## Barron, Robert B SAJ

**From:** Daniel Pagan [daniel_paganrosa@yahoo.com]
**Sent:** Tuesday, July 19, 2011 4:28 PM
**To:** Collazo, Osvaldo SAJ; Barron, Robert B SAJ; LarryEvans@bcpeabody.com; IVELISSE SANCHEZ SOULTAIRE; Jousef Garcia; FRANCISCO E. LOPEZ GARCIA; Frank Hernandez; Pedro Ray; marcb@gie.com; Doug Cebryk
**Subject:** Revised Frac Out Plan
**Attachments:** Supplementary data R4.pdf; GIE frac out plan R4.pdf

Greetings: As agreed during our conference call of last Friday, enclosed please find Revision 4 of the referenced document including the supplemental HDD information requested. Thanks, Danny

# HORIZONTAL DIRECTIONAL DRILL FRAC OUT PLAN

**July, 2011**

**Revision 4**

**GIE Project Number 1446**

**HORIZONTAL DIRECTIONAL DRILL**

**FRAC OUT PLAN**

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# HORIZONTAL DIRECTIONAL DRILL
# FRAC OUT PLAN

## 1.0 INTRODUCTION

As part of Puerto Rico Electric Power Authority's (PREPA) fuel diversification policy, PREPA has proposed the construction of a 24-inch diameter steel natural gas (NG) pipeline for approximately 92 miles from the EcoEléctrica LNG Terminal in Peñuelas north to the Cambalache Termoeléctricas Authority Central electric power plant (PES) in Arecibo, then east to the Palo Seco facility in Toa Baja and the San Juan facility in San Juan. The pipeline will be buried over its entire length, with the exception of the first mile which will be installed above ground, and will pass through the municipalities of Peñuelas, Adjuntas, Utuado, Arecibo, Barceloneta, Manati, Vega Alta, Vega Baja, Dorado, Toa Baja, Cataño, Bayamón, and Guaynabo.

The pipeline will cross several water bodies, wetlands and other environmentally sensitive features. To avoid major impacts to the environment during the construction of the project, PREPA has proposed the use of Horizontal Directional Drilling (HDD) to cross some of these features.

HDD will be used at eighteen (18) locations in Waters of the U.S. These 18 crossings incorporate twenty (20) separate waterways (some with associated wetlands on one or both banks) and one (1) independent Forested Wetland system.

HDD is a trenchless construction technique used to install pipeline under water bodies and other obstacles. The primary advantage of HDD is that it minimizes and often eliminates altogether, the impact of construction on the water body being crossed.

The primary potential environmental impact of HDD is a frac out into the feature being crossed.

In the HDD industry the term frac out is used to describe an inadvertent release of drill fluid resulting from the fluid escaping from an underground HDD borehole and rising to the surface above the borehole.

The purpose of this document is to establish generic procedures for preventing the occurrence of a frac out and for addressing potential impacts associated with a frac out of drilling fluid during the HDD process. The procedures described will generally apply to all HDD crossings on the project. In addition the Contractor(s) will be required to submit a Detailed Installation Plan for each crossing. Site specific variations and details for each crossing will be described in the Detailed Installation Plan.

PREPA will provide on-site environmental and construction inspection during the HDD process to keep adequate documentation, daily progress reports, as-built information, etc.

## 2.0 HDD PROCESS

Installation of an HDD crossing involves drilling an open borehole under an obstacle and the pulling a pipeline section into the borehole. There are three basic steps, or processes, that are executed in sequence: pilot hole, hole opening, and pullback. During all three processes drilling fluid is pumped into the borehole under pressure. This section describes the HDD process.

### 2.1 Pilot Hole Process

The pilot hole is the first step in the HDD process. The pilot hole is drilled along a predetermined alignment and profile. The entry and exit points are located using traditional survey methods. The trajectory of the pilot hole is surveyed by two separate methods both of which employ a down hole survey tool referred to as a probe. The first method uses the earth's natural magnetic field as a reference while the second method uses a wire coil on the surface that creates an artificial magnetic field that is used as a reference. The survey data provided by the wire coil is more accurate than that provided by the earth's natural magnetic field. However the coil is difficult to use in water bodies. Hence coils are normally set up in the upland areas on both sides of the crossing but not in the water body. After each section of the drill pipe has been drilled (approximately 30 feet), both methods of survey are used to calculate the pilot hole location. The difference between the two data sets is calculated. This difference is used to correct readings from the earth's magnetic field that are taken under the water body where the coil cannot be used. The accuracy of this system is good but does diminish with depth. Readings taken at shallow depth (less than 20') are normally accurate to within 2 feet. Readings taken at deep depths (greater than 50') could have much larger errors particularly in the horizontal plane.

The pilot hole process consists of drilling a small diameter hole along the pre-determined alignment and profile. The pilot hole is drilled using either a jetting assembly or a down hole mud motor connected to a tri-cone rotary bit. Drilling fluid is pumped downhole via the string of drill pipe. The flow of drilling fluid powers the mud motor or jetting assembly that cuts the rock strata or soil. The fluid then flows back to the surface along the annular space between the drill pipe and the inside of the pilot hole. As it does so, the fluid also lubricates the drill stem, suspends and carries the drilled cuttings to the surface, and forms a wall cake to keep the hole open.

Data obtained during the pilot hole process will aid the contractor in planning the details of subsequent phases of the installation. These data include the rate of penetration and the friction forces acting upon the drill string. More subjective data on the behavior of the drill string during the process is equally valuable.

### 2.2 Hole Opening Process

Once the pilot hole is complete the borehole diameter must be increased to allow it to accommodate the pipeline. Typically, the final borehole diameter is approximately 1-1/2 times the pipe diameter. The final borehole diameter is determined by the contractor and is dependent to a large degree on the length of the crossing and the types of geological formations through which the borehole passes.

The borehole diameter is typically increased in several increments or passes. There are two types of downhole tools that are used: fly cutters, used for most soil formations, and rock hole opening tools, used for very dense soil or rock formations.

Typically, the fly cutter or hole opening tool is attached to the drill pipe string that drilled the pilot hole and is then rotated and pulled back towards the drill rig from the entry point. A second drill rig or a track hoe is typically used to handle the drill pipe at the exit point.

For each hole opening pass, as the fly cutter or hole opening tool progresses along the crossing profile, drill pipe is added to the string behind it while drill pipe is removed from the string ahead of it. Doing so maintains a continuous string of drill pipe in the borehole over its entire length.

In soil formations, typically there will only be two or three hole opening passes. The first pass may be between a 24-inch- and a 30-inch-diameter fly cutter. Subsequent fly cutter passes will enlarge the hole to the desired diameter. Depending on the stability of the hole, the HDD contractor may use a barrel reamer, typically several inches smaller than the outside diameter of the final hole opening tool, and pull it through the hole immediately prior to pullback. This is typically referred to as a swab pass. The purpose of the swab pass is to ensure the establishment of a good drilling fluid wall cake, a clean hole, and a hole full of drilling fluid with the proper density.

In rock formations, there will be several passes starting typically with a 22-inch-diameter hole opening tool and increasing in steps of 6-inch to 12-inch increments until the desired diameter is achieved. The diameter of each reaming pass is typically determined by the contractor based on field conditions.

The drilling fluid serves continues to serve as a lubricant, facilitates the removal of cuttings, and stabilizes the borehole.

### 2.3 Pullback Process

The last step to complete a successful installation is the pullback of the prefabricated pipeline into the enlarged hole. A reinforced pull head is attached to the leading end of the pipe and to a swivel that is connected to a hole opener or fly cutter and the drill pipe. On the surface, the pipeline is supported with rollers as it is guided into the borehole.

Once in the borehole the large diameter pipeline will be very buoyant in the drill fluid that occupies the borehole. The buoyancy will push the pipeline to the top of the borehole with considerable force. This will result in the following:

- A dramatic increase in the friction between the side of the borehole and the pipe.
- The possibility that the leading edge of the pull head could dislodge a cobble or rock fragment, binding the pipeline and making it impossible to move the pipeline in either direction.
- The possibility that the external coating could be damaged by sharp and/or protruding material and highly abrasive material (coarse sands).

The buoyant force will be counteracted by adding water to the pipeline to increase its weight. The amount of water will be controlled to make the pipe as close to neutrally buoyant, or weightless, as possible.

## 2.4 Drilling fluid

The drilling fluid (also referred to as drilling mud) is made up primarily of water and bentonite. The concentration of bentonite typically varies between 0.24lb/gal and 0.36 lb/gal. Bentonite is a naturally occurring, non-toxic, inert clay that meets NSF/ANSI 60 NSF Drinking Water Additives Standards and is frequently used for drilling potable water wells. Environmentally benign additives, such a polymers and soda ash, may be added to the drill fluid to optimize its properties. The contractor will be required to provide MSDS of all drill fluid components as part of its Detailed Installation Plan.

The environmental impact of a release of drilling fluid into a water body is a temporary increase in local turbidity until the drilling fluid dissipates with the current or is settles to the bottom. In the immediate vicinity of a release, benthic organisms may be smothered if sufficient quantities of bentonite settle upon them.

Drill fluid is easily contained by standard erosion and sedimentation control measures such as stray bales and silt fence. Drill fluid would be contained on entry and exit worksites by hay bales and silt fence installed and maintained around the perimeter of each site. Within the boundaries of the worksites drill fluid would be controlled through the use of pits at the crossing entry and exit points and typical fluid handling equipment such as trash pumps. Drill fluid is released regularly on the drill rigs as part of normal operations when sections of drill pipe are separated. The worksite will be graded such that fluid released on the rig will flow into the fluid pit in front of the rig.

## 2.5 Operating hours

Due to issues associated with borehole stability for the large diameter boreholes required, it will be necessary for all HDD installation operations to be performed on a 24 hour per day, 7 day per week basis.

## 2.6 Shut downs

Any time that the flow of drill fluid through the annular space in the borehole is interrupted there is a risk that the borehole will collapse. This is the reason behind conducting operations on a continuous basis. For this same reason shutdowns will be avoided or minimized. As described elsewhere in this document brief shutdowns will take place if a frac out occurs. \

Shutdowns could also occur if there is a major equipment breakdown. HDD contractors routinely stock replacement parts on site and have a mechanic on site to deal with breakdowns. Normally if a breakdown occurs the duration of the associated shutdown is short.

## 2.7 Inclement Weather

Typically there is little or no change in operations during inclement weather. During heavy rainfalls it may be necessary to perform more repairs to erosion and sedimentation controls than normal. Drill fluid handling and recycling equipment can handle the additional flow of water associated with rainwater entering the open pits.Operations will be shut down only if it is decided that the weather presents a risk to the safety of the crew.  This typically occurs during severe lightning storms or during named tropical storms.  If a shutdown is deemed necessary then drill and fluid pumping operations will cease, the entry and exit pits would be pumped dry with their contents being transferred to onsite holding tanks.  All equipment would then be shut down and the worksite evacuated.

### 2.8 Pipeline testing and validation

The section of pipeline that is installed in the HDD crossing will be tested and validated as follows:

All welds in the pipeline section will be radiographically inspected according to the same specifications as the rest of the pipeline system, which are in accordance with ASME B31.8 and CFR49 part 192.

Prior to the pullback operations the pipeline section will be subjected to a 4 hour hydrotest.  The minimum and maximum test pressures will be 2625 psi and 2800 psi.

After the installation is complete a gauging plate with a diameter of 22.5” will be run through the pipeline section.  This test will ensure that the pipeline section has not been damaged by denting or buckling during the installation.

Finally the pipeline sections will be hydrostatically tested a second time when the entire pipeline system is tested prior to be being put into service.  This test will be done in accordance with Federal regulations and ASME standards.

## 3.0 FRAC OUT OF DRILLING FLUID

Throughout the HDD process there is a loss of drilling fluid into the geologic formation through which the drill passes.  In some cases, the drilling fluid may be forced to the surface resulting in what is commonly referred to as a frac out.  Therefore, while the intent of the HDD method is to avoid surface disturbance, surface disturbance may occur when there is a frac out of drilling fluid.

<u>It is extremely important to note that a loss of drilling fluid into the formation is not necessarily an indication that a frac out has occurred or is about to occur.  It is normal to lose a significant amount of fluid into the formation without ever having a frac out.  In fact, in very soft ground formations or in highly fractured formations it is normal to lose all of the drill fluid pumped into the borehole without a frac out occurring.</u>

A frac out cannot occur unless drill fluid escapes from the borehole into the formation. Hence preventing and managing such escapes will in turn prevent and manage frac outs.

Drilling fluid releases are typically caused by pressurization of the drill hole beyond the containment capability of the overburden soil material.  In some cases, an frac out of drilling fluid can be caused by existing conditions in the geologic materials (e.g., fractures) even if the down hole pressures are low.

Drill fluid pressures are generally the highest during the pilot hole process and hence it is this process that presents the greatest risk for a frac out.  If a frac out occurs during the pilot hole it opens a path through the ground formation for drill fluid to escape during the subsequent processes. Hence frac outs are likely, at the same location during the hole opening and pullback process. Similarly, if the pilot hole process can be completed without a frac out, then it is likely that the entire installation can also be completed without a frac out.

Considerations for preventing and managing frac outs are described below.

### 3.1 Frac out prevention

The risk of a frac out in a sensitive area can be mitigated through profile design and through implementation of specific measures throughout the installation process.

#### 3.1.1 Profile design

The HDD profile is designed to minimize the potential for the release of drilling fluid in sensitive areas. The type of subsurface material and the depth of cover material are factors considered in developing the profile of an HDD crossing. Cohesive soils, such as clays, dense sands, and competent rock are considered ideal materials for containment of drill fluid. An industry recommended minimum depth of cover of 25 feet in cohesive soils should be maintained to provide a margin of safety against drilling fluid loss in sensitive areas. In non cohesive soils, a greater depth of cover will be used. In the designs of all the HDD crossings, PREPA has used depths of cover well in excess of the recommended minimum.

In the vicinity of the entry and exit points of the crossing the depth of cover will be minimal. It is probable, and expected, that frac outs will occur in these segments of the crossing. The crossings are designed such that these segments will be in upland areas.

#### 3.1.2 Preventative measures implemented during installation

Key preventative measures implemented during installation are geared toward keeping the drill fluid contained in the borehole and preventing its escape to surrounding ground formations. This is accomplished through monitoring and management of drill fluid pressures and drill fluid volumes.

##### 3.1.2.1 Drill fluid pressure monitoring and management

Drill fluid pressures are affected by several factors. A description of some of these factors and how they can be managed follows.

- *Drill fluid density.* Greater drill fluid densities result in greater downhole pressures. A large component of drill fluid density is the concentration of cuttings in the fluid. By controlling drilling and hole opening penetration rates and maximizing the effectiveness of drill fluid recycling equipment drill fluid densities can be kept below acceptable limits.
- *Drill fluid viscosity.* Greater drill fluid viscosities result in greater downhole pressures. However, greater viscosities also help seal off fissures and other escape paths into the surrounding formation from the HDD borehole. Similarly increased viscosity improves the cuttings carrying capability of the drill fluid. Drill fluid viscosity must be carefully managed to obtain a balance between these conflicting requirements.

- *Borehole cleanliness.* Cuttings tend to settle out of the flow of drill fluid in the annular space around the drill pipe string. Accumulations of cuttings or cutting beds restrict the flow of drill fluid through the annular space. This results in an increase in the pressure required to maintain flow. Careful management of drill fluid properties and the regular use of borehole swabbing techniques will keep the borehole free of cuttings beds and their associated pressure increases.

The drill fluid pressures in the borehole will vary throughout the installation processes. They will change with the depth of cover, the distance drilled, and the borehole diameter. However, changes in pressure should be gradual and can to large extent be predicted. Rapid or unexpected changes in pressure are indicators of potential problems downhole. It is critical that drill fluid pressures be monitored and recorded throughout the pilot hole process, when pressures are the highest. There are two techniques available for drill fluid pressure monitoring. They are standpipe pressure monitoring and downhole pressure monitoring.

*Standpipe pressure monitoring*

Standpipe pressure is the pressure in the drill pipe string at the surface. The difference between this pressure and the downhole pressure in the borehole is the pressure drop experienced by the fluid as it flows down the drill pipe string and through the downhole tool. Hence standpipe pressure gives only an approximate indication of the downhole pressure.

Nevertheless, careful monitoring of standpipe pressure can provide an indication of a rapid or unexpected change in downhole pressure.

*Downhole pressure monitoring*

Downhole pressure monitoring can be used during the pilot hole operation only. This is a sophisticated technique that involves the use of a pressure transducer incorporated into the downhole survey probe immediately behind the drilling assembly. The transducer measures the drill fluid pressure in the annular space around the probe. Data from the transducer is transmitted to the drill rig at the surface via the same electrical wire line used to transmit survey data. Due to the added complexity and cost associated with the use of this technology it will only be used on crossings that are deemed to be particularly sensitive.

Prior to beginning the HDD installation, a specialist HDD engineering firm shall be engaged to develop an annular pressure diagram for the crossing. This diagram will show, for every point along the length of the planned profile, the maximum annular pressure that can safely be resisted by the formations. This pressure is known as the confining pressure. The curve will also show the predicted drill fluid pressure that will be required to push the cuttings laden drill fluid back to the surface via the annular space.

Throughout the pilot hole drilling operation the annular drill fluid pressure measured at the bottom hole assembly will be continuously monitored. The measured pressure will be compared with the predicted and allowable pressures shown on the annular pressure curve. The following three scenarios are possible:

1) Measured pressure approximately equal to predicted pressure.
This is an indication that conditions are normal and the driller will be allowed to proceed with the pilot hole drilling.

2) Measured pressure greater than predicted pressure.
This is an indication that the annular space behind the drill bit is becoming plugged with cuttings or that the concentration of cuttings in the drill fluid returns is too high resulting in excess drill fluid density. The driller will be required to implement measures to clean the annular space and or reduce the concentration of cuttings. This typically involves “swabbing” the borehole by slowly retracting the drilling assembly while pumping clean drill fluid into the bore to flush out cuttings and replace the cuttings laden fluid with clean, less dense fluid. The composition of the drill fluid pumped into the bore may also be modified to improve its cuttings carrying capacity.

3) Measured pressure less than predicted pressure.
If the measured pressure is significantly less than the predicted pressure this is normally an indication that some of the drill fluid is escaping from the borehole.

It is extremely important to note that having fluid escape from the borehole is not necessarily an indication that a frac out has occurred or is about to occur. It is quite normal to have a significant amount of fluid lost to the surrounding formation without a frac out occurring.

Nevertheless, if the measured pressure is less than the predicted pressure and in particular if this is the result of a sudden drop in pressure, the contractor will be required to implement measures to reduce or eliminate the loss of drill fluid from the borehole. One measure that may be implemented is the use of Lost Circulation Materials (LCM) to plug a fissure in the formation. The use of additives to improve the sealing properties of the drill fluid is another measure.

#### 3.1.2.2 Drill fluid volume monitoring and management

It is intuitive that if drill fluid is not allowed to escape from the borehole then the entire volume of fluid pumped downhole should return to the surface via the annular space. However, as described above, it is normal that a portion or all of the drill fluid will be lost to the surrounding formation. Nevertheless a program for monitoring and managing the volumes of drill fluid used will be beneficial in identifying sudden increases in the volume of fluid lost which could signal a potential frac out.

Throughout the HDD processes the contractor will keep a running balance of the total volume of fluid pumped downhole and the total volume recovered from the return pits. The difference between these volumes will be the volume lost from the borehole.

If the rate of loss of fluid is greater than expected or if it suddenly increases this could be an indication of a problem downhole. Measures to reduce the loss of fluid from the borehole would be implemented as described in previous paragraphs.

## 3.2 Frac out management

Management of frac outs is key to minimizing the environmental impact of an HDD crossing and ensuring its successful completion. Managing frac outs requires that appropriate equipment is available, that the frac outs are detected in a timely manner, and that appropriate procedures are used to minimize the volume of fluid released and its environmental impact. A discussion of these issues follows.

### 3.2.1 Response Equipment

Equipment for containing, controlling and cleaning up any drill fluid released during a frac out will be kept on site throughout the installation process.

Heavy equipment not specifically designated for control and clean up of drill fluid such as backhoes will also be available on site.

The following list identifies some materials and equipment that will be maintained at each HDD site in sufficient quantities to help ensure containment of frac outs of drilling fluid:

- Weedfree straw or hay bales.
- Sand bags
- Stakes to secure bales.
- Silt fence.
- Shovels, rakes, brooms and buckets
- Trash pumps and flexible hose
- Light tower(s), so that cleanup work could continue after dark.
- A boat with appropriate personal safety equipment at major water body crossings.

### 3.2.2 Monitoring and detection

An obvious key to the timely detection of a frac out is monitoring of the surface above the HDD crossing for drill fluid. This is relatively easy to accomplish in upland areas during daylight hours. However, for large diameter pipelines such as the one proposed by PREPA, the HDD process must be done on a 24 hour per day, 7 day per week basis.

Visually detecting a frac out in a large waterbody or marshy area will be difficult, especially at night.

Unfortunately the areas where the potential environmental impact of a frac out is greatest are wetlands and waterbodies. These areas will present the greatest challenge visual monitoring.

PREPA will require the selected contractor to employ a program of visually monitoring the ground above the HDD crossing for frac outs. However, this program will be supplemented by data from the downhole monitoring measures described above, namely pressure monitoring and volume monitoring.

The downhole pressure is greatest in the vicinity of the downhole tool in all three of the HDD processes described above. If a frac out occurs it will initiate from the borehole in the immediate vicinity of the downhole tool. Hence, visual monitoring on the surface will be concentrated on the area above the downhole tool.

Survey stakes will have been placed and labeled on the surface at 100 foot intervals along the HDD centerline. The monitors will be constant radio contact with the driller who will keep them apprised of the position of the downhole tool. The survey stakes will provide the monitors with the necessary reference to allow them to concentrate their efforts above the downhole tool.

The driller will also keep the monitors apprised of the drill fluid pressures and mud volume balance and will provide his professional opinion of level of risk of a frac out occurring at any given time.

Armed with this data the monitors will be able to decide if monitoring a difficult area, such as a deep swift river at night is warranted. It will also allow them to allocate their resources in the most effective manner.

The identification of a potential frac out prior to it actually occurring is dependent upon the skill and experience of the people involved. For this reason, PREPA will be using a contractor that specializes in HDD to perform the proposed crossings. Similarly the environmental inspector who will supervise monitoring and mitigation efforts will also be experienced in this type of work as required by the Environmental Protection Agency (EPA).

### 3.2.3 Corrective Action for Frac outs

If a frac out occurs the chief inspector and the environmental inspector will be immediately notified. The following describes the sequence of events that will then take place.

#### 3.2.3.1 Minimization of volume released.

The first action required when a frac out is detected is to minimize the volume of drill fluid that is released. This will be done by immediately halting pumping of drill fluid downhole. Pumping will not resume until the situation is assessed and, if possible, the fluid release is contained and controlled. As it is probable that the frac out will resume as soon as fluid pumping starts again containment and control measures will have to be able to contend with a further release of fluid. Normally the frac out stops of its own accord when the drilling assembly progresses a short distance ahead of the release point.

The risk of failure of the HDD installation increases dramatically as the duration over which pumping is halted increases. Hence, actions will be taken quickly in order that pumping may resume as quickly as possible.

#### 3.2.3.2 Containment and control of drill fluid released

The types of measures implemented to contain the fluid released will depend on the type of area in which the release occurs.

*Upland areas*. Frac outs in upland areas are most common as the drill profiles are designed such that the portions that have minimal depth of cover are beneath upland areas. Containment measures in these areas are easily implemented and consist of using hay bales, and or silt fence to contain the fluid within the immediate vicinity of the release. If the rate of release is large, a collection pit will be dug at the point of release and a trash pump will be set up to draw fluid from the pit and pump it back to the drill rig via a flexible hose. Once the containment measures are in place drilling operations will resume.

*Wetlands*. Frac outs in wetlands are quite rare as the depth of cover provided in these areas is normally sufficient to prevent frac outs. If a frac out occurs the containment and control measures will be similar to those used in upland areas with the exception that the use of heavy equipment will be severely restricted. Once the containment measures are in place drilling operations will resume. Depending of the flow rate of fluid released, drilling procedures may be modified to reduce that rate. These modifications may include introduction of LCM's (Lost Circulation Material) into the drill fluid, increasing drill fluid viscosity and the temporary reduction of drill fluid pumping rates. Drill penetration rates may also be temporarily increased in an effort to move the drilling assembly away from the release point as quickly as possible in order that the release stops quickly.

*Waterbodies*. Frac outs in waterbodies are also rare due to the provision of adequate depth of cover. Implementation of containment and control measures is most difficult in waterbodies and is only practicable when the depth of water is less than two feet and the water is slow moving. In these cases only, the drill fluid will be contained by hand carrying sand bags into the waterbody. A containment barrier that extends above the water surface will be built by hand placing the sand bags around the release point. If practicable, a trash pump will be placed on the shore and a suction hose extended from the pump to the release point. The drill fluid will then be pumped through a flexible hose back to the drill rig. Once the containment measures are in place drilling operations will resume.

Drilling operations will resume immediately and measures will be implemented to limit the further release of fluid into the waterbody. These include introduction of LCM's into the drill fluid, increasing drill fluid viscosity and the temporary reduction of drill fluid pumping rates. Drill penetration rates will also be temporarily increased in an effort to move the drilling assembly away from the release point as quickly as possible in order that the release stops quickly.

The effectiveness of the measures implemented to limit the release of drill fluid will be closely monitored. If the measures are not effective and if the environmental impact of the release is deemed unacceptable the HDD installation will be abandoned. Another attempt using a modified profile or at an alternate location may be made.

PREPA will notify appropriate downstream water intake authorities of the existence and location of any drill fluid plume that extends more than 1,000 yards from the HDD crossing site.

#### 3.2.3.3 Additional control measures

A determination will be made of the cause of the frac out. If it is determined that downhole pressures are excessive then measures to reduce them will be implemented. These measures are described above and include swabbing the hole and or modifying the drill fluid properties.

### 3.2.4 Drill fluid clean up

Measures to clean up drill fluid released by a frac out will be determined on a case by case basis in consultation with the environmental inspector. Often, if the features affected are not sensitive and the volumes released are small, minimal or no clean up will be required.  Similarly, it is often determined that clean up measures will do more harm than good to sensitive features and that it is best to let the drill fluid dissipate naturally.

Drill fluid can be cleaned up by collecting it by hand with shovels, brooms and buckets. Larger volumes can be cleaned up by means of pits and pumps or mechanized equipment.

In wetland and upland areas drill fluid can be diluted by washing the affected area down with water.

### 3.2.5 Agency Notification Procedures

If a frac out occurs within a stream, wetland or wetland buffer, or other sensitive resources, or poses a threat to public safety, the Environmental Inspector will immediately notify Senior Environmental Specialist for the project who will, in turn, notify all required State and Federal environmental agencies.

The Environmental Inspector will provide the following:

- The location of the frac out;
- A description of the area affected; and
- The containment measures implemented.

As soon as possible, a report, containing the following information, will be prepared and emailed to the appropriate agencies.

- The cause of the release;
- Photographs of the release site;
- The area affected;
- The location and size of the resulting work area; and
- The location of any drainage, streams or wetlands in the area and the distance to them from the failure site.

Upon completion of HDD activities, PREPA or the selected contractor will prepare a report that summarizes:

- The events leading up to the frac out;
- The measures taken to minimize the impacts following the release;
- Any impacts from the release;
- Mitigation for the impacts from the release; and
- Agency contacts.

## 4.0 DETAILED INSTALLATION PLAN

The HDD contractor will be required to submit a site specific Detailed Installation Plan for each crossing for prior to beginning work.  At a minimum, the Detailed Installation Plan will provide the following:

- A detailed description of all drilling equipment including manufacturer and model, maximum pull push capability, torque capability and horsepower
- A detailed description of all drill fluid pumping, recycling, and handling equipment including manufacturer and model, maximum pumping pressure and flow rates, tank sizes, recycling flow capacities, number of hydrocyclones and sizes, number and size of shaker screens.
- MSDS for all drill fluid components that will be or could be used
- Anticipated drill fluid pumping rates and volumes for each phase of the HDD installation
- A detailed list of all frac out containment and clean up equipment and materials that will be kept on site.
- Locations and descriptions of disposal sites for excess drill fluid and cuttings
- Resumes of all key personnel that will be involved.
- Proposed variations from or additions to the frac out plan described above

## Via Verde Project
## Horizontal Directional Drill (HDD) Information and Supplemental Data

| No. | Milepost | Name | Drawing No. | length | Estimated Water Withdrawal Rate (GPM) | Water Source | Pressure Monitoring Type | Cuttings Disposal Method | Excess Fluid Disposal Method |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.28 | Matilde River | 48.0-Z-325.00 | 1,417 | 200 | PREPA's wells / Eco electrica water supply | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 2 | 0.7 | Canal | 48.0-Z-325.18 | 1,100 | 200 | PREPA's wells / Eco electrica water supply | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 3 | 1.48 | Rio Tallaboa | 48.0-Z-325.01 | 1,298 | 200 | PREPA's wells / Eco electrica water supply | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 4 | 28.1 | Rio Grande de Arecibo & minor road | 48..0-Z-325.03 | 1,185 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 5 | 35.2 | Rio Grande de Arecibo, PR 123 & PR10 | 48.0-Z-325.04 | 1,850 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 6 | 36.2 | Rio Grande de Arecibo | 48.0-Z-325.05 | 1,200 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 7 | 37.4 | Rio Tanama and minor road | 48.0-Z-325.14 | 1,360 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 8 | 40.1 | Drainage Channel | 48.0-Z-325.22 | 1100' | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 9 | 40.7 | Rio Grande de Arecibo | 48.0-Z-325.06 | 1,838 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 10 | | Cambalache Power Station | 48.0-Z-325.23 | 898' | 200 | | Downhole | | Recycle to next HDD |
| 11 | 53.1 | Rio Manati & PR 684 | 48.0-Z-325.07 | 1,230 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 12 | 54 | Hacienda Esperanza/PR 616 | 48.0-Z-325.24 | 3023 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 13 | 56.9 | Rio Manati | 48.0-Z-325.08 | 1,200 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 14 | 57.7 | Rio Manati PR6685 | 48.0-Z-325.09 | 1,910 | 200 | Temporary water well on nearby HDD site | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 15 | 66.6 | Rio Indio | 48.0-Z-325.10 | 1,387 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 16 | 76.4 | Rio de la Plata | 48.0-Z-325.11 | 1,600 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |
| 17 | 79.8 | Forested Wetland | 48.0-Z-325.17 | 1,300 | 200 | Temporary On-Site Water Well | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 18 | 81.1 | Rio Cocal & PR 165 | 48.0-Z-325.12 | 4,531 | 200 | Temporary water well on nearby HDD site | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 19 | 81.8 | Punta Salinas | 48.0-Z-325.19 | 3,568 | 200 | PREPA Palo Seco Power Plant | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 20 | 82.3 | PR 165 Levittown Beach HDD 1 | 48.0-Z-325.20 | 4,495 | 200 | PREPA Palo Seco Power Plant | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 21 | 83.3 | PR 165 Levittown Beach HDD 2 | 48.0-Z-325.21 | 3,782 | 200 | PREPA Palo Seco Power Plant | Downhole | Spread and mix with topsoil on Pipeline ROW | Recycle to next HDD |
| 22 | 84.1 | Rio Hondo / Rio Bayamon | 48.0-Z-325.13 | 1,831 | 200 | PREPA Palo Seco Power Plant | Downhole | Spread and mix with topsoil on Pipeline ROW | Spread and mix with topsoil on Pipeline ROW |

Note: Successful Contractor shall engage a specialist HDD Engineering firm to prepare an Annular Pressure Curve for each HDD crossing requiring Downhole Pressure Monitoring