OVERVIEW OF ER 1110-1-1807
“DRILLING IN EARTH EMBANKMENT DAMS AND LEVEES”

Requirements and Processes for Drilling in or Below a Levee

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ER 1110-1-1807

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Regulation
No. 1110-1-1807

Engineering and Design
DRILLING IN EARTH EMBANKMENT DAMS AND LEVEES

31 December 2014
PURPOSE OF ER 1110-1-1807

1. This regulation establishes policy, requirements and guidance for drilling in or below levee embankments and foundations.

2. The primary purpose of this regulation is to prevent unnecessary damage to levees and dams.

THERE ARE NO EXCEPTIONS TO ER 1110-1-1807!
BLUF: An approved Drilling Program Plan (DPP) is required prior to any drilling, sampling, grouting, CPT’s, or other “destructive” methods which pose a risk for damage or failure.

- This includes drilling activities related to investigation, construction, and remediation.

- The data needs must be weighed against the potential risks for damage created by the drilling/installation process.

THIS INCLUDES DRILLING THROUGH OR BELOW THE LEVEE.
WHEN DOES ER 1110-1-1807 APPLY?

• Any drilling or investigation into or near a structure with Federal Interest including Dams, Locks, and Levees (Includes PL84-99).

• If the Investigation is being instituted by an outside group it requires a 408 alteration.

• This includes requirements for drilling below the levee HDD (horizontal directional drilling).
WHAT DOES A DPP ACCOMPLISH?

1. Guarantees the investigation is justified, well planned, and well executed.

2. Standardizes practices and procedures to provide consistency across the United States.

3. Ensures that all existing subsurface information is thoroughly evaluated and understood.

4. Provides guidance and best practices to minimize risks to the project.
WHAT DOES A DPP ACCOMPLISH?

5. Minimize the amount of drilling through embankments and foundations.

6. Ensure methodologies, controls, and personnel will not cause damage to the levee.

RISKS INCLUDE:

- Down-hole Erosion From Fluids – Cavities/Voids
- Foundation Heave – Soft, loose zones
- Hydraulic Fracturing – Rupturing the bond of the soil
- Failure
What damage has occurred?

1. Heave, borehole collapse, and significant disturbance while drilling in granular materials below the groundwater level.
   - Creates defects within the levee embankment.

2. Fluid loss with hydraulic fracturing of the embankment while using air, water, drilling mud, grouts, etc.
   - Creation of preferential seepage pathways.
     - Connections to other borings and blowouts on embankment slopes.
   - Includes filling boreholes with water and grout.
DOWN-HOLE EROSION/DAMAGE

- Borings
- Levee Embankment
- Cohesive Clay Soils
- Levee Foundation
- Silts, Clays, Sands, Gravels
- Caving Hole
- Heaving Sand
- Heaving Sand/Caving Hole
- Over-Augering
- Caving Hole
- Levee Embankment
- Levee Foundation
- Casing
- Loose Zone/Low Stress Zone
- Void/Loose Zone
HOW DO YOU VERIFY DAMAGE???
POOR DRILLING TECHNIQUES CREATE SEEPAGE ISSUES SIMILAR TO PENETRATIONS
TELEPHONE POLE EXAMPLE
HYDRAULIC FRACTURING PROCESS

- Levee
- Boring
- Hydrofracture Ruptures Ground
- Hydrofracture Heaves Ground
- Foundation
HYDRAULIC FRACTURING PROCESS

Increased Gradient and Shorter Seepage Pathway
FIELD VERIFIED
HYDRAULIC FRACTURES

Photo of hydro-fracture courtesy of Jeff Schaefer – “2012 USACE Geotechnical CoP Meeting”
HYDRAULIC FRACTURE BREAKOUT

Photo of hydro-fracture courtesy of Jeff Schaefer – “2012 USACE Geotechnical CoP Meeting”
RESTRICTION ON DRILLING FLUIDS

• Minimize the need for any pressurized drilling fluid (air, gas, water, mud, polymers, slurries, etc.) to reduce risks.

• If ANY fluid is required the DPP shall contain a plan to minimize risk for damage and include a hydrofracture analysis.

• Pressurized air, water, or foam is not permitted.
DPP CONTENTS

ADDITIONAL INFORMATION CONTAINED IN APPENDIX B OF ER 1807
WHAT TO INCLUDE IN A DPP?

- Objective and Justification
- Exploration Team
- Existing Information Review
- Essential Geologic/Engineering Drawings
- Drilling Scope and Methods
- Risk Evaluation
- DSO/LSO Certification

No need to throw everything but the kitchen sink in there.
HOW MUCH DETAIL IS REQUIRED?
OBJECTIVE AND JUSTIFICATION

Clearly define the purpose of the drilling and how the information will be used.

• Non-destructive alternatives considered.

• Drilling outside of levee footprint considered.

Include District concurrence that the need is justified.
1. OBJECTIVE AND JUSTIFICATION

The Vincennes Levee is located along the left bank of the Wabash River approximately 128 miles above confluence of the Wabash and Ohio Rivers. The sections of the levee included in our scope consist of an earthen embankment, concrete flood walls, and an I-wall. In addition, toe drains, relief wells, and relief trenches were originally constructed to alleviate seepage pressures during a flood event. The Levee System Evaluation (LSE) performed by USACE determined that some drainage elements were necessary for safe operation of the levee system, but the analyses were performed with limited subsurface information and are not considered to be conclusive. Following the LSE, video inspection of the toe drains and relief wells showed a section of clogged toe drains and significant siltation in the relief wells. Due to the cost of maintenance and/or replacement of the drainage elements, the city would like to further evaluate the necessity of the drainage elements, and if acceptable, properly abandon the elements.

The objective of our work is to evaluate if the existing drainage elements along Vincennes Levee Unit (Section A, Part 2 and Section B, Part 1) are required for levee safety (i.e., O&M). Our geotechnical evaluation will include performing eight sets of "arrays" of exploratory test borings oriented perpendicular to the alignment of the levee. Each array will include three borings. On completion of our exploratory and laboratory testing program on soils, a subsurface profile will be developed for each array for purposes of preparing seepage and stability models. Our analyses will be completed with a water level assumed at the top of the levee and a phreatic surface based on steady-state conditions. If we are able to conclude that the drainage elements are not necessary for levee performance, we understand that our work will be finished. However, if drainage elements are determined to be necessary, we will model the Corps preferred toe drain alternative and provide information for other's use in completing their plan preparation.

If the above work is not completed, evaluation of the drainage elements will remain inconclusive. In the event of a flood (e.g., a Q99 event), unacceptable exit gradients may occur causing instability to the levee system. Therefore, in order to further evaluate levee safety, this geotechnical evaluation is necessary.

Key Points:

- Why is there a need – Reduce Risks or 408 Alteration?
- What action is being requested?
- What are the impacts if this is not done?
EXPLORATION TEAM

• Drillers shall have a minimum of 5 years experience drilling with the equipment and procedures described in the DPP on USACE dams and levees.

• All drilling activities on USACE levees shall be conducted in the presence of a registered professional geotech/geologist who shall be responsible for maintaining the integrity of the structure.

• Include resumes of Key Personnel – Plan Developers, Field Personnel, Drillers
INFORMATION REVIEW

• Research existing available information for inclusion.
  - Does the sponsor have applicable data?
  - Are there nearby developments which have applicable data?

• Locations of prior subsurface explorations and data for the levee.
  - Soils information used for original construction?
  - Recent modifications?

• Current As-Built Drawings showing the embankment and foundation zones and any nearby structures.
ESSENTIAL GEOLOGIC AND ENGINEERING DRAWINGS

Drawings should also include the following information:

• Details of subsurface material classification and contacts, including top of rock – Geologic Drawings.
• Test Results Defining Engineering Properties.
• Boring/Installation Plan/Profile.
• Instrumentation.
• Geophysical data.
• Seepage areas.
DRILLING SCOPE AND METHODOLOGY

- Number and location of proposed borings in plan and profile view.
- Proposed drilling equipment.
- Drilling sampling and testing methods.
- Required sample type, location, and reason for sampling.
- Materials to be drilled, sampled and tested.
- Utilities, surface, and underground obstacles, accessibility.
- Borehole completion requirements.
EVALUATION OF DRILLING RISK

Evaluation for the risk of hydro-fracturing

- Detail description of any drilling fluid and why.
- Details on the circulation system.
- Locations where fluid will contact soil.
- Circulation pressure, fluid backfill pressures, charge water to prevent heave.
EVALUATION OF DRILLING RISK

What measures are being taken to minimize these risks?

FOLLOW THE PLAN!!!

• Limit any fluid pressures below hydrofacture pressures.

• Have a licensed Geotechnical Engineer or Geologist with the drillers.

• Monitor loss of fluids, sudden rod drops etc.
Backfilling with drill cuttings is not permitted.

All boreholes shall be sealed per the following requirements:

- Impervious zones – Backfilled by tremie placed cement-bentonite grout (90:10) or bentonite pellets.
- Pervious zones – Backfilled with tremie placed filter compatible materials.
- Rock core holes shall be gravity grouted (hydrofracture analysis required).
REVIEW PROCESS

Drilling Plan submitted to LRL through 408 process.

1. The Louisville District and LSO will provide a cursory review to see if the plan is complete and adequately justified.
   - LRL may require additional information or comment resolution from the submitter.
   - LSO approval **REQUIRED**.

2. The plan is forwarded to the USACE Drilling Review Plan Coordinator at the Risk Management Center (RMC).
   - The RMC will provide comments for resolution.
   - Revised proposal submitted back to LRL from sponsor or 3rd party for routing.

3. Assume 30-90 days to gain approval from LRL and the RMC.
ANY QUESTIONS???