways			X	
Familiar with empirical and 1D spillway erosion techniques, calculation of material strength values (Headcut Erodibility Index), exploration techniques, and in-situ and laboratory rock and soil testing			X	
Familiar with empirical methodologies (streampower vs. erodibility index), 1D (SITES, WINDAMB), and case studies related to erosion of materials at spillways			X	
Proficient in calculating erodibility index values for rock and soil from field, drilling, and laboratory testing results which relate to rock (rock strength, RQD measurements, rock joint description and orientation) and soil (blow counts, gradations, plasticity data)			X	
Thorough familiarity with rock and soil drilling techniques as well as pressure testing and downhole camera-geophysical techniques			X	
Experience in failure mode analysis, risk assessment of spillway, evaluation of risk reduction measures for dam safety projects, and familiarity with the USACE dam safety guidance			X	
Working knowledge of applicable USACE design criteria and shall be a licensed Professional Geologist or Professional Engineer			X	
Geotechnical Engineer				
Senior-level geotechnical engineer with extensive experience in the field of geotechnical engineering related to the analysis, design, and construction of embankment dams and levees, including rehabilitations of these structures				X
Knowledge and experience in the evaluation of backward erosion piping (BEP) potential failure modes in the foundations of embankment dams and/or levees, and in the development, design, and construction of remediation alternatives for correcting BEP issues				X

Table B-2. Mohawk DSMS IEPR Panel: Technical Criteria and Areas of Expertise (Continued)

Technical Criterion	Luckie	Denbow	Shakoor	Hartley
Experience in failure mode analysis, risk assessment of embankment dams and/or levees, evaluation of risk reduction measures for dam safety assurance projects, and familiarity with the USACE dam safety guidance				X
Working knowledge of all applicable USACE design criteria				X
Licensed Professional Engineer				X

[1] This (W) waiver requirement was accepted by USACE as part of the Task 2 deliverable previously submitted.

B.3 Panel Member Qualifications

Detailed biographical information on each panel members' credentials and qualifications and areas of technical expertise are summarized in the following paragraphs.

Name	**David Luckie**
Role	**Plan Formulator / Economist**
Affiliation	**Independent Consultant**

Mr. Luckie is an independent consultant with nearly 30 years of professional experience in water resource economics, planning, plan formulation, benefit-cost analysis, and risk-based analysis. His public works experience encompasses decades of work with federal and non-federal agencies, including local, state and federal organizations. Since earning his B.S. in economics and finance from the University of South Alabama in 1986, he has worked with multidisciplinary teams to provide or review complex planning studies for dam safety, flood risk management, ecosystem restoration, and water supply and water quality studies. He is intimately familiar with ER-1105-2-100 and the 6-Step Planning Process and has prepared, supervised, or reviewed numerous planning studies in his career.

Mr. Luckie is familiar with the evaluation of alternative plans for Dam Safety Modification Studies, and has conducted, supervised, or reviewed several water resource studies featuring numerous alternative plans constructed from an array of different management measures. Examples of such studies include the Village Creek Watershed Feasibility Study in Birmingham, Alabama and the Buffalo Bayou General Reevaluation Report in Houston, Texas. He has also served as an IEPR panel member on the Success Dam and Lake Isabella dam safety modification studies in California, where his knowledge of ER-1105-2-100 and the 6-Step Planning Process was applied to these dam safety projects.

Least cost analysis, also known as cost effectiveness analysis, has been a very important aspect of his decades of work. He is familiar with the evaluation of alternative plans and, as a Regional Economist (1988-2006) with the USACE Mobile District, conducted, supervised, or reviewed benefit-cost analyses for a variety of water resource projects, including single purpose projects and multi-purpose projects covering the full range of USACE missions. Relevant studies include the Apalachicola Chattahoochee Flint and Alabama Coosa Tallapoosa Comprehensive Studies and the draft Programmatic Environmental Impact Statements covering the states of Alabama, Florida, and Georgia and the Hunting Bayou General Reevaluation Report (GRR) in Houston, Texas.

Mr. Luckie is very familiar with USACE standards and procedures. He has extensive experience in performing National Economic Development (NED) analysis procedures, specifically as they relate to flood risk management. For more than 25 years, he has performed, supervised, or reviewed NED procedures for technical accuracy, compliance with policy and guidance, and accepted planning principles. Such studies as the Village Creek Watershed Feasibility Study and Buffalo Bayou GRR reflect this experience.

Mr. Luckie has also worked with consequence analysis. He has dealt directly with the Hydrologic Engineering Center's Flood Impact Analysis (HEC-FIA) software and has performed simulations calculating the loss of life for a selected Event-Exposure Scenario and given structure inventory with population. His experience with HEC-FIA is reflected in such studies as the Flint River at Albany, Georgia study and the Upper White Oak Bayou GRR in Houston, Texas, and the IEPRs of Success Dam in Porterville, California, and Lake Isabella Dam in Kern County, California. He is also familiar with risk and uncertainty analysis, and understands Monte Carlo simulations. He has constructed or reviewed project-specific risk analysis models on such projects as the Choctawhatchee, Pea, and Yellow Rivers Section 22 study and the Okaloosa County Water Supply Shortage Risk Analysis.

Name	**Thomas Denbow**
Role	**NEPA/Environmental**
Affiliation	**Biohabitats, Inc.**

Mr. Denbow is the Great Lakes Bioregional Team Leader and Senior Environmental Scientist with Biohabitats, Inc. He earned his B.S. in zoology from Bowling Green State University in 1971, and has more than 40 years of experience directly related to water resource environmental evaluation or review and National Environmental Policy Act (NEPA) compliance. Mr. Denbow specializes in watershed and regional conservation planning, flood risk management, innovative floodplain management, wetlands, riparian, and stream protection and restoration, and water quality management for both public and private project stakeholders and clientele.

Mr. Denbow has a strong knowledge of the habitat, fish, and wildlife species that may be affected by the project alternatives in this study area, which includes the Muskingum River Basin and other areas of Ohio. His career has focused on environmental evaluation of water resources in both the public and private sectors for compliance with the Fish and Wildlife Coordination Act, Endangered Species Act, Clean Water Act, and NEPA. For example, while working in central Ohio early in his career, he completed numerous environmental baseline and impact assessment (aquatic, terrestrial, etc.) studies, which required knowledge of plant communities and aquatic and terrestrial species. He participated in the first Ohio Breeding Bird Atlas as regional coordinator. More recently, he was a member of a team assessing long-term protection strategies for City of Columbus's watersheds, which required an understanding of natural resource base and threatened and endangered species. Other Ohio project experience includes Little Cuyahoga River Sec. 206 Restoration Project (USACE Buffalo District); the Portage County Comprehensive Wetland Inventory and Map and Advanced Identification Demonstration Project (EPA Region 5, Chicago, Illinois); the Blanchard River Flood Risk Minimization Feasibility Study (served as project manager), and the Western Lake Erie Basin Report to Congress (prepared for the USACE Buffalo District) including preparation of 10 watershed plans focused on fish and wildlife resources, water quality, water quantity, and commercial and recreational navigation in the Western Lake Erie Basin.

Mr. Denbow has sufficient expertise and knowledge regarding application of cultural resource rules, regulations and appropriate laws, including the National Historic Preservation Act, as amended, to ensure proposed project modifications are in compliance. He has completed Section 106 coordination for several projects, with the most recent being the Acacia Reservation Ecological Restoration project on the eastside of Cleveland. He also assisted USACE in completing Section 106 coordination for the Blanchard Flood Risk Minimization Study, as well as overseeing work for archaeological and historic investigations in Ohio.

Mr. Denbow is familiar with the U.S. Fish and Wildlife Service Habitat Evaluation Procedure (HEP), having received formal training in its use by the U.S. Fish and Wildlife Service and later using HEP models as a foundation for assessing restoration benefits of the Little Cuyahoga River Section 206 Restoration Feasibility Study. Mr. Denbow received formal wetland delineation training from the National Wetlands Training Institute and served as co-principal investigator for preparing a national manual on wetland replacement (NCHRP 379), which required a thorough understanding of various wetland types, wetland hydrology, and restoration techniques.

As past member and Chair of the Ohio Water Advisory Council (external advisory group to Ohio Department of Natural Resources [ODNR] Division of Water, which includes Dam Safety and Floodplain Management Sections), he is familiar with local dam and flood risk policies, technical requirements, regulations, and issues throughout the State of Ohio, including within the Muskingum River Basin. Mr. Denbow is also a member of the Society of Ecological Restoration and the Natural Areas Association.

Name	**Abdul Shakoor, Ph.D., C.P.G., P.G.**
Role	**Engineering Geologist**
Affiliation	**Independent Consultant**

Dr. Shakoor is an emeritus professor of engineering geology at Kent State University and an independent consultant. He earned a Ph.D. in engineering geology from Purdue University in 1982. He is a registered professional geologist (P.G.) in Pennsylvania and a certified professional geologist (C.P.G.) by the American Institute of Professional Geologists. He is a senior level geologist with more than 46 years of academic and practical experience in physical geology, structural geology, engineering geology, environmental geology, soil mechanics, rock mechanics, rock slope stability, foundation engineering, geohydrology, and remote sensing.

His primary research focuses on the engineering behavior of weak rocks (shales, claystones, mudstones, etc.), stability of slopes in both soils and rocks, evaluation of construction materials, influence of geologic characteristics on engineering properties/behavior of soils and rocks, and environmental hazards such as lakeshore erosion, mine subsidence, and structural damage due to blasting operations. His research in these areas involves extensive field and laboratory studies, with a number of his research projects regularly conducted in collaboration with local engineering firms or government organizations, such as the Ohio Department of Transportation, geological surveys, National Park Service, and Environmental Protection Agency. His advanced engineering geology course focuses on rock mass classification systems, dams, and tunnels, based on his knowledge of dam hydraulics, failure mode analysis, risk assessment, risk reduction measures, empirical methods for evaluating erodibility of soils and rocks, especially spillway erodibility, drilling and logging techniques, and pressure testing. He is also well-versed in using rock and soil properties for evaluating their erodibility potential.

Dr. Shakoor is familiar with all applicable USACE guidance criteria including USACE dam safety guidance and procedures. He is familiar with the probability-based analysis currently used by USACE and has working knowledge of all applicable USACE design criteria and related documents. He served as an engineering geology expert on IEPR panels for the Dover and Bolivar Dams, Ohio; Zoar Levee and Diversion Dam, Ohio; Bluestone Dam, West Virginia; the Lake Isabella Dam, California; the Center Hill Dam, Tennessee; and the Joe Pool Dam, Texas; on all these projects he applied his considerable experience in failure mode analysis (both the embankment and the foundation), risk assessment of spillway, risk assessment for embankment dams and levees, and the evaluation of risk reduction measures for dam safety projects.

He is very familiar with empirical and 1D spillway erosion techniques, calculation of material strength values (Headcut Erodibility Index), exploration techniques, and in situ and laboratory rock and soil testing. Examples include reviews of Lake Isabella and Bluestone dams. Dr. Shakoor is also familiar with empirical methodologies (streampower vs. erodibility index), 1D (SITES, WINDAMB), and case studies related to erosion of materials at spillways. He is proficient in calculating erodibility index values for rock and soil from field, drilling, and laboratory testing results that relate to rock (rock strength, RQD measurements, rock joint description, and orientation) and soil (blow counts, gradations, plasticity data). He evaluated and conducted similar work for Lake Isabella and Bluestone dams. Dr. Shakoor is thoroughly familiar with rock and soil drilling techniques, as well as pressure testing and downhole camera-geophysical techniques. He teaches these techniques in several of his courses (engineering geology, advanced engineering geology, and rock slope stability).

Name	**Michael Hartley, P.E.**
Role	**Geotechnical Engineer**
Affiliation	**PND Engineers, Inc.**

Mr. Hartley is a past senior vice president of PND Engineers, Inc. and currently provides consulting services as a senior geotechnical engineer through PND. He earned his M.S. in civil/geotechnical engineering in 1979 from Oregon State University and is a registered professional engineer in the states of Alaska, Washington, and Oregon. He has 37 years of experience providing civil, coastal, and geotechnical engineering services for projects throughout the United States and overseas. His geotechnical engineering experience includes the studies and design for marine infrastructure, levees, dams, buildings, roads, trails, bridges, breakwaters, and dredging projects. He is also recognized in the federal court system as an expert in civil, coastal, and geotechnical engineering.

Mr. Hartley is knowledgeable and experienced in the analysis, design, and construction of embankment dams and levees, including rehabilitations of these structures. Since 1979 he has been active in the evaluation of seepage and piping potential failure modes in the foundations of embankment dams and levees. He has knowledge and experience in the evaluation of backward erosion piping (BEP) potential failure modes in the foundations of embankment dams and/or levees, and in the development, design, and construction of remediation alternatives for correcting BEP issues. Studies have involved intermediate and high head earthfill dams, levees, and impoundments for roads.

He has performed many dam safety inspections for the Federal Energy Regulatory Commission (FERC) and the State of Alaska Dam Safety Division of Department of Natural Resources. He has also performed dam design or rehabilitation assessment for concrete gravity, concrete arch, and earthfill dams and levees. This has included many challenging projects such as the design of a 1,000-foot-long, 30-foot head earthfill dam constructed at temperatures down to -30 degrees Fahrenheit. He is the Senior Geotechnical Engineer responsible for quality assurance oversight and training of personnel in flow net, seepage, and piping analysis at PND and provides training to other geotechnical engineers at PND in dam safety evaluation. He recently assisted in QA analysis for piping and seepage analysis of three football-size cofferdams constructed in New Orleans for the Permanent Canal Closures and Pumps project.

Mr. Hartley is experienced in the development, design, and construction of remediation alternatives for correcting seepage and piping issues and has evaluated various dam and levee structures for remediation using hydromax panels, clay cores, sheetpile, and other techniques to mitigate piping and seepage issues. He has served on numerous panels as a geotechnical engineer expert involving large high-head dams, performing peer review of proposed seepage corrections. Relevant design modifications include Campbell Lake Dam safety studies and design of rehabilitation measures using sheetpile. He is experienced in both failure mode analysis and risk assessment of embankment dams and using risk-based procedures, most recently having reviewed the risk assessment for levees in Mt. Vernon and Burlington. He evaluated the procedures used by two separate geotechnical firms for levee stability assessments as part of the USACE Skagit River, Washington IEPR.

Mr. Hartley has experience in the evaluation of risk reduction measures for dam safety assurance projects, reflected in his efforts in support of USACE IEPR dam safety assurance projects for the Dover, Bluestone, and Bolivar Dams, as well as other construction-phase review services. He has testified in federal court on risk-based assessment analysis and is very familiar with probabilistic methods of geotechnical assessment of levees, recently performing an IEPR review for the Skagit river levee system in Washington state. Other relevant projects include Sherwood Estates Dam, Squaw Harbor Dam, Lyon Lake Dam, Upper Petersburg Creek Dam, Cabin Creek Dam, Campbell Lake Dam, Valdez Creek Dam, and levee assessment for Skagit County. He is very familiar with USACE dam safety guidance and has used USACE publications in the design, risk-based assessment, and review of flood control dam and levee reviews. For example, he has worked on previous USACE peer reviews and the current cofferdam design for the permanent canal closures project for USACE New Orleans District. He is also familiar with all applicable USACE design criteria and USACE engineering manuals, and has used these in the design of projects and in the peer review of designs by others. Examples include the West Bank Levee designs peer review for WBV 12, 14f.2, and 18 levees, and the geotechnical design analysis for the PCCP cofferdams in New Orleans.

APPENDIX C

Final Charge for the Mohawk DSMS IEPR

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Charge Questions and Guidance to the Panel Members for the Independent External Peer Review (IEPR) of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio

This is the final Charge to the Panel for the Mohawk DSMS IEPR. This final Charge was submitted to USACE as part of the final Work Plan, originally submitted on October 4, 2016.

BACKGROUND

Mohawk Dam is one component of a system of flood risk management (FRM) projects located in the Muskingum River Basin in Ohio. This project was authorized and constructed through a cooperative agreement with the Muskingum Watershed Conservancy District (MWCD). The Flood Control Act of 1939 turned over ownership, as well as operations and maintenance, of the Muskingum Basin projects to the U.S. Army Corps of Engineers (USACE). This transition resulted in a partnership between the USACE and the MWCD wherein the USACE owns the dams and immediate land foot-print of the dam, while the MWCD owns the land beneath the reservoir, stored waters, and surrounding lands.

Mohawk Dam is located on the Walhonding River, a tributary of the Muskingum River. The dam is located 17.4 miles above the mouth of the Walhonding River and approximately 129.8 miles above the mouth of the Muskingum River. The floodplain between Mohawk Dam and downstream at-risk population centers can generally be described as a broad, gently sloping valley. Development is relatively sparse downstream of the dam, being comprised primarily of small to moderate municipalities and incorporated communities, several industrial sites, and farmland.

Mohawk Dam is a “dry dam” and does not retain a permanent pool during any season of the year. Four other USACE FRM dams are located upstream of Mohawk Dam: the Mohicanville, Charles Mill, Pleasant Hill, and North Branch of Kokosing River Dams. Two non-USACE dams with permanent pools are located upstream of Mohawk Dam: Apple Valley Lake (22,485 acre feet maximum storage) and Knox Creek Lake (3,750 acre feet maximum storage). No other FRM dams are located downstream of Mohawk Dam, either on the Walhonding or the Muskingum River.

The project consists of a rolled earthfill embankment, an outlet works control tower with two 20-foot diameter conduits that transition to horseshoe-shaped tunnels, and an uncontrolled spillway. The embankment is composed of a central clay core flanked by pervious zones and outer rock fill shells. The outlet works consist of an approach channel, intake tower, horseshoe-shaped tunnel and conduit, stilling basin, and outlet channel. The intake structure consists of a reinforced concrete substructure and a brick and block superstructure to house the gate-operating machinery for six 8-foot by 17-foot sluice gates and the auxiliary power unit. Access to the structure is by a service bridge extending from the left abutment. The outflow is directed through one of two 20-foot diameter concrete conduits that transition to concrete-lined horseshoe-shaped tunnels. The tunnels then extend through the left abutment from a transition section near the gates to the stilling basin.

OBJECTIVES

The objective of this work is to conduct an independent external peer review (IEPR) of the Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio (hereinafter: Mohawk DSMS IEPR) in accordance with the Department of the Army, USACE, Water Resources Policies and Authorities' *Civil Works Review* (Engineer Circular [EC] 1165-2-214, dated December 15, 2012), and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004).

Peer review is one of the important procedures used to ensure that the quality of published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of hypotheses, validity of the research design, quality of data collection procedures, robustness of the methods employed, appropriateness of the methods for the hypotheses being tested, extent to which the conclusions follow from the analysis, and strengths and limitations of the overall product.

The purpose of the IEPR is to assess the "adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (EC 1165-2-214; p. D-4) for the Mohawk DSMS documents. The IEPR will be limited to technical review and will not involve policy review. The IEPR will be conducted by subject matter experts (i.e., IEPR panel members) with extensive experience in plan formulator/economist, National Environmental Policy Act (NEPA)/environmental, engineering geologist, and geotechnical engineer issues relevant to the project. They will also have experience applying their subject matter expertise to FRM.

The Panel will be "charged" with responding to specific technical questions as well as providing a broad technical evaluation of the overall project. Per EC 1165-2-214, Appendix D, review panels should identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods. Review panels should be able to evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable. Reviews should focus on assumptions, data, methods, and models. The panel members may offer their opinions as to whether there are sufficient analyses upon which to base a recommendation.

DOCUMENTS PROVIDED

The following is a list of documents, supporting information, and reference materials that will be provided for the review. The following documents are to be reviewed by designated discipline:

Report Title for IEPR Panel Review	Subject Experts				
	No. of Review Pages	Plan Formulation/ Economics	NEPA/ Environmental	Engineering Geologist	Geotechnical Engineer
DSMR Main Report	90	90	90	90	90
Appendix A – Existing Condition Risk Assessment and Future Without Action Condition Report	206	206	206	206	206
Addendum A – PMP/IDF Update	171	-	-	171	171
Addendum B – Glacial Geology & Geomorphology	21	-	-	21	21
Addendum C – Geotechnical Investigations - Embankment	796	-	-	796	796
Addendum D – Geotechnical Analysis - Embankment	248	-	-	248	248
Addendum E – Geotechnical Investigations & Analyses - Spillway	168	-	-	168	168
Addendum F – Site Characterization Drawings	19	-	-	19	19
Addendum G – Consequences	39	39	-	39	39
Addendum H – DAMRAE Inputs and Results	86	-	-	86	86
Appendix B – With Project Risk Assessment	38	38	38	-	38
Appendix C – Formulation	3	3	3	-	3

Report Title for IEPR Panel Review	Subject Experts				
	No. of Review Pages	Plan Formulation/ Economics	NEPA/ Environmental	Engineering Geologist	Geotechnical Engineer
Appendix D – Engineering Analysis	33	-	-	-	33
Addendum A – Relief Well Design Calculations	41	-	-	-	41
Addendum B – Toe Drain Calculations	4	-	-	-	4
Addendum C – Seepage Collection System Analyses	13	-	-	-	13
Addendum D – Calculations for Further Design of TSP	7	-	-	-	7
Addendum E – Drawings for TSP	12	-	-	-	12
Addendum F – Abbreviated Constructability Review	3	-	-	-	3
Appendix E – Applicable Essential USACE Guidelines	10	-	-	-	10
Appendix F and Appendix G – Cost	TBD	TBD	TBD	-	TBD
Appendix H – Environmental Documentation	6	-	6	-	-
Dam Safety Action Decision Summary	18	18	18	18	18
Total # of Pages	**2,032**	**394**	**361**	**1,862**	**2,026**

Documents for Reference

- USACE guidance *Civil Works Review,* (EC 1165-2-214, December 15, 2012). Available online: http://www.publications.usace.army.mil/Portals/76/Publications/EngineerCirculars/EC_1165-2-214.pdf.
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004)
- Chapter 9 (Section 9.6.8.2.6) in Engineer Regulation (ER) 1110-2-1156, Engineering and Design - Safety of Dams - Policy and Procedures (31 March 2014)

USACE engineer regulations (ER) publications are available online: http://www.publications.usace.army.mil/USACEPublications/EngineerRegulations.aspx.

General

- ER 1110-1-12, Engineering and Design - Quality Management, 31 March 2014 (change 2)
- ER 1110-1-8159, Engineering and Design - DrChecks, 10 May 2001
- ER 1110-2-1150, Engineering and Design - Engineering and Design for Civil Works Projects, 31 August 1999
- ER 1110-2-1156, Engineering and Design - Safety of Dams - Policy and Procedures, 31 March 2014
- National Academy of Sciences, "Policy and Procedures on Committee Composition and Balance and Conflicts of Interest for Committees Used in the

- Development of Reports," May 2003 for General Scientific and Technical Studies and Assistance: General Scientific and Technical Studies and Assistance. Available at: http://www.nationalacademies.org/coi/index.html
- Water Resources Development Act of 2007, Sections 2034 and 2035, Pub. L.110-114.
- Privacy Act, 5 U.S.C. § 522a as amended

Environmental/Planning

- ER 200-2-2, Environmental Quality, Procedures for Implementing NEPA.
- CECWRE (now CECW-A), 4 March 1988
- ER 1105-2-100, Planning Guidance Notebook. CECW-P, 22 April 2000
- Council on Environmental Quality. 1978. Regulations for Implementing the
- Procedural Provisions of the National Environmental Policy Act. 40 CFR Parts
- 1500-1508. Washington, DC: U.S. Government Printing Office (November 29,
- 1978).

Engineering Geology

- EM 1110-1-1802, Geophysical Exploration for Engineering and Environmental Investigations, 31 August 1995
- EM 1110-1-1804, Engineering and Design - Geotechnical Investigations, 01 January 2001
- ER 1110-1-1807, Engineering and Design - Procedures for Drilling in Earth Embankments, 01 March 2006

Geotechnical Engineering

- EM 1110-2-1901, Engineering and Design - Seepage Analysis and Control for Dams, 30 April 1993
- EM 1110-2-1902, Engineering and Design - Slope Stability, 31 October 2003
- EM 1110-2-1908, Engineering and Design - Instrumentation of Embankment Dams and Levees, 30 June 1995
- EM 1110-2-2300, Engineering and Design - General Design and Construction Considerations For Earth and Rock-Fill Dams, 30 July 2004
- EM 1110-2-1906, Laboratory Soils Testing, 20 August 1986
- EM 1110-2-2000, Engineering and Design - Standard Practice for Concrete for Civil Works Structures, 31 March 2001
- EM 1110-2-2002, Evaluation and Repair of Concrete Structures, 30 June 1995
- EM 1110-2-2100, Engineering and Design - Stability Analysis of Concrete Structures, 1 December 2005
- EM 1110-2-2102, Waterstops and Other Preformed Joint Materials for Civil Works Structures, 30 September 1995
- EM 1110-2-2104, Engineering and Design - Strength Design for Reinforced-Concrete Hydraulic Structures, 20 August 2003
- EM 1110-2-2400, Engineering and Design - Structural Design and Evaluation of Outlet Works, 02 June 2003
- EM 1110-2-4300, Instrumentation for Concrete Structures, 30 November 1987

Hydraulic Engineering

- EM 1110-2-1602, Engineering and Design - Hydraulic Design of Lake Outlet Works, 15 October 1980
- EM 1110-2-1603, Engineering and Design - Hydraulic Design of Spillways, 16 January 1990

- EM 1110-2-2902, Engineering and Design - Conduits, Culverts, and Pipes, 31March 1998
- EM 1110-2-3600, Engineering and Design - Management of Water Control Systems, 30 November 1987
- ER 1110-2-240, Water Control Management, 8 October 1998
- ER 1110-2-8156, Preparation of Water Control Manuals, 31 August 1995
- ER 1110-8-2 (FR), Inflow Design Floods for Dams and Lakes, 1 March 1991
- ER 1130-2-530, Flood Control Operations and Maintenance Policies, 30 October 1996

SCHEDULE

This schedule is based on the September 13, 2016, receipt of the final review documents. Note that dates presented in the schedule below could change due to panel member and USACE availability.

Task	Action	Due Date
Conduct Peer Review	Battelle sends review documents to panel members	10/11/2016
	Battelle convenes kick-off meeting with panel members	10/11/2016
	Battelle convenes webinar kick-off meeting with USACE and panel members	10/13/2016
	USACE, Battelle, and Panel visit the site (Travel day: 10/19/2016)	10/20/2016
	Battelle convenes mid-review teleconference for panel members to ask clarifying questions of USACE, if needed	10/31/2016
	Panel members complete their individual reviews	11/2/2016
	Subcontractors complete mandatory Operations Security (OPSEC) training	11/6/2016
Prepare Final Panel Comments	Battelle provides talking points for Panel Review Teleconference to panel members	11/3/2016
	Battelle convenes Panel Review Teleconference	11/4/2016
	Battelle provides Final Panel Comment templates and instructions to panel members	11/7/2016
	Panel members provide draft Final Panel Comments to Battelle	11/10/2016
	Battelle provides feedback to panel members on draft Final Panel Comments; panel members revise Final Panel Comments	11/11/2016 - 11/16/2016
	Battelle finalizes Final Panel Comments	11/17/2016
Review Final IEPR Report	Battelle provides Final IEPR Report to panel members for review	11/18/2016
	Panel members provide comments on Final IEPR Report	11/21/2016
	*Battelle submits Final IEPR Report to USACE	11/22/2016
	USACE RMC provides decision on Final IEPR Report acceptance	11/29/2016

Task	Action	Due Date
Comment/ Response Process	Battelle inputs Final Panel Comments to Design Review and Checking System (DrChecks) and provides Final Panel Comment response template to USACE	11/30/2016
	Battelle convenes teleconference with Panel to review the Comment Response Process	11/30/2016
	USACE Project Delivery Team (PDT) provides draft Evaluator Responses to USACE Planning Center of Expertise (RMC) for review	12/8/2016
	USACE RMC reviews draft Evaluator Responses and works with USACE PDT regarding clarifications to responses, if needed	12/12/2016
	USACE RMC provides draft PDT Evaluator Responses to Battelle	12/13/2016
	Battelle provides draft PDT Evaluator Responses to panel members	12/13/2016
	Panel members provide draft BackCheck Responses to Battelle	12/13/2016
	Battelle convenes teleconference with panel members to discuss draft BackCheck Responses	12/14/2016
	Battelle convenes Comment-Response Teleconference with panel members and USACE	12/15/2016
	USACE inputs final PDT Evaluator Responses to DrChecks	12/19/2016
	Battelle provides final PDT Evaluator Responses to panel members	12/19/2016
	Panel members provide final BackCheck Responses to Battelle	12/20/2016
	Battelle inputs panel members' final BackCheck Responses to DrChecks	12/21/2016
	*Battelle submits pdf printout of DrChecks project file	12/22/2016

* Deliverables

CHARGE FOR PEER REVIEW

Members of this IEPR Panel are asked to determine whether the technical approach and scientific rationale presented in the Mohawk DSMS documents are credible and whether the conclusions are valid. The Panel is asked to determine whether the technical work is adequate, competently performed, and properly documented; satisfies established quality requirements; and yields scientifically credible conclusions. The Panel is being asked to provide feedback on the economic, engineering, environmental resources, and plan formulation. The panel members are not being asked whether they would have conducted the work in a similar manner.

Specific questions for the Panel (by report section or appendix) are included in the general charge guidance, which is provided below.

General Charge Guidance

Please answer the scientific and technical questions listed below and conduct a broad overview of the Mohawk DSMS documents. Please focus your review on the review materials assigned to your discipline/area of expertise and technical knowledge. Even though there are some sections with no questions associated with them, that does not mean that you cannot comment on them. Please feel free to make any relevant and appropriate comment on any of the sections and appendices you were asked to review. In addition, please note the following guidance. Note that the Panel will be asked to provide an overall statement related to 2 and 3 below per USACE guidance (EC 1165-2-214; Appendix D).

1. Your response to the charge questions should not be limited to a "yes" or "no." Please provide complete answers to fully explain your response.

2. Assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, and any biological opinions of the project study.

3. Assess the adequacy and acceptability of the economic analyses, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, and models used in evaluating economic or environmental impacts of the proposed project.

4. If appropriate, offer opinions as to whether there are sufficient analyses upon which to base a recommendation.

5. Identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods.

6. Evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable.

7. Please focus the review on assumptions, data, methods, and models.

Please **do not** make recommendations on whether a particular alternative should be implemented, or whether you would have conducted the work in a similar manner. Also please **do not** comment on or make recommendations on policy issues and decision making. Comments should be provided based on your professional judgment, **not** the legality of the document.

1. If desired, panel members can contact one another. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, or was part of the USACE Agency Technical Review (ATR).

2. Please contact the Battelle Project Manager (Jessica Tenzar, tenzarj@battelle.org) or Program Manager (Rachel Sell; sellr@battelle.org) for requests or additional information.

3. In case of media contact, notify the Battelle Program Manager, Rachel Sell (sellr@battelle.org) immediately.

4. Your name will appear as one of the panel members in the peer review. Your comments will be included in the Final IEPR Report, but will remain anonymous.

Please submit your comments in electronic form to Jessica Tenzar, **tenzarj@battelle.org**, no later than November 2, 2016, 10 pm ET.

Independent External Peer Review of the
Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio

Charge Questions and Relevant Sections as Supplied by USACE

GENERAL (4)

1. Were risk and uncertainty sufficiently estimated and characterized for the existing, future without-project and future with-project conditions?

2. Were risk and uncertainty sufficiently considered during the study?

3. In your opinion, is there sufficient data upon which to base the selection of a risk management plan (RMP)?

4. In your opinion, is the proposed RMP appropriate given the risks and uncertainty estimated for Mohawk Dam?

EXISTING AND FUTURE WITHOUT PROJECT RESOURCES (3)

5. Are the methods used to estimate the risk adequate and appropriate given the circumstances?

6. Have all the significant potential failure modes been identified and appropriately considered?

7. Are future Operation, Maintenance, Repair, Replacement, and Rehabilitation efforts adequately described, and are the estimated cost of those efforts reasonable for future without-action risk condition?

PLAN FORMULATION / EVALUATION (5)

8. Was a reasonably complete array of possible measures considered in the development of alternatives/RMPs, including those non-structural measures, such as removing the project?

9. In your professional opinion, are the metrics used in the alternatives/RMPs evaluation and screening, that lead to a final array of alternatives/RMPs, acceptable?

10. Please comment on the evaluation and comparison of the proposed alternatives/RMPs. Were the evaluation criteria applied correctly, and was the final array of alternatives/RMPs compared appropriately?

11. Have the potential benefits and impacts of each alternative/RMP been clearly and adequately presented?

12. Were the engineering, economic, and environmental analyses used for this study consistent with generally accepted methodologies? Why or why not?

RECOMMENDED PLAN (2)

13. Does the proposed RMP address the study objectives and avoid violating the study constraints?

14. Please comment on the completeness of the proposed RMP (i.e., will any additional efforts, measures, or projects be needed to realize the expected benefits?).

DAM SAFETY (2)

15. Has the condition of the project (including the design and construction of the project and appurtenant features, project maintenance, previous remediation, and the dam's performance over time) been clearly described?

16. Is there sufficient information presented to identify, explain, and comment on assumptions which underlie engineering analyses? Why or why not?

SAFETY ASSURANCE REVIEW (SAR) (4)

17. In accordance with ER 1110-2-1150, are the quality and quantity of the surveys, investigations, and engineering sufficient for a concept design?

18. Are the models used to assess hazards appropriate?

19. Are the assumptions made for the hazards appropriate?

20. Does the analysis adequately address the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project?

FINAL OVERVIEW QUESTION (1)

21. What is the most important concern you have with the document or its appendices that was not covered in your answers to the questions above?

Battelle Summary Charge Questions to the Panel Members[2]

Summary Questions

22. Please identify the most critical concerns (up to five) you have with the project and/or review documents. These concerns can be (but do not need to be) new ideas or issues that have not been raised previously.

23. Please provide positive feedback on the project and/or review documents.

[2] Questions 22 and 23 are Battelle supplied questions and should not be construed or considered part of the list of USACE-supplied questions. These questions were delineated in a separate appendix in the final Work Plan submitted to USACE.

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APPENDIX D

Conflict of Interest Form

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Conflicts of Interest Questionnaire

Independent External Peer Review

Mohawk Dam, Dam Safety Modification Study (DSMS), Coshocton County, Ohio

The purpose of this document is to help the U.S. Army Corps of Engineers identify potential organizational conflicts of interest on a task order basis as early in the acquisition process as possible. Complete the questionnaire with background information and fully disclose relevant potential conflicts of interest. Substantial details are not necessary; USACE will examine additional information if appropriate. Affirmative answers will not disqualify your firm from this or future procurements.

NAME OF FIRM: **Battelle Memorial Institute**
REPRESENTATIVE'S NAME: **Courtney Brooks**
TELEPHONE: **614-424-5623**
ADDRESS: **505 King Avenue, Columbus, OH 43201**
EMAIL ADDRESS: **brooksc1@battelle.org**

I. INDEPENDENCE FROM WORK PRODUCT. Has your firm been involved in any aspect of the preparation of the subject study report and associated analyses (field studies, report writing, supporting research etc.) **No** Yes (if yes, briefly describe):

II. INTEREST IN STUDY AREA OR OUTCOME. Does your firm have any interests or holdings in the study area, or any stake in the outcome or recommendations of the study, or any affiliation with the local sponsor? **No** Yes (if yes, briefly describe):

III. REVIEWERS. Do you anticipate that all expert reviewers on this task order will be selected from outside your firm? No **Yes** (if no, briefly describe the difficulty in identifying outside reviewers):

IV. AFFILIATION WITH PARTIES THAT MAY BE INVOLVED WITH PROJECT IMPLEMENTATION. Do you anticipate that your firm will have any association with parties that may be involved with or benefit from future activities associated with this study, such as project construction? **No** Yes (if yes, briefly describe):

V. ADDITIONAL INFORMATION. Report relevant aspects of your firm's background or present circumstances not addressed above that might reasonably be construed by others as affecting your firm's judgment. Please include any information that may reasonably: impair your firm's objectivity; skew the competition in favor of your firm; or allow your firm unequal access to nonpublic information.

No additional information to report.

Courtney Brooks　　　　September 1, 2016

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