ATTACHMENT N

HDD Contingency Plan

Spire STL Pipeline Project

Horizontal Directional Drill Contingency Plan

FERC Docket Nos. CP17-40-000 and CP17-40-001

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Table of Contents

Acronyms and Abbreviations

FERC	Federal Energy Regulatory Commission
HDD	horizontal directional drill
LGC	Laclede Gas Company
Project	Spire STL Pipeline Project
Spire	Spire STL Pipeline LLC

Horizontal Directional Drill Contingency Plan

The following discussions summarize the minimum requirements for dealing with an inadvertent return during horizontal directional drill ("HDD") installations beneath the Mississippi and Missouri Rivers. It also presents a contingency plan in the event of a failed HDD installation. A detailed hydraulic fracture/inadvertent return plan will be developed by the HDD contractor and reviewed by Spire STL Pipeline LLC ("Spire") prior to commencing drilling operations.

1.0 Background Information

Spire is seeking authorization from the Federal Energy Regulatory Commission ("FERC") to construct and operate the proposed Spire STL Pipeline Project ("Project") located in Scott, Greene, and Jersey Counties, Illinois, and St. Charles and St. Louis Counties, Missouri. The proposed Project will consist of approximately 65 miles of new, greenfield, 24-inch-diameter steel pipeline in two segments. The first segment (referred to as the "24-inch pipeline" portion of the Project) will originate at a new interconnect with the Rockies Express Pipeline LLC pipeline in Scott County, Illinois and extend approximately 59 miles through Greene and Jersey Counties in Illinois before crossing the Mississippi River and extending east through St. Charles County, Missouri. The 24-inch pipeline then crosses the Missouri River into St. Louis County, Missouri, and terminates at a new interconnect with Laclede Gas Company ("LGC"). The second segment of new, greenfield pipeline (referred to as the "North County Extension"), will consist of a 24-inch-diameter steel pipeline which will extend approximately six miles from the LGC interconnect through the northern portion of St. Louis County and terminate at a new interconnect with Enable Mississippi River Transmission, LLC and LGC.

Spire proposes to use the HDD method to install the pipeline under the Mississippi River, Missouri River, and Spanish Lake Park. A traditional single drill rig operation is anticipated to be used to complete the Missouri River, and Spanish Lake Park HDD installations. For the Mississippi River, it is anticipated the HDD contractor will use the drill and intersect method to complete the installation due to the need for temporary conductor casings on each end of the HDD alignment (casings will be removed upon completion of pullback operations). The intersect method involves drilling individual pilot bores from each end of the HDD installation and intersecting in a target intersection location established in the bottom horizontal tangent of the HDD profile. Use of the drill and intersect method decreases the flow pathway length for each individual pilot bore. One advantage of this method is a lower required drilling fluid pressure necessary to complete each pilot bore operation.

1.1 HDD Construction Method

HDD is a surface-to-surface installation technique comprised of three primary stages including pilot bore, reaming, and product pipe installation. This method of construction is typically used to install pipelines in areas not amenable for open cut construction, including waterbodies, highways, railroads, runways, environmentally sensitive areas and urban environments. Assuming proper design and good HDD construction practices, the HDD method allows for the installation of pipelines with minimal impacts to the crossing feature(s).

The first stage of the installation process consists of advancing a steerable, rotary drill bit along the design alignment from the drill rig entry location to the exit location. The downhole tooling is matched to the anticipated ground conditions. Soil tooling is typically used in soils and bedrock tooling is used to drill through bedrock materials. As the pilot bore is advanced, a tracking system is used to locate the position and orientation of the assembly to allow for steering inputs required to maintain the design profile and alignment.

The second stage of the installation process is referred to as the reaming stage. This process consists of enlarging the pilot bore to a final diameter necessary to accommodate the product pipe. Depending upon the outer diameter of the product pipe, multiple reaming passes of increasing diameter are typically used to incrementally increase the size of the bore to the final required diameter. The acceptable HDD industry standard for the final bore diameter is generally 1.5 times the outer diameter of the pipe being installed for product pipe diameters less than or equal to 24 inches and 12 inches larger than the outer diameter of the product pipe for product pipe diameters greater than 24 inches. Hence, for the anticipated NPS24 pipeline, the final bore diameter is expected to be 36 inches.

Upon completion of the reaming pass(es), the condition of the HDD bore is assessed by pushing or pulling a barrel or ball reamer with a slightly larger diameter than the product pipe (but less than the final diameter of the bore) through the fully reamed bore from start to finish. This proving step is referred to as a swab pass. The observed drill rig effort during this installation step allows the HDD contractor to evaluate if the bore has been conditioned sufficiently to receive the product pipe.

The final stage of the installation process consists of pulling/installing the fabricated product pipe from the pipe entry location toward the drill rig. A reamer and swivel is placed between the drill pipe within the reamed bore and the pulling head connected to the product pipe. The swivel is used to isolate the torsional stresses from the rotating drill pipe and reamer assembly and prevent rotation of the product pipe during its installation. The reamer used in the pulling assembly is slightly larger than the pipe diameter, but smaller than the final bore diameter. The reamer assembly is used to clear any cuttings that may remain in the bore, reducing installation risks during the product pipe pullback phase of the installation process.

The use of the reamer also allows for fluids to be pumped downhole during pullback to assist with cuttings removal and lubrication of the product pipe string. Large diameter product pipes are typically buoyant when pulled into a drilling fluid filled bore and tend to float to the top of the bore. To counter buoyancy conditions and increased frictional forces, water is often added to the back end of the product pipe to increase the net weight of the product pipe string. Without the use of buoyancy counter measures, risks associated with overstressing of the product pipe and excessive damage to abrasion resistant coatings and corrosion protection due to the increased frictional forces will increase.

Pipe rollers and additional heavy equipment (i.e., cranes, excavators, and/or side booms) are required to assist the pullback process. The rollers and slings on the equipment provide support for the fully fabricated pipe string, help to reduce the amount of friction acting on the tail string (thus reducing the overall amount of force required to pull the pipe into the bore) and also help to position the pipe such that the angle that the pipe enters the bore matches the exit angle of the bore itself. All of these features reduce the bending and tensional stresses applied to the product pipe at the break-over location during installation.

Drilling fluids, consisting of a mixture of water, bentonite, and/or polymers are pumped into the bore during the entire HDD installation process. The exact mixture of fluids is typically determined by the HDD contractor based on the anticipated and actual geotechnical materials encountered within the bore and the performance of the drilling equipment as the drilling process progresses. Polymers are commonly used to modify specific drilling fluid properties that bentonite alone is incapable of providing. The drilling fluids are typically a mixture of freshwater and bentonite (sodium montmorillonite). Bentonite is natural clay usually mined in Wyoming. Bentonite is extremely hydrophilic and can absorb up to 10 times its weight in water. Typically, the drilling fluid contains no more than five percent bentonite (95 percent freshwater).

Drilling fluids perform several functions integral to the success of the installation. These primary functions include:

- cooling, lubricating, and cleaning drilling tools, drill pipe and the product pipe during its installation;
- suspension of cuttings within the drilling fluid to facilitate their removal;
- transport soil/bedrock cuttings from the bore during each phase of the installation process;
- stabilization of the bore against collapse and minimization of raveling of the surrounding soil materials;
- provide a bentonite filter cake along the bore walls to help maintain fluid flow within the drilled bore;
- provide a hydrostatic fluid pressure within the bore to offset ground formation/groundwater pressure; and
- drive downhole tooling (mud motor assemblies) for drilling in bedrock materials.

The HDD contractor maintains drilling fluid performance through sampling, testing, and recording the fluid properties during drilling operations. The HDD contractor also analyzes, adjusts, and maintains the fluids as necessary to afford the most efficient drilling fluid rheology to adapt to various geological conditions.

The drilling fluid is pumped into the bore through the drill pipe. As the drilling fluid exits the down-hole tooling within the bore, it mixes with the soil and/or rock cuttings generated by the down-hole tooling to create “flowable” slurry. This mixture flows through the HDD bore under an induced fluid pressure gradient generated by the injection of additional drilling fluids into the bore.

When the drilling fluids reach the ground surface at either the HDD entry or exit locations, these fluids are either transferred to a separation plant for processing or removed from the site with vacuum trucks (or other means). Separation plants are commonly used on installations where the cost to dispose of the drilling mud and cuttings exceeds the costs to recycle and reuse the fluids.

Controlling and maintaining fluid flow within the HDD bore during all installation stages is critical to the success of an HDD installation. While the HDD method is a proven technology, there are certain impacts that could occur as a result of the drilling such as the inadvertent release of drilling fluid, which is a slurry of bentonite clay and water which is classified as non-toxic to the aquatic environment and is a non-hazardous substance. Drilling fluids that are released typically contain a lower concentration of bentonite when they surface because the bentonite is filtered out as its passes through existing sediments of varying types. All drilling fluid components will be approved by the Owner prior to transportation and use on each HDD installation.

The following sections provide the process of HDD and procedures to be implemented in the case of an inadvertent release of drilling fluid.

1.2 Inadvertent Release Procedures/Contingency Plan

Prior to drilling operations, site-specific HDD procedures will be prepared by the HDD contractor and submitted to Spire for review and approval. Drilling fluid returns (flow of drilling fluids to the HDD entry/exit location) will be continuously monitored visually during the installation.

Lost circulation materials may be introduced to the drilling fluid to help seal off a flow pathway that is allowing for drilling fluid migration away from the HDD bore. All mud products will be approved by the Owner prior to use on-site. Lost circulation materials can include, but are not limited to, sawdust, bentonite chips, ground corn, magma fiber, and/or other manufactured materials.

As a minimum, the HDD Procedures will address the following:

1.2.1 Inadvertent Return Prevention

The drill rig operator will monitor the downhole annular pressure at all times. If the bore pressure is observed to be abnormally high or fluid loss is apparent and a release has occurred, the driller has the following options (or any combination of these options):

- temporarily cease drilling operations and shut down mud pump delivering drilling fluids downhole;
- notify Spire representatives immediately;
- dispatch experienced company personnel to monitor the area in the vicinity of the drilled path;
- restart pump and stroke bore hole in 30 foot (+/-) lengths to restore circulation ("swab" the hole) as many as six times but no fewer than two times;
- introduce additional flow along the borehole starting at the entry/exit using "weeper" subs; and
- modify the drilling mud with a change in viscosity and/or lost circulation additives.

1.2.2 Monitoring of Inadvertent Returns

1.2.2.1 Personnel and Responsibilities

The actions in this Plan are to be implemented by the following personnel:

- Chief Inspector - Spire will designate an HDD Chief Inspector for the Project. The Chief Inspector will have overall authority for construction activities that occur on the Project.
- Environmental Inspector - At least one Environmental Inspector will be designated by Spire to monitor the HDD activities. The Environmental Inspector will have status over all other activity inspectors and will report directly to the HDD Chief Inspector who has overall authority. The Environmental Inspector will have the authority to stop activities that violate the environmental conditions of the FERC Certificate (if applicable), other federal and state permits, or landowner requirements, and to order corrective action.

- HDD Superintendent - The HDD Superintendent will be the senior on-site representative of the HDD contractor and will have the overall responsibility for implementing this Plan on behalf of the HDD contractor. The HDD Superintendent will be familiar with all aspects of the drilling activities, the contents of the Plan, and the conditions of approval under which the activity is permitted to take place. The HDD Superintendent will make a copy of this Plan available at the drill site and will distribute it to the appropriate construction personnel. The HDD Superintendent will ensure that workers are properly trained and familiar with the necessary procedures for response to an inadvertent release.
- HDD Operator - The HDD Operator will be responsible for operating the drilling rig and mud pumps, monitoring circulation back to the entry and exit locations, and monitoring annular pressures during pilot hole drilling. In the event of loss of circulation or higher than expected annular pressures, the HDD Operator must communicate the event to the HDD Superintendent and HDD contractor field crews, as well as the on-site Spire inspection staff. The HDD Operator is responsible for stoppage or changes to the drilling program in the event of observed or anticipated inadvertent returns.
- HDD Contractor Personnel - During HDD installation, field crews will be responsible for monitoring the HDD alignment along with the Spire's field representatives. Field crews, in coordination with the Environmental Inspector, will be responsible for timely notifications and responses to observed releases in accordance with this Plan. The Environmental Inspector ultimately must sign-off on the action plan for mitigating the release.

Prior to drilling, the HDD Superintendent, Chief Inspector, and Spire's Environmental Inspector will verify that the HDD Operator and field crew receive, at minimum, the following site-specific training:

- Project-specific safety training;
- review provisions of this Plan and site-specific permit requirements;
- review location of sensitive environmental resources at the site;
- review drilling procedures for release prevention;
- review the site-specific monitoring requirements;
- review the location and operation of release control equipment and materials; and
- review protocols for reporting observed inadvertent returns.

1.2.2.2 Monitoring and Reporting

Appropriate monitoring and reporting actions will be as follows:

- Site monitoring along and adjacent to the immediate HDD alignment will be completed daily by the HDD Contractor and Spire's Environmental Inspector. This will include walking along the alignment (where practical) and visually determining if any drilling fluid inadvertent returns have occurred along the alignment or within 50 feet perpendicular to the HDD alignment.

- Site monitoring will be increased in the event a suspected drilling fluid loss event has occurred that may contribute to an inadvertent drilling fluid return.
- If the HDD Operator observes a sudden decrease in the downhole annular fluid pressure or significant decrease in the drilling fluid volume returning to the drill rig that may suggest a loss in circulation event has occurred, the Operator will notify the HDD Superintendent and field crews of the event and approximate position of the tooling.
- If the HDD Operator observes a sudden increase in the downhole annular fluid pressure, the HDD contractor will reduce their drilling fluid pump rate and pullback one or more drill pipe joints to clear any blockage that may have developed behind the drill bit.
- Where practical, a member of the field crew will visually inspect the ground surface near the position of the cutting head.
- If an inadvertent release is observed:
  - field crew will notify (via handheld radio or cell phone) the HDD Operator;
  - the HDD Operator will temporarily cease pumping of the drilling fluid and notify the HDD Superintendent and Chief Inspector;
  - the Chief Inspector will notify and coordinate a response with the Environmental Inspector;
  - the Environmental Inspector will notify appropriate permit authorities, as necessary, of the event and proposed response and provide required documentation within 24 hours; and
  - the Chief Inspector will prepare a report that summarizes the incident.

1.2.3 Response to Inadvertent Returns

Typically, inadvertent releases are most often detected in an area near the entry or exit locations of the drill alignment when the pilot bore is at shallow depths, above bedrock, and in permeable/porous soils. In these occurrences, the release will be assessed by the HDD Superintendent, Environmental Inspector, and Chief Inspector to determine an estimated volume and footprint of the release. The potential of the release to reach adjacent waterbodies, wetlands, or other types of infrastructure will also be assessed.

The HDD Superintendent will assess the drilling parameters (depth, annular pressures, fluid flow rate, and drill fluid characteristics) and incorporate appropriate changes.

The HDD Superintendent, Environmental Inspector, and Chief Inspector will implement installation of appropriate containment structures and additional response measures. Access for personnel and equipment to the release site is a major factor in determining the methods used for containment and disposal. Typically, containment is achieved by excavating a small sump pit (five cubic yards) at the site of the release and to surround the release with hay bales, silt fence, and/or sand bags. Once contained, the drilling fluid is either collected by vacuum trucks or pumped back to the mud recycle unit or to a location accessible to vacuum trucks. The fluids are then transported either back to the HDD drilling rig or to a disposal site.

If the release is mitigated and controlled, forward progress of the drilling will be approved by the Environmental Inspector in coordination with the HDD Superintendent and Chief Inspector.

The site-specific response will follow the guidelines presented below.

1.2.3.1 Inadvertent Fluid Release at Inaccessible Location

If inadvertent returns are observed surfacing on the ground surface at a location that is inaccessible, the following procedures will be followed:

- contractor will ensure all reasonable measures within the limitations of current technology have been taken to re-establish circulation; and
- continue drilling utilizing a minimal amount of drilling fluid as required to penetrate the formation or to maintain a successful product pull back.

1.2.3.2 Upland Location

- Evaluate the amount of release to determine if containment structures are warranted and will effectively contain the release.
- Promptly implement appropriate containment measures as needed to contain and recover the slurry.
- If the release is within 50 feet of a wetland or waterbody, silt fence and/or hay bales will be installed between the release site and the wetland or waterbody.
- If the release cannot be contained, then the HDD Operator will suspend drilling operations until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location accessible to a vacuum truck.
- After the HDD installation is complete, perform final clean-up.

1.2.3.3 Wetland Location

Spire’s proposed HDD installations are designed to minimize the potential for inadvertent releases to the HDD crossing locations. Although final design is still in progress, Spire expects that the Mississippi and Missouri River crossings will be in soils in the vicinity of the HDD entry and exit locations transitioning to bedrock materials. The bedrock materials are capable of resisting higher drilling fluid pressures than the soils. To further minimize the potential for inadvertent returns, casing will be installed through overburden soils at both ends of the HDD for the Mississippi River. Casing is anticipated at the HDD entry location only for the Missouri River crossing.

Even with these controls in place, if a release of drilling fluids does occur, the following steps will be taken:

- Evaluate the amount of release to determine if containment structures are warranted and will effectively contain the release.

- Promptly implement appropriate containment measures to contain and recover the slurry.
- Efforts to contain and recover slurry in wetlands may result in further disturbance by equipment and personnel and possibly offset the benefit gained in removing the slurry.
- If the amount of the slurry is too small to allow the practical collection from the affected area, the fluid will be diluted with freshwater or allowed to dry and dissipate naturally.
- If the release cannot be controlled or contained, drilling operations will be suspended immediately until appropriate containment is in place.
- Remove the fluids using either a vacuum truck or by pumping to a location accessible to a vacuum truck.
- After the HDD installation is complete, perform final clean-up.

1.2.3.4 Final Clean-Up

After completion of the HDD installation, site-specific clean-up measures will be developed by the Chief Inspector and HDD Superintendent for approval by the Environmental Inspector. Potential for secondary impact from the clean-up process will be evaluated, along with the benefits of clean-up activities.

The following measures are considered appropriate:

- Drilling mud will be removed by hand using shovels, buckets, and soft bristled brooms to minimize damage to existing vegetation.
- Freshwater washes may be employed if deemed beneficial and feasible.
- Containment structures will be pumped out and the ground surface scraped to bare topsoil, thereby minimizing loss of topsoil or damage to adjacent vegetation.
- The recovered drilling fluid will be recycled or disposed of at an approved upland location or disposal facility. No recovered drilling fluid will be disposed of in streams or storm drains.
- All containment structures will be removed.
- Recovered materials will be collected in containers for temporary storage prior to removal from the site.

1.3 Failed HDD Installation

While not anticipated, if an attempted HDD installation is unsuccessful, the proposed HDD alignment could be modified beneath the River using the same general location to accommodate an additional HDD attempt, depending on the condition that resulted in the HDD failure. Prior to attempting a second HDD crossing, a risk mitigation workshop should be held with all parties to determine the cause of the initial failure and any mitigation measures that could be adopted to reduce the risk(s) during the second HDD attempt.

Potential causes that may lead to a failed HDD installation include:

- stuck or damaged product pipe during pullback operations; this risk is mitigated by:

- completing swab pass or passes to gauge the condition of the HDD bore by evaluating the drill rig effort required to pull tooling through the HDD bore;
- only commencing pullback operations after verification that the bore is adequately conditioned; and
- minimizing the amount of downtime associated with delays during pullback operations.

- bore instability/collapse; this risk is mitigated by:
  - designing the HDD profile in favorable ground materials along the alignment that are not amenable to raveling causing collapse of the bore.
- Excess loss of drilling fluids and inability to remove cuttings from the bore; this risk is mitigated by:
  - designing the HDD profile in favorable ground materials along the alignment;
  - evaluating the required and allowable drilling fluid pressures for the installation and providing sufficient separation between the required and allowable drilling fluid pressures; and
  - incorporating temporary casing pipe to support shallow soils.

If an open HDD bore could not be advanced and abandonment where required, the bore would be grouted with a cement-based material to fill the excavation and minimize risks of a potential groundwater flow pathway.

If an HDD installation were completed and the installed pipe was damaged to the point it could not be used for its intend purpose, the inside of the steel product pipe would be grouted with a cement based grout and the annular space around the pipe would be grouted for a distance of approximately 200 feet at each HDD entry and exit location. The above approach is as outlined in the US Army Corps of Engineers' "Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling" (Latorre et al. 2002) that requires backfilling with grout or bentonite. In addition, any additional requirements set forth in permits acquired for a specific HDD installation will be met in terms of abandonment.

1.4 Reference

Latorre, Carlos A., Wakeley, Lillian D., and Conroy, Patrick J. 2002. *Guidelines for Installation of Utilities Beneath Corps of Engineers Levees Using Horizontal Directional Drilling.* United States Army Corps of Engineers. ERDC/GS LTR-02-9.