US Army Corps of Engineers®

Buffalo District

Great Lakes and Ohio River Division

Project Title: Lorain Harbor Outer Breakwater Repair

Authority: O&M Program

P2/Project Number: 461157

Review Plan

PREPARED BY:

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Engineering Technical Lead
USACE, Buffalo District

RECOMMENDED BY

[redacted]

LTC, EN
Commanding
USACE, Buffalo District

ENDORSED BY:

[redacted]

Senior Regional Engineer
Review Management Organization Representative
USACE, Great Lakes and Ohio River Division

APPROVED BY:

[redacted]

Regional Business Director
USACE, Great Lakes and Ohio River Division

MSC APPROVAL DATE:

[redacted]

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REVIEW PLAN

ENGINEERING AND DESIGN PRODUCTS
LORAIN HARBOR OUTER BREAKWATER REPAIR
BUFFALO DISTRICT

Current Version Date: [redacted]
Mandatory Revision Date: [redacted]

1. PURPOSE AND REFERENCES

a. Purpose. This review plan describes necessary quality reviews for engineering and design (E&D) products for the Lorain Harbor Outer Breakwater Repair Project.

b. References.

(1) Engineering Regulation (ER) 415-1-11, Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Reviews
(2) Engineering Regulation (ER) 1165-2-217, Civil Works Review Policy
(3) Qualtrax 08504 LRD, Supplemental Quality Procedures for Civil Works (CW) Engineering and Design (E&D) Products
(4) Project Management Plan (PMP)

2. REVIEW MANAGEMENT ORGANIZATION (RMO). The RMO for this project is the MSC (Great Lakes and Ohio River Division).

3. PROJECT SCOPE AND PRODUCTS

a. Project Description and Scope of Work: Lorain Harbor in Lorain, OH contains various manmade structures designed by USACE which were installed in the harbor to aid in its safe navigation. Among these structures is an outer breakwater approximately 2,180 feet in length comprised of steel sheet pile (SSP) cylindrical cells approximately 46.25 feet in diameter, connected by steel sheet pile metal closure arcs. The breakwater was originally constructed in 1964-65. In 2016, on-site investigation revealed that the SSP of the cylindrical cells is exhibiting material degradation, to include vertical cracking extending above and below the mean water level, approximately 4 feet outboard from the wye-connection of the closure arc, at eight locations along the overall breakwater structure. Furthermore, during this 2016 site investigation, one of the cylindrical cells approximately at the middle of the overall breakwater structure was found to have failed, resulting in significant loss of fill from the cell.

In 2016, the failed cell and its connecting arcs to the adjacent cells were removed. To address the cracking sheet piles, ½" thick metal strips were bolted on the exterior face of the cylindrical cells, perpendicularly across the cracking, from the top of the breakwater cell down to approximately 17 feet below the low water datum (LWD) on the affected sheet piles. In 2017, an on-land demonstration of grouting the cell fill was conducted, but it yielded unsuccessful results. The team pivoted to filling the void under each existing cell concrete cap with controlled low strength mortar (CLSM) fill, placed through the access holes in the caps. During this repair, each of the existing SSPs was bolted to the concrete caps. Additional metal strip repairs were also installed. In 2019, a rectangular cell was designed and constructed within the gap left in the breakwater from the 2016 cell failure and removal.

The aforementioned visual inspection of the overall Lorain Harbor outer breakwater, as well as additional viewing during subsequent repair efforts, identified degradation of the SSP material at the LWD of the cylindrical cells and closure arcs. This degradation included surface pitting resulting and section loss, as well as evidence of additional vertical cracking.

Alternative formulation was performed to address the observed damage, resulting in the selection of installation of new SSP diaphragm cells outboard of existing cells as the proposed solution. This design will be developed for the entire breakwater with additional details included to allow for incremental rehabilitation of the breakwater.

In summary, the project will involve the demolition and removal of the SSP closure arcs between the in-place cylindrical cells, followed by the installation of new SSP cells/arc having a cord length of approximately 49.5 feet, outboard of the existing SSP cylindrical cells. These cell arcs are to have their ends connected in series for the length of the breakwater, stabilized by a linear SSP diaphragm tension members spanning the width of the breakwater transversely, between the connected ends of the new diaphragm cell arcs. New fill will be placed between the ETR cylindrical cells and the new cell arcs and the linear diaphragm tension member. All locations receiving new fill will then be covered with cast-in-place concrete caps. Due to the scope and magnitude of work required, this work will be split into multiple construction phases/projects. Lessons learned from early phase will be incorporated into follow on phases as appropriate.

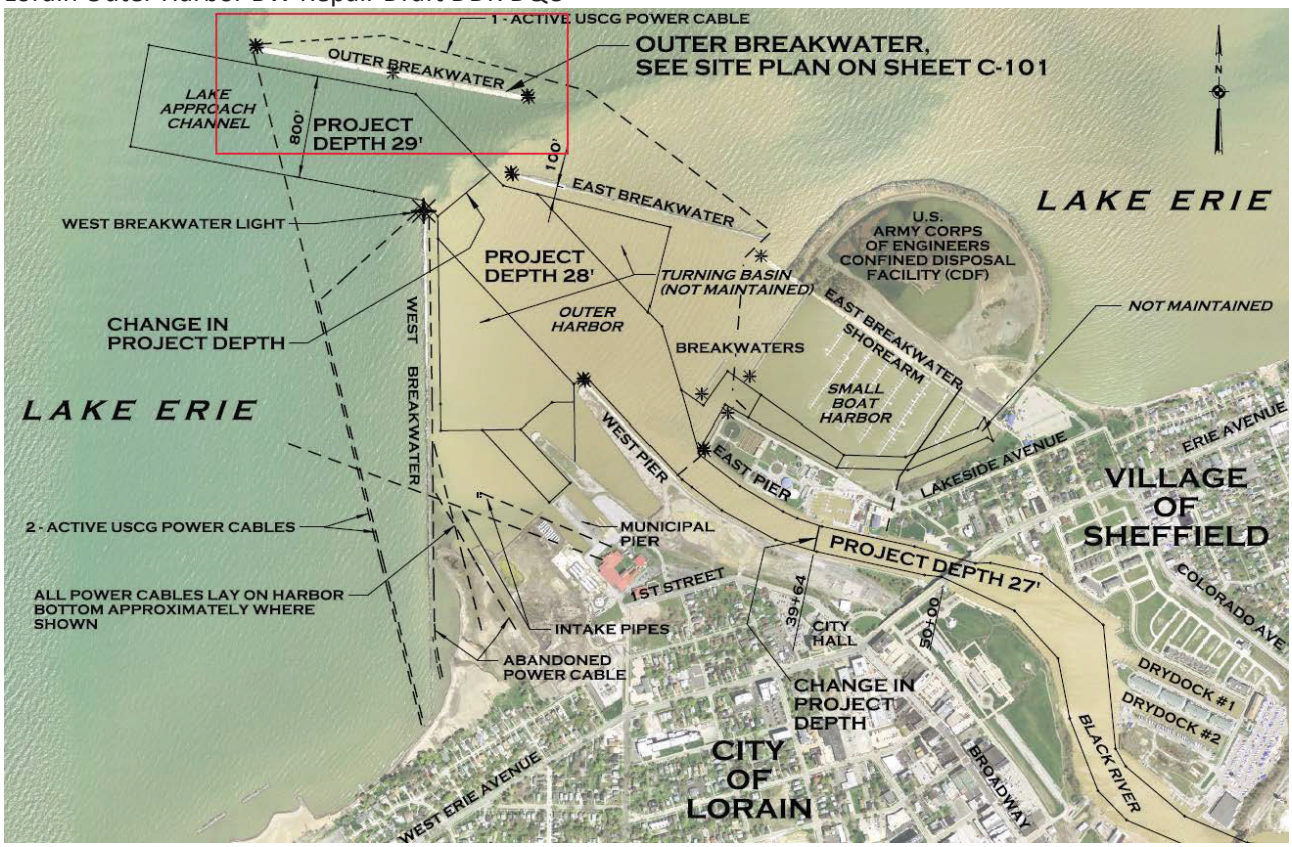

Figure 1. Lorain Harbor Outer Breakwater Site Location (outlined in red)

Project Number	461157
Business Line	O&M
Project Type	Breakwater Repair
Geographic Location	Lorain Harbor; Lorain, OH
Main Project Features	Breakwater, Steel Sheet Pile (SSP) diaphragm cells
Estimated Construction Cost	$[redacted] (initial expressed capability for $[redacted] in FY24 workplan)[1]
E&D Product Delivery Method	In-House Design
Construction Delivery Method	Fixed Price

[1]Expressed capability of $[redacted] FY24 Workplan includes E&D completion and phased approach to construction.

b. Products. The E&D products to be reviewed include the following:

(1) Design Documentation Report (DDR)
(2) Plans and Specifications (P&S)
(3) Engineering Considerations and Instructions for Field Personnel (ECIFP)
(4) E&D Products for Engineering During Construction (EDC)

4. DOCUMENTATION OF RISKS AND ISSUES

a. Life Safety Assessment: The District Chief of Engineering has reviewed the project requirements and determined there is not a significant threat to human life if the project were to fail.

b. Technical Complexities and Risks: The project delivery team (PDT) performed a thorough risk analysis of the anticipated project design, construction, and operations activities and identified the critical technical complexities and risks listed below. Quality reviews will be planned and performed with the goal to best manage these project technical complexities and risks.

(1) Overall Viability of Repair and Structure: Additional breakwater degradation can result in additional failure prior to completion of the project. This risk will be mitigated with detailed design of the new rehabilitation structure and through continued inspection of the existing structure.

(2) Deep-Water Work: Construction work in these conditions is more exposed and more drastically impacted by changes in weather and water conditions. Additionally, the materials required are heavier and/or larger than for nearshore. This risk will be transferred to the construction contractor with appropriate detail provided in the plans and specifications.

(3) Unknown Site Conditions: Differing site conditions than those expected or unknown design deficiencies can result in re-work or require additional time and money to acceptably complete the project.

(4) Incremental/phased Nature of Repair: Schedule/funding delays between incremental construction phases have the potential to allow for changes in site conditions after completion of design. These delays are being accounted for and mitigated in the design. The new construction is being planned in such a way that even significant changes in site conditions between completion of design and initiation of construction would be extremely unlikely to require any design rework.

5. REVIEW EXECUTION

a. Project Delivery Team (PDT): PDT members are listed in Attachment 1. PDT members will work collaboratively with review team members to ensure effective performance of the planned quality reviews.

b. District Quality Control (DQC): DQC is required for all products. Follow DQC procedures in Chapter 4 of ER 1165-2-217 and District local work instructions. The Engineering Technical Lead and DQC Lead will collaborate to oversee and ensure effective DQC performance.

c. Biddability, Constructability, Operability, Environmental, Sustainability (BCOES): BCOES reviews are required for all products. Follow BCOES review procedures in ER 415-1-11 and District local work instructions. The Engineering Technical Lead and DQC Lead will collaborate to oversee and ensure effective BCOES execution.

d. Agency Technical Review (ATR): ATR is required for all products and shall follow ATR procedures in Chapter 5 of ER 1165-2-217. ATR will address the technical complexities and risks described in sub-section 4.b. Required senior technical disciplines and expertise needed for ATR are described in Table 1. Assigned ATR team members are listed in Attachment 1. PDT and review team leaders will collaborate to oversee and ensure effective execution.

Table 1. ATR Technical Discipline(s) and Required Expertise

Technical Discipline	Expertise Required
ATR Team Leader	Middle to senior level professional experienced with leading ATR teams, preferably with Pier/Breakwater Design/Repair projects. May also serve as a discipline reviewer. CERCAP Level 1 or 2 certified.
Geotechnical Engineer	Middle to senior level professional experienced with Pier/Breakwater Design/Repair projects. CERCAP Level 1 or 2 certified.
Structural Engineer	Middle to senior level professional experienced with Pier/Breakwater Design/Repair projects. CERCAP Level 1 or 2 certified.

e. Safety Assurance Review (SAR): The District Chief of Engineering has determined that a Safety Assurance Review (SAR) is not required. The SAR determination is documented in a separate memorandum stored in the project files.

f. Review Charge. Reviewers will refer to and perform ATR per Section 5.7 of ER 1165-2-217, Objectives, Scope, and Review Criteria. Reviewers shall check to confirm the project engineering and design addresses the technical complexities and risks described in Section 4.b.

6. REVIEW SCHEDULE AND BUDGETS. The schedule and budgets for reviews are shown in Table 2. Considering the nature of this project, BCOES and ATR reviews will be performed concurrently, following DQC reviews.

Table 2. Review Schedule and Budgets			
Review Activities	Start Date	Finish Date	Budget ($)
Design (30%) Documentation Report – DQC	[redacted]	[redacted]	[redacted]
Design (30%) Documentation Report – BCOES and ATR	[redacted]	[redacted]	[redacted]
Draft Design P&S – 60% Design	[redacted]	[redacted]	[redacted]
Final (95%) Design (P&S) – DQC	[redacted]	[redacted]	[redacted]
Final (95%) Design (P&S) – BCOES and ATR	[redacted]	[redacted]	[redacted]
100% Design – BCOES and ATR Backcheck	[redacted]	[redacted]	[redacted]
Handoff to Contracting	[redacted]	[redacted]	[redacted]

*Schedule dates shown are contingent upon receipt of funds for completion of E&D and const.

7. REVIEW DOCUMENTATION. The ATR leader will prepare an ATR report per Section 5.10 of ER 1165- 2-217. The ATR report with certification form will be provided to the approval signatories, including the RMO representative. Review documents will be stored with the official project records.

8. REVIEW PLAN POINTS OF CONTACT. Questions and comments relating to this review plan can be directed to the following points of contact:

a. District Project Leaders

(1) Project Manager: [redacted], CELRB-PMP-M, [redacted]

(2) Engineering Technical Lead: [redacted], CELRB-TDD-A, [redacted]

b. Review Management Organization (RMO) Representative: CELRD-ECD, [redacted] or [redacted]

9. APPROVED AND RECOMMENED BY:

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District Chief of Engineering
USACE, Buffalo District

ATTACHMENT 1 – TEAM MEMBERS

PROJECT DELIVERY TEAM		
Function/Discipline	**Name (Last, First)**	**Office**
Project Manager	[redacted]	CELRB-PMP-M
Biologist, Environmental Analysis	[redacted]	CELRB-PML-E
Engineering Technical Lead	[redacted]	CELRB-TDD-A
Structural Engineer	[redacted]	CELRB-TDD-S
Geotechnical Engineer	[redacted]	CELRB-TDD-C
Cost Engineer	[redacted]	CELRB-TDD-T
District Value Engineer	[redacted]	CELRB-TDD-E
Geospatial Lead	[redacted]	CELRB-TDE-S
Realty Specialist	[redacted]	CELRE-REP
Coastal Engineer	[redacted]	CELRB-TDD-C
Coastal Engineer	[redacted]	CELRB-TDD-C
Specifications Writer	[redacted]	CELRB-TDD-S
DQC REVIEWERS		
Function/Discipline	**Name (Last, First)**	**Office**
DQC Lead -Chief Design	[redacted]	CELRB-TDD
Civil Structural Design	[redacted]	CELRB-TDD-S
Cost Engineering	[redacted]	CELRB-TDD-E
Coastal / Geotech	[redacted]	CELRB-TDD-C
A-E & Project Engineering	[redacted]	CELRB-TDD-A
Environmental	[redacted]	CERLB-PML-E
BCOES REVIEWERS		
Function/Discipline	**Name (Last, First)**	**Office**
Counsel	[redacted]	CELRB-OC
Contracting	[redacted]	CECT-LRB
Environmental	[redacted]	CERLB-PML-E
Civil/Structural	[redacted]	CELRB-TDD-S
Coastal/Geotechnical	[redacted]	CELRB-TDD-C
A-E & Project Engineering	[redacted]	CELRB-TDD-A
Real Estate	[redacted]	CELRE-REP
Operations	[redacted]	CELRB-TDO-O
Safety	[redacted]	CELRB-SO
Ohio Operations Office	[redacted]	CELRB-TDO-O
Construction	[redacted]	CELRB-TDO-O
Ohio Area Office	[redacted]	CELRB-TDO-C
Ohio Area Office / COR	[redacted]	CELRB-TDO-C
Design Branch	[redacted]	CELRB-TDD-D
ATR Reviewers		
Function/Discipline	**Name (Last, First)**	**Office**
ATR Team Leader	TBD	
Geotechnical Engineer	TBD	
Structural Engineer	TBD	