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Independent External Peer Review of the Delaware Beneficial Use of Dredged Material for the Delaware River Feasibility Study

Final Report

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Executive Summary

This Independent External Peer Review (IEPR) Final Report provides the results of an IEPR of the documents associated with the *Delaware Beneficial Use of Dredged Material for the Delaware River Feasibility Study* (Delaware BUDM). The Delaware BUDM is being conducted by the Philadelphia District of the US Army Corps of Engineers (USACE).

Project Background

The purpose of the Delaware BUDM is to analyze coastal storm risk management issues in various Delaware communities with the intent to use dredged material from federal navigation channels within the Delaware River and Bay for beneficial purposes.

The USACE Tentatively Selected Plan (TSP) consists of dune and berm construction at eight dredged material placement locations in Delaware along approximately 29 miles of the Delaware Bay. These are (from north to south): Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Big Stone Beach, Slaughter Beach, Prime Hook Beach, and Lewes.

Independent External Peer Review Process

The LMI Team, consisting of Logistics Management Institute (LMI) and Analysis Planning and Management Institute (APMI), has conducted an IEPR of the Delaware BUDM. The IEPR has been 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:

- Biological Resources and Environmental Law Compliance
- Civil/Design Engineering
- Coastal Engineering
- Geotechnical Engineering
- Hydrology and Hydraulic Engineering
- Planning Formulation/Economics.

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

Summary of the Independent External Peer Review Results

The IEPR Panel has completed a detailed independent technical review of the Delaware BUDM prepared by the USACE Philadelphia District. The IEPR included a review of engineering and economic issues,

models, assumptions, and calculations as well as an assessment of the environmental studies documenting potential project impacts. The following paragraphs provide a summary of the Panel's comments in specific subject matter areas.

Biological Resources and Environmental Law Compliance

From the perspective of environmental impacts and National Environmental Policy Act (NEPA) compliance, the Delaware BUDM is well written, lucid, and easy to follow as a description of the potential benefits and impacts of the TSP. The physical benefits of using dredged material from the lower reaches of the Delaware Bay to improve coastal resiliency are clear. However, there are several areas of the document that require more detail to support the assertions made therein, several of which have important implications regarding justification of the project. To ascertain whether the project is in the public interest, the costs to the taxpayer must be justified by the benefits of the project. There are several cases in which the information necessary to support both the benefits and costs need augmentation and further detail. For example, existing erosion rates do not seem to be adequately quantified and explained, which is critical for justifying the amount of material needed to protect shoreline areas. The selection of the 26 areas considered for restoration/replenishment is incorporated only by document reference, but a methodological description of how they were selected is necessary for the reader to understand the basis of the TSP. The Delaware BUDM discusses how the project would be beneficial to wildlife, but does not distinguish between benefits/impacts to different species groups, nor does it discuss in detail the wildlife management areas it is designed in part to protect, or how they would benefit from the TSP. Some quantification should be given to the habitat acreage that would be protected from implementing the TSP, and more detailed discussion should be provided about which species groups might benefit (e.g., ducks, migrating passerine birds, migrating shorebirds, and others) so that a more detailed picture of the project benefits can emerge. The report discussion seems to focus entirely on endangered species.

The Delaware BUDM does not describe how beneficial reuse of dredged material for habitat restoration relates to an overall strategy of watershed management for the Delaware River, including such issues as sustainable sediment management (e.g., reducing sediment loading from the watershed) and the potential interaction among dredging activities and coastal erosion processes. By limiting the Delaware BUDM discussion entirely to the description of specific beach replenishment projects proposed under the TSP for the Delaware side of the bay, USACE has not explained how these proposed projects would be successful within a regional framework that would include other potential erosion control measures that do not involve dredged material. The text discussion should make it clear whether USACE has undertaken an analysis of overall sediment load to the system and evaluated the degree to which the problem of what to do with large volumes of dredged material could be eliminated by working with states, municipalities, and others to minimize sediment loads into the system. Reducing sediment loading via sustainable sediment management could reduce the overall amount of material requiring removal and disposal.

Civil/Design Engineering

The concept of using dredged materials for improving coastal resiliency instead of disposal is a win-win concept of beneficial use. The mostly granular nature (sand/gravel) of the materials to be dredged renders this concept feasible as clearly explained in the TSP. Appendix C2, *Civil Design*, provides the method by which the estimated quantities of beach fill were determined using dredged materials. Dune and berm dimensions and slopes (i.e., the simplified cross sections) are appropriate. However, a single simplified existing grade was assumed for all sites. It is not clear how the existing grade was obtained and

how representative it is. The fill area thus obtained was multiplied by an assumed length of fill at each site to determine the volume of fill required. However, the criterion for designated length of fill is not evident. The dredged material is already eroded bay-bottom sediment and in this coastal environment is likely to erode again, requiring continual replenishment. The material is already an erosion product, implying that it will not have full resistance to storm events. This may result in more frequent nourishment than the anticipated every-fourth-year cycle and may require a plan to protect the seaward face of berms/dunes. The relative cost of providing such protection compared with more frequent nourishment than the assumed 4-year cycle is not presented.

Coastal Engineering

Considering the study level as a feasibility study, the Delaware BUDM has paid attention to the key issues and discussed realistic assumptions and applicable approaches. The *Hydrology and Hydraulics* report has been put together very well and the format is easy to follow. The Delaware BUDM needs to include some necessary information and clarifications on the assumptions and values utilized in the study. For example, Appendix C1, *Hydrology and Hydraulics*, does not provide enough information on the dredged material characteristics and the erosion processes and rates at the project sites to determine if the dredged material is compatible with the native beach material, if the material is in the valid range of the SBEACH model, and the frequency of beach nourishment that will be required.

Some of the hydrodynamic parameters are not clearly explained as to how they were obtained and the procedure and criteria used to select them. The bases for transect locations that have been used for analyses of the shoreline and the criteria that have been used to locate transects need more explanation. The infrastructure information and structure inventory for the project areas that were used in the Beach-fx model is not clearly discussed and defined. Important requirements such as the proximity of the project sites to areas designated under the Coastal Barrier Resources Act have not been explored and discussed. The main body of the Delaware BUDM does not discuss or evaluate the potential for secondary inundation resulting from flooding of the marshland or streams on the landward side of the various communities.

Geotechnical Engineering

The proposed concept represents an innovative way to combine navigational maintenance requirements with the need to reduce the impacts of storm damages. The report clearly documents this concept. The schedule and cost estimate included in the feasibility report assumes that the initial and subsequent placement of dredge material at the eight sites can be accomplished utilizing one mobilization. The environmental constraints described in the report, however, indicate that placement of material would be limited to approximately 6 or 7 months per year during the fall and winter seasons. The Panel is concerned that the assumption of one mobilization per placement cycle is unrealistic based upon the environmental constraints. The mobilization cost represents up to approximately 20 percent of the direct project cost, and an increased number of mobilizations would have a significant impact upon the total project cost. Another factor that affects the feasibility of the project is the possibility of continued disposal at the current Buoy 10 site or at other potential disposal sites that would be closer than the Artificial Island site. The report does not discuss the potential increased availability of disposal at the Buoy 10 site beyond 2030 or the feasibility of developing other sites closer than the Artificial Island confined disposal facility. The report does not deal with the possible need for stormwater outfalls through the constructed berm/dune system to accommodate landward precipitation at any locations where drainage is directly to the Delaware Bay.

Hydrology and Hydraulic Engineering

This study adopted a logical approach to assess the potential hydrologic/hydraulic performances of various alternatives at selected locations. The basis of the analysis relies on the results of the North Atlantic Coastal Comprehensive Study (NACCS). Most assumptions appear to be reasonable scenarios.

Although the review documents described the approach adopted in the analyses and how some of the parameters were selected, the parameters used and the data/observations utilized to develop these parameters were not presented in detail. Some parameters that led to the selected alternative are uncertain. The significance of the major assumptions and impacts of possible deviations from these assumptions on decision-making were not comprehensively addressed. Examples are assumptions of average shoreline erosion rate, wave height, and sea level change curves. It would be important to identify major uncertainties that could potentially influence the cost-effectiveness of various alternatives. Parametric, sensitivity, uncertainty, and/or decision analyses can be performed to estimate the impacts of uncertainties on potential performance and total costs (capital, operational, and non-performance costs).

The study is based on 26 evaluation locations pre-selected based on current condition. Some of the locations were screened out based on current land use. Since the study considers a 50-year implementation and operation period, it is anticipated that land use and population will change. These changes might result in addition and/or elimination of project locations. It is unclear how the cost-effectiveness of various alternatives would be affected by these potential changes and whether adaptive implementation might be beneficial. Hydrology and hydraulic evaluation at other potential locations might be insightful.

Planning Formulation/Economics

The decision document effectively addresses the stated need and intent of the scientific and technical information for the plan formulation and economic analyses. The beneficial use of dredged material to minimize flood-related damages to Delaware communities and increase resiliency along the Delaware shoreline is clearly a desirable opportunity. However, the Delaware BUDM does not include critical project evaluation information used in the study analyses that is necessary for the reviewer to evaluate the analysis and findings. The types of information not provided includes detailed project cost; equivalent annual costs and benefits; cost sharing; and operation, maintenance, repair rehabilitation and replacement actions, costs, and responsibilities.

Summary of Final Panel Comments

Presented below is a summary of the final IEPR Panel comments. Section 5 contains definitions of comment significance and the complete comments with explanations and recommendations.

Significance of Comment	Number of comments
High	2
Medium High	6
Medium	11
Medium Low	2
Low	3

No.	Final Panel Comment
Significance: High	
1	The Delaware Beneficial Use of Dredged Materials (BUDM) for the Delaware Feasibility Study excludes important cost elements.
2	The analysis in Appendix D, *Evaluation of Section 404(b)(1) Guidelines*, does not address the question as to whether alternatives to the Tentatively Selected Plan (TSP) exist that would minimize any disturbance to wetlands or open water areas as a result of dredged material placement.
Significance: Medium High	
3	The cost estimate for the TSP assumes that only one mobilization will be required for the initial beach nourishment. Based upon environmental considerations, this assumption is not realistic, and therefore the cost estimate contained in the TSP underestimates the likely construction cost.
4	Impacts of the uncertainties of critical parameters on potential cost-effectiveness of various alternatives and selection decision were not comprehensively evaluated.
5	The Delaware BUDM does not describe how the 26 specific coastal storm risk management (CSRM) problem areas were identified and selected. Also, the Delaware BUDM and the *Value Engineering (VE) Study* Appendix identify different numbers of alternatives that should be carried forward to be considered.
6	Table 6 in the Delaware BUDM does not describe what species/taxa of wildlife and aquatic organisms and their habitats would benefit from the TSP and which could be impacted, both on a short-term and long-term basis.
7	The assumptions regarding dredged material disposition under the Future No-Action condition require further support in the Delaware BUDM as a basis for cost estimates and need for the project.
8	There is insufficient information on the dredged material characteristics and the erosion processes and rates at the project sites to determine if the dredged material is compatible with the native beach material and the frequency of beach nourishment that would be required.

Significance: Medium	
9	The Delaware BUDM does not clearly state the range of the grain sizes of the dredged material and the native beach material to show that grain size is in the valid range to use the SBEACH model.
10	Table 4 in the *Report Synopsis* does not adequately support the findings of the Delaware BUDM with respect to selected alternatives.
11	There is no description of how beneficial reuse of dredged material for habitat restoration is related to an overall strategy of watershed management for the Delaware River, including such issues as sustainable sediment management (e.g., reducing sediment loading from the watershed) and the potential interaction between dredging activities and coastal erosion processes.
12	There is no description of the impacts/benefits of the TSP on specific wildlife management areas mentioned in Section 2.4.
13	The discussion of sediment quality regarding contaminants requires further documentation.
14	Data and observations used for developing major parameter values in hydrologic and hydraulic analyses are not adequately documented in the review documents (including Appendix C1).
15	The Delaware BUDM does not discuss or evaluate the flood risk to the project communities from storm-surge flooding of the marshland or streams on the landward side of the various communities.
16	The beach erosion modeling and analyses need additional explanation regarding save points and the reason for adding half of the wave height to the still-water elevation.
17	The *Hydrology and Hydraulics* report does not clearly establish the basis for transect locations used for analyses of the shoreline and what criteria have been used to locate transects.
18	The Delaware BUDM does not clearly describe how the infrastructure information and structure inventory for the project areas to be used in the Beach-fx model were determined and defined.
19	There is no information regarding how the project sites are affected by the requirements of the Coastal Barrier Resources Act (CBRA) of 1982.
Significance: Medium Low	
20	There is no discussion of the possible need for stormwater outfalls through the constructed-dune storm protection barrier to drain stormwater to Delaware Bay from behind the dune barrier at those locations where land drainage is directly into Delaware Bay.
21	Future land use changes and planning are not addressed.

Significance: Low	
22	The Cycle 1 screening process utilized a maximum 20-mile haul distance for material from maintenance dredging to eliminate potentially feasible disposal sites from consideration. This criterion is relatively arbitrary, and alternative criteria were used in the final screening analysis.
23	Statements on page 11 of the VE Study incorrectly state that USACE standards do not commonly support the construction of levees from dredged material or totally pervious material.
24	There are insufficient details regarding the hydrodynamic characteristics of the project sites, such as routine recurrence intervals for parameters such as wave height and still-water elevation to help the reader understand the sites better.

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1 Introduction

1.1 Introduction and Report Overview

This Independent External Peer Review (IEPR) Final Report provides the results of an IEPR of the documents associated with the *Delaware Beneficial Use of Dredged Material for the Delaware River Feasibility Study* (Delaware BUDM). The Delaware BUDM is being conducted by the Philadelphia District of the US Army Corps of Engineers (USACE).

The purpose of the Delaware BUDM is to analyze coastal storm risk management (CSRM) issues in various Delaware communities with the intent to use dredged material from federal navigation channels within the Delaware River and Bay for beneficial purposes.

The USACE Tentatively Selected Plan (TSP) consists of dune and berm construction at eight dredged material placement locations in Delaware along approximately 29 miles of the Delaware Bay. These are (from north to south): Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Big Stone Beach, Slaughter Beach, Prime Hook Beach, and Lewes.

Section 1 of the IEPR Final Report provides a description of the objectives of this IEPR, general background information on the IEPR, and a brief introduction to the Logistics Management Institute (LMI) and Analysis Planning and Management Institute (APMI) Team that managed the IEPR process and supported and assisted the IEPR Panel. Section 2 provides an overview description of the USACE project reviewed in this IEPR. Section 3 summarizes the process followed to perform the IEPR. Section 4 describes the IEPR Panel composition and the IEPR Panel Members' expertise. Section 5 presents the IEPR Panel comments. Appendix A reproduces the USACE Charge to Reviewers provided to the IEPR Panel to use as guidance for the IEPR. Appendix B provides short resumes for the IEPR Panel Members.

1.2 Independent External Peer Review Overview

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 Delaware BUDM and associated appendices. The IEPR has been 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.

1.3 Independent External Peer Review Management Team

This IEPR was conducted by a group of independent experts under the auspices of APMI as a subcontractor to LMI, collectively referred to as the LMI Team. Both organizations are not-for-profit science and technology entities that provide impartial, independent assistance, free of Conflict of Interest (COI) with federal government organizations. Neither organization has performed or advocated for nor against any federal water resources projects or has 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 efforts documented in the Delaware BUDM.

2 Project Description

The US Congress has directed and authorized the USACE to investigate the beneficial uses of dredged material within the Delaware River and Estuary area.[1] The authorization includes conducting a utilization-study reconnaissance phase and any ensuing feasibility-phase investigations. The USACE has prepared the Delaware BUDM under this authority.

2.1 Background

The USACE dredges approximately 3,000,000 cubic yards of sediment annually from the Delaware River in the Philadelphia-to-the-Sea reach and the Philadelphia-to-Trenton reach. The sediment is removed from the estuary and placed in confined disposal facilities or nearby open disposal areas. The USACE is studying innovative methods to manage and reuse the dredged material to improve flood risk management.

The USACE has conducted the *Delaware River New Jersey, Delaware, and Pennsylvania Dredged Material Utilization and Beneficial Use Opportunities Expedited Reconnaissance Study*. The purpose of the study was to examine beneficial use opportunities using maintenance dredging material from the Delaware River and its tributaries for flood reduction, environmental restoration, and related purposes.

The reconnaissance study found that there is a federal interest in additional investigations of opportunities for beneficially reusing sediment for multiple purposes by conducting a feasibility study within the State of Delaware. Based on a screening of alternatives in the reconnaissance study, there were potential projects within Delaware that would be consistent with Army policies regarding costs, benefits, and environmental impacts. The Delaware BUDM documents the analysis of these projects.

2.2 Project Description

The purpose of the Delaware BUDM is to analyze coastal storm risk management (CSRM) issues in various Delaware communities with the intent to use dredged material from federal navigation channels within the Delaware River and Bay for beneficial purposes. The objectives of the study are the following:

- Reduce flood-related impacts to people, property, and infrastructure along and adjacent to the Delaware shoreline from 2020 to 2070 via the beneficial use of dredged material.
- Increase the resiliency of coastal Delaware via the beneficial use of dredged material, specifically along the Delaware River/Bay and Delaware Inland Bay shoreline.

The study is evaluating flood-related damages in Delaware occurring in two distinct zones of the tidal Delaware River watershed as defined by the Delaware River Basin Commission (Figure 1). Zone 5 extends from River Mile 78.8 to River Mile 48.2. Zone 5 is in the tidal freshwater portion of the watershed, extending from the Pennsylvania/Delaware boundary line to Liston Point. Zone 6 extends from River Mile 48.2 to the Atlantic Ocean (River Mile 0). Zone 6 represents the bay/estuary region, extending from Liston Point

[1] *Senate Resolution on Beneficial Use of Dredged Material on the Delaware River, Delaware, New Jersey, and Pennsylvania* and the *Disaster Relief Appropriations Act, 2013* (Public Law 113-2).

to the Atlantic Ocean (including the tidal portions of the tributaries). The study is also evaluating CSRM solutions along the inland bays of the Delaware ocean coastline.

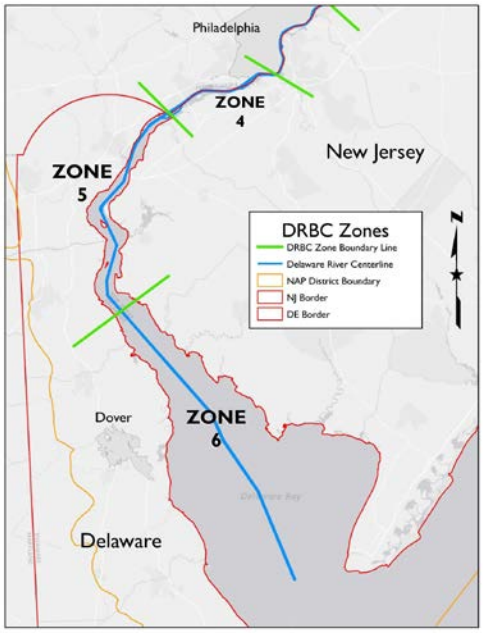


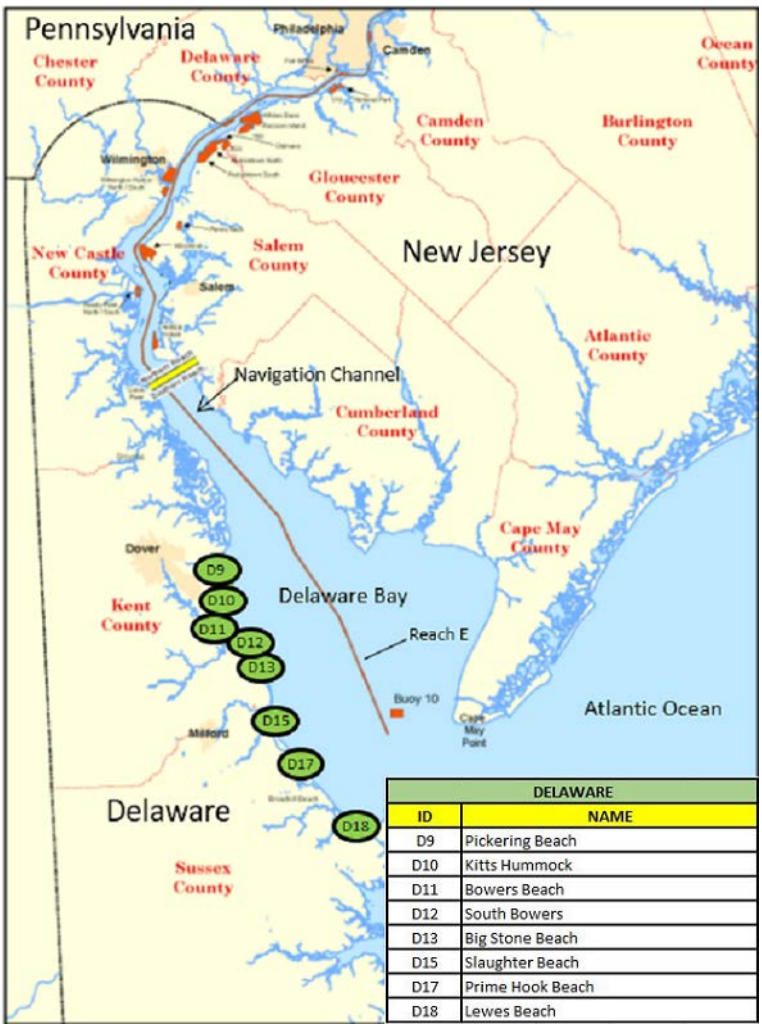
Figure 1: Delaware River Zones as Defined by the Delaware River Basin Commission

The USACE developed a wide variety of management measures that would address one or more of the planning objectives. These measures were evaluated and screened, and the final array of alternative plans for the entire study area were the following:

- No-Action Plan
- Levee/Dike Plan
- Beach Restoration Plan
- Beach Restoration with Groin(s) Plan
- Beach Restoration with Breakwater Plan
- Beach Restoration with Groin(s), Breakwater, Living Shoreline, and Wetland Plan.

2.3 Tentatively Selected Plan

The USACE TSP consists of dune and berm construction at eight dredged material placement locations in the southern reach of the study area (Figure 2). The eight dredged material placement locations are located along approximately 29 miles of the Delaware Bay. These are (from north to south): Pickering Beach, Kitts Hummock, Bowers Beach, South Bowers Beach, Big Stone Beach, Slaughter Beach, Prime Hook Beach, and Lewes.



DELAWARE	
ID	NAME
D9	Pickering Beach
D10	Kitts Hummock
D11	Bowers Beach
D12	South Bowers
D13	Big Stone Beach
D15	Slaughter Beach
D17	Prime Hook Beach
D18	Lewes Beach

Figure 2: Location of Sites in the Tentatively Selected Plan

The USACE developed a project template for constructing the dune-and-berm plan at the locations shown in Figure 2. The template was based on the following:

- Summary of existing conditions at each site.
- Range of existing project dimensions along Delaware Bay (Broadkill Beach, Prime Hook National Wildlife Refuge, and Lewes).
- Assumption that the design purpose is to provide storm damage-reduction benefits.
- Assumption that the design will include periodic nourishment.

The USACE determined that one type of template is suitable for seven of the eight locations, and that a variation of the design is suitable for Lewes Beach.

Figure 3 shows the proposed design template for Lewes Beach. The design template will expand the linear footprint of an existing authorized project by 10,100 feet to the southeast. The authorized project consists of a dune and berm extending from Roosevelt Inlet approximately 900 feet southeast with a 500-foot taper. Initial construction of the existing project included reconstructing the adjacent terminal groin

for Roosevelt Inlet for the purpose of navigation and beach fill. The project consisted of a 15-foot wide berm (North American Vertical Datum of 1988—NAVD 88) extending bayward at a slope of 1V:10H above mean high water and a dune with a 25-foot crest width with an elevation of 14 feet (NAVD 88) for the purpose of coastal storm damage reduction. The Lewes Beach portion of the TSP proposes to utilize the design template of the existing Lewes project for the remaining 10,100-foot stretch of the community.

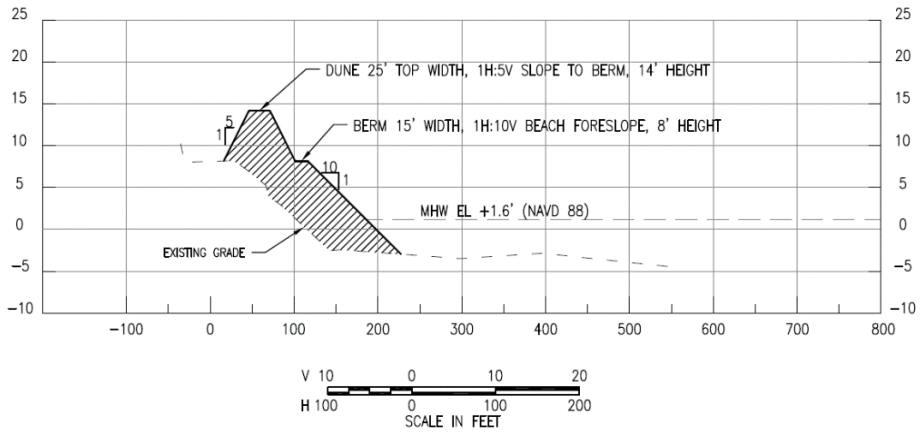


Figure 3: Design Template for Placing Dredged Material at Lewes Beach

Figure 4 shows the proposed design template for the other seven locations. The template features a berm of 25-foot width at a height of 7 feet (NAVD 88) with a foreslope of approximately 400 feet in length on a slope of 1V:10H extending bayward to a depth of closure of -5.0 feet (NAVD 88). The top of the berm has a crest width of 25 feet at a height of 12 feet (NAVD 88). The dune transitions both bayward to the berm and landward to existing grade on a slope of 1V:5H.

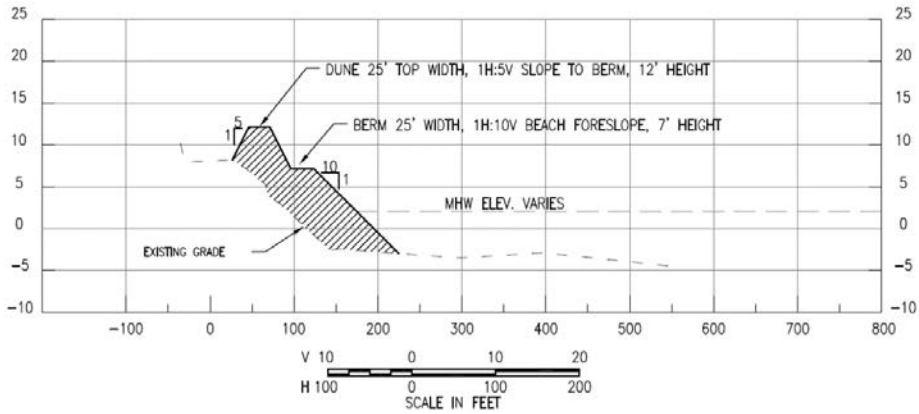


Figure 4: Design Template for Placing Dredged Material at Seven Locations

Varying volumes of dredged material are required at each of the eight placement locations, depending on the length of shoreline to be nourished and the existing beach profile. The USACE anticipates using a 4-year periodic nourishment cycle to maintain optimal CSRM. This nourishment cycle is consistent with the proposed operation and maintenance dredging to be performed in the proposed project dredged material source area in the lower Delaware Bay shipping channel; however, the nourishment cycle will be further refined during the plan optimization project phase.

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 Managing the Project

The LMI Team developed and executed a Work Plan 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.

The organizational structure for managing the IEPR is shown in Figure 5. The purpose of this organizational structure was to assure the independence of the review. As shown, the LMI Team mediated any interactions between the Panel and USACE. There was no direct interaction of Panel Members with USACE.

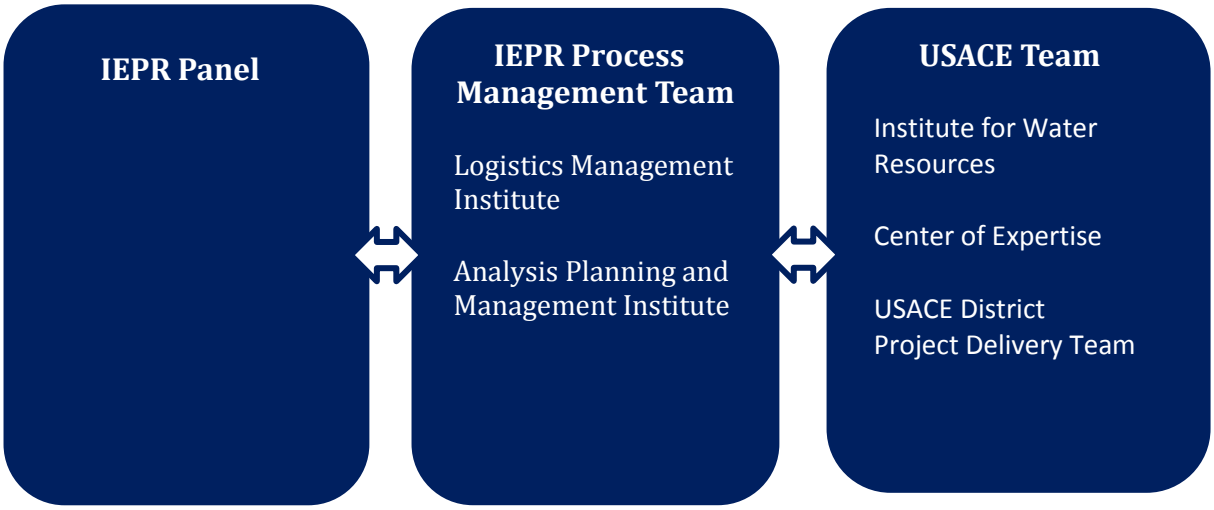


Figure 5: Organization for Managing the IEPR

3.2 Selecting the Panel

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 Sciences (NAS) and Office of Management and Budget 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:** The reviewer was not involved with projects for the Delaware BUDM 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 candidate's availability to meet the project schedule.

The LMI Team conducted an initial screening of candidates to exclude those with inadequate expertise or potential COI issues. We then selected several candidates 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 who would be available to serve on the IEPR Panel while ensuring a balanced panel representing perspectives from academia, industry, and government to the extent possible. The LMI Team 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 are in Appendix B.

3.3 Preparing and Charging the Panel

The USACE provided to the LMI Team the documents to be reviewed by the IEPR Panel. Table 1 includes the list of the documents used in this review. We 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

Documents for Review
Feasibility Report and Integrated Environmental Assessment
Appendix A – Economic Analysis
Appendix B – Real Estate Plan
Appendix C1 – Hydrology and Hydraulics
Appendix C2 – Civil Design
Appendix C3 – Cost Engineering
Appendix D – 404(b) Analysis
Documents for Reference Only
Enclosure 4 – Report Synopsis
Appendix C4 – Geotechnical Engineering
Appendix E – Pertinent Correspondence
Appendix F – Value Engineering Study
Enclosure 3 – Risk Register
Public Comments

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 the LMI Team would be the conduit for information exchange between the Panel and USACE throughout the project in order to ensure a truly independent review.

3.4 Performing the Independent External Peer Review

This review involved conducting an independent technical peer review of the Delaware BUDM 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.

A kickoff meeting was held at the start of the IEPR with the Panel, USACE, and the LMI Team. At this meeting, introductions were made among the Panel members, USACE, and the LMI Team. The main purpose of this meeting was for the USACE to present an overview briefing of the USACE project that was the subject of this IEPR. The Panel asked questions of the USACE and discussed any initial issues of interest.

A teleconference was held with the Panel, USACE, and the LMI Team at the approximate midpoint of the IEPR, but before the Panel Members had formulated their comments. The purpose of the meeting was for the Panel to ask the USACE questions about the project and the documents under review, discuss project technical issues, and identify any additional USACE documentation and information that could help the Panel in its review. The Panel used the information from the meeting to help prepare and finalize its comments submitted in the Panel Final Report.

Throughout the review process, the LMI Team 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 and independence of the IEPR process.

3.5 Finalizing the Panel Comments

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

The LMI Team 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:** An explanation of 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, including a description of any additional research that would appreciably influence the conclusions.

3.6 USACE Responses to Panel Comments

After submitting this IEPR Final Report to the USACE, the LMI Team entered the FPCs into the Design Review and Checking System (DrChecks) for USACE internal tracking of the FPCs and recommendations as well as the formal responses by the USACE and IEPR Panel's responses (called the BackCheck) to complete the IEPR process. DrChecks is an Internet-based review and checking application that the USACE uses.[2]

The USACE will review and respond to the FPCs. 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 (ER) to each comment.

The IEPR Panel will then review the USACE draft ERs. The LMI Team will hold a meeting with the Panel Members and the USACE evaluators so that the Panel and USACE can discuss the draft ERs and ensure there is a clear understanding of the intent of FPCs. After this meeting, the USACE will finalize their ERs and enter them into DrChecks. The USACE's responses usually indicate whether documentation will or will not be expanded, revised, or changed in response to the FPCs.

3.7 Panel BackCheck Responses

After the USACE final ERs are submitted and entered into DrChecks, the LMI Team will meet with the Panel, as needed, to discuss the responses and the approach for preparing the Panel's BackCheck. As part of the BackCheck process, the Panel will select either "Concur" or "Non-Concur" with each USACE final ER and provide comments (as needed) to indicate whether each response adequately addresses the Panel's identified concerns. The LMI Team will enter the Panel's BackCheck responses to each USACE ER into DrChecks.

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

4 Panel Organization

The LMI Team 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.

4.1 Independent External Peer Review Management

Figure 6 shows the organization of this IEPR. The purpose of this organization is to ensure the independence of the review.

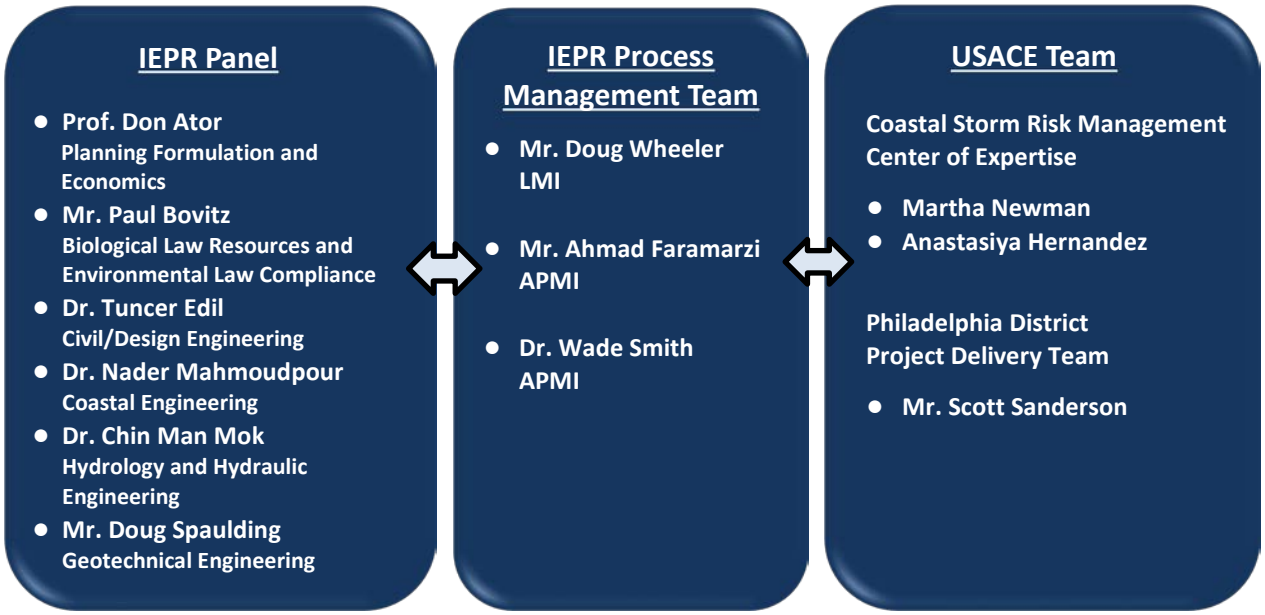


Figure 6: Organization for this IEPR

4.2 Independent External Peer Review Panel Members

The IEPR Panel Members satisfied the qualification requirements for each of the areas of expertise called for in the USACE PWS:

- Planning Formulation/Economics
- Biological Resources and Environmental Law Compliance
- Civil/Design Engineering
- Coastal Engineering
- Hydrology and Hydraulic Engineering
- Geotechnical Engineering.

Prof. Don Ator

Role: Planning Formulation/Economics

Prof. Ator has over 30 years' experience conducting economic analyses for more than 450 water resources planning projects nationwide. He has specialized experience conducting the economic analysis that determines a project's benefits. The large capital investment projects he has worked on have required the economic analysis of benefits and costs on a common time basis. He has discounted the economic value of the projects' benefits and costs over the period of analysis using the appropriate interest rate to develop benefits-to-costs ratios indicating the project's economic efficiency.

Prof. Ator has worked as an economist for the USACE Vicksburg District, Gulf South Research Institute, and three architect-engineer firms conducting water resources economic evaluations. He has extensive experience with the USACE planning process as outlined in Engineer Regulation (ER)-1105-2-100, *Planning Guidance Notebook*, especially with regard to Flood Risk Management studies, and has worked with the USACE Hydrologic Engineering Center Flood Damage Reduction Analysis (HEC-FDA), Computerized Agricultural Crop Flood Damage Assessment System, @RISK, and USACE Institute for Water Resources Planning Institute software programs.

Mr. Paul Bovitz

Role: Biological Law Resources and Environmental Law Compliance

Mr. Bovitz is a certified professional wetlands scientist and ecologist with a Master of Science (MS) degree in Ecology and over 30 years of experience, much of it directly applicable to the issues being addressed in the peer review. He is experienced in National Environmental Policy Act (NEPA) compliance, having completed several environmental assessments (EAs), Dredged Material Management Plans, environmental impact statements (EISs), and other NEPA documents. He also has extensive USACE contracting experience in preparing NEPA-compliant feasibility studies for habitat restoration and environmental remediation projects. Thus, he is well familiar with the USACE planning process for civil works projects.

Mr. Bovitz has conducted and reviewed cultural resources surveys for several NEPA-related projects, performed and reviewed biological assessments nationwide, evaluated endangered species issues, worked in both lake and river ecosystems, having performed aquatic surveys and ecological risk assessments at several sites. In addition, he has performed extensive cumulative impacts analyses, including one for the Meadowlands Mills EIS on behalf of the USACE New York District Regulatory Branch, wherein he evaluated potential impacts of several concurrent projects within the Hackensack Meadowlands on flooding, wildlife, and other wetland values.

Dr. Tuncer Edil

Role: Civil/Design Engineering

Dr. Edil has been a civil and environmental engineering faculty member at the University of Wisconsin-Madison with over 40 years of experience as an engineer in academia. He has acted as an engineering consultant to government agencies and private firms on a variety of civil, environmental, coastal, and geotechnical topics. Dr. Edil is a Professional Engineer registered in the State of Wisconsin for more than 40 years. Dr. Edil has worked on flood risk management structures including dams, levees, retaining walls, coastal protection structures, etc., as a researcher and consultant. Specific project examples include his service in dam safety inspection on USACE teams and currently on the Dam Safety Expertise Committee

for the Republic of Turkey. His latest assignment is serving as the reporter for the investigation of settlement issues in Ataturk Dam, the largest Dam in Turkey. He designed the revetment to protect the Indian Cemetery in Madeleine Island, Wisconsin, from flooding and erosion. He also designed dikes for storm-water-retention lagoons to prevent rapid drawdown and the capping of hazardous sludge lagoons. Dr. Edil has 40 years of experience in coastal erosion and coastal bluff restoration in the Great Lakes. He has researched, designed/reviewed coastal protection structures, and currently serves on the Coastal Hazards Committee of the State of Wisconsin. Dr. Edil was on the review panel of the USACE Green Bay, Wisconsin, dredging project and became familiar with the USACE procedures. He has taught a course on slopes and seepage and settlement for 40 years at the university and lectured on these topics for more than 30 years in professional short courses. He had numerous consulting engagements on slope stability and settlement issues. He has notable experience with dredged materials and coastal processes. He is a Distinguished Member of American Society of Civil Engineers (ASCE) and Diplomate of Geotechnical Engineering. He is the recipient of numerous personal and team/project awards from the ASCE, American Society for Testing and Materials (ASTM), and other organizations, including Thomas A. Middlebrooks and Terzaghi awards from ASCE and the Woodland G. Shockley Memorial Award from ASTM.

Dr. Nader Mahmoudpour

Role: Coastal Engineering

Dr. Mahmoudpour has a Doctor of Philosophy (PhD) and professional engineering registration as a civil engineer. He has more than 24 years of experience as a water resources engineer conducting hydrologic and hydraulics analyses for riverine systems and for 2D hydrodynamic storm surge, waves, and sediment transport modeling. He has provided technical expertise for Federal Emergency Management Agency (FEMA) flood hazard risk analyses for riverine and coastal studies for many miles of riverine and coastal shoreline. He has experience in stormwater management analysis and design; in National Pollutant Discharge Elimination System, Total Maximum Daily Load, and Municipal Separate Storm Sewer System (MS4) requirements; and watershed studies utilizing geographic information system (GIS) applications. He has thorough knowledge of near-shore coastal processes including refraction/diffraction analysis, run-up, littoral transport, shoaling, and beach erosion. He has served on a variety of water resources projects in transportation, water supply, bridge hydraulics and scour analysis, and sewer system design and construction.

Dr. Mahmoudpour provided technical assistance on wave damage functions for the USACE Coastal Storm Damage Prevented Research and Development project, and was a lead engineer for the *Limit of Moderate Wave Action Operating Guidance* and *Primary Frontal Dune Best Practices* documents prepared for FEMA. He has co-presented at the Ocean Studies Board meeting on the topic: "Developing a Coastal Impact Factor to Assess Hurricane Intensity for the Ocean Studies Board," Board on Atmospheric Sciences and Climate, National Research Council, NAS, March 2013.

Dr. Chin Man Mok

Role: Hydrology and Hydraulic Engineering

Dr. Mok has over 30 years of experience in hydrological, hydraulic, geotechnical, seismic, and environmental engineering. He has managed and directed the analysis, design, and/or evaluation of a wide range of engineering projects, including locks, dams, levees, flood-walls, transportation infrastructures, and water resources systems. He received his MS and PhD in Civil and Environmental Engineering from the University of California, Berkeley. He is a Professional Engineer and a Professional Geologist as well as

a board certified Water Resources Engineer and Geotechnical Engineer. He is a Fellow of the ASCE and the Environmental and Water Resources Institute. He specializes in risk/reliability/hazard analysis, computational modeling, optimization, and decision support. Recently, he has completed the scour and erosion evaluation for eight hydropower dams in California. He has performed analyses to evaluate the impacts of climate variation and uncertainties on water systems, including the sea water level rise. Dr. Mok is a seasoned reviewer. He has served on an IEPR Panel for a USACE project and on the expert panel for the Independent Review of the Yucca Mountain Project License Application Documents. Dr. Mok is also active in academia. He is an Adjunct Professor at the University of Waterloo, Ontario, and a Rudolf Diesel Industry Fellow at the Technical University of Munich. He has been teaching professional short courses worldwide as well as academic courses at the University of California, Berkeley, and University of Hong Kong. Dr. Mok is and has been the Principal Investigator of many research projects funded by the US Department of Energy (DOE) and US Department of Defense (DoD).

Mr. Doug Spaulding
Role: Geotechnical Engineering

Mr. Spaulding has over 48 years of experience in the design, evaluation, and inspection of water retaining structures such as dams, levees, and floodwalls. Mr. Spaulding has an MS in Civil Engineering (MSCE) degree in geotechnical engineering and is currently a registered professional engineer in four states. His experience includes 10 years with the USACE where he served as Chief of the Levee & Channel Design Section for the St. Paul District. He also has worked as an Independent Consultant conducting inspections, evaluation, and design of more than 70 flood control and hydroelectric dams throughout the United States. His recent experience includes serving as a facilitator for the Federal Energy Regulatory Commission (FERC) Potential Failure Mode (PFM) Evaluation for more than 70 dams located throughout the United States. He has served on several IEPR Panels for projects located throughout the United States and has provided design services, project management, and peer review for over 18 local flood protection projects located throughout the country. 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 and involved analyses of trade-offs between right-of-way costs and structural costs. Mr. Spaulding's career includes evaluation of risks associated with the long-term performance and design of water retaining structures and conveyance facilities. This process requires evaluating appropriate analytical procedures, making appropriately conservative assumptions, and obtaining sufficient geotechnical data to describe the subsurface profiles and performance characteristics. Each project is unique and must be viewed and evaluated without preconceived concepts of risk or performance.

4.3 Independent External Peer Review Process Management Team

The IEPR process management team consisted of the following members.

Mr. Doug 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, 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 function. He led the review of the USACE McClellan-Kerr Arkansas River Navigation System maintenance activity and supported the USACE Inland Marine Transportation System. Because of this work, 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 the 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 a Master of Business Administration (MBA) and a Bachelor of Science (BS) in Mechanical Engineering from Columbia University and an MS in Engineering 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 US Army, the US 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 NAS. Mr. Faramarzi has a Post-Masters applied scientist/engineer degree from the George Washington University in Aerospace and Mechanical Engineering (fluid mechanics and biomimetics), an MS in Thermofluid Engineering, and a BS in Nuclear Engineering. He has extensive experience with nodal and multi-dimensional fluid flow models, and 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.

Dr. Wade Smith, Task Leader (APMI)

Dr. Smith is an ecologist and environmental scientist who received his PhD 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 prepared programmatic and site-specific EISs, 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.

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5 Independent External Peer Review Comments

The IEPR Panel has completed a detailed independent technical review of Delaware BUDM prepared by the USACE Philadelphia District. The review included review of engineering and economic issues, models, assumptions, and calculations as well as an assessment of the environmental studies documenting potential project impacts.

Section 5.1 provides a summary of the IEPR Panel comments. Section 5.2 presents the complete set of IEPR Panel comments.

5.1 Summary of Independent External Peer Review Comments

There were a total of 24 Panel comments. Of these, 2 were identified as having High significance, 6 as Medium High significance, 11 as Medium significance, 2 as Medium Low significance, and 3 as Low significance. The specific comments noted by the IEPR Panel are provided in Section 5.2. The following paragraphs provide a summary of the Panel's comments in specific subject matter areas.

Biological Resources and Environmental Law Compliance

From the perspective of environmental impacts and NEPA compliance, the Delaware BUDM is well written, lucid, and easy to follow as a description of the potential benefits and impacts of the TSP. The physical benefits of using dredged material from the lower reaches of the Delaware Bay to improve coastal resiliency are clear. However, there are several areas of the document that require more detail to support the assertions made therein, several of which have potentially significant implications regarding justification of the project. To ascertain whether the project is in the public interest, the costs to the taxpayer must be justified by the benefits of the project. There are several cases in which the information necessary to support both the benefits and costs need augmentation and further detail. For example, existing erosion rates do not seem to be adequately quantified and explained, which is critical for justifying the amount of material needed to protect shoreline areas. The selection of the 26 areas considered for restoration/replenishment are incorporated only by document reference, but a methodological description of how they were selected is necessary for the reader to understand the basis of the TSP. The Delaware BUDM discusses how the project would be beneficial to wildlife, but does not distinguish between benefits/impacts to different species groups, nor does it discuss in detail the wildlife management areas it is designed in part to protect or how they would benefit from the TSP. Some quantification should be given to the habitat acreage that would be protected from implementing the TSP, and more detailed discussion should be provided about which species groups might benefit (e.g., ducks, migrating passerine birds, migrating shorebirds, and others) so that a more detailed picture of the project benefits can emerge. The report discussion seems to focus entirely on endangered species.

The Delaware BUDM does not describe how beneficial reuse of dredged material for habitat restoration relates to an overall strategy of watershed management for the Delaware River, including such issues as sustainable sediment management (e.g., reducing sediment loading from the watershed) and the potential interaction among dredging activities and coastal erosion processes. By limiting the Delaware BUDM discussion entirely to the description of specific beach replenishment projects proposed under the TSP for the Delaware side of the bay, USACE has not explained how these proposed projects would be successful within a regional framework that would include other potential erosion control measures that

do not involve dredged material. The text discussion should make it clear whether USACE has undertaken an analysis of overall sediment load to the system and evaluated the extent to which the problem of what to do with large volumes of dredged material could be eliminated by working with states, municipalities, and others to minimize sediment loads into the system. Reducing sediment loading via sustainable sediment management could reduce the overall amount of material requiring removal and disposal.

Civil/Design Engineering

The concept of using dredged materials for improving coastal resiliency instead of disposal is a win-win concept of beneficial use. The mostly granular nature (sand/gravel) of the materials to be dredged renders this concept feasible as clearly explained in the TSP. Appendix C2, *Civil Design*, provides the method by which the estimated quantities of beach fill were determined using dredged materials. Dune and berm dimensions and slopes (i.e., the simplified cross sections) are appropriate. However, a single simplified existing grade was assumed for all sites. It is not clear how the existing grade was obtained and how representative it is. The fill area thus obtained was multiplied by an assumed length of fill at each site to determine the volume of fill required. However, the criterion for designated length of fill is not evident. The dredged material is already eroded bay-bottom sediment and in this coastal environment is likely to erode again, requiring continual replenishment. The material is already an erosion product, implying that it will not have full resistance to storm events. This may result in more frequent nourishment than the anticipated every-fourth-year cycle and may require a plan to protect the seaward face of berms/dunes. The relative cost of providing such protection compared with more frequent nourishment than the assumed 4-year cycle is not presented.

Coastal Engineering

Considering the study level as a feasibility study, the Delaware BUDM has paid attention to the key issues and discussed realistic assumptions and applicable approaches. The *Hydrology and Hydraulics* report has been put together very well and the format is easy to follow. The Delaware BUDM needs to include some necessary information and clarifications on the assumptions and values utilized in the study. For example, Appendix C1, *Hydrology and Hydraulics*, does not provide enough information on the dredged material characteristics and the erosion processes and rates at the project sites to determine if the dredged material is compatible with the native beach material, if the material is in the valid range of the SBEACH model, and the frequency of beach nourishment that will be required.

Some of the hydrodynamic parameters are not clearly explained as to how they were obtained and the procedure and criteria used to select them. The bases for transect locations that have been used for analyses of the shoreline and the criteria that have been used to locate transects need more explanation. The infrastructure information and structure inventory for the project areas that were used in the Beach-fx model is not clearly discussed and defined. Important requirements such as the proximity of the project sites to areas designated under the Coastal Barrier Resources Act have not been explored and discussed. The main body of the Delaware BUDM does not discuss or evaluate the potential for secondary inundation resulting from flooding of the marshland or streams on the landward side of the various communities.

Geotechnical Engineering

The proposed concept represents an innovative way to combine navigational maintenance requirements with the need to reduce the impacts of storm damages. The report clearly documents this concept. The schedule and cost estimate included in the feasibility report assumes that the initial and subsequent placement of dredge material at the eight sites can be accomplished utilizing one mobilization. The environmental constraints described in the report, however, indicate that placement of material would be limited to approximately 6 or 7 months per year during the fall and winter seasons. The Panel is concerned that the assumption of one mobilization per placement cycle is unrealistic based upon the environmental constraints. The mobilization cost represents up to approximately 20 percent of the direct project cost, and an increased number of mobilizations would have a significant impact upon the total project cost. Another factor that affects the feasibility of the project is the possibility of continued disposal at the current Buoy 10 site or at other potential disposal sites that would be closer than the Artificial Island site. The report does not discuss the potential increased availability of disposal at the Buoy 10 site beyond 2030 or the feasibility of developing other sites closer than the Artificial Island confined disposal facility. The report does not deal with the possible need for stormwater outfalls through the constructed berm/dune system to accommodate landward precipitation at any locations where drainage is directly to the Delaware Bay.

Hydrology and Hydraulic Engineering

This study adopted a logical approach to assess the potential hydrologic/hydraulic performances of various alternatives at selected locations. The basis of the analysis relies on the results of the North Atlantic Coastal Comprehensive Study (NACCS). Most assumptions appear to be reasonable scenarios.

Although the review documents described the approach adopted in the analyses and how some of the parameters were selected, the parameters used and the data/observations utilized to develop these parameters were not presented in detail. Some parameters that led to the selected alternative are uncertain. The significance of the major assumptions and impacts of possible deviations from these assumptions on decision-making were not comprehensively addressed. Examples are assumptions of average shoreline erosion rate, wave height, and sea level change curves. It would be important to identify major uncertainties that could potentially influence the cost-effectiveness of various alternatives. Parametric, sensitivity, uncertainty, and/or decision analyses can be performed to estimate the impacts of uncertainties on potential performance and total costs (capital, operational, and non-performance costs).

The study is based on 26 evaluation locations pre-selected based on current condition. Some of the locations were screened out based on current land use. Since the study considers a 50-year implementation and operation period, it is anticipated that land use and population will change. These changes might result in addition and/or elimination of project locations. It is unclear how the cost-effectiveness of various alternatives would be affected by these potential changes and whether adaptive implementation might be beneficial. Hydrology and hydraulic evaluation at other potential locations might be insightful.

Planning Formulation/Economics

The decision document effectively addresses the stated need and intent of the scientific and technical information for the plan formulation and economic analyses. The beneficial use of dredged material to minimize flood-related damages to Delaware communities and increase resiliency along the Delaware shoreline is clearly a desirable opportunity. However, the Delaware BUDM does not include critical project

evaluation information used in the study analyses that is necessary for the reviewer to evaluate the analysis and findings. The types of information not provided includes detailed project cost; equivalent annual costs and benefits; cost sharing; and operation, maintenance, repair, rehabilitation, and replacement actions, costs, and responsibilities.

5.2 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
- Recommendation for resolution of the comment.

Comments are rated to indicate the general significance that the comment has to the project implementability 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.

5.2.1 Significance: High

Comment 1
The Delaware Beneficial Use of Dredged Materials for the Delaware Feasibility Study (BUDM) excludes important cost elements.
Basis for Comment
The following cost elements are not provided: Project Costs; Equivalent Annual Costs and Benefits; Cost Sharing; and Operation, Maintenance, Repair, Rehabilitation, and Replacement action, costs, and responsibilities.

Significance: High
Crucial cost information necessary for evaluating the adequacy of the analysis is not provided.
Recommendation for Resolution
Recommendation 1: Include the following in the *Report Synopsis*, Delaware BUDM, and *Economic* Appendix: Project Costs; Equivalent Annual Costs and Benefits; Cost Sharing; and Operation, Maintenance, Repair, Rehabilitation, and Replacement action, costs, and responsibilities.

Comment 2
The analysis in Appendix D, *Evaluation of Section 404(b)(1) Guidelines*, does not address the question as to whether alternatives to the Tentatively Selected Plan (TSP) exist that would minimize any disturbance to wetlands or open water areas as a result of dredged material placement.
Basis for Comment
Federal Section 404(b)(1) guidelines (40 CFR 230) state: *"(a) Except as provided under section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.* *(1) For the purpose of this requirement, practicable alternatives include, but are not limited to: (i) Activities which do not involve a discharge of dredged or fill material into the waters of the United States or ocean waters; (ii) Discharges of dredged or fill material at other locations in waters of the United States or ocean waters…"* The discussion in the Delaware BUDM addresses other aspects of Section 404(b)(1) review, but does not discuss this issue.
Significance: High
To ensure compliance with regulations, the Section 404(b)(1) analysis should address impacts from alternatives.
Recommendation for Resolution
Recommendation 1: Include in the Delaware BUDM a discussion of the Section 404 issues cited above and include an explanation of how the project purpose cannot be achieved via means that would involve fewer impacts.

5.2.2 Significance: Medium High

Comment 3
The cost estimate for the TSP assumes that only one mobilization will be required for the initial beach nourishment. Based upon environmental considerations, this assumption is not realistic, and therefore the cost estimate contained in the TSP underestimates the likely construction cost.
Basis for Comment
The current estimated cost for the initial dredging and construction effort is approximately $71.3 million. The cost of mobilization and initial site work included in this estimate is approximately $15 million. The TSP cost estimate assumes that only one mobilization will be required for the initial

construction and that the mobilization cost can be spread across all eight sites. This assumption appears to conflict with the environmental requirements stated on page 97 of the Delaware BUDM:

"The use of seasonal windows (April 15 to August 31) will reduce adverse effects to horseshoe crabs by avoiding dredging during the spring and summer seasons when horseshoe crabs are most numerous in the shallow inshore areas.

Impacts to overwintering blue crabs in the channel can be reduced by dredging in the late summer and fall while the crabs are mobile and can leave the impact area."

If the project construction complies with the two environmental recommendations given above, there would only be approximately six months of the year when dredging and beach restoration can occur. This would likely require multiple-stage operations, which could increase the mobilization costs significantly. Based upon the current estimates, staging of the initial construction into three separate time periods would result in an overall increase of approximately 42 percent for the initial project construction. Compliance with the environmental time restrictions could also impact the scheduling of the ongoing nourishment of the eight sites over the entire length of the project.

Significance: Medium High

Compliance with the environmental requirements related to allowable dredging and beach nourishment work could have a significant impact on both the project cost and project schedule. The environmental constraints will likely impact both the initial construction and the scheduling of longer-term maintenance dredging.

Recommendation for Resolution

Recommendation 1: Determine whether the environmental restrictions represent mandatory conditions .

Recommendation 2: If there are environmental time constraints, develop a reasonable multistage construction plan for the initial construction based upon estimated construction periods for the various project sites. Subsequently, modify the cost estimate for the TSP to reflect multiple mobilizations.

Recommendation 3: Coordinate with the USACE operations office to develop a long-term plan for nourishment at each of the sites over the life of the project. This plan should be based upon estimated length of construction periods and the need for maintenance dredging. The project cost estimate should be revised to reflect the adopted long-term schedule.

Comment 4

Impacts of the uncertainties of critical parameters on potential cost-effectiveness of various alternatives and selection decision were not comprehensively evaluated.

Basis for Comment

Many parameters in the analyses that led to the selected alternative are highly uncertain. Assumptions were made in the analyses. While most assumptions appear to have been made based on reasonable scenarios, the significance of these assumptions and impacts of possible deviations from these assumptions on decision-making were not comprehensively addressed. For example, the average shoreline erosion rate used in the hydrology/hydraulic/risk analysis was assumed to be the average of the minimum and maximum reported in the 1991 study. However, some of the resulting

averages are quite different from the estimated rates based on 1991-2011 aerial photo interpretation. There is no evaluation how average erosion rate and its uncertainty would affect the results. Another example is the adoption of 0.5 wave height.

Significance: Medium High

It is important that the selected alternative is the right decision considering the anticipated uncertainty in the critical parameters/assumptions. The conclusion would be questionable if the selected alternative is cost-effective only under limited idealized condition.

Recommendation for Resolution

Recommendation 1: Identify major uncertainties that could potentially influence the cost-effectiveness of various alternatives. Perform parametric, sensitivity, uncertainty, and/or decision analyses to estimate the impacts of uncertainties on potential performance and total costs (capital, operational, and non-performance costs).

Comment 5

The Delaware BUDM does not describe how the 26 specific coastal storm risk management (CSRM) problem areas were identified and selected. Also, the Delaware BUDM and the *Value Engineering (VE) Study* Appendix identify different numbers of alternatives that should be carried forward to be considered.

Basis for Comment

The text in several locations in the Delaware BUDM (Executive Summary Section 2 on p. ES-1, Section 2.2, p. 10, Section 3.1, p. 22) refers to 26 specific CSRM problem areas without explaining how these areas were identified.

The Delaware BUDM identifies 26 CSRM problem areas that were evaluated and 13 that are carried forward to the TSP (Section 2.2 Public Concerns, page 10). The VE Study dated 16 March 2016 analyzed 19 site alternatives and recommends that 7 of the 19 alternative sites continue to be evaluated (Section 3.3 VE Job Plan, page 7).

Significance: Medium High

It is important for the reader to understand how the original sites were identified and on what basis in order to evaluate whether the project is in the public interest. The reader cannot make a reasonable comparison of the alternatives in the Delaware BUDM and VE report without an explanation of the reason why they consider different numbers of alternatives.

Recommendation for Resolution

Recommendation 1: Describe the process for identifying the 26 sites and any objective criteria applied to identify them. This should be more than a citation of any prior studies and more of a methodological description and supporting rationale.

Recommendation 2: Include a clear explanation in the Delaware BUDM for the difference in the number of alternatives in the Delaware BUDM and the VE Study.

Comment 6
Table 6 in the Delaware BUDM does not describe what species/taxa of wildlife and aquatic organisms and their habitats would benefit from the TSP and which could be impacted, both on a short-term and long-term basis.
Basis for Comment
Table 6 describes a "System of Accounts Analysis" that very generically discusses benefits of the TSP on wildlife. However, a more detailed analysis is warranted for a project wherein a stated goal is to increase the resiliency of coastal Delaware, specifically along the Delaware River/Bay and Delaware Inland Bay shoreline, via the beneficial use of dredged material since many of the areas USACE is trying to protect are refuges and wildlife management areas. The habitat acreage that would be protected from implementing the TSP should be quantified, and more detailed discussion should be provided about which species groups might benefit (e.g., ducks, migrating passerine birds, migrating shorebirds, and others) so that a more detailed picture of the project benefits can emerge. For example, dune plantings once established would provide valuable habitat for passerine birds migrating along the Atlantic Flyway, while open beach replenishment could help breeding or nesting shorebirds that use that habitat. A discussion of the specific habitat acreages proposed to be created or improved by the TSP is warranted, as well as species groups that would benefit or be impacted. The report discussion seems to focus entirely on endangered species.
Significance: Medium High
Without a detailed discussion of the impacts and benefits to different species groups, the reader is unable to ascertain whether the project would result in net benefits and their significance.
Recommendation for Resolution
Recommendation 1: Include a table of habitat acreages and species groups that would benefit from implementing the TSP, and provide a discussion of any short term impacts from implementation.

Comment 7
The assumptions regarding dredged material disposition under the Future No-Action condition require further support in the Delaware BUDM as a basis for cost estimates and need for the project.
Basis for Comment
The project benefits are largely determined by the economics of hauling dredged materials a distance of 10 to 20 miles to the eight proposed project sites rather than 40 miles to the Artificial Island site. **Current Analysis** The Future No-Action condition (and resulting cost estimates) assume continued disposal of dredged material at the Buoy 10 site, which would have additional capacity after New Jersey Department of Environmental Protection (NJDEP) issues a new permit currently under review. The Buoy 10 site would be used until it reaches capacity in the year 2030. From the years 2030-2070 the assumption is that dredged material would be transported 40 miles upriver to Artificial Island. While the cost estimate assumption of looking at net costs (Future with TSP minus Future No-Action) seems entirely reasonable, the assumption of having to take material all the way to Artificial Island does not seem to be well supported. Projecting what placement sites would be available from years 2030-2070 is an uncertain enterprise at best, so it is not clear how other potential alternatives were screened out.

Potential for Future Additional Capacity at the Buoy 10 Disposal Site

Based upon the proximity of the 45-foot-deep navigation channel to the Buoy 10 site, it appears that the most economical operational alternative to maintain the navigation channel would be to continue to utilize the Buoy 10 site rather than the eight project sites or the Artificial Island disposal facility. The overall feasibility of the project therefore depends upon the limited future capacity of the Buoy 10 site and the anticipated need to find disposal areas closer than the Artificial Island facility. The overall feasibility of the project could be significantly affected if an expansion of the Buoy 10 site could be permitted for longer than the additional 10 years currently under review by NJDEP or if a new site closer than Artificial Island could be developed.

Significance: Medium High

The limited capacity of the Buoy 10 site for continued disposal of maintenance dredge material from the navigation project is a major factor in the need and feasibility for the project. If future disposal costs were overestimated because of the need to transport dredged material to Artificial Island, this would skew the comparison of benefit-cost ratios between Action and No-Action alternatives so that they are artificially high in favor of the Action alternative.

Recommendation for Resolution

Recommendation 1: Present a discussion of how the USACE determined that transport to Artificial Island would be the only viable option after capacity at Buoy 10 is reached. This analysis should include discussion of the following:

a) How the capacity at Buoy 10 was determined (e.g., on the basis of bathymetry?),
b) The possibility of permitting additional disposal capacity at the Buoy 10 site for a 20-year or greater period as well as the 10-year period currently under review and how that affects the analysis.
c) Other alternatives for the disposition of dredge material in the future without the project such as construction of a small confined disposal facility closer to the source of the material, or other beneficial reuse options.
d) How the other alternatives were eliminated from consideration to reach the conclusion that Artificial Island would be the only option in the future for disposition of dredged material. These alternatives should be discussed and screened on the basis of a back-of-the-envelope cost analysis or review of available open properties based on ownership, access, presence of tidal wetlands, etc., before the assumption is made that the only site available will be 40 miles away.

Comment 8

There is insufficient information on the dredged material characteristics and the erosion processes and rates at the project sites to determine if the dredged material is compatible with the native beach material and the frequency of beach nourishment that would be required.

Basis for Comment

The TSP considers using dredged materials in beach nourishment in select areas. The dredged material should be compatible with the native beach material in order for the nourished beach to work with the native beach to stabilize over time. It is indicated that the dredged materials are predominantly sand and similar in grain size to the beach materials (about 0.30 mm), thus is suitable

for beach nourishment. However, sufficient information is not provided in the documentation to verify the compatibility of the nourishment material and the native beach material.

In addition, the text does not describe the physical characteristics of sediments removed during past dredging. This information is critical because the analysis assumes the same characteristics for the sediment that would settle into the channel over time after it is dredged.

The erosion rate for the project site is a crucial parameter that is used to determine the frequency of nourishment maintenance. Beach nourishment, in this case construction of beach berm and dunes, requires that the materials be designed for the wave and storm environment at the sites, in other words, resistant to erosion. While the sandy nature of the dredged materials make it valuable in this sense, that by itself is not a sufficient condition. The dredged material is already eroded bay-bottom sediment and in this coastal environment is likely to erode again, requiring continual replenishment. Since the material is already an erosion product, it implies that it will not have full resistance to storm events. This may result in more frequent nourishment than the anticipated once-every-fourth-year cycle.

There is no indication of a plan to protect the seaward face of berms/dunes. The relative cost of providing such protection versus more frequent nourishment is not presented.

The TSP proposes to use a 4-year nourishment cycle at the project sites. However, the basis for selecting this cycle is not provided. Is it based on maintenance dredging needs or based on the erosion rate of the project sites? What if emergency maintenance dredging and beach nourishment is needed because of a Hurricane-Sandy-like storm?

The Delaware BUDM uses an "average" erosion rate based on two earlier studies. Specifically, Table 20 on page 20 summarizes average erosion rates by location relative to the minimum and maximum rates. In this table, the "average" was calculated by adding the maximum to the minimum and dividing by 2. It is not clear if this is the appropriate way to calculate an average for the project situation.

Significance: Medium High

The grain size plays an important role in analyzing and designing beach nourishment. The frequency of beach nourishment maintenance depends on the rate of the beach erosion and directly affects cost/benefit analysis and project justification. Resolution of this issue will improve the reliability and predictability of the nourishment plan and cycle and will affect the overall project cost.

Recommendation for Resolution

Recommendation 1: Justify that the material to be used for beach nourishment is compatible with the native beach material. Add a discussion in the *Hydrology and Hydraulics* report on the grain size of the dredged material and the natural beach material.

Recommendation 2: Identify and justify the assumption that that the physical characteristics of sediments already removed during dredging are the same as those that settle into the channel over time after it is dredged.

Recommendation 3: Conduct additional analyses of the erosion processes and rates at the beach nourishment sites to obtain adequate data to establish the required beach nourishment frequencies. Determine the potential for erosion of dredged materials placed on beaches at each site for the conditions they are exposed to and make a determination of the most cost-effective approach for dealing with the issue (e.g., coarser materials on seaward face of the beach berms/dunes or more frequent nourishment).

Recommendation 4: If the USACE does not conduct additional analysis at this stage of the project, then justify in the report how the current analysis is adequate to support the necessary decisions that are being made at this stage of the project and for selecting the TSP. The report should also describe how the average erosion rate was calculated and justify how that is adequate to support the TSP.

5.2.3 Significance: Medium

Comment 9
The Delaware BUDM does not clearly state the range of the grain sizes of the dredged material and the native beach material to show that grain size is in the valid range to use the SBEACH model.
Basis for Comment
SBEACH has limitation on grain sizes between 0.2 to 0.42 mm. The SBEACH valid range of grain size should be met in order to obtain reliable results. Although the report indicates that the dredged material is predominately sand (about 0.3 mm), the report does not adequately document that the grain-size condition has been met to use SBEACH for this project analysis.
Significance: Medium
The grain size must be within the limitation range for the SBEACH to provide reliable results.
Recommendation for Resolution
Recommendation 1: Justify that the SBEACH is used appropriately for this project given the grain-size range of the dredged material to be used for beach nourishment.

Comment 10
Table 4 in the *Report Synopsis* does not adequately support the findings of the Delaware BUDM with respect to selected alternatives.
Basis for Comment
Table 4 of the synopsis section summarizes in an objectives/measures matrix the various alternatives considered for coastline stabilization. While this is a good concept for evaluation, it is unclear why alternatives that received a “no” answer on meeting the project purpose were carried through the process. After reviewing asterisked responses, the reader may come away questioning whether the approach was sufficiently objective.
Significance: Medium
The table is important to the justification of alternatives screening as a basis for the project.
Recommendation for Resolution
Recommendation 1: Table 4 in the *Report Synopsis* should be clarified and corrected as necessary to support the findings of the Delaware BUDM.

Comment 11
There is no description of how beneficial reuse of dredged material for habitat restoration is related to an overall strategy of watershed management for the Delaware River, including such issues as sustainable sediment management (e.g., reducing sediment loading from the watershed) and the potential interaction between dredging activities and coastal erosion processes.
Basis for Comment
The study authority for the Delaware BUDM was the 26 October 2005 resolution of the Committee on Environment and Public Works of the United States Senate to request that the Secretary of the Army evaluate the authorized projects on the Delaware River to determine whether any modifications are advisable in the interest of beneficial use of dredged material as it relates to comprehensive watershed and regional sediment management, ecosystem restoration, navigation, stream restoration, water quality, and other allied purposes. The National Research Council of the Natural Academy of Sciences, *Mitigating Erosion Along Sheltered Coasts (NAS, 2007)*, provides the following insights: *"Four categories of commonly used techniques to address erosion are identified: (1) Manage land use, (2) Vegetate, (3) Harden, and (4) Trap and/or add sand. Each of these techniques has one or more specific type of technology or measure that can be used to meet its objective, discussed in the following sections. It is common for some combination of techniques to be applied at any particular location of a sheltered coast. For instance, if a decision is made to vegetate a site with a fringe marsh on a low to moderate wave energy coast, a combination of marsh plantings (vegetate) on sand fill (add sand), protected by a stone sill (harden) might be installed as a system. Although these techniques are discussed as separate topics, it is common for multiple methods to be used in combination*." By limiting the Delaware BUDM discussion entirely to the description of specific beach replenishment projects proposed under the TSP for the Delaware side of the bay, USACE has not explained how these proposed projects would be successful within a regional framework that would include other potential erosion control measures that do not involve dredged material. The text discussion should make it clear whether USACE has undertaken an analysis of overall sediment load to the system and evaluated the extent to which the problem of what to do with large volumes of dredged material could be eliminated by working with states, municipalities, and others to minimize sediment loads into the system. Reducing sediment loading via sustainable sediment management could reduce the overall amount of material requiring removal and disposition. In addition, no integrated discussion of the relation between dredging activities and shoreline dynamics is provided. Regional opponents of dredging may argue that dredging activities can help create less stable shorelines and ironically worsen the situation that this project is attempting to remedy. **Reference:** Committee on Mitigating Shore Erosion along Sheltered Coasts, National Research Council, National Academy of Science (2007). *Mitigating Shore Erosion along Sheltered Coasts.* ISBN: 0-309-66651-1, 188 pages.
Significance: Medium
A discussion of the context is required in order to meet the basic objectives of the project as defined in the Secretary of the Army authorization.

Recommendation for Resolution
Recommendation 1: Include a discussion regarding how the proposed TSP would address not only the project purpose of reusing dredged material and restoring habitat, but how these issues could be addressed independently in the context of an overall watershed management plan or regional Dredged Material Management Plan, such as those that have been adopted by other USACE Districts for sediment management. For example, some of the costs for disposition of dredged material could be potentially avoided by reducing sediment loading to begin with. The document should discuss whether this approach was considered. In addition, the text should address the issue of whether dredging activities is contributing to shoreline erosion within the Delaware River, since the ultimate solution might be related to altering dredging methods.

Comment 12
There is no description of the impacts/benefits of the TSP on specific wildlife management areas mentioned in Section 2.4.
Basis for Comment
In summarizing existing coastal storm risk as background for the project, Section 2.4, p. 13, last paragraph notes that "*There are several notable wildlife areas experiencing coastal erosion and habitat loss due to flooding. These include Augustine Wildlife areas, Silver Run Wildlife area, Appoquinimink Wildlife area, Cedar Swamp Wildlife area, Bombay Hook National Wildlife refuge, Little Creek Wildlife area, Ted Harvey Wildlife area Logan Tract, and Prime Hook National Wildlife refuge."* Later in the text (p. 24, last paragraph) it is noted that Little Creek and Bombay Hook "*were screened out because CSRM was not a primary problem*…" Yet the text discussion on wildlife impacts in Section 5.3.4 is generic in nature, and while it discusses individual endangered species impacts, does not adequately address impacts and benefits to specific wildlife management areas that may have as their focus individual species groups (e.g., waterfowl, migrating shorebirds, etc.).
Significance: Medium
If a significant justification for the project lies in protection of critical wildlife management areas, some discussion is needed to address that issue at the specific wildlife management areas mentioned.
Recommendation for Resolution
Recommendation 1: Section 5.3.4 of the Delaware BUDM should discuss how the TSP addresses the erosion issues at each of the wildlife management areas mentioned in Section 2.4 in terms of acreage of erosion impacts and how much habitat would be restored by habitat type.

Comment 13
The discussion of sediment quality regarding contaminants requires further documentation.
Basis for Comment
The discussion of sediment quality regarding contaminants on p. 60 of the Delaware BUDM is sufficient as a physical description of what is expected to be encountered during implementation of the TSP. However, some summary data tables are needed to support the statements made so that the reader can verify their accuracy. Examples would be mean concentrations of analytes encountered by

reach, the range of concentrations encountered, a column indicating current sediment quality guidelines used for screening, and the associated grain size and total organic carbon characteristics.
Significance: Medium
While it is agreed that most of the material likely to be used for replenishment and other reuse is sand, some detailed discussion of sediment quality is warranted to support that contention.
Recommendation for Resolution
Recommendation 1: Provide more information about sediment quality, preferably in the form of tabular summaries.

Comment 14
Data and observations used for developing major parameter values in hydrologic and hydraulic analyses are not adequately documented in the review documents (including Appendix C1).
Basis for Comment
Although the documents explain the approach adopted in the analyses and how the values of critical parameters were selected, the data/observations utilized to develop these parameters were not presented in sufficient details. For example, the shoreline erosion rates assumed in the analyses were based on a 1991 study. The period of observations and the spatial extent were not provided. Although some of the parameter values were selected based on the *North Atlantic Coast Comprehensive Study* (NACCS), the basis of adopting these values were not presented.
Significance: Medium
The conclusion of this study was partially based on the results of hydrology and hydraulic analyses. It is important to clearly present the parameters actually used in the analysis and to justify that these parameters are supported by adequate data, observations, and/or peer-reviewed studies.
Recommendation for Resolution
Recommendation 1: Provide summary of data used to develop parameters in the analyses, including a summary of the information from the NACCS and the basis for these parameter values.

Comment 15
The Delaware BUDM does not discuss or evaluate the flood risk to the project communities from storm-surge flooding of the marshland or streams on the landward side of the various communities.
Basis for Comment
The project communities are located along the narrow, sandy, higher-elevation strip of land along Delaware Bay. The sites have extensive wetlands and marshes on their landward side that are open to storm-surge flooding through the many existing inlets along that stretch of the Delaware Bay coastline and from overwash along undeveloped beach areas. Because of this, the project sites are exposed to flooding from the landward side that will not be controlled by the proposed project. The Value Engineering Report (Appendix F) identifies secondary inundation from the landward side as a potential concern for several of the sites included in the Delaware BUDM. Specifically, it is stated on page 24 of Appendix F for the Prime Hook site:

"Beachfill alone may not effectively address flood risk management for the community. Large water bodies (ponds and marshes) exist "behind" community due to breach to the north at the National Wildlife Refuge. These could pose as a potential secondary inundation sources. Any proposed beachfill along Prime Hook Beach coastline would not address these secondary inundation sources. "

Similar concerns were identified for several of the other sites. The Delaware BUDM does not discuss this residual risk.

Considering the relatively low elevation of project site areas with their current topography, flooding of the back bay areas might also affect the proposed dune design and cause failure of the dune systems.

The hydrologic and hydraulic analyses primarily focus on coastal erosion. Flood risks within the study area were not comprehensively evaluated. At minimum, the report should address the potential for secondary inundation and provide information on how this concern has been incorporated or not incorporated in the evaluation. If coastal erosion is the only consideration in this study, that should be explained and clearly stated.

Significance: Medium

It is important that the conclusion of the Delaware BUDM fully addresses all objectives and critical considerations. The study does not provide information regarding the potential for back flooding of the protected areas either due to storm surge that enters the low lands behind the shoreline or due to rainfall events independent of storm surge. The lack of information makes it uncertain regarding the amount of protection provided by the TSP and the amount of residual risk.

Recommendation for Resolution

Recommendation 1: Clarify the Delaware BUDM to indicate whether the proposed improvements will provide any level of protection against flooding from the landward side attributable to either storm surge through the existing inlets or from significant rainfall events.

Recommendation 2: Address the flood risk from the landward side within the study area if it is a consideration.

Recommendation 3: Discuss the effect on the proposed dune features of flooding from the landward side.

Comment 16

The beach erosion modeling and analyses need additional explanation regarding save points and the reason for adding half of the wave height to the still-water elevation.

Basis for Comment

Save Points

It is not clear why certain save points have been selected in order to compile input data for the beach erosion models. The depth of save points might greatly affect wave height since the SBEACH model utilizes the time-series-of-wave hydrograph. The report does not describe the criteria used to select certain save points. For example, Augustine Beach uses save point 13298, which is shown in the river system. This location would not have significant wave height for the beach erosion analysis.

Still-Water Surface Elevation

The purpose of adding half-of-the-wave-height elevation to the still-water surface elevation is not clearly explained. Also, it is not clear if the associated wave height for each annual exceedance probability is considered in the half-of-wave-height calculation or if it has been applied for a certain return period. The erosion models utilize the wave hydrograph as an input, and the water-surface elevation in the North Atlantic Comprehensive Coastal Study includes the tide, storm surge, and wave setup as part of the resulting water-surface elevation. The reason to add half of the wave height has not been clearly explained in the report. Considering run-up in order to estimate the height of the proposed dune might be more helpful.

Significance: Medium

The location of a save point and its depth influences the wave height and ultimately drives the analysis results. The report should be clear and self-explanatory about the procedures and assumptions used for the analysis.

Recommendation for Resolution

Recommendation 1: Reconsider the save points based on a set of hydrodynamic criteria such as wave steepness and breaking depth. Describe in the report the criteria that are used.

Recommendation 2: Explain why half of wave height needs to be added to the still-water surface elevation.

Comment 17

The *Hydrology and Hydraulics* report does not clearly establish the basis for transect locations used for analyses of the shoreline and what criteria have been used to locate transects.

Basis for Comment

Shoreline transects should not be located based on assumed distances in order to represent some unique characteristics of the beach and conduct a meaningful analysis. Transect locations can be based on topography of the beach, populated areas, existing structures, type of the beach and dune, and other beach characteristics.

Significance: Medium

Shoreline transects represent a stretch of the shoreline and care should be taken to locate transects to present the characteristics of the shoreline correctly.

Recommendation for Resolution

Recommendation 1: State the criteria for selecting shoreline transect locations for each project area or in general in the report.

Comment 18

The Delaware BUDM does not clearly describe how the infrastructure information and structure inventory for the project areas to be used in the Beach-fx model were determined and defined.

Basis for Comment
Infrastructure information and a structure inventory are needed as part of the input data to utilize the Beach-fx model to estimate the economic benefits of the beach nourishment projects, In order to calculate a realistic benefit/cost ratio, the structure inventory of the project area should be included in the analysis.
Significance: Medium
The relationship between the cost and the level of protection for the investments such as infrastructures on the shoreline depends on the inclusion of such structures in the database used for analysis in order to justify the projects.
Recommendation for Resolution
Recommendation 1: Add a discussion of how the structure inventory was determined and defined for use in the Beach-fx analysis.

Comment 19
There is no information regarding how the project sites are affected by the requirements of the Coastal Barrier Resources Act (CBRA) of 1982.
Basis for Comment
The CBRA has made many of areas similar to the project areas ineligible for most new federal expenditures and financial assistance.
Significance: Medium
If there are restrictions on federal funds for CBRA areas, the project cannot move forward.
Recommendation for Resolution
Recommendation 1: Add a discussion of CBRA and how this project is eligible for federal funding. Discuss any potential condition of approval from the US Fish and Wildlife Service.

5.2.4 Significance: Medium Low

Comment 20
There is no discussion of the possible need for stormwater outfalls through the constructed-dune storm protection barrier to drain stormwater to Delaware Bay from behind the dune barrier at those locations where land drainage is directly into Delaware Bay.
Basis for Comment
Drawing C301 in the *Civil Engineering* Appendix shows two cross-sections of the proposed constructed-dune storm protection. It appears based on this limited information that there may be low areas on the landward side of the constructed dune that would capture water and cause flooding during normal precipitation events. If this condition exists at any of the sites, provisions could be required in the TSP to provide drainage of normal rainfall through the constructed dune into Delaware Bay. Including this type of drainage would require gate structures at the outfall locations, which would increase the overall project cost.

Significance: Medium Low
This comment is Medium Low because the situation may not exist and provisions could be employed in the TSP to resolve it.
Recommendation for Resolution
Recommendation 1: Analyze available topographic data to determine if there is any potential for flooding caused by trapped drainage on the landward side of the storm protection structures. If this potential does exist, provisions should be developed to provide drainage or ponding for this water and the cost for such structures estimated. **Recommendation 2:** The results of the above analysis should be documented in the TSP.

Comment 21
Future land use changes and planning are not addressed.
Basis for Comment
The Delaware BUDM is based on 26 evaluation locations pre-selected based on current conditions. In addition, some of the locations were screened out based on current land use. Since the study considers a 50-year implementation and operation period, it is anticipated that land use and population will change. Critical infrastructures and facilities might be constructed. Additional potential project sites might be possible in the future. The study does not account for these potential changes, and it is unclear how they would affect the cost-effectiveness of various alternatives.
Significance: Medium Low
It is anticipated that land use will change within the life span of the project. It would be useful to know how cost-effective the select alternative is under the likely scenarios.
Recommendation for Resolution
Recommendation 1: Evaluate the potential performance and costs of major alternatives under selected future land use scenarios.

5.2.5 Significance: Low

Comment 22
The Cycle 1 screening process utilized a maximum 20-mile haul distance for material from maintenance dredging to eliminate potentially feasible disposal sites from consideration. This criterion is relatively arbitrary, and alternative criteria were used in the final screening analysis.
Basis for Comment
On page 22 of the feasibility report, it is stated: *"During Cycle 1 screening, a primary driver behind assessing the feasibility of using dredged material was determining if potential sediment sources were within a reasonable distance (less than 20 miles) from the problem area(s)."* This criterion appears to be somewhat arbitrary, and, in fact, one of the eight project sites (Lewes Beach) has a haul distance of 20.9 miles based upon the tabulation contained in Appendix C3. Discus-

sions during the Midpoint Review session indicated that the distance criterion had not been rigorously applied in the analysis and that other factors were also used to screen potentially feasible disposal sites.

Significance : Low

The issue only affects the clarity of the document.

Recommendation(s) for Resolution

Recommendation 1: Modify the Delaware BUDM to describe the criteria used to screen possible disposal sites

Comment 23

Statements on page 11 of the VE Study incorrectly state that USACE standards do not commonly support the construction of levees from dredged material or totally pervious material.

Basis for Comment

Page 11 of the VE Study (Appendix F) includes the following statements:

1. *"During the information phase, it was determined that USACE does not commonly support the use of dredged material for levee construction."*

2. *"Silt, sand and organic soil comprises the bulk of dredged material available for use. This material is unsuitable for levee construction without improvement of material and additional imported impervious fill for core."*

Although the Panel recognizes that the TSP in the Delaware BUDM does not include construction of levees, the statement contained in Appendix F does not correctly reflect historical USACE policy or procedures. There are many USACE hydraulic fill-sand levees and navigation dams on the Mississippi River in the USACE St. Paul and Rock Island Districts.

Using hydraulically placed sand fill was analyzed in a 1976 PhD thesis entitled *Analysis and Performance of Hydraulic Sand Fill Levees* by Dr. Paul H Schwartz at the University of Iowa. This research was sponsored by the USACE.

There is a potential to utilize totally pervious fill sections for levee construction, although the inclusion of silt and organic material could make the dredge material unsuitable.

Significance: Low

Although the statements in Appendix F are incorrect, it is probable that the contamination of the dredge fill with silt and organic material in the areas near to the potential TSP projects would limit its use for levee construction. The conclusions related to the use of dredge fill obtained from sources near the potential levee sites are therefore reasonable.

Recommendation for Resolution

Recommendation 1: Modify the Delaware BUDM to reflect the fact that hydraulic sand fill is a potential source of levee fill and that the inclusion of silt and organic matter in the dredge material compromises its use as levee fill.

Recommendation 2: The report should also document whether the sources of clean sand fill are close enough to be considered for levee fill.

Comment 24
There are insufficient details regarding the hydrodynamic characteristics of the project sites, such as routine recurrence intervals for parameters such as wave height and still-water elevation to help the reader understand the sites better.
Basis for Comment
Knowing some relevant hydrodynamic characteristics helps the reader to understand the project area. Some of the characteristics have been mentioned in the Delaware BUDM, such as the range of high-ground elevation and relative sea level change, and addition of others, such as water-surface elevations and wave height, would also be helpful.
Significance: Low
The physical and hydrodynamic parameters provide information about a site that could be used in conducting a comparative analysis to other sites.
Recommendation for Resolution
Recommendation 1: Provide a table with hydrodynamic data for each project site for some routine recurrence interval.

Appendix A Charging the Independent External Peer Review Panel

The text below reproduces the Charge to Reviewers as prepared by the USACE. The provided the charge questions to the review Panel at the beginning of the review process. The Panel Members used these charge questions to guide their review.

DELAWARE BENEFICIAL USE OF DREDGED MATERIAL
FOR THE DELAWARE RIVER FEASIBILITY STUDY
INDEPENDENT EXTERNAL PEER REVIEW
CHARGE TO REVIEWERS

The following Charge to Reviewers outlines the objective of the Independent External Peer Review (IEPR) for the subject study and the specific advice sought from the IEPR 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 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 charge. The 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 charge.

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 panel may 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 Performance Work Statement provides additional details on how comments should be structured.

<u>Broad Evaluation Charge Questions</u>

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

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, and
16. The analysis adequately address the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project.

Appendix B Qualifications of the Independent External Peer Review Panel Members

The qualifications or the IEPR Panel Members are provided in this appendix. Appendix B.1 shows how the IEPR Panel Members meet the qualifications for this task. Appendix B.2 provides the overall qualifications and experience of each IEPR Panel Member.

B.1 Panel Member Technical Requirements

Table 2 shows how the IEPR Panel Members meet the qualifications for the IEPR as specified in the USACE Performance Work Statement.

Table 2: Summary of Panel Member Qualifications by Discipline for this IEPR

Discipline	Requirements	Prof. Don Ator	Mr. Paul Bovitz	Dr. Tuncer Edil	Dr. Chin Man Mok	Dr. Nader Mahmoudpour	Mr. Doug Spaulding
General Qualifications	Highest Degree	**MBA**	**MS**	**PhD**	**PhD**	**PhD**	**BS**
	Years of Experience	**35**	**31**	**35**	**30**	**24**	**48**
	USACE Experience (Direct (D), Indirect (I), and none (N))[⊖]	**D**	**I**	**I**	**I**	**I**	**D**
Biological Resources and Environmental Law Compliance	Must be a scientist from academia, a public agency, a non-governmental entity, or an Architect-Engineer or Consulting Firm.		✓				
	Have a minimum of 15 years demonstrated 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.		✓				
	Experience directly related to environmental evaluation or review and must have extensive knowledge of the following: ecosystem restoration opportunities associated with flood risk management studies, especially tidal wetland enhancement.		✓				
	Familiar with the habitat, and fish and wildlife species that may be affected by the project alternatives in this study area.		✓				
	Experience with United States Fish and Wildlife Service Habitat Evaluation Procedure (HEP) (USFWS, 1980), Endangered Species Act (ESA), essential fish habitat (EFH), and the Marine Mammals Protection Act (MMPA).		✓				
	Be capable of addressing the USACE Safety Assurance Review (SAR) aspects of all projects.		✓				

Discipline	Requirements	Prof. Don Ator	Mr. Paul Bovitz	Dr. Tuncer Edil	Dr. Chin Man Mok	Dr. Nader Mahmoudpour	Mr. Doug Spaulding
Civil/Design Engineering	Be from academia, a public agency, 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.			✓			
	Experience with structural and nonstructural flood risk management measures.			✓			
	Familiar with beach restoration/beach nourishment designs, including but not limited to beach dune and berm combinations.			✓			
	Be capable of addressing the USACE Safety Assurance Review (SAR) aspects of all projects.			✓			
Coastal Engineering	An expert in coastal engineering with a strong background in river and bay/estuary hydrology and hydraulics.					✓	
	A registered professional engineer having a minimum of 10 years' experience in coastal engineering or as a professor from academia with an extensive background in coastal theory and practice, with a minimum MS degree in engineering.					✓	
	Extensive knowledge of the coastal and hydraulic evaluation of nearshore restoration actions.					✓	
	Be capable of addressing the USACE Safety Assurance Review (SAR) aspects of all projects.					✓	
Geotechnical Engineering	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 geotechnical engineering with a minimum MS degree or higher in engineering.						✓
	Demonstrate experience in performing geotechnical evaluation and geo-civil design for all phases of flood risk management projects to include both structural and nonstructural flood risk management measures.						✓
	Extensive experience in geotechnical evaluation of flood risk management structures such as static and dynamic slope stability evaluation, evaluation of the seepage through earthen embankments and underseepage through the foundation of the flood risk management structures, including canal and levee embankments, floodwalls, closure structures and other pertinent features, and in settlement evaluation of the structure.						✓
	Active participation in related professional engineering and scientific societies is encouraged.						✓

Discipline	Requirements	Prof. Don Ator	Mr. Paul Bovitz	Dr. Tuncer Edil	Dr. Chin Man Mok	Dr. Nader Mahmoudpour	Mr. Doug Spaulding
	Be capable of addressing the USACE Safety Assurance Review (SAR) aspects of all projects.						✓
Hydrology and Hydraulic Engineering	The Review Panel member must be a registered professional engineer with a minimum of 15 years' experience in hydrologic and hydraulic engineering.				✓		
	Demonstrate experience with all aspects of hydrology and hydraulic engineering including: flood risk management studies, development of flow and stage frequency curves, open channel dynamics, enclosed channel systems, application of detention/retention basins, application of levees and flood walls, interior drainage, non-structural solutions involving flood warning systems and flood proofing.				✓		
	Familiar with Hydraulic Engineering Center (HEC) modeling computer software including HEC River Analysis System (RAS) and HEC Flood Damage Analysis (FDA) and Beach FX, Flow 2D.				✓		
	Be capable of addressing the USACE Safety Assurance Review (SAR) aspects of all projects.				✓		
Planning Formulation/ Economics	Must have 10 years demonstrated experience or combined equivalent of education and experience.	✓					
	Must have an MS degree or higher in economics and be recognized in applied economics related to water resource economic evaluation (ecosystem restoration and flood risk management analyses) or review.	✓					
	Be familiar with evaluation or alternative plans for flood risk management projects and ecosystem restoration.	✓					
	Familiarity with USACE standards and procedures is required.	✓					
	Must have experience related to evaluating traditional Civil Works plan benefits associated with flood risk management projects, to include experience in determining the cost effectiveness of alternatives evaluations.	✓					
	Must be capable of evaluating traditional National Economic Development plan benefits associated flood risk management as well as have experience working with HEC-FDA and the USACE Beach-fx model.	✓					

⊖ Direct Experience (D): A past USACE employee
Indirect Experience (I): Work experience with USACE water resources projects
None (N): No working experience with USACE water resources projects

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B.2 Panel Member Qualifications and Experience

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

B.2.1 Prof. Donald Ator

Role: Planning Formulation/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, and 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 more than 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 interest. His work 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 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 the 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 PDTs 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 more than 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 EIS for US 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 in the area of community economic vitality through his work 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 population vulnerability issues through his work on a social impact assessment for the Kissimmee River Upper Basin Restoration Project (USACE, Jacksonville District) and from the EIS for the proposed widening of the Pascagoula Lower Sound/Bayou Casotte Channel (USACE, Mobile District).

B.2.2 Mr. Paul Bovitz

Role: Biological Resources and Environmental Law Compliance

Mr. Bovitz has over 30 years' experience as an Environmental Project Manager with expertise in leading interdisciplinary, high-performing teams on national and international projects. He has extensive professional experience in ecological assessment and natural resources management in the public, private, and academic sectors, engaging in both theoretical and applied aspects of ecological research and encompassing a variety of geographic regions, habitats, and taxa. Mr. Bovitz earned his BS in Wildlife Biology from Colorado State University, an MS in Ecology from Rutgers University, and an MBA in Finance from Rutgers University.

Mr. Bovitz is an experienced peer reviewer of USACE ecological restoration plans, EISs, and feasibility studies. Much of his career has been spent as a US Environmental Protection Agency (EPA) and USACE contractor directing ecological investigations of sites requiring environmental restoration. Mr. Bovitz is experienced in NEPA compliance, having completed several EAs, Dredged Material Management Plans, EIS, and other NEPA documents, including extensive USACE contracting experience in preparing NEPA-compliant feasibility studies for habitat restoration and environmental remediation projects. He has worked nationwide, and for the past 5 years has been working as lead ecological risk assessor for investigation and cleanup of two contaminated sites at Tyndall Air Force Base in Panama City, Florida. He has performed aquatic surveys and ecological risk assessments at several sites, and his NEPA experience includes cumulative impacts analyses. He has served as an IEPR Panel Member for both ecological issues and NEPA compliance on projects for the USACE, including dam safety projects for the Albuquerque, Dallas, St. Louis, and New York Districts.

Mr. Bovitz currently serves as acting member of the New Jersey Governor's Science Advisory Board, Ecological Sciences Committee, and formerly served on the Comparative Risk Analysis Panel of the New Jersey Department of Environmental Protection. In July 2014, he served as Chair for a session he organized on "Integrating Ecological Restoration Projects into a Regional Framework" at the Conference for Ecological and Ecosystem Restoration, which focused on regional approaches for coastal restoration projects.

Mr. Bovitz holds the following credentials; Licensed Site Remediation Professional – New Jersey (#586403, 2010); Certified Professional Wetland Scientist – Society of Wetland Scientists; Certified Energy Manager – Association of Energy Engineers (No. 14394; 2009); Leadership in Energy and Environmental Design Accreditation Professional – US Green Building Council and Certification in Green Supply Chain Management – Rutgers University.

B.2.3 Dr. Tuncer Edil

Role: Civil/Design Engineering

Dr. Edil has been an active researcher and educator for nearly 40 years at the University of Wisconsin-Madison. Dr. Edil has been serving as Research Director of the new Recycled Materials Resource Center sponsored by Federal Highway Administration (FHWA). His research interests are in various areas of geotechnical and geoenvironmental engineering, including soft materials engineering and improvement, use of geosynthetics, coastal erosion and landslides, use of recycled materials and sustainable construction, and landfill liners and chemical transport. He has published over 350 papers in the field of geotechnical

and geoenvironmental engineering and sediment transportation. Dr. Edil is a former Editor-in-Chief of the ASCE's *Journal of Geotechnical Engineering* and current Editor-in-Chief of the journal *Geotechnical and Geological Engineering*. He served as President of the US Universities Council on Geotechnical Engineering & Research and President of the ASCE Wisconsin Section. Dr. Edil is recipient of numerous personal and team/project awards from ASCE, ASTM, and other organizations and has participated in many IEPRs.

Dr. Edil is currently serving as Research Director of the new Recycled Materials Resource Center sponsored by FHWA. He has undertaken several projects relating to highway construction and has been actively involved in the use of recycled materials. In the 1980s, he was one of the first investigators to study the use of fly ash in generating hydraulic barriers. His research involving coal combustion byproducts has expanded significantly in recent years involving different applications in highway construction such as stabilization of poor subgrade and stabilization of recycled pavement materials and road-surface gravel to form the base for flexible pavements. Dr. Edil has also investigated the use of granular industrial byproducts in highway subbase or fill construction such as bottom ash, foundry slag, and recycled asphalt shingles. He has also undertaken extensive research on foundry sands involving numerous applications such as geosynthetic-reinforced backfill, flowable fill, and subbase materials. In the 1990s he started research on the use of shredded tires as light-weight fill material alone or in mixtures with soils. Dr. Edil serves on the Technical Oversight Committee for Geotechnical Research at the Wisconsin Department of Transportation. He is a member of the Transportation Research Board Committees AFP30 and AFS70. He is also a core member of TC-3 Geotechnics of Pavements Technical Committee of the International Society of Soil Mechanics and Geotechnical Engineering. He was appointed as founding Chair of the newly formed ASTM Subcommittee D18.14 on Geotechnics of Sustainable Construction. He is the holder of the 2007 Special Science Award from the Scientific and Technological Research Council of Turkey.

B.2.4 Dr. Nader Mahmoudpour

Role: Coastal Engineering

Dr. Mahmoudpour has a PhD and professional engineering registration as a civil engineer. He earned his BA in Civil Engineering, MA in Hydraulic Structures, and PhD in Water Resources. He has over 24 years of experience as a civil and water resources engineer conducting hydrologic and hydraulics analysis for riverine systems, and for 2D hydrodynamic storm surge, waves, and sediment transport modeling. He has provided technical expertise for FEMA flood hazard risk analysis for riverine and coastal studies for many miles of riverine and coastal shoreline. He has experience in stormwater management analysis and design, and in NPDES, TMDL, and MS4 requirements, and watershed studies utilizing GIS applications. He has thorough knowledge of near-shore coastal processes including refraction/diffraction analysis, run-up, littoral transport, coastal structures, and beach erosion. He has served on a variety of water resources projects in transportation, water supply, bridge hydraulics and scour analysis, and sewer system design and construction.

Dr. Mahmoudpour provided technical assistant on wave damage functions of the USACE Coastal Storm Damage Prevented Research and Development project, and was a lead engineer for the *Limit of Moderate Wave Action Operating Guidance* and *Primary Frontal Dune Best Practices* documents prepared for FEMA. He has co-presented at the Ocean Studies Board meeting on the topic: "Developing a Coastal Impact Factor to Assess Hurricane Intensity, for Ocean Studies Board," Board on Atmospheric Sciences and Climate, National Research Council, National Academy of Sciences, March 2013.

Dr. Mahmoudpour has extensive experience in Stormwater Management, Erosion Sediment Control, and Best Management Practices design for linear and land development projects. He has provided the technical lead for hydrologic and hydraulic and scour analysis utilizing HEC-18, USACE publication, of full design demolition and replacement of Fort Benning and PennDOT bridges.

Dr. Mahmoudpour performed flood hazard risk analysis and prepared flood insurance studies for Hillsborough County, Lee County, Monroe County, and Flagler County, Florida. He oversaw and supervised 2D storm surge and wave modeling; coastal near-shore processes and analysis; coastal flood hazard statistical analysis, performing event- and response-based approaches; overland wave propagation modeling utilizing WHAFIS, CHAMP, and Runup (utilizing the Cross-Shore numerical model for waves, currents, sediment transport); and beach profile evaluation for Great Lakes studies. He supervised the entire flood hazard risk mapping effort for the entire shorelines of the states of Connecticut, Massachusetts, and Maine, and for Clatsop (Oregon), and Thurston (Washington) Counties.

He provided technical services for sediment transportation utilizing Soulsby's equation for Currents and Sediment Dynamics Studies for the Raritan Bay Slag Superfund Site, provided technical services for coastal structure of the Hurricane Barrier Walkway Design (USACE New Bedford, Massachusetts), and provided quality review for Rondout Reservoir (New York) Spillway Siphon Design, Environmental Loads, such as wave forces in conceptual design.

Dr. Mahmoudpour has overseas experience as a hydraulic engineer conducting the review of a pre-feasibility study of a water supply project from Iran to the United Arab Emirates, prepared by the La-Mayer consultancy in which he investigated and reanalyzed water hammer issues for the project. He served as design engineer and marine installation manager to design and install a 10-mile sub-sea pipeline from Bandar-Abass to Hormuz Island in the Persian Gulf, Iran.

B.2.5 Dr. Chin Man Mok

Role: Hydrology and Hydraulic Engineering

Dr. Mok received his PhD and MS from the University of California, Berkeley, and his BSc (Eng.) with First Class Honors from the University of Hong Kong. He is a licensed Professional Civil Engineer and Geotechnical Engineer, Professional Geologist. He is board certified as a Founding Diplomate/Water Resources Engineer by the American Academy of Water Resources Engineers and as a Diplomate/Geotechnical Engineering by the Academy of Geo-professionals. Dr. Mok has been named a Fellow of the ASCE as well as a Fellow of the Environmental and Water Resources Institute.

Dr. Mok has over 30 years of consulting experience in a wide range of engineering and earth sciences projects worldwide, particularly in applying computational modeling, high-resolution characterization, reliability/risk/hazard analysis, and decision analysis/optimization to cost-effectively solve hydrological, hydraulic, environmental, geotechnical, geological, seismic, and structural problems. He has directed and managed numerous projects nationwide and overseas, supporting the design and evaluation of dams, locks, water supply systems, surface water and groundwater resources, bridges, underground structures and tunnels, buildings, nuclear-related facilities, chemical containment and remediation, water supply and wastewater treatment plants, landfills, and land development. In addition, he has technical experience in providing litigation and cost-allocation support. He has been appointed as an expert on review panels for several high-profile projects.

Dr. Mok is active in research and teaching. He is an Adjunct Professor at the University of Waterloo, Ontario. He teaches at the University of California, Berkeley. He has been a Rudolf Diesel Fellow and Affiliated Professor at the Technical University of Munich, as well as a Visiting Associate Professor at the University of Hong Kong. He has been a Principal Instructor of short courses in California, Hong Kong, Taiwan, Israel, Thailand, Germany, and India on soil and groundwater contamination, environmental statistics, health risk assessment, geotechnical engineering, earthquake engineering, climate change, carbon reduction, and green buildings. Dr. Mok has been a Principal Investigator in many research studies funded by federal agencies, including DOE, DoD, and Department of the Interior. He has been an invited speaker and keynote lecturer at conferences, workshops, and seminars. He serves as the Past Chair of the Groundwater Management Committee and a member of the KSTAT Standard Committee of the ASCE.

B.2.6 Mr. Doug Spaulding

Role: Geotechnical Engineering

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 Potential Failure Mode Analysis (PFMA) facilitation. He holds an MSCE in Geotechnical Engineering from Purdue University and a BS in Civil Engineering from Valparaiso University. He is affiliated with the ASCE, Minnesota Geotechnical Society, Society of American Military Engineers; a member of the American Arbitration Association, and on the Construction Claims Panel, Minneapolis, Minnesota.

He served 10 years with the USACE, 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 W 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 USACE $190 million seepage control upgrade project in East St. Louis, Missouri. Evaluation included review design for relief wells, slurry trenches, and seepage berms.
- Fargo Moorhead Flood Control Project: Served on IEPR Panel to review USACE 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 USACE 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 draw-down failures and stability analyses to determine the configuration of a sloping drain and stability berm section.

- Byllesby Dam, Dakota County, Minnesota: 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 (USACE's Sliding stability of concrete structures program).
- 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: 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. On-site work included dye testing, preliminary grout testing, and down-the-hole photography.
- Served as FERC approved independent consultant on more than 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 USACE 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 USACE 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 USACE dams (1981 to 2011) and electric utility owned structures (1995 and 2008). Training included program on identification of potential harmful conditions. He is an approved facilitator for the FERC's 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).

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Acronyms

@RISK	Program to perform risk analysis for Flood Insurance Studies
APMI	Analysis Planning and Management Institute
ASCE	American Society of Civil Engineers
BS	Bachelor of Science
BUDM	Beneficial Use of Dredged Materials for the Delaware Feasibility Study
CBRA	Coastal Barrier Resources Act
CFR	Code of Federal Regulations
COI	Conflict of Interest
CSLIDE	Program developed by USACE that assesses the sliding stability of concrete structures
CSRM	Coastal Storm Risk Management
Delaware BUDM	Delaware Beneficial Use of Dredged Material for the Delaware River Feasibility Study
DoD	Department of Defense
DOE	US Department of Energy
DrChecks	Design Review and Checking System
EA	Environmental Assessment
EC	Engineer Circular
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	US Environmental Protection Agency
ER	Engineering Regulation
ER	Evaluator Response
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FPC	Final Panel Comment
GIS	Geographic Information System
GSA	General Services Administration
HEC-FDA	Hydrologic Engineering Center Flood Damage Reduction Analysis
HEP	Habitat Evaluation Procedure
IEPR	Independent External Peer Review
LMI	Logistics Management Institute
MBA	Master of Business Administration

mm	Millimeter
MMPA	Marine Mammals Protection Act
MS	Master of Science
MS4	Municipal Separate Storm Sewer System
MSCE	Masters of Science in Civil Engineering
NAS	National Academy of Sciences
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
NJDEP	New Jersey Department of Environmental Protection
NPDES	National Pollutant Discharge Elimination System
PE	Professional Engineer
PFM	Potential Failure Mode
PFMA	Potential Failure Mode Analysis
PhD	Doctor of Philosophy
PMP	Project Management Professional
PWS	Performance Work Statement
RAS	River Analysis System
RMP	Risk Management Plan
SAR	Safety Assurance Review
TO	Task Order
TSP	Tentatively Selected Plan
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
VE	Value Engineering