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FINAL
Independent External Peer Review Report

Independent External Peer Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System
WBV 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1

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U.S. Army Corps of Engineers
Coastal Storm Risk Management National Planning Center of Expertise
Baltimore District

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November 12, 2013

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ACRONYMS

ASCE	American Society of Civil Engineers
CECW-CP	Corps of Engineers Civil Works – Coastal Protection
CIL	Critical Items List
COI	Conflict of Interest
CPRA	Coastal Protection and Restoration Authority
CPT	Cone Penetration Test
DDR	Design Documentation Report
DrChecks	Design Review and Checking System
EAR	Engineering Alternatives Report
EC	Engineer Circular
ER	Engineer Regulation
ERDC	Engineer Research and Development Center
GIWCC	Gulf Intracoastal Waterway Closure Complex
HSDRRS	Hurricane and Storm Damage Risk Reduction System
HTRW	Hazardous, Toxic, and Radioactive Waste
IEPR	Independent External Peer Review
IPET	Interagency Performance Evaluation Task
MCACES	Micro-Computer Aided Cost Estimating System
NTP	Notice to Proceed
OMB	Office of Management and Budget
O&M	Operations and Maintenance
PDD	Project Description Document
PDT	Project Delivery Team
PRQCP	Peer Review Quality Control Plan
QA	Quality Assurance
QAR	Quality Assurance Report
QC	Quality Control
SFWMD	South Florida Water Management District
SLFPA	Southeast Louisiana Flood Protection Authority
SWL	Still Water Level
USACE	United States Army Corps of Engineers
WBV	West Bank and Vicinity

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Final Independent External Peer Review Report

Independent External Peer Review of the Greater New Orleans Hurricane and Storm Damage Risk Reduction System, WBV 14C.2 – New Westwego Pump Station to Orleans Village 3rd Enlargement – Phase 1

Executive Summary

The U.S. Army Corps of Engineers (USACE) designed and constructed the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the West Bank and Vicinity (WBV) 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1 project (hereinafter WBV 14C.2). This project consisted of raising the elevation of approximately 3.5 miles of new earthen levee to the 100-year level of protection on the floodside of the previously constructed existing earthen levee and the construction of new floodwalls tying into the Westminster Pump Station. These levee improvements occurred south of Lapalco Boulevard from Station 0+44 near the New Westwego Pump Station to Station 185+90.21 near the Borrow Canal adjacent to the Orleans Village Subdivision in Jefferson Parish, Louisiana.

Battelle Memorial Institute (hereinafter Battelle), as a 501(c)(3) non-profit science and technology organization experienced in establishing, administering, and conducting expert peer reviews, was engaged by the USACE Coastal Storm Risk Management National Planning Center of Expertise to conduct the Independent External Peer Review (IEPR) of the WBV 14C.2 project. Subject matter experts with knowledge of specific technical disciplines and relevant engineering/construction experience pertinent to the WBV 14C.2 project were engaged to form an IEPR Panel (also known as panel members) and to specifically address key issues associated with the construction of this project.

Battelle developed processes and procedures for the IEPR to be in compliance with the procedures described in the Department of the Army, Corps of Engineers *Engineering and Design, Quality Management* (Engineer Regulation [ER] 1110-1-12) dated July 21, 2006; *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001; *Civil Works Review Policy Change 1* (Engineer Circular [EC] 1165-2-209)[1] dated January 31, 2012; and *Engineering and Design for Civil Works Projects* (EC 1110-2-1150) dated August 31, 1999.

This final IEPR report describes the IEPR process developed by Battelle and followed by the IEPR Panel, summarizes the Panel's findings, and describes the panel members' qualifications and selection process.

[1] On December 15, 2012, USACE issued *Civil Works Review* (EC 1165-2-214), which supersedes EC 1165-2-209. However, the contract for this IEPR was awarded on September 25, 2012, before EC 1165-2-214 took effect. Accordingly, all tasks under this contract, including development of this IEPR report, were performed under *Civil Works Review Policy Change 1* (EC 1165-2-209).

From a list of potential candidates, generated from an established internal resource database and external resources, Battelle initially identified candidate panel members, confirmed their availability, evaluated their technical expertise, and inquired about potential conflicts of interest (COIs). The credentials of the available candidate panel members were evaluated according to the overall scope of the WBV 14C.2 project requirements. Participation in previous USACE technical review committees and other related technical review expertise and experience were considered. From this draft list of candidates, Battelle selected the final IEPR panel members based on availability, technical background, and apparent absence of COIs and provided the selected list of candidates to USACE to review for COI. Battelle selected the final IEPR panel members based on their specific experience in the areas of expertise specified in the scope of work.

The three panel members selected for the WBV 14C.2 IEPR Panel were affiliated with consulting companies or were independent engineering consultants. Corresponding to the technical content of the WBV 14C.2 IEPR project, the areas of technical expertise of the selected IEPR panel members were construction management/civil engineering (one panel member), geotechnical engineering (one panel member), and civil engineering (one panel member).

The IEPR panel members were provided electronic copies of the WBV 14C.2 plans and specifications, reports, and supporting documentation listed in Table ES-1, along with the charge for conducting the review.

Table ES-1. WBV 14C.2 IEPR Project Review Documents

Title	No. of Pages
Final WBV 14C.2 Geotechnical Report	434
WBV14C.2 Site Inspection, 10 August 2011	4
Quality Assurance Reports (QARs)	1,214
Site Observation Report for WBV-14C.2, Thursday 27 January 2011	4
Construction documentation on WBV 14C.2 (quality control [QC] and quality assurance [QA] proctor tests, settlement calculations, summary of non-federal sponsor visits, QC compaction testing log, borrow material source charts, modifications)	2,294
Report on Geophysical Survey Services, October 2011	79
Historical Documentation (WBV14C.1 construction documentation, Louisiana Department of Transportation and Development files provided by Coastal Protection and Restoration Authority [CPRA], Initial Hazardous, Toxic and Radioactive Waste [HTRW] Assessment, June 7, 1994, and all other pertinent information)	370
QA Team Report of Findings (Tiger Team Report)	6,795
USACE, New Orleans District Final Comprehensive Report	12,873[a]
WBV HSDRRS Operation, Maintenance, Repair, Replace, and Rehabilitation Manual	192
Total	**24,259**[a]

[a] Some pages were duplicates of the other review documents listed.

On December 4, 2012, the USACE Project Delivery Team (PDT), with the non-federal sponsor in attendance, conducted an orientation briefing via teleconference on the WBV 14C.2 project for the IEPR panel members. The PDT also hosted a construction site visit for the IEPR Panel on January 9, 2013, during which panel members were further briefed by USACE on the project. During the exit briefing on January 10, 2013, the IEPR panel members provided positive feedback on the briefing and site visit; posed specific questions and concerns related to observations made during the site visit; and identified and requested documents that were identified in the charge questions but not previously received.

At the start of the peer review, Battelle (with input from the IEPR panel members) developed a Critical Items List (CIL), which identified specific design/construction elements and components that are critical to the successful completion and function of the construction project. In total, the IEPR panel members produced 17 critical items. Using the CIL as the basis for their review, panel members developed individual responses to 15 charge questions on the WBV 14C.2 review documents. Upon review and discussion by the Panel of the individual comment responses, no conflicts or technical concerns were identified that necessitated development of a Panel comment for entry in the Design Review and Checking System (DrChecks). Given the lack of technical concerns, the Panel developed responses to each of the non-federal sponsor's charge questions for inclusion in this report.

At the completion of the review, the IEPR panel members agreed that the levee was constructed in accordance with the contract plans and specifications requirements and consistent with general construction practices. The panel members reviewed settlement rates and assessed potential impacts to maintenance operations of the objectionables (e.g., wood) that remain in the levee; assessed the structural integrity and performance of the levee as designed and constructed; and reviewed and assessed the results of seepage analyses provided in the documents. In general, the IEPR panel members agreed that the WBV 14C.2 project documents contained sufficient design-engineering-construction information to determine that the construction of the WBV 14C.2 project as completed (taking into account the actions conducted after its construction and suggested by the Tiger Team) was consistent with the original design and HSDRRS Design Guidelines (including Factors of Safety) and standard practice (Safety Assurance Review).

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1 INTRODUCTION

1.1 Program Background

The U.S. Army Corps of Engineers (USACE) designed and constructed the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the West Bank and Vicinity (WBV) 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1 project (hereinafter WBV 14C.2). An integral part of the HSDRRS is the conduct of an Independent External Peer Review (IEPR) to ensure the reliability of scientific information and engineering analysis contained within the project documents and continuing through the construction phase. Battelle Memorial Institute (hereinafter Battelle), as a non-profit science and technology organization experienced in conducting expert peer reviews, was engaged by the USACE Coastal Storm Risk Management National Planning Center of Expertise to conduct the IEPR of the WBV 14C.2 project. Subject matter experts with knowledge of specific technical disciplines and relevant engineering/construction experience pertinent to the WBV 14C.2 project were engaged to form an IEPR Panel (also referred to as panel members) and to specifically address key criteria associated with the design, engineering, and construction of WBV 14C.2.

Battelle developed processes and procedures for the IEPR to be in compliance with the procedures described in the Department of the Army, Corps of Engineers *Engineering and Design, Quality Management* (Engineer Regulation [ER] 1110-1-12) dated July 21, 2006; *Engineering and Design, DrChecks* (ER 1110-1-8159) dated May 10, 2001; *Civil Works Review Policy, Change 1* (Engineer Circular [EC] 1165-2-209)[1] dated January 31, 2012; and *Engineering and Design for Civil Works Projects* (EC 1110-2-1150) dated August 31, 1999.

This final IEPR report describes the IEPR process developed by Battelle and followed by the IEPR Panel, summarizes the Panel's findings, and describes the panel members' qualifications and selection process.

1.2 Project Description

This project consisted of raising the elevation of approximately 3.5 miles of new earthen levee to the 100-year level of protection on the floodside of the previously constructed existing earthen levee and the construction of new floodwalls tying into the Westminster Pump Station. These levee improvements occurred south of Lapalco Boulevard from Station 0+44 near the New Westwego Pump Station to Station 185+90.21 near the Borrow Canal adjacent to the Orleans Village Subdivision in Jefferson Parish, Louisiana.

[1] On December 15, 2012, USACE issued *Civil Works Review* (EC 1165-2-214), which supersedes EC 1165-2-209. However, the contract for this IEPR was awarded on September 25, 2012, before EC 1165-2-214 took effect. Accordingly, all tasks under this contract, including development of this IEPR report, were performed under *Civil Works Review Policy, Change 1* (EC 1165-2-209).

1.3 Purpose of the IEPR

The purpose of the IEPR is to strengthen USACE's safety assurance as outlined in the Water Resources Development Act of 2007, Section 2035 (Type II IEPR) for the HSDRRS program in the Greater New Orleans area. Independent, objective external peer review is regarded as a critical element in ensuring the reliability of scientific and engineering analyses. To help ensure that USACE projects are supported by the best scientific, technical, and engineering information, a peer review process has been implemented by USACE that utilizes an IEPR to complement the agency technical review, as described in EC 1165-2-209. In this case, the IEPR of the WBV 14C.2 project was conducted and managed using contract support from an independent 501(c)(3) organization, Battelle, to ensure independent objectivity, along with a high degree of flexibility and responsiveness, which was essential for USACE to meet deadlines.

The purpose of the review was to:

1. determine if the design and construction of the WBV 14C.2 project was consistent with the HSDRRS Design Guidelines (including Factors of Safety) and standard practice (Safety Assurance Review),
2. assess whether the levee was constructed in accordance with the contract plans and specifications requirements and consistent with general construction practices,
3. review settlement rates and assess potential impact to maintenance operations,
4. assess the structural integrity and performance of the levee as designed and constructed, and
5. review and assess the results of seepage analyses provided in the documents.

2 IEPR PROCESS

This section describes the approach for selecting IEPR panel members and for planning and conducting the IEPR. The IEPR followed the process described in the Peer Review Quality Control Plan (PRQCP)[2] that Battelle developed specifically for this project and was conducted in accordance with procedures described in USACE's guidance (cited in Section 1.1) and the Office of Management and Budget's (OMB's) *Final Information Quality Bulletin for Peer Review*, released December 16, 2004. Supplemental guidance on the evaluation of conflicts of interest (COIs) from the National Academies' *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports*, dated May 12, 2003, was also followed.

2.1 Planning and Schedule

Table 1 defines the schedule followed by Battelle in executing the WBV 14C.2 IEPR.

[2] During the review, the Panel determined that no technical issues needed to be raised regarding the project; therefore, the comment response portion of the project was not conducted as specified in the PRQCP because it was not necessary.

Table 1. WBV 14C.2 IEPR Project Schedule

Task[a]	Action	Due Date
1	WBV 14C.2 Notice to Proceed (NTP)	9/25/2012
	USACE provides Review Documents	10/26/2012; 01/10/2013
	Battelle submits draft PRQCP[b]	10/08/2012
	USACE provides comments on draft PRQCP	10/23/2012
	Battelle submits final PRQCP[b]	06/10/2013
2	Battelle submits list of selected panel members for IEPR Panel[b]	10/11/2012
	USACE confirms the Panel has no COI	10/26/2012
	Battelle completes subcontracts for IEPR panel members	11/09/2012
3	Battelle submits Critical Items List (CIL)[b]	12/14/2012
4	USACE/Battelle kick-off meeting	10/19/2012
	Battelle/Panel kick-off meeting	11/16/2012
	Orientation briefing (USACE/Battelle/Panel)	12/04/2012
6	Panel members complete their individual reviews	11/16/2012 - 06/21/2013[3]
	Battelle merges Panel responses and provides merged file to Panel for Panel Teleconference	06/27/2013
	Battelle convenes Panel Teleconference to discuss review findings	07/02/2013
	Panel develops Panel responses to each Charge Question[c]	07/10/2013
7	Construction Site Visit	01/09/2013
	Battelle submits Draft Field Visit Report[b]	01/25/2013
	USACE provides comments on Draft Field Visit Report	08/14/2013
8	Battelle submits Draft IEPR Report to USACE[b]	09/13/2013
	USACE provides comments on Draft Report	11/05/2013
	Battelle submits Final Report to USACE (includes the Final CIL and Field Visit Reports [Tasks 3 and 7, respectively])[b]	11/12/2013
	Project Closeout	03/24/2014

Notes: [a] Task 5 represents monthly reporting activity and is not shown in the above schedule.
[b] Activities represent deliverables.
[c] Actions associated with the comment response process and the Design Review and Checking System (DrChecks) under Task 6 were not necessary and therefore were eliminated from the schedule.

2.2 Identification and Selection of IEPR Panel Members

Battelle initially identified 12 candidates for the WBV 14C.2 IEPR Panel. The process required confirming their availability, evaluating their technical expertise, and inquiring about/assessing

[3] Upon receipt of the review documents, it was determined that a cost modification was necessary to cover the extended number of pages provided for the review. A cost modification was requested in January 2013 and received on May 29, 2013. Once the modification was received, the review of the documents was completed.

potential COIs. Of those initially contacted, three candidates confirmed their interest and availability. The remaining candidates were not proposed because they either were unavailable, disclosed COIs, lacked the precise technical expertise required, or were being proposed for participation on a different HSDRRS IEPR Panel.

The credentials of the available candidates were evaluated according to the requirements of the project's overall scope. The evaluation focused on the key technical areas of construction management/civil engineering, geotechnical engineering, and civil engineering. Participation in previous USACE technical review committees and other technical review panel experience was also considered a benefit.

The candidates were screened for the following *potential* exclusion criteria or COIs.[4] Past participation in USACE peer reviews and other technical reviews did not automatically preclude a candidate from serving on the Panel. The following outlines the screening inquiry for assessing the candidates:

- Previous and/or current involvement by you or your firm[5] in the HSDRRS, notably the WBV 14C.2 - New Westwego Pump Station to Orleans Village.
- Previous and/or current involvement by you or your firm[5] related to flood control in the Jefferson Parish, Louisiana, and Greater New Orleans region.
- Previous and/or current involvement by you or your firm[5] in HSDRRS-related projects.
- Previous and/or current involvement by you or your firm[5] in the conceptual or actual design, construction, or operations and maintenance (O&M) of any projects in the HSDRRS, notably the WBV 14C.2 - New Westwego Pump Station to Orleans Village - 3rd Enlargement - Phase 1 related projects.
- Current employment by the USACE.
- Previous and/or current involvement with paid or unpaid expert testimony related to HSDRRS, notably the WBV 14C.2 - New Westwego Pump Station to Orleans Village.
- Previous and/or current employment or affiliation with members of the cooperating agencies or local sponsors or the non-federal sponsors or any of the following cooperating federal, state, county, local, and regional agencies, environmental organizations, and interested groups including Task Force Hope, New Orleans District (Protection Restoration Office), Hurricane Protection Office, or officials from the State of Louisiana and local governing entities, including the Southeast Louisiana Flood

[4] Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. See OMB's December 2004 *Final Information Quality Bulletin for Peer Review* (p. 18), "….when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

[5] Includes any joint ventures in which a panel member's firm is involved and if the firm serves as a prime or as a subcontractor to a prime.

Protection Authority (SLFPA) and Coastal Protection and Restoration Authority (CPRA), Interagency Performance Evaluation Task (IPET) Force, American Society of Civil Engineers (ASCE) External Review of IPET, Louisiana Coastal Protection and Restoration Study, National Research Council Committee on New Orleans Regional Hurricane Protection and/or the Quality Assurance (QA) Tiger Team for WBV 14C.2.

- Past, current, or future interests or involvements (financial or otherwise) by you, your spouse, or children related to Jefferson Parish, Louisiana, and Greater New Orleans region.
- Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, Engineer Research and Development Center [ERDC], etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the New Orleans District.
- Previous or current involvement with the development or testing of models that were used for or in support of the HSDRRS, notably the WBV 14C.2 - New Westwego Pump Station to Orleans Village - 3rd Enlargement - Phase 1 project.
- Current firm[5] involvement with other USACE projects, specifically those projects/contracts that are with the New Orleans District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please also clearly delineate the percentage of work you personally are currently conducting for the New Orleans District. Please explain.
- Any previous employment by the USACE as a direct employee or contractor (either as an individual or through your firm[5]) within the last 10 years, notably if those projects/contracts were with the New Orleans District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.
- Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning coastal storm damage reduction, and include the client/agency and duration of review (approximate dates).
- Pending, current, or future financial interests in the HSDRRS, or contracts/awards from USACE related to the WBV 14C.2 - New Westwego Pump Station to Orleans Village.
- A significant portion (i.e., greater than 50 percent) of personal or firm[5] revenues within the last 3 years came from USACE contracts.
- A significant portion (i.e., greater than 50 percent) of personal or firm[5] revenues within the last 3 years from contracts with the non-federal sponsors of the HSDRRS, notably the WBV 14C.2 - New Westwego Pump Station to Orleans Village.
- Any publicly documented statement (including, for example, advocating for or discouraging against) related to the HSDRRS, or the WBV 14C.2 - New Westwego Pump Station to Orleans Village.
- Participation in relevant prior federal studies relevant to this project and/or the HSDRRS.
- Previous and/or current participation in prior non-federal studies relevant to this project and/or the HSDRRS.

- Is there any past, present, or future activity, relationship, or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe.

The three available candidates were determined to fit the criteria for the required expertise and did not have any actual or perceived COIs. Based on these considerations, the three panel members were selected for the final Panel (Section 3 provides biographical information on the selected panel members). The three panel members were independent engineering consultants or affiliated with consulting companies. Battelle established subcontracts with each of the panel members after confirming the absence of COIs for each panel member through a signed COI form.

2.3 IEPR Kick-Off Teleconferences and Orientation Briefing

Battelle held a project kick-off teleconference with USACE on October 19, 2012, to review the preliminary schedule, discuss the IEPR process, and address any questions regarding the scope of the WBV 14C.2 project. On November 16, 2012, Battelle staff conducted a kick-off teleconference with the Panel for the review of the WBV 14C.2 project. During this teleconference, Battelle provided an overview of the IEPR process, reviewed project and reference materials, and discussed overall schedule dates, milestone activities, and logistics for the orientation briefing and site visit.

The USACE Project Delivery Team (PDT) conducted an orientation briefing on the WBV 14C.2 project for Battelle and the IEPR panel members via teleconference on December 4, 2012. During the meeting, the USACE PDT and the non-federal sponsor briefed the panel members on the WBV 14C.2 project, and the panel members were provided an opportunity to ask questions.

2.4 Construction Site Visit

The construction site visit for the WBV 14C.2 project was conducted on January 9, 2013. On the morning of January 9, the IEPR Panel, Battelle representatives, non-federal sponsor representatives, and USACE staff (see Appendix A - Attachment 2) convened at the USACE Construction Office (West Bank) for an initial briefing of the project and construction activities (see Appendix A - Attachment 3). USACE, Battelle staff, and IEPR panel members drove the length of the WBV 14C.2 levee and stopped at various points along the reach to observe the key components, range of conditions, and associated construction challenges that were faced during the construction effort. Throughout the construction site visit, USACE staff members pointed out specific project features to help the IEPR panel members better comprehend the design and construction intent of the project and answered questions posed by the panel members.

2.4.1 Results of the Construction Site Visit

On the morning of January 10, 2013, the USACE staff, Battelle representatives, and the IEPR Panel convened at the USACE New Orleans District Office for the exit briefing. The exit briefing focused on panel member concerns and safety assurance issues. The panel members asked specific questions related to their observations and the goals of the project, which resulted in a discussion among the USACE, the non-federal sponsor representatives, and the panel members. This discussion was documented. In general, the content of the exit briefing includes

positive feedback, questions/concerns, and requests from Battelle for additional documentation (see Appendix A - Attachment 4 – Exit Briefing Presentation).

A draft Field Visit Report was submitted to USACE on January 25, 2012, and is being finalized in Appendix A as part of the final IEPR report (this deliverable). Questions and concerns (see Section 4.2.2) stated in the Field Visit Report were either discussed and answered during the exit briefing by USACE or were answered by the panel members during the review of the documents.

2.4.2 Requests for Documentation

During the exit briefing, the IEPR Panel indicated that additional documentation was needed to conduct a thorough review. The additional documents requested included the Final Comprehensive Report, Orientation Briefing Slides, and non-federal sponsor construction site pictures. At the conclusion of the construction site visit exit briefing on January 10, 2013, USACE provided Battelle with a CD of the documents.

All of the requests made by the Panel during the exit briefing were fulfilled with the exception of Volume 3 of the O&M manual, which was not readily available as it was still being developed. Therefore, Volumes 1 and 2 of the O&M manual were the only volumes reviewed.

2.5 Preparation of the Charge to Panel Members

The charge to the IEPR panel members was provided by Battelle based on guidance provided in EC 1165-2-209 and OMB's December 2004 *Final Information Quality Bulletin for Peer Review*. The 15 charge questions included in the charge were developed by the non-federal sponsor (see Appendix B).

2.6 Conduct of the Design Peer Review

The review of the WBV 14C.2 project was conducted according to the schedule shown in Table 1. The IEPR panel members were provided electronic copies of the WBV 14C.2 project review documents listed in Table 2, along with the charge (Appendix B) for conducting their review.

Table 2. WBV 14C.2 Review Documents

Title	No. of Pages
Final WBV 14C.2 Geotechnical Report	434
WBV14C.2 Site Inspection, 10 August 2011	4
Quality Assurance Reports (QARs)	1,214
Site Observation Report for WBV-14C.2, Thursday 27 January 2011	4
Construction documentation on WBV14C.2 (quality control [QC] and QA proctor tests, settlement calculations, summary of non-federal sponsor visits, QC compaction testing log, borrow material source charts, modifications)	2,294
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Historical Documentation (WBV14C.1 construction documentation, Louisiana Department of Transportation and Development files provided by CPRA, Initial Hazardous, Toxic and Radioactive Waste [HTRW] Assessment, June 7, 1994, and all other pertinent information)	370
QA Team Report of Findings (Tiger Team Report)	6,795
USACE, New Orleans District Comprehensive Report	12,873[a]
WBV HSDRRS Operation, Maintenance, Repair, Replace, and Rehabilitation Manual	192
Total	24,259[a]

[a] Some pages were duplicates of the other review documents listed.

In addition, the following supporting documents were provided to the IEPR panel members:

- HSDRRS – Quality Management Plan 30 October 2009
- HSDRRS Design Guidelines – June 2008
- ER 1110-1-12, Engineering and Design, Quality Management, 21 July 2006
- ER 1110-1-8159, Engineering and Design, DrChecks, 10 May 2001
- EC 1165-2-209, Water Resources Policies and Authorities, Civil Works Review Policy, Change 1, 31 January 2012
- EC 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999.
- Corps of Engineers Civil Works – Coastal Protection (CECW-CP) Memorandum dated March 31, 2007
- OMB's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

To maintain independence and control, the Panel did not have direct or unmonitored discussions, e-mail, or phone contact with USACE. Battelle managed and facilitated interactions between the Panel and USACE during the orientation briefing and construction site visit.

2.6.1 Preparation of the Critical Items List (CIL)

Battelle (with input from the IEPR panel members) developed a CIL for the peer review, which listed specific items that are critical to the successful completion and function of the construction project. The intended purpose of the CIL was to assist the panel members and focus their review. The CIL considered the following:

- Information provided at the USACE orientation briefing for the WBV 14C.2 project on December 9, 2012
- Project review documents and supporting documentation (see Table 2)
- HSDRRS Quality Management Plan, 30 October 2009
- HSDRRS Design Guidelines, June 2008

The development of a CIL is important for conducting an analysis and identifying critical components, subcomponents, or systems whose malfunction can cause (1) a failure of a component/subcomponent, or (2) a cascading failure of the entire system or structure that poses a risk of serious injury, loss of life, or loss of mission objectives. The CIL was considered a living document that the IEPR panel members could continue to develop throughout the life of the project to focus the review of the design documents and construction activities towards critical issues. However, changes were not necessary after the document was submitted to USACE in December 2012.

With the aid of the CIL, a more effective and efficient peer review was conducted because the Panel was able to focus on those items that must not fail, rather than reviewing all details of design and construction. Table 3 shows an example of a critical item for the WBV 14C.2 project. In total, the IEPR panel members produced 17 critical items. The full text of the 17 critical items for the WBV 14C.2 project was presented in an earlier deliverable submitted on December 14, 2012, and is included in Appendix C of this report.

2.6.2 Design Review

Using the charge and the CIL as the basis for their review, panel members answered each of the charge questions. After reviewing the documents and completing responses to each charge question, the Panel raised no technical concerns regarding the WBV 14C.2 project as constructed, taking into account the future actions suggested by the Tiger Team and the Comprehensive Report.

During IEPR project development, USACE informed Battelle that the charge questions in the statement of work were supplied by the non-federal sponsor. Since the Panel did not identify any technical issues that needed to be brought to USACE's attention at the conclusion of the review, Battelle, after consultation with the USACE PCX, instructed the Panel to compile responses to each of the non-federal sponsor's charge questions as confirmation that the Panel had assessed the project based on each charge question provided. Given the lack of technical issues requiring a response from or action by USACE, the responses were not entered into the Design Review and Checking System (DrChecks); however, they have been included in Section 4.3 of this report. Battelle reviewed the comments to ensure applicability and consistency in response to the charge. Battelle's review also served to ensure that the responses were comprehensive, clear, and of acceptable technical and editorial quality.

Table 3. Example of a Critical Item from the WBV 14C.2 IEPR

WBV 14C.2 – Critical Item # 1		
1	**Component/System Name**	Earthen Levee - Embankment
2	**Component/System Function**	Provides primary hurricane protection
3	**Potential Failure Mode**	Global slope instability / failure, breach
		Localized slope instability / sloughing / failure, breach
		Seepage, piping, erosion, and ground loss
		Settlement – overtopping, erosion/scour, breach
		Differential settlement
		Loss of levee integrity due to erosion, wetting and drying cracks
4	**Possible Cause(s) of Potential Failure**	Non-conservative / non-representative design soil parameters: test data distribution; individual soil sample test property(s) versus soil mass/strata property(s) performance (i.e., with objectionables)
		Non-conservative design assumptions / analysis methods
		Unknown embankment discontinuities - pocket(s) of objectionables
		Levee settlement due to poor subsurface conditions
		Soil design assumptions in foundation is typical of reaches; Soil in specific areas may differ allowing more settling at some areas
		Armor system on flood and/or protected side of levee inadequate to withstand wave/water/impact forces
		Armor on top of levee inadequate for overwash effects
5	**How is the Failure Detected**	Review of derivation of design soil parameters and assumptions
		Review of test trench data, findings
		Review of analysis, design methods and assumptions
		Review of criteria for adherence to HSDDRS including changes during construction
		Monitoring and Inspection
		Observed cracks in levee crest
		Observed differential settlement of crest causing separation cracks
		Erosion on either side of levee or crest
6	**Consequence(s) of Failure**	Levee slope failure / settlement / displacement – overtopping, erosion/scour, and breaching
		Partial or full collapse of levee section
		Poor performance of team blamed on dysfunctional element
		Expensive repair required/property damage
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Proper derivation, development and selection of Design Soil Parameters, analyses, criteria, design procedure (per HSDRRS); settlement monitoring / subsequent / supplemental embankment raises / berms, erosion / scour protection; Frequent inspections, repairs, alternative access plans, etc.

2.7 IEPR Final Report

After concluding the review, Battelle prepared draft and final versions of the final IEPR report (this document is the final version) on the overall IEPR process and the IEPR panel members' findings. The draft and final IEPR reports were reviewed by each panel member and Battelle technical and editorial experts prior to submission to USACE. USACE commented on the draft IEPR report. USACE comments were addressed in preparing this final IEPR report.

3 IEPR PANEL MEMBER SELECTION

The IEPR panel members met the following minimum requirements:

- Experience with design and construction of projects similar in scope to the WBV 14C.2 project
- Familiarity with the HSDRRS Design Guidelines
- Master's degree or hands-on relevant engineering experience in the listed disciplines (see following bullet)
- Minimum 20 years of experience and responsible charge of engineering work
- Registered professional engineer

Panel members in each discipline also were required to have specific technical experience in the areas summarized in Table 4.

Table 4. Specific Experience of IEPR Panel Members Requested in Scope of Work

Technical Criterion	Fowler	McCaskie	Hall
Construction Manager/Civil Engineer			
Registered Professional Engineer with a minimum of 20 years of demonstrated/extensive experience and responsible charge of engineering work with federal construction and/or construction management of levee embankment construction projects in Louisiana or states/countries with similar soft soils, soft foundation conditions, and naturally occurring clay borrow sources in south Louisiana	X		
Familiarity with HSDRRS Design Guidelines	X		
M.S. degree or higher in related field of study, preferred but not required; hands-on field experience in the listed discipline is more important	X		

Table 4. Specific Experience of IEPR Panel Members Requested in Scope of Work (continued)

Technical Criterion	Fowler	McCaskie	Hall
Geotechnical Engineer			
Registered Professional Engineer with a minimum of 20 years of demonstrated/extensive experience and responsible charge of engineering work with design and material composition of levees and earthen structures over very soft (Louisiana-type) clay foundations, subsurface investigations in very soft soil and in naturally occurring borrow sources in south Louisiana, seepage design, and slope stability analyses for very soft soils		X	
Familiarity with HSDRRS Design Guidelines		X	
M.S. degree or higher in related field of study, preferred but not required; hands-on field experience in the listed discipline is more important		X	
Civil Engineer			
Registered Professional Engineer with a minimum of 20 years of demonstrated/extensive experience and responsible charge of engineering work with:			X
• Designs utilizing very soft soils			X
• Design of levees, earthen structures			X
• Related construction procedures			X
Familiarity with HSDRRS Design Guidelines			X
M.S. degree or higher in related field of study, preferred but not required; hands-on field experience in the listed discipline is more important			X[a]

[a] Waiver statement presented as part of Task 2 deliverable and approved by USACE.

The credentials and qualifications of the three reviewers selected for the Panel are summarized in the following paragraphs. Appendix D includes a resume for each reviewer that provides detailed biographical information and the reviewer's technical areas of expertise.

Mr. Deane Fowler, P.E., PgMP, C.C.M. (Construction Manager/Civil Engineer):
Mr. Fowler is an independent consultant with 35 years of experience managing civil engineering projects. He also is a Construction Documents Technologist and Certified Construction Manager. He earned his M.S. in civil engineering/construction management in 1986 from the University of Florida and is a registered professional engineer in Florida and Virginia. He has program, project, facility, and construction contract management experience and has held positions in every facet of engineering, including daily and long-term budgeting, planning, operations, and executive-level management. He served with USACE from 1976 to 1998, ultimately as Deputy Commander, Jacksonville District, and was the engineer/senior officer/project manager on multiple USACE civil engineering projects for USACE's Baltimore, Mobile, Jacksonville, New Orleans, and Portland Districts. His experience includes efforts in QA/quality control (QC) of studies, reports, and design and construction documents; construction management; change order negotiation; and conflict resolution. Mr. Fowler also has over 20 years of experience developing

cost estimates for cost-effectiveness studies and general inspection and feasibility studies for water resources, flood control, and hurricane protection projects.

Mr. Fowler's experience includes conducting design reviews of stability analysis and seepage control on Reaches J, H, F and G for the Morganza to the Gulf Hurricane Protection Project (New Orleans District) using the HSDRRS Design Guidelines. He also worked for USACE, Mississippi Valley Division, on the East Baton Rouge Parish Flood Control, St. Charles Parish Flood Risk Reduction, and St. John the Baptist Flood Risk Reduction projects. These projects involved cost analysis of multiple alternatives (using the Micro-Computer Aided Cost Estimating System [MCACES] Second Generation [MII] cost estimating program), a review of economic storm damage analysis and projections, and interagency coordination.

Mr. Stephen McCaskie, P.E. (Geotechnical Engineer): Mr. McCaskie is a senior geotechnical engineer for Hanson Professional Services. He has 34 years of experience in project management, engineering, and QA/QC of flood protection, water resource, transportation, inland navigation, underground, and port and harbor projects. He also has experience in planning, conducting, and supervising subsurface explorations, condition surveys, evaluations, assessments, safety inspections, foundation analysis, and design; construction monitoring and inspection; O&M; specialized foundation analyses; earth dam/levee and embankment design, instrumentation, data collection and analyses; and soil-structure interaction and earthquake engineering. Mr. McCaskie has experience in the design and construction of levees, flood walls (I-walls, T-walls, and L-walls), and closure structures including pile driving, and load testing for piles, for large flood control projects.

As a project manager, he completed the Design Documentation Report (DDR) for 12 miles of roads and embankments adjacent to Devils Lake, currently impounding water due to the flooding of Devils Lake. Work included design of dam alignments and features; slope stability and seepage analyses; embankment design to minimize future construction costs; constructability and sequencing analyses; riprap sizing; and development of standards for utility and infrastructure features crossing the embankments, meeting all Dam Safety requirements. He also provided engineering services for a realignment of an urban flood protection system involving 1,200 feet of pile-supported, reinforced concrete floodwall and two railroad closure structures, to provide 500-year level of protection for 4,700 acres of commercial/industrial development, including I-64 and the Spirit of St. Louis Airport, from the Missouri River and its tributaries. As a District Engineer (1993 to 2007), Mr. McCaskie provided engineering services for an urban flood protection system involving 12 miles of earthen levee, closure structures, floodwalls, relief wells, and pump stations to protect 4,700 acres of commercial/industrial development. Services included O&M, inspection, flood monitoring and response, analyses, design, permitting, and construction of post-1993 flood repairs and improvements, and 500-year levee improvements; wetlands mitigation and recreational use; and coordination with all federal, state, and local jurisdictions.

Mr. C. Alan Hall, P.E. (Civil Engineer): Mr. Hall offers over 38 years of experience in the fields of water resources, environmental, and civil engineering in government service and private practice. He serves as a technical consultant to the South Florida Water Management District (SFWMD) on its $2 billion Acceler8 Program, a five-year design and construction initiative to

fast-track restoration of the South Florida ecosystem, enhance flood protection, and increase water supply. During his 25+ year public career as Director of Ecosystems Restoration for the SFWMD, Mr. Hall oversaw more than $1 billion in ecosystem restoration construction projects. Mr. Hall's specific accomplishments with SFWMD include the $600 million Everglades Construction Project, the Kissimmee River Restoration Program, and the Florida Bay Restoration and Emergency Interim Project. As Deputy Director of O&M at SFWMD, Mr. Hall was responsible for the leadership and control of the water management operations and project maintenance functions for a 1,800-mile water control and treatment system, which provided flood control, water supply, and environmental enhancement for central and south Florida. Mr. Hall has led the design and construction management of levees and structures on top of muck-based soils within fresh water marshlands of south Florida, as well as erosion control measures and multi-use roadways on multiple water resource projects. Mr. Hall also has experience in professional and engineering management and has served on previous USACE IEPRs.

Mr. Hall was project manager for a $200 million stormwater management project serving a 174-square-mile urban watershed. Project elements included a 6,600-acre aboveground stormwater detention area, two stormwater pumping stations of 3,700 cubic feet per second each, and 6.5 miles of conveyance canal enlargements. He also was a project hydrologist for a $15-million pilot project designed to demonstrate the feasibility of large-scale river restoration by strategically installing three steel sheet-pile notched weirs in a canal 30 feet deep and 250 feet wide. The success of this project led to approval of a $430-million joint federal-state river restoration program founded upon the Demonstration Project's performance and principles. As an expert in civil engineering, Mr. Hall served in multiple professional capacities to oversee the design and construction of the Gulf Intracoastal Waterway Closure Complex (GIWCC) Project. Included within the GIWCC was a 19,000-cubic-foot-per-second flood control pumping station, a 225-foot waterway closure gate, extensive levees and hurricane protection walls, and an environmentally sensitive water control structure.

4 RESULTS — SUMMARY OF REVIEW

The IEPR panel members followed the processes described in Section 2.6 to conduct their review. These processes were in accordance with the PRQCP and the USACE guidance documents cited in Section 1.1. This section summarizes the IEPR Panel's overall review approach (Section 4.1), the results of the construction site visit (Section 4.2), and the Panel responses to charge questions (Section 4.3).

4.1 Overall Review Approach

As discussed in Sections 2.3 and 2.4, the IEPR panel members participated in an orientation briefing via teleconference in December 2012 and a construction site visit to the WBV 14C.2 levee reach in January 2013 to familiarize themselves with the project and with construction activities conducted at the site and to gain a better understanding of the project scope.

With feedback from the IEPR panel members, Battelle developed the CIL (see Appendix C) and provided it to USACE. The IEPR panel members were instructed to use the CIL along with the charge to focus their review, within their area of expertise, on those project components that are

critical to the successful completion and safe operation of the project. For each critical item identified, potential failure modes and causes were assessed. This assessment provided the basis for the review of the WBV 14C.2 review documents. Most panel members used the HSDRRS Design Guidelines, and all used their respective expertise in engineering practice and their experience, to guide their technical review of the documents.

The IEPR panel members were encouraged to work independently or in conjunction with their fellow IEPR panel members, as appropriate. The panel members' broad range of experience allowed them to offer comments within their assigned discipline as well as in other associated disciplines. In general, each IEPR panel member chose to work independently in reviewing the project documents; however, the panel members engaged in project discussions during the site visit and throughout the IEPR review process. For instance, IEPR panel members discussed their comments with each other after they submitted their individual responses to the charge questions.

4.2 Summary of Construction Site Visit Findings

During the exit briefing, the IEPR panel members provided positive feedback, asked questions, and stated several concerns about the project.

4.2.1 Positive Feedback

Orientation Briefing

- Excellent IEPR Brief on WBV-14C.2 Design and Construction.
- Good synopsis of the design approach.
- Good description of project history and performance, construction processes, and recent specific construction and sequences.
- Extremely helpful description of construction modifications.
- Good representation of USACE staff/disciplines.
- Overall, team was very knowledgeable and well prepared.

Construction Briefing

- Good opportunity for panel members to see the construction site, made possible by stopping at multiple locations along the levee.
- General orientation of the levee profile and key issues that arose during construction.
- Opportunity for panel members to appreciate the magnitude of the effort required to construct the levee.
- Detailed discussion of construction procedures, including those to address problem areas and specific descriptions concerning QA trenching and testing to determine quantity of debris mixed into the levee section.
- Detailed discussion of specific O&M issues and any potential maintenance issues that the sponsor may encounter.
- Discussion of recommendations for additional improvements (e.g., armoring/sheet pile cutoff) to ease the sponsor's concerns about maintaining the project.

4.2.2 Questions/Concerns

The IEPR panel members identified four questions and concerns from the construction site visit, which are restated in the Field Visit Report. These issues were discussed among USACE, the non-federal sponsor, and the panel members during the exit briefing. The questions and concerns were resolved through discussion with USACE during the exit briefing or during the panel members' review of the documents and supporting documentation.

The four questions/concerns that were discussed at the exit briefing are as follows:

1. **Concern about the moisture/ wet density testing and analysis. The panel members requested more explanation of the testing and retesting/reissue process.**

The greatest concern expressed was the disparity between the approved Contractor Quality Control program soil test moisture results and the approved standards. The stated approval per specification was based on +5 percent or -3 percent of the optimum moisture content; however, the QA review has published results showed approved results ranging from 18 percent (October 10, 2012) to 33 percent (February 11, 2012). On the surface, this range seems to violate the approved standard; however, the process used for approval proved to be sound. During the exit briefing, USACE staff explained the iterative process used to perform the testing; they stated that when values were found to be out of specification, a retest was performed. USACE also clarified that the terms "reissue" and "retest" are used synonymously. In addition, they explained that a contractor pulled samples and ran tests, but the official data analysis was conducted by a third-party laboratory hired by USACE. When discussing the quality of material received from the borrow pit, USACE staff confirmed that in addition to the information gained along with the soil tests, preliminary visual inspections of the trucks coming from the borrow pit were conducted before the material was used. This was a driving factor in the change of borrow pit source.

2. **Question as to why a different borrow pit was required. The change was not clear from documentation reviewed.**

During the construction briefing, prior to the site tour, the panel members asked why USACE needed to change borrow pits during construction. USACE explained that the change was not a requirement; however, they instructed the contractor to change borrow pits because they wanted cleaner borrow material, especially for use on the tops of the levees.

3. **Question as to whether the project deviated from the HSDRRS Design Guidelines.**

Concerns and questions were raised about the use of the HSDRRS Design Guidelines in reference to this particular design. For example, occasionally a waiver of a guideline is requested due to unusual circumstances. It appeared that this specific site had many challenging and unusual circumstances that might have required special considerations, such as the handling of the pre-project dumpsite. USACE confirmed that there was no deviation from the Design Guidelines and that all specifications used were derived from those stated in the approved Design Guidelines document.

4. Question as to the process and/criteria for deciding to waste certain material.

During the construction discussion, USACE stated that certain materials were wasted (offsite disposal) during the construction process, which concerned the panel members. USACE clarified that the decision to waste the material was subjective. As an example, they stated that the soils found around the pumping station contained more material that is objectionable. USACE also mentioned this issue in an appendix to the Comprehensive Report. The appendix documents each trench that was dug, includes photos accompanied by descriptions, and explains why the decision was made to waste the materials.

Plans and specifications were provided to the Panel after the site visit, with the awareness that some of the comments and questions could be addressed later based on the information in those documents or in operating manuals, closure plans, or other data sources.

4.3 Summary of Panel Review Findings

The Panel did not identify any technical issues that needed to be brought to USACE's attention at the conclusion of the review. Therefore, Battelle directed the Panel to compile responses to each of the non-federal sponsor's 15 charge questions. The Panel's responses to the questions are provided below. The charge questions were supplied in the original statement of work USACE provided to Battelle. They are presented verbatim.

General Charge Questions

Q1. Do the design assumptions made during the decision document phase (interpreted as the EAR, PDD, DDR, or similar appropriate design document for the specific project – to be provided to the Panel) for hazards remain valid through the completion of design and construction as additional knowledge is gained and the state-of-the-art evolves?

Response: The Comprehensive Report states the following:

> "The offsite borrow material for this contract was from Contractor-furnished sources, which is consistent with the majority of the HSDRRS contracts. In addition, a portion of the required levee fill material was obtained from the partial degrading operation of the existing levee. It should be noted that for Contractor-furnished borrow, the Contractor is obligated to furnish satisfactory material that meets the contract specifications for embankment as well as environmental compliance. The contract requires the Contractor to submit the borrow source owner's package that includes a Geotechnical Report signed and sealed by a licensed civil engineer with a specialization in Geotechnical Engineering certifying that the proposed source contains suitable material. Borrow material soil samples are classified and tested for Atterberg Limits, moisture content, sand content, and organic matter content. In addition, the Contractor is required to perform salinity testing of the borrow source material to ensure grass growth can occur." (Comprehensive Report, Section 3.0, page 5)

The design assumptions related to hazards were incorporated into the contract specifications and were monitored closely throughout the construction phase. The Comprehensive Report further states:

> "Contract modifications were issued to address changed site conditions when debris was found while degrading the existing levee. In portions of the Westwego and Westminster reaches, degraded material was hauled offsite and was not used as fill in the new levee." (Comprehensive Report, Section 3.0, page 5)

Substantial trenching conducted by the Tiger Team confirmed three sources of debris in the fill: the existing levee, the River Birch borrow pit, and an abandoned landfill. In each case, USACE and the contractor took appropriate actions to remove any material that could compromise the integrity of the levee design. Additional measures have been proposed in the Comprehensive Report; when implemented, these measures should eliminate any remaining safety and levee integrity issues.

The design assumptions appear to have been based on a history of soil management issues for the region and a continuing process of product improvement. The design approach centered on using highly plastic clays in the levee sections and ensuring that organic debris found in the fill material is removed from the final product. This approach, which also applies to material from borrow pits, directs the removal of objectionable material from existing (pre-contract) subgrade, as noted in the specification for WBV 14C.1:

> "Grubbing shall be performed within the limits of the embankment together with the 5-foot strips contiguous thereto. All roots and other projections over 1 ½-inches in diameter shall be removed to a depth of 3-feet below the natural surface of the ground or surface of existing embankments. The areas to be grubbed are those specific areas within the limits of the levee design section." (WBV 14C.1 ED07-029, Para 3.3.2.1 Embankments)

Further, the WBV14C - Geotechnical Report identified soil characteristics in the existing conditions in preparation for design.

> "For the current study, thirty-six (36) Cone Penetration Tests (CPTs) were obtained, most drilled to 70 feet and some drilled to 90 foot depths, including centerline, flood side toe and protected side toe borings" (WBV14C-Soils Report, March 2009).

These 36 were in addition to the 38 bored in 2007 for the same project area. Boring logs indicated numerous incidents of woody debris at the 0- to -15-foot level. After Notice to Proceed (NTP), numerous site visits were conducted by various USACE District staff to assess, inspect, and collectively develop solutions. For example:

> "During contractors operations of degrading existing levee in the vicinity of [centerline (C/L)] Sta. 181+00 (Westminster to Orleans Village Reach) it was found that the embankment contained excessive debris not in compliance with the

specification" (Situation Observation Report, for WBV 14C.2 dated 27 January 2011).

As each lift of material was placed for a given reach under construction, the material provided by the contractor was disced, repeatedly as necessary, and picked until there was no observable evidence of appreciable objectionable materials. The lift was then inspected again immediately prior to compaction. After meeting testing requirements for moisture content and density, each lift was inspected one final time during scarification and prior to allowing placement of the next lift.

During levee construction, verification borings were taken to confirm the presence of organic material in the existing levee section for WBV 14C.2:

> **"Field Sampling Completed:** On 16 Feb 12 to 21 Feb 2012, FFEB (Geotechnical Drilling Contractor) bored 13 investigation sites and completed 7 Cone Penetrometers in the vicinity of the closed Westwego landfill access road past the foot of Central Avenue at the levee site…" (WBV 14C.2 Auger and CPT Report dated June 2012)

A portion of the site "Access Road" in Westwego Reach had a documented history of being used as a municipal dump. The presence of concrete, wood, tires, etc., in the existing embankment could be expected, and such materials were identified in the contract documents before construction started. As a result, the contractor was required to remove objectionable material from the site down to 3 feet below the existing surface.

The addendum to the Draft WBV 14C.2 Soils Report described additional borings taken in key areas of the three levee reaches. More significantly, the levee stability has been changed and is now based on splitting the project into smaller reaches to utilize more reach-specific data rather than the one-reach approach used for the original design.

In summary, the design assumptions used in the initial feasibility and preliminary design were valid and remained so throughout the construction. Lessons learned have been incorporated, and a progressive process of product improvement through implementation of key construction change orders has been followed to ensure the quality of the levee section. Where debris (materials outside of the specification limits) was found in new fill materials, the contractor had not followed the specifications; however, these incidents were identified and corrective action taken by USACE field personnel with assistance from representatives of the non-federal sponsor to enforce the contract plans and specifications.

Geotechnical assumptions, design criteria, analyses, designs, and technical specifications are believed to meet or exceed those of the HSDRRS Design Guidelines and standard practice and are believed to be valid–and to remain valid–through design and construction completion. Our review of available information did not find any reason, bases, findings, or unanticipated conditions disclosed during construction which might warrant a possible change in design criteria or basis for design and construction.

Furthermore, the same conclusions are anticipated to remain valid with respect to geotechnical aspects considering the near term and potential future changes in the "state of the practice." A specific example is the development and use of the HSDRRS Design Guidelines, which have been applied in the construction of many projects and have matured over time. Levees designed in accordance with the HSDRRS Design Guidelines have performed successfully when hurricane tested, and the Guidelines have been used as guidelines/reference on similar projects elsewhere.

Q2. Do the project features adequately address redundancy, resiliency, or robustness with an emphasis on interfaces between structures, materials, and project phases?

Response: Yes, the design and construction elements follow the standards established for the HSDRRS, the 1% Design Elevation, previous Lessons Learned, and the System Consistency Review process. Although no project is perfect, the overall intent, functionality, reliability, maintainability, and performance requirements are incorporated into the project features. Review of the Construction Contract with Modifications, HSDRRS Quality Management Plan, QA and Site Visit Reports, and other relevant documents indicates that repeated emphasis has been placed on integrating the project features to create a workable system. Examples of these efforts are as follows:

- Addressing continuous concerns about creating a bond between the existing subgrade and imported fill brought in by the contractor
- Conducting detailed inspections of the connection/tie-ins of the levee sections to fixed structures
- Extending the berm sections to cover 'wet areas' and any potential areas that may cause future maintenance issues
- Increasing the tilling from 2 inches to 4 inches and hand-picking objectionable material to reduce future maintenance concerns
- Undertaking exploratory holes and trenching to verify the level of debris incorporated into the existing and new berm and whether it meets the specifications
- Wasting (offsite disposal) objectionable material from the existing berm that was originally thought to be suitable and bringing in suitable contractor-supplied borrow material.

All of this product improvement errs on the side of caution during the multiple phases of the project development and includes implementation of construction change orders due to differing site conditions not identified during the design phase. These practices indicate that the relevant issues were addressed. Geotechnical explorations, assumptions, design criteria, analyses, designs, and technical specifications implemented as part of the design process and construction QC (including construction contract modifications) have resulted in project features that meet or exceed the HSDRRS Design Guidelines and standard practice, and provide for increased redundancy, resiliency, and robustness. Specific assumptions resulting in a conservative design and product improvement include the following:

- Expectations regarding seepage boundary conditions (headwater/tailwater), steady-state conditions, permeability values

- Projections regarding slope stability, soil profile/strength, lack of strength gain with time/ consolidation, potential failure surfaces, levee setback / centerline relocation
- Estimates regarding settlement parameters, pore pressure dissipation, rate of construction, loadings, future raises
- Construction contract modifications such as berm extensions, added lifts/cover
- Additional planned future modifications and raises.

Redundancy: A 250-foot sheetpile wall has been constructed on the flood side at the site of the previous landfill to prevent further seepage through the materials surrounding the former landfill access road (Comprehensive Report, page 60). Detailed investigations and seepage analysis showed that even in a worst-case scenario, the seepage concerns over piping of materials were not significant.

Resiliency: Additional clay layers will be applied at key areas to further ensure the lasting integrity and stability of the levee section. The monitoring and inspection regimes provided for in the O&M manuals will further ensure the completed levee's ability to sustain loads greater than the original design.

Robustness: In all analyses, USACE personnel assumed the worst combination of circumstances to ensure the lasting structural integrity of the completed project.

Q3. Do the project features and/or components work effectively as a system?

Response: Yes. The design uses HSDRRS Guidelines that, when incorporated properly, integrate this levee system with the rest of Hurricane Protection Levees in the Greater New Orleans/Southeast Louisiana region. The design features include the following:

- Projected levee heights that take into account projected increases to still water level (SWL) for various future conditions (i.e., climate change, settlement) in establishing the project features
- Protective berms on the flood side and the protected side
- Clay core
- Low organic and sand content
- Worst-case stability analysis
- Tie-ins to existing structures (pump stations, flood walls, etc.)
- Extensive boring analysis with identification of problem areas and solutions integrated into the construction activities
- A conservative approach to resolving worst-case scenarios

Further, the O&M volumes discuss the actions/operations to take before, during, and after storm events to ensure that the entire system is integrated with the rest of the premier line of defense for the West Bank. Review of the HSDRRS Design Guidelines and plans and specifications indicates that each component is necessary to work/function effectively as a system well into the

future. The system also relies on the remaining planned modifications (armoring, etc.), proper O&M, and planned future raises. The components, as built with the additional safety measures recommended by USACE, will work effectively together.

Q4. Do the assumptions made during design remain valid through construction as additional knowledge is gained and the state-of-the-art evolves? (Final DDRs, CO QMPs, site visits, and other similar appropriate documents to be provided to the Panel for this assessment, including Appendix C)

Response: In the case of material properties, yes. The design assumptions related to material properties such as minimum weight of 110 pounds per cubic foot, 400-pounds per square foot shear strength, organic matter less than 9 percent, a plasticity index greater than 10, and clay with less than 35 percent sand content still remain valid through the construction phase. For the design of this levee, 636 laboratory strength tests were performed between the historical borings and the new borings in preparation for creating the contract plans and specifications. Seventeen (17) consolidation tests were performed to determine soil compressibility and to estimate future foundation settlement from levee loading for the 3.5 miles of levee.

Due to concerns by the non-federal sponsor, verification borings were performed after construction to confirm that the design assumptions were valid. Typically, verification borings retrieve samples from the fill placed during the current contract, but for this project, verification borings were extended into the pre-existing levee soils in select areas. The soil samples obtained from the verification borings were lab tested for strength, organic matter, Atterberg limits, sand content, and unit weight. The data obtained from these borings were then compared against design and specification requirements. Verification borings are normally for design and analysis purposes and are not part of QA/QC records. As demonstrated in the reach-by-reach evaluation, the verification boring results indicated that the levee materials met the design requirements.

Assumptions related to the suitability of existing levee material for the new levee lift and assumptions related to the availability of suitable material at the borrow sites turned out not to be valid through construction because debris and objectionable materials were discovered and had to be mitigated through contract modifications. Another design assumption—that the previous landfill is not beneath the new levee centerline—turned out to be valid, but it was discovered that promiscuous dumping along the landfill access road, which extends beneath the levee, did occur and must be dealt with, as outlined by the Tiger Team, as further modified by the USACE recommendations.

Q5. For O&M manuals, do the requirements adequately maintain the conditions assumed during design and validated during construction? Will the project monitoring adequately reveal any deviations from assumptions made for performance? (Understood that monitoring plans and O&M manuals may be developed after construction and before project turnover. Must determine how to retain the Panel or issue new task order for this work.)

Response: If the guidelines as set forth in Volumes 1 and 2 are incorporated into Volume 3 and are followed by the non-federal sponsor, the design assumptions and conditions will be

adequately maintained. The monitoring and inspection protocols presented in Volume 2 will reveal any deviations and identify performance limitations far enough in advance to allow for the implementation of corrective measures. The non-federal sponsor is fully capable of maintaining the levee system as designed, built, and modified by USACE criteria. The O&M specifics outlined in the manuals for levees are very good. If followed faithfully, they will effectively prevent any hazards to maintenance crews and maintain the design integrity of the levee system. Based upon the description in Volumes 1 and 2 of the O&M manual, it is assumed that Volume 3 of the O&M manual will describe specific areas for heightened monitoring and corrective measures for repair of observed deficiencies due to weathering and operational conditions. The IEPR Panel would like to review Volume 3 when it is completed. The Panel understands that information contained in Volume 3 will be specifically applicable to WBV 14C.2 (for example, detailed O&M plans such as monitoring and surveillance, pre-hurricane and post-hurricane responses, and any unique requirements). If the manuals are rigorously followed during project O&M, the Panel believes that the O&M manuals will guide and validate design assumptions and conditions and maximize levee performance.

Performance Charge Questions

Q6. Was the project constructed in accordance with plans and specifications?

Response: Although the WBV 14C.2 levee has been built in accordance with the plans and specifications, USACE offered several recommendations to further enhance the system. Several recommendations were offered with the intent of further improving O&M efforts for the WBV 14C.2 levees. The USACE Comprehensive Report (page 60) and the consensus of opinion expressed by the Tiger Team conclude that the levee complies with the specifications. (Tiger Team Report, page 11-2). Specifically:

1. The levee as constructed meets the design intent.
2. The levee was constructed in accordance with the contract plans and specifications.
3. Potential future settlement attributed to wood content decay and loss of volume will be negligible.
4. The embankment specifications will be revised for future contracts based on the lessons learned on this project.
5. Additional construction as described by both the Tiger Team and USACE recommendations should be incorporated in certain areas of the project site.

With the proper O&M, completion of planned modifications (armoring, etc.), and future raises, the project will provide the desired hurricane protection with a reasonable level of redundancy, resiliency, and robustness.

Q7. Were contract specifications violated by allowing the contractor to chop wood contained in the embankment that would be considered objectionable (length greater than 1 foot, and cross sectional area greater than 4 square inches) into small wood chips, then placing the material into the embankment?

Response: The Narrative Completion Report and various field reports discuss the presence of woody debris in the fill section, with several references to the contractor chipping wood from the clearing/grubbing operation conducted early in the contract. The Comprehensive Report states:

> "The trees were removed using the marsh buggy excavators outfitted with grab buckets, which pulled the trees out of the soft ground removing the tree, and root ball. As this timber was considered merchantable, it was stacked and hauled offsite to be milled. Other removed timber was chipped onsite, loaded into dump trucks, and then hauled offsite to be disposed of. This heavy clearing and grubbing was required along the entire length of the project site." (Comprehensive Report, page 12)

Fundamentally, as long as the parameters outlined in the contract plans and specifications (including related safety documents and references) were met, the contractor's means and methods are not subject to review. Further, the contract specifically states that the contractor may process borrow material upon the new levee berm (Section 31 24 00.00 12 Embankment). In addition, the limits on objectionable material (i.e., wood) per the specification for the embankment state that the material must not exceed 1 foot in length or 4 square inches in area with no more than 1 percent by volume for each cubic yard of levee section. This implies that such objectionable woody material is allowed in the new levee section as long as it does not exceed the specified dimensions and volume nor appear in pockets, zones, or levels of concentration.

Based on the documents reviewed, no evidence was found that the practice of chopping up wood or objectionable material into smaller non-objectionable pieces and incorporating them into the embankment was permitted or occurred in the field. Records show that the objectionable material was hauled away for offsite disposal.

Geotechnical Analysis Charge Questions

Q8. Were geotechnical analyses, including boring logs, sufficient and did the analyses adequately consider seepage during the design process and construction?

Response: Geotechnical explorations, assumptions, and analyses performed as part of the design process and construction QC, including construction contract modifications, indicate that the levee enlargement meets the stability criteria required for HSDRRS. Further, under-seepage was evaluated in accordance with HSDRRS loading conditions and was conducted in general accordance with procedures established in DIVR 1110-1-400 (dated December 12, 1998) and Engineer Manual 1110-2-1913, Design and Construction of Levees (dated April 30, 2000).

The subsurface conditions disclosed by the geotechnical documentation indicate that seepage was not a critical factor in the design, construction, and performance of the earthen levee. The Panel concurs that under-seepage and through-seepage are not controlling design conditions or factors. The design assumptions regarding seepage (steady-state seepage, design head / tail water elevations), coupled with contract modifications implemented during construction (berm extension, additional cover), result in increased redundancy, resiliency, and robustness.

Specifically, a geotechnical investigation was conducted prior to design and again during construction for this 3.5-mile levee project. The analysis of the 38 borings under the feasibility level-of-design analysis, the 36 CPTs, and later the verification borings (32) along with the trench investigation followed standard practices to analyze the soil properties, using site-specific boring data, cone penetrometer results, survey data, and shallow soil exploration information. The stability analysis followed Spencer's Method along with the Lower Mississippi Valley Division Method of Planes. These analyses evaluated piping, seepage, and heave for the levee sections using the SWL case. The laboratory test results indicated that shear strength, moisture content, organic matter content, liquid limit, and plastic limit, along with percent clay/sand values, met or exceeded the requirements. Fundamentally, as stated in WBV 14c2 Soils Report, page 6:

> "Soil stratification is consistent throughout the proposed levee enlargement site with predominately fat clays with silty sand strata noted below elev. -50, usually 5 foot thick. A consistent organic clay stratum is present in most borings, but appears predominately in the upper 20 feet below the surface throughout the levee reaches. Below elevation -20, soft clays are present with water contents mostly in the 50 to 80 percent range. Consistency of the clay samples vary widely, from very soft to medium."

The initial geotechnical investigation in 2009 did miss some critical information related to subsurface conditions. In addition, the report did not identify deficiencies within the existing levee section, which would restrict its viability for reuse in the new levee. However, geomagnetic surveys and subsequent trenching investigations during construction did identify the magnitude of the site limitations. Fortunately, through the diligence of USACE and non-federal sponsor personnel, these issues became elevated to the point that further geotechnical investigations were made and corrective measures identified to ensure the long-term integrity of the new levee.

Q9. Was adequate investigation of any wet areas performed during construction?

Response: Yes. First recorded in USACE inspection reports dated October 2012, the 'wet' areas were observed during construction and investigated by USACE and the Tiger Team. The Panel concurs with the USACE and Tiger Team assessment:

> "Drawings reveal a protected side natural "berm drainage blanket" constructed in the initial levee lift (1997 to 98) in the Westminster levee reach approx. 75 to 125 feet from levee [centerline (C/L)]. The drainage blanket drained the old existing berm away from the levee towards the canal. A layer of sand was placed on the natural ground (low area) and was capped with a small clay cover (~1 foot). The wet surface area observed appears close to a straight line approximately 110 feet parallel to the existing levee crown." (Comprehensive Report, Appendix E, Letter Report for WBV-14c.2 Levee Enlargement, 25 February 2011)

USACE believed that the wet areas are at or near the end of the drainage blanket and that the blanket water bleeds into areas of low relief adjacent to or just past the end of the drainage

blanket. There is no evidence of under-seepage from the flood side as the source of water at the wet areas. It is further thought that ongoing construction and nearby construction activities have exacerbated the situation and that wet areas have cropped up in more areas as the Project progressed. The adjacent haul road used for heavy construction equipment and loaded haul trucks had heavy usage and likely caused a "pumping" effect in the drainage blanket that drove the blanket water toward the end of (or just past) the blanket into low-lying areas. The wet surface areas on the protected side are not in the levee design section, and are located well past the levee stability toe. A dark reddish-brown coloring in the soil appears to be due to near-surface woods (cypress and cedar) that the water has drained through the sand layer. The Tiger Team conclusion is similar to the USACE recommendation: provide an 18-inch clay blanket overtopping the wet areas to eliminate any future maintenance issues (e.g., rutting).

The Panel does not believe that additional geotechnical explorations beyond those completed would have increased the knowledge base or understanding, nor would they have changed the design or contract modifications implemented.

Operation & Maintenance Charge Questions

Q10. Will any additional maintenance requirements be incurred due to subsidence; would damage to maintenance equipment and to the levee occur as a result of objectionable material remaining in the levee?

Response: If the USACE-recommended modifications to the design are implemented, there should be no additional maintenance requirements as a result of objectionable material remaining in the levee.

Settlement for the levee section is anticipated and planned (i.e., multiple lifts are planned over decades to re-establish the final elevation of 14.0 feet to compensate for the anticipated 3.5 feet of settlement). Settlement is expected to occur uniformly, not within a point-specific area, and no additional maintenance requirements should be incurred by the non-federal sponsor that would damage equipment as a result of objectionable material exposed in the levee section. Additional settlement beyond that due to soil consolidation is expected to be very minimal or nonexistent. Buried wood / organics are expected to decay very slowly because they are not exposed to oxygen, which promotes decay. Subsequent volume change is also expected to occur very slowly compared to soil consolidation settlement, which will control and dictate future raises. Further, the question implies that subsidence due to localized decomposition of organic material (wood) in the levee section will cause holes/ruts or other differences in elevation (differential settlement) that could harm maintenance equipment. That is not the case.

As discussed in the Comprehensive Report, the degrading of the surface (crown) of the levee section will not be impacted by any deterioration of woody debris encapsulated within the levee footprint. To ensure that no physical projections above the levee crown or side slopes are present, an additional construction modification was enacted that changed the tilling depth from 2 inches to 4 inches, with the requirement that any objectionable material identified be handpicked during the tilling process.

Q11. Review the settlement analyses with consideration of the wood in the embankment material and assess whether settlement and subsidence rates would be accelerated due to the presence and/or decadence of wood.

Response: According to the Comprehensive Report:

> "The maximum computed loss of height due to wood decay was estimated to be about 1 inch for the minimum wood volume from the bulk samples and about 2.2 inches for the maximum wood volume from the bulk samples." (Comprehensive Report, Chapter 10, pages 10-11)

This represents the worst-case scenario assuming 8 feet of levee fill and maximum distribution of wood throughout. It is unlikely that the rate of settlement will be accelerated because the majority of the wood pieces are encapsulated within the fat clay and are not exposed to the combination of oxygen and moisture required for rapid decomposition.

Review of the documentation provided leads to the following conclusions:

1. Deleterious material is contained in the levee sections.
2. Elimination of the River Birch borrow site reduced the incidence of woody debris in the contractor-provided fill material.
3. Wood debris is part of the encapsulated material in the clay matrix and, when not at the surface, lacks any exposure to the air that supports normal decay.
4. Anaerobic decomposition can promote the decay of wood particles; however, the dissolved oxygen in the clay samples, analyzed as part of the verification borings, is extremely low and will not support this type of volume reduction.
5. Debris is not concentrated in layers, patches, or bunches, as verified through trenching and borings.
6. The amount of debris is less than 1 percent by volume for each cubic yard of levee section. A letter from the Louisiana Office of Coastal Protection and Restoration contained worst-case estimates on settlement (wood decay) that appeared to be based on speculation.
7. The size of individual pieces of debris (concrete, wood, cable, steel rods, etc.) is less than 1 foot in length and less than 4 square inches in area.
8. Increased tilling of the levee surface from 2 inches to 4 inches should expose any near-surface objectionable material and allow it to be removed during the handpicking process.
9. Settlement and subsidence rates will not be impacted to any significant degree by the decay of wood in the levee section.

After an extensive search concerning decay of woody debris in a subsurface environment (i.e., wood trapped in the levee cross-section), the following quote was found from the U.S. Forest Service:

> "Lack of sufficient air or moisture prevents decay. Wood kept constantly dry, continuously submerged in the water or mud, or buried deep underground does not decay…Submerged or deeply buried wood, such as submerged piling that supports the masonry foundations of bridges or large buildings, contains too little air. The air supply in the soil becomes deficient a few feet below the surface of the ground; at depths of more than 5 or 6 feet, the rate of decay is usually very slow, especially in dense, compact soils." (U.S. Forest Service Research Note, FPL 0154, January 1967)

Further, a great deal of literature supports the notion that petrifaction or mineralization of the wood may result with sufficient time when encapsulated within the levee profile due to the replacement of wood cell components with minerals contained in the clay matrix. Typically, the presence of wood in a consolidating soil mass tends to reinforce the soil mass and decrease or slow settlement due to consolidation. For this to happen, the wood type, content, and distribution would have to be considerably more than what is apparent in the levee. Conversely, the apparent volume and distribution of wood in the levee is not thought to be sufficient to substantially impact settlement through decay and reduction in volume.

In summary, review of settlement analyses and evaluation of the apparent type and distribution of the objectionable material, including wood, possibly remaining in the levee indicates that the presence of wood is not expected to accelerate settlement. Any wood / organics that are buried (and therefore lack oxygen) will decay very slowly, and any subsequent volume change will be much less than the change that would occur through settlement from soil consolidation, which will control and dictate future embankment raises.

Q12. Review all documents provided with consideration of the wood and other unsuitable materials in the embankment, and assess the quality of construction, as well as employee safety in performing maintenance activities and the public's welfare.

Response: Once the USACE-recommended modifications are implemented, there should be no unusual threats to safety of the public or employees while performing maintenance operations. The quality of construction is a function of the quality of the materials and available information used for the design and construction. USACE and non-federal sponsor staff observed and contributed to identifying the need for changes in means and methods during the construction period, and the ultimate completed project will include the recommended enhancements.

After reviewing all the relevant documents as they relate to wood and other objectionable materials in the embankment, and assessing the impact of the materials on the functionality, maintainability, safety, and overall performance of the levee system, the Panel believes the following:

1. The levee sections for all three reaches should perform as planned for a 1 percent event.
2. The levee profile fundamentally meets the requirements of WBV 14C.2 plans and specifications per the referenced reports.
3. If all contract modifications (i.e., extended berm, clay cap, increased tilling / hand picking, sheet pile installation, etc.) and Tiger Team recommendations are incorporated, any potential

damage to maintenance equipment should be eliminated, and the non-federal sponsor's concerns about future maintenance should be alleviated. Further, any protrusions of objectionable material above the levee surface should be removed by the contractor before project O&M is turned over to the non-federal sponsor.

4. The public's welfare will be enhanced because the levee system is designed to prevent flooding/surge protection up to a 100-year event.
5. Issues related to quality of material were raised by numerous parties, and corrective actions were taken to meet the design intent and HSDRRS guidelines.
6. Unsuitable material was first recorded in inspection reports dated October 2010, before the contractor degraded the existing levee. Further, there were reports of debris in the levee section for WBV 14C.1 prior to the start of WBV 14C.2.
7. Increasing the tilling depth from 2 inches to 4 inches and follow-on 100 percent handpicking of objectionable debris materially reduces the potential of maintenance equipment being damaged or causing harm to the public.
8. Keeping all personnel a minimum of 100 feet from any mowing operation will ensure the public's safety.

The results of the construction contract and review of the available documents indicate that the levee enlargement has met the required industry standards for quality, functionality, maintainability, safety, and performance. With completion of the planned modifications and future raises, as well as proper O&M, the project is expected to allow for safe maintenance as well provide the desired hurricane protection.

Q13. Due to presence of "other foreign matter" such as large chunks of concrete, culverts, crane hooks, and other materials in the embankment, review all documentation and reports provided and assess whether levee construction provides adequate cover and compaction over such items or whether placement of additional clay material placed on the levee provides for a safe environment for maintenance employees and the public?

Response: Based on the documents reviewed, no evidence was found to suggest that "other foreign matter" such as chunks of concrete, culverts, crane hooks, and other materials were incorporated into or remain in the embankment. A thorough review of all related documents (including contract plans and specifications, modifications, geotechnical reports, QARs, QC reports, field reports, site visit reports, and other related documents) indicates that the project is expected to provide flood protection while maintaining a safe environment for maintenance employees and the general public. Provided the USACE-recommended modifications are completed (including the placement of as much as 2 feet of additional clay material), the project area is expected to provide a safe environment for maintenance employees and the public. The additional clay cover will further enhance safety during maintenance beyond the level of safety covered in the USACE Safety Officers Report.

Numerous contract modifications were issued to address changed site conditions when debris was found while the existing levee was undergoing degradation. In portions of the Westwego and Westminster reaches, degraded material was hauled off-site and was not used as fill in the

new levee. A modification was issued to extend the protected-side berm in the Westminster reach after a high-moisture area was discovered beyond the toe of the design berm. The purpose of this modification was to improve conditions for maintenance mowing. Fill material from one of the contractor-furnished borrow pits contained an unacceptable amount of woody debris. A contract modification was issued directing the contractor to cease using that source. Several other contract modifications called for the addition of clay cover (6 inches to 1.5 feet) over several areas of concern where objectionable material (including woody pieces) and wet areas were previously observed; the woody debris was subsequently removed. These solutions were developed to address concerns about maintenance vehicles striking material projecting above the levee crown/side slopes. An additional modification included increasing the tilling depth from 2 inches to 4 inches to expose any near-surface objectionable materials not removed previously. As part of this tilling and harrowing activity, the levee was inspected one last time for the presence of objectionable materials, with mandatory handpicking added to further reduce any potential incident of material projecting above the levee surface and being struck by maintenance equipment.

As discussed in the Panel's response to Q10, soil consolidation or local erosion over the long term could expose near-surface objectionable material, which could pose a hazard to maintenance operations. This is not expected to be a problem with adequate cover, as has been demonstrated in a number of areas under construction contract modifications. Construction photos at the levee show that for the type and size of the typical objectionable material possibly remaining in the embankment, a 2-foot-thick layer of compacted soil would be prudent and could be expected to provide satisfactory long-term cover.

Borrow Pit Issue Charge Questions

Q14. Review the Contractor's Submittal Package and assess whether the information and details provided are in accordance with the Section 3.1 Contractor-Furnished Borrow Areas, in particular with Section 3.1.5.12 Borrow Area Management Plan of the specifications?

Response: Neither the Borrow Area Management Plan nor the Contractor's Submittal Package was made available for Panel review. However, the Comprehensive Report stated that USACE's recommended borrow sources were used by the Contractor:

> "The WBV 14c.2 project required the Contractor to provide and utilize a borrow source, the contract provided a list of preapproved borrow sources, which had been subjected to the necessary investigations required to determine that the earthen material therein was adequate for levee construction. From this list of "Government Approved, Contractor Furnished" borrow sources, the Contractor initially elected to utilize the Willow Bend borrow pit which is located in St. Charles Parish, Louisiana. The Contractor also selected a second preapproved borrow source known as the River Birch borrow area. Nearly all earthen material on the WBV 14c.2 project came from one of these two approved sources." (Comprehensive Report, Appendix F, page 13)

During the course of excavation within the approved limits of the River Birch borrow pit, a layer of wooden debris intermixed with earthen clay material was discovered. This wooden debris, the remnants of large trees, consisted of stumps, branches, and smaller roots. As the intermixed clay and woody debris was excavated at River Birch, the contractor removed the larger stumps and branches with construction equipment. It was deemed unsafe to have a debris-picking crew attempt to remove the smaller woody debris at the borrow site due to the limited processing area. Therefore, the contractor maintained a picking crew at the project site to remove remaining objectionable debris from the fill as it was placed in the new levee section. These crews removed wooden debris during initial material placement, throughout the processing effort, before compaction, and after compaction. During this process, walk-throughs were conducted at multiple points to inspect the material and ensure adequate debris removal. Eventually, the level of debris at River Birch became such that a construction modification was issued directing the contractor to cease using this borrow-site.

Q15. Did borrow pit development contribute to an increase in the level of unsuitable materials placed into the embankment?

Response: In reviewing the sequence of construction, the Panel found that the expansion at the River Birch borrow pit did contribute to an increase in the amount of objectionable materials. This problem was identified by USACE staff, and a contract modification was issued to discontinue use of the borrow pit.

Follow-on efforts by the contractor to handpick objectionable material from the contractor-provided fill resulted in a finished project that met the requirements of the contract documents. During all phases of levee construction, the fill materials were observed for objectionable materials. To comply with the compaction requirements of the contract, the contractor began discing the material to reduce moisture and scarify the ground surface for proper bond between lifts. The Tiger Team expressed some concern that the increased discing to reduce the moisture content and expose objectionable debris would mechanically reduce large pieces of objectionable debris to be within the specification and as such would be incorporated into the levee profile. USACE staff examined this possibility and determined that it was not a significant concern. As objectionable materials were observed, they were removed, stockpiled, and scrapped at an approved off-site dumpsite. The objectionable materials were observed and removed to ensure that the clay fill material would comply with the contract plans and specifications. It should also be noted that debris was encountered in the existing levee material at the site. The existing material was part of the original levee structure; it was not obtained from the borrow sources for the current WBV 14C.2 contract, nor was it hauled to the project site under the WBV14C.2 contract. Isolated objectionable materials encountered in the existing levee material included wood, concrete, tires, and metal, none of which complied with the original plans and specifications. Objectionable materials observed in the existing levee were also removed from the fill and disposed of at an off-site dumpsite per QAR Documentation and Field Reports.

Overall, the placement and compaction of the clay fill material was monitored to ensure that the specification requirements were met. The levee material was subjected to rigorous testing, including 1,228 QC compaction tests, 123 QC sand cone density tests, 32 QC standard proctor tests (64 single proctor tests), and 247 one-point proctor tests. In addition, moisture content,

organic content, sand content, and plasticity index tests were performed for each of the above tests except one-point proctors, resulting in 5,532 additional QC tests performed for this contract. In the end, the final product met the contract requirements.

5 CONCLUSIONS

After completing the review, the IEPR panel members agreed that the levee was constructed in accordance with the contract plans and specifications and consistent with general construction practices. The panel members reviewed settlement rates and assessed potential impact to maintenance operations from the presence of objectionables (e.g., wood) that remain in the levee; assessed the structural integrity and performance of the levee as designed and constructed; and reviewed and assessed the results of seepage analyses provided in the documents. In general, the panel members agreed that the WBV 14C.2 project documents contained sufficient design-engineering-construction information to determine that the construction of the WBV 14C.2 project, as completed, taking into account the actions conducted after its construction and suggested by the Tiger Team, was consistent with the original design and HSDRRS Design Guidelines (including Factors of Safety) and standard practice (Safety Assurance Review).

APPENDIX A

Final Field Visit Report

on the

WBV 14C.2 Project

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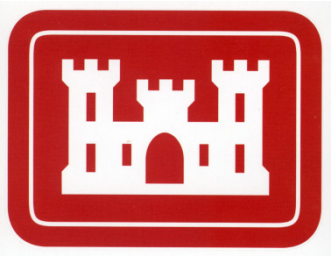

US ARMY CORPS OF ENGINEERS

Final

FIELD VISIT REPORT For

INDEPENDENT EXTERNAL PEER REVIEW OF WBV 14C.2 - NEW WESTWEGO PUMP STATION TO ORLEANS VILLAGE – 3RD ENLARGEMENT – PHASE 1

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FIELD VISIT REPORT

INDEPENDENT EXTERNAL PEER REVIEW OF WBV 14C.2 – NEW WESTWEGO PUMP STATION TO ORLEANS VILLAGE – 3RD ENLARGEMENT – PHASE 1

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November 12, 2013

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1. INTRODUCTION

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the WBV 14C.2 (referred to as Westwego) project, which consists of (1) raising the elevation of approximately 3.5 miles of new earthen levee to the 100-year level of protection on the floodside of previously constructed earthen levee, and (2) constructing new floodwalls tying into the Westminster Pumping Station. These levee improvements will occur south of Lapalco Blvd. from Station 0+44 near the New Westwego Pump Station to Station 185+90.21 near the Borrow Canal adjacent to the Orleans Village Subdivision in Jefferson Parish, Louisiana. An integral part of the HSDRRS process is the conduct of an Independent External Peer Review (IEPR) to ensure the reliability of scientific information and engineering analysis contained within the project documents. Battelle Memorial Institute (hereinafter Battelle), as a non-profit science and technology organization experienced in conducting expert peer reviews, was engaged by the USACE Coastal Storm Risk Management National Planning Center of Expertise (PCX) to conduct the IEPR of Westwego. Subject matter experts with knowledge of specific technical disciplines and project knowledge similar to Westwego are engaged to form a Battelle IEPR Panel (a.k.a. panel members) and specifically address the assessment and analysis of key criteria associated with the design, engineering, and construction of the Westwego project.

2. OBJECTIVE

Specific background on the overall USACE project, objectives of this IEPR, and the key tasks for the IEPR are defined in detail in the USACE Project Statement of Work (SOW) (Appendix A), received in the award notification on September 25, 2012. In general, the purpose of the review is to determine if the design and construction of the Westwego project is consistent with the HSDRRS Design Guidelines and standard practice (Safety Assurance Review). The objective of this report is to summarize the observations and key items identified by the panel members based on a review of the Westwego construction site during the field visit.

3. ACTIVITIES

3.1 Field Visit Briefing

The field visit for the Westwego program was conducted on January 9, 2013 (see Attachment 1 – Agenda). On the morning of January 9, the panel members (Table 1), Battelle representatives, non-federal sponsor representatives, and USACE staff (see Attachment 2 – Attendance) convened at the USACE construction office (West Bank) for an initial briefing of the project and construction activities (see Attachment 3 – USACE briefing). USACE Project Manager Mr. Richard Pinner provided a design approach briefing and USACE Construction Manager Mr. John Thompson provided a construction site overview. During the field visit briefing, the panel members were able to ask any questions to help them better comprehend the design and construction intent of the project prior to proceeding out into the project construction site.

Table 1. Westwego Panel Members

Name	Discipline	Years of Experience
Alan Hall	Civil Engineer	38
Stephen McCaskie	Geotechnical Engineer	34
Deane Fowler	Construction Manger/ Civil Engineer	35

3.1.1 Design Briefing

Overall, the panel members found the briefing to be well prepared. Appropriate staff members were present, and all panel member questions could be answered by the present staff. The design process and historical overview presented an excellent visual timeline of the phases of the Westwego levee construction. In addition, the orientation briefing conducted by USACE staff provided an excellent presentation on design approach / criteria, including field exploration / laboratory testing; development of design stratification and soil properties (shear strength); seepage, global stability, and settlement analyses; and the use of HSDRRS Design Guidelines. In addition, USACE provided boring samples for the panel to examine.

The following questions, concerns, and discussions summarize the issues that arose during the design briefing:

- The selection of design soil parameters was based on laboratory testing / distribution of test results and empirical data from existing levee construction / observations. The design soil parameters selected accounted for the distribution of lab test results, empirical data, and engineering judgment, but were not modified to reflect any changes due to the inclusion of objectionables (2 inches square x 1 foot long)[1]. As part of design verification, limited evaluation / sensitivity analyses were made to assess the influence of changes in soil parameters on analyses results and designs.
- The assumption of "no gain" in strength during construction (strength gain through consolidation) resulted in a conservative approach.
- The assumption of "hurricane hits" immediately after construction (no strength gain through consolidation) resulted in a conservative approach.
- The use of Spencer's Method for Global Stability (accepted norm) was backed up by the Method of Planes (MOP), traditional New Orleans District analyses, to serve as a design check.
- No deviations were made from the HSDRRS Design Guidelines and specifics.
- The results of seepage and stability analyses indicate that stability controls and seepage concerns / influence are insignificant. Expected seepage forces are negligible. The water loading (and its influence on design) is small relative to gravity loads, meaning that if the levee construction is built and is stable, it will withstand hurricane (water) loadings.
- Settlement discussions found that the current and future lifts are planned to meet the design grade elevation (100 years) through the project life. The predicted crest elevation / settlement curve can be used with settlement measurements to plan and complete future

[1] The term objectionables refers to matter in fill material that needs to be removed or that exceeds the specifications.

lifts, accounting for settlement, ground subsidence, and sea level rise. The settlement analyses use empirical data from the existing levee raise / lift construction.
- The floodside offset or levee improvements were driven primarily by global stability and the typical landside drainage channel, not seepage analyses.

3.1.2 Construction Briefing

As with the design briefing, the panel members observed that the construction briefing provided by USACE staff was comprehensive and well presented. The briefing discussed past and recent levee history, construction, raises, and hurricane performance; "problem" areas during construction (past and recent); structure tie-ins and utility interface treatments; contract specifications and quality control (QC); QC test results; construction / contract modifications; post-construction design verification borings / testing and field trenching and evaluation; and the USACE Comprehensive Report. The panel members particularly appreciated the oral description of the construction process provided by USACE staff members who conducted daily site visits. This description allowed the panel members to visualize the challenges and opportunities that faced the construction management team throughout the period of construction. The USACE staff was knowledgeable and forthright about the decisions made during the construction sequencing.

The following bullets summarize the questions, concerns, and discussions that occurred, based on the construction briefing:

- Original levee construction and subsequent raises (pre-1983 to present) accounted for ongoing settlement, increasing level of protection, hurricane performance, and floodside improvements with increasing floodside offsets.
- Specific floodside offsets and levee / berm foundation preparation (clearing/grubbing, soft ground stabilization [specifically soft "wet" floodside areas], initial / subsequent lift placement, moisture conditioning, compaction, and testing) were confirmed.
- Degradation of existing levee material and removal / disposal of unsuitable material ("picking" removal and disposing of objectionables from placed fill) were confirmed
- A discussion of borrow activities and fill preparation provided confirmation of bucket / dragline excavation of borrow material with ground / surface water control (slope/sump and pump), picking and disposal of "objectionables," and borrow stockpiling. Material was transported to site only after moisture content was found to be <10% and after satisfactory visual inspections observed few objectionables (dimension / percentage per specifications).
- Fill was placed on-site in lifts with moisture conditioning to within +5% or -3% of optimum moisture content, and compaction, testing (density and moisture content).
- Several "problem" areas, historic and recent, and their planned mitigation or contract modifications confirmed that work was completed in accordance with plans and specifications and that prudent engineering judgment was used to meet field conditions as disclosed and observed.
- A discussion of project requirements / specifications including QC, provided confirmation that the embankment raise was generally completed in accordance with plans and specifications subject to interpretation of acceptable / unacceptable

objectionables (including construction and woody debris and "satisfactory" manual picking / removal / and offsite disposal of objectionables). Various potential interpretations of (and the need for refinement of) project specifications for future work were discussed. Specifically, borrow material properties (QC) (reported in the briefing slides) were discussed, including the lack of trends / statistics for moisture control. Further IEPR review of the QC test results will be completed to better understand, acceptable/unacceptable/retest and QC results as reported.

- Design verification borings and testing, and findings of in-place shear strength and density (compaction) exceeding design values / specifications were discussed in detail. Actual levee embankment soil samples from verification borings were provided for observation of objectionables.
- Field trenching and evaluation performed by the USACE and for the Tiger Team evaluation and findings with respect to "objectionables," number, dimensions, and distribution were discussed. There was additional discussion of documentation / photos of "objectionables" (both as removed and remaining in-place) provided by the non-federal sponsor. The USACE Comprehensive Report (provided at briefing) and findings in general were discussed. The IEPR Panel will review the report in further detail.
- A discussion of problem areas (known and discovered during construction), mitigation / treatments, and contract modifications to address problem areas was very detailed and helpful. This discussion continued during the site visit.

3.2 Site Review

After the USACE team briefings, Battelle and the panel members were given a safety briefing then transported through the construction site. Stopping at various points along the length of the levee, USACE staff discussed specific areas of the construction including the general levee embankment raise; New Westwego pump station / floodwall tie-in and levee transition; abandoned landfill haul road; full levee degradation and disposal and partial geotextile treatment; Westminster pump station / floodwall tie-in and levee transitions; "soft spot"; wet areas (landside berm toe); excessive debris in the existing levee; and existing utility crossing, floodwall tie-in, and levee transitions.

USACE staff and panel members stopped at multiple locations throughout the project reaches, providing opportunities for the panel members to see the range of conditions and associated construction challenges faced during the construction effort. The site visit was conducted during a rainy period, which provided good first-hand observation of the operations and maintenance challenges. The staff identified for the panel all of the key areas of interest such as the previous dumpsite and the "soft spot." The multiple days of rain prior to the site visit caused many wet spots, which resulted in the perching of water above natural grade associated with the relatively impermeability of the tight clay construction formations. This confirms that there will most likely be negligible seepage during storm conditions.

The panel members also appreciated discussions on future corrective actions to be taken at the access road for the abandoned landfill, tie-ins to pump stations, the Seaplane Airport concerns, anticipated armoring and general issues with regard to degradation of the existing levee and wasting of material containing excessive amounts of objectionables material. These discussions show that USACE is continuing to improve upon the levee.

The following discussions occurred during the tour of the construction site:

- More detailed discussions took place regarding construction history, observations, and treatments at specific areas confirming the information presented in the briefing. By physically observing the construction site in addition to attending the USACE staff briefings, the panel members were able to gain a more complete understanding of all of the project components. The opportunity will save considerable time in document review.
- On-site discussions also included operation and maintenance (O&M) issues likely to be faced; O&M measures completed and potential recommendations for additional measures to facilitateO&M activities, including mowing and vegetation control, site access and inspection, and hurricane protection monitoring.
- Further discussions were held on field trenching and evaluation efforts and findings.
- Field discussions also addressed overtopping / erosion protection, which is still under study or in process (being conducted in Colorado). Once studies are complete (Colorado) and the overtopping / erosion protection approach is finalized, protection measures (e.g., turf mat) will be designed and implemented. Specific design approach / details, cost and implementation schedule are to be determined.

3.3 Peer Reviewer Exit Briefing

On the morning of January 10, 2013, USACE staff, Battelle representatives, and panel members convened at USACE New Orleans District Office for the peer reviewer exit briefing. The exit briefing focused on panel member concerns or safety assurance issues. The panel members asked specific questions related to their observations and the goals of the project, which resulted in a discussion among USACE, the non-federal sponsor representatives, and the panel members. This discussion was documented. In general, the content of the exit briefing includes positive feedback, questions/concerns, and requests from Battelle for additional documentation (see Attachment 4 – Exit Briefing Presentation).

4. CONCLUSIONS

The following sections summarize the points discussed/documented as a result of the construction site visit process.

4.1 Positive Feedback

Orientation Briefing

- Good synopsis of the design approach.
- Good description of construction process, specifically construction history and sequences.
- Extremely helpful description of construction modifications.
- Good representation of USACE staff/disciplines.
- Overall, team was very knowledgeable and well prepared.

Construction Briefing

- Good opportunity for panel members to see the site, made possible by stopping at multiple locations along the levee.
- General orientation of the levee profile and key issues that arose during construction.
- Opportunity for panel members to appreciate the magnitude of the effort required to construct the levee.
- Detailed discussion of construction procedures, including those to address problem areas.
- Detailed discussion of specific O&M issues.
- Discussions of recommendations for additional improvements (i.e. armoring/sheet pile cutoff).

4.2 Questions/Concerns

Four questions/concerns that were discussed at the exit briefing are summarized below:

- **Concerned about the moisture/ wet density testing and analysis. The panel members requested more explanation of the testing and retesting/reissue process.**

The greatest concern expressed was the disparity between approved construction control quality (CQC) soil test moisture results. The stated approval per specification was based on +5% or -3% of the optimum moisture content; however, the quality assurance review (QAR) published results showed approved results ranging from 18% (Oct.10, 2012) to 33% (Feb.11, 2012). On the surface, this range seems to violate the approved standard; however, the process used for approval proved to be sound. During the exit briefing, USACE explained the iterative process used to perform the testing; they stated that when values were found to be out of specification, a retest was performed. They also clarified that the terms "reissue" and "retest" are used synonymously. Additionally they explained that a contractor pulled samples and ran tests, but the official data analysis was conducted by a third-party laboratory hired by USACE. When discussing the quality of material received from the borrow pit, USACE staff confirmed that aside from the soil tests, preliminary visual inspections of the trucks received from the borrow pit were conducted prior to use of the material. This was a driving factor in the change of borrow pit source.

- **Question as to why a different borrow pit was required. The change was not clear from documentation reviewed.**

During the construction briefing, prior to the site tour, there was some discussion on changing the borrow pit used during construction. The panel members questioned why a different borrow pit was required to be used. USACE clarified that the change in borrow pit was not a requirement; however they made the contractor change the borrow pit source because they wanted 'cleaner' material, especially for use on the tops of the levees.

- **Question as to whether any deviations from the HSDRRS Design Guidelines were taken.**

Concerns were raised about the use of the HSDRRS Design Guidelines with questions in reference to this particular design. For example, occasionally a waiver of a guideline is requested due to unusual circumstances. It appeared that this specific site offered up many challenging and unusual circumstances which might have required special considerations, such as the handling of the pre-project dumpsite. USACE confirmed that there were no deviation from the Design Guidelines and that all specifications used were derived from those stated in the approved Design Guidelines document.

- **Question as to the process and/criteria for deciding to waste certain material.**

During the construction discussion, USACE communicated that certain materials were wasted during the construction process, which concerned the panel members. USACE clarified that the decision to waste material was subjective. As an example, they stated more objectionable material was found around the pumping station. USACE also mentioned this issue in the Comprehensive Report, as an appendix. The appendix documents each trench that was dug, includes photos with descriptions of the photo, and explains why the decision was made to waste materials.

4.3 Requests for Documents

At the conclusion of the peer review exit briefing, USACE provided Battelle with the following:

- The Comprehensive Report
- Orientation briefing slides
- Non-federal sponsor site pictures

Upon review of the project documents provided, the panel members indicated that some documentation was still required in order to address two of the specific charge questions: Numbers 1 and 4. Both charge questions refer to design documents, specifically the Engineering Alternatives Report (EAR), Project Description Document (PDD), and Design Documentation Report (DDR). These charge questions focus on design assumptions found in the referenced documents.

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Attachment 1 – Agenda

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WBV 14C.2 - New Westwego PS to Orleans Village – Phase 2 Independent External Peer Review Design & Construction Field Visit

09 & 10 January 2013

Location: Day 1 - Project Site, West Bank Area Office, 5750 Bayou Estates Avenue Marrero, LA 70072

Day 2 – USACE, New Orleans District Headquarters, 7400 Leake Avenue, New Orleans, LA 70160 - Room 186

Purpose: To conduct a site visit for the design and construction of the WBV-14C.2 project for the independent external peer review and an outbrief from the Reviewers.

AGENDA – DAY 1

0930	Welcome and Introductions	
0940	Design and Construction Briefings	Jean Vossen/Richard Pinner
1000	Safety and PPE Briefing	John Thompson
1030	Project Site Visit	John Thompson
1200	Lunch	
1300	Discussions/Questions	All
1530	Adjourn	

AGENDA – DAY 2

0900	Introductions	
0910	Follow-up from Field Visit, if needed	All
0930	IEPR Field Visit Outbrief	Battelle Program Manager/Reviewers
1030	Additional Discussions/Questions, if needed	All
1200	Adjourn	

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Attachment 2 – Attendance

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INDEPENDENT REVIEW SIGN IN SHEET

PROJECT: WBV 14C.2
CONTRACTOR: Phylway
1/9/2013

NAME	POSITION	PHONE #	E-MAIL
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STEVE MCCASKILL	IEPR - GEOTECH		
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Attachment 3 – USACE Briefing

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WBV-14C.2
Westwego Pump Station to Orleans Village Levee Enlargement (2nd Lift)

IEPR Brief on Design and Construction

Richard Pinner, P.E.

Chief, Geotechnical Branch

USACE, New Orleans District

8 January 2013

US Army Corps of Engineers
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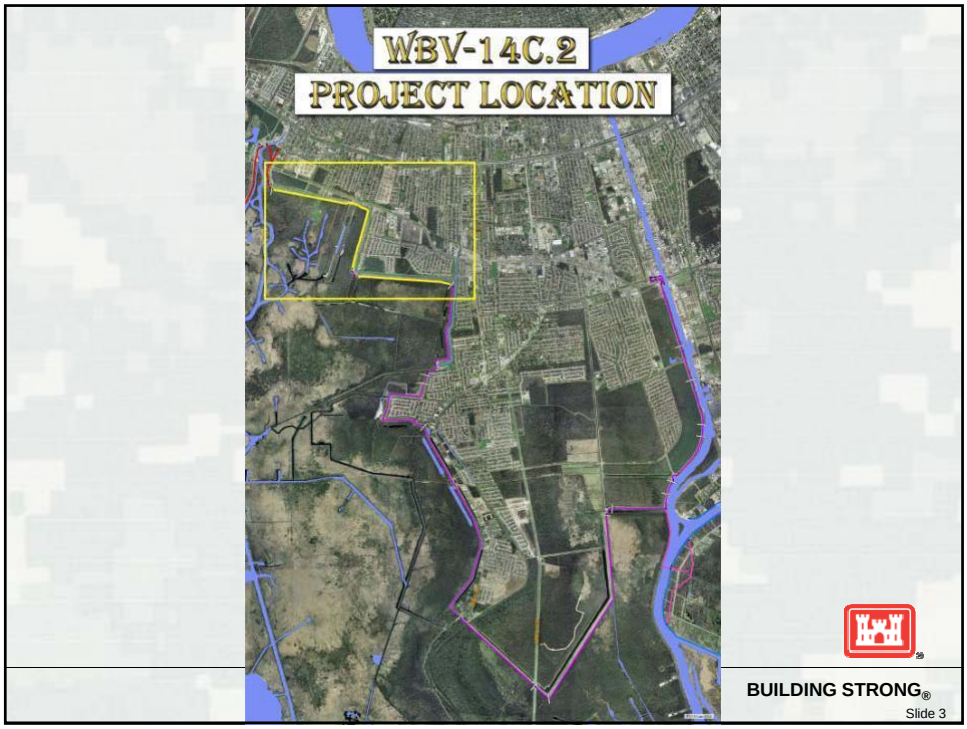
Progress Meeting Agenda

- Opening Remarks
- Overview
- Design
  - Field Investigations
  - Design Load Cases
  - Verification Borings
- Construction
  - Levee Construction History
  - Contract Specifications and Quality Control
  - Modifications
- Access Road Area
- High Moisture Area


WBV-14C.2
PROJECT LOCATION
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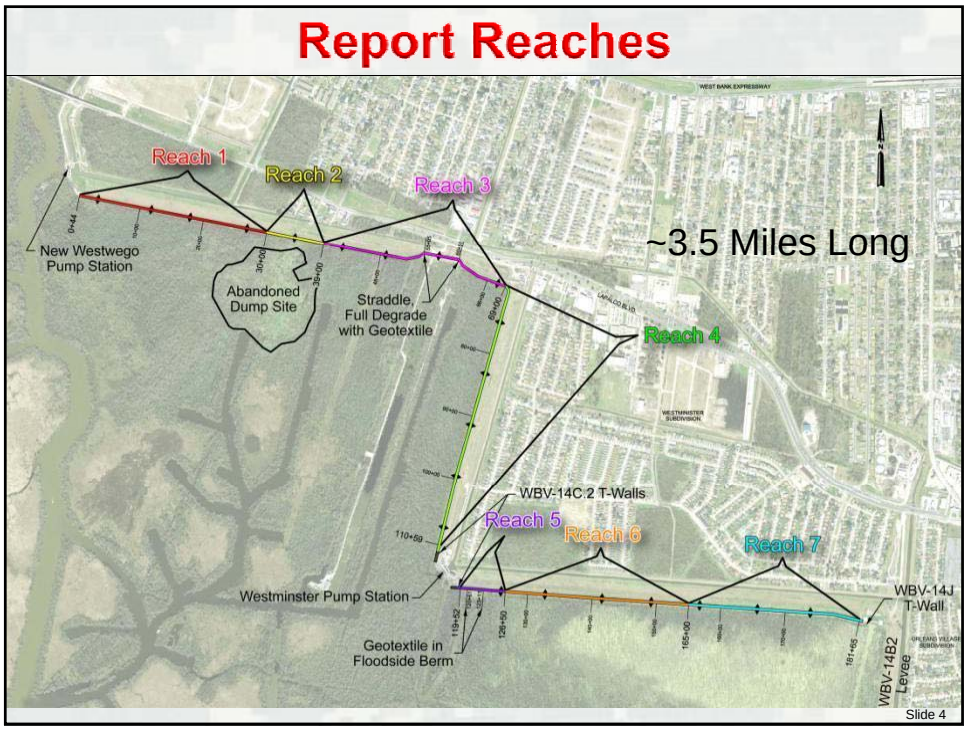
Slide 3


Report Reaches
Reach 1
Reach 2
Reach 3
Reach 4
Reach 5
Reach 6
Reach 7
New Westwego Pump Station
Abandoned Dump Site
Straddle, Full Degrade with Geotextile
~3.5 Miles Long
WBV-14C.2 T-Walls
Westminster Pump Station
Geotextile in Floodside Berm
WBV-14J T-Wall
WBV-14B2 Levee
Slide 4

Field Investigation and Design

- **Extensive Field Investigations**
  - Borings and CPTs taken every 500'
  - 38 undisturbed borings and 36 CPTs taken for this lift
  - 20 borings from previous lifts
- **Extensive Lab Testing**
  - 636 laboratory strength tests
  - 17 consolidation tests
- **Based on available data**
  - Geologic profiles were developed
  - Design stratification and shear strength

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Slide 5

Design Load Cases – Global Stability

- Spencer's Method is primary design tool
  - MOP is design check (Wedge Type Analysis)
- Global Stability analysis
  - Assumes no gains in strength during construction
  - Assumes hurricane hits immediately after construction

Hurricane Load Case	Required Factor of Safety (Spencer's Method)
Still Water Level (SWL)	1.5
Water at Project Grade	1.4
Water at Construction Grade	1.2

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Slide 6

Design Load Cases – Underseepage

- Analyzed using Seep/W
  - Steady-State Analysis
  - No significant seepage concerns

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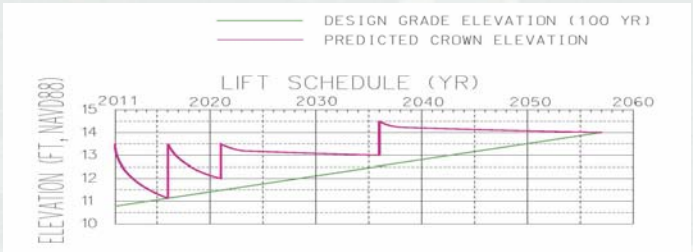
Slide 7

Design Load Cases – Settlement

- Levee to settle ~5’ over design life
  - Settlement evaulation is conservative. Uses empirical data from existing levee lift construction.
  - 2.5’ – 3.5’ of anticipated settlement within 5 years
  - Future Levee lifts can be adjusted based on measured results



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Slide 8

Design Verification Borings

After Construction

- **34 Design Verification Borings performed**
  - **Main Purpose to Check Design Assumptions of fill material**
    - **Strength far exceeded design strength**
    - **High unit weight indicated high compaction**
  - **Checked Material Properties**

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Slide 9

Background: Levee Construction History

 **= Pre-1983: Developers constructed tidal levee using excavated drainage canal material**

	1983-1984 Jeff. Parish Assumed Maintenance	1985 Hurricane Juan (info)	1987-1988 WJLD / DOTD Interim Levee	1995-2000 USACE Contracts	2000-2002 WJLD / DOTD Contract	2007 USACE Contract	2010 USACE Contract WBV-14c.2
Westwego East-West Reach		Multiple Breaches	El 7 ft, F/S Shift *	El 10 ft, 150 ft F/S Shift, Hwy 45 Borrow	El 10 ft, Straddle, Drake Stockpile	El 11.5 ft, Straddle, Hwy 45 Borrow	El 13.5 ft, 38 ft F/S Shift, CF Borrow
North-South Reach		No Overtopping or Failures	El 10 ft, 130 ft F/S Shift *	El 10 ft, Straddle, Hwy 45 Borrow	No Lift	El 11.5 ft, Straddle, Hwy 45 Borrow	El 13.5 ft, 38 ft F/S Shift, CF Borrow
Westminster East-West Reach		Overtopping, but No Failures	El 7.5 ft, 76 ft F/S Shift , Borrow: Drainage Stockpiles	El 10 ft, 150 ft F/S Shift, Hwy 45 Borrow	El 11 ft, Straddle, Drake Stockpile	El 12.5 ft, Straddle, Hwy 45 Borrow	El 13.5 ft, 38 ft F/S Shift, CF Borrow

* Construction records not available

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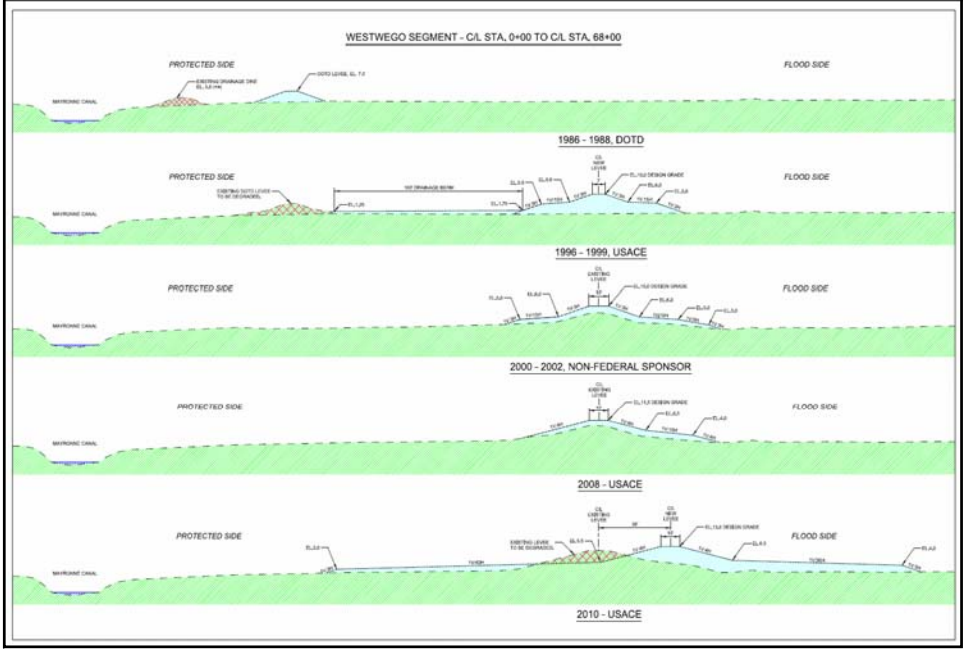
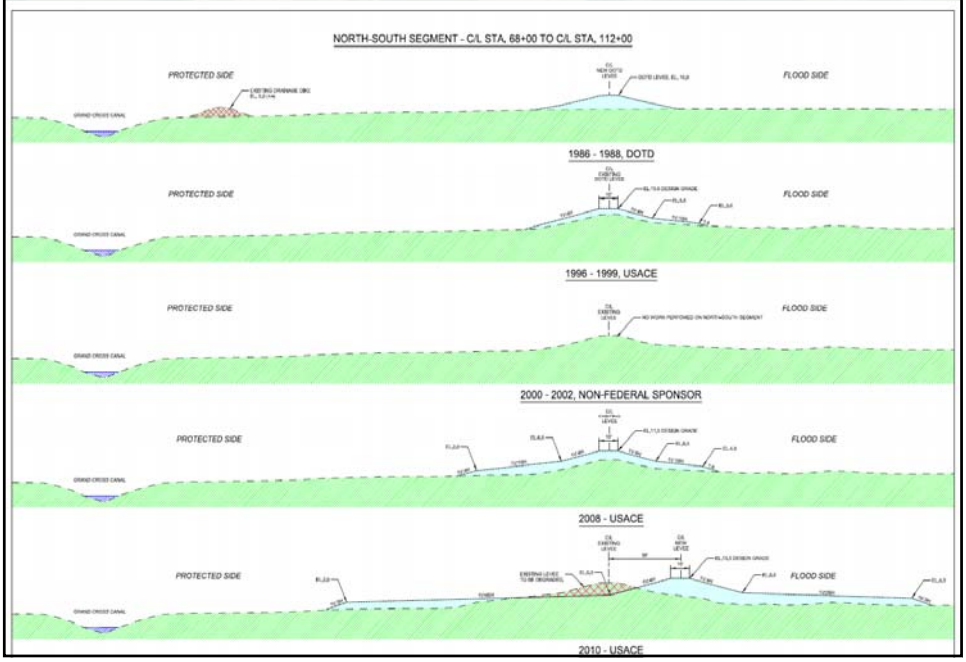
Slide 10

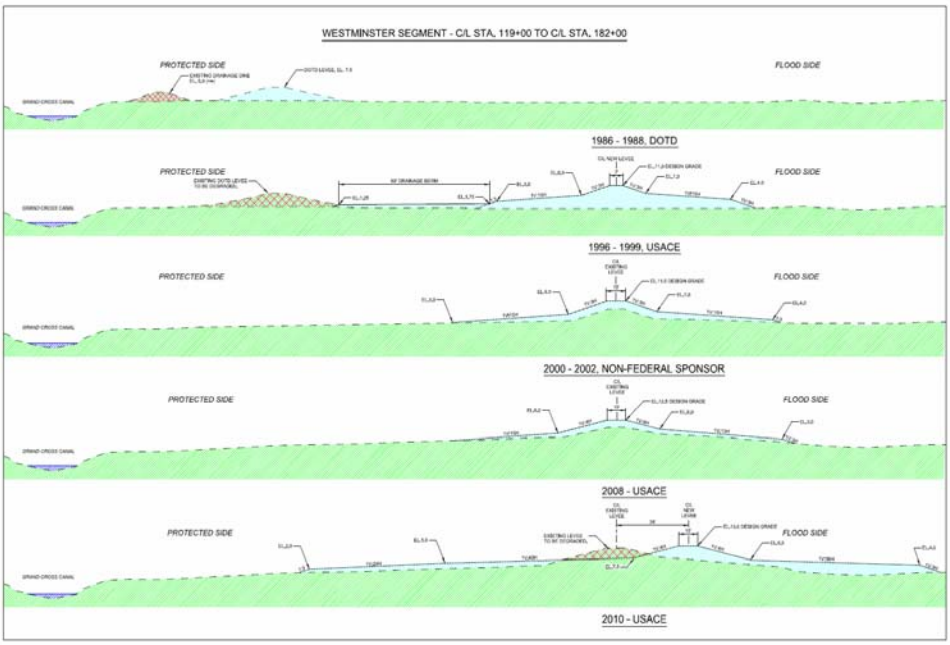
Levee Construction History



Levee Construction History



Levee Construction History



Contract Specifications and Quality Control

Excavation, Contractor-Furnished Borrow Areas:

- Submittal package must include a Geotechnical Report stamped and signed by a licensed civil engineer with a specialization in geotechnical engineering certifying that the proposed source contains suitable material. Government reviews submittal package for concurrence

Lift Construction:

- 12” thick lifts were placed except for first and last two which were 6” lifts.
- Material met contract specifications prior to compaction

Borrow Material Properties:

- CH or CL material. PI>10 (Ave. 45)
- < 35% Sand Content (Ave. 5.1%)
- <9% Organic Content (Ave. 3.6%)
- >90% compaction (Standard Proctor) (Ave. 96.8%)

Contract Specifications and Quality Control

Embankment:

- Quality Control Testing. Performed by Contractor, includes: soil classification, moisture content, control compaction curves, organic content, sand content and in-place density
- Quality Assurance. As a control, the Government will perform assurance and check tests for maximum dry density for all materials in accordance with ASTM D 698
- 5,000 +/- QA/QC tests were taken on this contract. Test types included: density and moisture content, Atterberg limits (PI), organic content, sand content tests. Tests were required every 500 cubic yards or every 500 linear feet and one per lift. Tested beyond contract requirements
- Example: STA 165+00-181+65, 110 QA/QC tests (+/-) were performed. Only (approx.) 40 tests were required by contract specifications.
- No organic or sand content tests failed during the construction
- All density tests that failed were retested after additional disking, drying, etc.

Contract Specifications and Quality Control

Field Trenching and Evaluation:

- Shows well compacted clay levee section
- Shows no sign of layering of material – no through seepage or fill strength concerns

Contract Specifications and Quality Control

Typical Excavation and Completed Trenches

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Slide 17

WBV-14c.2 Modifications

- Some of contract modifications:
  - Westminster Reach: Wasted degraded material from the existing levee in a 1,600-foot reach (Sta. 165+00 to 181+65) due to objectionable material and replace that material with borrow from the contactor's borrow pit. Two feet of protected side cap was placed on protected side slope which increased crown width to 12'.
  - Westminster Reach: (~Sta. 120 to 165) Two feet of embankment was added to the protected side slope design section, with additional berm fill to address objectionable material in the existing levee slopes in that area.
  - Westminster Reach: Modified berm and extended it by 24' to cover high moisture areas.
  - Westwego Reach: Waste degraded material from a 5,400-foot reach (Sta. 0+69 to 54+50) of the pre-existing levee due to objectionable material in the pre-existing levee and replace with material from the Willow Bend borrow pit.
  - North-South Reach: No Modifications

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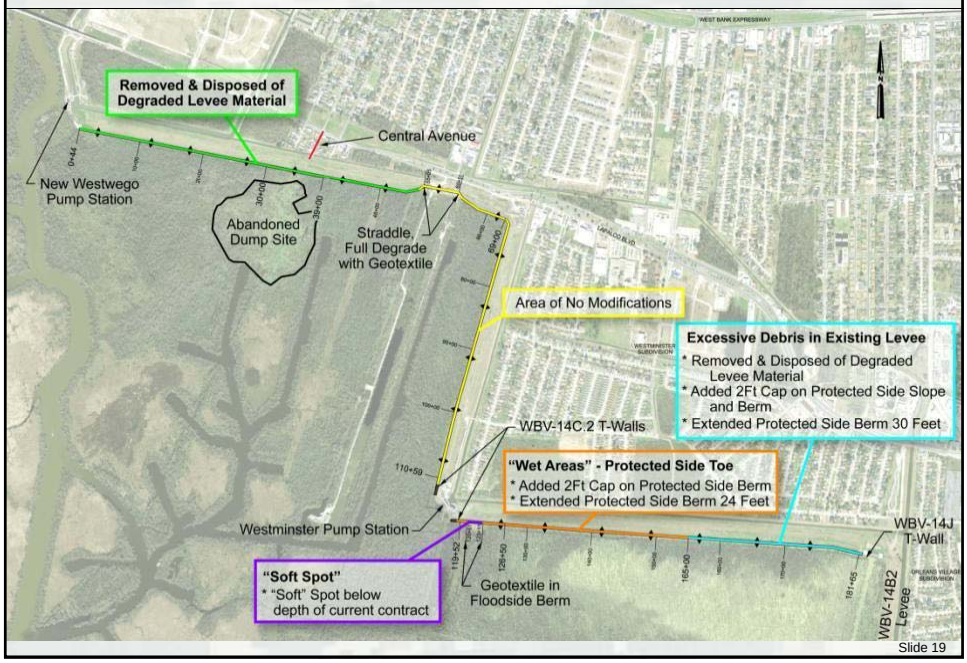
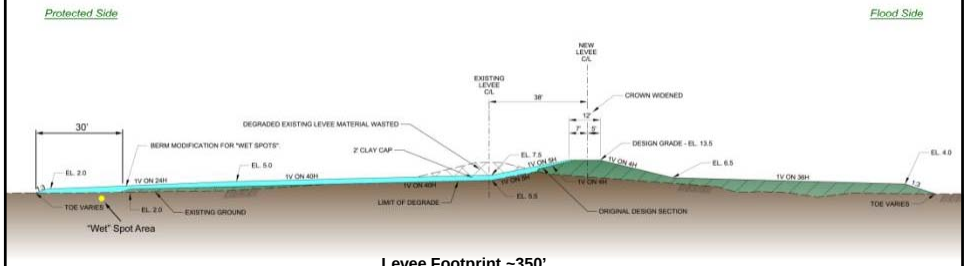
Slide 18

Modifications



Slide 19

Modification Section



Levee Footprint ~350'

Added 2Ft Cap on Protected Side Slope & Berm & Berm Modification

Approx. STAS 165+00 to 181+65

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Slide 20

Vicinity of Old Access Road to Closed Landfill

1997 USACE Contract:

- Numerous junk cars and piles of used tires discovered on site
- Contractor encountered debris while degrading the existing interim levee
- In vicinity of Central Avenue (access to old landfill), contractor exposed debris while shaping the protected side berm to slope to drain. Contract modified to remove debris and add clay cap

- **Environmental Review:**
  - **LDEQ documents**
  - **EIS and 1994 EA**
  - **EPA documents**

Environmental Review Conclusion: Levee alignment does not cross the main body of the landfill. Debris source along levee at Central Avenue access road is from promiscuous dumping.

- **Additional geotechnical site investigation was performed using augers and CPTs.**
- **Geotechnical analysis shows that seepage is not an issue. To cover unknowns, sheet pile cutoff recommended in the vicinity of the old access road.**

High Moisture Area
Sta. 138+85 to 139+85

- **Detailed seepage analysis performed. No underseepage issues**
- **Not a levee performance issue, not a seepage issue**
- **Appeared in area during previous levee contracts**
- **Have appeared on multiple jobs**
  - **Can be due to several factors such as excess porewater pressure from new fill placement, high water table, raint events, low ground elevation, etc.**
- **Issue is to facilitate mowing without rutting, maintenance of VFZ**

Discussion

Attachment 4 –Exit Briefing Presentation

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Westwego IEPR

Construction Site Visit Outbrief

January 9, 2013

Agenda

- Introductions
- Purpose
- Positive Feedback
- Question/Concerns
- Support Documents
- Path Forward

Introductions

- Battelle
  - Karen Johnson Young – Program Manager
  - Monica Malhotra –Project Manager (stand in)
- Peer Reviewers

Name	IPR Discipline
Stephen McCaskie	Geotechnical Engineer
Deane Fowler	Construction Management
Alan Hall	Civil Engineer

Purpose

- To provide an overview of the Reviewers' observations resulting from the construction site visit on January 9, 2013
- Discuss action items for path forward

Site Review – Positive Feedback

- Orientation Briefing
  - Good synopsis of the design approach.
  - Good description of construction process, specifically construction history and sequences.
  - Extremely helpful description of construction modifications.
  - Good representation of USACE staff/disciplines.
  - Overall, team was very knowledgeable and well prepared.

5

Site Review – Positive Feedback

- Construction Site Visit
  - Reviewers received a good opportunity to see the site, made possible by stopping at multiple sites along the levee.
  - Gave a general orientation of the levee profile and key issues that arose during construction.
  - Gained an appreciation for the magnitude of the effort required to construct the levee.
  - Detailed discussion of construction procedures, including those to address problem areas.
  - Provided a detailed discussion of specific O&M issues.
  - Included discussions of recommendations for additional improvements (i.e. armoring/sheet pile cutoff).

6

Site Review – Questions/Concerns

- Concerned about the moisture/ wet density testing and analysis. Would like more explanation of testing and retesting process. (reissue?)
- Question as to why a different borrow pit was required. Not clear from documentation reviewed.
- What deviations in design, if any, were taken from the HSDRRS Design Guidelines.
- What was the process and/our criteria for deciding to waste certain material?

Site Review – Requested Support Docs

- Design documents necessary to answer charge question
- Orientation design briefing

Document Status

- Final WBV 14C.2 Geotechnical Report
- WBV-14c.2 Site Inspection, 10 Aug 2011
- Quality Assurance Reports (QARs)
- Site Observation Report for WBV-14c.2, Thursday 27 Jan 2011
- Construction documentation on WBV14C.2 (QC and QA Proctor tests, settlement calculations,
- summary of Non-Federal Sponsor visits, QC compaction testing log, borrow material source charts,
- modifications)
- Report on Geophysical Survey Services, Oct 2011
- Historical Documentation (WBV14C.1 construction documentation, LDOTDs files provided by CPRA, Initial Hazardous, Toxic and Radioactive Waste (HTRW) Assessment, June 7, 1994, and all other pertinent information)
- Quality Assurance (QA) Team Report of Findings (Tiger Team report)
- USACE, New Orleans District Comprehensive Report
- Final WBV 14C.2 Plans and Specifications and contract modifications.
- Office of Coastal Protection and Restoration, Final Report, Levee Fill Sampling and Evaluation,
- Westwego and Westminster Levees, Jefferson Parish, Louisiana, 24 June 2011
- Office of Coastal Protection and Restoration, Project Site Visit Report, September 27, 2011
- Office of Coastal Protection and Restoration, Project Site Visit Report, September 28, 2011
- Summary of Evaluation of USACE QA Reports by SLFPA-W
- SLFPA-W Inspection Reports
- SLFPA-W pictures

Path Forward

- Receive outstanding documents.
- Work with PCX to develop schedule for review process.

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APPENDIX B

Final Charge to the Independent External Peer Review Panel as Submitted to USACE on June 10, 2013

on the

WBV 14C.2 Project

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Charge and Guidance to the Panel Members
for the
Independent External Peer Review of WBV 14C.2 –
New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1

BACKGROUND

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the West Bank Vicinity (WBV) 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1 project (hereinafter WBV 14C.2). This project consists of raising the elevation of approximately 3.5 miles of new earthen levee to the 100-year level of protection on the floodside of the previously constructed existing earthen levee and the construction of new floodwalls tying into the Westminster Pumping Station. These levee improvements will occur south of Lapalco Boulevard from Station 0+44 near the New Westwego Pump Station to Station 185+90.21 near the Borrow Canal adjacent to the Orleans Village Subdivision in Jefferson Parish, Louisiana.

OBJECTIVES

The objective of this work is to conduct an independent external peer review (IEPR) of the design and construction of WBV 14C.2 in accordance with the Department of the Army, USACE, Water Resources Policies and Authorities' *Civil Works Review Policy*, Change 1 (EC 1165-2-209) dated January 31, 2012, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

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

The purpose of the review is to: (1) determine if the design and construction of the WBV 14C.2 project is consistent with the HSDRRS Design Guidelines (including Factors of Safety) and standard practice (Safety Assurance Review), (2) assess whether the levee is constructed in accordance with the contract plans and specifications requirements and consistent with general construction practices, (3) review settlement rates and assess potential impact to maintenance operations, (4) assess the structural integrity and performance of the levee as designed and constructed, and (5) review and assess seepage analyses performed in the documents provided.

The IEPR will be limited to technical review and will not involve policy review. The IEPR will be conducted by subject matter experts (i.e., panel members) with extensive experience in geotechnical engineering, civil engineering, and construction management/civil engineering issues relevant to the project. They will also have experience with the HSDRRS Design Guidelines and applying their subject matter expertise to hurricane and storm damage reduction and flood damage reduction projects.

The IEPR Panel (the Panel) will be "charged" with reviewing the documents and the project in relation to items identified as part of a Critical Items List (CIL) as well as providing a broad technical evaluation of the overall project in relation to significant threats to human safety. Per EC 1165-2-209, Appendix E, review panels should identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods. Review panels should be able to evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable. Reviews should focus on the "adequacy, appropriateness, and acceptability of the design and construction activities for the purpose of assuring that good science, sound engineering, and public health, safety, and welfare" (EC 1165-2-209, Appendix E Section 1a, page E-1) have been taken into account. These "are the most important factors that determine a project's fate" (EC 1165-2-209, Appendix E Section 1a, page E-1). The panel members may offer their opinions as to whether there are sufficient analyses upon which to base a recommendation.

GENERAL GUIDANCE

Throughout this project, there will be a variety of formal and informal opportunities to interact with USACE in the presence of project sponsors, including representatives of the State of Louisiana. Battelle is providing each panel member with the following guidance on how various portions of the project will be conducted:

- Orientation Briefing – The orientation briefing (e.g., kick off meeting with USACE/Battelle/Panel) will be held via teleconference. During this briefing, USACE will provide an overview of the project. Panel members will not render any opinions or recommendations at this time, but they are encouraged to ask questions to assist in their understanding of the document.

- Site Visits – Panel members will participate in one construction site visit to review construction activities. Upon completion of the site visit, the panel members will participate in an exit briefing, which will include USACE and project sponsor personnel, to discuss any findings. Following the site visit, panel members are to provide written feedback to the Battelle Project Manager and Deputy Project Manager on what discussion and input they provided at the exit briefing.

- Design Reviews and Comment/Response Process – Each panel member assesses the provided documents and then prepares comments for Battelle. Panel members can discuss openly their reviews with other panel members; however, they should not discuss their findings with anyone outside of the team (except when requested to do so by the Battelle Project Manager or Battelle Deputy Project Manager). Individual findings from each respective expert reviewer must remain as an individual finding; no consolidation of similar findings will be developed to form a joint finding. However, notation of independent panel members arriving at similar conclusion(s) through independent means will be highlighted.

- Clarifying Questions – If a USACE/Contractor responds in DrChecks with a clarification question to the panel member, the panel member will answer the question. In providing

comments, the panel member must refer to the specific reference so that the representative can easily access the information in question.

- Handling of Non-Conforming Design and Construction Issues – At times, the panel member and the USACE design engineer may end up having a difference of opinion. It is not the purpose of the IEPR to resolve these non-conforming issues. These unresolved non-conforming issues will be clearly noted in DrChecks, at Design Review Conferences, and in Design Review Reports.

- All comments are to remain within the scope of the project to be reviewed.

- to maintain an IEPR, it is important that at all times the panel members maintain their independence. If they feel that any representative is trying to unduly interfere with this independence in providing an opinion, this is to be brought immediately to the attention of the Battelle Project Manager and Battelle Deputy Project Manager.

DOCUMENTS PROVIDED

Table 1 lists the documents that will be reviewed. Supporting documentation and reference materials that will be provided for the review are listed below.

Supporting Documentation
- HSDRRS – Quality Management Plan 30 October 2009
- HSDRRS Design Guidelines – June 2008

References
- ER 1110-1-12, Engineering and Design, Quality Management, 21 July 2006
- ER 1110-1-8159, Engineering and Design, DrChecks, 10 May 2001
- EC 1165-2-209, Water Resources Policies and Authorities, Civil Works Review Policy, Change 1, 31 January 2012
- EC 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999
- CECW-CP Memorandum dated March 31, 2007
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* released December 16, 2004.

Table 1. WBV 14C.2 Review Documents

Title	No. of Pages
Final WBV 14C.2 Geotechnical Report	434
WBV-14C.2 Site Inspection, 10 August 2011	4
Quality Assurance Reports (QARs)	1,214
Site Observation Report for WBV-14C.2, 27 January 2011	4
Construction documentation on WBV14C.2 (QC and QA Proctor tests, settlement calculations, summary of Non-Federal Sponsor visits, QC compaction testing log, borrow material source charts, modifications)	2,294
Report on Geophysical Survey Services, October 2011	79
Historical Documentation (WBV14C.1 construction documentation, Louisiana Department of Transportation and Development files provided by CPRA, Initial Hazardous, toxic and Radioactive Waste (HTRW) Assessment, June 7, 1994, and all other pertinent information)	370
Quality Assurance (QA) Team Report of Findings (Tiger Team Report)	6,795
USACE, New Orleans District Comprehensive Report	TBD
Final WBV 14C.2 Plans and Specifications and contract modifications	817
Office of Coastal Protection and Restoration, Final Report, Levee Fill Sampling and Evaluation, Westwego and Westminster Levees, Jefferson Parish, Louisiana, June 24, 2011	~52
Office of Coastal Protection and Restoration, Project Site Visit Report, September 27, 2011	TBD
Office of Coastal Protection and Restoration, Project Site Visit Report, September 28, 2011	TBD
Summary of Evaluation of USACE QA Reports by SLFPA-W	~30
SLFPA-W Inspection Reports	~400 (71 reports)
SLFPA-W pictures	~7300 photos

CHARGE FOR IEPR PANEL MEMBERS

Members of this Panel should understand that they are being asked to review "the adequacy, appropriateness, and acceptability of the design and construction activities for the purpose of assuring that good science, sound engineering, and public health, safety, and welfare" have been taken into account.

Per EC 1165-2-209 (page E-1), "The following excerpt from The American Society of Civil Engineers (ASCE), *Civil Engineering* magazine, February 2009, Volume 79, Number 2, Guiding Principles for Critical Infrastructure, page 58, column one, by ASCE's Critical Infrastructure Guidance Task Committee should serve as a back drop for conducting Safety Assurance Reviews. It captures the essence of the challenge and purpose of the review:

> "For example, critical infrastructure must be designed to provide a balanced level of protection based on hazard level and reliability, and designs must be sufficiently conservative to accommodate unforeseen conditions. With the rapid expansion of knowledge and the spread of practices that have proved to be extremely effective ("best practices"), we must review the adequacy of existing infrastructure within the context of that new knowledge and ensure that processes are in place to respond quickly to any performance problems that arise. Resilience to prevent catastrophic failures must be a component of all designs. Performance monitoring should be rigorously employed in the operation and maintenance of protection systems."

The panel members are not being asked whether they would have conducted the work in a similar manner. Specific questions for the Panel are derived from the Critical Items List (CIL) and included in the general charge questions below.

General Charge Guidance

Please answer the questions listed below and conduct a Safety Assurance Review of the WBV 14C.2 design documents and construction. Please feel free to make any relevant and appropriate comment on any of the information you were asked to review. In addition, please note the following guidance.

1. Your response to the charge questions and CIL should not be limited to a "yes" or "no." Please provide complete answers to fully explain your response. Note that for each Panel review comment entered into DrChecks, you will be responsible for providing the following information: (1) a clear statement of the comment; (2) the basis for the comment; (3) a statement as to whether the comment is a "critical" level comment; and (4) recommendations to resolve the comment (including additional research or analysis that may influence the conclusions).
2. The project design requires redundancy, resiliency, and robustness.
    a) Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or failsafe.
    b) Resiliency is the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use.

c) Robustness is the ability of a system to continue to operate correctly across a wide range of operational conditions (the wider the range of conditions, the more robust the system), with minimal damage, alteration or loss of functionality, and to fail gracefully outside of that range.

Please **do not** make recommendations on whether the design/construction method should be implemented, or whether you would have conducted the work in a similar manner. Also, please **do not** comment on or make recommendations on policy issues and decision-making. Panel review comments should be provided based on your professional judgment, **not** the legality of the document.

1. If desired, panel members may contact one another. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, or was part of the USACE Independent Technical Review.
2. Please contact the Battelle Project Manager (Lynn McLeod, mcleod@battelle.org) or Deputy Project Manager (Monica Malhotra, malhotram@battelle.org) for requests or additional information.
3. In case of media contact, notify the Battelle Program Manager, Karen Johnson-Young (johnson-youngk@battelle.org) immediately.
4. Your name will appear as one of the panel members in the IEPR of WBV 14C.2. Your review comments will be included in the DrChecks entries but will remain anonymous.

Independent External Peer Review
of the WBV 14C.2 –
New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1

Charge Questions As Supplied By USACE

General Charge Questions

1. Do the design assumptions made during the decision document phase (interpreted as the EAR, PDD, DDR, or similar appropriate design document for the specific project – to be provided to the Panel) for hazards remain valid through the completion of design and construction as additional knowledge is gained and the state-of-the-art evolves?
2. Do the project features adequately address redundancy, resiliency, or robustness with an emphasis on interfaces between structures, materials, and project phases?
    a) Redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or failsafe. Systems that are redundant use multiple lines of defense that are linked to potential failure modes. The most vulnerable failure modes need the greatest redundancy.
    b) Resiliency is the ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use. Systems that are resilient use enhancements to improve the ability of the system to sustain loads greater than the design load to achieve gradual failure modes over some duration rather than sudden failure modes.
    c) Robustness is the ability of a system to continue to operate correctly across a wide range of operational conditions (the wider the range of conditions, the more robust the system), with minimal damage, alteration or loss of functionality, and to fail gracefully outside of that range. Systems that are robust use more conservative assumptions to increase capacity to compensate for greater degrees of uncertainty and risk.
3. Do the project features and/or components work effectively as a system?
4. Do the assumptions made during design remain valid through construction as additional knowledge is gained and the state-of-the-art evolves? (Final DDRs, CO QMPs, site visits, and other similar appropriate documents to be provided to the Panel for this assessment, including Appendix C.)
5. For operation and maintenance (O&M) manuals, do the requirements adequately maintain the conditions assumed during design and validated during construction? Will the project monitoring adequately reveal any deviations from assumptions made for performance? (Understood that monitoring plans and O&M manuals may be developed after construction and before project turnover. Must determine how to retain the Panel or issue new task order for this work.)

Performance Charge Questions

6. Was the project constructed in accordance with plans and specifications?
    a) Was the embankment placed of earth materials naturally occurring or Contractor blended, and classified as CL or CH with less than 35% sand content or ML, if blended to produce a material that classifies as CH or CL according to ASTM D 2487?
    b) Were fill materials free from masses of organic matter, sticks, branches, roots, and other debris including hazardous and regulated solid wastes?
7. Were contract specifications violated by allowing the contractor to chop wood contained in the embankment that would be considered objectionable (length greater than 1 foot, and cross sectional area greater than 4 square inches) into small wood chips, then placing the material into the embankment?

Geotechnical Analysis Charge Questions – Field inspections documented wet areas adjacent to and along the levee alignment.

8. Were geotechnical analyses, including boring logs, sufficient and did the analyses adequately consider seepage during the design process and construction?
9. Was adequate investigation of any wet areas performed during construction?

Operation & Maintenance Charge Questions - The safety of the public and the SLFPA-W maintenance staff is paramount.

10. Will any additional maintenance requirements be incurred due to subsidence; would damage to maintenance equipment and to the levee occur as a result of objectionable material remaining in the levee?
11. Review the settlement analyses with consideration of the wood in the embankment material and assess whether settlement and subsidence rates would be accelerated due to the presence and/or decadence of wood.
12. Review all documents provided with consideration of the wood and other unsuitable materials in the embankment, and assess the quality of construction, as well as employee safety in performing maintenance activities and the public's welfare.
13. Due to presence of "other foreign matter" such as large chunks of concrete, culverts, crane hooks, and other materials in the embankment, review all documentation and reports provided and assess whether levee construction provides adequate cover and compaction over such items or whether placement of additional clay material placed on the levee provides for a safe environment for maintenance employees and the public?

Borrow Pit Issue Charge Questions

14. Review the Contractor's Submittal Package and assess whether the information and details provided are in accordance with the Section 3.1 Contractor-Furnished Borrow Areas, in particular with Section 3.1.5.12 Borrow Area Management Plan of the specifications?
15. Did borrow pit development contribute to an increase in the level of unsuitable materials placed into the embankment?

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APPENDIX C

Final Critical Items List

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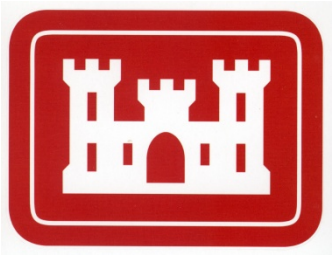

US ARMY CORPS OF ENGINEERS

Final CRITICAL ITEMS LIST for INDEPENDENT EXTERNAL PEER REVIEW OF WBV 14C.2 – NEW WESTWEGO PUMP STATION TO ORLEANS VILLAGE – 3RD ENLARGEMENT – PHASE1

Battelle Memorial Institute
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Prepared for
U.S. Army Corps of Engineers
Coastal Storm Risk Management
National Planning Center of Expertise
Baltimore District

Contract No. W911NF-11-D-0001
Delivery Order: 0173
Task Control Number: 12074
Scientific Services Program

November 12, 2013

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administered by Battelle Memorial Institute,
Contract No. W911NF-11-D-0001.

Final Critical Items List

Independent External Peer Review
of
WBV 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1

by

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November 12, 2013

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Table of Contents

Appendices

List of Tables

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1. Background

The U.S. Army Corps of Engineers (USACE) is currently designing and constructing the Greater New Orleans Hurricane and Storm Damage Risk Reduction System (HSDRRS). One of the vital components of this system is the West Bank Vicinity (WBV) 14C.2 – New Westwego Pump Station to Orleans Village – 3rd Enlargement – Phase 1 project (hereinafter WBV 14C.2). This project consists of raising the elevation of approximately 3.5 miles of new earthen levee to the 100-year level of protection on the floodside of the previously constructed existing earthen levee and the construction of new floodwalls tying into the Westminster Pumping Station. These levee improvements will occur south of Lapalco Boulevard from Station 0+44 near the New Westwego Pump Station to Station 185+90.21 near the Borrow Canal adjacent to the Orleans Village Subdivision in Jefferson Parish, Louisiana.

An integral part of the HSDRRS process is the conduct of an Independent External Peer Review (IEPR) to ensure the reliability of scientific information and engineering analysis contained within the project documents. Battelle Memorial Institute (hereinafter Battelle), as a non-profit science and technology organization experienced in conducting expert peer reviews, was engaged by the USACE Coastal Storm Risk Management National Planning Center of Expertise (PCX) to conduct the Type II IEPR for the WBV 14C.2 project during the design and construction phases. Subject matter experts with knowledge of specific technical disciplines and project knowledge similar to the features of WBV 14C.2 are engaged to form a Battelle IEPR Panel (a.k.a. panel members) and specifically address the assessment and analysis of key criteria associated with the design, engineering, and construction of the three features of WBV 14C.2.

2. Objective

The identification of the critical items list (CIL) is one of the documents resulting from the IEPR analysis and assessment of design and construction components, subcomponents or systems of the flood management project whose malfunction can cause a single significant failure or a cascading failure of the entire structure and can pose a risk of serious injury, loss of life, or negative critical impact on one or more mission objectives. The IEPR Panel will prepare the CIL with the intentof focusing its review of design documents and construction activities on critical issues for mission success. The CIL will evolve as panel members add to it based on subsequent reviews of the project features. Of significance for the IEPR is consideration of resilience, redundancy, and robustness of components, subcomponents or systems; subsequently the panel members focus on reviewing critical items of the design and construction versus reviewing all the details of design and construction. The panel members focus on those critical items which must not fail. DrChecks will be used to provide specific comments on an issue or question that relates to the CIL. Appendix A contains instructions on completing the CIL assessment. The approach and example developed for the National Aeronautics and Space Administionation O-ring CIL was used as a basis for developing this CIL assessment.

3. References

The project technical references and design-construction documents noted in Table 1 and the bullets following were used by the panel members to develop the CIL.

Table 1. WBV 14C.2 Type II IEPR Documents Used to Develop the CIL

Title
Final WBV 14C.2 Geotechnical Report
WBV-14c.2 Site Inspection, 10 Aug 2011
Quality Assurance Reports (QARs)
Site Observation Report for WBV-14c.2, 27 Jan 2011
Construction documentation on WBV14C.2 (QC and QA Proctor tests, settlement calculations, summary of Non-Federal Sponsor visits, QC compaction testing log, borrow material source charts, modifications)
Report on Geophysical Survey Services, October 2011
Historical Documentation (WBV14C.1 construction documentation, LDOTDs files provided by CPRA, Initial Hazardous, Toxic and Radioactive Waste (HTRW) Assessment, June 7, 1994, and all other pertinent information)
Quality Assurance (QA) Team Report of Findings (Tiger Team Report)
Final WBV 14C.2 Plans and Specifications and contract modifications

- HSDRRS Design Guidelines, June 2008
- HSDRRS Quality Management Plan, 30 October 2009.

4. CIL and Failures

A critical item (as defined in Section 2) and the resulting CIL (as represented by the examples in Table 2) exemplify those components, subcomponents or system components that demand greater attention during the design-engineering development as well as the construction execution to ensure mission success. The failure of any of these represented items can endanger mission success. A failure is also defined as non-conformance with defined performance criteria and inability to perform as intended. As noted, each of the panel members would further develop the following representative CIL to identify associated concerns and effects.

Table 2. Examples of Critical Items

Examples of Critical Items	
Earthen Levee	Quality control of materials
Scour protection	Monolith/wall sheet pile cutoff
I-wall/levee transitions	Floodwall structures
Settlement monitoring	Operations and Maintenance
Sheet pile driving	Existing Utilities

Based on each professional discipline's focus, viewpoint, and analysis of failure effects, two or more disciplines can develop a different set of CIL tables as a supplement to the original CIL. Table 3 describes some of the possible causes of failures. The actual CIL is contained in Appendix B.

Table 3. Examples of Possible Causes of Failure

Examples of Possible Causes of Failure
Levee settlement due to poor subsurface conditions
Armor on top of levee inadequate for overwash effects.
Isolated zones of unsuitable material from the approved borrow sites incorporated into the levee profile.
Excessive subsidence or movement of control points.
Obstructions in the subgrade
Unknown embankment discontinuities - pocket(s) of objectionables
Non-conservative design assumptions / analysis methods
Overtopping, erosion

5. Conclusion

The WBV 14C.2 CIL is a dynamic document developed and updated as needed by panel members throughout the course of the project. The CIL analysis will assist in focusing each panel member's attention to the critical components, subcomponents and/or systems that can fail through one or more modes. The panel member can evaluate how these possible failures can be mitigated. Deficiencies in the design and construction of the critical items will prompt the panel member to enter review comments into DrChecks; USACE will then evaluate the comments and provide written feedback. If any comments cannot be resolved through the USACE evaluator's comments, the unresolved comments may be addressed during a Peer Review Teleconference.

Changes to the CIL may also be discussed on the teleconference. Subsequent to the teleconferences, DrChecks input will be revised to reflect all discussions held between the panel members and the USACE evaluators.

Appendix A – Instructions for Completing a CIL

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Appendix A – Instructions for Completing a CIL

A critical item is defined as a component, subcomponent, or system component whose failure can result in endangering mission success. A failure is also defined as non-conformance with defined performance criteria and inability to do what was intended.

The following areas will be assessed per component/system, as outlined on the form below:

- Component/System Name
- Component/System Function
- Potential Failure Mode
- Possible Cause(s) of Potential Failure
- How is the Failure Detected
- Consequence(s) of Failure
- Severity of Failure (Mild, Moderate, Severe)
- Potential Mitigation Measure
- Actions Taken.

To fill out the form, use the following section descriptions as a guide:

1. Critical Item (Component/System) Name: The component/system name indicates the component/system that the form is assessing.

2. Component/System Function: Indicates the primary function of the component/system.

3. Potential Failure Mode: A failure mode is defined as the manner in which the component/system could potentially fail to meet the design intent (i.e., corrosion, cracking, electrical short, etc.).

4. Possible Cause(s) of Potential Failure: A failure cause is defined as a design weakness that may result in failure. The potential causes for each failure mode should be identified and documented. The cause should be listed in technical terms and not in terms of symptoms (i.e., improper torque applied, contamination, erroneous algorithms, etc.).

5. How is the Failure Detected:

6. Consequence(s) of Failure: For each critical item, the form should indicate what the ultimate effect will be. A failure effect is defined as the result of a failure mode on the function of the design/system. This should be described in terms of what will happen if the failure mode occurs (i.e., personal injury, degraded performance, etc.).

7. Severity of the Failure: The severity of the failure is assessed based on the probability of occurring, the likelihood of detection, and ultimately the impact (minor, major, or severe). This block should indicate the overall impact as defined below:

- Minor = Insignificant loss or no loss of component function or system functionality;
- Moderate = Important loss of component function or system functionality;
- Severe = Catastrophic loss of component function or system functionality that could result in serious injury, loss of life, or severe damage to protected property or equipment

8. Potential Mitigation Measures: These actions are those to be performed to mitigate the failure from occurring (i.e., inspections, preventative maintenance, redesign, etc.).

WBV 14C.2. – Critical Item			
1	**Critical Item (Component/System Name)**		
2	**Component/System Function**		
3	**Potential Failure Mode**		
4	**Possible Cause(s) of Potential Failure**		
5	**How is the Failure Detected**		
6	**Consequence(s) of Failure**		
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☐Severe	
8	**Potential Mitigation Measures**		

Appendix B – Critical Items List

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WBV 14C.2 Critical Items List

Critical Item #	Component/System Name	Severity of Failure
1	Earthen Levee - Embankment	Severe
2	Scour Protection - Protected and Flood Side (Levee, Floodwall and Transitions)	Severe
3	Quality Control of Materials	Severe
4	Earthen Levee - Foundation	Severe
5	Floodwall Structure(s)	Severe
6	I-Wall/Levee Transitions at Westminster Pumping Station	Moderate
7	Option Area A - Removal of Floodwall Plus Pipeline Replacement	Moderate
8	Survey of Critical Components of the Levee System	Moderate
9	Sheet Pile Driving	Moderate
10	Settlement Monitoring	Moderate
11	Installation of Geotextile	Moderate
12	Levee – System Maintenance / Inspection / Safety	Moderate
13	Floodwall – Monolith/Wall Sheet Pile Cutoff	Moderate
14	Floodwall Monolith Joints / Transitions: Waterstops	Moderate
15	Floodwall Pile Foundations	Moderate
16	Operations, Maintenance, Emergency and Safety; Emergency Response Plan, Operations and Maintenance Manual, As-Built Drawings	Moderate
17	Existing Utility – 20” Gulf South Pipeline (Levee Foundation Penetration)	Moderate

WBV 14C.2 – Critical Item # 1		
1	**Component/System Name**	Earthen Levee - Embankment
2	**Component/System Function**	Provides primary hurricane protection
3	**Potential Failure Mode**	Global slope instability / failure, breach
		Localized slope instability / sloughing / failure, breach
		Seepage, piping, erosion, and ground loss
		Settlement – overtopping, erosion/scour, breach
		Differential settlement
		Loss of levee integrity due to erosion, wetting and drying cracks
4	**Possible Cause(s) of Potential Failure**	Non-conservative / non-representative design soil parameters: test data distribution; individual soil sample test property(s) versus soil mass/strata property(s) performance (i.e. with objectionables)
		Non-conservative design assumptions / analysis methods
		Unknown embankment discontinuities - pocket(s) of objectionables
		Levee settlement due to poor subsurface conditions
		Soil design assumptions in foundation is typical of reaches; Soil in specific areas may differ allowing more settling at some areas
		Armor system on flood and/or protected side of levee inadequate to withstand wave/water/impact forces
		Armor on top of levee inadequate for overwash effects
5	**How is the Failure Detected**	Review of derivation of design soil parameters and assumptions
		Review of test trench data, findings
		Review of analysis, design methods and assumptions
		Review of criteria for adherence to HSDDRS including changes during construction
		Monitoring and Inspection
		Observed cracks in levee crest
		Observed differential settlement of crest causing separation cracks
		Erosion on either side of levee or crest
6	**Consequence(s) of Failure**	Levee slope failure / settlement / displacement – overtopping, erosion/scour, and breaching
		Partial or full collapse of levee section
		Poor performance of team blamed on dysfunctional element
		Expensive repair required/property damage
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Proper derivation, development and selection of Design Soil Parameters, analyses, criteria, design procedure (per HSDRRS); settlement monitoring / subsequent / supplemental embankment raises / berms, erosion / scour protection; Frequent inspections, repairs, alternative access plans, etc.

WBV 14C.2 – Critical Item # 2		
1	**Component/System Name**	Scour Protection – Protected and Flood Sides (Levee, Floodwall and Transitions)
2	**Component/System Function**	Overtopping scour and erosion protection (protected side) Scour and erosion due to wave action (flood side)
3	**Potential Failure Mode**	Scour, erosion, ground loss
		Overtopping, breach
4	**Possible Cause(s) of Potential Failure**	Loss of soil, hence reduced soil resistance
5	**How is the Failure Detected**	Review of analyses, design methods and assumptions, drawings and specifications
		Monitoring and inspection
6	**Consequence(s) of Failure**	Levee slope failure / settlement / displacement - breaching and overtopping
		Floodwall / closure settlement / displacement – breaching and overtopping
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Concrete slab apron, grouted riprap, rock-filled mattresses, articulated concrete mats, crest road / protection; concrete slab planned / constructed for floodwall / transitions, scour protection system under evaluation for levees.

WBV 14C.2 – Critical Item # 3		
1	**Component/System Name**	Quality Control of Materials
2	**Component/System Function**	Quality of the materials incorporated into the levee profile has a direct impact on the functionality of the levee system
3	**Potential Failure Mode**	High Organic Content
		Excessive subsidence and degradation of the functionality of the levee profile as the organics breakdown over time
		High Moisture Content
		Excessive soil moisture does not allow full design strength to be achieved and allows the creation of localized failure planes
		Sand content > 35%
		Creates a plane of weakness that allows water flow through the levee section and generate a failure plane
4	**Possible Cause(s) of Potential Failure**	Breakdown in the QC/QA system
		Inadequate training of the on-site personnel
		Isolated zones of unsuitable material from the approved borrow sites incorporated into the levee profile
		Lack of calibration of testing equipment
		Contractor working in more than their approved work zones simultaneously overwhelming QC personnel
		Insufficient number of tests being conducted
5	**How is the Failure Detected**	Periodic testing by contractor and Government forces
		Site inspections
		Observed failures during QA testing
		Excessive subsidence in isolated locations of the levee profile
		Repeated remediation of isolated soft spots in levee section
		Vehicles becoming mired in soft soils working levee section
6	**Consequence(s) of Failure**	Levee section not being able to withstand design requirements
		Weakened section due to localized material failure and loss of overall strength capabilities
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Additional soil testing of in place material to verify quality

WBV 14C.2 – Critical Item # 4		
1	**Component/System Name**	Earthen Levee - Foundation
2	**Component/System Function**	Provides primary hurricane protection
3	**Potential Failure Mode**	Global instability / failure
		Loss of foundation support / bearing capacity, settlement – displacement and overtopping
		Seepage, piping, erosion, and ground loss
4	**Possible Cause(s) of Potential Failure**	Non-conservative / non-representative design soil parameters: test data distribution; individual soil sample test property(s) versus soil mass/strata property(s) performance (i.e. with objectionables)
		Non-conservative design assumptions / analysis methods
		Geotechnical analyses, design methods, assumptions and criteria: As per HSDRRS vs. deviation from HSDRRS
		Unknown foundation discontinuities - pocket(s) of objectionables, unknown / incomplete foundation treatments (< 3feet below natural ground?) during construction (inspection trench?)
		Levee settlement due to poor subsurface conditions
5	**How is the Failure Detected**	Review of derivation of design soil parameters and subsurface profile assumptions
		Review of analysis, design methods and assumptions
		Review of criteria for adherence to HSDDRS including changes during construction
		Monitoring and inspection
		Observed cracks in levee crest
		Observed differential settlement of crest causing separation cracks
6	**Consequence(s) of Failure**	Levee slope failure / settlement / displacement – overtopping, erosion/scour, and breaching
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Proper derivation, development and selection of design soil parameters, analyses, criteria, design procedure (per HSDRRS); settlement monitoring / subsequent / supplemental embankment raises / berms, erosion / scour protection; Frequent inspections, repairs, alternative access plans

WBV 14C.2 – Critical Item # 5		
1	**Component/System Name**	Floodwall Structure(s)
2	**Component/System Function**	Hurricane protection
3	**Potential Failure Mode**	Global instability / failure
		Pile displacement, loss of foundation support / pile capacity, floodwall settlement – displacement and overtopping
4	**Possible Cause(s) of Potential Failure**	Non-conservative soil parameters
		Non-conservative design assumptions / analysis methods
		Geotechnical analyses, design methods, assumptions and criteria: As per HSDRRS vs. deviation from HSDRRS
5	**How is the Failure Detected**	Review of derivation of design soil parameters and assumptions
		Review of analysis, design methods and assumptions
		Review of criteria vs. HSDDRS
6	**Consequence(s) of Failure**	Floodwall settlement – displacement and overtopping
		Foundation support system failure
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☐Moderate ☒Severe
8	**Potential Mitigation Measures**	Proper derivation, development and selection of Design Soil Parameters, analyses, criteria, design procedure (per HSDRRS)

WBV 14C.2 – Critical Item # 6		
1	**Component/System Name**	I-Wall/Levee Transitions at Westminster Pumping Station
2	**Component/System Function**	Provides flood protection in areas of transition such as at highway gates and pump stations
3	**Potential Failure Mode**	Differential Settlement of the wall and levee; I-shape sits adjacent to and partially within the levee and settlement of levee may be bridged by the I-Wall structure
		Loss of levee supporting wall base due to erosion on flood or protection side of wall
4	**Possible Cause(s) of Potential Failure**	Levee settlement due to poor subsurface conditions
		Soil design assumptions in I-wall foundation is typical of reaches; Soil in specific areas may differ allowing more settling at one point in wall
		Armor system on flood side of levee inadequate
		Insufficient coordination with WBV-30 contractor
5	**How is the Failure Detected**	Observed leaning or cracks in I-wall
		Observed settlement between wall and embankment causing separation cracks
		Erosion on either side of wall
6	**Consequence(s) of Failure**	Partial or full collapse of wall section
		Poor performance of team blamed on dysfunctional element
		Expensive repair required/property damage
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐ Severe
8	**Potential Mitigation Measures**	Frequent inspections, repairs, alternative access plans, etc.

WBV 14C.2 – Critical Item # 7		
1	**Component/System Name**	Option Area A - Removal of Floodwall Plus Pipeline Replacement
2	**Component/System Function**	Provides flood protection in areas of transition such as at pipelines and pump stations
3	**Potential Failure Mode**	Differential settlement site of the wall and levee; Removal of wall may require extra care in debris removal and compaction of lifts
		Removal of partial sheetpile sections may result in gaps in subsurface conditions requiring extra attention during filling and compaction processes
4	**Possible Cause(s) of Potential Failure**	Levee settlement due to poor subsurface conditions
		Soil in specific areas may differ allowing more settling at one point in removed wall
		Armor system on flood side of levee inadequate
5	**How is the Failure Detected**	Observed leaning or cracks in area of removed wall
		Observed settlement near location of removed wall and embankment causing separation cracks
		Erosion on either side of wall location
6	**Consequence(s) of Failure**	Partial or full collapse in area of wall section
		Poor performance of team blamed on dysfunctional element
		Expensive repair required/property damage
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐ Severe
8	**Potential Mitigation Measures**	Frequent inspections, repairs, alternative access plans, etc.

WBV 14C.2 – Critical Item # 8		
1	**Component/System Name**	Survey of Critical Components of the Levee System
2	**Component/System Function**	Shape, line, and grade of levee profile
3	**Potential Failure Mode**	Improper alignment of levee could concentrate wave actions during storm events and overwhelm levee system
		Incorrect placement of Geotextile could cause reduced capabilities of levee system
		Levee profile not configured per plans and specifications could prevent system from meeting its design requirements
		Levee section not constructed per design shape could reduce level of protection originally envisioned
		Contractor QC not back checking survey layout
4	**Possible Cause(s) of Potential Failure**	Incorrect Bench marks and offsets
		Misalignment caused by failures in survey equipment
		Inadequate training of survey crews
		Excessive subsidence or movement of control points
		Inaccurate vertical/horizontal controls
5	**How is the Failure Detected**	QA inspection
		Aerial photographs
		Site inspection by outside personnel
		Pre-final inspection of vertical measurements
6	**Consequence(s) of Failure**	Failure of the levee profile to provide the level of protection originally designed
		Construction of elements of the levee not integrated with the rest of the system
		Improper tie-in with existing structures creates a weakened section
		Excessive cost due to additional material requirements and sections not meeting PandS requirements
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Multiple checks using different personnel of vertical and horizontal controls and overall surface features.

WBV 14C.2 – Critical Item # 9		
1	**Component/System Name**	Sheet Piling Driving
2	**Component/System Function**	Sheet piles in the levee section reduce settlement, control lateral deflections and enhance stability.
3	**Potential Failure Mode**	Piles are misaligned
		Out of plumb (1/8 per foot)
		Engagement of Interlocks between sheet piles fails
		Incorrect tip and/or cut-off elevations
		Exceed vertical or uplift tolerances
		Spliced piles fail at welded connections
		Piles damaged during driving
		Obstructions prevent driving piles to required depth
4	**Possible Cause(s) of Potential Failure**	Obstructions in the subgrade
		Incorrect handling and driving methods used during installation
		Inadequate training of pile driving crew
		Failure of QC to monitor installation
		Construction equipment (Hammer) issues
		Too many piles started and not finished within a normal workday
5	**How is the Failure Detected**	Use of instrumentation to monitor vertical and lateral movements
		Visual inspection
		Detecting differences in driving characteristics
		Aerial photos of progress
		Aggressive QC/QA
6	**Consequence(s) of Failure**	Overtopping and flooding
		Levee section not performing per design requirements
		Movement of levee section above cut-off pile elevations due to improper placement of the piles
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Installation of additional piles

WBV 14C.2 – Critical Item # 10		
1	**Component/System Name**	Settlement Monitoring
2	**Component/System Function**	Settlement Gages
3	**Potential Failure Mode**	Excessive settlement
		Increased cost to Government due to requirement for more fill
		Improper levee profile in grade, line and shape
		Soft spots generate planes of weakness that could put levee protection capabilities at risk
		Failure of foundation material to support levee section
4	**Possible Cause(s) of Potential Failure**	Improper placement/maintenance of settlement gages
		Contractor not determining elevations of gages prior to fill material and again within 72 hrs after compliance cross-sections have been taken over the completed embankment
		Failure of foundation material to support the levee section
		Unsuitable material incorporated into levee section (organics, moisture, sand, etc.)
5	**How is the Failure Detected**	Monitor the installation and maintenance of gages
		Periodically check gages by survey
		Identify unplanned work around gage beds that could generate inaccurate readings
		Gaps/cracks in fill material appearing after compacted placement near tie-in to hard structures
6	**Consequence(s) of Failure**	Increased cost to Government due to increase in the required amounts of embankment fill
		Indicates a larger problem with the foundation material of the levee
		Weakened area during hurricane season until repaired/improved
		Levee section not meeting design requirements
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Increase the number and frequency of settlement gages.

WBV 14C.2 – Critical Item # 11		
1	**Component/System Name**	Installation of Geotextile
2	**Component/System Function**	Support majority of the main levee section
3	**Potential Failure Mode**	Failure of the levee system to perform as designed
		Partial failure of levee section due to improper placement of geotextile
		Plane of weakness through the crucial elements of the levee section
		Differential settlement of the levee section material
4	**Possible Cause(s) of Potential Failure**	Improper placement/alignment of geotextile
		Geotextile not tied into the adjoining material per design
		Improper lap joints of geotextile
		Incorrect material
		Improper handling of geotextile
		Material not protected during storage and placement from ultraviolet light
5	**How is the Failure Detected**	QC/QA inspection
		Monitoring fill placement
		Aerial photographs
		Pre-final survey
		Visual observations of levee profile
		Heavy equipment observed transiting geotextile prior to fill coverage
6	**Consequence(s) of Failure**	Failure of the levee section
		Levee not meeting design requirements in strength and profile
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Remove and replace with new geotextile material

WBV 14C.2 – Critical Item # 12		
1	**Component/System Name**	Levee – System Maintenance / Inspection / Safety
2	**Component/System Function**	Hurricane protection
3	**Potential Failure Mode**	Embankment debris – debris comes to surface / exposed objects
		Embankment debris – difficult / lack of maintenance / inspection with surface debris
		Embankment debris – maintenance / inspection personnel safety (mowing / inspection) with surface debris
		Localized slope instability / sloughing / seepage / piping / erosion and ground loss failure (burrowing animals, lack of vegetation / scour protection)
4	**Possible Cause(s) of Potential Failure**	Ground loss, settlement and displacement
		Overtopping, erosion
5	**How is the Failure Detected**	Monitoring and Inspection
6	**Consequence(s) of Failure**	Levee operations and maintenance personnel safety
		Levee slope failure / settlement / displacement – erosion/scour
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Levee degradation (2 feet?) and 2 foot (?) thick clay cap / engineered zone

WBV 14C.2 – Critical Item # 13		
1	**Component/System Name**	Floodwall - Monolith/Wall Sheet Pile Cutoff
2	**Component/System Function**	Seepage cutoff, piping protection, scour and erosion protection
3	**Potential Failure Mode**	Seepage and piping
		Opening of sheet pile interlocks during driving
		Splicing failure during driving
4	**Possible Cause(s) of Potential Failure**	Poor utility connections
		Displacement and differential settlement
		Quality of splicing / interlocks
5	**How is the Failure Detected**	Review of analyses, design methods and assumptions, drawings and specifications
		Quality control during construction
6	**Consequence(s) of Failure**	Excessive seepage and ground loss
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Account for differential settlement during design, utility penetration and transition design details, construction monitoring and inspection

WBV 14C.2 – Critical Item # 14		
1	**Component/System Name**	Floodwall Monolith Joints / Transitions: Waterstops
2	**Component/System Function**	Water tightness, leakage and seepage control
3	**Potential Failure Mode**	Waterstop failure
		leakage
4	**Possible Cause(s) of Potential Failure**	Mis-alignment
		Lack of maintenance
		Differential settlement
5	**How is the Failure Detected**	Quality assurance during construction
6	**Consequence(s) of Failure**	Uncontrolled leakage, erosion and ground loss
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Design details, construction monitoring and inspection

WBV 14C.2 – Critical Item # 15		
1	**Component/System Name**	Floodwall Pile Foundations
2	**Component/System Function**	Hurricane Protection - pile foundation support (various load cases)
3	**Potential Failure Mode**	Bearing / displacement in compression / tension
		Lateral capacity / displacement
		Global instability / failure
		Loss of foundation support / pile capacity, floodwall settlement – displacement and overtopping
4	**Possible Cause(s) of Potential Failure**	Insufficient capacities
		Excessive settlement and displacement
		Overtopping, erosion
		Gapping, seepage and piping
5	**How is the Failure Detected**	Review of analyses, design methods and assumptions, drawings and specifications
		Monitoring during preproduction pile load test, production pile testing (PDA)
6	**Consequence(s) of Failure**	Floodwall settlement – displacement and overtopping
		Foundation support system failure
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Proper derivation, development and selection of Design Soil Parameters, analyses, criteria, design procedure (per HSDRRS)

WBV 14C.2 – Critical Item # 16		
1	**Component/System Name**	Operations, Maintenance, Emergency and Safety; Emergency Response Plan, Operations and Maintenance Manual, As-Built Drawings
2	**Component/System Function**	Operations and maintenance; response and supervision audits during flood emergency
3	**Potential Failure Mode**	Not completing proper operations and maintenance
		Not able to develop good emergency response plan
4	**Possible Cause(s) of Potential Failure**	Human negligence
5	**How is the Failure Detected**	Audit supervisors during emergency
6	**Consequence(s) of Failure**	Inadequate maintenance, operations and response to / performance during hurricane / high water conditions.
		Levee slope failure / settlement / displacement - overtopping and breaching
		Floodwall settlement / displacement – overtopping and breaching
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Develop: Emergency Response Plan, Operations and Maintenance Manual, As-Built drawings

WBV 14C.2 – Critical Item # 17		
1	**Component/System Name**	Existing Utility – 20" Gulf South Pipeline (Levee Foundation Penetration)
2	**Component/System Function**	Seepage cutoff, piping protection, scour and erosion protection
3	**Potential Failure Mode**	Seepage and piping
4	**Possible Cause(s) of Potential Failure**	Poor utility connections
		Displacement and differential settlement
5	**How is the Failure Detected**	Review of analyses, design methods and assumptions, drawings and specifications
		Quality control during construction
6	**Consequence(s) of Failure**	Excessive seepage and ground loss
7	**Severity of Failure (Mild, Moderate, Severe)**	☐Mild ☒Moderate ☐Severe
8	**Potential Mitigation Measures**	Confirm existing utility / backfill conditions, utility penetration design details, construction monitoring and inspection; supplemental berms, erosion / scour protection

APPENDIX D

IEPR Panel Member Resumes

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Chester Deane Fowler, PE, PgMP, CCM

Professional Engineer with over 25+ years of program, project, facilities and construction contract management experience. Using Situational Leadership techniques, have adapted numerous staffs and organizations to increased productivity, improved quality and enhanced performance through positive motivators. Organizations have ranged from small technical staffs of 4 through professional field staffs of 300 to military engineer units of 1000 plus. Personal involvement included every facet of engineering, including daily and long-term budgeting, planning, operations, and executive level management. My goal remains the desire to solve problems by creating a cohesive team of hard working professionals to complete assigned requirements on time, within budget and to the highest quality attainable.

Employment History

Jan 2012-Present: Program Manager, Independent Consultant
Jan 2011 – Dec 2011: Program Manager, MOCA Systems, Inc
Sep 2002 – Dec 2010: Senior Program Manager, HDR Engineering, Inc.
Feb 2000 – Sep 2002: Vice President, Civil Works Design & Engineering
Sep 1998 – Jan 2000: Senior Resident Engineer, HNTB, Inc
Aug 1995 –Aug 1998: Deputy District Engineer for the Antilles, Jacksonville District, US Army Corps of Engineers (USACE)
Dec 1976 – Nov 1998: Active Duty, US Army, Corps of Engineers (USACE)

Program/Project Management:

- Program Manager (MOCA) under an IT support contract to HQ, US Army Corps of Engineers (USACE) for improvements to P2 Portal/P6 Web which included: assessments of existing conditions, development of dashboards to aid in reporting information, training plans/materials for increasing the utilization by USACE employees and creation of a Prospect course for Advanced Scheduling.
- Program Manager (MOCA) leading and directing the efforts of scheduling and cost estimating support for the Florida Area Office, Mobile District, USACE at Eglin AFB, MacDill AFB and Hurlburt and Duke Fields. Also, PM for five construction representatives overseeing USACE renovation work at VA Hospitals in Florida.
- Senior Program Manager (HDR) for a program and project management support contract with both the Jacksonville and New Orleans Districts, USACE that included: project and program scheduling support (Corps' P2 and Primavera P3e), program assessments with a web based review process, meeting facilitation, quality control/assurance review of documents and products, program/project management plan formulation and PM support to the District's Staff.
- Client Liaison (HDR) for a web-based information management system developed for Jacksonville District, CorpsConnect, which combined multiple databases (scheduling, financial, project, GIS, file sharing and distribution) into a single, user friendly format that met user requirements for all levels.. As the PM, a similar system was developed for the United States Citizenship and Immigration Service (USCIS) that allowed segmented and phase-controlled access to real property records (impute and review) from various locations throughout the US. Both projects were rated as exceeding all requirements and providing real return-on-investment value to the Federal Agencies supported.

EDUCATION

Masters, Construction Management, University of Florida
Bachelors, Civil Engineering, University of Arkansas

QUALIFICATIONS

Professional Engineer, Florida and Virginia
Program Management Professional, Project Management Institute
Certified Construction Manager, CCMA
Construction Documents Technologist
Fellow, Society of American Military Engineers
Life Member, Chi Epsilon

Chester Deane Fowler, PE, PgMP, CCM

- Program Manager (HDR) in support of the Jacksonville Port Authority (JAXPORT) Capital Improvement Program which includes Mayport Cruise Terminal Complex, Security Enhancements for all three port installations, Systematic Inspection program of their infrastructure and general assistance of their goals and mission. Support was rated as superior and was critical in winning follow-on task support.
- Coordinated (HDR) with client and supporting contractors on concept and scope development for 24 separate task orders, contract and task order negotiation, quality control/assurance review, pay estimate and accounting of project costs and the full range of program and project management assistance to the Jacksonville District. Further, marketed capabilities both internally and externally to other clients and agencies at conferences, workshops and one-to-one/group presentations. Received the highest ratings allowable under USACE's AE evaluation system.
- Program manager (HNTB) for the Greater Orlando Aviation Authority's (GOAA), (an element of the City Government of Orlando) design of stormwater, drainage, roadway and taxiway projects at Orlando International Airport and Orlando Executive Airport. This required extensive interface with multiple consultants, GOAA Staff and the City of Orlando Engineering and Utilities Departments. Projects were completed on time and under budget.
- Senior Project Manager (IC) for four projects at Cape Canaveral associated with the refurbishment of the infrastructure for NASA totaling in excess of $30M in construction dollars and $3M in fees. Work involved overseeing construction, coordinating engineering responses, client interface and contract administration. All efforts were reported with high praise through the client's internal reporting system.
- Led four design teams (CWDE) responsible for providing 30%, 60%, 95% and bid set drawings and specifications for 15 clients in the Central Florida area with total project costs exceeding $250 million. Provided primary engineering services, client interface and coordination, construction administration including negotiations with contractors and subconsultants concerning base bid and change orders and final inspection, acceptance of work and approval of all invoices. All projects were completed by due date and within budget constraints.
- Coordinated (CWDE) with the City of Orlando, Orange County, St Johns River Water Management District, South Florida Water Management District and Florida Department of Environment Protection and various federal agencies in securing all levels of permits for private residential developments (four subdivisions from 450 lots to 1400 lot size), commercial projects (Industrial Park of Orlando valued at $12 to $55 million), government projects (includes: local, state and federal).
- Directly managed (USACE) three offices, 9 staff chiefs and a total staff of 74 multidisciplined engineers, project managers, technicians, economists, biologists, geologist, logisticians, legal, public affairs, safety and contract specialists administering construction and planning projects exceeding $1.2 billion as Deputy Commander, Jacksonville District. Projects included: construction of a thin arched double recurve dam, a major flood control project in a heavily urbanized area, a unique water park, and a design/build 75-room hotel with support facilities. Received rating that exceeded the standards.

Chester Deane Fowler, PE, PgMP, CCM

Construction Management:

- Senior Resident Engineer (Owner's Authorized Representative - HNTB) providing construction management oversight of 18 engineers, inspectors and technicians on a two aircraft bridge with 1.1 mile of associated taxiway project totaling over $51M (BP 250 - North Crossfield Taxiway Project) operating within a 7% budget.
- Rated as outstanding (USACE) in the management of planning and construction projects for the Commonwealth of Puerto Rico, and the Territory of the US Virgin Islands - recognized as one of the best in USACE. Successfully facilitated the partnering agreement/relationship of a very difficult/contentious contract valued in excess of $52M. Provided executive-level oversight on all federal (planning, engineering and construction) projects associated with harbors and waterways in the US controlled territories of the Caribbean Basin while assigned to Jacksonville District.
- As project manager (USACE), supervised a 4-person field staff during the construction of a $50M eight-story concrete office building for the Baltimore District. Principal negotiator with the Prime Contractor on all pay estimates, constructive and user-requested change orders and general conduct of the site and its overall looks and functionality. Site conditions involved a high level of security awareness and control of activities by prime and subcontractors due to the sensitivity of the military complex. Construction was accomplished without major incidents in safety or security over the three-year project within the tight time constraints.
- Director of Public Works (USACE) for a joint engineering organization of 28 engineers, technicians and specialists that managed a $32M base service support contractor with 750 workers; planned, designed and supervised construction of a $6.8M base improvement plan that improved quality of life for 1200 United States Military Service Members located in a remote corner of Central America under difficult environmental conditions. Meet or exceeded goals in all evaluation categories.

Environmental Management (USACE):

- Supervised the environmental cleanup for formerly used US Government sites (FUDS) of chemical weapons storage, unexploded ordnance and underground fuel storage tank removal. Projects followed strict environmental guidelines and accomplished without incident.
- Regulator for enforcement of Section 404b, Clean Water Act and Title 10, Rivers and Harbors Act throughout the Commonwealth of Puerto Rico and the United States Virgin Islands. Ensured public and commercial projects that impacted Waters of the United States met federal standards and policy requirements. Worked closely with the United States District Attorney in the enforcement of violations and resolution of conflicts. Permitted over 200 private and public projects for construction and resolved over 50 violations of the federal statues. Regulated the permitting and enforcement of US navigation issues as it relates to harbors, ports and waterways in the Caribbean Basin. All permits meet regulatory guidelines.

Emergency Management (USACE/HDR/MOCA):

- Program Manager (MOCA) for Emergency Recovery to Mobile District, USACE in support of the $150M Presidentially-declared Disaster associated with the

Tornado Cleanup in Northern Alabama leading, coordinating and ensuring quality assurance oversight of debris removal contractors in 23 counties. Effort included fielding 50 plus quality assurance monitors in a 36 hour period of notification and response. Field representatives were responsible for oversight, safety assurance review and validating pay for debris management contractors throughout the impact areas. Led field team and coordinated with local, state and federal representatives throughout the recovery effort. Personally coordinated and negotiated scope of work with senior Mobile District USACE Representatives that was declared highly successful, extremely responsive and professionally executed.

- Created a full service staff of a 308-person engineer organization of designers, quality control/assurance inspectors, contract and real estate specialists, security and a logistics element that provided ESF-3, Public Works and Engineering, response for 100,000 inhabitants of the US Virgin Islands in the wake of Hurricane Marilyn in 1995. Team procured, transported and distributed: 50,000 gals of bottled water and 75,000 lb. of ice per day, repaired roofs on 2400 private houses and 100 public facilities, clearing 10 M cubic yards of debris, installed and supported 332 emergency generators and constructed/renovated 150 public shelters during difficult environmental conditions and short time constraints. Personally coordinated with local and territorial leaders, Federal Emergency Management Agency and heads of 27 other Federal Agencies to ensure rapid, life saving support reached the citizens of the US Virgin Islands.
- Developed, supervised and executed the highly successful public works response ($68M) during Hurricanes' Bertha and Hortense in the US Virgin Islands and Puerto Rico in 1996.

Charles Alan Hall, PE, D.WRE

Education

B.S., Professional Engineering Management, Nova University
Graduate Studies, Master of Science Program, Engineering Management, University of South Florida
Undergraduate Studies, Industrial Engineering and Operations Research, Virginia Polytechnic Institute and State University

Registrations

Professional Civil Engineer, Florida

Affiliations

American Academy of Water Resources Engineering, Diplomate
American Society of Civil Engineers, Member
American Institute of Industrial Engineers, Senior Member
National Society of Professional Engineers, Member
Florida Engineering Society, Member
Governor's Conference on Library and information Systems, Delegate
Governor's Technical Advisory Committee on Lake Okeechobee, Member
Florida State Task Force on Stormwater Management, South Florida Representative
South Florida Ecosystems Restoration Task Force, Working Group Member
Society of Collegiate Scholars, Member
Vice-President, Alpha Pi Mu, Industrial Engineering Honor Society, Virginia Tech
Member, Alpha Pi Mu, Industrial Engineering Honor Society, USF
President, American Institute of Industrial Engineers, Virginia Tech Chapter

Summary of Experience

Mr. Charles Alan Hall, P.E., D.WRE, offers 40 years of experience in the fields of water resources, environmental, and civil engineering in government service and private practice. Mr. Hall is currently responsible for marketing and management of watershed-scale water resources consulting services to the public and private client groups. He has managed over $2 billion in water resources programs and has led organizations of over 700 staff. Prior to his career in private practice, Mr. Hall had a 25-year record of accomplishments in public service. He served as the Director of Ecosystems Restoration for the South Florida Water Management District (SFWMD), where he oversaw more than a billion dollars in ecosystems restoration construction projects. Mr. Hall's specific accomplishments with SFWMD include the design and implementation of the Everglades Construction Project, The Kissimmee River Restoration Program, Florida Bay Restoration and the Emergency Interim Flood Control Project. Before serving as Director of Ecosystems Restoration for SFWMD, Mr. Hall was Deputy Director of Operations and Maintenance. His responsibilities included the leadership and control of the water management operations and project maintenance functions for a water control and treatment system, consisting of 2,000 miles of canals and levees, over 300 pump stations and control structures, and over two million acres of water storage and treatment areas which provided flood control, water supply, and environmental enhancement for central and south Florida, serving a population of over 7 million. Mr. Hall also led the emergency operations for hurricane response and recovery for severe storms in South Florida such as Hurricane Andrew in 1992.

Relevant Project Experience

- **Gulf Intracoastal Waterway Closure Complex, New Orleans, Louisiana (2008 - 2013) -** As an expert in Civil Engineering, Water Resources Engineering and Operations and Maintenance, Mr. Hall served in multiple professional capacities to oversee the design and construction of the Gulf Intracoastal Waterway Closure Complex project. Included within the GIWCC were a 19,000-cubic-foot-per-second (cfs) flood control pumping station, a 225-foot waterway closure sector gate, extensive levees and hurricane protection walls, and a water control structure to protect environmentally sensitive wetland marshes.

- **Professional Engineering Services, Florida (2006 -2013)** - Served as Chief Consulting Civil Engineer for advisory and review services for $2.5 billion of civil and water resource projects for state agency**.** Saved the client over $300 million dollars in both design and construction costs through innovative and creative design modifications and adjustments prior to construction. Developed new hydraulic modeling tools for use by agency engineering staff for design purposes in order to reduce design time and enhance project estimating.

- **Professional Services Marketing, Florida (2004 - 2013)** - Responsible for securing contracts for engineering services for an international engineering firm in the South Florida marketplace. Secured over $25 million in engineering services contracts for civil, water resources, electrical,

mechanical engineering as well as construction management services.

- **Everglades Forever Act Implementation, South Florida (1994 -1999)** - Program manager responsible for the management of the design and construction of the project requirements of this landmark Florida legislation which included 6 marsh treatment systems consisting of over 50,000 acres with levees and canals and multiple major pumping stations up to 4,000 cfs in size. Program elements included: a $700 million stormwater quality improvement construction program, a regulatory program for monitoring agricultural clean-up efforts, a research program to identify best management practices (BMPs) and new clean-up technologies, and a fiscal management program to generate revenues and monitor expenses.

- **C-51 Flood Control Project, Palm Beach County, Florida (1988 - 1992)** - Project manager for a $200 million stormwater management project serving a 174 square mile urban watershed. Project elements included a 6,600-acre above-ground stormwater detention area, two stormwater pumping stations of 3,700 cubic feet per second each, and 6.5 miles of conveyance canal enlargements.

- **Kissimee River Restoration Demonstration Project, Okeechobee County, Florida (1982 - 1984)** - Project hydrologist for a $15 million pilot project designed to demonstrate the feasibility of large-scale river restoration by strategically installing three steel sheet-pile notched wiers in a canal which was 30 feet deep and 250 feet wide. This project was so successful that a $430 million joint federal-state river restoration program was subsequently approved founded upon the Demonstration Project's performance and principles.

- **Hurricane Andrew Restoration Project, Miami-Dade County, Florida, Miami-Dade County, Florida (1992)** - Project manager for restoration and recovery program to restore the water control systems to operation readiness in the quickest possible time that resulted from the devastation in south Florida in 1992 from Hurricane Andrew.

- **Royal Palm Beach Flood Emergency, Palm Beach County, Florida (1988)** - Project manager responsible for leading a disaster and emergency response team and directing the use of physical and fiscal resources on a real-time basis to reduce and eliminate severe flooding of residences in western Palm Beach County community served by the West Palm Beach Canal.

- **Lake Apopka Restoration Demonstration Project, Central Florida (2000)** – Deputy project manager for the development, design, construction and operation of a pilot project to investigate the feasibility of using lake bottom sediments as capping material on adjacent farm lands to prevent migration of pesticides. Project results will be used to quantify costs of full-scale lake restoration options.

- **CERP – ASR Pilot Projects Source Water Characterization, South Florida (2002)** – Project manager for two south Florida Aquifer Storage and Recovery Source Water Characterization studies in support of the Comprehensive Everglades Restoration Plan. The surface and groundwater

are characterized in relation to all major public drinking water standards for two pilot projects around Lake Okeechobee and the Hillsboro Canal in Palm Beach County. Project work involves sampling and analysis for both surface waters and ground water from the Upper Floridan Aquifer system.

- **Multi-year Professional Services for Dredging Design and Technology, Central Florida (2001 - 2003)** – Deputy project manager for this five-year professional services contract to provide expert assistance to the St. Johns River Water Management District. Work involves identification of problems and development of design solutions for sediment contamination problems in the many lakes and waterways of the District.

- **Loxahatchee Wetland Mitigation Bank, Palm Beach County, Florida (2002)** – Construction director for the restoration of a 1,250-acre wetland system in south Florida. Developed and designed the hydrologic restoration and hydraulic performance criteria for the removal of exotic vegetation and recovery and planting of natural wetland species. Project is used for selling of mitigation credits for developments. Example of a highly successful private-public partnership between Foster Wheeler and the South Florida Water Management District.

Publications

Impacts of I-75 on Everglades Restoration for CEPP. C.A. Hall. Development and application of new hydraulic models for computing the effects of the I-75 roadway on alternative restoration scenarios for the Central Everglades Planning Project, 2013.

Technical Memorandum - Modeling of L-8 Reservoir for Pump and Structure Design. C.A. Hall. Developed a hydrologic and hydraulic simulation model to predict reservoir performance over a wide range of meteorological conditions in order to establish flows and levels for the design of input structures and output pump stations in a suburban watershed, 2011.

Estimation of Resistance to Flow of Alligator Alley for the River of Grass Phase II Planning Process. C.A. Hall. Utilizing various hydraulic models estimated the impact on stages and flows of the existing bridge crossings of Alligator Alley through the Florida Everglades in order to determine the need for enlargement, 2010.

Operations Report of the South Dade Drawdown Operations for October 2009 through April 2010. C.A. Hall. Hydrologic and hydraulic summary of actual water control systems performance during a historically dry period in Miami-Dade County, Florida, 2010.

Hydraulic Evaluation of a Large-scale Flow-way. C.A. Hall. Using existing and newly developed hydraulic models, a flow-way with dimensions of 2 miles wide by 7 miles long was simulated for stage and flow dynamics in order to estimate restoration conditions for the Everglades Restoration Program. Existing land uses are agricultural and proposed land uses are wetland and stormwater treatment marshes, 2009.

Using Continuous Simulation Modeling to Optimize Impoundment Operations

to Achieve Ecological Objectives. C.A. Hall. Developed a continuous simulation model for the design and operations of an urban stormwater reservoir, Site 1, with optional ASR systems. The model used a 35-year period of simulation to model projected reservoir performance, 2006.

Reevaluation of the C-51 Basin Rule. C.A. Hall. Contracted flood management study of a 164-square-mile watershed for South Florida Water Management District (SFWMD). Included the construction of hydrologic and hydraulic simulation models of the watershed, 2002.
De-watering Plan for the S-362 Everglades Pump Station. C.A. Hall. Contract Product for REP Associates, 2000.

Guide for the Management of High Stages of Lake Okeechobee. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1992.

Lake Okeechobee Supply-Side Management Plan. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1991.

Staff Manual for Program/Project Management. C.A. Hall, et al. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1985.

Design of Ex-filtration Trenches. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1981.

Permit Information Manual Volume IV. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1979.

Finally! An Easy Hydrograph Method. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1978.

Technical Memorandum: Water Storage Under Impervious Services. C.A. Hall. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1978.

Basis of Review for Surface Water Management System Design. C.A. Hall and R.A. Rogers. South Florida Water Management District (SFWMD), West Palm Beach, Florida, 1976.

HANSON

Stephen McCaskie, P.E., G.E.

Geotechnical Lead

YEARS OF EXPERIENCE	TOTAL 35 WITH FIRM 6
EDUCATION	B.S. / 1977 / Civil Engineering (Geotechnical/Structural Engineering) / University of Miami M.S. / 1980/ Civil Engineering (Geotechnical Engineering) / Carnegie-Mellon University
REGISTRATIONS	Professional Engineer / CA,CO, FL, IL, KS, LA, MO, ND, TX, Geotechnical Engineer / CA National Council of Engineering Examiners NCEES
AFFILIATIONS	American Society of Civil Engineers / Earthquake Engineering Research Institute / Society of American Military Engineers / American Council of Engineering Companies / United States Society on Dams / Association of State Dam Safety Officials / International Society for Soil Mechanics and Foundation Engineering / Tau Beta Pi (National Engineering Honor Society) / Missouri State Emergency Management Agency– Structural Assessment and Visual Evaluation (SAVE) Coalition

REPRESENTATIVE PROJECT EXPERIENCE

Mr. McCaskie has experience in project management, engineering and QA/QC of flood protection, water resource, transportation, inland navigation, underground, port and harbor projects; planning, conducting and supervising subsurface explorations, condition surveys/evaluations/ assessments, safety inspections, foundation analysis and design, construction monitoring and inspection; operations and maintenance; specialized foundation analyses, earth dam/levee and embankment design, instrumentation, data collection and analyses, soil-structure interaction and earthquake engineering. Mr. McCaskie is an Independent Consultant for Inspection of Dams, under Subpart D Part 12, Title 18 Code of Federal Regulations, Federal Energy Regulatory Commission.

Illinois Department of Natural Resources, Office of Water Resources, William G. Stratton Lock & Dam, Lock & Gate Structure Improvements, Phase 2, McHenry County, IL. Project manager. Engineering services to improve capacity and water control at the existing lock and dam, which consists of a 62-foot long navigation lock, a sluice gate structure, an Obermeyer Gate, and a fixed crest dam. Services include analyses, design, preparation of plans and specifications, construction cost estimate, and O&M Manuals for a lock extension and a new gate structure, along with other site improvements. Services included all aspects of the civil, hydrology and hydraulics, structural, mechanical, electrical, and geotechnical work.

U.S. Army Corps of Engineers, Rock Island District, Lockport Pool Stage IB Approach Dike, Chicago Sanitary and Ship Canal (CSSC), Will County, IL. Project manager. Test Section Evaluation, Instrumentation Plan, and Construction Monitoring; planning, development, design and implementation of test plan and instrumentation program including: observation wells, seepage weirs, reference points, survey monuments, inclinometers, and data loggers to monitor and evaluate seepage cutoff barrier (cement / bentonite) construction for the 4,300 foot long west approach dike on the CSSC.

U.S. Army Corps of Engineers, Rock Island District, Lockport Concrete Canal Wall, Chicago Sanitary and Ship Canal (CSSC), Will County, IL. Project manager. Wall Exploration; planning, development, implementation of wall exploration program including: condition survey, test borings, concrete / rock coring, geologging, petrographic examination, and core testing, to evaluate existing concrete canal wall lock approach on the CSSC.

U.S. Army Corps of Engineers, St. Paul District, Design Documentation Report and preliminary design for Roads Acting As Dams (RAADS), Devils Lake, ND. Project manager. Completing the design documentation report and preliminary design (design and analysis computations) for eight miles of roads adjacent to Devil's Lake, N.D., currently impounding water due to the flooding of Devil's Lake. Complete

(McCaskie, cont.)

design of alignments, alternate raises and features and document the design analysis, design an embankment that minimizes future construction costs, hydraulic design including interior flood control design, riprap sizing, and design water surface elevations and develop standards for utility and infra-structure features crossing the embankments.

U.S. Army Corps of Engineers St. Paul District Devils Lake City Embankments Phase 1, Raise to 1466.2, Creel Bay Reach, Devils Lake, ND. Project Manager. Completing the design documentation report (design and analysis computations), plans, specifications, cost estimate and schedule for 1.5 miles of dam and Creel Bay Pump Station replacement protecting the City of Devils Lake from the flooding of Devil's Lake. Complete design of alignments and features and document the design analysis, design an embankment raise, hydraulic design including interior flood control design, riprap sizing, and design water surface elevations and develop standards for utility and infra-structure features crossing the embankments. Hanson also provided engineering services during construction (EDC) for this project.

U.S. Army Corps of Engineers, St. Paul District, Devils Lake City Embankments, Phase 2A and 2B and East Ditch Pump Station, Raise to 1467.2, Devils Lake, ND. Lead geotechnical engineer. The project included the completion of design, plans, specifications, and other supporting documents for the Devils Lake City Embankments Phase 2 (Project). The services to be performed under this contract consist of designing a six foot raise to the existing embankment to an elevation of 1467.2, designing a new East Ditch pump station compatible with the embankment raise, documenting the design analysis in the Design Documentation Report (DDR), preparing construction plans and specifications, preparing the construction cost estimate, and responding to questions and preparing amendments during the solicitation period. Hanson also provided engineering services during construction (EDC) for this project.

MCD Busch Wildlife Lake No. 35 Dam and Spillway Improvements, St. Charles County, MO. Project principal for design and project manager during construction. The Missouri Department of Conservation's (MDC's) Lake No. 35 Dam in the Busch Wildlife Area required a dam raise and spillway upgrade to meet Hazard Class I standards due to increasing downstream development. Services provided included: site reconnaissance; geotechnical exploration; watershed analyses and hydrologic and hydraulic modeling to develop design alternatives to meet the Class I requirements; analysis and design of dam raise and improvements; hydraulic analyses of the modified spillway and cost estimates, spillway and erosion protection analyses and design, borrow evaluations; rock blasting and excavation analyses; preparation of construction drawings and specifications; MDNR permit applications for land disturbance and dam operation of the upgraded structure, and construction monitoring.

U.S. Army Corps of Engineers, St. Louis District, Monarch-Chesterfield Levee, Centaur Road Railroad Closure Structure, Walnut Grove Railroad Closure Structure and Floodwall Design, Chesterfield/Wildwood, MO. Geotechnical engineer. Provided engineering services for the design and construction of two closure structures and a floodwall. Participating in the analyses and design, preparation of plans and specifications, and construction cost estimate for the pile-supported reinforced-concrete closure structures and T-wall, appurtenances and all civil site improvements to protect Chesterfield Valley and the Walnut Grove commercial development from a 500-year flood on the Missouri River and Bonhomme Creek.

U.S. Army Corps of Engineers, Louisville District, Olmstead Dam, Olmsted, IL. Geotechnical engineer. Provided geotechnical evaluations, seismic analyses including soil-structure interaction, foundation analyses, ground stability/liquefaction analyses, foundation analyses and designs, under seepage control, and instrumentation for the Feature Design Memorandum and construction plans and specifications for the planned 2,400-foot-long Olmsted Dam on the Ohio River near Olmsted, IL.

U.S. Army Corps of Engineers, St. Paul District, Lock and Dam #4, Alma, WI. Geotechnical engineer for geotechnical evaluations, foundations analysis and designs, and construction consultation for rehabilitation of lock chamber monoliths, guidewalls, and support buildings, for the 50-year-old Lock and Dam #4 on the Mississippi River at Alma, WI.