FEDERAL ENERGY REGULATORY COMMISSION

Office of Energy Projects

Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans

DRAFT

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LIST OF ACRONYMS AND ABBREVIATIONS

Commission	Federal Energy Regulatory Commission
EI	Environmental Inspector
FERC	Federal Energy Regulatory Commission
HDD	Horizontal Directional Drill
HDD Plan	*Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan*
IR	Inadvertent Return of Drilling Fluids to the Ground Surface
NEPA	National Environmental Policy Act of 1969
NSF/ANSI	NSF International/American National Standards Institute
Procedures	*Wetland and Waterbody Construction and Mitigation Procedures*

1.0 INTRODUCTION

The Environmental Staff of the Federal Energy Regulatory Commission's (FERC or Commission) Office of Energy Projects has prepared this guidance document to assist pipeline industry professionals with the development of *Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans* (HDD Plan). We[1] believe that this guidance will help industry professionals improve the quality and consistency of their HDD Plans and, as a result, increase the efficiency and effectiveness of the Commission's environmental review.

This guidance does not substitute for, amend, or supersede the Commission's regulations under the *Natural Gas Act* or the Commission's and Council on Environmental Quality's regulations under the National Environmental Policy Act of 1969 (NEPA). It imposes no new legal obligations and grants no additional rights. We use non-mandatory language such as "recommend," "should," and "may" to describe Commission staff's recommendations that will help the Commission meet its obligations under NEPA. We use mandatory language such as "required," "must," and "must not" to describe controlling requirements under the terms and statutes and regulations. This guidance discusses our preferred format for certain documents and data presentation. However, an alternative approach can be used if it satisfies the requirements of the applicable statutes and regulations. Some of the guidance provided herein may not be appropriate for the scope of a proposed project. Each HDD Plan should be prepared in consideration of project-specific issues, impacts, and public and agency comments.

We encourage projects with HDDs constructed under the automatic provisions of the FERC's regulations to adopt the mitigation measures outlined within this document; however, there is no requirement for those project applicants to file the HDD plans.

To see how various HDD-related issues have been previously addressed, Companies may refer to other recent environmental assessments, environmental impact statements, and Commission orders (available on the Commission's website, www.ferc.gov, and eLibrary). However, we caution Companies not to rely exclusively on these documents given that they deal with specific issues that may not apply generally.

1.1 Overview

The purpose of this guidance is to describe the technical components of an HDD Plan including drilling fluid[2] composition and management, monitoring procedures, and

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[1] "We," "us," and "our" refer to the environmental staff of the Federal Energy Regulatory Commission's Office of Energy Projects. "You," whether explicit or implied, or "Company" refers to the applicant/company proposing a natural gas project or to the applicant/company's agent(s) who prepares, uses, or reviews these types of environmental documents.

[2] The terms "drilling mud" and "drilling fluid" are used interchangeably within our *Wetland and Waterbody Construction and Mitigation Procedures* and other FERC guidance documents.

response procedures for an inadvertent return of drilling fluid to the ground surface (IR). We also identify and discuss information that is not specifically required by regulation, but is often considered during staff's environmental review.

We provide in this document an outline for an HDD Plan. This format is an effective presentation based on our experience, but is not mandatory and may be modified (including the use of footnotes where necessary for clarification) for individual projects.

2.0 PREPARING HDD PLANS FOR NATURAL GAS ACT APPLICATIONS

The Commission's *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures) at section V.B.6.d requires Companies to file a site-specific plan prior to the beginning of construction for all HDD crossings of wetlands and waterbodies which contains:

1) site-specific construction diagrams that show the location of mud pits, pipe assembly areas, and all areas to be disturbed or cleared for construction;
2) justification that disturbed areas are limited to the minimum needed to conduct the crossing;
3) identification of any aboveground disturbance or clearing between the HDD entry and exit workspaces during construction;
4) a description of how inadvertent release of drilling mud would be contained and cleaned up;
5) a contingency plan for crossing the waterbody or wetland in the event the HDD is unsuccessful; and
6) how the abandoned drill hole would be sealed, if necessary.

However, information that is not specifically required by regulation, but is often considered during staff's environmental review, should also be considered, provided, and incorporated into these plans, including: crossing-specific geotechnical information and crossing profiles showing the feasibility of the crossing; a hydrofracture and IR risk evaluation; drilling fluid composition (including the use of drilling mud additives, and source water identification and analysis) and management; HDD monitoring procedures and document retention; and unique conditions identified along proposed HDD alignments that may increase the risk of HDD construction complications, inadvertent releases, or cause other environmental concerns. We therefore recommend for projects where an HDD is proposed that this information be provided such that it can be analyzed during the project NEPA review.

Measures described in the HDD Plan may be applicable to all proposed HDD crossings; however, site-specific HDD crossing plans should also be prepared for each crossing, and may be included as an attachment to the HDD Plan (refer to section 4.0).

You should revise the HDD Plan, as necessary, if new information becomes available both during the course of application review and post authorization.[3] However, because HDD Plan details may affect our analysis of impacts and alternatives, we suggest that the HDD geotechnical investigation, hydrofracture analysis, and source water identification and analysis be provided during preparation of the final NEPA document. Further, the plan itself may offer suitable mitigation for impacts on resources and will support conclusions provided in the final NEPA document.

In HDD Plan preparation, you should ensure that all data are accurate and consistent throughout the HDD Plan and with other application documentation. Lastly, you should use consistent project terminology throughout the HDD Plan and other application documentation.

3.0 HDD PLAN CONTENTS

The below list and the following sub-sections provide an outline for an adequate HDD Plan. This format is an effective presentation based on our experience. It is not mandatory, and the outline should be modified (including the use of footnotes where necessary for clarification), as appropriate, for individual projects.

- Introduction
- Personnel and Responsibilities
- Pre-Construction Activities
- Documentation
- Drilling Fluid Management
- HDD Operational Conditions and Response Actions
- Responding to IRs
- Restoration
- Contingency Planning

3.1 Introduction

You should clearly state the purpose, objectives, and applicability of the HDD Plan, and provide basic information for each crossing. Basic information may be sufficiently summarized as shown in example table 3.1-1, below.

[3] Modifications to an approved HDD Plan may require approval, as a variance request, by the Director of the Office of Energy Projects, or the Director's designee.

Table 3.1-1 Proposed HDD Locations					
Crossing Name	**Pipeline Diameter (inches)**	**Approx. Entry Milepost**	**Approx. Exit Milepost**	**Total Length (feet)**	**Subsurface Material**
Project Component Name					
(Feature crossed or other unique identifier)					(description of overburden or bedrock)
Project Component Name					

Additionally, we have provided example tables (tables 3.1-2 and 3.1-3), below, for documenting sensitive environmental resources. You should modify these tables as necessary to also include sensitive resources that are not crossed by the HDD but which could be susceptible to impacts from HDD activities, as determined based on specific project geology or design.

Table 3.1-2 HDD Wetland Crossings							
Wetland ID	**Wetland Type**	**Delineated Acres**	**Entry (Station)**	**Exit (Station)**	**Entry/Exit Elevation Difference (feet)**	**Depth of Cover[1] (feet)**	**Horizontal Setback Distance (Entry/Exit, feet)[2]**
HDD ID							
HDD ID							
[1] Vertical separation between the wetland and the drill alignment [2] Distance from the closest edge of the sensitive resource being crossed to the HDD entry and exit locations							

Table 3.1-3 HDD Waterbody Crossings						
Waterbody ID (Name)	**Estimated Range of Stream Flow During Crossing (cfs)**	**Entry (Station)**	**Exit (Station)**	**Entry/Exit Elevation Difference (feet)**	**Depth of Cover[1] (feet)**	**Horizontal Setback Distance (Entry/Exit, feet)[2]**
HDD ID						
HDD ID						
[1] Vertical separation between the bed of the waterbody and the drill alignment [2] Distance from the closest edge of the sensitive resource being crossed to the HDD entry and exit locations						

You should also identify or tabulate other unique conditions or features in proximity to the alignment(s) that may increase the risk of drill failure or potential impacts (e.g., existing contamination, artesian groundwater, karst features, significant grade change, presence of retaining walls, abandoned and/or orphan oil and gas wells, specially managed infrastructure [such as levees], proximity to residences [and basements]) and measures that would be implemented to minimize any risks.

3.2 Personnel and Responsibilities

You should commit to implementation of qualified, responsible oversight (identify the position titles, if known) of HDD activities by contractor[4] and Company personnel, as well as all associated personnel and environmental inspectors (EI) (and/or monitors) responsible for overseeing HDD activities. These responsibilities include the following:

- implementing the HDD Plan on behalf of the contractor;
- ensuring that workers are properly trained, including knowledge of the procedures for response to an IR;
- monitoring drilling fluid circulation back to the entry and exit locations;
- communicating loss of drilling fluid circulation status to other project staff;
- stopping or changing the drilling program in the event of an observed or anticipated IR;
- monitoring the HDD alignment for IRs and other signs of environmental impact (such as sinkhole development or subsidence over the alignment);
- notifying regulatory and/or resource agency staff in a timely manner, and responding to these staff regarding observed releases in accordance with the HDD Plan; and
- ordering and overseeing corrective actions for an IR.

The parties responsible for carrying out compliance with various HDD Plan elements should be clear.

3.3 Pre-Construction Activities

3.3.1 Training

Prior to HDD site set-up, HDD-specific implementation and safety training should be conducted for Company and contractor personnel, including EIs and Compliance Monitors (if applicable). This training should address all applicable environmental impact avoidance and minimization measures that would be implemented during drilling. Each person involved in HDD operations should be familiar with the locations of IR containment equipment and materials, and the specific procedures for handling IRs. The HDD Plan should describe the frequency of training and any circumstances that would

[4] contractor refers to the company or companies retained by the Company or another contractor to complete the HDD installations.

result in additional training. The HDD Plan should also describe the scope of the training and training documentation records that would be maintained, and by whom.

3.3.2 Site Inspection

You should inspect each drill path prior to construction. Any site-specific condition(s) that impedes the ability to conduct the visual and pedestrian field inspection of any portion of a drill path should be identified, and a site-specific modification to the proposed inspection routine should be developed for that location. You should incorporate modifications into site-specific HDD crossing plans prior to construction and communicate these modifications to HDD contractors as part of training (section 3.3.1). If unique conditions or features along or in proximity to the alignment(s) are discovered during drill path inspections that may increase the risk of drill complications (e.g., existing contamination, karst features, slope instability, abandoned and/or orphan oil and gas wells), you should incorporate measures into the HDD Plan that you would implement to minimize these risks.

If such condition(s) are identified post-authorization, which require modifications to the approved HDD Plan, a variance may be required, which must be approved by the Director of the Office of Energy Projects, or the Director's designee, prior to implementation.

3.3.3 Landowner Notification Procedures

The HDD Plan should describe how landowners would be notified of HDD activities, as well as the content and timing of this notification. To facilitate expedited response times in the event of an IR, or to monitor sensitive environmental resources located outside of approved work areas, consider requesting landowner permission in advance to perform pedestrian surveys of any property that may be reasonably traversed to conduct monitoring or response activities (discussed in section 3.6 and 3.7).

3.3.4 Agency Notification Procedures

The HDD Plan should describe how and when regulatory agencies with jurisdiction over the crossing(s) (including the FERC) would be notified of the planned initiation of HDD activities. We recommend that applicable agencies are notified of the anticipated timing and duration of HDD construction prior to commencing drilling operations.

3.4 Documentation

A copy of the HDD Plan should be available and accessible to all construction personnel at each applicable crossing. The HDD Plan should clearly describe other documentation that would be maintained during HDD activities. At a minimum, documentation detailed in table 3.4-1 should be maintained. The HDD Plan should also identify the position titles of personnel responsible for maintaining this information. If

requested, you should be prepared to provide this information to the FERC and other federal and state agencies with applicable regulatory jurisdiction.

Table 3.4-1. Documentation Maintained	
Procedure	**Documentation**
Employee Training	Record of employee training detailing when training was conducted, material covered, and employees in attendance.
HDD Visual and Pedestrian Monitoring	The name of the inspector, time of the examination, and observations of the inspector should be logged following each inspection.
HDD Instrument Logs	The contractor should maintain instrumentation logs that document pilot hole progression, drill string axial and torsional loads, drilling fluid discharge rate and pressure, and down-hole annular pressure monitoring during drilling of the pilot hole (or provide alternative monitoring methods and/or best drilling practices to ensure that the drilled and bored (reamed) holes do not become plugged with drill cuttings leading to hydrofracture and IR).
Drilling Fluid Composition	Monitoring logs of drilling fluid physical properties throughout drilling activities (mud weight, viscosity, sand content, and pH).
	A clear description of the intent to reuse drilling fluid between HDD locations, as well as documented consultation with local and state agencies for such reuse. Laboratory results of sampled drilling fluid/source water for any inorganic and organic environmental contaminants should also be retained.
Public and Agency Inquiries/Comments	A record of communication with the public and agencies that has occurred during HDD activities. This record should include inquiries and comments, as well as response actions.

We recommend that a summary of HDD-specific information be included in construction status reports provided to FERC, including: overall status, a summary of visual and pedestrian monitoring activities, issues encountered (including any IRs) and response actions, and complaints and how they were addressed.

3.5 Drilling Fluid Management

You should develop a drilling fluid management plan that discusses, for each HDD crossing, the source of drilling water, anticipated water use, volume, and any sampling and laboratory analysis of the water source. Discuss the anticipated fluid losses for each crossing based on geologic conditions present.

3.5.1 Drilling Fluid Additives

The HDD Plan should identify any additives that would be mixed with the drilling fluid and include Safety Data Sheets for drilling fluid materials (besides bentonite and water) proposed for use during each HDD as an attachment to the HDD Plan. Only pre-approved, non-petrochemical-based, non-hazardous additives that comply with permit requirements and environmental regulations should be utilized. We recommend that proposed additives are NSF International/American National Standards Institute

(NSF/ANSI) 60 Drinking Water Treatment Chemicals – Health Effects compliant. In addition, you should indicate the ecotoxicity of each additive. Express this characteristic by estimating its expected concentration in the mud relative to identified toxicity value for relevant biotic receptors (e.g., fish). It is important to identify additives for consideration during the project's NEPA review.

If drilling fluid is sourced from an off-site location (transported from another drill site) or if the water supply is a non-municipal source, the drilling fluid/water source should be tested for environmental contaminants prior to use, and documentation of consultation with local and state agencies regarding the results of such tests be provided.

3.5.2 Drilling Fluid Physical Properties

The contractor should monitor the drilling fluid properties (e.g., fluid weight, viscosity, sand content, pH) during drilling operations. A drilling fluid specialist should be consulted if any changes to the fluid properties are required in order to prevent an IR from occurring or to maintain hole stability for successful completion of the crossing. The HDD Plan should describe the frequency of this monitoring and the documentation that would be maintained.

3.5.3 Drilling Fluid Disposal

You should describe the proposed method(s) of drilling fluid disposal. Drilling fluid disposal should comply with the FERC's *Upland Erosion Control, Revegetation and Maintenance Plan* at section III.E.

3.6 HDD Operational Conditions and Response Actions

In our experience, HDD activities can be characterized by three operating conditions:

- Normal Drilling (full drilling fluid circulation);
- Loss of Drilling Fluid Circulation; and
- Inadvertent Returns.

At a minimum, you should describe drilling and monitoring procedures for each operational condition. Response actions that would be taken in the event of significant or complete loss of drilling fluid circulation and confirmation of an IR should also be described. This discussion should include how you would determine and communicate a change in operating status, and response actions and reporting procedures for involved parties.

3.6.1 Drilling Procedures

To minimize the potential environmental impact associated with a loss or release of HDD drilling fluids, the contractor should employ best efforts to maintain full annular

circulation of drilling fluids. The contractor should consider utilizing real-time annular pressure monitoring with the use of a down-hole annular pressure tool throughout pilot hole drilling operations, or provide alternative monitoring methods and/or best drilling practices to ensure that the drilled and bored (reamed) holes do not become plugged with drill cuttings leading to hydrofracture and IR. The contractor should also provide and maintain instrumentation that accurately locates the pilot hole, measures drill string axial and torsional loads, and measures drilling fluid circulation rate and pressure. The contractor should closely and continuously monitor the entry/exit pits during the reaming process to ensure that drilling fluids are circulating to the mud pits.

In the event of significant or total loss of drilling fluid circulation, the contractor should notify project inspector(s) and the Company, and should take steps to restore circulation. Contractor downtime and steps taken to restore circulation should be documented.

If an IR is observed, the EI, the Company, and the FERC Environmental Project Manager and Compliance Monitor (if applicable) should be notified as soon as reasonably possible. In the event of an IR, you should notify other jurisdictional regulatory and resource agencies per permit or consultation requirements and commitments (e.g., Endangered Species Act consultation). The contractor should promptly investigate the IR, employ measures to minimize impacts, and initiate containment measures. Documentation of the IR and clean-up efforts should be maintained. If public health, safety, and/or sensitive environmental resources are threatened by an IR, or if the amount of an IR exceeds that which can be practically contained and collected by the equipment on-site, drilling operations should be stopped until the threat of additional or increased IRs are eliminated or brought under control.

3.6.2 Monitoring and Pedestrian Surveys

You should fully describe how monitoring of the HDD alignment(s) would be conducted and whether monitoring methods would vary at each crossing. For example, describe if the alignment would be monitored via pedestrian survey, unmanned aerial vehicle, boat, fixed camera, etc. For each operating status, quantify the frequency of monitoring activities and describe the documentation that would be maintained, by whom it would be maintained, and the availability of this documentation.

In developing monitoring procedures, consider the need for additional precautions, including intensified monitoring and inspection protocols, at sensitive environmental resources (e.g., waterbodies and wetlands), and increased frequency of monitoring during lost circulation or following remediation of an IR.

3.7 Responding to IRs

You should describe the procedures that would be followed if an IR is observed surfacing at locations that are:

1. inside of certificated workspaces;
2. outside of certified construction work areas;
3. in inaccessible areas; and
4. within sensitive environmental resources such as wetlands and waterbodies.

In accordance with the FERC's Procedures at section V.B.6.d.4, you must describe how an IR would be contained and cleaned up. The protocols and measures you would follow to respond to an IR in upland, wetland, and waterbody locations should be described, including for both containment of the release to minimize impact (for example, the prevention of an upland release reaching a wetland or waterbody and restrictions for equipment use and clearing in accessing an IR) and clean-up of a release. In addition, you should describe measures to be taken if an IR occurs within or in close proximity to a potable water source, such as a seep, spring, or water-supply well. Such measures may include testing the water source for water quality and yield, as well as providing an alternate supply of water to affected landowners until such time as the water source is remediated to pre-construction conditions for both yield and water quality. You should also describe notification measures for releases in a wetland or waterbody. Include contact information for regulatory agencies with jurisdiction over the wetland/waterbody.

3.7.1 IR Response Materials and Equipment

Equipment and materials required to contain an IR should be available at each HDD entry point and exit point. Examples of expendable materials and equipment to be maintained on site in sufficient supply depending on the extent of sensitive environmental resources at each crossing may include:

- spill sorbent pads and booms;
- straw bales (certified weed-free);
- wood stakes;
- sandbags;
- silt fence;
- plastic sheeting;
- corrugated plastic pipe;
- shovels; and
- push brooms.

Additionally, mechanized and other equipment should be maintained on site or be immediately available to the site depending on the extent of sensitive environmental resources at each crossing and may include:

- centrifugal, trash, and sump pumps;
- vacuum truck;
- rubber-tired or wide-track backhoe;
- bobcat (if needed);

- storage tanks; and
- floating turbidity curtains for use in large waterbodies.

3.7.2 Accessing Releases off Right-Of-Way and in Inaccessible Areas

The HDD Plan should address procedures you would use to secure landowner permission, obtain the necessary environmental and cultural resource clearances, and obtain the required FERC variances to access and restore affected resources and/or areas that are outside of approved workspaces, or not directly accessible without an approved workspace variance. You should take proactive steps to seek landowner permissions *in advance*, to limit downtime during drilling operations and expedite environmental response times if an IR occurs. During project development, for HDDs in which hydrofracture analysis, or bedrock conditions, such as highly weathered bedrock or karst-conduit permeability, indicate a likelihood of IR, you should consider expanding the biological and cultural survey corridor and pre-prepare variances for off-right-of-way access in adjacent areas prior to initiating HDD operations (to be filed with the Commission if needed). For inaccessible areas, procedures may also involve attempts to minimize the quantity of drilling fluid lost, visual monitoring of the IR, and criteria for which drilling operations would be suspended until measures are in place to properly respond to the IR.

3.8 Restoration

You should restore all areas affected by IRs to pre-existing conditions and contours to the extent practicable. Upland areas should be restored through typical right-of-way restoration procedures, such as grading, seeding, and temporary and permanent erosion control devices, as necessary. Restoration of wetlands and waterbodies may vary depending on the extent of disturbance during the initial response to the IR. You should solicit recommendations from the appropriate regulatory agencies (e.g., the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Bureau of Land Management, and state permitting agencies) for restoration activities in regulated wetlands and waterbodies.

3.9 Contingency Planning

You should describe the criteria for identifying what would be deemed a failed HDD, and contingencies to address a failure, such as: a new drill path, drill hole abandonment, or alternate crossing measures.

3.9.1 Alternate Crossing Measures

In accordance with the FERC's Procedures (section V.B.6.d.5), you must describe the contingency plan for crossing a waterbody or wetland in the event that an HDD is unsuccessful. In considering the detail of site-specific contingency plans, you should consider the risks of HDD failure and IR (and potentially affected resources), as well as the need to secure permits for alternative crossing methods. You should indicate whether there is a contingency plan for HDD crossings in the event that a drill is unsuccessful or

proves infeasible due to drill hole instability and/or loss of drill fluids directly related to, for example, bedrock/overburden transitioning, coarse unstable materials such as gravel layers, highly weathered bedrock, and karst-conduit porosity/permeability. HDD contingencies may include, for example, defining a new drill path to avoid the problematic area, relocating the crossing, or defining a new method such as direct pipe installation, if feasible. Site-specific contingency plans should be included within an attachment to this plan (refer to section 4.0). Contingency crossing plans should be reviewed and approved by the appropriate permitting and regulatory agencies, including the FERC (per the requirements of the project-specific Order or section IV.A.1 of the Commission's *Upland Erosion Control, Revegetation, and Maintenance Plan*), prior to their implementation.

3.9.2 Abandonment

In accordance with our Procedures (section V.B.6.d.5), you must describe how an abandoned drill hole would be sealed (if necessary). Abandonment procedures should be approved by the appropriate permitting and regulatory agencies prior to their implementation.

4.0 HDD PLAN ATTACHMENTS

4.1 Site-Specific Crossing Plans

Site-specific components of HDD Plan may be filed as an attachment to the project HDD Plan (attachment 1) and should be revised as new information becomes available. If conditions are identified post-authorization which require modifications to the approved HDD Plan, requests for variances will require approval by the Director of the Office of Energy Projects, or the Director's designee, prior to implementation.

We recommend that site-specific HDD crossing plans are filed for each proposed HDD (whether or not the drill crosses a wetland or waterbody). Site-specific plans should include a scaled drawing identifying all areas to be disturbed by construction and a listing of any necessary permits, and their status. Each site-specific plan should also incorporate any proposed noise mitigation measures. We also recommend you conduct geotechnical studies as early in the planning process as practicable to determine whether HDD is a suitable method for the specific crossing location and to facilitate the development of appropriate crossing plans and contingency crossing plans.

Each site-specific HDD crossing plan should contain an HDD drill alignment profile depicting the geotechnical information (borings) used to characterize the subsurface material along the alignment, or a clear justification why crossing-specific geotechnical borings are not warranted, based on subsurface information collected from nearby investigations. For each planned HDD crossing, the alignment profile should incorporate:

1. site-specific geotechnical investigations used to depict the subsurface lithology along the drill path and the top of the water table (zone of saturation); and
2. standard penetration test results, soil mechanic properties/Atterberg Limits, and rock coring results including core recovery, and rock quality designation for each bedrock core run.

You should develop and provide an HDD feasibility study conducted by a qualified contractor. Discuss the potential for hydrofracture and an IR using the U.S. Army Corps of Engineers' Delft method[5] (or an equivalent method) for crossings through unconsolidated material, and/or a qualitative analysis for an IR through bedrock utilizing rock quality designation values obtained from bedrock cores.

For each HDD, you should describe subsurface conditions identified by geotechnical investigations that may increase the risk of drill complications (e.g., artesian groundwater, karst conduit porosity/permeability, highly weathered bedrock, potential sources of cross contamination such as abandoned oil/gas wells in the vicinity of the drill alignment). For these subsurface conditions and for any alignment characterized by significant elevation differences between entry and exit points, describe any increased risk of an IR and the measures that would be implemented to minimize the loss of drilling fluids.

If any HDD operations are proposed in karst areas, we recommend that you identify all wells and springs within 1,000 feet of the work areas, describe the degree of karst through desktop assessments, and provide the results of geophysical investigations that were conducted. We further recommend that you evaluate the potential to impact downgradient environmental resources and/or water supply sources through a lineament/fracture trace analysis using aerial or Light Detection and Ranging (LiDAR) imagery analysis, field reconnaissance, and site surveys. Based on the results of these studies, you should consider the need for additional landowner notification.

4.2 Safety Data Sheets

As discussed in section 3.5.1, you should include as an attachment (attachment 2) Safety Data Sheets for drilling fluid materials proposed for use during each HDD as an attachment to the HDD Plan.

[5] *Recommended Guidelines for Installation of Pipelines beneath Levees using Horizontal Directional Drilling*, prepared for U.S. Army Corps of Engineers, Kimberlie Staheli [et al], April 1998.