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CECW-EC

Engineering and Design
Drilling and Invasive Activities at Dams and Levees

FOR THE COMMANDER:

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Purpose. This engineer regulation (ER) establishes policy and requirements and provides guidance for drilling and other invasive activities in/on/under all USACE dams or levees, or if owned and operated by non-federal sponsors, within the real property identified and acquired for USACE dams and levees, and near enough to potentially cause damage. The primary purpose of this ER is to prevent damage to dams, levees, and their foundations from hydraulic fracturing, erosion, filter/drain contamination, heave, etc. during invasive activities such as drilling and excavation.

Applicability. This ER applies to all Major Subordinate Commands (MSCs), district commands, laboratories, and field operating activities having Civil Works and/or Military Program responsibilities. It also applies to third-party interests performing drilling or other invasive activities for all dams, levees, and their appurtenant structures with a federal interest, including non-federally owned and operated dams and levees. Drilling or other invasive activities performed by a third-party may require authorization under Section 408 (33 U.S.C. 408).

Distribution Statement. Approved for public release; distribution is unlimited.

Proponent and Exception Authority. The proponent of this regulation is the CECW-EC. The proponent has the authority to approve exceptions or waivers to this regulation that are consistent with controlling law and regulations. Only the proponent of a publication or form may modify it by officially revising or rescinding it.

*This regulation supersedes ER 1110-1-1807, dated 31 December 2014.

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Summary of Change

1. Purpose.

This engineer regulation (ER) establishes policy and requirements and provides guidance for drilling and other invasive activities in/on/under all U.S. Army Corps of Engineers (USACE) dams or levees, or if owned and operated by non-federal sponsors, within the real property identified and acquired for USACE dams and levees, and near enough to potentially cause damage. The primary purpose of this ER is to prevent damage to dams, levees, and their foundations from hydraulic fracturing, erosion, filter/drain contamination, heave, etc. during invasive activities such as drilling and excavation.

2. Applicability.

This ER applies to all Major Subordinate Commands (MSCs), district commands, laboratories, and field operating activities having Civil Works and/or Military Program responsibilities. It also applies to third-party interests performing drilling or other invasive activities for all dams, levees, and their appurtenant structures with a federal interest, including non-federally owned and operated dams and levees. Drilling or other invasive activities performed by a third-party may require authorization under Section 408 (33 U.S.C. 408).

3. Distribution Statement.

This ER is approved for public release; distribution is unlimited.

4. Records Management (Recordkeeping) Requirements.

The records management requirement for all record numbers, associated forms, and reports required by this regulation are addressed in the Army Records Retention Schedule—Army (RRS–A). Detailed information for all related record numbers is located in the Army Records Information Management System (ARIMS)/RRS–A at <https://www.arims.army.mil>. If any record numbers, forms, and reports are not current, addressed, and/or published correctly in ARIMS/RRS–A, see Department of the Army Pamphlet 25-403, Guide to Recordkeeping in the Army, for guidance.

5. Background.

Drilling and other invasive activities on or near dams and levees, their foundations, and appurtenant structures pose risk to the facilities. For example, water, compressed air, and various fluids can be used as circulating media while drilling. However, there is a delicate balance between too much induced fluid pressure (that can cause hydraulic fracture) and not enough fluid pressure (that can result in borehole instability, heave, or significant sample disturbance). Hydraulic fracture can create seepage pathways and defects that may be exploited by, or change, the subsurface flow conditions. This can lead to poor performance or even a potential failure mechanism during hydraulic loading.

a. Invasive activities include, but are not limited to:

- (1) Drilling (including sampling, instrumentation installation, etc.)
- (2) In situ testing (Cone Penetrometer Testing [CPT], hydraulic conductivity, permeameter, pressure meter, etc.)
- (3) Backfilling (casing, grouting, etc.)

- (4) Excavation (test pit, trenching, etc.)
 - (5) Piezometer or well rehabilitation or redevelopment
 - (6) Anchoring or stabilization construction
 - (7) Installing seepage control features or cutoff structures (foundation grouting, cutoff walls, etc.)
 - (8) Horizontal directional drilling (HDD) activities
- b. Potential detrimental effects of these activities may include but are not limited to:

- (1) Filter/drain contamination, clogging, or plugging.
- (2) Washout of materials that creates or widens fractures or cavities.
- (3) Heave or increased uplift pressures.
- (4) Creating preferential seepage paths.
- (5) Hydraulic fracture or cracking a foundation grout curtain
- (6) Damaging a utility, conduit, or other internal structure.

c. All drilling and other invasive activities need to be evaluated for the potential to cause adverse impacts. The risk varies based on the selected methods and the site conditions. Every invasive scope of work must not create more adverse conditions than previously existed and must have benefits of successful completion that outweigh the risk of potentially negative impacts.

6. Drilling and Invasive Program Plan

a. An approved Drilling and Invasive Program Plan (DIPP) is required prior to any drilling or invasive activities located in/on/under all USACE dams or levees, or if owned and operated by non-federal sponsors, within the real property identified and acquired for USACE dams and levees, and near enough to potentially cause damage. It is the responsibility of the District Dam Safety Officer (DSO) for dams, or the District Levee Safety Officer (LSO) for levees, to assure compliance with the restrictions and procedures outlined in this ER.

b. DIPPs must be prepared and signed by a licensed Professional Engineer or Geologist experienced in the type of activities proposed. Programmatic DIPPs to address large drilling programs may be considered on a case-by-case basis. All drilling and invasive activities that are subject to this ER must be conducted in the presence of a licensed professional engineer or geologist who has at least five years of experience performing the work that is proposed. That individual is responsible for maintaining the integrity of the structure, monitoring, and documenting the conditions and observations during the field activities.

c. DIPPs must include the following items. In cases where specific details may be unknown at the time of the DIPP (contractor personnel, specific methodology, etc.), contingent approval can be provided, pending submission and approval of final details after contract award. Additional details are included in Appendix B.

(1) The proposed drilling or invasive activities, including justification for those activities and targeted objectives.

(2) Plan, profile, and cross-sections showing all pertinent project features and proposed invasive locations.

(3) Existing data, if any, including drawings depicting the current understanding of subsurface conditions as they relate to the proposed work.

(4) Proposed equipment, methods, and processes, including proposed completion methodology.

(5) Project personnel, including qualifications/experience.

(6) Anticipated and potential adverse issues or risks posed to the dam, levee, or foundation integrity due to the planned program

(7) Mitigation alternatives or measures to monitor for and reduce those identified risks, including hydraulic fracture calculations.

(8) Emergency response plan if adverse impacts occur including repair alternatives, materials to be available on-site, or actions that will be implemented if issues arise.

d. Justification. When planning an investigation or remediation program, the data needs must be weighed against the potential risks of damage created by the drilling or invasive methods. DIPPs must include justification for taking on these risks.

(1) For USACE dams, the justification for drilling must include an approved recommendation from a risk assessment performed in support of the Dam Safety risk management process described in ER 1110-2-1156, Safety of Dams – Policy and Procedures or be part of normal and required Operations and Maintenance (O&M) activities.

(2) For USACE structures that have not had a Potential Failure Mode Analysis (PFMA), a thorough evaluation similar to the PFMA process must be performed and presented in the DIPP to show that the drilling is justified to target a specific failure mode or is part of normal and required O&M activities.

(3) For projects owned and operated by non-federal sponsors, all drilling should be justified and targeted for a valid engineering purpose or be part of normal and required O&M activities.

e. Existing Data Review. It is critical that all existing subsurface information is thoroughly evaluated and understood by the exploration/design team prior to developing a plan for additional investigations. To understand and communicate subsurface conditions and understand risks, available existing subsurface information must be assimilated into essential plan and section drawings showing the proposed activities, borehole projections, target sample areas, and/or proposed instrumentation with respect to the subsurface conditions anticipated and all project features. This is in part to ensure that proposed activities do not adversely affect cutoff walls, instrumentation, sheet pile walls, or other critical features.

f. Use of Drilling Fluids.

(1) All drilling programs in dams and levees should be developed to minimize the need for and impact of circulated drilling fluid (including water, fluid mixtures, or air). If the drilling objective can be performed using dry methods, such as auger or sonic drilling, these methods should be employed in lieu of methods that require fluids. Although auger or sonic drilling may require the addition of clean water to offset hydrostatic pressure, they are still considered dry drilling provided surge pressures are controlled

(2) Alternately, a combination of wet and dry drilling methods may be implemented to reduce the impact of circulated drilling fluid. For example, dry methods could be used

through the embankment and a casing could be seated into the foundation before using drilling fluid.

(3) However, not all projects, conditions, or objectives can be successfully achieved using only dry drilling methods. Therefore wet, or circulation, drilling methods may be required and even preferred (e.g., mud rotary or rotary wash, casing advance systems, air percussion, or Becker Hammer).

g. Risk Identification and Mitigation.

(1) All DIPP's must contain an analysis of the potential to cause damage to the structure, features of the structure, or foundation. DIPP's should include hydraulic fracture calculations at one-foot intervals along the bore path for both drilling fluids (if used) and borehole backfill. Factors of safety (FS) should be calculated using at least two commonly used methods (e.g., Fell et al., 2018; Jaworski et al., 1981; Marchi, et al., 2014 and/or Chang and Huang, 2016). For HDD or other trenchless pipe installation methods, the Delft Equation, as used by the HDD industry to limit inadvertent returns, is not appropriate as explained in EM 1110-2-2902. The DIPP must identify areas of potential hydraulic fracture and describe measures that will be used in the field to minimize risk.

(2) A minimum FS of 1.3 is required for drilling and backfilling applications, with consideration of a higher FS based on the risk of the specific structure. A minimum FS of 1.5 is required for HDD applications, as indicated in EM 1110-2-2902, Conduits, Pipes, and Culverts Associated with Dams and Levee Systems.

h. Borehole Completion. All boreholes and other penetrations in and around dams and levees must be sealed after completion. Completing a borehole by backfilling with drill cuttings is not acceptable. All boreholes and similar penetrations in the impervious portions of a dam or levee and its foundations must be backfilled by tremie-placed cement-bentonite grout or with bentonite pellets/chips. In some cases, the backfill may need to be staged, allowing lower initial stages to set up prior to placing higher stages of backfill, based on the potential for hydraulic fracture. Grout must obtain strength equal to or greater than the soil. Backfill procedures must comply with local and state regulations.

(1) The DIPP must address the possibility of confined and separate groundwater aquifers and address methods for safe completion that reduce the risk of cross-contamination and leakage. Note that some instrumentation installations may require additional considerations for the grout strength, permeability, etc.

(2) For borings that penetrate zones with low confining stress, it is possible to induce hydraulic fracturing from gravity backfill at lower pressures than assumed or calculated. Low confining zones can occur along the foundation abutments where they are steep or have irregularly stepped interfaces, where soil bridging can occur (e.g., very narrow cores surrounded by rockfill), near or adjacent to settlement areas or conduits, or along soil-concrete interfaces. Extra care should be used in these areas of low confining stress.

(3) For pervious portions of the dam or levee, the borehole must be backfilled by tremie placement of granular materials that are sized to provide drainage without being susceptible to migration through the pervious embankment or foundation materials or segregation during placement. Lutenecker et al. (1995) is a good source for borehole backfill guidelines.

i. Drilling Personnel.

(1) On-site personnel (i.e., contractor, operator, field supervisor) experienced in drilling methods and operations, with knowledge of potential difficulties, are essential to the prevention/minimization of adverse conditions when actively drilling through dams, levees, and foundations. For example, instantaneous pressure surges can occur when borings are advanced too fast and aggressively, when fluid circulation systems become plugged or restricted, or mechanical problems occur. Instantaneous pressure surges can result in damage and are not typically assumed in the static hydraulic fracture calculations (dynamic fluctuations within the bore). Drilling personnel with knowledge of the activities that can produce inadvertent pressure surges are key to limiting the risk of damage.

(2) Drill rig operators must have a minimum of three years of experience drilling with the type of equipment proposed, on at least two dam and/or levee projects, and be familiar with the procedures described in the DIPP. The drill rig operator and field supervisors must also be familiar with USACE guidelines and the issues that can cause adverse impacts. Future drill rig operators may gain experience through training with 100% oversight by an experienced drill rig operator. For new technologies where three years of experience is not possible, the DIPP should outline other relevant experience of the drill rig operator and weigh the advantages and disadvantages of the new proposed methodology.

j. Approval Requirements.

(1) DIPPs must be reviewed and approved by the District DSO/LSO in coordination with the District Dam Safety Program Manager/Levee Safety Program Manager (DSPM/LSPM). If any drilling fluid or other stabilizing or circulating medium is proposed, a technical review is required by the Geotechnical, Geology, and Materials Community of Practice (GGM CoP) Standing Committee on Drilling and Invasive Activities and the MSC DSPM or LSPM to ensure compliance with this ER. Following satisfactory resolution of the technical review comments, the plan then requires approval from the District DSO/LSO. The District DSO/LSO has the ultimate determination of the satisfactory resolution of comments. The Standing Committee on Drilling and Invasive Activities is chaired by the GGM CoP Lead, managed by the Risk Management Center, and staffed with GGM CoP subject matter experts.

(2) The decision to authorize or approve invasive activities (whether performed by USACE or a third party) on real property identified and acquired for a USACE project, including approval of a DIPP, is a federal action subject to the requirements of National Environmental Policy Act (NEPA) and other applicable laws and regulations. Invasive activities by a third-party may require authorization under Section 408 (33 U.S.C. 408). If the activities covered in a DIPP are in furtherance of O&M activities specified in a USACE-issued O&M manual or associated with activities to restore the physical dimensions and design of the constructed project, then NEPA and other environmental compliance requirements may have already been satisfied.

7. Exemptions.

a. Drilling or other invasive activities that are required for immediate emergency measures, where delays required to develop the DIPP and obtain approvals would result in unacceptable risk of damage or failure, may be exempted from the requirement

for a DIPP by the District DSO/LSO. Emergency activities should be appropriately expedited but should follow the guidelines presented in this ER.

b. Drilling or other invasive activities that are being performed as part of a major dam or levee modification (for example, cutoff wall installation, anchor installation, foundation grouting) that are described in design reports, plans, and specifications that have undergone Agency Technical Review are also exempt from the requirement to prepare a standalone DIPP. However, the potential adverse impacts and risks related to these activities must be evaluated following the guidelines and considerations presented in this ER and reviewed/addressed prior to construction. Specifically, personnel experience requirements should be established in the plans and specifications. Note that invasive activities that are not associated with the major feature of work (for example, instrumentation, investigatory borings, drilling for in situ testing) are not exempt from the requirement to prepare a DIPP.

c. Requests for waivers or variances to this regulation must be submitted to the Chief, CECW-EC, through the GGM CoP Lead.

8. Documentation.

The District is responsible for ensuring that subsurface data generated (boring logs, CPT records, etc.) by these activities are archived in the USACE authoritative boring log database. All boring logs generated by non-federal sponsors, or their representatives should be provided to USACE for documentation within 30 days of drilling, preferably in digital format.

9. Distress Reporting.

All incidents of damage or potential damage related to drilling and invasive activities for dams or levees must be reported following procedures outlined in ER 1110-2-1156. Damage in dams or levees must be reported to the DSO/LSO and DSPM/LSPM at both the MSC and Headquarters.

10. Environmental Operating Principles.

The user of this ER, as a member of a Project Delivery Team, is required to comply with the NEPA. USACE NEPA process can be found at Environmental Quality (army.mil). A listing of the Environmental Operating Principles can be found at Environmental Operating Principles (army.mil).

Appendix A References

Section I

Required Publications

Unless otherwise indicated, all U.S. Army Corps of Engineers publications are available on the USACE website at <https://publications.usace.army.mil>.

ER 1110–2–1156

Safety of Dams – Policy and Procedures

EM 1110–1–1804

Geotechnical Investigations

EM 1110–2–2902

Conduits, Pipes, and Culverts Associated with Dams and Levee Systems

33 USC 408

Protection of Navigable Waters and of Harbor and River Improvements Generally: Taking Possession of, Use of, or Injury to Harbor or River Improvements. (Available at www.uscode.house.gov.)

PL 91–190

National Environmental Policy Act. (Available at www.congress.gov.)

Fracturing Pressure in Clay

Marchi, M., Gottardi, G. and Soga, K. 2014. “Fracturing Pressure in Clay.” *Journal of Geotechnical and Geoenvironmental Engineering* 140(2): 04013008. (Available at [https://doi.org/10.1061/\(ASCE\)GT.1943-5606.0001019](https://doi.org/10.1061/(ASCE)GT.1943-5606.0001019).)

Geotechnical Engineering of Dams

Fell, R. MacGregor, P., Stapledon, D., Bell, G., and Foster, M. 2018. *Geotechnical Engineering of Dams*. 2nd Edition.

Laboratory Study of Hydraulic Fracturing

Jaworski, G.W., Duncan, J.M., and Seed, H.B. 1981. “Laboratory Study of Hydraulic Fracturing.” *Journal of Geotechnical Engineering Division* 107(6): 713–732. (Available at <https://doi.org/10.1061/AJGEB6.0001147>.)

Observations of Hydraulic Fracturing in Soils through Field Testing and Numerical Simulations

Chang, M. and Huang, R. 2016. “Observations of Hydraulic Fracturing in Soils through Field Testing and Numerical Simulations.” *Canadian Geotechnical Journal* 53: 343–359. Boca Raton, FL: CRC Press. (Available at <https://doi.org/10.1139/cgj-2015-0193>.)

Recommended Guidelines for Sealing Geotechnical Exploratory Holes

Lutenegger, A.J., DeGroot, D.J., Mirza, C. and Bozozuk, M. 1995. "Recommended Guidelines for Sealing Geotechnical Exploratory Holes." *National Cooperative Highway Research Board Program Report 378*. (Available at http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_378.pdf.)

Section II

Prescribed Forms

This section contains no entries.

Appendix B

Drilling and Invasive Program Plan

B-1. Policy.

An approved drilling and invasive program plan (DIPP) is required for any invasive activities proposed in or near dams, levees, and appurtenant structures or their foundations. When these activities are justified, an exploration team must be formed to determine and document the program components required to address the project needs adequately and safely. The exploration team must thoroughly consider and evaluate the potential program-related impacts to minimize program risk and meet the project goals. DIPPs must be prepared and signed by a licensed Professional Engineer or Geologist experienced in the type of activities proposed and the dam/levee safety concerns related to invasive activities, with advice from drilling specialists.

B-2. Oversight of Field Activities.

All drilling and invasive activities on USACE dams or levees must be conducted in the presence of a licensed professional engineer or geologist who has at least five years of experience performing the work that is proposed. That individual is responsible for maintaining the integrity of the structure, monitoring, and documenting the conditions and observations during the field activities.

B-3. Contents of the DIPP.

a. Objective and Justification. Justification for drilling or invasive activities may not be required in DIPPs for projects associated with a construction contract. Contract documents should further discuss the project-specific requirements.

(1) Clearly summarize the objective of the drilling or invasive program, including the purpose of the invasive activities and how the borings/test pits, samples, testing, instrumentation, etc. will be performed/collected and used to solve an identified problem or address technical uncertainties.

(2) Thoroughly justify the need for the drilling. Drilling should be minimized by first using non-destructive methods, including parametric analysis, the use of published correlations, assessment of existing and available data, and non-destructive geophysical testing or remote sensing (if applicable).

(3) For USACE dams, the justification for drilling must include an approved recommendation from a risk assessment performed in support of the Dam Safety risk management process described in ER 1110-2-1156, Safety of Dams – Policy and Procedures or be part of normal and required Operations and Maintenance (O&M) activities.

(4) For USACE structures that have not had a Potential Failure Mode Analysis (PFMA), a thorough evaluation similar to the PFMA process must be performed and presented in the DIPP to show that the drilling is justified to target a specific failure mode or is part of normal and required O&M activities.

(5) For projects owned and operated by non-federal sponsors, all drilling should be justified and targeted for a valid engineering purpose or be part of normal and required O&M activities.

b. Exploration Team. DIPPs must be prepared and signed by a licensed Professional Engineer or Geologist. The DIPP must list members of the exploration team who develop the DIPP and are responsible for implementing, performing, and documenting the work. Include name, organization, title, registration, and years of experience. Include drillers names and years of experience. If a contractor is unknown at the time of the DIPP, contingent approval can be provided, pending submission and approval of final personnel after contract award. Include the field supervision personnel name, organization, title, registrations, and years of experience, including identification of who will be responsible for logging materials and assuring geologic drawings are updated during drilling.

c. Existing Information Review. To understand subsurface conditions, justify additional invasive activities, and estimate risks, the exploration team must assimilate, review, and concisely summarize all relevant available existing information in the DIPP. Information review typically includes, but is not limited to:

- (1) Geologic mapping, boring logs, driller notes, and reports portraying information from previous investigations and construction.
- (2) Geotechnical files and reports, including site characterization reports.
- (3) Foundation completion reports.
- (4) Embankment construction reports.
- (5) Periodic inspection or periodic assessment reports.
- (6) As-built drawings.
- (7) Archived records.
- (8) Other construction reports.
- (9) Construction photos for both original embankment construction and any subsequent construction.
- (10) Instrumentation plans, data, and reports.
- (11) Project records available in district and project offices.

d. Essential Geologic and Engineering Drawings. The DIPP must include a set of drawings depicting the current understanding of subsurface conditions, as they relate to the proposed work. These items can be included by reference for DIPPs associated construction contracts.

(1) This detailed set of foundation and structure drawings typically requires a plan showing all previous and proposed subsurface investigation locations, profile drawings, and sections of the embankment in the areas proposed for exploration.

(2) The sections must be drawn to scale with no vertical exaggeration and must show the proposed work locations, along with all available data and appropriate geologic or engineering interpretations.

(3) The drawings should be updated regularly during the field operations to show conditions encountered and adjust geologic interpretations to help guide the program. Maintaining updated geologic sections and a plan during the field operations is important for making exploration changes and for responding to unusual or unexpected conditions or events. The process for updating geologic interpretations during field activities must be outlined in the drilling program.

(4) The information on the plan, profile and sections must be detailed and include a summary of all data significant to the analytical and exploration needs, such as the following:

- (a) Relevant information about constructed features, including embankment zones, berms, blankets, filters, and drains/drainage features.
- (b) Details of subsurface material classification.
- (c) Geologic contacts and continuity interpretations supported by all nearby drilling and sampling details.
- (d) Depth of the top of rock and all other zones of importance.
- (e) Piezometer locations showing screened influence zones and recorded piezometric levels tied to the reservoir water level.
- (f) Other instrumentation, such as inclinometers, movement monuments, etc., shown in the context of the foundation geology contacts and interpretations.
- (g) Standard penetration test (SPT) blow counts or other test results defining engineering properties.
- (h) Geophysical data, where useful (e.g., cross-hole shear wave velocity profiles).
- (i) Estimated extent of any zones of interest, including natural and made-made (e.g., grout holes).
- (j) Seepage areas tied to geologic units, where possible.
- (k) Location of all structures, including seepage control features, outlet works, etc.
- (l) Location and types of any distress features (e.g., seepage, wet spots, sand boils, sinkholes).

e. Drilling Scope and Methodology. The drilling program must include a summary of the scope and methods that will be used, including the following:

- (1) Number and location of proposed invasive activities.
- (2) Utilities, surface and underground obstacles, and accessibility.
- (3) Materials expected to be encountered, sampled, and tested.
- (4) Depth, diameter, bearing, and inclination of borings.
- (5) Required sample type (disturbed or undisturbed), size, location, and reason for sampling. Methods for minimizing risk of hydraulic fracture during sampling
- (6) Drilling, sampling, and testing methods.
- (7) Details of the proposed tools and drilling equipment.
- (8) Instrumentation installation (e.g., influence zone, seals, development plan).
- (9) Borehole completion to include hydraulic fracture calculations for grouting, considerations for staged grouting, and backfill of drainage features.
- (10) Site access, and environmental considerations
- (11) Procedures for documenting field investigations (including locations, boring logs, instrumentation installation, boring abandonment, etc.)

f. Risk Evaluation. Include an evaluation of the risk of hydraulic fracturing, erosion, contamination of drainage features, heave, or any other potential adverse damage that could result from the investigation program. This should include:

- (1) A detailed description of any drilling fluid used, including details on the circulation system, locations where fluid will contact soil, and circulation pressures that will be used.

(2) Monitoring needs during drilling, and a contingency plan if loss of drilling fluid or other complications are observed during drilling.

(3) Measures to minimize the risk of damage to the dam or levee foundation and other critical project features.

(4) Measures to prevent the possibility of groundwater cross-contamination and leakage from confined and separate aquifers.

(5) Measures to prevent drill influence or contact with structural features, such as conduits or anchors.

(6) Nearby instruments whose behavior will be monitored during the investigation, their expected responses, including threshold and limit values, and contingency plans for unexpected responses.

(7) An emergency action plan, including a list of emergency equipment and supplies to have onsite (e.g., phone/radio, filter materials, grout materials).

g. DSO/LSO Certification. Provide a certification page with the signature of the appropriate DSO/LSO. The certification must state: "This Drilling Program Plan has been developed and reviewed by experienced professionals and complies with all the requirements of ER 1110-1-1807. The proposed actions are justified and have been developed to minimize the likelihood of damage to the existing structure."

SUMMARY of CHANGE

ER 1110-1-1807

Drilling and Invasive Activities at Dams and Levees

Changes in this revision

Establishes a minimum Factor of Safety for hydraulic fracture of 1.3.

Requires two methods to calculate Factor of Safety for hydraulic fracture and provides suggested methodologies.

Expands application to all dams and levees, not just embankments.

Changes Drilling Program Plan to Drilling and Invasive Program Plan since this ER also applies to test pits and other non-drilling activities.

Adds Major Subordinate Command Levee/Dam Safety Program Managers to the list of reviewers.

Adds a professional licensure requirement for preparer of Drilling and Invasive Program Plans.

Clarifies experience requirements for drillers.

Clarifies exemption for major construction projects.

Clarifies that approval of a Drilling and Invasive Program Plan is a federal action that triggers National Environmental Policy Act.