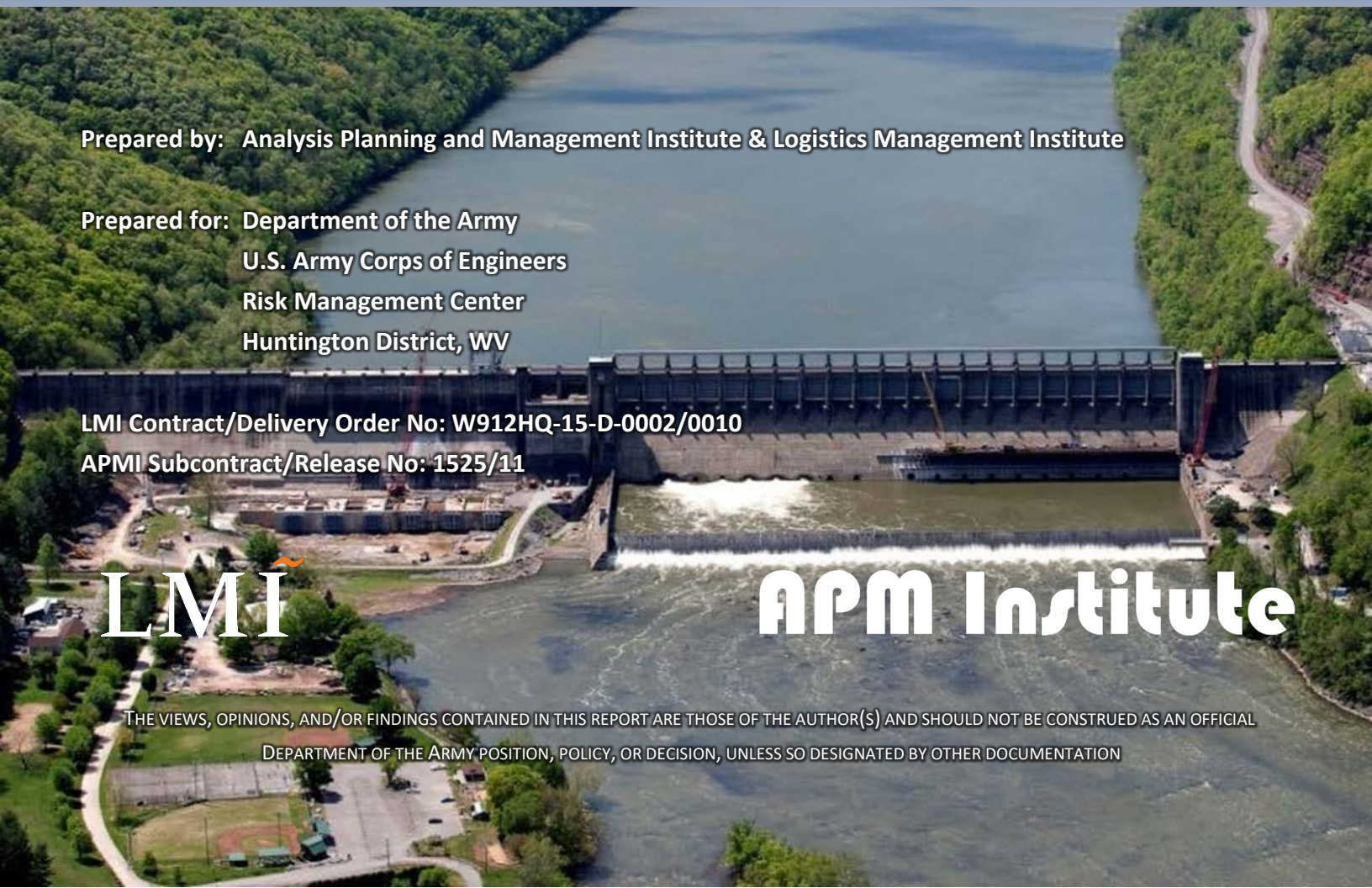
TR-2016-COE-009

Independent External Peer Review of the Bluestone Dam, Summers County, WV Draft Dam Safety Modification Report

Final Report

31 October 2016



Prepared by: Analysis Planning and Management Institute & Logistics Management Institute

Prepared for: Department of the Army
U.S. Army Corps of Engineers
Risk Management Center
Huntington District, WV

LMI Contract/Delivery Order No: W912HQ-15-D-0002/0010
APMI Subcontract/Release No: 1525/11

LMI

APM Institute

THE VIEWS, OPINIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER DOCUMENTATION

This Page Intentionally Blank

Executive Summary

Project Background

This report presents the results of an independent external peer review (IEPR) of the Bluestone Dam, Summers County, Hinton, WV, Draft Dam Safety Modification Report (DSMR).[1] The Draft DSMR was prepared by the Huntington District of the U.S. Army Corps of Engineers (USACE). The USACE conducted the Draft DSMR to document the decisions made during the Bluestone Dam Safety Modification Study (DSMS). The Bluestone Dam DSMS further defines the Dam Safety issues, confirms Federal interest in operating the project, and recommends a risk management plan to reduce incremental dam safety risk to be within tolerable risk guidelines so that the project can continue to operate as originally authorized. An array of risk management measures and plans were formulated, evaluated, and compared to recommend a Risk Management Plan (RMP) that reduces incremental risks to meet tolerable risk guidelines.

Of the seven RMPs developed as part of the Draft DSMR, the USACE has identified RMP #6, Hydraulic Jump Basin with Supercavitating Baffles, as the Tentatively Selected Plan (TSP). This alternative includes modifying the existing stilling basin system with a protective concrete apron and larger baffles, among other features described in the Draft DSMR. This alternative would also include a remotely controlled crest gate operating system, as well as non-structural risk management measures. Modification to the dam is expected to occur over an 8- to 10-year period.

Officials from the USACE are collecting comments on the Supplementary Draft Environmental Impact Statement (SDEIS) through stakeholder engagement. Comments have been received from the general public; environmental groups; tribal entities; and federal, state, local, and governmental organizations. However, the SDEIS comment period was not complete at the time of the publication of this report and more comments are expected. Consequently, not all SDEIS comments have been considered by the IEPR Panel in this review.

Independent External Peer Review Process

The LMI Team, comprising of Logistics Management Institute (LMI) and Analysis Planning and Management Institute (APMI), has conducted an IEPR of the Draft DSMR. This IEPR was conducted in accordance with the procedures described in the Department of the Army, USACE Engineer Circular (EC) No. 1165-2-214, *Civil Works Review*, dated 15 December 2012. The IEPR was conducted to analyze the adequacy and acceptability of methods, modeling, data, and analyses used. The IEPR focused on an engineering and economic technical review and did not involve policy review.

The IEPR review was conducted by a Panel of subject matter experts with the following expertise and experience:

- Civil Engineering
- Structural Engineering
- Hydrology and Hydraulic Engineering

---

1 "*Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", U.S. Army Corps of Engineers, Huntington District, Great Lakes & Ohio River Division, 1 September 2016, NID ID: WV08902

- Biological Resources and Environmental Law Compliance
- Civil Works Planning/Economics
- Engineering Geology

The IEPR Panel (the Panel) was "charged" with providing a broad technical evaluation of the material contained in the selected technical appendices of the Draft DSMR and reference documentation. This report provides the final comments of the IEPR Panel.

Results of the IEPR

The Panel has conducted an in-depth review of the proposed Bluestone DSMR with regards to economic, engineering, and environmental methods, models, and analyses considerations. The Panel notes that all engineering and planning studies were conducted with a high degree of professionalism and outstanding quality. The Panel believes that the Draft DSMR thoroughly identifies and considers a complete array of possible measures, including both structural and nonstructural, in the development of alternatives. The formulation process fulfilled the requirement to avoid, minimize, and mitigate adverse impacts to resources while meeting the formulation requirements of the USACE definitions of being effective, efficient, complete, and acceptable. In accordance with USACE Engineering Regulation (ER) 1110-2-1156,[1] the five required alternatives, with seven RMPs, have been identified and adequately discussed and considered, including identification of an alternative, "Achieving only tolerable risk limit for life-safety."

However, some deficiencies and inconsistencies were also noted by the Panel. Many of these can be evaluated in further detail during the Planning, Engineering, and Design (PED) phase of the project. Some issues should be reevaluated as part of revising the Draft DSMR and be resolved to the extent practical before proceeding further.

There were a total of 33 comments. Of these, 2 were identified as having High significance, 6 as Medium/High significance, 18 as Medium significance, 3 as Medium/Low significance, and 4 as Low significance. The following paragraphs provide a summary of the Panel's comments in specific subject matter areas.

Civil Engineering

Overall, in regards to the Civil Engineering completed for the Draft DSMR, the Panel agrees that the work is complete and of high quality. Drawings contain all required plan sheets and details. USACE has done a thorough evaluation of the anticipated construction challenges and has configured the project to allow new work to be completed in two phases splitting the new concrete apron into two halves. The extent of proposed contractor work limits appears reasonable, and USACE has tried to arrange the work site to minimize truck traffic impacts to nearby communities, which addresses an important public comment. However, the Panel has also noted some important issues requiring immediate resolution and several that should be evaluated further in PED.

The Panel has identified multiple inconsistencies amongst the engineering appendices, the drawing sets, and the main report. These issues are generally minor in nature but several relate to inconsistencies

---

1 ER 1110-2-1156, "*Engineering and Design, Safety of Dams – Policy and Procedures*", USACE, 2014-03-31

between recommended TSP component crest elevations and estimated design water surface levels. The most important of these identified by the Panel are differences between the proposed divider wall crest elevation and the elevation of the adjacent cofferdam. The Panel assumed these would be the same as the divider wall, once constructed, and would fulfill the cofferdam function for the remaining "half" of construction in the discharge basin. The crest elevation differences need to be resolved immediately and will require revisions to engineering calculations, drawings, main report, appendices, and the final cost estimate.

The Panel also identified issues related to evacuation mobilization rates. The Panel had two separate comments regarding these assumptions and calculations. First, including more specific and detailed risk communication plans must be a USACE focus during the PED. USACE, working with local, state, and Federal stakeholders, has a great opportunity to contribute to risk reduction for both "breach and non-breach" scenarios by taking full advantage of nonstructural measures including both passive and active risk-communication. Second, the USACE should undertake further integration between evacuation scenarios and hydrologic design storms. Better integration of the design storm(s) timelines coupled with knowledge regarding first chance of sudden dam failure should potentially allow USACE to legitimately revise the 8-hour and 24-hour (and longer) evacuation mobilization rates. These efforts could be undertaken during the PED, including further participation of the expert elicitation team used previously for these estimates. The Panel believes that a reduction in loss-of-life estimates may be a feasible outcome from these new evaluation efforts.

The Panel was concerned that the probable maximum precipitation (PMP) and resulting probable maximum flood (PMF) scenarios were limited during development of the Draft DSMR. The Panel identified shortcomings in the evaluation of both coincident flooding downstream of Bluestone Dam as well as the selection of the storm scenario itself. The Panel believes that USACE should consider possible scenarios involving multiple "tracking" storms rather than one single storm event. Both coincident flooding and impact of multiple storms can affect estimates of loss-of-life, economic damages, and dam operation.

Finally, the Panel encourages USACE to program further cost-optimization efforts as part of PED. The Panel agrees that while RMP #6 may be complete and very safe, it may be more costly than required. Also, given USACE's dam safety funding limitations, large, mega-projects like Bluestone need to compete for limited funds, further delaying project implementation and increasing overall cost. As such, the Panel feels it is important to make all reasonable efforts to optimize the final design of RMP #6 further in order to maximize its benefits while minimizing cost.

Structural Engineering

The Draft DSMR satisfactorily documents the formulation activities associated with addressing Potential Failure Mode (PFM) 33 spillway monolith instability. This is the only failure mode that was considered actionable as a result of the risk assessment update in 2016. The report adequately documents the development, evaluation, and comparison of risk management plan (RMP) alternatives to reduce the risk associated with PFM 33. Four primary structural RMPs were considered: a downstream conventional stilling basin, transitional flip stilling basin, a stilling basin with supercavitating baffles, and a concrete overlay in the existing stilling basin. Evaluation of the alternatives resulted in selection of RMP #6, which consists of the stilling basin with the supercavitating baffles as the most cost-effective solution. This alternative also includes additional anchors and drains in the spillway monoliths, modifying the existing

first stage basin to prevent rock scour, installing drains and anchors in the first stage basin, stabilizing the existing stilling weir, reinforcing the second-stage basin to minimize scour and address scour concerns with overtopping the training walls. These remedial measures were reviewed and evaluated from a structural engineering perspective to determine their adequacy to address the spillway monolith instability issue.

The Panel concurs that the measures included in RMP #6 should provide robust, redundant, and resilient solutions to effectively reduce the potential for spillway monolith instability during high discharges, but at a very high cost. The Panel, however, believes that the structural analysis and reinforcement design of the supercavitating baffle blocks should be refined using a more sophisticated methodology, such as plane-stress finite element analysis, to produce a more economical reinforcement design. The Panel also recommends that roller-compacted concrete (RCC) be considered for construction of the lower portion of the apron extension slabs to reduce the cost of materials and construction time. The documentation of the design of the underdrain system proposed for the first-stage stilling basin should be expanded to further justify the spacing of the drains, the hydraulics of the pumping system, and the ease of cleaning the long lateral drains. The Panel also recommends that the stability of the spillway monoliths and stilling basin structures be checked assuming zero drain efficiency for all drains for the usual loading condition to ensure that the structures are stable if the drains become plugged over time. Measured drain efficiencies can possibly be used for the unusual and extreme loading conditions depending on how quickly the drains are judged to react to sudden changes in the reservoir pool level.

Hydrology and Hydraulic Engineering

The USACE has performed a substantial amount of work relating to the update of the hydrology modeling. There are data that have been developed and are presented in the Appendices that are not conclusively presented clearly in the narrative report. Examples are the discussion about using the temporal and spatial distribution precipitation patterns from 1982, which results in the 1982 PMP being maintained as the design analysis for the selected project, and the discussion concerning coincident flooding and "tracking" storms that are believed to be highly likely in this area, which is affected by both tropical storm events and frontal systems. The new USACE criteria[1] will now require the USACE to address the future effects of climate change for this project, which should take place during the Planning, Engineering, and Design (PED) phase of the project. There are still unanswered questions, especially with the new guidance on climate change, which leads to the concern that not all forecasted conditions have been thoroughly evaluated.

The hydrology and hydraulics associated with the RMP is adequate to assess the existing risk assessments and some conditions for the future. There are areas where additional explanation or clarifications have been noted in the comments. With regard to the charge question as to whether the care and diversion scheme associated with implementation of the RMP is feasible, the diversion scheme as modeled shows very little change between the base condition flows and the diversion scheme flows (left and right cofferdam) beyond the immediate zone of influence of the construction cofferdam (approximately

---

1 Engineering and Construction Bulletin (ECB) 2016-25, "*Subject: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*", USACE, 2016-09-16

1,500-feet downstream of the dam). The areas downstream that are currently affected, including the public recreation area, are not shown to be inundated with any greater degree of flow or velocity.

The recommendation presented in the Stantec Modeling Report[1] for developing an operating rule curve was not included in the documents reviewed by the Panel and should be developed during the PED phase with concurrence of hydraulic modeling to avoid the potential for creating eddy currents that could potentially undermine either the penstock basin or the spillway stilling basin over time. Initial eddy currents were identified in the recent physical modeling, thus the previous recommendation for an operating rule curve to avoid such damage.

The use of supercavitating baffle blocks has not been clearly justified in the report. There may be a logical thought process in the design to date and thus the use of the supercavitating baffles is the correct decision, but there is no written documentation that supports using supercavitating baffles over other conventional baffle design (likely an enhanced design to withstand higher velocities).

Civil Works Planning/Economics

There are a few sections of the report that need further clarification, specifically with regard to population at risk, population per structure, and loss of life. The population under the Future Condition (Future Condition without Federal Action Condition, FWAC) is significantly lower (16%) than under the Baseline Condition (Baseline Condition Risk Assessment, BCRA) and to a lesser extent under the Existing Condition (Existing Condition Risk Assessment, ECRA) (5%), but no rationale is provided for the differences. Similarly, the population per structure numbers and, as a result expected loss of life numbers, from a dam breach, range from 33% to 56% less under the FWAC condition than under existing condition with no rationale provided for the differences. In addition, in the incremental loss of life associated with potential failures of the Bluestone Dam under existing conditions and FWAC are expected to be lower if the failure occurs at night, when people are asleep and harder to contact and evacuate, than if it occurs during the day, but it is not explained how this is the case.

Two other issues were identified that require clarification. There is no mention in the SDEIS of the effects of the project in the 17% of the watershed that lies within North Carolina. The Panel also was not able to find an updated website for the project that is supposed to be active. Addressing these concerns would meaningfully increase the technical quality of the Draft DSMR.

Biological Resources and Environmental Law Compliance

Overall, the Supplemental SDEIS and Draft DSMR make a reasonable effort to address the intent of the decision document and the purpose and need for the project. The SDEIS describes the current status of the biologic community to an informative level of detail and generally provides substantive information regarding impacts associated with the considered alternatives. However, there are several issues that need to be addressed. There does not appear to be sufficient data to support the presence/absence of threatened and endangered species within areas potentially impacted by the project nor the potential impacts associated with invasive species, undermining the evaluation of forecasted conditions (with and

---

[1] Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics"*, Attachment 6 – Final Report of Physical Model Observations (Stantec 2015), "*Final Report of Physical Model Observations*", Bluestone Dam Phase 5, RMP Modeling Evaluation, Stantec Consulting Services Inc., 2015-01-30 (PDF page 1043)

without proposed actions). Further, the analyses of the human environment and natural resources within the project area appear insufficient to support the estimation of impacts of the final array of alternatives, as data regarding low-income populations is deficient and appears to be partly inconsistent within the Draft DSMR. While the formulation process appears to follow the requirement to avoid, minimize, and then mitigate adverse impacts to resources, it is not clear that impacts are fully avoided and minimized, making it unclear whether mitigation is sufficient as proposed. Finally, the analyses may underestimate the significance of the length of construction time in both the consideration and the definition of impacts. Thus, the analysis does not appear to sufficiently consider that temporary, but long-term (chronic), impacts can result in permanent effects to biologic communities, environmental justice populations, and children.

Engineering Geology

The geotechnical and geologic evaluations presented in the Draft DSMR are generally thorough and well done. The Panel did identify a few important issues that require clarification or further consideration. Two issues deal with the Automated Data Acquisition System (ADAS) and the key below the proposed supercavitating baffles.

The ADAS is only planned to be used during construction and not for future operations. Major concerns addressed by this project relate to stability of the concrete structures under extreme flood events. The ADAS can provide necessary information, real time, to the District office. The use of an ADAS during both construction and operation periods would increase the overall integrity of the dam by decreasing the time required to identify harmful conditions and to provide technical support response to these conditions. In the worst case, the use of an ADAS could allow earlier implementation of an emergency action plan, in response to a possible dam failure. Therefore, the Panel suggests that USACE consider implementing ADAS during the dam operations period as well as during the construction phase.

Increasing the depth of the key below the proposed supercavitating baffles needs further evaluation and optimization. Doing so would increase overall stability of the section and also the global stability of the dam structures and result in the need for fewer anchors. USACE should conduct further studies to evaluate cost-risk tradeoffs between a deeper key section versus rock anchors. The Panel feels that it may be possible to further reduce the overall project cost and reduce the project implementation schedule.

Table of Contents

Executive Summary i
Introduction 1
1.1 Introduction and Report Overview 1
1.2 Independent External Peer Review Process 2
1.3 IEPR Management Team 2
2 Project Description 3
3 Independent External Peer Review Process 7
3.1 Project Management 7
3.2 Selecting the Independent External Peer Review Panel 7
3.3 Preparing and Charging the Panel 7
3.4 Performing the Independent External Peer Review 9
3.5 Finalizing the Panel Comments 9
3.6 USACE Responses to Panel Comments 9
3.7 Panel Backcheck Responses 10
4 Panel Organization 11
4.1 IEPR Panel Description 11
4.2 IEPR Panel Members 14
4.3 IEPR Process Management Team 19
5 Independent External Peer Review Findings 21
5.1 Independent External Peer Review Panel Comments 25
5.2 Significance: High 27
5.3 Significance: Medium/High 30
5.4 Significance: Medium 40
5.5 Significance: Medium/Low 62
5.6 Significance: Low 65
Appendix A Charging the Independent Peer Review Panel 69
Appendix B Qualifications of the Independent External Peer Review Panel Members 73
B.1 Prof. Don Ator, MBA 73
B.2 Dr. Christopher Brown, PhD, PE 75
B.3 Prof. James Dobberstine, MS 76
B.4 Mr. Charles Hutton, PE 77
B.5 Mr. Willard Smith, PE, CFM 78
B.6 Mr. Douglas Spaulding, PE 80
Acronyms 83

List of Figures

Figure 1: Kanawha River Basin with Bluestone Dam Drainage Area 3
Figure 2: Bluestone Dam (Early Aerial Photo)..... 4
Figure 3: Bluestone Dam – Existing Features..... 5
Figure 4: IEPR Organization..... 11

List of Tables

Table 1: IEPR Documentation 8
Table 2: Summary of IEPR Panel Member Qualifications by Discipline..... 12

Introduction

1.1 Introduction and Report Overview

This Independent External Peer Review (IEPR) Final Report provides the results of the review of the Draft Dam Safety Modification Report (DSMR) prepared for the Bluestone Dam located on the New River in Summers County, Hinton, WV. The Draft DSMR documents the decisions made during the Bluestone Dam Safety Modification Study (DSMS), which is being conducted by the Huntington District of the U.S. Army Corps of Engineers (USACE). The DSMS further defines the Dam Safety issues, confirms Federal interest in operating the project, and recommends a risk management plan (RMP) to reduce incremental dam safety risk to be within tolerable risk guideline so that the project can continue to operate as originally authorized. An array of reasonable risk management measures and plans were formulated, evaluated, and compared to recommend a RMP that reduces incremental risks to meet tolerable risk guidelines. USACE Tolerable Risk Guidelines are defined in Chapter 5 of Engineering Regulation (ER) 1110-2-1156 and are utilized to define what dam safety issues present unacceptable risks.[1]

The purpose of the IEPR was to assess the adequacy and acceptability of specific economic and engineering methods, models, and analyses presented in the Draft DSMR (main report and appendices), which also includes a Supplementary Draft Environmental Impact Statement (SDEIS). The Interim IEPR focused on engineering and economic technical review and did not involve policy review.

The IEPR was conducted by an independent Panel comprising subject matter experts with experience in areas relevant to the technical issues of this project. The Panel members were nominated, screened for technical qualifications and presence of Conflict of Interest (COI), and "charged" with providing a broad technical evaluation of the overall project as well as responding to specific technical questions. The Panel review was guided by the general charge questions listed in Appendix A.

The Panel reviewed the assumptions that underlie the analyses and evaluated the soundness of models, surveys, investigations, and methods. The Panel assessed whether the assumptions of the planning analysis are sound and whether or not the conclusions based on the planning analysis are appropriate and logically follow from the stated problems, opportunities, objectives, constraints, screening, and alternatives evaluation.

Officials from the USACE are collecting comments on the SDEIS through stakeholder engagement. Comments have been received from the general public; environmental groups; tribal entities; and federal, state, local, and governmental organizations. However, the SDEIS comment period was not complete at the time of the publication of this report and additional comments are expected. Consequently, not all SDEIS comments have been considered by the IEPR Panel in this review.

Section 1 of the Interim IEPR Final Report provides a description of the objectives of this effort and general background information on the IEPR. Section 2 provides a project description of Bluestone Dam. Section 3 summarizes the process followed to perform the IEPR. Section 4 describes the IEPR Panel composition and the Panel members' expertise. Section 5 presents the IEPR Panel comments. Appendix A

[1] ER 1110-2-1156, "*Engineering and Design, Safety of Dams – Policy and Procedures*", USACE, 2014-03-31

provides the charge to the Panel and Appendix B summarizes the qualifications of the IEPR Panel members.

1.2 Independent External Peer Review Process

The USACE lifecycle review strategy for Civil Works projects provides for a review of project documents from initial planning through the project phases of design; construction; and operation, maintenance, repair, replacement, and rehabilitation. The strategy provides procedures for ensuring the quality and credibility of USACE decision, implementation, and operations and maintenance documents and work products.

Peer reviews, such as this IEPR, are one of the important procedures used to ensure that the quality of USACE 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 objective of this IEPR was to review the Draft DSMR and SDEIS. To ensure the adequacy of the Draft DSMR and SDEIS, the Panel analyzed the adequacy and acceptability of economic, engineering, and environmental methods, models, and analyses in accordance with the procedures described in the Department of the Army, USACE Engineer Circular (EC) No. 1165-2-214, *Civil Works Review*, dated 15 December 2012.

1.3 IEPR Management Team

This IEPR was conducted by a group of independent experts under the auspices of Analysis Planning and Management Institute (APMI) as a subcontractor to the Logistics Management Institute (LMI), collectively referred to as the Outside Eligible Organization (OEO). Both organizations are not-for-profit science and technology entities that provide impartial, independent assistance, free of COI, to Federal government organizations. Neither organization has performed or advocated for or against any Federal water resources projects or have real or perceived COI for conducting IEPRs. LMI, APMI, and the Panel members for this IEPR have not been involved in any capacity with the projects documented in the Bluestone Dam Draft DSMR. For this IEPR, both organizations are free from COI with the USACE.

2 Project Description

Bluestone Dam is located in southern West Virginia in Summers County within the New River Basin, which is a sub-basin of the Kanawha River Basin. Bluestone Dam is located approximately 1½-miles upstream of the City of Hinton and ½-mile upstream of the confluence of the New and Greenbrier Rivers. The project began operations in 1949 and controls an approximate 4,600-square-mile drainage area upstream of the dam (See Figure 1).

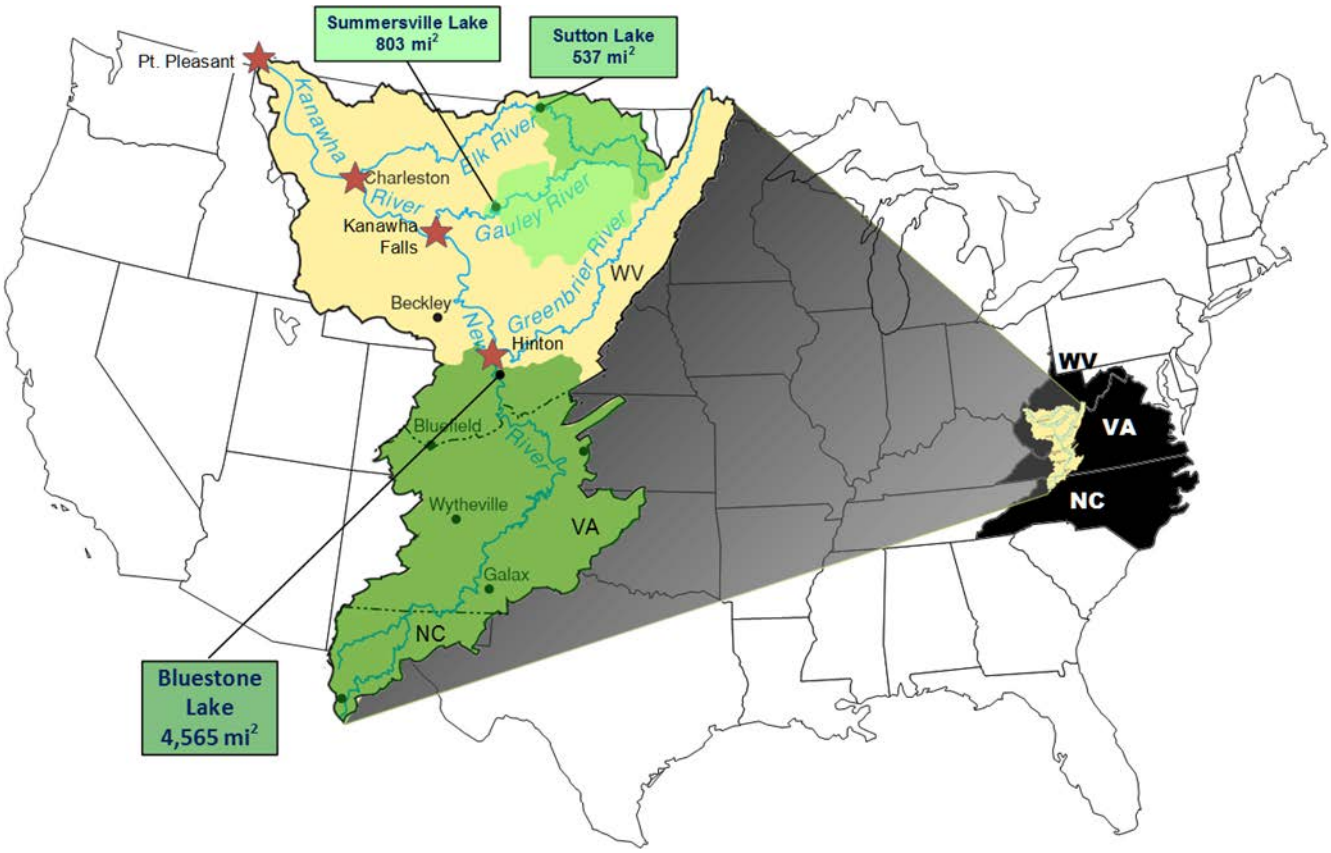


Figure 1: Kanawha River Basin with Bluestone Dam Drainage Area

Bluestone Dam and reservoir was authorized by Executive Order 7183 in September 1935 and the Flood Control Acts of 1936 and 1938 for the purposes of flood control and power development. The stated purposes were later expanded under the Flood Control Act of 1944 to include recreation activities and under the Fish and Wildlife Coordination Act of 1958 to include fish and wildlife enhancement. Section 102(ff) of the Water Resource Development Act (WRDA) of 1992, as amended by Section 357 of WRDA 1996, further modified the original project authorization to address the accumulation and disposal of drift and debris at the project.

Bluestone Dam was originally constructed at full Federal expense for $28,600,000. Construction of the Bluestone project was started in January 1942 and continued until March 1944. The War Production Board stopped the project construction for the duration of World War II. The project resumed construction in 1946 and was completed in December 1948. While the original authorization for Bluestone Dam

provided for hydropower development, extensive electric power development during wartime resulted in a decision to defer hydropower development at the project and use all available storage for flood control. This lowered the elevation of the lake 80 feet from 1,490 to 1,410 feet above mean sea level (MSL). Section 547 of Public Law 106-541 (commonly referred to as the WRDA 2000) and Section 122 of Public Law 109-103 (commonly referred to as the Energy and Water Development Appropriations Act, 2005) provides Tri-Cities Power Authority with exclusive rights to develop hydropower at Bluestone Dam.

As seen in Figure 2 and 3, Bluestone Dam is a straight, concrete gravity structure with an overall length of 2,060 feet and a maximum height of 165 feet above the streambed. Discharge capacity of the existing structure consists of gated sluices and a gated auxiliary spillway. The spillway section is 790-feet long and includes 21 bays with vertical lift gates. The total design discharge capacity of the dam is 430,000 cubic feet/second (cfs). Operation of the reservoir is by 16 gated sluices with a total discharge capacity of 72,000 cfs (at pool elevation 1,520.5 with no spillway crest flow).

Figure 2: Bluestone Dam (Early Aerial Photo)

To address the accumulation and disposal of drift at the project, the original project authorization was further modified under the WRDA of 1992, as amended in 1996. Following construction of the dam, a subsequent Corps risk assessment showed potential safety hazards in light of more current engineering standards. Consequently, the Corps signed a Record of Decision in 1999 to modify Bluestone Dam as described in the Dam Safety Assurance Evaluation Report. The 1999 Record of Decision allowed the Corps to begin detailed design and subsequent construction of the recommended alternative which included: a 13-foot cantilever wall on top of the dam to prevent overtopping; an additional concrete monolith on the east abutment; a floodgate closure across West Virginia Route 20 at the west abutment; extension and

retrofit of the existing hydropower penstocks with gates to supplement discharge capacity of the spillway and outlets; scour protection downstream of the penstocks; removable closures at each end of the spillway; and dam stability improvements. When completed, the current modifications under construction will strengthen the dam's stability through use of steel anchors and massive concrete thrust blocks, and allow for increased discharge capacity through the hydropower penstocks, substantially reducing risk during high flow events.

Figure 3: Bluestone Dam – Existing Features

The USACE has determined that even with these most recent modifications, risk of dam failure and downstream scour remains in the event of a Probable Maximum Flood (PMF). Modeling and analysis by the Corps of recent precipitation estimates, coupled with detailed terrain, soil, and runoff data, has shown that the PMF possible for the New River Basin has a peak flow of 1,086,000 cfs, which is double the peak of the original design flow (430,000 cfs). The Corps has concluded that under such high flow events, the downstream bedrock is vulnerable to erosion as a result of deficiencies with the current stilling basin configuration. According to the USACE, this potential erosion creates an unacceptable risk of dam failure and downstream scouring of the bedrock.[1] While the probability of a flood of this

[1] "*Bluestone Dam Risk Reduction and Management Measures Identification Meeting report*", USACE, Huntington District, WV, 45 pp

magnitude is small,[1] the consequences of dam failure and catastrophic flooding would put lives and property at risk from the dam all the way to the Ohio River, including: The New River Gorge National River; the Greenbrier, Gauley, Kanawha, and Elk Rivers; and the heavily populated and industrialized capital city of Charleston.

To reduce risk to acceptable levels, the Corps is now studying the feasibility of a wide array of additional structural modifications to the dam and river, as well as nonstructural measures. This IEPR addresses the seven RMPs developed as part of the Draft DSMR Tentatively Selected Plan (TSP), RMP #6. Modifications that are currently being evaluated as part of this TSP are Hydraulic Jump Basin with Supercavitating Baffles. This alternative includes modifying the existing stilling basin system with a protective concrete apron and larger baffles, among other features described in the Draft DSMR. This alternative would also include a remotely controlled crest gate operating system, as well as non-structural risk management measures. Modification to the dam is expected to occur over an 8- to 10-year period.

[1] A PMF of 1,086,000 cfs is approximately equivalent to a 63,000-year flood event (A. Johnson, USACE, 2013). While such an event could occur in any year, the risk of such a flood happening in any year is one in 63,000 (e.g. an annual probability of 0.001 percent). Smaller floods, such as a 625-year flood event, also pose risk. There is a 1.6 percent annual probability that the dam will reach a pool that threatens the dam's stability (the Imminent Failure Flood elevation).

3 Independent External Peer Review Process

This section summarizes the process for conducting this IEPR. The LMI Team performed the IEPR in accordance with the procedures described in EC 1165-2-214.

3.1 Project Management

A Work Plan was developed and executed to define and manage the process for conducting the IEPR. The Work Plan described the process for screening and selecting independent reviewers, communicating and meeting with the USACE project team, maintaining the project schedule and quality control, compiling and disseminating the independent reviewers' comments, and project management and administration.

3.2 Selecting the Independent External Peer Review Panel

Reaching out to its various pools of experts, the LMI Team identified experts who met and exceeded the technical expertise and requirements of this IEPR. We identified any potential COI issues that potential Panel members could have with the project following the standards of the National Academy of Science and Office of Management and Budget (OMB) M-05-03, *Final Information Quality Bulletin for Peer Review*. The following criteria were considered in the screening of the candidates:

- **Expertise:** Ensuring the selected reviewer has the knowledge, experience, and skills necessary to perform the review.
- **Independence:** Ensuring that the reviewer was not involved in this project or in producing the documents to be reviewed.
- **Conflict of interest:** Identifying any financial or other interest that conflicts with the service of an individual on the Panel because it could impair the individual's objectivity or could create an unfair competitive advantage for a person or organization.
- **Availability:** Assessing the candidates' availability to meet the project schedule.

After an initial screening of candidates to exclude those with inadequate expertise or potential COI issues, several candidates were selected for further in-depth screening and evaluation to ensure they met or exceeded the requirements of this task. The list was then narrowed down to identify the most qualified candidates that would be available to serve on the IEPR Panel while ensuring a balanced panel representing perspectives from academia, industry, and government. We provided the list of selected Panelists along with their summary qualifications relevant to this IEPR and detailed résumés to the USACE. The USACE used this information to determine if any proposed panel members had a potential COI based on USACE's general knowledge of the candidate's past employment or current involvement with the project. USACE acknowledged the relevancy of panel members' experience relative to the requirements of the IEPR and that there were no real or perceived COI issues. Information about the Panel members is provided in Appendix B.

3.3 Preparing and Charging the Panel

The USACE provided documents to be reviewed by the IEPR Panel. Table 1 includes the list of the documents used in this review as well as the corresponding file names provided to the Panel. The Team provided these documents to the Panel members along with the final Charge to Reviewers. These charge questions established the general boundaries for the IEPR. The charge questions are in Appendix A.

Table 1: IEPR Documentation

File Name (Renamed for Panel)	# Pages
Documents for Review	
- Draft DSMR – ATR Submittal.pdf	192
Appendix A – Risk Assessment.pdf	121
Appendix B – Structural (DQC Revisions 31 Aug 2016)(OCR'd).pdf	145
Appendix C – Civil Engr – No As-Built Dwgs, No Current Recor Dwgs (OCR'd).pdf Appendix C – Civil Engr (ALL)(OCR'd).pdf	1,303
Appendix D – Hydrology and Hydraulics (OCR'd).pdf	1,307
Appendix E – Geology and Geotechnical Engineering.pdf	1,201
Appendix F – Instrumentation.pdf	23
Appendix G – Electrical-Mechanical.pdf	7
Appendix H – Planning.pdf	113
Appendix J – Consequences Analysis.pdf	32
Appendix L – Real Estate Design Memo (Revised after DQC).pdf	9
Appendix M – Existing Contracts (OCR'd).pdf (Withdrawn)	
Appendix N – Authorizations.pdf	29
Appendix O – Project Management Plan.pdf	181
Bluestone Dam DSMR – Disposal Site MFR (DRAFT)(22 Mar 2016).pdf	6
Bluestone Dam DSMR – Project Schedule Updat.pdf	2
NOTE – Appendices To The Risk Assessment Technical Summary Are Not Included.doc	1
Supplemental DEIS – Vol I (OCR'd).pdf	285
Supplemental DEIS – Vol II Appendices A through G.pdf	546
Supplemental DEIS – Vol III Appendices H through L (OCR'd).pdf	404
Total Review Documents	5,907
Documents for Reference Only	
2016 Bluestone Dam – Risk Register (USACE).docx	20
Public Comments (anticipated number of pages)	50
REF Bluestone DSA Phase 4 (100 Percent) – DDR Main Report (2012-05-08).PDF	31
REF Bluestone DSA Phase 4 (100 percent) – Appendix A Geotechnical DDR (USACE).PDF	1,177
REF 2016-09-07 Bluestone DSMR ATR-IEPR – Briefing (USACE)(Rev 3-Final).PPT	104
Total Reference Documents	**1,382**
Total Documents	**7,289**

The Panel was provided templates and instructions for preparing their comments to ensure proper coverage of all important issues and consistency in preparing the IEPR comments. The Panel was instructed that OEO would be the conduit for information exchange between the Panel and USACE throughout the project in order to ensure a truly independent review.

The USACE also hosted a site visit at Bluestone Dam for the Panel and OEO Task Leader. The USACE provided a large, knowledgeable team as escort for the detailed tour and for a question and answer period afterward.

3.4 Performing the Independent External Peer Review

This review involved conducting an independent technical peer review of the Bluestone Dam Draft DSMR to analyze the adequacy and acceptability of engineering methods, models, data, and analyses presented in the documents. The review focused on conducting a technical review and did not involve policy issues. The Panel used the charge questions as guidance for identifying relevant information and developing their comments and recommendations.

Throughout the review process we communicated to the Panel all relevant project information, instructions, and required actions and deadlines. We acted as the conduit for information exchange between the Panel and USACE throughout the project in order to maintain the integrity of the IEPR process.

3.5 Finalizing the Panel Comments

After completing the review, the Panel submitted a draft of their comments to OEO. We collated the Panel comments and ensured they were complete and responsive to the charge. Overall themes were identified that were presented by multiple peer reviewers or repeated by one reviewer, comments that indicated conflicting peer review opinions, and other noteworthy comments. OEO ensured that the Panel comments focused on performing a technical review of the documents and did not comment on policy-related issues.

The OEO coordinated with the Panel to reach consensus on the comments, identify any overlapping comments, and resolve any contradictions. Further refinement and consolidation of the comments occurred via e-mail exchange and telephone discussions.

Each IEPR Final Panel Comment (FPC) consisted of four parts:

- **Comment:** A clear statement of the concern.
- **Basis for Comment:** A narrative describing the basis for the concern.
- **Significance:** A significance rating (see Section 5) of the concern (the importance of the concern with regard to project implementability) as well as a statement supporting this significance rating. Comments are rated as “high”, “medium high”, “medium”, “medium low”, or “low” to indicate the general significance the comment has to project implementability.
- **Recommendation[s] for Resolution:** Recommended actions necessary to resolve the concern to include a description of any additional research that would appreciably influence the conclusions.

3.6 USACE Responses to Panel Comments

After submitting the IEPR report, the final panel comments were entered into the Design Review and Checking System (DrChecks) for USACE internal tracking of the final panel comments and recommendations as well as the formal responses by the USACE and backcheck by the IEPR Panel to complete the IEPR process. DrChecks is an Internet-based review and checking application that the USACE uses[1].

[1] Hosted on the USACE’s PROJect extraNET (ProjNet), a web service that allows secure exchange of information.

The final panel comments will be reviewed and responded to by the USACE. The USACE will either "Concur" or "Non-Concur" with each panel comment and will "Adopt" or "Not Adopt" each recommendation provided with that comment. The USACE will prepare a draft written evaluator response to each comment.

The IEPR Panel will then review the USACE draft evaluator responses. OEO will hold a meeting with the Panel and the USACE evaluators so that the Panel and USACE can discuss the draft evaluator responses and ensure there is a clear understanding of the intent of original panel comments. After this meeting, the USACE will finalize their evaluator responses and enter them into DrChecks. The USACE's responses usually indicate whether documentation will or will not be expanded, revised, or changed.

3.7 Panel Backcheck Responses

After the USACE final evaluator responses are submitted and entered into DrChecks, OEO will meet with the Panel, as needed, to discuss the responses and the approach for preparing the Panel's responses (called the Backcheck). As part of the Backcheck process, the Panel will select either "Concur" or "Non-Concur" with each USACE final evaluator response and provided comments (as needed) to indicate whether each response adequately addresses the Panel's identified concerns. APMI will enter the Panel's Backcheck responses to each USACE evaluator response into DrChecks.

4 Panel Organization

The OEO assembled a Panel of experts that met the qualifications set forth by the USACE in the Performance Work Statement (PWS) for the task. We supported and assisted the Panel in carrying out its review and served as the intermediary for communications between the Panel and USACE during the IEPR process. Figure 4 shows the organization of the this IEPR. The purpose of this organization is to assure the independence of the review.

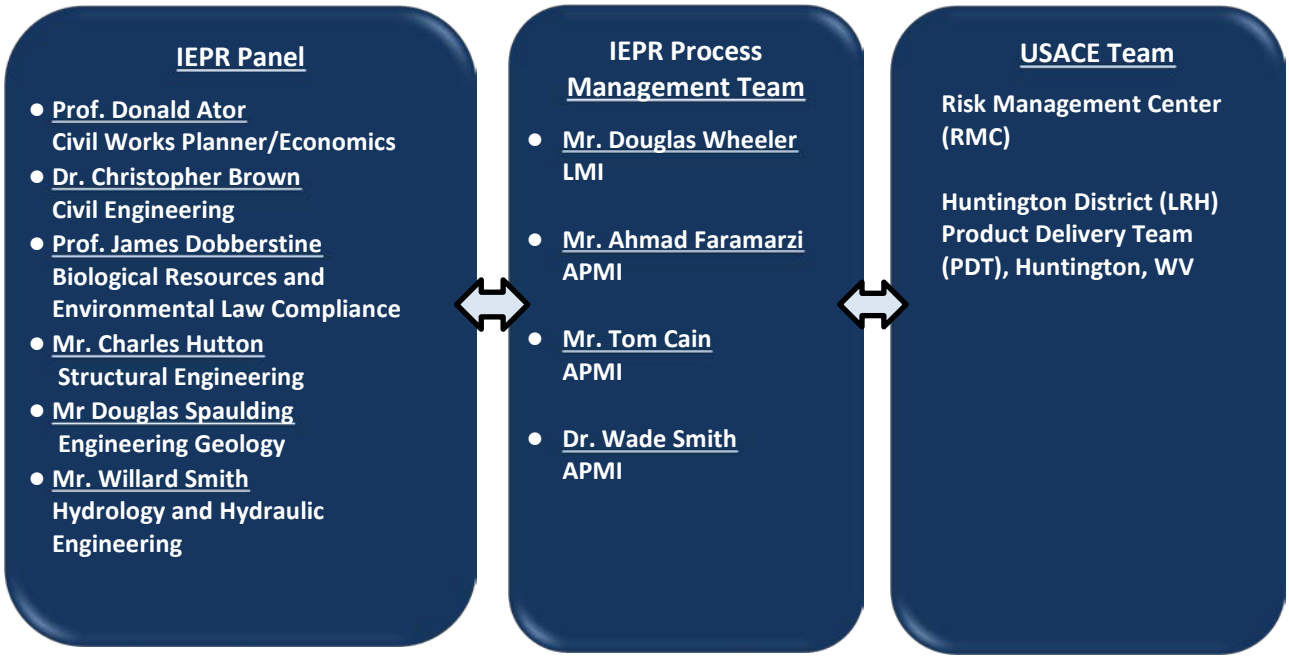


Figure 4: IEPR Organization

4.1 IEPR Panel Description

The Panel members satisfied the qualification requirements for each of the areas of expertise. The Panel members have experience working in academia, industry, and government. Table 2 depicts the Panel members' qualifications and experience.

Table 2: Summary of IEPR Panel Member Qualifications by Discipline

	Requirements	Prof. Donald Ator	Prof. James Dobberstine	Dr. Christopher Brown	Mr. Douglas Spaulding	Mr. Willard Smith	Mr. Charles Hutton
Subject Matter Expertise	**Highest Degree**	**MS/ MBA**	**MS**	**PhD /PE**	**MS/ PE**	**BS/ PE**	**MS/ PE**
	Years of Experience	**36**	**23**	**27**	**48**	**41**	**48**
	Past Experience with USACE (Direct [D], Indirect [I], and none [N])①	**D**	**I**	**D**	**D**	**I**	**I**
Civil Works Planning/ Economics	Should be from academia, a public agency, a non-governmental entity, or an architect-engineer or consulting firm with a minimum of 10-years demonstrated experience in public works planning.	✓					
	Familiar with USACE plan formulation process, procedures, and standards.	✓					
	Familiar with evaluation of alternative plans for Dam Safety Modification Studies.	✓					
	Familiarity with USACE standards and procedures is required.	✓					
	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.	✓					
Biological Resources and Environmental Law Compliance	Be a scientist from academia, a public agency, a non-governmental entity, or an architect-engineer or consulting firm.		✓				
	Must have at least 15 years' experience directly related to water resource environmental evaluation or review and National Environmental Policy Act (NEPA) compliance, with a minimum MS degree or higher in a related field.		✓				
	Familiar with the habitat, fish, and wildlife species that may be affected by the project alternatives in this study area.		✓				
	An expert in compliance with additional environmental laws, policies, and regulations, including compliance in Fish and Wildlife Coordination Act and Endangered Species Act.		✓				
	Familiar with United States Fish and Wildlife Service (USFWS) Habitat Evaluation Procedure (HEP) (USFWS, 1980).		✓				
	In addition to environmental science related requirements, also possess 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.		✓				
Civil Engineering	Be a registered Professional Engineer from academia, a public agency whose mission includes flood risk management, or an architect-engineer or consulting firm, having a minimum of 15 years' experience in civil engineering with a minimum MS degree or higher in engineering.			✓	✓		
	Have knowledge in the general field of civil engineering; extensive experience in the design, layout, and construction of flood control structures including dams and levees.			✓	✓		

	Requirements	Prof. Donald Ator	Prof. James Dobberstine	Dr. Christopher Brown	Mr. Douglas Spaulding	Mr. Willard Smith	Mr. Charles Hutton
	Demonstrated knowledge regarding hydraulic structures, erosion control, earthwork, concrete placement, design of access roads, and relocation of underground utilities.			✓	✓		
	Be a licensed Professional Engineer, familiar with USACE regulations and industry building codes.			✓	✓		
	Demonstrated experience in the specific field of dams engineering in evaluating, designing, and constructing major flood control structures including dams, levees, diversion channels, and other hydraulic structures.			✓	✓		
Engineering Geology	Be a registered Professional Geologist (PG) with 10 years or more of demonstrated experience in the general field of engineering geology; and should have extensive experience in similar types of work as described in the project description.				✓[1]		
	Active participation in related professional engineering and scientific societies is encouraged.				✓		
	Proficient in assessing seepage and piping through and beneath dams constructed on or within various geologic environments, including but not limited to alluvial soils, colluvium, and other geological formations.				✓		
	Familiar and knowledgeable with identification of geological hazards; field and laboratory testing and the determination of in-situ material properties; foundation inspection and assessment; foundation grouting and other foundation treatment methods including construction of foundation seepage barriers; and the design, installation and assessment of instrumentation.				✓		
	Proficient in assessing rock strengths and evaluating uplift for performing stability analyses using limit equilibrium.				✓		
Hydrology and Hydraulic Engineering	Registered Professional Engineer with a minimum of 15 years' experience in hydrologic and hydraulic engineering.					✓	
	Experience associated with flood risk management projects, and the analysis and design of hydraulic structures related to flood control projects including the design of hydraulic structures such as outlet works, spillways, and stilling basins, flood control channels and levees, diversion channel design, and large river control structures.					✓	
	Performed work in hydrologic analysis, floodplain analysis, hydraulic design of channels and levees using various channel and bank protection works, and river sedimentation.					✓	
	Must demonstrate knowledge and experience with physical modeling and the application of data from physical model testing to the design of stilling basins and scour protection, and in the ability to coordinate, interpret, and explain testing results with other engineering disciplines, particularly structural engineers, geotechnical engineers, and geologists.					✓	
	Must demonstrate knowledge and experience with the routing of inflow hydrographs through multipurpose flood control reservoirs utilizing					✓	

[1] Mr. Spaulding's 48-years' of experience in the geotechnical design of various types of dams, including gravity dams, and his Professional Civil Engineer registration was considered to be acceptable by USACE.

	Requirements	Prof. Donald Ator	Prof. James Dobberstine	Dr. Christopher Brown	Mr. Douglas Spaulding	Mr. Willard Smith	Mr. Charles Hutton
	multiple discharge devices, including gated sluiceways and gated spillways.						
	Familiar with USACE application of risk and uncertainty analyses in flood damage reduction studies and also have a familiarity with standard Corps hydrologic and hydraulic computer models (including but not limited to HEC-1, HEC-HMS, HEC-2, HEC-RAS, FLO-2D, and HEC-DSS) used in drawdown studies, dam break inundation studies, hydrologic modeling, and analysis for dam safety investigations.					✓	
Structural Engineering	Be from academia, a public agency whose mission includes flood risk management, a non-governmental entity, or an architect-engineer or consulting firm.						✓
	Be a registered Professional Engineer having a minimum of 15 years' experience in engineering or architecture.						✓
	Extensive experience in the design and construction of hydraulic structures for large and complex civil works projects including spillways, outlet works, and floodwalls.						✓
	Be a recognized expert in stability analysis and structural design of mass concrete scour protection and stilling features including the design of baffles, end sills, and training walls; seismic design, the determination and evaluation of dynamic site-specific response spectra analysis, and the evaluation of soil-structure interaction; and the design and construction of T-wall and L-wall floodwall design.						✓
	Proficient in performing stability analysis using limit equilibrium analysis; design and installation of post-tensioned high-strength steel anchors to stabilize mass concrete gravity dams and structures; and cofferdam design.						✓

① – Direct experience (D): A past USACE employee
Indirect experience (I): Work experience with USACE projects
None (N): No working experience with USACE projects

4.2 IEPR Panel Members

Prof. Donald Ator
Role: Civil Works Planning/Economics

Prof. Ator was selected primarily for his civil works economics experience and expertise. He earned an MS in Economics and Agriculture Economics from Louisiana State University in 1978 and an MBA in Finance and Accounting from Louisiana State University in 1984. He has over 35 years of experience working for 26 USACE districts. During this time he worked first as a full-time employee with USACE, and then in the private sector with a not-for-profit research institute, and with three architect-engineer firms. He has conducted more than 500 economics flood risk management studies evaluating and conducting complex multi-objective public works projects with high public and interagency interest nationwide. He has worked extensively with USACE conducting economics studies in accordance with ER 1105-2-100 and other pertinent guidance, laws, and regulations applicable to the USACE Six-Step Planning Process and EC 1165-2-209 review requirements.

Prof. Ator is nationally recognized for experience with USACE flood risk management analysis, economic benefit calculations, and expertise in economic analysis for flood risk management; specifically, with appropriate methodologies for estimating damages, and use of Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA). He is intimately familiar with Palisade @RISK Software and has demonstrated experience in determining the cost effectiveness of alternatives evaluations. Prof. Ator is actively involved in professional engineering and scientific societies including the American Society of Civil Engineers (ASCE) and the Society of American Military Engineers (SAME).

Prof. James Dobberstine
Role: Biological Resources and Environmental Law Compliance

Prof. Dobberstine currently serves as chair of the Math, Engineering, and Sciences Division at Lee College. He is responsible for all operational aspects of the Mathematics, Engineering, and Science Division. He holds a BA in Life Sciences from Concordia University, an MS in Environmental Management from the University of Houston-Clear Lake, and an MS in Environmental Science from the University of Houston, Clear Lake. Prof. Dobberstine teaches Environmental Science and Biology and is engaged in ecosystem studies in the Galveston Bay, TX estuary with his students, the results of which have been featured through organizations including Restore America's Estuaries, among others.

Prof. Dobberstine holds certificates in USACE wetland delineation (Texas A&M University) and water quality improvement using constructed wetlands (Clemson University). He has also completed numerous professional development courses, including GIS Techniques in Environmental Assessment (University of North Texas), Probabilistic Ecological Risk Assessment (Texas Tech University), Application of Adaptive Management to Address Climate Change Related Challenges (National Oceanic and Atmospheric Administration (NOAA), Coastal Service Center and the PBSJ Corporation's Ecosystem Restoration Division), Benthic Mapping Techniques (Environmental Protection Agency (EPA), U.S. Department of Agriculture Natural Resource Conservation Service, and the University of Rhode Island), Sampling Benthic Sediments: Methods, Analyses, and Judgments (University of North Texas Institute of Applied Sciences), and Conserving Land with Conservation Easements (National Land Trust Alliance Land Conservation Leadership Program).

As an environmental scientist focusing on wetlands and other sensitive habitats, Prof. Dobberstine is experienced with the complex regulatory framework affecting projects that potentially impact natural habitats. He has experience working with ecologic models as they relate to adaptive management and resource use planning. He is currently engaged in grant-funded ecosystem studies examining the effect of restoration technique on aquatic ecosystem function. The results will be used to help develop adaptive management techniques for ongoing ecosystem restoration. He has experience assessing aquatic habitats using the Sediment Triad/MLE method (toxicology, chemistry, biologic community) and has a background with a wide range of aquatic and riparian habitats and biologic communities. Prof. Dobberstine also has extensive experience with habitat conservation and restoration, including project development, implementation, monitoring, and adaptive management.

Prof. Dobberstine is frequently called on to serve as an advisor on projects and panels. He currently serves on the Advisory Council to the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University and formerly served as a curriculum review advisor to the Environmental Management Program at the University of Houston-Clear Lake. He serves on the Memorial Park Demonstration Project Vegetation Advisory Workgroup, a project led by the Harris County Flood Control District to stabi-

lize the shoreline of Houston's Buffalo Bayou while enhancing riparian habitat. He serves on the Monitoring and Research Subcommittee of the Galveston Bay Council (Galveston Bay Estuary Program), on the Boards of Directors of the Texas Association of Environmental Professionals (President 2010–present) and the South Central Regional Chapter of Society for Environmental Toxicology and Chemistry (as President 2013–2015), and as a former Trustee and current Advisory Board Member of the Galveston Bay Foundation.

Prof. Dobberstine has served on several independent panels and IEPRs for USACE projects in the areas of biologic resources and environmental law compliance. IEPR experience includes infrastructure projects (dam safety and flood risk reduction), ecologic modeling, and water management.

Dr. Christopher Brown, PE
Role: Civil Engineering

Dr. Brown is an Associate Professor at the University of North Florida (UNF) teaching civil engineering, fluid mechanics, hydraulics, senior design, and engineering geology. He earned his Ph.D. in civil engineering in 2005 from the University of Florida, his Master's Degree from Villanova University in 1997, and his B.S. degree in civil engineering from Temple University in 1991. He has over 25 years of experience working on public works projects for the City of Philadelphia, Waste Management, USACE, and for Golder Associates Inc. as a private consultant for various complex civil engineering projects. While working for the USACE, he worked within the Planning, Engineering, and Construction Divisions during his tenure. He was consistently recognized for his excellent technical skills including award of "engineer of the year" twice over 16 years with USACE. He has also recently been recognized for excellence in teaching and mentoring with award of several teaching accolades at UNF and the national Bliss Medal from the SAME.

Dr. Brown is a registered Professional Engineer to both Pennsylvania and Florida. During his career, Dr. Brown has worked on flood-risk management structures including dams, levees, retaining walls, gates, closure structures, etc., looking at both geotechnical and general civil engineering aspects. Specific project examples include the Prompton Dam spillway modification project, Molly Ann's Brook flood mitigation project, Portugués Dam design, Everglades Agricultural Area (EAA) Reservoir project, C-111 levees, and many others. Dr. Brown has extensive experience on public works projects for the City of Philadelphia, City of Savannah, City of Jacksonville, EPA, USACE, State of Florida, and Commonwealth of Puerto Rico. Dr. Brown has also designed projects that were designed per requirements outlined in Engineering Manual (EM) 1110-2-1913.[1] As an expert peer reviewer, Dr. Brown has been involved with review projects in eight USACE districts over a period of 8 years.

Dr. Brown has worked on the geotechnical side of water resources and the hydrologic modeling side of design and modeling projects. Dr. Brown has completed both stability studies using Slope/W and UTEXAS and seepage studies using SEEP/W, Seep2D, and MODFLOW. Dr. Brown has used reliability and stochastic analysis studies on all types of water resources projects dating back to version 1.0 of "@Risk" software. Dr. Brown served on the first USACE ad-hoc committee on levee assessment, which included the initial development of the current USACE fragility curve/risk management design approach.

Dr. Brown has extensive knowledge of USACE cost estimating systems with direct experience using MCACES and working knowledge of M2. Dr. Brown has also developed his own risk-based cost estimates

---

1 EM 1110-2-1913, "*Engineering and Design, Design and Construction of Levees*", USACE, 2000-04-30

using both @Risk and Crystal Ball. He is experienced in developing estimated construction costs and is knowledgeable regarding construction methods related to large civil works projects including levee design, floodwall design, box culverts, bridge pier modifications, utility relocations, and drainage structure design. Dr. Brown has acted as cost-estimating IEPR reviewer on some of the largest civil works projects in USACE including the most expensive lock and dam replacement in USACE history.

Dr. Brown is familiar with, and has participated in, the design of floodwalls and gated structures, as well as non-structural flood mitigation solutions (e.g., buy-out or minor flood proofing). Specific project examples of direct design experience include Molly Ann's Brook project (included t-walls, l-walls, underpinning of buildings, levee, bridge modification), Portugués Dam (included access road, foundation prep, arch dam, drainage gallery, rock bolts), and City of Savannah storm sewer upgrade (included new conduit, cut/fill construction, utility relocation and hardening, vibration monitoring). Dr. Brown was also a key designer for the F. E. Walter Dam access road replacement (on design team and field inspection) as well as the design of new bridges across Everglades National Park along the Tamiami Trail in Florida. Dr. Brown has also been involved in other large civil works projects including C&D Canal Deepening Project in Maryland and Delaware and the Delaware Main Channel Deepening Project in Pennsylvania and New Jersey.

Mr. Douglas Spaulding, PE
Role: Engineering Geology

Mr. Spaulding has over 48 years of experience in the design, evaluation and inspection of water retaining structures such as dams, levees, and flood walls. His experience includes 10 years with the Corps of Engineers where he served as Chief of the Levee & Channel Design Section for the USACE St. Paul District. He also has worked as an Independent Consultant conducting inspections, evaluation, and design of over 70 flood control and hydroelectric dams throughout the United States. His recent experience includes serving as a facilitator for the Federal Energy Regulatory Commission's (FERC) Potential Failure Mode Evaluation for over 70 dams located throughout the United States. Mr. Spaulding has an MS in Civil Engineering in geotechnical engineering and is currently a registered Professional Engineer in four states. He has served on several IEPR panels for projects located throughout the U.S. and has provided design services, project management, and peer review for over 18 local flood protection projects located throughout the United States. These projects have included earth levee systems, diversion channels, concrete channels, floodwalls, gate wells and pumping stations. The foundation conditions for these projects have ranged from soft lacustrine clay deposits to stratified granular deposits requiring seepage berms and relief well design. The majority of the projects were located in urban areas, which involved analyses of trade-offs between right away costs and structural costs. Mr. Spaulding's career includes evaluation of risks associated with the long-term performance and design associated with water retaining structures and conveyance facilities. This process requires evaluating appropriate analytical procedures, making appropriately conservative assumptions and obtaining sufficient geotechnical data to both describe the subsurface profiles and performance characteristics. Each project is unique and must be viewed and evaluated without preconceived concepts of risk or performance.

Mr. Willard Smith, PE
Role: Hydrology and Hydraulic Engineering

Mr. Smith is president of Hydropower International Services Inter-National Consultancy, LLC, a private consulting firm. He has extensive expertise in providing engineering services for hydroelectric generating

projects, and other hydrologic, hydraulic, and floodplain management projects. He is a graduate of the Missouri School of Mines with a BS in Civil Engineering specializing in hydrology and hydraulics.

Mr. Smith was president of the National Hydropower Association (NHA) from 1988–1989 and an active member of NHA's Board of Directors for over 5 years (1984–1989). He also served as Vice President, Creator and Chairman of both the FERC Committee and the International Committee and represented NHA as a technical specialist on Trade Missions throughout the world from 1989 to 1994. He is the recipient of the NHA 2008 *Dr. Kenneth Henwood Lifetime Achievement Award*. In October 2009, along with Dr./Ms. Linda Church Ciocci, he was recognized by the International Water Power & Dam Construction's list as one of the 60 most influential people who have helped shape the course of the global hydropower and dam business in the world over the past 60 years. Mr. Smith is also a Past Chair of the Oklahoma Floodplain Managers Association for 2007–2008 and remains active in the association coordinating a Disaster Response Team, Training Cadre, and is the current Vice Chair (2nd time).

Mr. Smith has conducted independent reviews of dams over the past 25 years as a FERC Independent Part 12D Inspection Consultant. He has experience with using the USACE Hydraulic Engineering Center (HEC) Hydrologic Modeling System (HEC-HMS) and River Analysis System (HEC-RAS) computer programs regularly in performing floodplain management and storm water design projects. He has designed non-federal hydropower projects such as USACE navigation locks and dams and prepared designs in accordance with USACE design standards. Mr. Smith has been designated as the Chief Dam Safety Engineer for FERC Licensed Hydropower Projects by two of his clients in accordance with the requirements of dam safety for FERC projects.

Mr. Charles Hutton, PE
Role: Structural Engineering

Mr. Hutton has an MS degree in Structural Engineering and professional engineering registration as a Civil Engineer. He has 48 years of experience in the design and management of water resource projects involving dams, hydraulic structures, hydropower, pumping plants, and water conveyance facilities in Asia, Africa, Latin America, Middle East and the United States. His expertise includes preparing feasibility studies, designs, drawings, and specifications for roller-compacted concrete (RCC), gravity and arch dams, hydropower plants, pumping plants, pipelines, canals, waterways, spillways and other hydraulic structures; performing dam safety inspections; conducting condition assessments of existing dams, hydropower facilities, and water conveyance systems; developing designs for rehabilitation; technical review; project management; and construction management. The first 15 years of his career was with the Bureau of Reclamation in Denver, CO, followed by 23 years with the international water resource firm AECOM, Inc. (formerly ECI Consultants).

Mr. Hutton completed training for the Sandia National Laboratories Risk Assessment Methodology for Dams (RAM-D) and performed vulnerability and risk assessments for concrete and earth dams and their appurtenant facilities. He also has completed training for the Federal Energy Regulatory Commission (FERC) Dam Safety Performance Monitoring Program and Potential Failure Mode Analysis methodology and has been involved in numerous projects that required application of this methodology. He also participated in Risk Analysis Training conducted by Prof. David Bowles, Managing Principal at RAC Engineers and Economists, for a USACE contract. He has served as a FERC qualified independent consultant for the safety inspection of over 25 dam and hydroelectric projects. He has been the IEPR Dam Safety Assurance

Program Structural Engineer panel member for four previous Corps of Engineers projects including: Bluestone Dam in West Virginia, Dover Dam in Ohio, Rough River Dam in Kentucky, and Addicks and Barker Dams in Texas. Mr. Hutton is currently a Structural Engineer for the Morris Sheppard Dam Concrete Assessment and Service Life Extension project for the Brazos River Authority in Texas that will involve a comprehensive Probable Failure Mode Analysis and Risk Assessment.

4.3 IEPR Process Management Team

The IEPR process management team consisted of the following members.

Mr. Douglas Wheeler, PMP, CCP, RMP, Program Manager (LMI)

Mr. Wheeler is an industrial and mechanical engineer with more than 20 years of experience in strategic process engineering and financial analysis including work for USACE, Department of Energy (DOE), and General Services Administration (GSA). For USACE, he led a consultant and client team in a business process reengineering effort for the Navigation Locks and Dams High-Performing Organization. He also led project teams in a variety of tasks to provide reengineering services to the USACE information technology (IT) function. Because of his work leading the review of the USACE McClellan-Kerr Arkansas River Navigation System (MKARNS) maintenance activity and his support for the USACE Inland Marine Transportation System (IMTS), Mr. Wheeler understands USACE's water navigation business area and supporting projects. He has also focused on real property and lease-related projects for GSA as well as economic assessments of infrastructure projects for DOE. Mr. Wheeler will apply LMI's COI process by reviewing each task order (TO) PWS with LMI's management team. LMI's process ensures that each LMI business unit manager is aware of TO scope and can raise organizational COI issues before LMI responds. He currently is focused on LMI's project cost engineering practice, privatization, and competitive sourcing services. Mr. Wheeler holds an MBA and a BS in mechanical engineering from Columbia University and an MSE in industrial engineering from Arizona State University.

Mr. Ahmad Faramarzi, PE, PMP, Project Manager (APMI)

Mr. Faramarzi supervised project personnel and communicated policies, procedures, and goals to the IEPR Team. In coordination with Mr. Wheeler, Mr. Faramarzi maintained regular contact with USACE and was responsible for the overall project plan, project performance, and client satisfaction on this as well as future tasks for USACE. He will also have multiple technical and administrative staff as direct reports. Mr. Faramarzi is a registered Professional Engineer and a Certified Project Management Professional with 35 years of experience providing managerial and technical expertise to government clients, including the USACE, Office of the Secretary of Defense, the U.S. Army, the U.S. Air Force, and Defense Nuclear Facilities Safety Board. He has organized and managed several important and highly visible expert panels in response to recommendations by the National Academy of Sciences (NAS). Mr. Faramarzi has a Post-Masters applied scientist/engineer degree from the George Washington University in Aerospace and Mechanical Engineering (fluid mechanics), an MS in Thermofluid Engineering, and a BS in Nuclear Engineering. He is on the Board of Directors of the Washington, DC Section of the American Society of Mechanical Engineers and an active member of the Fluid Dynamics branch.

Mr. Tom Cain, Task Lead (APMI)

Mr. Cain is a Principal Chemical/Process Engineer with over 30 years of experience providing managerial and technical expertise to government clients, including the USACE, Office of the Secretary of Defense, the U.S. Army, the U.S. Air Force, the Department of Justice, and other government agencies. He has organized and managed and/or participated in several important and highly visible expert panels and conducted numerous studies in response to recommendations by the NAS. Mr. Cain has experience with environmental regulations, including the NEPA process, and with analyzing the environmental impacts of a wide variety of types of federal projects, particularly the technical aspects. Mr. Cain has routinely applied his engineering, scientific, and analytical skills to unclassified, sensitive, and classified government programs. Areas of expertise are primarily related to the Chemical, Biological, Radiological, Nuclear, and high-yield Explosive (CBRNE) field with particular subject matter expertise in chemical and explosives areas. Roles range from team contributor to technical lead to task/project/program manager while working across multiple disciplines and organizations to solve challenges, collaborate in research, and share expert knowledge.

Dr. Wade Smith, Analyst (APMI)

Dr. Smith is an ecologist and environmental scientist who received his Ph.D. in environmental engineering sciences from the University of Florida. He has over 30 years of experience with environmental regulations, including the NEPA process, and with analyzing the environmental impacts of a wide variety of types of federal projects. Examples include dredging and dredged material disposal, offshore oil and gas exploration and production, domestic and industrial wastewater disposal, operation of electric power generating stations, construction and operation of coastal recreational developments, pipeline construction and operation, realignment and re-stationing of military forces, closing of military installations, operation of chemical munitions destruction facilities, and dismantling of chemical warfare agent production facilities. Dr. Smith is experienced in working on scientific and engineering issues involving complex and controversial projects. He has participated in all aspects of the NEPA process. He has prepared programmatic and site-specific Environmental Impact Statements (EISs), Environmental Assessments (EAs), and subject-specific environmental analyses. Dr. Smith has been responsible for all elements of analysis of the physical, biological, and socioeconomic environments. He has participated in all NEPA phases/scoping, draft EIS, public hearings, response to public comments, final EIS, and record of decision. Dr. Smith has also prepared NEPA and environmental analysis guidance documents to be used by federal environmental managers and planners.

5 Independent External Peer Review Findings

The Panel has conducted an in-depth review of the proposed Bluestone DSMR with regards to economic, engineering, and environmental methods, models, and analyses considerations. The Panel notes that all engineering and planning studies were conducted with a high degree of professionalism and outstanding quality. The Panel believes that the Draft DSMR thoroughly identifies and considers a complete array of possible measures, including both structural and nonstructural, in the development of alternatives. The formulation process fulfilled the requirement to avoid, minimize, and mitigate adverse impacts to resources while meeting the formulation requirements of the USACE definitions of being effective, efficient, complete, and acceptable. In accordance with USACE Engineering Regulation (ER) 1110-2-1156,[1] the five required alternatives, with seven RMPs, have been identified and adequately discussed and considered, including identification of an alternative, "Achieving only tolerable risk limit for life-safety."

However, some deficiencies and inconsistencies were also noted by the Panel. Many of these can be evaluated in further detail during the Planning, Engineering, and Design (PED) phase of the project. Some issues should be reevaluated as part of revising the Draft DSMR and be resolved to the extent practical before proceeding further.

There were a total of 33 comments. Of these, 2 were identified as having High significance, 6 as Medium/High significance, 18 as Medium significance, 3 as Medium/Low significance, and 4 as Low significance. The following paragraphs provide a summary of the Panel's comments in specific subject matter areas.

Civil Engineering

Overall, in regards to the Civil Engineering completed for the Draft DSMR, the Panel agrees that the work is complete and of high quality. Drawings contain all required plan sheets and details. USACE has done a thorough evaluation of the anticipated construction challenges and has configured the project to allow new work to be completed in two phases splitting the new concrete apron into two halves. The extent of proposed contractor work limits appears reasonable, and USACE has tried to arrange the work site to minimize truck traffic impacts to nearby communities, which addresses an important public comment. However, the Panel has also noted some important issues requiring immediate resolution and several that should be evaluated further in PED.

The Panel has identified multiple inconsistencies amongst the engineering appendices, the drawing sets, and the main report. These issues are generally minor in nature but several relate to inconsistencies between recommended TSP component crest elevations and estimated design water surface levels. The most important of these identified by the Panel are differences between the proposed divider wall crest elevation and the elevation of the adjacent cofferdam. The Panel assumed these would be the same as the divider wall, once constructed, and would fulfill the cofferdam function for the remaining "half" of construction in the discharge basin. The crest elevation differences need to be resolved immediately and will require revisions to engineering calculations, drawings, main report, appendices, and the final cost estimate.

---

1 ER 1110-2-1156, "*Engineering and Design, Safety of Dams – Policy and Procedures*", USACE, 2014-03-31

The Panel also identified issues related to evacuation mobilization rates. The Panel had two separate comments regarding these assumptions and calculations. First, including more specific and detailed risk communication plans must be a USACE focus during the PED. USACE, working with local, state, and Federal stakeholders, has a great opportunity to contribute to risk reduction for both "breach and non-breach" scenarios by taking full advantage of nonstructural measures including both passive and active risk-communication. Second, the USACE should undertake further integration between evacuation scenarios and hydrologic design storms. Better integration of the design storm(s) timelines coupled with knowledge regarding first chance of sudden dam failure should potentially allow USACE to legitimately revise the 8-hour and 24-hour (and longer) evacuation mobilization rates. These efforts could be undertaken during the PED, including further participation of the expert elicitation team used previously for these estimates. The Panel believes that a reduction in loss-of-life estimates may be a feasible outcome from these new evaluation efforts.

The Panel was concerned that the probable maximum precipitation (PMP) and resulting probable maximum flood (PMF) scenarios were limited during development of the Draft DSMR. The Panel identified shortcomings in the evaluation of both coincident flooding downstream of Bluestone Dam as well as the selection of the storm scenario itself. The Panel believes that USACE should consider possible scenarios involving multiple "tracking" storms rather than one single storm event. Both coincident flooding and impact of multiple storms can affect estimates of loss-of-life, economic damages, and dam operation.

Finally, the Panel encourages USACE to program further cost-optimization efforts as part of PED. The Panel agrees that while RMP #6 may be complete and very safe, it may be more costly than required. Also, given USACE's dam safety funding limitations, large, mega-projects like Bluestone need to compete for limited funds, further delaying project implementation and increasing overall cost. As such, the Panel feels it is important to make all reasonable efforts to optimize the final design of RMP #6 further in order to maximize its benefits while minimizing cost.

Structural Engineering

The Draft DSMR satisfactorily documents the formulation activities associated with addressing Potential Failure Mode (PFM) 33 spillway monolith instability. This is the only failure mode that was considered actionable as a result of the risk assessment update in 2016. The report adequately documents the development, evaluation, and comparison of risk management plan (RMP) alternatives to reduce the risk associated with PFM 33. Four primary structural RMPs were considered: a downstream conventional stilling basin, transitional flip stilling basin, a stilling basin with supercavitating baffles, and a concrete overlay in the existing stilling basin. Evaluation of the alternatives resulted in selection of RMP #6, which consists of the stilling basin with the supercavitating baffles as the most cost-effective solution. This alternative also includes additional anchors and drains in the spillway monoliths, modifying the existing first stage basin to prevent rock scour, installing drains and anchors in the first stage basin, stabilizing the existing stilling weir, reinforcing the second-stage basin to minimize scour and address scour concerns with overtopping the training walls. These remedial measures were reviewed and evaluated from a structural engineering perspective to determine their adequacy to address the spillway monolith instability issue.

The Panel concurs that the measures included in RMP #6 should provide robust, redundant, and resilient solutions to effectively reduce the potential for spillway monolith instability during high discharges, but at a very high cost. The Panel, however, believes that the structural analysis and reinforcement design of the supercavitating baffle blocks should be refined using a more sophisticated methodology, such as

plane-stress finite element analysis, to produce a more economical reinforcement design. The Panel also recommends that RCC be considered for construction of the lower portion of the apron extension slabs to reduce the cost of materials and construction time. The documentation of the design of the underdrain system proposed for the first-stage stilling basin should be expanded to further justify the spacing of the drains, the hydraulics of the pumping system, and the ease of cleaning the long lateral drains. The Panel also recommends that the stability of the spillway monoliths and stilling basin structures be checked assuming zero drain efficiency for all drains for the usual loading condition to ensure that the structures are stable if the drains become plugged over time. Measured drain efficiencies can possibly be used for the unusual and extreme loading conditions depending on how quickly the drains are judged to react to sudden changes in the reservoir pool level.

Hydrology and Hydraulic Engineering

The USACE has performed a substantial amount of work relating to the update of the hydrology modeling. There are data that have been developed and are presented in the Appendices that are not conclusively presented clearly in the narrative report. Examples are the discussion about using the temporal and spatial distribution precipitation patterns from 1982, which results in the 1982 PMP being maintained as the design analysis for the selected project, and the discussion concerning coincident flooding and "tracking" storms that are believed to be highly likely in this area, which is affected by both tropical storm events and frontal systems. The new USACE criteria[1] will now require the USACE to address the future effects of climate change for this project, which should take place during the Planning, Engineering, and Design (PED) phase of the project. There are still unanswered questions, especially with the new guidance on climate change, which leads to the concern that not all forecasted conditions have been thoroughly evaluated.

The hydrology and hydraulics associated with the RMP is adequate to assess the existing risk assessments and some conditions for the future. There are areas where additional explanation or clarifications have been noted in the comments. With regard to the charge question as to whether the care and diversion scheme associated with implementation of the RMP is feasible, the diversion scheme as modeled shows very little change between the base condition flows and the diversion scheme flows (left and right cofferdam) beyond the immediate zone of influence of the construction cofferdam (approximately 1,500-feet downstream of the dam). The areas downstream that are currently affected, including the public recreation area, are not shown to be inundated with any greater degree of flow or velocity.

The recommendation presented in the Stantec Modeling Report[2] for developing an operating rule curve was not included in the documents reviewed by the Panel and should be developed during the PED phase with concurrence of hydraulic modeling to avoid the potential for creating eddy currents that could potentially undermine either the penstock basin or the spillway stilling basin over time. Initial eddy currents were identified in the recent physical modeling, thus the previous recommendation for an operating rule curve to avoid such damage.

---

1 Engineering and Construction Bulletin (ECB) 2016-25, "*Subject: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects*", USACE, 2016-09-16

2 Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics*", Attachment 6 – Final Report of Physical Model Observations (Stantec 2015), "*Final Report of Physical Model Observations*", Bluestone Dam Phase 5, RMP Modeling Evaluation, Stantec Consulting Services Inc., 2015-01-30 (PDF page 1043)

The use of supercavitating baffle blocks has not been clearly justified in the report. There may be a logical thought process in the design to date and thus the use of the supercavitating baffles is the correct decision, but there is no written documentation that supports using supercavitating baffles over other conventional baffle design (likely an enhanced design to withstand higher velocities).

Civil Works Planning/Economics

There are a few sections of the report that need further clarification, specifically with regard to population at risk, population per structure, and loss of life. The population under the Future Condition (Future Condition without Federal Action Condition, FWAC) is significantly lower (16%) than under the Baseline Condition (Baseline Condition Risk Assessment, BCRA) and to a lesser extent under the Existing Condition (Existing Condition Risk Assessment, ECRA) (5%), but no rationale is provided for the differences. Similarly, the population per structure numbers and, as a result expected loss of life numbers, from a dam breach, range from 33% to 56% less under the FWAC condition than under existing condition with no rationale provided for the differences. In addition, in the incremental loss of life associated with potential failures of the Bluestone Dam under existing conditions and FWAC are expected to be lower if the failure occurs at night, when people are asleep and harder to contact and evacuate, than if it occurs during the day, but it is not explained how this is the case.

Two other issues were identified that require clarification. There is no mention in the SDEIS of the effects of the project in the 17% of the watershed that lies within North Carolina. The Panel also was not able to find an updated website for the project that is supposed to be active. Addressing these concerns would meaningfully increase the technical quality of the Draft DSMR.

Biological Resources and Environmental Law Compliance

Overall, the Supplemental SDEIS and Draft DSMR make a reasonable effort to address the intent of the decision document and the purpose and need for the project. The SDEIS describes the current status of the biologic community to an informative level of detail and generally provides substantive information regarding impacts associated with the considered alternatives. However, there are several issues that need to be addressed. There does not appear to be sufficient data to support the presence/absence of threatened and endangered species within areas potentially impacted by the project nor the potential impacts associated with invasive species, undermining the evaluation of forecasted conditions (with and without proposed actions). Further, the analyses of the human environment and natural resources within the project area appear insufficient to support the estimation of impacts of the final array of alternatives, as data regarding low-income populations is deficient and appears to be partly inconsistent within the Draft DSMR. While the formulation process appears to follow the requirement to avoid, minimize, and then mitigate adverse impacts to resources, it is not clear that impacts are fully avoided and minimized, making it unclear whether mitigation is sufficient as proposed. Finally, the analyses may underestimate the significance of the length of construction time in both the consideration and the definition of impacts. Thus, the analysis does not appear to sufficiently consider that temporary, but long-term (chronic), impacts can result in permanent effects to biologic communities, environmental justice populations, and children.

Engineering Geology

The geotechnical and geologic evaluations presented in the Draft DSMR are generally thorough and well done. The Panel did identify a few important issues that require clarification or further consideration. Two issues deal with the Automated Data Acquisition System (ADAS) and the key below the proposed supercavitating baffles.

The ADAS is only planned to be used during construction and not for future operations. Major concerns addressed by this project relate to stability of the concrete structures under extreme flood events. The ADAS can provide necessary information, real time, to the District office. The use of an ADAS during both construction and operation periods would increase the overall integrity of the dam by decreasing the time required to identify harmful conditions and to provide technical support response to these conditions. In the worst case, the use of an ADAS could allow earlier implementation of an emergency action plan, in response to a possible dam failure. Therefore, the Panel suggests that USACE consider implementing ADAS during the dam operations period as well as during the construction phase.

Increasing the depth of the key below the proposed supercavitating baffles needs further evaluation and optimization. Doing so would increase overall stability of the section and also the global stability of the dam structures and result in the need for fewer anchors. USACE should conduct further studies to evaluate cost-risk tradeoffs between a deeper key section versus rock anchors. The Panel feels that it may be possible to further reduce the overall project cost and reduce the project implementation schedule.

5.1 Independent External Peer Review Panel Comments

This section contains the complete set of comments of the IEPR Panel. Each comment consists of four parts:

- Comment,
- Basis for comment,
- Significance of the concern, and
- Recommendation for resolution of the comment.

Comments were rated to indicate the general significance the comment has to the project implementability. The final comments below are grouped by the significance level from high to low using the following definitions:

- **High** – Comment describes a fundamental problem with the project that could affect the recommendation or justification of the project.
- **Medium High** – Comment affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is a fundamental problem with the project or not.
- **Medium** – Comment affects the completeness or overall understanding of the recommendation or justification of the project.
- **Medium Low** – Comment affects the technical quality and understanding of the project based on the presentation of information related to the recommendation or justification of the project. However, the Panel does not have sufficient information to determine the effect on project implementability.

- **Low** – Comment affects the technical quality and understanding of the project based on the presentation of information related to the recommendation or justification of the project, but there is limited concern regarding project implementability.

5.2 Significance: High

Panel Comment 1: High

It is not clear from the SDEIS or Draft DSMR whether there might be disproportional impacts to Environmental Justice populations and/or children as a result of the implementation of the project.

Basis for Comment

The Draft DSMR, Appendix K, SDEIS, Volume I, Section 5.14, states, "*However, impacts associated with the construction of the TSP would be experienced by both low-income and non-low-income individuals within these counties; therefore, no disproportionate impact would be borne by low-income populations.*" This statement fails to address a substantive concern regarding Environmental Justice (EJ) population impacts; EJ populations, specifically low-income populations, are often disproportionately impacted as a result of not having the resources to compensate for the impacts while they are occurring, or recover after they have ceased, in comparison to non-EJ populations exposed to the same impact. These issues can include lack of health care to respond to air quality impacts, lack of transportation options, and means to accommodate cost increases to avoid heavily trafficked/closed roadways, etc.

Further, the section states, "*…alternative would be expected to cause moderate, disproportionate impacts on children due to the construction activities under the No Action, particularly increased air and noise emissions from heavy construction equipment; however, these impacts would not be permanent and would cease when construction is complete.*" Temporary impacts can have permanent effects, including health effects from exposure to air pollutants (especially in children, who have lower thresholds for effects than adults). Impacts to children should be better considered in the SDEIS.

Additionally, the Draft DSMR, Section 3.2.2.6, states, "*Based on the 2009-2013 American Community Survey, approximately 39 percent of individuals within the City of Hinton live below poverty levels compared to 17.5 percent in the State of West Virginia and 18 percent in Summers County. The median household income within the City of Hinton is $24,488, which is substantially lower than the median household income of $41,043 for the entire state and $33,784 for Summers County.*" Based on this statement, it seems counterintuitive that the USACE could come to the conclusion that EJ populations would not be disproportionately affected by the project given the proximity of this community to the project site.

Impacts to EJ populations should be better considered and discussed in the SDEIS and Draft DSMR. The SDEIS, Section 3.4.2, indicates that the duration of construction is estimated to last 8–10 years. It should also be noted that the current DSA project, initiated in 2000, was anticipated at the time of the original EIS and Record of Decision (ROD) to last for 5 years (see Section 2.2.3), and yet is still ongoing and is currently not anticipated to be completed until 2026, an increase in duration exceeding 20 years. Significant impacts that persist or repeat over years or decades can result in permanent effects to EJ communities. Failure to fully consider and address EJ concerns can result in avoidable impacts to sensitive populations, and potentially result in both litigation and costly impacts to the project schedule. In the counties exceeding the stated 20% threshold, it seems advisable to take additional steps to avoid those impacts or provide mitigation. Further, the Panel believes that the county-level screen

may be too coarse for this project, and additional efforts at a finer resolution may yield more informative data on this subject. In the counties where the EJ population numbers fail to meet the noted threshold, it would be advisable (responsible) to look at the distribution of EJ populations within the counties wherever possible to identify whether project activities might disproportionately impact specific micro-populations that could be avoidable or should be mitigated. Data to this extent may be available through local colleges and universities, city planning or development boards, or, in some cases, available via online resources and/or searchable databases such as www.City-Data.com.

Finally, it would be helpful if the SDEIS included a note in each relevant subsection of Section 4 to indicate whether the objectives of the referenced Executive Orders are met by the TSP, and where within the document additional information might be located. For example, in Section 4.14.2.11 (p. 171) would benefit from either a short statement on whether/how the Executive Order was addressed for the project (TSP), and a reference to the appropriate section in the DEIS.

Significance: High

Failure to provide a complete analysis of potential project related impacts to EJ populations 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.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Provide a more robust analysis and discussion of potential impacts to Environmental Justice populations and children within the SDEIS and Draft DSMR as noted above.
2. Include a note in each relevant subsection of the SDEIS, Section 4, to indicate whether the objectives of the referenced Executive Orders are met by the TSP, and where within the document additional information might be located.

Literature Cited:

- Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations
- Executive Order 13045 – Protection of Children from Environmental Health Risks and Safety Risks
- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia, Volume I", USACE, Huntington District, 2016-09-01*
- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 2: High

It is not clear from the SDEIS whether invasive species proliferation and control has been adequately considered.

Basis for Comment

Areas disturbed by construction related activities can provide prime opportunities for invasive species to establish and proliferate. The SDEIS provides an acceptable overview of the invasive species known to occur within the vicinity of the project site. However, outside of some limited consideration of invasive mussels, it does not prominently address invasive species proliferation issues that might arise as a direct result of disturbance associated with the project alternatives, nor does it prominently specify controls on proliferation during construction or post-construction monitoring plans. These might include direct disturbance by construction related activities, to additional stress related to changes in hydrology as a result of dam operations during construction. Further, impacts to and/or displacement of native species can alter ecologic niche fulfillment within biologic communities, opening pathways for introduction and proliferation of invasive species.

Executive Order 13112 and subsequent USACE Invasive Species Policy sets comprehensive goals for invasive species management, but those do not appear to be fully reflected by the information provided in the SDEIS. It would be advisable to clearly address this issue prior to construction, rather than potentially introducing the need for more cost-intensive, difficult to implement controls after-the-fact. The Panel also suggests that invasive species management plans for the project clearly include criteria and education for contractors working on the project to avoid and control proliferation on invasive species, or introduction of such species from offsite.

Significance: High

Lack of a comprehensive invasive species management plan specific to the project 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.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Revise the SDEIS to clearly include additional information on invasive species management, monitoring, and control as noted above.

Literature Cited:

- Executive Order 13112, "Invasive Species", Federal Register: 1999-02-08 (Volume 64, Number 25)
- "*Memorandum: U.S. Army Corps of Engineers Invasive Species Policy*" with enclosures, USACE, 2009-06-02
- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia", Volumes I, Volume II (Appendices A through G), & Volume III (Appendices H through L)(as appropriate), USACE, Huntington District, 2016-09-01*

5.3 Significance: Medium/High

Panel Comment 3: Medium/High

The spacing of the drains in the stilling basin is relatively large compared to the spacing of the drains in the new spillway gallery and other similar stilling basin underdrain systems. The methodology used for the design of the drain spacing for the existing spillway apron and the apron extensions appears inconsistent within the documentation and there is no discussion on how the spacing was selected.

Basis for Comment

According to the Draft DSMR, Appendix E, the new gallery near the downstream toe of the spillway will contain a curtain of drains spaced on 10-foot intervals. A new underdrain system is proposed for the entire first-stage stilling basin. The existing spillway apron will have two rows of drains spaced 38-feet apart in the longitudinal direction and approximately 16-feet apart in the transverse direction. The drains in the new apron slabs will be spaced on approximately 30-foot centers with the four rows spaced approximately 25- to 35-feet apart. The Draft DSMR, Appendix B, "Structural", Sheet Identification (Drawing) S-001, "Overall Site Plan", shows the drains for the stilling basin apron slab as 30-feet apart in the longitudinal (upstream-downstream) direction and 15- to 30-feet apart in the transverse direction. There appears to be a discrepancy in the drain spacing indicated in Appendix E compared to the drain spacing shown on drawings S-001 and S-003, "Basin Typical Sections". In addition, there is no discussion in the reports on how the drain spacing for the gallery and stilling basin was determined. Furthermore, spacing of the drains in the stilling basin is relatively large compared to the spacing of the drains in the gallery and other similar stilling basin underdrain systems. The methodology used for the design of the drain spacing for the existing spillway apron and the apron extensions should be revisited/reevaluated, verified, and documented for the final design and reports.

Significance: Medium High

If the drain spacing is too large, the uplift reduction will be less than assumed in the stability analysis, and the anchor size and spacing will be affected.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Reevaluate and verify the spacing of the drains for the existing stilling basin apron and the apron extensions.
2. Document the methodology used for the drain spacing design in the final design report.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01
- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix E – Geology & Geotechnical Engineering, ATR Submittal*", USACE, Huntington District, 2016-09-01

Panel Comment 4: Medium/High

The structural analysis of the supercavitating baffle blocks incorrectly assumes that the spine of the baffle will act like a sloped column and ignores the rigid connection with the slab along the bottom side.

Basis for Comment

The structural analysis described in the Draft DSMR, Section 2a, indicates the spine of the baffle was assumed to act as a sloped column to resist the hydrodynamic and debris impact loads for design of the reinforcement. The reinforcement shown on the drawings for the spine of the baffles appears to be excessive, and may not adequately address potential tensile and shear stresses within the baffle and along the plane between the baffle and slab. Apparently, the amount of reinforcement was based on code minimums for columns based on gross area, which is incorrect since the baffle will not act like a column and should not analyzed as such. Assuming the spine acts as a column ignores the fact that the baffle is connected to the slab by reinforcement and forces on the baffle will be transferred into the slab. The baffles will likely be cast separately in a pocket after the slab is placed, similar to the construction of the baffles in the recently constructed penstock stilling basin. If the surface of the pocket is prepared properly before placement, the lift joint will develop significant bond and the baffle concrete will essentially become monolithic with the stilling basin slab. In addition, reinforcement will be placed across the joint between the baffle and slab to transfer the loads and stresses. Also, the design of the reinforcement for the baffle and anchors for the edge armor should follow the methodology used to develop the designs for the Folsom Dam auxiliary spillway published in the reference cited below.

Significance: Medium/High

Using the finite element method of analysis would more correctly model the deformation and stresses within the baffle block and between the baffle block and slab and result in a more appropriate and less costly design.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Analyze the baffle using a finite element model consisting of plane stress elements (or other appropriate elements) to more accurately model the behavior of the concrete.
2. Use the results from the finite element model to design the reinforcement for the baffle.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01
- "*Stainless Steel Armor Plate Design for Protecting Supercavitating Baffle Blocks against Debris Impacts in High-Velocity Stilling Basins*", C. M. Abela, August 2012

Panel Comment 5: Medium/High

System-wide flood effects resulting from coincident flooding during large, single-storm events or from the landing of multiple "tracking storms" have not been considered adequately in determining breach and non-breach flood impacts.

Basis for Comment

Coincident flooding:

Ostensibly, during an unusual rainfall event like a probable maximum precipitation (PMP) occurrence, large areas in West Virginia and the extended watershed into adjacent states would be subject to significant rainfall. A PMP event is likely to be tropical in origin such that rainfall covers a much larger area than just the watershed upstream of Bluestone Dam. Therefore, it is possible and probably likely that the Kanawha River watershed downstream of Bluestone Dam would also have to contend with significant rainfall intensity and potential flooding. An exceptionally large tropical system or a major frontal storm event could further involve watersheds upstream of both Summersville Lake and Sutton Lake. It is not clear if USACE has considered the implications of coincident flooding (from other runoff or discharge contributions) in areas downstream of Bluestone Lake, especially in the City of Charleston, WV. If such a scenario were to come to pass, coincident flooding could be severe resulting in economic damages and loss of life exceeding the current "breach" or "non-breach" estimates. Therefore, the incremental damages and life loss could be different than what is presented in the Draft DSMR. If incremental damages are projected to be lower, structural measures to reduce the

probability of failure could be scaled back. The opposite could also be true. The Panel understands that normally projects focus upon the effects from the project only, however, this project is unique in that the primary impacts from a dam failure don't start for at least 65 miles downstream from the dam encompassing a large additional downstream area for which runoff may also occur.

Multiple Tracking Storms:

On Page 23 it states, "While the previous study cautioned against relying too much on orographic effects on PMP storms, the analysis of multiple tropical systems in this present study demonstrates that such an isohyetal pattern is not only possible but may also be likely. This is especially the case for tropical systems that approach the basin from the south or east." Based on this quotation it is highly likely that multiple "tracking" storms are possible on the watershed, and that consideration should be given to this possibility. In the IEPR Midpoint Meeting, it was stated that to address the multiple storm events or "tracking" storms, moist antecedent conditions were assumed (e.g. the ground was saturated); however even with saturated ground conditions the effect of even minor "tracking" storms can result in significant stormwater runoff.

Appendix D, Hydrology and Hydraulics, embedded report, "Development of the Hydrologic Loading Curve for Bluestone Dam", Chapter 3, page 7 (PDF page 929), states "The current study limited the number of events to one per year." This assumption of a single storm event in one year is unreasonable given the history of tropical storms and/or hurricanes, and/or normal rainfall events from fronts passing from west to east across the state, primarily during the spring rainy season and hurricane season.

It is unclear in the Panel review whether an analysis of multiple tropical storm systems or "tracking" of storms could result in higher accumulated precipitation and thus higher inflow values to Bluestone Dam and whether this type of scenario could lead to more dramatic pool stages and ultimately increases in projected spillway outflow. With higher inflows the risk to the downstream population could be increased and the expected damages could be increased.

Significance: Medium/High

Resolution of the multiple issues discussed herewith determines if there is a fundamental problem with the project or not. Consideration of coincident flooding or impact of multiple tracking storms may alter the project justification and selected alternative.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. At a minimum, revise the main report and Appendix D, Hydrology and Hydraulics, to include a discussion of how (or if) coincident flooding has been evaluated. If policy considerations restrict inclusion of coincident flooding impacts in the consequences evaluation, some explanation of the practical implications for citizens should still be included in the report.
2. If USACE believes, like the Panel, that coincident system-wide effects should be considered, revise the report to discuss the additional modeling necessary during PED to address the issue.
3. Clarify what evaluations (if any) were completed regarding the multiple "tracking" storm scenario, other than consideration of antecedent conditions.

4. If USACE believes, like the Panel, that the multiple tracking storm scenario is important, revise the report to discuss the additional modeling necessary during PED to address the issue.

Literature Cited:

- "*Development of the Hydrologic Loading Curve for Bluestone Dam*", USACE, Oct 2015

Panel Comment 6: Medium/High

It is not clear whether there may be unidentified impacts to important biologic communities resulting from a lack of supporting data, studies, or other sufficiently substantive consideration.

Basis for Comment

The Draft DSMR, Appendix K, SDEIS, Section 5.2.1.1, states, "*Likewise, as the Federally-listed bats and WVDNR-tracked rare bat species within the project area are likely already avoiding the area in the immediate vicinity of the dam for roosting, and no hibernacula habitat (caves and mines) exists in the immediate area, significant impacts are not anticipated to bat species from the continued construction noise in the area.*" However, this does not appear to be well-supported in the documentation. For example, the U.S. Fish and Wildlife Service (USFWS) has noted elsewhere that all forested areas in West Virginia are considered potential summer habitat for the endangered Indiana bat (*Myotis sodalis*). Further, the National Park Service noted in 2007 that, "*Based on our results, the large areas of relatively contiguous mature forest within these parks provide summer foraging habitat for at least nine bat species, two of which are state and federally listed as vulnerable to extinction, highlighting the potential importance of these park units for bat conservation.*" The USFWS Final Planning Aid Letter (PAL) notes, "*Winter hibernacula and summer roosting and foraging habitat of the endangered Indiana bat occurs in Reconnaissance Areas 1 and 2*", and, "*Indiana bats forage in or along the edges of forested areas and sources of water*." The PAL also references the 2006 NFS study, noting these bats (among others) were detected in Reconnaissance areas 1 and 2. Further, the SDEIS does not appear to thoroughly address noise impacts to wildlife. Section 5.8.1 indicates that noise would not be an issue for people, but wildlife appears to be excluded from this discussion. Also, it is not clear whether the area potentially impacted near the site (including for noise and vibration) has been, or will be, further surveyed to determine if there is suitable habitat that might be used by federally-listed bat species (as is recommended by USFWS guidance for Indiana bats), whether there have been more recent direct bat surveys near the site, or identification of other data sources that could be informative on this subject to support the conclusions noted in this section. This may be a concern for other animal species as well.

The SDEIS, Section 5.2.1.2, notes that there are numerous native mussel populations within the river, but it is not clear whether native mussels might be affected (direct or indirect) by the project. Section 5.3.1.2 states, "*Approximately 62.5 acres of aquatic habitat could be impacted by the altered flow regime (USFWS 2014) … …The altered flow regime could lead to the loss of emergent water willow and could cause stress and/or mortality of benthic invertebrates, macrophytes and mussels, some of which could be state-listed rare species*." As the last survey in the tailwater area appears to have been con-

ducted in 2002, additional documentation or surveying may be warranted. The documents would benefit from a more robust discussion on this subject. Also, the SDEIS, Section 5.3.1.1, notes, "*No endangered species are expected within the tailwater area, so no direct impacts to these species are expected*.". Yet, the SDEIS and Draft DSMR are unclear whether endangered species surveys have been conducted within the study area (i.e., see Section 3.2.2.10.3 of the Draft DSMR). Additional effort in this regard may need to be expended prior to the initiation of work to ensure any taking would be avoided, as the USFWS has previously identified suitable habitats in the vicinity of the project. The Draft DSMR and the SDEIS would benefit from a more robust discussion supporting these statements and findings. Presumably, these are largely based on the Habitat Evaluation Procedures (HEP) analysis conducted by the USFWS, along with other information provided in the PAL. However, the HEP analysis is focused on specific indicator populations within the habitat, rather than the whole community (including endangered species). While HEP analyses can provide useful information toward mitigation values based on the indicator species chosen, they do not typically provide utility for assessing the presence/absence/abundance of threatened and endangered (T&E) species. Further, many of the studies referenced in the PAL are 8-years old or more. Given the importance of this habitat in association with the National Scenic River designation, and the emphasis on the value of the habitat and presence of T&E species within the surrounding area, the conclusions drawn in the SDEIS would be better supported if there were more extensive documentation and current supporting data in this regard.

Further, while the definition of "*significant, long-term but non-permanent impacts*" (i.e., as used within Section 5.3.1.2, pg 5-14) is also used by the USFWS within their supporting documentation (i.e., Draft Mitigation Plan), the definition might be somewhat misleading. The SDEIS, Section 3.4.2, indicates that the duration of construction is estimated to last 8-10 years. It should also be noted that the current DSA project initiated in 2000 was anticipated at the time of the original EIS and ROD to last for 5 years (see Section 2.2.3), and yet is still ongoing and is currently not anticipated to be completed until 2026, an increase in duration exceeding 20 years. Significant impacts that persist or repeat over years or decades can result in permanent (i.e., indefinite), non-recoverable alterations to biologic communities, including loss of keystone species, alterations to species distributions within the biologic community, and incursion by invasive species that are frequently opportunistic under disturbed conditions and can outcompete native species for habitat and resources, displacing those species indefinitely. These impacts can extend some distance from the project site as a result of changes in water quality or quantity, noise and light impacts, etc. An example of this could be the increase in high pool conditions above the dam as a result of modifications to dam operations that could both alter and displace species occupying and/or utilizing shoreline habitat that may not be able to tolerate the new "temporary" paradigm. Another example could include changes to hydrology to the downstream portion of the river. Upon returning to previous (i.e., preconstruction) conditions, reestablishment of the preconstruction biologic community is subject to a number of factors related to ecologic succession, species present in adjacent communities/habitats, and ambient conditions during reestablishment (which may take years or decades to achieve, depending on the habitat). Attaining preconstruction community metrics is rarely guaranteed, and made more difficult the longer the initial impact/disturbance persists. In this case, it may be further complicated by the prevalence of invasive aquatic species noted in the system. It may be advisable to revise discussions in the SDEIS to reflect these potential complications as it applies to these defined impact categories.

Even with the understanding that the USACE SMART Planning initiative incorporates less detailed information to reach decision points more efficiently than in the past, the data currently presented appears insufficient to support some of the conclusions noted. The SDEIS would benefit from a more

robust discussion regarding impacts to biologic communities and species therein, including better references to supporting data or studies. These may in turn present opportunities for additional safeguards for recovery in the affected systems post-construction.

Significance: Medium/High

Lack of supporting data and/or substantive consideration affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

As appropriate, revise the SDEIS to address the above noted concerns, or reference where information can be found within the document (or both), including:

1. Preconstruction surveys and/or documentation of current conditions for T&E species.
2. Impacts to sensitive wildlife populations (i.e., instream and adjacent forested habitats).
3. More robust discussion regarding impacts and potential complications for habitat restoration stemming from "*significant, long-term but non-permanent impacts*".

Literature Cited:

- "*Range-wide Indiana Bat Protection and Enhancement Plan Guidelines*", Office of Surface Mining Reclamation and Enforcement (OSM), the U.S. Fish and Wildlife Service (FWS), and a representative group of RAs on behalf of the Interstate Mining Compact Commission (IMCC), 2009
- "*Distribution of Federally Listed Threatened and Endangered Species and Proposed Species in West Virginia*", West Virginia Field Office of the U.S. Fish and Wildlife Service (FWS), August 6, 2012
- *"Survey of Bat Communities in the New River Gorge National River, Gauley River National Recreation Area, and Bluestone National Scenic River: Species Occurrence, Relative Abundance, Distribution, and Habitat Use (Technical Report NPS/NER/NRTR—2007/101)",* Steven B. Castleberry, et al., National Park Service, December 2007
- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia, Volume I", USACE, Huntington District, 2016-09-01*
- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 7: Medium/High

It is not clear whether mitigation for construction impacts is fully supportable based on the information provided in the Draft DSMR and SDEIS.

Basis for Comment

The Draft DSMR, Appendix K, SDEIS, Volume I, Section 5.3.1.1, notes, "*Unique and irreplaceable habitat would be filled and dewatered for eight to ten years, causing a significant long-term, but nonpermanent, reduction in riffle-run habitat in what is considered a highly productive aquatic zone. USACE will remove cofferdam material, restoring the aquatic environment to near baseline conditions allowing for reestablishment of fish habitat after construction completion, though full recovery of the local microhabitat and full species assemblages would occur over several years or even decades.*" (Nilsson et. al. 2014). It should also be noted that the current DSA project, initiated in 2000, was anticipated at the time of the original EIS and ROD to last for 5 years (see Section 2.2.3), and yet is still ongoing and is currently not anticipated to be completed until 2026, an increase in duration exceeding 20 years. Significant impacts that persist or repeat over years or decades can result in permanent (i.e., indefinite), non-recoverable alterations to biologic communities, including loss of keystone species, alterations to species distributions within the biologic community, and incursion by invasive species that are frequently opportunistic under disturbed conditions and can outcompete native species for habitat and resources, displacing those species indefinitely. Upon returning to previous conditions (i.e., preconstruction), reestablishment of the preconstruction biologic community is subject to a number of factors related to ecologic succession, species present in adjacent communities/habitats, and ambient conditions during reestablishment (which may take years or decades to achieve, depending on the habitat). Attaining preconstruction community metrics is rarely guaranteed, and made more difficult the longer the initial impact/disturbance persists. In this case, it may be further complicated by the prevalence of invasive aquatic species noted in the system. It is not clear from the SDEIS whether mitigation to offset timeframe to recovery in addition to any replacement of habitat units assessed within the HEP analysis has been included. It is also not clear whether mitigation for impacts (i.e., erosion, loss of access for aquatic species) associated with drying noted in Section 5.3.1.2 that might impact downstream habitats has been fully considered under the current mitigation analysis. It may be advisable to revise discussions in the SDEIS to reflect these issues as it applies to habitat restoration and mitigation.

The SDEIS, Section 5.4.1.3, is not clear on why the USACE is not proposing mitigation for wetland resources, especially given the emphasis on the importance of the Resource Category 1 habitat within the document, and the importance of wetlands as part of the habitat complex of the region overall. This needs some explanation to support the statement, or potentially consideration of mitigation for these impacts.

There needs to be additional information within the SDEIS regarding disposal and management of any dredge material removed during construction. The included memorandum (March 2016) denotes this need and identifies additional sites that were/are being considered, but this issue needs to be much better explained within the EIS moving forward. Issues include impacts to the placement site, mitigation, invasive species, transportation concerns (which might affect the overall impacts associated with the project substantively), etc. Previously disturbed sites, or commercial facilities, should be prioritized in the event that there are not beneficial uses available for the material. See also, Draft DSMR, Section 6.3.3 (pg 156) and Section 6.4.4 (pg 166).

Even with the understanding that the USACE SMART Planning initiative incorporates less detailed information to reach decision points more efficiently than in the past, the data and supporting information presented is insufficient to support some of the conclusions noted. The SDEIS would benefit from a more robust discussion regarding mitigation for impacts to biologic communities and species

therein, including better references to supporting data or studies. These may in turn present opportunities for additional safeguards for recovery in the affected systems post-construction.

Significance: Medium/High

Lack of supporting data and/or substantive consideration affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Provide more robust discussion within the SDEIS regarding impacts and potential complications for habitat restoration and mitigation stemming from "*significant, long-term but non-permanent impacts*", including discussion regarding mitigation for time to recovery for affected habitats.
2. Provide more robust discussion regarding mitigation for wetland resources.
3. Provide more robust discussion on disposal and management of dredge material as noted above.

Literature Cited:

- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia, Volume I", USACE, Huntington District, 2016-09-01*
- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 8: Medium/High

It is not clear from the SDEIS whether Cumulative Impacts have been adequately considered.

Basis for Comment

Cumulative impacts, as they are defined by NEPA and subsequent USACE guidance, can extend significant distances from a project site, depending on the nature of the project. In this case, impacts could include changes to water quality and quantity, noise, traffic, and other impacts that could extend some distance from the project site. Over the period of disturbance, these impacts can yield substantive changes to ecologic and human communities that, in some cases, could manifest as a permanent condition even after the impact has ceased concurrent with construction. Further, improvements to infrastructure frequently bring subsequent private and public investment and development to the affected (protected) area, which in this case extends downstream a significant distance. In the SDEIS,

Section 6.3, it appears that cumulative impacts have been considered only in Reconnaissance Area 1, but the SDEIS acknowledges potential effects in other Reconnaissance Areas elsewhere throughout the document.

For example, the SDEIS, Volume I, Section 2.5.3, notes, "*For the purposes of this SDEIS, most resource impacts would be limited to Reconnaissance Areas 1 and 2. These combined areas extend from the New River near Bluff City, VA to Gauley Bridge, WV.*" Further, Section 5 notes potential effects of dam failure under the no action alternative that extend some distance downstream, including Charleston. In another example, Section 5.15.2 notes numerous direct and indirect impacts that would likely occur as far downstream as Charleston, while Section 5.15.1 states, "*While major uncontrolled flooding would result from extreme flood events, modifications to the dam under the TSP would strengthen the dam so that the possibility of failure or breach and associated flooding would be greatly reduced*" and "*The future population and development upstream and downstream of the dam was assessed to determine the population at risk, which is estimated at 165,000. While development and population is expected to increase slightly upstream of the dam, the difference is not appreciable over the near future. It was also determined that there would not be a significant change to population at risk due to future development and/or redevelopment of areas downstream of the dam in the Kanawha Valley including Kanawha, Putnam, and Mason counties.*" Conversely, Section 5.13.2.2 notes, "*Additionally, previously completed and remaining DSA modifications may still stimulate development in the vicinity"*, suggesting that improvements to the dam may influence secondary development. Presumably, this would be the case in any area influenced or substantively protected by the presence and operation of the dam.

Thus, it is not clear from the SDEIS or the Draft DSMR why the cumulative impact analysis is limited to Reconnaissance Area 1, nor whether this is sufficient. Further, from the information included in Section 5, it appears some effort has already been expended investigating cumulative impacts outside of Reconnaissance Area 1. This is particularly the case in light of the numerous references to impacts and effects to communities outside of Reconnaissance Area 1, which implies the effect of the dam extends far beyond Reconnaissance Area 1 and thus could influence cumulative impacts beyond this region as well. Section 6, Cumulative Impacts, should expand on this effort, including information on population projections, development expectations, etc. For example, while population trends suggest slight population declines across the state, the Kanawha County Comprehensive Development plan projects a 27% increase in employment by 2040, which could suggest investments in additional infrastructure and secondary growth in some parts of the county that could be further influenced by flood protection operations of the dam.

While it is clear that the USACE is following their SMART Planning initiative, and that not all of the direct, indirect, and cumulative impacts have been determined, the SDEIS would benefit from a more substantive discussion regarding cumulative impacts throughout the entire affected region. As secondary and cumulative impacts in this system could have the potential to affect Endangered Species Act (ESA)-listed species, low-income populations, cultural resources, and economic interests, a robust analysis of these issues becomes critical to fully evaluating the proposed project alternatives, and could affect the alternatives analysis and selection of the TSP.

Significance: Medium/High

Lack of documentation and substantive discussion regarding cumulative impacts affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Provide more robust discussion regarding cumulative impacts within the SDEIS, including a more comprehensive inclusion of areas potentially impacted and/or influenced by the operation of the dam.

Literature Cited:

- *"Kanawha County Comprehensive Development Plan",* Kanawha Planning and Development Office, Charleston, WV, 2014
- *"Population Trends in West Virginia through 2030",* Christiadi, et al., Bureau of Business and Economic Research, West Virginia University, March 2014
- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia, Volume I", USACE, Huntington District, 2016-09-01*

5.4 Significance: Medium

Panel Comment 9: Medium

The reservoir operating scenario and rule curve, which may help reduce premature scour on the penstock basin, that is recommended to be prepared in the modeling report is not referenced in any document provided to the Panel to date.

Basis for Comment

DSMR, Appendix B, Chapter 3 (pg 7), states, "*Characterizing operations at Bluestone Dam is critical to achieving an estimate of the pool frequency curve for infrequent events. Many historical peak stages were the result of outflow from Bluestone being limited by downstream controls. Due to downstream constraints, the magnitude of inflow into Bluestone is not a perfect indicator of the resultant peak stage. A large inflow event may result in very little pool rise if releases from the dam are allowed to reach the maximum capacity because no flooding is occurring downstream; conversely, a small inflow may result in significant stage if the rest of the Kanawha/New basin is flooding.*" With the variety of scenarios that can occur with inflow values and downstream flooding, and the effect of the Ohio River on the downstream flooding, it is unclear in the documentation what final scenario of inflow, reservoir, and Ohio River condition was used for the tentatively selected plan design.

In the Stantec Model Report, Page 9, Item viii, recommends that an Operating Rule Curve be developed to reduce the potential for premature scour on the Penstock basin.

In reviewing some of the model data and photographs, it would appear that without a coordination effort, either the spillway releases could create an eddy that would impose scouring potential on the penstock basin, or penstock releases could create an eddy that would impose scouring potential on the spillway basin area. Neither of these are beneficial. In the review of all of the documents received from the USACE, there was no reference to any Operating Rule Curve in any document. The recommendation in the Stantec Report may have been overlooked, development of the Operating Rule Curve is still in progress, or the documentation has not been distributed for review.

The development of eddy currents from high releases of water through a spillway or a penstock can have significant damage potential to adjacent hydraulic structures, whether it is a concrete structure or an earthen embankment. The operation of the spillway gates, or operation of the penstock openings, or a combination of these features to release significant volumes of water under significant velocities needs to be controlled. There was no discussion of how this is to be accomplished.

Significance: Medium

It is important that the various options that were considered to determine the inflows into the reservoir combined with the downstream constraints be clearly understood, and documented, so that the reservoir operation and rule curve is developed in a concise manner for the USACE and general population that is impacted by the future operation of the dam.

The potential for scouring on adjacent structures could be a significant issue that results in either undermining of an adjacent structure resulting in a structural failure, or results in a major remediation project after operation commences. Resolution of eddy currents during the final design phase is imperative.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Clarify the conditions that were used for the selected design as discussed above.
2. Prepare an Operating Rule Curve for the Gated Spillway and the Penstock areas of the dam.
3. The final design of the project should have a defined plan for resolution of eddy currents on the spillway section and the penstock section.
4. If additional modeling is needed to resolve the potential for scouring beneath adjacent structures, it should be performed during the final design phase and prior to construction.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics"*, Attachment 6 – Final Report of Physical Model Observations (Stantec 2015), "*Final Report of Physical Model Observations*", Bluestone Dam Phase 5, RMP Modeling Evaluation, Stantec Consulting Services Inc., 2015-01-30 (PDF page 1043)

Panel Comment 10: Medium

The evacuation mobilization rates used in the risk analysis do not seem well integrated with the hydrologic model results.

Basis for Comment

The estimates for persons at risk and potential loss of life in downstream urban areas like Charleston, WV, are somewhat dependent upon the assumed evacuation mobilization curve for existing conditions and future conditions. The current study developed these curves from expert opinion elicitation (EOE) and those stakeholders asked about expected mobilization after 8 hours and 24 hours. The mobilization curve presented as Figure 3-16 in the main report plots "time after receiving warning" on the horizontal axis. In the modeling appendix, simulations show that the flood wave after dam-break would arrive downstream to Charleston in about 7 hours or close to the 8-hour mobilization time used in the analysis. However, it seems that the residents might have considerably more time than that to get a warning based upon the hydrologic modeling if warnings went out before probable failure. In PMF-like events, the discharge from the dam would be massive and certainly unusual. The maximum discharge of record is about 62,000 cfs, versus a PMF peak outflow discharge of ~1,300,000 cfs. According to Figure 3-9, and similar figures in the hydraulics appendix, the peak outflow occurs at about 54 hours. Also, it appears that the worst-case simulation assumes the reservoir was at an elevation of 1,520 feet (NGVD 29), which would be at full flood control pool. Surely, during a PMP rainfall event, it would also take a lot of time for the pool to reach 1,520 feet. According to the last Design Documentation Report (DDR), Section 5.0, the earliest failure would occur is at elevation of 1,514.1-feet (NGVD 29). Therefore, overall, it appears that there would be considerable time, when the reservoir is filling (even before any possible failure) during this extreme event, when "first level" evacuation warnings could be issued. If so, it would seem that much more than 8-hours warning could be provided if the proposed new water control plan contemplates such a consideration. It would be very useful if the total timeline to fill the reservoir, overtop the dam, dam-break, start of dam-break flood wave routing, etc. could be illustrated and discussed by USACE. Then, USACE could evaluate if current mobilization rates used are consistent with the expected timeline for a PMF level event.

Significance: Medium

Resolution of this issue will improve the overall understanding of the recommendation and justification of the project.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Include a more thorough discussion in the main report regarding the total timeline (in hours) expected for flood control pool filling followed by possible dam failure followed by dam-break flood wave routing. An illustration or figure would be essential to explain the timeline.
2. Compare the assumptions used for the EOE regarding mobilization times/rates and determine if the expert Panel assumptions were consistent with the expected full timeline in a PMF-like

event [e.g., are 8-hour and 24-hour mobilization percentages presented (in unnamed tables on page 72 of the main Draft DSMR report) logical when looking at the whole picture]. If significant differences in EOE understanding/assumptions are identified, discuss work to be completed during PED to revise mobilization tables and revise the risk analysis.

Literature Cited:

- "*Bluestone Dam Safety Assurance (DSA), Phase 4, Design Documentation Report (DDR)*", USACE, Huntington District, May 2012

Panel Comment 11: Medium

The nonstructural component of the selected plan RMP #6, risk communication, should be revised and expanded to include comprehensive flood warning communications from USACE to the public at risk.

Basis for Comment

The current detail regarding the risk communication plan is very limited and not specific. The Dam Safety Modification Report text includes mention of use of "social media, traditional advertisement, public meetings…. etc.". This is more of a laundry list and not a risk communication plan. Also, "active" risk communication measures do not appear to be included. Some examples of active risk communication measures might include direct USACE operation of an emergency transmitter or USACE-common carrier emergency communication agreements.

The report indicates that mobilization time/rate to evacuate residents to safety is a sensitive parameter and somewhat uncertain. Presumably, the higher this value, the lower the estimated potential loss of life. Reducing this uncertainty, and perhaps legitimately moving the mobilization rate higher, would have significant cost benefits, as well since risk reduction measures at the dam itself, may be further reduced in the "breach case". In addition, a robust passive and active risk communication approach may also lower non-breach risks. The current cost estimate range is $300 to $500 million for RMP #6 (and this is probably a low estimate based upon past history of other "mega" projects). The return on investment of including comprehensive risk communication measures could be very large indeed including <u>immediate</u> risk-reduction benefits as compared to structural risk reduction at the dam (e.g., at least 10- to 15-year wait to accrue full benefits).

Significance: Medium

Resolution of this issue will improve the overall understanding of the recommendation and justification of the project. Resolution of the issue may also reduce overall project cost.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Develop a detailed final risk communication plan as part of PED—including all passive measures and appropriate active measures—to inform and warn the public of danger. Ensure that the plan is well explained and discussed.
2. Consider development of a real-time flood warning model during PED to establish warning communication thresholds defining when there should be broadcasts to stakeholder agencies and directly to residents. Determine if the existing HEC-RAS dam break model can be modified and used for such a purpose. Integrate the flood warning model with the proposed new Water Control Plan.
3. Undertake further coordination with state, city and county emergency managers in order to improve the new risk communication plan as well as bring important stakeholders together (e.g. FEMA, USACE, State, City, County, private companies) to identify concrete actions and long-term, sustainable funding sources.
4. With the new, more-detailed risk communication plan in place, reconvene the expert elicitation Panel regarding evacuation and mobilization rates to investigate the benefit of proposed risk communication measures in regards to adopting higher mobilization rates in the final PED risk calculations, potentially lessening the need for structural measure risk reduction at the dam.

Literature Cited:

- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 12: Medium

It is unclear as to what analyses were performed to determine the final precipitation distribution pattern used in the modeling for the TSP alternative. If the 1982 PMP temporal and spatial distributions were determined to be the best analysis, then it was not clearly stated in the report.

Basis for Comment

The Draft DSMR, Appendix D, "*Hydrology and Hydraulics*" (pg 6) states, "*The final temporal and spatial distributions of the 1982 PMP results were maintained in the present study prior to incorporating the NOAA Atlas 14 data. This consistency enabled a more direct comparison between both studies and a better determination as to the effects of orographic data on the overall PMP pattern within the basin.*"

Later (pg 19), it concludes with, "*When the results from the current study are compared to the report from 1982, a slight reduction is seen for both maximum volume and peak discharge. This can be explained by the use of GIS gridding, in this case 1 km² grids, in order to calculate depth-area relationships for each subarea and basin average. An important point must be made to emphasize that the 1982*

study appears to have decreased the basin PMP when the spatial distribution of precipitation was incorporated into the results. The 1982 report mentions the use of precipitation frequency data from both inside and outside of the basin, which is likely the reason for this discrepancy. Therefore, the current results may inadvertently give the impression of higher runoff in the subareas from the previous report even though the precipitation amounts are slightly less than the PMP values. Hydrological Engineers should consider this when interpreting the results of subsequent hydrologic routing models." (Emphasis added on the last two sentences.)

It seems with all of the modeling that was performed, the first sentence should be rewritten to conclude that, based on all of the modeling, the 1982 PMP results remained as the appropriate temporal and spatial distributions for this project. If newer historical data (1982 to present) shows that there is a better temporal and spatial distribution pattern for the rainfall than the 1982 PMP that results in possible higher stormwater runoff flows, then that should have been used as the basis of analysis.

Significance: Medium

One of the basic requirements for a detailed hydrologic analysis are the spatial and temporal distributions that determine the amount of effective precipitation resulting in runoff that flows into the watershed, and thus into Bluestone Dam. The basis of the conditions has been evaluated in much detail in the report but the basis of conclusion is not clearly defined.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. If not already done, investigate if there is a more appropriate Temporal and Spatial Distribution on the watershed for the period 1982 to present. If the 1982 PMP temporal and spatial distributions are determined to be the best analysis then it should be clearly stated in the report.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics"*, USACE, Huntington District, 2016-09-01

Panel Comment 13: Medium

There is no description in the reporting documents of a plan to periodically review or update the hydrology for the Project area in the future to consider updated precipitation data that may be the increasing trend of climate change.

Basis for Comment

Since this area appears to have a minimal change in precipitation over the next 40 years, but more of any increase beyond the 40-year period, at some time in the future, the PMP that is being slightly downsized for this project may need to be re-evaluated and possibly increased in the future due to changing weather patterns. While it is understood that climate change is a policy issue that is not discussed in the IEPR, Appendix H does allude to future increase in precipitation; thus, increasing stormwater runoff, resulting in increased inflow to the dam, and creating potential impacts to the dam in the future. It was learned during the IEPR Midpoint Meeting that an updated directive was issued within the past few weeks (i.e., after the Draft DSMR was provided), ECB 2016-25, "*Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies*". The document and the updated required analyses associated with this document are understood to now be applicable to this Project. (Note: The Draft DSMR was published before the update to ECB 2016-25 was released.)

Significance: Medium

The consideration of climate change is important to all long-range Projects to assure that the current design changes will accommodate future precipitation patterns.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Both Planning and Hydrology and Hydraulics disciplines should periodically review any trends in increased precipitation and determine when the time is right to update the hydrologic and hydraulic analyses for the effects of climate change.

Literature Cited:

- "*Bluestone Dam, Dam Safety Assurance Mega-Project Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, Appendix H – Planning ATR Submittal*", USACE, Huntington Division, NID ID: WV08902, 2016-09-01
- Engineering and Construction Bulletin (ECB) 2016-25, "*Subject: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies*, Designs, and Projects", USACE, 2016-09-16

Panel Comment 14: Medium

The crest elevation for several components of RMP #6 appear to be lower than required compared to the expected water surface profile generated from a PMF event.

Basis for Comment

The final TSP for Bluestone Dam as recommended by USACE is RMP #6. RMP #6 has undergone several permutations during the design process. One major change was that training wall modifications to raise the walls to retain the PMF stage were scrapped after reviewing results of physical model testing with a group of experts. The original proposed maximum heights of the training walls varied from 1,445 feet National Geodetic Vertical Datum (NGVD) of 1929 (NGVD 29) to 1,450 feet (NGVD 29) (see Civil Sheet CS302 in the Appendix C). For the new RMP #6, the training walls will not be modified; instead, concrete rock erosion protection will be added east or west of the training walls since these are expected to be significantly overtopped in the PMF scenario. Outside the left training wall, the proposed concrete rock protection (7-feet thick) will only be extended to elevation 1,416 feet (NGVD 29) or considerably less than the original modified wall heights. Also, as shown on Sheet 03, the extents do not continue upstream to the dam. The concrete rock protection is ended in line with the supercavitating baffle block ("Super Baffle") heads. It is likely that this protection will need to be further extended upstream due to splashing and possible back-eddies. Outside of the right training wall, the proposed concrete rock protection appears to cover all exposed erodible surfaces; however, the top elevation of the penstock training wall is only topped at elevation 1,410 feet (NGVD 29). This wall may also get overtopped and the Panel is not clear if this would be detrimental to the penstock operation. The Panel understands that erosion would not be the issue for this case. Lastly, the proposed new divider wall top crest elevation is listed as 1,401 feet (NGVD 29) on Sheet 04, as compared to the temporary coffer dam height of 1,405 feet (NGVD 29). The Panel assumed that since the divider wall is proposed to be used in lieu of coffer dam for "Left Side" construction it would need to be constructed to the same height as the coffer dam.

Significance: Medium

Resolution of this issue will improve the overall understanding of the recommendation and justification of the project. Resolution may also result in cost increases to the project.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Review the proposed extent of concrete rock protection on the right outside of the right training wall. If USACE considers the proposed extent adequate, provide further justification in the main report and in Appendix C, "Civil Engineering". If USACE considers, like the Panel, that the extents should be expanded, modify the documents accordingly including estimated quantities in Appendix C.
2. Review the possible implications of overtopping the penstock training wall to determine if hydraulic function of the penstock section is reduced. Provide some text updates in the main report and Appendix D, "Hydrology and Hydraulics", to clarify the effects (if any) of the overtopping of the penstock training wall.
3. Raise the proposed height of the new divider wall to be consistent with the top of proposed temporary coffer dam. Revise text in the main report and Appendix C indicating the new heights. Revise quantities in Appendix C. Revise all necessary drawings accordingly.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix C – Civil Engineering, ATR Submittal*", USACE, Huntington Division, 2016-09-01
- Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics*", USACE, Huntington District, 2016-09-01

Panel Comment 15: Medium

The current design does not provide information regarding the discharge system required to ensure that water from the proposed drain system can be safely and continuously discharged under a range of upstream pool conditions.

Basis for Comment

The relief of uplift pressures beneath the stilling basin area is a critical element to ensure the stability of this structure. The Draft DSMR, Appendix B indicates that "Flow from each row of drains will be conducted via a 12-inch diameter lateral to the stilling basin divider wall gallery where it will be pumped away". There is no information provided regarding the pumping system or the redundancies that are required for the system in order to ensure satisfactory performance under a variety of reservoir pools. The pumping system will need to operate under heads that very from zero upwards to 80 ft, possibly higher, (Note: Discrepancies in elevations specified in the Draft DSMR allow only rough order of magnitude estimates. This issue is addressed in a separate comment.), and convey uplift flows that increase in volume with increasing head. In order to ensure satisfactory performance, system should include redundant pumping systems, redundant power supplies and emergency backup power. The operation of the pumps should be monitored by automatic data acquisition system which can be used to remotely identify performance issues under normal or high flow conditions.

Significance: Medium

Pumping of uplift discharge is a critical element in the successful operation of the project and the lack of a developed conceptual design for this system is considered to be a medium level.

Recommendation for Resolution

1. Develop a preliminary, conceptual design for the current Draft DSMR describing how water from the proposed drain system can be safely and continuously discharged under a range of upstream pool conditions.
2. Carry the discharge conceptual design developed for the current Draft DSMR forward in the detailed design stage. Include estimates of the drain flow under extreme flood events as a basis of hydraulic and pump design in development of a final design.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural, ATR Submittal*", USACE, Huntington District, 2016-09-01

Panel Comment 16: Medium

The hydraulics of the proposed pumping scheme for the spillway stilling basin underdrain system requires further evaluation and description.

Basis for Comment

The drawings indicate the 12-inch diameter drain lateral will be 3.5 to 5.0 feet below the invert of the spillway center divider wall. The Draft DSMR does not describe how the water in the drain lateral will flow by gravity upwards into the divider wall gallery so that it can be pumped back into the stilling basin or downstream of the existing weir. There would need to be a surcharge on the drains for the water to flow upward into the divider wall gallery. The difference between the reservoir water elevation and the tailwater level should be sufficient to force the water into the lateral drains and upward into the drainage gallery in the center divider wall. Alternatives to pumping would be to use an eductor system or extend the drain system downstream to drain by gravity.

Significance: Medium

The performance of the underdrain system is critical to the stability of the spillway stilling basin structures.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Better develop the design concept for the spillway stilling basin underdrain system during the next design phase.
2. Evaluate extending the underdrain system downstream so that it can drain by gravity or using an eductor system to remove the drain water.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01
- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix E – Geology & Geotechnical Engineering, ATR Submittal*", USACE, Huntington District, 2016-09-01

Panel Comment 17: Medium

Cleaning and maintenance of the lateral drains in the stilling basin slabs will be very difficult, if not impossible due their very long length.

Basis for Comment

The stilling basin underdrain system can only be considered effective and reliable if it can be cleaned, maintained, and monitored for performance. The stilling basin width is approximately 800 feet. With the new center divider wall, the width of each stilling basin segment is approximately 400 feet. The 12-inch diameter drain laterals will extend from the center divider wall to within a few feet of the opposite training wall. Cleaning the very long lateral drains will be difficult, if not nearly impossible. During the meeting of the Expert Hydraulic Structures Designers held on 12-13 January 2016, one of the discussion points was that the width of the stilling basin makes the ability to clean and maintain an underdrain system infeasible and therefore, possibly not beneficial. The Draft DSMR proposes an underdrain system for the stilling basin, but does not describe how the drain lateral will be cleaned and maintained.

The individual vertical drains can be cleaned by removing the stainless steel cover plate and the threaded cap. There is risk that the cover plates and threaded caps in the first-stage stilling basin could be damaged due to the very high velocities of up to about 98 feet per second allowing water to enter the underdrain system and create additional uplift beneath the slab.

Significance: Medium

Cleaning the lateral drains is critical to the continued, long-term performance of the spillway stilling basin underdrain system and to maintaining the uplift reduction assumptions used in the stability analyses.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Further evaluation of the cleaning and maintenance of the spillway stilling basin lateral drains should be completed during the next phase of the design.
2. Potential failure of the drain cover plates should be evaluated during the next phase of the design.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01
- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix E – Geology & Geotechnical Engineering, ATR Submittal*", USACE, Huntington District, 2016-09-01

Panel Comment 18: Medium

The stability load case with zero drain efficiency for all drains has not been considered to ensure the dam and stilling basin structures are stable for full uplift.

Basis for Comment

DSMR, Appendix E, indicates that 50% drain efficiency was assumed for the drainage system for development of RMP #6 in accordance with EM 1110-2-2200. Appendix B, Structural, Section 1.c.ii, indicates the uplift relief was assumed to be 9% drain efficiency for the existing spillway drainage gallery and 50% drain efficiency for the proposed, new toe drainage gallery/underdrain system. Appendix B, Section 2.c, indicates the drain efficiency of the new toe gallery drains was estimated as 50% effective and that drain efficiency for the underdrain system was not considered. The documents also indicate that the drain efficiencies of both systems will be refined and optimized during Planning, Engineering, and Design (PED). The assumed drain efficiencies are applicable for satisfying the minimum required factors of safety for stability for the various failure conditions. It is prudent, however, to evaluate one additional load condition assuming zero drain efficiency for all drains to verify that the stability factors of safety are at least one, should the drains were to become plugged over time.

Significance: Medium

If the drains become clogged over time and cannot be maintained, the uplift pressure under the structures will likely increase and the stability factor of safety will decrease.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Check the stability factors of safety for zero drain efficiency for all of the structures to ensure that they are stable if the drains become plugged over time.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01
- "*Best Practices in Dam and Levee Safety Risk analysis, Concrete Gravity Structures*", U.S. Bureau of Reclamation and USACE, 2012-11-07
- EM 1110-2-2200, "*Engineering And Design, Gravity Dam Design*", USACE, 1995-06-30

Panel Comment 19: Medium

Using roller-compacted concrete for the lower portion of the conventional concrete in the 10-foot-thick apron slab of the stilling basin could reduce the cost of materials and time required for construction.

Basis for Comment

The new supercavitating baffle monolith and the upper and lower apron extensions are indicated to be 10-foot thick conventional concrete. According to USACE response to the Panel questions at the IEPR Midpoint Meeting, the 10-foot thickness was selected based on the site geology and the bottom elevation of the existing apron and second-stage weir and stilling basin. The lower 5 to 6 feet of the new apron could be roller-compacted concrete (RCC) covered with an overlay of conventional concrete with a higher strength to resist erosion from high velocity. RCC can be placed at significantly less cost and in less time than conventional concrete. There is over 55,000 cubic yards of concrete in the apron slabs alone and approximately half of that concrete could be RCC. The use of RCC would reduce the amount of cement and fly ash required for construction. Both of these materials are predicted to be in short supply and high demand during the proposed construction schedule. A significant savings in construction cost and time could be realized with RCC placed for the lower half of the apron slabs. RCC was used recently for construction of a major stilling basin slab and gravity walls at USACE's Fort Peck Dam in Montana.

Significance: Medium

Using RCC for the lower 5 to 6 feet of the new apron slabs would result in a significant savings in the amount of materials and construction cost and time. The use of RCC also would reduce the heat of hydration during curing and minimize the potential for cracking of the slabs during construction.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Consider using RCC for the lower 5 to 6 feet of the apron covered with conventional concrete.
2. Compare the costs and schedules for construction using all conventional concrete versus a combination of conventional concrete and RCC for and the stilling basin apron slabs.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix B – Structural*", USACE, Huntington District, 2016-09-01

Panel Comment 20: Medium

The decision for the use of supercavitating baffle blocks as compared with conventional designed spillway configuration baffle blocks is not clearly stated or justified. The basis of determination that there will be a supercritical bubble around the baffle blocks to deter cavitation is not clearly stated in the report nor in the modeling report.

Basis for Comment

The Panel has considered the use of supercavitating baffles from several perspectives: hydraulics, structural design, cost, and benefit. It is our opinion that, to date, the use of other more traditional designs for baffle blocks has not been given due consideration for the Project. The magnitude of this specific design for supercavitating baffles is extremely expensive with the massive block structures, anchoring system requirements, and time consideration for construction. DSMR, page 144, states, "Baffle block size and configuration was optimized through iterative testing." In the hydraulic model report there is no description of "iterative testing". If such iterative testing was performed it should be discussed further in the report, likely in an appendix. It appears that the testing was based on the Folsom Dam spillway design, not specific design for Bluestone Dam. Appendix D, "*Hydrology and Hydraulics*", page 1/2, states, "*Alternatives assessed were a conventional stilling basin with supercavitating baffle blocks (with and without stilling weir dentates) and a flip bucket (with and without center pier). The conventional stilling basin with super-cavitation baffle blocks and no weir dentates was deemed the best alternative from this study*". Again the discussion of the alternatives resulting in the justification for selecting the supercavitating baffle blocks is not found in the documents. In Appendix E, "*Geology and Geotechnical Engineering*", page 13, there is a discussion of 1) a modified conventional stilling basin with added large baffle blocks, 2) a transitional flip, and 3) a remote conventional stilling basin. In Paragraph 2.2.2, it discusses only the modeling relating to a flip and Supercavitating baffle alternatives—nothing about more conventional baffle blocks. If the USACE evaluated conventional baffle blocks and they were unable to withstand the velocities or were shown to have damage as a result of the high velocities resulting in erosion of the concrete, for example, that is a justification for the use of the supercavitating baffles. There is no such justification found written in the documents.

The physical modeling report does not specifically state that there was consideration of various configurations for the length and cross section of the proposed supercavitating baffles, and spacing between the baffles. It appears that the general design from the Folsom Dam was used without examining a number of modeling options. The spacing of the blocks was stated to be determined from equal distribution using the existing Folsom Dam design with minor adjustments. It was confirmed that there were vortices identified in the model between the blocks.

When comparing the Folsom Hydraulic Model shape results with the Bluestone Dam Model shape results for the supercavitating baffle blocks, the general configuration is very similar. In the Folsom report there were vortices formed between the blocks. There was no documentation or discussion about coordination between the Project Team and those who performed the Folsom model and final design relating to the supercavitating baffle blocks that were used for Folsom Dam. Neither the current design description, nor the model testing, confirms that supercritical bubbles will be created

around the baffle blocks, only the statement that the high velocities will create the supercritical bubbles.

It appears from some of the comments in the Stantec report that there was a lack of time to determine the final design of the second-stage stilling basin, which would lead one to believe there may have not been sufficient time to examine alternatives to focus on the best results for the primary stilling basin and/or the use or applicability of supercavitating baffle blocks. There is concern that there may not have been sufficient examination of the options available to provide a true, final design of the baffle blocks that could lead to cavitation in the future. It is very possible that this design will result in positive results, but if options were not considered, then there may not be positive results or this may not be the most economical option.

Significance: Medium

A thorough evaluation of the use of supercavitating baffle blocks to achieve the desired goal of and the costs associated with these baffle blocks is very important to the long term longevity of the Project. Planning is far less expensive than replacement of construction that is determined to be ineffective. The primary concern is the cost of the supercavitating baffles. The Panel was not provided any justification that the selection of the use of the supercavitating baffles was based on solid engineering judgment and an engineered cost analysis.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Design of the supercavitating baffle blocks is a critical component of this remediation and the USACE needs to be certain that the design is correct and effective. If necessary, additional modeling with the proposed alternative and some variations of the design option might be warranted during the PED phase to determine if there is a better dimensional option.
2. If the proposed design has not been tested in Low Ambient Pressure Chamber (LAPC), similar to the Folsom Dam model in Reclamation's hydraulic laboratory, and there is insufficient data to support the certainty that the supercritical bubble around the baffle blocks is being formed, then it is recommended that such a test be performed during the PED phase of the Project.
3. Verify that supercavitating baffle blocks are indeed necessary and that conventional baffle blocks that may be structurally enhanced are inadequate.
4. The USACE should clearly document the process that was developed in the selection of the use of the supercavitating baffles along with the cost justification.
5. If the recommendation for the use of supercavitating baffles is not able to be substantiated, then alternatives should be considered.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix D, *"Hydrology and Hydraulics"*, USACE, Huntington District, 2016-09-01
- *"Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix E – Geology & Geotechnical Engineering, ATR Submittal"*, USACE, Huntington District, 2016-09-01

Panel Comment 21: Medium

There is limited discussion in the main report regarding potential for cost-growth risk of the project or the prospect of minimizing potential costs of RMP #6 during Planning, Engineering, and Design (PED).

Basis for Comment

The order of magnitude costs presented for RMP #6 range up to perhaps $500 million. Based upon current USACE dam safety project backlog, there is no guarantee that the proposed upgrades at Bluestone Dam will be completed in a timely manner (e.g. current USACE backlog would take about 50 years to complete given current funding realities). Therefore, cost minimization is critical to make the project feasible to accomplish. In reviewing the document, the Panel notes that while USACE has done an extraordinary job with the overall engineering analysis for the project, the development of RMP #6 appears to be somewhat conservative in nature. For example, rock strengths used from past DDR appear very low (ultra-conservative due to high factor of safety) based upon the lab testing data available. The proposed thickness of the concrete stilling basin overlay is 10 feet while rock protection concrete overlays are 7-feet thick, but there is only limited discussion as to the cost effectiveness of these design selections as compared to thinner, cheaper sections. In addition, engineering evaluations of RMP #7 were extremely limited even though to some extent #7 is a "light" version of RMP #6 and offers significant cost savings. RMP #7 is considered incomplete by USACE but components of the alternative might be worth further exploration during PED.

Also, the order of magnitude cost for RMP #6 is likely underestimated based upon other USACE "mega" project's cost growth. This same point was also identified in the risk register as a cost risk. Past cost estimates for the 1996 dam assurance upgrades appear to have also been low. For example, Table 2-2 of the main report outlines actual construction costs for the 1990s first dam safety assurance efforts. The approved plan was estimated to have a total cost of $91 million in 1996 dollars. Using available consumer price index inflation data, the Panel converted this to approximate 2016 dollars resulting in a rough-order magnitude estimate of $140 million. Similar conversions were made to items listed on Table 2-2 resulting in total actual construction costs of about $270 million or about twice the approved cost. This type of cost growth is typical for mega projects and should be expected with the proposed new dam safety modifications. These past experiences provide an opportunity for USACE to plan accordingly. USACE should make all efforts to optimize the final design for RMP #6 to minimize the total costs. Possible studies that are needed to evaluate the final cost and hopefully lower it, should be identified and discussed in the main report.

Significance: Medium

Resolution of this issue will improve the overall understanding of the recommendation and justification of the project. Resolution may lead to more economical designs.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Revise the main report to add a section discussing possible efforts to be undertaken during PED design optimization that would focus upon cost reduction and economy.
2. Evaluate several permutations of RMP #6 during design optimization such that the "with project" FWAC f-N chart position plots exactly (or as close as practical) on the TRL rather than considerably below it; thereby minimizing total cost.

Literature Cited:

- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 22: Medium

It is not clear from the Draft DSMR or the SDEIS whether material dredged during implementation of the project has or will be analyzed for contaminants (HTRW) including heavy metals and organic contaminants. Further, in the event the material is analyzed and found to be "clean", it is unclear whether it could be used beneficially rather than placed in disposal.

Basis for Comment

The Draft DSMR, Appendix K, SDEIS does not appear to indicate whether any contaminant determinations have been conducted on the material to be removed from the stilling basin beyond the Phase I Environmental Site Assessment (ESA) that was conducted for the project. The 404(b)(1) Evaluation states: "*The risk of contamination of waters resulting from the placement of fill material into waters located within the project area is low. Excavation and filling operations associated with this project are not expected to significantly affect the water chemistry of waters within the project area"* (section III D). However, data supporting this conclusion is not prevalently noted. The 404(b)(1) Evaluation also notes, "*The area to be filled with concrete for the apron within the stilling weir is natural riverbottom…*" (section II E3), and "*The riverbottom is primarily comprised of sand, silt, gravel, cobble and boulder*" (section III A2). While the Panel agrees that the potential for contaminants in the material within the stilling basin appears to be low, based on the Phase I ESA, the composition of the river bottom as described here does not preclude the potential for contaminant sequestration in sediments from upstream or legacy sources.

The New and Kanawha River basins appear to have some history of legacy pollutants throughout the basin, including polycyclic aromatic hydrocarbons (PAHs) and heavy metals (i.e., nickel, chromium, zinc, and arsenic). Many pollutants can sequester to underlying sediments from the water column, which can, in turn, be remobilized if disturbed. However, it is unclear from the SDEIS whether sediments slated for disturbance and disposal have been analyzed for pollutants. Presumably, these

would be analyzed prior to project implementation and material removal, in order to avoid suspension of contaminated sediments and introduction of suspended contaminants downstream. Pesticides may also be a contaminant of concern, depending on the makeup of sediments targeted for disturbance. Additionally, it should be specified that any material brought in from offsite to achieve project objectives (i.e., to construct cofferdams, etc.) should also be of clean source material so as not to introduce contaminants to the site.

In addition, based on the supporting material provided for the Draft DSMR and Appendix K, SDEIS, it appears that the material slated for removal during project implementation would be relocated to one or more of several disposal sites yet to be determined. The current SDEIS indicates that the preferred site is a commercial landfill, but other sites are being considered. It also appears that all of the disposal sites (except for the commercial landfill) would require a calculation of impacts and additional mitigation to compensate for impacts. However, it is not clear whether the material could be used beneficially in support of the project objectives, including habitat restoration/mitigation, where required. Doing so might reduce environmental impacts and costs, while providing benefits in support of project objectives. Likewise, investigation into beneficial uses for other, unrelated projects could be worthwhile, provided opportunities and appropriate timing can be identified.

Significance: Medium

Failure to identify and evaluate all opportunities for impact reductions associated with the project affects the completeness or overall understanding of the recommendation or justification of the project.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Better specify any requirements for dredge and fill material analysis as it pertains to HTRW.
2. Identify and discuss beneficial use options for the removed dredge material should it be suitable.

Literature Cited:

- "*DRAFT 2014 West Virginia Integrated Water Quality Monitoring and Assessment Report*", WV Department of Environmental Protestation (DEP), 2015-04-15
- *"Water Quality in the Kanawha-New River Basin, West Virginia, Virginia, and North Carolina, 1996-98 (Circular 1204)",* Paybins, et al., U.S. Department of the Interior and U.S. Geologic Survey, 2000
- *"Polycyclic aromatic hydrocarbons in bottom sediment and bioavailability in streams in the New River Gorge National River and Gauley River National Recreation Area, West Virginia, 2002 (Scientific Investigations Report 2005-5045)",* Terrance Messinger, U.S. Department of the Interior and U.S. Geologic Survey, 2004
- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia", Volumes I, Volume II (Appendices A through G), & Volume III (Appendices H through L)(as appropriate), USACE, Huntington District, 2016-09-01*

Panel Comment 23: Medium

It is not clear from the Draft DSMR whether there are standard onsite verifications/inspections for contractor compliance regarding implementation and maintenance of Best Management Practices (BMPs), pollutant discharge values, in-situ environmental quality, etc.

Basis for Comment

While the Draft DSMR does indicate that BMPs would be employed during project implementation, in order to reduce impacts to the environment, it is not clear whether there are protocols for ensuring compliance throughout implementation and completion of project activities that would ensure targets and standards are met consistently. The documents would benefit from including references to USACE protocols for compliance verification, including periodic onsite inspection and receiving water/air sampling and analysis by a third party or by USACE personnel to verify that the appropriate standards are being met.

Significance: Medium

Identification and implementation of protocols for monitoring contractor compliance with requirements for BMPs and verification that in-situ standards (i.e., water quality standards, etc.) are being met affects the completeness or overall understanding of the recommendation or justification of the project

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Clearly identify a protocol or steps for monitoring contractor compliance with requirements for BMPs and verification that in-situ standards (i.e., water quality standards, etc.) are being met in the Draft DSMR and/or the SDEIS.

Literature Cited:

- "*Bluestone Dam, Dam Safety Assurance Mega-Project, Draft Dam Safety Modification Report (DSMR), Supplement to the 1998 Dam Safety Assurance Report, ATR, HQ, MSC, DSMMCX, RMC, and QCC Submittal*", USACE, Huntington District, Great Lakes & Ohio River Division, NID ID: WV08902, 2016-09-01

Panel Comment 24: Medium

The population per structure is less under FWAC than under existing conditions without supporting rationale), which impacts the loss of life evaluations, but no explanation for the difference is provided.

Basis for Comment

Appendix A, "*Risk Assessment*", Section 4.4.2.1, "*Life Loss*", states, "*The expected incremental life loss from a breach of Bluestone Dam ranges from 600 to 6,300 in the existing condition and from 400 to 2,800 in the FWAC. The main differences between the existing and FWAC parameters were the difference in population per structure and the improvement in the mobilization characterization.*" This is an issue because there is no explanation of why there would be a different population per structure under FWAC than there is under the existing condition. This population per structure issue was brought up during the IEPR Midpoint Meeting and USACE's clarification was that consequence modeling is based on aggregating the consequences from individual structures. Each structure has statistical population distributed to it based on the structure type, number of structures in a census block, and the total population of the census block. In order to capture the projected change in county-level population within the consequence modeling, an index factor was applied to the population estimates of each individual structure. The index factor represented the change in population between 2014 (ECRA) and 2040 (FWAC) for the county that each structure is in. Since the majority of counties are projected to have a population decrease over that time period, the population per structure is lower in the FWAC than it is in the baseline. The FWAC mobilization curve is also improved in the FWAC, so better mobilization and slightly lower population both contribute to the lower life loss estimate.

Significance: Medium

The difference in the population per structure affects the loss of life evaluations and must be resolved to ensure that it does not raise the level of risk.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Include in the report an explanation of why the population per structure is lower in the FWAC than it is in the baseline.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR) Appendix A – Risk Assessments, ATR Submittal*", USACE, Huntington District, 2016-09-01

Panel Comment 25: Medium

In DSMR, Appendix J, "*Bluestone DSMS Consequences Analysis*", the loss of life associated with potential failures of Bluestone Dam is expected to be lower if the flood event occurs at night than if it occurs during the day, but no explanation is provided for the reason/logic for the difference.

Basis for Comment

The Draft DSMR, Appendix J, Table 1-2, "*Existing Condition Life Loss*", and Table 1-3, "*FWAC Life Loss*", provide information regarding loss of life for both daytime and nighttime, but no explanation is provided for the reason/logic for the difference. This is an issue because notification and mobilization of the population to evacuate would be more effective during the day than it would be at night. This point was made during the IEPR Midpoint Meeting Conference and the USACE stated that the consequence modeling distributes population differently during the day and night. During the night, residential structures are assigned a higher percentage of the census block populations, while during the day commercial and industrial structures have higher populations and residential structures have lower population. Commercial and industrial structures also have employer-reported workers incorporated into the structure population. Because Charleston, WV, has such a relatively high concentration of industrial and commercial structures, the population is much higher in that area during the day because many people who work in Charleston actually live outside of the immediate area and outside of the floodplain. During the night, there are less people in the city itself, and even though USACE's modeling does account for the fact that any warning during that time would take longer to become effective the lesser amount of people still results in a lower life loss because all of those outside workers would not be in the city at night.

Significance: Medium

The daytime and nighttime populations affect the loss of life evaluations and must be resolved to ensure that it does not raise the level of risk.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Include in the report an explanation of why the population per structure is lower in the FWAC than it is in the baseline.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix J, "*Bluestone DSMS Consequences Analysis*", USACE, Huntsville District, 2016-09-01

Panel Comment 26: Medium

DSMR, Appendix A, "*Risk Assessments*", Table 1-1 (pg 35), has a population that is lower for the Future Condition (FWAC) than for the Baseline Condition (BCRA) and Existing Condition (ECRA), which impacts the loss of life evaluations, but no explanation for the difference is provided.

Basis for Comment

DSMR, Appendix A, "*Risk Assessments*" (pg 41), states, *"The goal was to determine whether changes in development could change the population at risk over the planning horizon. Through consultation with local planning and development staff, it was determined that while changes will occur there will not be a significant change to population at risk over the planning horizon. Therefore, established forecasts for population growth were used to determine potential changes to the population at risk which resulted in a slight decrease for the FWAC."* This is an issue because the document indicates that the population under the future without Federal action condition (FWAC) is going to be 31,854 (16%) less than under the Baseline Condition (BCRA) and 8,700 (5%) less than under the Existing Condition (ECRA). Panel questioned this topic during the IEPR Midpoint Meeting Conference and the USACE indicated the population change between the BCRA/ECRA and FWAC estimates was based on county-level population projections that contained projections out to 2040. USACE went on to state that in most cases, there is a projected decrease in county level populations between the 2010 census and the 2040 projections. This resulted in an overall decrease in population between existing conditions and FWAC, but it is not enough of a decrease to impact the order of magnitude of the life loss estimates.

Significance: Medium

The difference in the FWAC and ECRA impacts the loss of life evaluations and must be resolved to ensure that it does not raise the level of risk.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Include an explanation in the report of why the population is lower for the Future Condition (FWAC) than for the Baseline Condition (BCRA) and Existing Condition (ECRA).

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR) Appendix A – Risk Assessments, ATR Submittal*", USACE, Huntington District, 2016-09-01

5.5 Significance: Medium/Low

Panel Comment 27: Medium/Low

The SDEIS, Section 4.14.2.2, Tables 4-17 and 4-18, appear to be missing some information that is important for a complete understanding of the Environmental Justice information presented.

Basis for Comment

Within the Draft DSMR, SDEIS, Volume I, Section 4.14.2.2, Table 4-17, the row describing the proportion of minorities for a couple of the counties referenced (i.e., Giles County) does not correspond to the information in the rows under population. Is there an "other" row that is not included? For example, referencing Giles County, the ethnic data are expressed in percentages that add up to 100.4% of the population, and the data for the categories other than "White Alone" add up to 3.9% of the population, both of which are inconsistent with data presented in the population and percent minority categories of the table. A similar issue appears to exist in Table 4-18. It is unclear whether these are typographical/mathematical errors, or if there is data missing or not presented. In the event of the latter, some explanation or qualifier in the table should be included.

Defining poverty level would also be helpful in this section (in addition to, or perhaps referencing the definition in Section 4.14.2.10). Additionally, this section would benefit from the inclusion of a map showing the counties referenced and distribution of the minority/low income populations therein. It would be advisable to look at the distribution of these populations within the counties wherever possible to identify whether project activities might disproportionately impact specific micro-populations that could be avoidable or should be mitigated. Data to this extent may be available through local colleges and universities, city planning or development boards, or in some cases available via online resources and/or searchable data bases such as City-Data.com. This might be helpful in understanding whether the referenced Environmental Justice populations might be disproportionately impacted by project activities in any significant manner.

Significance: Medium/Low

Careful and complete calculation and presentation of data affects the technical quality and understanding of the project based on the presentation of information related to the recommendation or justification of the project. However, the Panel does not have sufficient information to determine the effect on project implementability.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Review and revise the SDEIS, Section 4.14.2.2, Tables 4-17 and 4-18, to include more comprehensive Environmental Justice information as noted above.
2. Include or reference a map (or maps) detailing distribution of Environmental Justice populations for, and (if possible) within the affected counties.

Literature Cited:

- *Draft DSMR Appendix K, "Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification, Hinton, West Virginia, Volume I", USACE, Huntington District, 2016-09-01*

Panel Comment 28: Medium/Low

The use of an Automated Data Acquisition System (ADAS) to monitor the performance of the dam will not be employed after the construction is completed. The lack of an ADAS system will likely increase the time required to identify, evaluate and possibly remediate harmful conditions that could threaten the integrity of the dam.

Basis for Comment

The major concerns addressed by the project relate to the stability of the concrete structures under extreme flood events. The measurement of uplift and the effectiveness of the drain and pumping systems are critical elements in assuring the integrity of the various project structures. The ability to monitor instrumentation readings in the District office will facilitate early identification of threshold exceedances issues and a timelier development of any remedial measures needed to ensure the safety of the structures. This is particularly true during the occurrence of regional high water events. The data will be available, but will not be automatically collected and analyzed in real time.

Significance: Medium/Low

The use of an ADAS would increase the overall integrity of the dam by decreasing the time required to identify harmful conditions and to provide technical support respond to these conditions. In the worst case, the use of an ADAS could allow earlier implementation of an emergency action plan, in response to a pending dam failure.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. An ADAS system is currently planned to monitor the integrity of the dam and temporary structures during the construction phase. It is recommended that an ADAS system linked to the District office be considered for the permanent instrumentation.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix F – Instrumentation*", USACE, Huntington District, 2016-09-01

Panel Comment 29: Medium/Low

An increase in the depth of the key below the proposed supercavitating baffle block section would increase the overall stability of the section and also the global stability of the dam structures and result in the need for fewer anchors.

Basis for Comment

As illustrated in the Draft DSMR, Appendix E, Section 5, Drawing Sheet Identification E5-1, Sheet 1 of 1 (PDF page 1083), the elevation of the assumed horizontal failure plane for stability analyses corresponds to the bottom elevation (1,350 ft) of the key below the baffle. Discussions provided in Appendix E indicate that the assumed elevation of this plane is not controlled by the character of the rock formation and therefore corresponds to the bottom elevation of the key section. If the depth of the key were increased, the stability of both the baffle section and the overall global stability would be increased. The increase would be attributable to the increase normal force on the failure plane and also to the increased passive force developed at the downstream end of the global section. The adoption of this concept would require an economic comparison of the cost of the increased key depth as compared to the potential savings attributable to fewer anchors.

Significance: Medium/Low

The proposed alternative, involving a deeper key represents a refinement in the design, requires further evaluation.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Prior to final design, implement an economic and stability evaluation to optimize the depth of the baffle block key section in comparison to the anchors required to satisfy stability requirements.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix E – Geology & Geotechnical Engineering, ATR Submittal*", USACE, Huntington District, 2016-09-01

5.6 Significance: Low

Panel Comment 30: Low

The SDEIS provides no mention of the impacts to the North Carolina portion of the watershed—17% of the watershed—which is more than the 16% in WV.

Basis for Comment

This is an issue because the North Carolina portion of the watershed is part of the study area and NEPA requires that the effects of the Federal action are identified and addressed even if the conclusion is that there are no effects. The omission of a section addressing the impacts to the 17% of the watershed that is in North Carolina was brought to the attention of USACE at the IEPR Midpoint Meeting and USACE indicated a section would be added to the SEIS to address this topic.

Significance: Low

Comment affects the technical quality and understanding of the project.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. If there is no impact to the portion of the watershed in North Carolina, that should be stated in the SEIS along with the reasoning why there is no impact.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix K, "*Supplemental Draft Environmental Impact Statement, Bluestone Dam Safety Modification*", Hinton, West Virginia, Volume 1, USACE, Huntington District, 2016-09-01

Panel Comment 31: Low

The website that is intended to communicate the various aspects of the project to the public and stakeholders does not provide the required information.

Basis for Comment

The Draft DSMR, Appendix O, "Project Management Plan, Appendix 8 (page 90), "Community Relations Plan for Bluestone Dam Safety Assurance Project", Section 4.2.5, "Website" (page 14), specifies: "*4.2.5.1 The Huntington District will utilize a project website, which has been made available for public viewing. The information contained on the website is intended to provide basic project information in a format that is understandable to a range of stakeholders. Expected information includes a location or project map, project background and history, links to project related documents, details about upcoming project meetings and events, and a point of contact for the study. The website will also allow users to submit comments electronically to the project team, and the website will be updated periodically to reflect progress of the study.*" However, no such website could be found.

The Panel discussed this at the IEPR Midpoint Meeting and USACE provided the following website, which is to be updated:
http://www.lrh.usace.army.mil/Missions/Civil-Works/Current-Projects/Bluestone-DSA/.
This is currently a basic "Project Status" webpage that does not yet provide the information required above.

Significance: Low

An understandable website with basic project information is a vital part of public outreach and can help inform a broad range of stakeholders and prevent misunderstandings that could otherwise impact cost and schedule. Comment affects the technical quality and understanding of the project.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Provide a website that fulfills the requirements spelled out in the Community Relations Plan for Bluestone Dam Safety Assurance Project.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix O, "Project Management Plan [For Civil Works Projects], Project Title: Bluestone Dam Safety Assurance Project", USACE, Project No.: 112490, Location: Hinton, WV, 2016-09-01

Panel Comment 32: Low

The Dam Safety Modification Main Report and relevant appendices include a number of important inconsistencies regarding dam dimensions, water surface elevations, or discharge capacities.

Basis for Comment

The Panel has noticed many differences in the main report text and relevant appendices for supposed equivalent values. In Section 2.8 of the main report, the discharge capacity of the penstock section is noted as 150,000 cubic feet per second (cfs) on page 24, while it is identified as 155,000 cfs on page 25. Figure 5-9 of the main report shows the left training wall top elevation to be 1,416 feet National Geodetic Vertical Datum (NGVD) of 1929 (NGVD 29) while it is listed as 1,418 feet in civil sheet CS 04 in Appendix C. In Section 4.5.2 of the main report text, elevation 1,553 feet North American Vertical Datum of 1988 (NAVD 88) is noted; all previous elevations were referenced to NGVD 29. The Panel recognizes that the difference between the two datums is small in this case but for the reader's sake, consistency would dictate all elevations in one datum only. Quantitatively, NGVD 29 is used 589 times in seven documents, while NAVD 88 is only used 38 times in four documents, so it is clear that some standardization is needed.

Significance: Low

Comment affects the technical quality and understanding of the project, which may potentially lead to other errors.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Revise the main report and appendices to eliminate the text and figure inconsistencies.

Literature Cited:

- "*Bluestone Dam, Dam Safety Modification Report (DSMR), Appendix C – Civil Engineering, ATR Submittal*", USACE, Huntington Division, 2016-09-01
- PDF index of Draft DSMR document package, APMI, 2016-09-02.

Panel Comment 33: Low

The Draft DSMR, Appendix D, "Hydrology and Hydraulics", Paragraph 2, pg 1, "*Runoff Conditions of the watershed were <u>more efficient</u> than previously estimated*". The use of the term "more efficient" makes this a confusing statement.

Basis for Comment

The use of the term "more efficient" as it applies to a watershed is confusing. The difference between the previous model and the 2013 PMP model that result in the watershed being "more efficient" is not clearly described.

Significance: Low

There is confusion in reading this term in the report and clarification is requested.

Recommendation for Resolution

The Panel has the following recommendations related to this comment:

1. Rewrite the sentence to explain what is meant rather than using a phrase “more efficient”.

Literature Cited:

- Draft Dam Safety Modification Report (DSMR), Appendix D, *“Hydrology and Hydraulics”*, USACE, Huntington District, 2016-09-01

Appendix A Charging the Independent Peer Review Panel

The following Review Charge to Reviewers outlines the objectives of the Independent External Peer Review (IEPR) for the subject study and identifies specific items for consideration for the IEPR Review Panel.

The objective of the IEPR is to obtain an independent evaluation of whether the interpretations of analysis and conclusions based on analysis are reasonable for the subject study. The IEPR Review Panel is requested to offer a broad evaluation of the overall study decision document in addition to addressing the specific technical and scientific questions included in the Review Charge. The Review Panel has the flexibility to bring important issues to the attention of decision makers, including positive feedback or issues outside those specific areas outlined in the Review Charge. The Review Panel can use all available information to determine what scientific and technical issues related to the decision document may be important to raise to decision makers. This includes comments received from agencies and the public as part of the public review process.

The Panel review is to focus on scientific and technical matters, leaving policy determinations for USACE and the Army. The Panel should not make recommendations on whether a particular alternative should be implemented or present findings that become "directives" in that they call for modifications or additional studies or suggest new conclusions and recommendations. In such circumstances the Review Panel would have assumed the role of advisors as well as reviewers, thus introducing bias and potential conflict in their ability to provide objective review.

Panel review comments are to be structured to fully communicate the Panel's intent by including the comment, why it is important, any potential consequences of failure to address, and suggestions on how to address the comment. The IEPR PWS provides additional details on how comments should be structured.

The Review Panel is asked to consider the following items as part of its review of the decision document and supporting materials.

Broad Evaluation Review Charge Questions

1. Is the need for and intent of the decision document clear?
2. Does the decision document adequately address the stated problem and intent relative to scientific and technical issues?

Given the need for and intent of the decision document, assess the adequacy and acceptability of the following:

3. Project evaluation data used in the study analyses;
4. Economic, environmental, and engineering assumptions that underlie the study analyses;
5. Economic, environmental, and engineering methodologies, analyses, and projections;
6. Models used in the evaluation of existing and future without-project conditions and of economic or environmental impacts of alternatives;

7. Methods for integrating risk and uncertainty;
8. Formulation of alternative plans and the range of alternative plans considered;
9. Quality and quantity of the surveys, investigations, and engineering sufficient for conceptual design of alternative plans, and;
10. Overall assessment of significant environmental impacts and any biological analyses.

Further,

11. Evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable, and;
12. Assess the considered and tentatively selected alternatives from the perspective of systems, including systemic aspects being considered from a temporal perspective, including the potential effects of climate change.

For the Tentatively Selected Plan, assess whether:

13. The models used to assess life safety hazards are appropriate;
14. The assumptions made for the life safety hazards are appropriate;
15. The quality and quantity of the surveys, investigations, and engineering are sufficient for a concept design considering the life safety hazards and to support the models and assumptions made for determining the hazards;
16. The analysis adequately addresses the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project; and
17. From a public safety perspective, the proposed alternative is reasonably appropriate or are there other alternatives that should be considered.

Specific Technical and Scientific Review Charge Questions

Plan Formulation/Evaluation

18. Was a reasonably complete array of possible measures considered in the development of alternatives, including those non-structural measures?
19. Have the five required alternatives (ER 1110-2-1156) been identified and adequately discussed and considered, including identification of an alternative "Achieving only tolerable risk limit for life-safety?"
20. Does each alternative meet the formulation criteria of being effective, efficient, complete and acceptable per USACE definitions? Do they meet the study objectives and avoid violating the study constraints? Is the evaluation and comparison of the alternative appropriate and are the results of the screening acceptable?

Structural

21. Does the design appropriately utilize data, including physical modeling data (both retained for analysis and screened out), to develop design loads and is the level of data available appropriate?
22. Does the design develop all loads appropriately and apply these loads appropriately to the structure, including loads developed from hydraulic physical modeling data, stagnation pressure, and uplift and are design results reasonable?

23. Are assumptions concerning drain effectiveness, waterstop effectiveness, and resulting uplift distribution developed and applied appropriately?

Civil

24. Do the drawings provide adequate detail to illustrate and describe the alternatives?
25. Are the major scope items adequately captured, described and illustrated to construct the TSP?
26. Are constructability issues addressed in adequate detail?
27. Is the intent of the TSP work limits adequately illustrated and described?

Engineering Geology

28. Does the study clearly characterize the pertinent geologic conditions of the dam's foundation?
29. Does the study clearly describe the geological investigations and supporting studies completed to date?
30. Does the study identify the material properties of the foundation rock needed to design features such as rock anchors?
31. Does the study adequately discuss the geological challenges of the design?

Hydrology and Hydraulics

32. Was the hydrology discussion sufficient to characterize current baseline conditions and to allow for evaluation of how forecasted conditions (with and without proposed actions) are likely to affect hydrologic conditions?
33. Is the care and diversion scheme associated with implementation of the risk management plan feasible?
34. Is the hydrologic loading curve supported to the level to support the risk management plan selection?
35. Is the proposed TSP stilling basin design consistent with current state of practice?

Environmental

36. Was the discussion of natural resources sufficient to characterize current baseline conditions and to allow for evaluation of forecasted conditions (with and without proposed actions)?
37. Are the analyses of the human environment including socio-economic and natural resources within the project area sufficient to support the estimation of impacts of the final array of alternatives?
38. Did the formulation process follow the requirement to avoid, minimize, and then mitigate adverse impacts to resources?
39. Does the conceptual mitigation compensate for unavoidable impacts as appropriate?
40. Does the supplemental EIS meet the NEPA requirements and implementing ER 200-2-2?

This Page Intentionally Blank

Appendix B Qualifications of the Independent External Peer Review Panel Members

The qualifications of the IEPR Panel members (in alphabetical order) are provided below in summary form to show their expertise for this project.

B.1 Prof. Don Ator, MBA

Role: Civil Works Planning/Economics

Prof. Ator is a Research Associate, Professor, and Undergraduate Advisor in the Department of Agriculture Economics and Agribusiness at Louisiana State University. Prof. Ator's responsibilities include research, grant writing and proposal development, extension and outreach, undergraduate advising and teaching Agricultural Commodity Marketing and Risk Management. His current research is in financial resiliency planning for local governments in Louisiana, Texas, Alabama, Mississippi, Florida, Georgia, Kentucky, and Nebraska.

Prof. Ator has over 35 years of demonstrated experience in public works planning, working with project teams to identify and evaluate measures and alternatives using appropriate planning methodologies to reduce life safety risk. He earned his MS in economics and agricultural economics and has an MBA in finance and accounting from Louisiana State University. He has worked with 22 different USACE districts nationwide, as well as with the Bureau of Land Management, Bureau of Reclamation, and the Department of Commerce. He was the associate director and senior economist for the Gulf South Research Institute and project/program manager and senior economist at three private engineering firms. He has conducted more than 500 Civil Works projects nationwide that required the development of relevant and credible socioeconomic information and analysis, and performed the quality assurance review for all economic aspects of these projects. He is experienced in determining the scope and appropriate methodologies for impact assessment and analyses for a variety of projects and programs with high public and interagency interests. His scope includes: Economic Evaluation of Benefits from Beneficial Use Disposal Alternatives of Dredged Material for Consistency with State of Texas Coastal Management Plan, Texas (USACE, Galveston District); Missouri River Authorized Purposes Study (MRAPS) Project Management Plan (USACE, Omaha and Kansas City Districts); and the Municipal and Industrial Water Use Forecast, Southwest Florida Feasibility Study, Florida (USACE, Jacksonville District).

Prof. Ator's experience has made him intimately familiar with the USACE plan formulation process, procedures, and standards as they relate to flood risk management. He has demonstrated proficiency in the USACE six-step planning process as evidenced by development of a template for preparing Project Management Plans for feasibility studies for USACE Regional Planning and Environment Division South, Mississippi Valley Division in 2011 and field testing the template in 2012. Most recently, he worked with the USACE New Orleans District Project Delivery Team to develop the Project Management Plan for the West Shore Lake Pontchartrain Flood and Storm Damage Risk Reduction Project. In 2010, Prof. Ator served as a team leader while embedded in the Plan Formulation Branch USACE New Orleans District directing plan formulation activities of three plan formulators and providing project oversight and review to ensure compliance with USACE guidelines.

Prof. Ator is familiar with the USACE structural flood-risk management analysis and economic benefit calculations and standard USACE computer programs, including HEC-FDA. He has conducted structure inventory surveys for flood damage reduction studies, developed content-to-structure value relationships for urban flood control economic analyses, and has prepared Section 905(b) flood damage reduction and ecosystem restoration reconnaissance reports. A majority of the projects he has conducted have required use of the HEC-FDA computer program. He attended a USACE-sponsored workshop on the model certified version of HEC-FDA in March of 2010 hosted by the Mississippi Valley Division. His related project experience includes the Structure and Content Depth Damage Relationship Surveys, Ouachita Parish, Louisiana (USACE, Vicksburg District); the Development of Content to Structure Value Relationships for Urban Flood Control Economic Analysis, Cypress Creek, Texas (USACE, Galveston District.); and the Orleans Parish, Louisiana, Urban Flood Control Feasibility Study, Structure Inventory (USACE, New Orleans District).

Prof. Ator's experience with National Economic Development analysis procedures, particularly as they relate to flood risk management, includes serving as a team leader in 2010 while embedded in the Plan Formulation Branch (USACE, New Orleans District). His responsibilities included directing plan formulation activities, and providing project oversight and review to ensure compliance with USACE guidelines. In this capacity, he worked closely with Project Delivery Teams to identify and evaluate measures and alternatives using appropriate planning methodologies on 13 projects to reduce life safety risk, all of which included a combination of flood risk management, life-loss probability analysis, population at risk, residual risk, and vulnerability analysis. For example, Prof. Ator's work on the Greens Bayou Residual Flood Plain Properties Buyout Analysis, Texas (USACE, Galveston District) included flood risk management, population at risk, residual risk, and vulnerability analysis. In addition, the Donaldsonville to the Gulf – Flood Damage Risk Reduction Feasibility Study, Louisiana (USACE, New Orleans District) included flood risk management, life loss probability analysis, population at risk, residual risk, and vulnerability analysis.

In Prof. Ator's 35+ years of experience, he has worked on social effects evaluation of large Civil Works projects for hundreds of NEPA compliance documents, including experience with community cohesion/identity, cultural and historical value, low-income population, economic vitality of the community, and vulnerability of the population. For example, he contributed to a social impact assessment for the Little Colorado River in Holbrook, Arizona (USACE, Los Angeles District) and an environmental impact statement for U.S. Navy Home Porting Projects (USACE, Galveston District), both of which dealt with community cohesion and identity. His work on the Historic American Building Survey Documentation for the Perry Creek Flood Control Project in Sioux City, Iowa (USACE, Omaha District) and on screening the cultural and historic features at the Di-Lane Plantation, Georgia (USACE, Savannah District) illustrates his experience with evaluating cultural and historical value. He gained experience working with low-income populations through assessing the socioeconomic impacts from flooding and flood control measures in the Yazoo Delta, Mississippi (USACE, Vicksburg District) and through the development of an initial job training program for the Community Impact Mitigation Plan for the Inner Harbor Navigation Canal Lock in New Orleans, Louisiana (USACE, New Orleans District). Prof. Ator has experience with the economic vitality of the community through working on the Memphis Riverfront Development Project (USACE, Memphis District) and on an analysis of economic development benefits from the construction of a floodwall and levee system along the Greenbrier River and Knapp Creek in Marlinton, West Virginia (USACE, Huntington District). Finally, he is familiar with the vulnerability of the population through his work on a social impact assessment for the Kissimmee River Upper Basin Restoration Project (USACE, Jacksonville District) and from the Environmental Impact Statement for the proposed widening of the Pascagoula Lower Sound/Bayou Casotte Channel (USACE, Mobile District).

B.2 Dr. Christopher Brown, PhD, PE

Role: Civil Engineering

Dr. Brown is an Associate Professor at the University of North Florida (UNF) teaching civil engineering, fluid mechanics, hydraulics, senior design, and engineering geology. He earned his Ph.D. in civil engineering in 2005 from the University of Florida, his Master's Degree from Villanova University in 1997, and his B.S. degree in civil engineering from Temple University in 1991. He has over 25 years of experience working on public works projects for the City of Philadelphia, Waste Management, U.S. Army Corps of Engineers (USACE), and for Golder Associates Inc. as a private consultant for various complex civil engineering projects. While working for the USACE, he worked within the Planning, Engineering, and Construction Divisions during his tenure. He was consistently recognized for his excellent technical skills including award of "engineer of the year" twice over 16 years with USACE. He has also recently been recognized for excellence in teaching and mentoring with award of several teaching accolades at UNF and the national Bliss Medal from the Society of American Military Engineers (SAME).

Dr. Brown is a registered Professional Engineer to both Pennsylvania and Florida. During his career, Dr. Brown has worked on flood-risk management structures including dams, levees, retaining walls, gates, closure structures, etc., looking at both geotechnical and general civil engineering aspects. Specific project examples include the Prompton Dam spillway modification project, Molly Ann's Brook flood mitigation project, Portugués Dam design, EAA Reservoir project, C-111 levees, and many others. Dr. Brown has extensive experience on public works projects for the City of Philadelphia, City of Savannah, City of Jacksonville, EPA, USACE, State of Florida, and Commonwealth of Puerto Rico. Dr. Brown has also designed projects that were designed per requirements outlined in EM 1110-2-1913. As an expert peer reviewer, Dr. Brown has been involved with review projects in eight USACE districts over a period of 8 years.

Dr. Brown has worked on the geotechnical side of water resources and the hydrologic modeling side of design and modeling projects. Dr. Brown has completed both stability studies using Slope/W and UTEXAS and seepage studies using SEEP/W, Seep2D, and MODFLOW. Dr. Brown has used reliability and stochastic analysis studies on all types of water resources projects dating back to version 1.0 of "@Risk" software. Dr. Brown served on the first Corps of Engineers Ad-hoc committee on levee assessment, which included the initial development of the current USACE fragility curve/risk management design approach.

Dr. Brown has extensive knowledge of USACE cost estimating systems with direct experience using MCACES and working knowledge of M2. Dr. Brown has also developed his own risk-based cost estimates using both @Risk and Crystal Ball. He is experienced in developing estimated construction costs and is knowledgeable regarding construction methods related to large civil works projects including levee design, floodwall design, box culverts, bridge pier modifications, utility relocations, and drainage structure design. Dr. Brown has acted as cost-estimating IEPR reviewer on some of the largest civil works projects in USACE including the most expensive lock and dam replacement in USACE history.

Dr. Brown is familiar with, and has participated in, the design of floodwalls and gated structures, as well as non-structural flood mitigation solutions (e.g., buy-out or minor flood proofing). Specific project examples of direct design experience include Molly Ann's Brook project (included t-walls, l-walls, underpinning of buildings, levee, bridge modification), Portugués Dam (included access road, foundation prep, arch dam, drainage gallery, rock bolts), and City of Savannah storm sewer upgrade (included new conduit,

cut/fill construction, utility relocation and hardening, vibration monitoring). Dr. Brown was also a key designer for the F. E. Walter Dam access road replacement (on design team and field inspection) as well as the design of new bridges across Everglades National Park along the Tamiami Trail in Florida. Dr. Brown has also been involved in other large civil works projects including C&D Canal Deepening Project in MD and DE and the Delaware Main Channel Deepening Project in PA and NJ.

B.3 Prof. James Dobberstine, MS

Role: Biological Resources and Environmental Law Compliance

Prof. Dobberstine currently serves as chair of the Math, Engineering, and Sciences Division (MES) at Lee College, in Baytown, Texas, where he is responsible for all operational aspects of the MES Division, including oversight of three departments (Mathematics, Biological Sciences, and Physical Sciences) and associated laboratories, approximately 30 faculty and staff, and departmental budgets. He teaches Environmental Science and Biology and is engaged in ecosystem studies in the Galveston Bay estuary with his students, the results of which have been featured through organizations including Restore America's Estuaries (RAE), among others. Prof. Dobberstine holds a BA in Life Sciences (Biology/Chemistry; Concordia University), an M.S. in Environmental Management (Environmental Policy and Law, including NEPA, CWA, ESA, and other regulatory; University of Houston-Clear Lake), and an MS in Environmental Science (Biology and Environmental Toxicology; University of Houston- Clear Lake). He also holds certificates in USACE wetland delineation (Texas A&M University) and water quality improvement using constructed wetlands (Clemson University) and has completed numerous professional development courses, including GIS Techniques in Environmental Assessment (University of North Texas), Probabilistic Ecological Risk Assessment (Texas Tech University), Application of Adaptive Management to Address Climate Change Related Challenges (NOAA Coastal Service Center and the PBS&J Ecosystem Restoration Division), Benthic Mapping Techniques (EPA, USDA-NRCS, and the University of Rhode Island), Sampling Benthic Sediments: Methods, Analyses, and Judgments (University of North Texas Institute of Applied Sciences), and Conserving Land with Conservation Easements (National Land Trust Alliance Land Conservation Leadership Program).

As an Environmental Scientist focusing on wetlands and other aquatic habitats, Prof. Dobberstine is experienced with the complex regulatory framework affecting projects that potentially impact coastal habitat. He has evaluation experience with NEPA impact and cumulative effects analyses on projects with high public and interagency interest within sensitive aquatic habitats, including wetlands. Prof. Dobberstine has extensive research experience with many aspects of aquatic and riparian habitats, including aquatic habitat characterization, the effect of adjacent land use on in-stream water and sediments, and ecosystem function. This includes experience assessing aquatic habitats using the Sediment Triad method (toxicology, chemistry, and biologic community). Data collected as part of a 2004-2007 study is part of the baseline aquatic habitat data being applied to an EPA superfund (CERCLA) project on the Houston Ship Channel (HSC-Patrick Bayou). He also has ongoing grant-funded (Texas Coastal Management Program/NOAA and the Galveston Bay Estuary Program/EPA) research gathering data to be used for adaptive management of ecosystem restoration in aquatic habitats in lower Galveston Bay, comparing the functional aspects of the biologic communities across different habitat restoration designs. The data are being gathered and managed under criteria developed for the EPA/TCEQ required Quality Assurance Program Plan (QAPP). Prof. Dobberstine is also studying the biologic community characteristics associated with small-scale shoreline restoration (Living Shorelines) in comparison to natural reference marshes and traditionally armored (bulkhead) shorelines in estuarine and freshwater ecosystems. He has experience associated with adaptive management strategy development with the GBEP Freshwater Inflows Group and

the Harris County Flood Control District (HCFCD) Memorial Park Demonstration Project/Buffalo Bayou shoreline stabilization/habitat restoration project. Prof. Dobberstine is also experienced with risk assessment for restoration projects in mixed urban/industrial environments where potential toxicant/exposure concerns contrast with significant cultural and environmental benefits including community education and recreation opportunities, and ecosystem enhancement. He is familiar with habitat and lifecycle requirements for many species of fish and wildlife endemic to rivers and watersheds in many areas of the U.S., including threatened and endangered species.

Prof. Dobberstine has worked in the area of habitat conservation with the Galveston Bay Foundation, where he led several programs including the Living Shorelines, Land Conservation, and Permit Review Programs. He has extensive experience with conservation easements including the development of habitat assessments, project cost models, and contract development. He was responsible for overseeing more than 2,500 acres of protected coastal habitat. He has extensive experience with aquatic habitat restoration projects including project development, planning, permitting, risk assessment and ecotoxicology, fundraising and grant development, project implementation, management, and monitoring. He has a working knowledge of coastal, riparian, and floodplain ecology, and methodologies for evaluation, including research, work on design and grant development for restoration projects (including beneficial uses of dredge material), and permit development and evaluation. He has successfully raised grant funds for projects from partners including the USFWS Coastal Program, the Texas Coastal Management Program, the Texas Coastal Assistance Program, the Galveston Bay Estuary Program, and others.

Prof. Dobberstine is frequently called on to serve as an advisor on projects and panels, currently serving on the Advisory Council to the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University, and formerly as a curriculum review advisor to the Environmental Management Program at the University of Houston-Clear Lake. He also serves as a member of the Memorial Park Demonstration Project Vegetation Advisory Workgroup, the Moody Gardens ACUC (Conservation) Committee, and on the Monitoring and Research Subcommittee of the Galveston Bay Council. Prof. Dobberstine is a member of the National Association of Environmental Professionals. He also currently serves on the Boards of Directors of the Texas Association of Environmental Professionals (President 2010–present) and the South Central Regional Chapter of Society for Environmental Toxicology and Chemistry (as President 2013–2015), and as a former Trustee and current Advisory Board Member of the Galveston Bay Foundation. Prof. Dobberstine has served on several IEPRs for USACE projects in the areas of biologic resources and environmental law compliance. IEPR experience includes infrastructure projects (dam safety and flood risk reduction), ecologic modeling, and water management.

B.4 Mr. Charles Hutton, PE

Role: Structural Engineering

Mr. Hutton is a civil/structural engineer with 48 years of experience in the design and management of water resource projects involving dams, hydraulic structures, hydropower, pumping plants, and water conveyance facilities in Asia, Africa, Latin America, Middle East and the United States. He achieved his Professional Engineer registration in 1981 in Colorado. Mr. Hutton's expertise includes preparing feasibility studies, designs, drawings, and specifications for RCC, gravity and arch dams, hydropower plants, pumping plants, pipelines, canals and hydraulic structures; performing dam safety inspections; conducting condition assessments of existing dams, hydropower facilities and water conveyance systems; developing

designs for rehabilitation; technical review; failure mode analysis and risk assessment of large complex systems; project management and construction management.

He received his MSCE and BSCE in Structural Engineering from Purdue University, completed graduate studies in Water Resource Engineering at the University of Colorado, RAM-D through the Corps of Engineers, and Potential Failure Mode Analysis through the Federal Energy Regulatory Commission.

Mr. Hutton has completed training for the Sandia National Laboratories RAM-D and performed vulnerability and risk assessments for several concrete and earth dams and their appurtenant facilities. He also has completed training for the Federal Energy Regulatory Commission (FERC) Dam Safety Performance Monitoring Program and Potential Failure Mode Analysis methodology and has been involved in many projects that required application of this methodology. He has served as a FERC qualified independent consultant for the safety inspection of numerous licensed dam and hydroelectric projects. Mr. Hutton has also been the structural engineer Panel member and reviewer for four Corps of Engineers Independent External Peer Review (IEPR) projects.

His long-term overseas assignments include Vietnam, Philippines, Malaysia and Peru, with short-term assignments in Cambodia, Zambia, Iceland, Jordan, Indonesia and Ecuador. In addition, he has worked on projects in the Dominican Republic, Turkey, Nicaragua, Guyana, Lebanon and Puerto Rico.

Mr. Hutton has served on multiple Independent External Peer Review panels. Some examples are:

- Addicks and Barker Dam Safety Assurance Program IEPR, Texas
- Fort Peck Dam Spillway Stilling Basin Emergency Repair Project, Montana Rough River Dam Safety Assurance Program IEPR, Kentucky
- Isabella Dam Seismic Evaluation, California Bluestone Dam Safety Assurance Program IEPR, West Virginia Dover Dam Safety Assurance Program IEPR, Ohio San Gabriel Dam and Hydroelectric Project Potential Failure Mode Analysis, California
- Barker Dam and Hydroelectric Project Potential Failure Mode Analysis, Colorado

He is the author or co-author of thirteen technical papers presented at national conferences, seminars and workshops and published in national engineering publications. In addition to his strong technical background in water resource engineering, he has been a successful project team leader and technical designer and/or reviewer on domestic and international water resource projects. He also has conducted seminars on dam design, dam safety engineering and construction inspection. Mr. Hutton is a member of the American Society of Civil Engineers, United States Society of Dams, and the Association of State Dam Safety

B.5 Mr. Willard Smith, PE, CFM

Role: Hydrology and Hydraulic Engineering

Mr. Smith has over 41 years of experience as a hydrologist. He has used this expertise on many hydroelectric, water resource development, and storm water/floodplain projects. Mr. Smith received his Bachelor of Science in Civil Engineering from the University of Missouri (Rolla) in 1974, his AAS in Mechanical Technology from S.U.N.Y. at Morrisville in 1968, and became a Certified Floodplain Manager in 2004. He is a registered Civil Engineering in Oklahoma, Arkansas, Kansas, Missouri, Colorado, and Wyoming.

Mr. Smith was President of the National Hydropower Association (NHA) from 1988-1989 and was an active member of NHA's Board of Directors for over five years (1984-1989). He served as Vice President, Creator, and Chairman of both the FERC Committee and the International Committee. Mr. Smith was chosen to represent the National Hydropower Association as a technical specialist on CORECT Trade Missions to the Caribbean Basin (1987), to the Pacific Rim (1990, 1991, and 1993) and to Panama (1994).

Mr. Smith has been involved in many hydropower projects both domestic and international, including: Arkansas River Lock and Dam Nos. 2-6, 9, and 13; Mississippi River Locks and Dams; Red River Lock and Dam Nos. 1 and 2; Lake Eucha Dam; W. D. Mayo Lock and Dam, Jigüey-Aguacate dam complex, Dominican Republic, Hidro Jones Dam, Guatemala. He has also worked on dam design projects including: Phillips

Refinery Stormwater Project; River Parks Low Water Dam, Caney River Water Supply Intake Dam, and the Arkansas River Corridor Study. Dam safety projects include Chimney Rock Dam, Robert S. Kerr Dam, Pensacola Dam, Warrenton Dam, Lee Creek Dam (Ft Smith), New Dam/Lake Project in Okmulgee County, Oklahoma, and Mosul Dam – Iraq. Mr. Smith is a FERC Part 12D Independent Consultant and a FERC Trained PFMA Facilitator.

Mr. Smith was presented the 1996 Newsmaker Award from Engineering News Record and was listed in International Who's Who of Professionals in 1995. Mr. Smith was awarded the Dr. Kenneth Henwood Lifetime Achievement Award from the National Hydropower Association in April 2008. In September 2009, he was awarded the Charles Don Ellison Memorial Award from the Oklahoma Floodplain Managers Association in recognition of long-term contributions of leadership and support to the advancement of floodplain management in Oklahoma. In November 2009, Mr. Smith was recognized by the International Water Power & Dam Construction's list as one of the 60 most influential people who have helped shape the course of the global hydropower and dam business in the world over the past 60 years.

He is the current Past Chair of the Oklahoma Floodplain Managers Association (2008-2009), and was previously Chair (2007-2008), Vice Chair (2006-2007) and Mitigation Committee Chair (2004-2006). Smith is also currently the coordinator of the Oklahoma Floodplain Managers Association (OFMA) Disaster Response Team (DRT) which provides support to communities, counties, and Indian Tribes in Oklahoma during disasters affecting the Special Flood Hazard Area.

Mr. Smith has two recent publications: Remediating a Scour Hole Beneath the Dam No. 2 Powerhouse" Civil Structures, Hydro Review, April 2005, and "Stroking the Compulsion – Workaholism", AuthorHouse, 2007 OFMA Disaster Response Team (DRT) Program, October 2008.

He has also participated in the following workshop presentations:

- "Hydrology 101", Oklahoma Floodplain Managers Association, Training Session, Fall Conference 2005
- "OFMA Basic Training for Floodplain Administrators", Oklahoma Floodplain Managers Association, Statewide Training Course, 2005-2007
- Facilitator – "Managing the NFIP in Oklahoma" – August 27-Sept. 1, 2006, on behalf of Oklahoma Water Resources Board (OWRB) and OFMA.
- "Hydraulics 101", Oklahoma Floodplain Managers Association, Training Session, 202 Workshops – Periodic throughout each year.

- “Hydrology and Hydraulics 202”, Oklahoma Floodplain Managers Association, Training Session, 202 Workshops – Periodic throughout each year.
- “Hydrology and Hydraulics for Map Mod”, Oklahoma Floodplain Managers Association, Training Session, Advanced Workshops – Periodic throughout each year.

B.6 Mr. Douglas Spaulding, PE

Role: Engineering Geology

Mr. Spaulding is a registered engineer with over 40 years of experience specializing in geotechnical design, local flood protection, dam inspection, dam rehabilitation, Part 12 inspections, and PMFA facilitation. He holds an MSCE in Geotechnical Engineering from Purdue University and a BSCE from Valparaiso University. He is affiliated with the American Society of Civil Engineers, Minnesota Geotechnical Society, Society of American Military Engineers; a member of the American Arbitration Association, and on the Construction Claims Panel, Minneapolis, MN.

He served 10 years with the U.S. Army Corps of Engineers, which included serving as Chief of the Levee Design Section and Program Manager for the National Dam Safety Program in Wisconsin and Minnesota. Duties included project management, feasibility and siting studies, economic analyses, regulatory coordination, and management of final design for flood control and navigation structures.

Mr. Spaulding has served on several independent peer reviews including:

- Currently serving on FERC Board of Consultants for the design of the 24 MW Lake Livingston Hydroelectric Project in Texas
- Currently serving on the FERC Board of Consultants for the design of the 400 MW Gordon Butte pumped storage project.
- Served as geotechnical representative on External Peer Review to evaluate the Corps of Engineers $190-million seepage control upgrade project in East St. Louis, MO, Evaluation included review design for relief wells, slurry trenches and seepage berms
- Fargo Moorhead Flood Control Project: Served on IEPR Panel to review Corps of Engineers feasibility study for flood protection for the Fargo Moorhead area. Alternatives plans included levees, floodwalls and two diversion alternatives. The recommended diversion plan involves a 35-mile-long channel with an estimated cost of $1.3 billion.
- Evaluation of Levee Cracking: Geotechnical Engineer for study and evaluation of the cause of cracking in Corps of Engineers earth levees located throughout the Red River of the North. Investigations include literature review, field inspection, subsurface investigations and evaluation of potential causes of cracking.
- Eau Pleine Dam, Mosinee Wisconsin: This project was part of a program to upgrade the discharge capacity and increase the stability of the downstream embankment slopes. Project included the use of transient finite element analyses to evaluate the potential for sudden drawdown failures and stability analyses to determine the configuration of a sloping drain and stability berm section.
- Byllesby Dam, Dakota County MN: Studies at the Lake Byllesby Dam included stability of Ambursen Dam and the rock spillway. This included core holes to identify the character of bedrock

at depth and recommendations regarding potential remediation. The work at Byllesby Dam included a sensitivity study to evaluate potential for sliding along the bedrock/concrete contact using "CSLIDE".

- Breckenridge Flood Control Stage 1: The project involved design of 7-mile long, 20-foot deep flood diversion channel in western Minnesota. Services included evaluation of stability and utilization of clay fill material. The value engineering study on project resulted in $1.5-million cost savings.
- Seneca Falls Hydroelectric Project, Seneca Falls, New York Seneca Falls project included stability analysis using a sensitivity analysis for this 50-foot high gravity structure and implementation of an exploration program to investigate soluble voids and foundation of powerhouse. Onsite work included dye testing, preliminary grout testing and down the hole photography.
- Served as FERC approved independent consultant on over 60 Part 12 inspections for projects located nationwide.
- Lorella Pumped Storage Project: Served as project manager for the development of the preliminary design of this $1 billion pumped storage project. Design included an underground powerhouse and evaluation of 80-foot-high embankments founded on soft clay deposits in addition to design of a 170-foot-high rock fill dam. The upper reservoir utilized an asphaltic concrete membrane to control seepage and reservoir losses in the upper portion of this project.
- Baldhill Dam-Evaluation of project alternatives to increase the spillway capacity at the Corps of Engineers Baldhill Dam. Project included preliminary structural and geotechnical design, earthwork layout and quantity estimates. Also responsible for design of remedial measures to stop earth movements in the discharge channel area.
- Highway 75 Dam: Developed geotechnical and civil designs for the Corps of Engineers Highway 75 Dam near Odessa, Minnesota. Design elements for this 3.5-mile-long structure included embankments, outlet channels, two outlet works and related access roads and other features. Project included stability evaluation for 25-foot-high dam founded on soft clay.
- High Falls Embankment Stabilization, Crivitz Wisconsin: Project required design of a downstream berm to increase the embankment stability and to provide a seepage control system for emerging seepage.
- Mr. Spaulding was responsible for development and implementation of training programs for operators at both the Corps of Engineers dams (1981 to 2011) and electric utility owned structures (1995 & 2008). Training included program on identification of potential harmful conditions.
- He is an approved facilitator for the FERC's Potential Failure Mode Analysis (PFMA) program and has served as facilitator for PFMA evaluations on 45 projects in a nine state area.
- He has served on the "Development of the Lower St. Anthony Falls Hydroelectric Project" HydroVision (2010), and "Computing Sliding Factors of Safety for Concrete Structures" HydroVision (2004).
- "*Disaster Response Team (DRT) Program*" – Oklahoma Floodplain Managers Association, Special Project – In Progress (Presented at 2008 OFMA Annual Conference and to be presented as The Association of State Floodplain Managers (ASFPM) National Conference in Orlando – June 2009)

This Page Intentionally Blank

Acronyms

ADAS	Automated Data Acquisition System
APMI	Analysis Planning and Management Institute, www.APM-Inst.Org
BCRA	Baseline Condition Risk Assessment
BS	Bachelor of Science
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second (used to describe water flow rate)
COI	Conflict of Interest
DrChecks	Design Review and Checking
DSMR	Dam Safety Modification Report
DSMS	Dam Safety Modification Study
EAA	Everglades Agricultural Area
EC	Engineer Circular
ECB	Engineering Change Bulleting
ECRA	Existing Condition Risk Assessment
EJ	Environmental Justice
ER	Engineering Regulation
EM	Engineering Manual
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FRM	Flood Risk Management
FWAC	Future without Federal Action Condition
FWOP	Future Without Project
FWP	Future With Project
HEC-FDA	Hydraulic Engineering Center's Flood Damage Reduction Analysis
HEC-RAS	Hydraulic Engineering Center's River Analysis System
IEPR	Independent External Peer Review
IT	Information Technology
IWR	Institute for Water Resources
LMI	Logistics Management Institute, www.LMI.Org
MBA	Masters of Business Administration
MS	Master of Science
MSL	mean sea level
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
OEO	Outside Eligible Organization

OMB	Office of Management and Budget
OWRB	Oklahoma Water Resources Board
PE	Professional Engineer
PED	Planning, Engineering, and Design
PFM	Potential Failure Mode
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PWS	Performance Work Statement
RAS	River Analysis System
RCC	Roller-Compacted Concrete
RMP	Risk Management Plan
SDEIS	Supplemental Draft Environmental Impact Statement
TO	Task Order
TSP	Tentatively Selected Plan
UNF	University of North Florida
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
PAL	Planning Aid Letter
U.S. DA-NRCS	U. S. Department of Agriculture Natural Resource Conservation Service
WRDA	Water Resources Development Act