
HORIZONTAL DIRECTIONAL DRILLING (HDD) STANDARDS

A. GENERAL

1. **Scope of Work:** The work specified in this section consists of furnishing and installing underground utilities using the HDD method of installation. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration. For the supply of potable water during construction, the Contractor shall utilize a CITY fire hydrant meter assembly (meter & backflow device) and pay for all water consumed unless otherwise approved by CITY's Authorized Project Representative. Un-metered reclaimed water may be utilized for flushing and testing of new reclaimed water mains. Non-metered potable water quantities shall be limited to the maximum extent possible.
2. **Quality Assurance:** The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional drilling installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification or within any associated permit (i.e.: FDEP, FDOT, etc.). Adherence to the specifications contained herein, or the CITY authorized Representative's approval on any aspect of any directional drilling operation covered by this specification, shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work authorized under the Contract. The HDD Contractor shall be responsible for the repair of all damage to private and/or public property (at no additional expense to CITY). Post construction restoration and/or repair work shall meet all local, state, and federal rules and requirements.
3. **Project Schedule and Cooperation:** The project schedule shall be established on the basis of working a normal work schedule including five days per week, single shift, and eight hours per day or four days per week, single shift, ten hours per day. Unless approved otherwise by CITY, normal or general items of work such as bacteriological testing, leakage and pressure testing, density testing and final inspections, shall be scheduled during the normal work schedule. CITY may require the Contractor to perform work outside of the normal work schedule. The Contractor shall provide such work or services at the unit prices shown on the Bid Form.
4. **Warranty:** The Contractor shall supply to CITY one (1) year unconditional warranty. The warranty shall include materials and installation and shall constitute complete replacement and delivery to the site of materials and installation of same to replace defective materials or defective workmanship with new materials/workmanship conforming to the specifications.
5. **Referenced Standards:** The work shall conform to applicable provisions of the CITY Water and Wastewater Standards, and the following standards, latest editions, except as modified herein.
 - a. **American Water Works Associations (AWWA) Standards:**
 - i. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch, for Water Distribution
 - b. **American Society for Testing and Materials (ASTM) Standards:**
 - i. ASTM D618 - Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing
 - ii. ASTM D638 - Standard Test Method for Tensile Properties of Plastics

- iii. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- iv. ASTM D1248 - Standard Specifications for Polyethylene Plastics Molding and Extrusion Materials
- v. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique
- vi. ASTM D1598 - Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- vii. ASTM D1599 - Standard Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
- viii. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics
- ix. ASTM D2122 - Standard Method of Determining Dimensions of Thermoplastics Pipe and Fittings
- x. ASTM D2290 - Standard Test Method for Apparent Tensile Strength of Tubular Plastics and Reinforced Plastics by Split Disk Method
- xi. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- xii. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
- xiii. ASTM D2839 - Standard Practice for Use of a Melt-Index Strand for Determining Density of Polyethylene
- xiv. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
- xv. ASTM E3261 - Standard Specification for Butt Heat Fusion Polyethylene Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- xvi. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
- xvii. ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- xviii. ASTM F412 - Standard Terminology Relating to Plastic Piping Systems

B. PERMITS

1. Permits for all work within the FDOT, City of Lake City, Columbia County and Submerged Land of the State of Florida right of way shall be obtained and paid for by CITY. The Contractor shall verify the existence of all permits before commencing any work on the project.

C. SUBMITTALS

1. **Work Plan:** Prior to beginning work, the Contractor may be required to submit to the CITY Authorized Representative a work plan detailing the procedure and schedule to be used to execute the project. The work plan should include a description of all equipment to be used, down-hole tools, a list of personnel and their qualifications and experience (including back-up personnel in the event that an individual is unavailable), list of sub-contractors, a schedule of work activity, a safety plan (including MSDS of any potentially hazardous substances to be used), traffic control plan (if applicable), an environmental protection plan and contingency plans for possible problems including a Frac-Out and Surface Spill Contingency Plan (for CITY review). The work plan should be comprehensive, realistic, and based on actual working conditions for the particular project. The work plan should document the thoughtful planning required to successfully complete the project. The HDD Contractor shall submit to CITY for review a pre-construction bore-log depicting a plan and profile (horizontal and vertical alignment) of the proposed bore path. The bore-log shall show all existing utility crossings and existing structures.
2. **Shop Drawing Submittals:** Actual catalog data, brochures and descriptive literature will not be required for items of standard usage which meet the requirements of the CITY Water and Wastewater Approved Materials and Construction Standards Manual. Any specialty item not shown in this manual will require a complete shop drawing submittal for any material which may, in the Engineer's opinion, not be in compliance with the CITY Water and Wastewater Approved Materials and Construction Standards Manual.
3. **Project Record Drawing(s):** Submit for CITY's approval the Record drawings in duplicate to the CITY Representative within five days after completing the pull back. The Record drawing (24" x 36" sepia and Auto CAD disk of as-built data, 20 foot horizontal max scale with 2 foot vertical max scale) shall include a plan, profile (data every 25 LF of main, at a minimum), and all information recorded during the progress of the work, including all subsurface anomalies identified by Ground Penetrating Radar or vacuum excavation. The HDD Contractor shall certify in writing the accuracy of all Record drawings.
4. **Notification:** For all HDD project construction occurring within the limits of the Columbia County Public Works Department (CCPWD) Rights-of-Way (ROW) the Contractor must strictly comply with the following administrative procedures:
5. Prior to starting any construction work, the Contractor must obtain a copy of the CCPWD Approved ROW Use Permit from CITY Engineering staff. The HDD Contractor must at all times retain a copy of the Approved Permit at the project site. The Contractor is required to provide CITY Engineering staff with a "firm" construction start date and time a minimum of 48-hours prior to requesting CITY staff to activate the CCPWD Permit.
6. The HDD Contractor is solely responsible for scheduling a Pre-Bore meeting with the CCPWD Inspector identified on the CCPWD Permit. The Pre-Bore meeting shall occur 24-hours (minimum) prior to beginning the HDD work.
7. Incidents involving failure by the HDD Contractor are to strictly comply with the stated requirements, Notification, and will be documented by CITY Engineering staff. CITY Engineering staff will consider documented non-compliance with the required Administrative procedures stated herein as part of a process to determine the award of future HDD project work.

D. SITE PREPARATION

1. Prior to any alterations to the work-site, the Contractor shall photograph or video tape the entire work area. One copy of which shall be given to CITY Representative and one copy to

remain with the Contractor for a period of two (2) years following the completion of the project.

2. The Contractor shall coordinate utilities locates with Sunshine State One-Call of Florida, Inc., (800/432-4770 or web site www.callsunshine.com). Once the locate service has field marked all utilities, the Contractor shall field verify each utility (including any service laterals, i.e. water, sewer, cable, gas, electric, phone, etc.) and those within each paved area. Verification may be performed by utilizing Ground Penetrating Radar, hand dig, or vacuum excavation. Prior to initiating drilling, the Contractor shall record on the construction drawings both the horizontal and vertical location of all existing utilities located within the project limits.
3. The work site shall be graded and filled to provide a level working area. No alterations beyond what is required for the Contractor's operations are to be made. The Contractor shall confine all activities to designated work areas.
4. Following drilling operations, the Contractor shall de-mobilize equipment and restore the work-site to pre-construction condition. All excavations shall be backfilled and compacted to 95% of the original density (at a minimum).
5. Environmental Protection: Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by the construction drawings and/or, local, state, and federal regulations. Contractor shall place hay bales, or other approved protection measures, to prevent any off-site discharge of silt and sediments from the project area. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations including environmental condition stated in local, state, and federal permits. Fuel may not be stored in bulk containers (greater than 25 gallons) within 200 feet of any water-body or wetland.

E. PROTECTION OF PROPERTY AND OBSTRUCTIONS

1. Temporary supports and/or adequate protection and maintenance shall be installed on all underground and surface structures encountered in the progress of the work. The structures that have been disturbed shall be restored upon completion of the work.
2. All underground utilities shall be notified 48 hours prior to beginning construction on an individual project. Any known obstruction shall be shown on the construction drawing (s) provided by the user department for the project. The utmost caution shall be taken during construction operations to avoid damage to existing obstructions (pipe, conduit, utility poles and other structures) whether or not shown on the drawings.
3. CITY shall be responsible for obtaining and the cost associated with all required permits for each project.

F. PERSONNEL QUALIFICATIONS CERTIFICATION

1. Directional Drilling: All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety. (Each person must have been fully trained for over 1,000 hours on all facets of directional drilling, including, but not limited to machine operations, mud mixing, locating and material fusion.) A responsible representative who is thoroughly familiar with the equipment and type of work to be performed, must be in direct charge and control of the operation at all times. In all cases the supervisor must be continually present at the job site during the actual directional drilling operation. The

Contractor shall have a sufficient number of competent workers on the job at all times to insure the directional drill is made in a timely and satisfactory manner.

2. Pipe and Fitting Joining: Heat Fusion Joining: Joints between plain end pipes and pipe fittings shall be made by butt fusion when possible. Electro-fusion welding may also be used to complete when the location is not accessible to butt fusion welding equipment. The on-site welder making the joints (butt fusion or electro-fusion) shall have received specific training from the manufacturer of the fittings and/or pipe being welded and shall have written proof of proper training/certification from the associated manufacturers. Only certified welders who have written training certifications from the fitting and/or pipe manufacturer will be allowed to perform this work. That is, to weld a fitting or electro-fusion coupling in place, the on-site welder (employee) must be trained and certified by the fitting manufacturer. The fusion work shall be accomplished (welding and cool-down/closing times) in accordance with the fitting and pipe manufacturers' recommendations, at a minimum. External and internal beads shall not be removed unless approved by CITY.

G. FUSIBLE POLYVINYLCHLORIDE (PVC) PIPE FOR INSTALLATION BY HDD

1. DELIVERY AND OFF-LOADING

- a. All pipe shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the owner or engineer.
- b. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify owner or engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, color, and type.
- c. Pipe should be loaded, off-loaded, and otherwise handled in accordance with AWWA M23, and all of the pipe supplier's guidelines shall be followed.
- d. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- e. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- f. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.

2. HANDLING AND STORAGE

- a. Any length of pipe showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the owner or engineer.
- b. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the owner or engineer.
- c. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.

- d. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way.
- e. If pipe is to be stored for periods of 1 year or longer, the pipe should be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- f. Pipe shall be stored and stacked per the pipe supplier's guidelines.

3. FUSION PROCESS

- a. Fusible PVC pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.
- b. Fusible PVC pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.
- c. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
- d. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:
- e. HEAT PLATE - Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
- f. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
- g. GENERAL MACHINE - Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
- h. DATA LOGGING DEVICE – An approved datalogging device with the current version of the pipe supplier's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
- i. Other equipment specifically required for the fusion process shall include the following:
 - i. Pipe rollers shall be used for support of pipe to either side of the machine
 - ii. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 - iii. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
 - iv. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

- v. Facing blades specifically designed for cutting Fusible PVC pipe shall be used.
- vi. JOINT RECORDING
 1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of Fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

H. DRILLING OPERATIONS

1. General
 - a. Bore path and alignment are as indicated in the contract documents. The path of the bore may be modified based on field and equipment conditions. Entry and exit locations and control-point elevations shall be maintained as indicated in the contract documents.
 - b. Bend radii shown in the contract documents are minimum allowable radii and shall not be reduced.
2. Location and Protection of Underground Utilities
 - a. Correct location of all underground utilities that may impact the HDD installation is the responsibility of the Contractor, regardless of any locations shown on the drawings or previous surveys completed.
 - b. Utility location and notification services shall be contacted by the Contractor prior to the start of construction.
 - c. All existing lines and underground utilities shall be positively identified, including exposing those facilities that are located within an envelope of possible impact of HDD installation as determined for the project specific site conditions. It is the Contractor and HDD system operator's responsibility to determine this envelope of safe offset from existing utilities. This will include, but is not limited to, soil conditions and layering, utility proximity and material, HDD system and equipment, and foreign subsurface material.
 - d. Water Main and Non-Water Main Separation Requirements: The minimum separation requirements between water main and a non-water main shall be shown on the construction drawings or in accordance with the Florida Department of Environmental Protection requirements.
3. Site Location Preparation
 - a. Work site as indicated on drawings shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made
 - b. Contractor shall confine all activities to designated work areas.
4. Drilling Layout and Tolerances
 - a. The drill path shall be accurately surveyed with entry and exit areas placed in the appropriate locations within the areas indicated on drawings. If using a magnetic guidance system, drill path will be surveyed for any surface geomagnetic variations or anomalies.
 - b. Instrumentation shall be provided and maintained at all times that accurately locates

the pilot hole, measures drill-string axial and torsional loads and measures drilling fluid discharge rate and pressure.

- c. Entry and exit areas shall be drilled so as not to exceed the bending limitations of the pipe as recommended by the pipe supplier.

5. Pilot Hole Bore

- a. Pilot hole shall be drilled along bore path. In the event that the pilot bore does deviate from the bore path, it may require contractor to pull-back and re-drill from the location along bore path before the deviation.
- b. The Contractor shall limit curvature in any direction to reduce force on the pipe during pull-back. The minimum radius of curvature shall be no less than that specified by the pipe supplier and as indicated on the drawings.

6. Reaming

- a. After successfully completing the pilot hole, the bore hole shall be reamed to a diameter which meets the requirements of the pipe being installed. The following table is offered as an estimated guide:

Nominal Pipe Diameter	Bore Hole Diameter
< 8 inches	Pipe Dia. + 4 inches
8 inches to 24 inches	Pipe Dia. X 1.5
> 24 inches	Pipe Dia. + 12 inches

- b. Multiple reaming passes shall be used at the discretion of the Contractor and shall conform to this specification.
- c. In the event of a drilling fluid fracture, returns loss or other loss of drilling fluid, the Contractor shall be responsible for restoring any damaged property to original condition and cleaning up the area in the vicinity of the damage or loss.

7. Pipe Pull-Back and Insertion

- a. Pipe shall be fused prior to insertion, if the site and conditions allow, into one continuous length.
- b. Contractor shall handle the pipe in a manner that will not over-stress the pipe prior to insertion. Vertical and horizontal curves shall be limited so that the pipe does not bend past the pipe supplier's minimum allowable bend radius, buckle, or otherwise become damaged. Damaged portions of the pipe shall be removed and replaced.
- c. The pipe entry area shall be graded as needed to provide support for the pipe and to allow free movement into the bore hole.
 - i. The pipe shall be guided into the bore hole to avoid deformation of, or damage to, the pipe.
 - ii. The Fusible PVC pipe may be continuously or partially supported on rollers or other Owner and Engineer approved friction decreasing implement during joining and insertion, as long as the pipe is not over-stressed or critically abraded prior to, or during installation.
 - iii. A swivel shall be used between the reaming head and the Fusible PVC pipe to minimize torsion stress on the pipe assembly.

- d. Buoyancy modification shall be at the sole discretion of the Contractor, and shall not exceed the pipe supplier's guidelines in regards to maximum pull force or minimum bend radius of the pipe. Damage caused by buoyancy modifications shall be the responsibility of the Contractor.
 - e. Once pull-back operations have commenced, the operation shall continue without interruption until the pipe is completely pulled through the bore hole.
 - f. The pipe shall be installed in a manner that does not cause upheaval, settlement, cracking, or movement and distortion of surface features. Any damages caused by the Contractor's operations shall be corrected by the Contractor.
8. Installation Cleanup
- 1. Following the installation, the project site shall be returned to a condition equal to or better than the pre-construction condition of the site. All excavations will be backfilled and compacted per the construction documents and jurisdictional standards. All pavement and hardscape shall be repaired per applicable jurisdictional standards, excess materials shall be removed from the site, and disturbed areas shall be re-landscaped. All drilling fluid shall be properly disposed of per these specifications and all applicable jurisdictional laws.
 - 2. Contractor shall verify that all utilities, structures, and surface features in the project area are sound.

I. EQUIPMENT REQUIREMENTS

- 1. General
 - a. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing, delivery, and recovery system of sufficient capacity to successfully complete the drill, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be re-used, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system. All equipment shall be in good and safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project.
- 2. Drilling System
 - a. Drilling Rig: The directional drilling machine shall consist of a power system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The power system shall be self-contained with sufficient pressure and volume to power drilling operations. The drilling equipment hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations. The rig shall be grounded during drilling and pull-back operations. There shall be a system to detect electrical current from the drilling string and an audible alarm which automatically sounds when an electrical current is detected.
 - b. Drill Head: The drill head shall provide the necessary cutting surfaces and fluid jets.
 - c. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better.
- 3. Guidance System

- a. Magnetic Guidance System (MGS) or proven gyroscopic system shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance shall be capable of tracking at all depths up to eighty feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). The guidance system shall be accurate to $\pm 2\%$ of the vertical depth of the borehole at sensing position at depths up to one hundred feet and accurate within 1.5 meters horizontally.
 - b. The Guidance System shall be of a proven type and shall be operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies on the surface of the drill path and shall consider such influences in the operation of the guidance system if using a magnetic system.
 - c. Bore Tracking and Monitoring: At all times during the pilot bore the Contractor shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axes. The Contractor shall record these data at least once per drill pipe length or every twenty-five (25) feet, whichever is more frequent.
 - d. Downhole and Surface Grid Tracking System: Contractor shall monitor and record x, y, and z coordinates relative to an established surface survey bench mark. The data shall be continuously monitored and recorded at least once per drill pipe-length or at twenty-five (25) feet, whichever is more frequent.
 - e. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed plus or minus 5 feet (horizontal or vertical deviation) from the design path, such occurrences shall be reported immediately to CITY. The Contractor shall undertake all necessary measures to correct deviations and return to design line and grade.
4. Drilling Fluid Pressures and Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the Contractor. The pressures shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming, and pullback operations.
5. Drilling Fluid (Mud) System
- a. Mixing System: A self-contained, closed drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. Mixing system shall continually agitate the drilling fluid during operations.
 - b. Drilling Fluids: Drilling fluids shall be composed of clean water, appropriate additives and clay. Water shall be from an authorized source with a minimum pH of 6.0. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No potentially hazardous material may be used in drilling fluid.
 - c. Delivery System: The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12" high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid cycling system to prevent spills into the surrounding environment. Pumps and/or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

- d. **Drilling Fluid Recycling System:** The drilling fluid recycling system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid reusable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.
- e. **Control of Drilling Fluids:** The Contractor shall follow all requirements of the Frac-Out and Surface Spill Contingency Plan as submitted and approved and shall control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydro fracture fluid losses to formations, and control drilling fluid spillage. This includes any spillages or returns at entry and exit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up. The Contractor shall maintain on-site mobile spill removal equipment during all drilling, pre-reaming, reaming and pullback operations and shall be capable of quickly removing spills. The Contractor shall immediately notify CITY of any inadvertent returns or spills and immediately contain and clean up the return or spill.

6. Other Equipment

- a. **Pipe Rollers:** Pipe rollers, if utilized, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. A sufficient number of rollers shall be used to prevent excess sagging of pipe.
- b. **Pipe Rammers:** Hydraulic or pneumatic pipe rammers may only be used if necessary and with the approval of CITY's Authorized Project Representative.
- c. **Restrictions:** Other devices or utility placement systems for providing horizontal thrust other than those defined above in the preceding sections shall not be used unless approved by CITY's Authorized Project Representative prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the projects.

7. Pull Back

- a. After successfully reaming the bore hole to the required diameter, Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel and reamer to compact bore hole walls. Once pull-back operations have commenced, operations must continue without interruption until pipe is completely pulled into bore hole. During pull-back operations Contractor will not apply more than the maximum safe pipe pull pressure at any time. Maximum allowable tensile force imposed on the pull section shall be equal to 80% of the pipe manufacturer's safe pull (or tensile) strength and as follows:
- b. Torsional stress shall be minimized by using a swivel to connect a pull section to the reaming assembly.
- c. The pullback section of the pipeline shall be supported during pullback operations so that it moves freely and the pipe is not damaged.
- d. External pressure shall be minimized during installation of the pullback section in the reamed hole. Damaged pipe resulting from external pressure shall be replaced at no cost to CITY.

- e. Buoyancy modification shall be at the discretion of the Contractor and shall be approved by the CITY Authorized Project Representative. The Contractor shall be responsible for any damage to the pullback section resulting from such modifications.
- f. In the event that pipe becomes stuck, Contractor will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If pipe remains stuck, Contractor will notify the CITY Representative. The CITY Authorized Project Representative and Contractor will discuss options and then work will proceed accordingly.

K. PIPE ASSEMBLY

1. Pipe shall be welded/fused together in one length, if project site space permits; pipe may be placed on pipe rollers before pulling into bore hole to minimize damage to the pipe. For pipes 16-inch and larger, a re-rounding clamp tool shall be utilized during the electro-fusion process to ensure pipe roundness. For pipe sizes larger than 12-inch, mechanical scrapers (per the fitting manufacturer's recommendation) shall be utilized during the electro-fusion work. It is critical that all original oxidized pipe surfaces be removed in order for fusion to take place. The scraping process requires that approximately 0.10" of the outer "skin" be removed in order to penetrate the oxidation and contamination barrier.
2. Acceptability of Damaged Pipe: Cuts or gouges that reduce the wall thickness by more than 10% are not acceptable and must be cut out and discarded.
3. Butt Fusion Testing: When requested by a CITY inspector, butt fusion testing will be performed. The test fusion shall be allowed to cool completely, and then fusion test straps shall be cut out. The test strap shall be 12" (min) or 30 times the wall thickness in length with the fusion in the center and 1" (min) or 1.5 times the wall thickness in width. Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new test fusion shall be made, cooled completely and tested.
4. Mechanical Joint and Flange Installation: Mechanical joints and flange connections shall be installed in accordance with the Manufacturer's recommended procedure. Flange faces shall be centered and aligned to each other before assembling and tightened bolts. In no case shall the flange bolts be used to draw the flanges into alignment. Bolts shall be lubricated, and flat washers shall be fitted under the flange nuts. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the Manufacturer. At least 1 hour after initial assembly, flange connections shall be re-tightened following the tightening pattern and torque step recommendations of the Manufacturer. The final tightening torque shall be 100 ft-lbs or less as recommended by the Manufacturer.

L. TESTING

1. Disinfection Tests (FOR POTABLE WATER MAINS ONLY)
 - a. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA – Standard C651 entitled "AWWA Standard for Disinfecting Water Mains" and shall be in accordance with Section 350. Bacteriological testing on the water main shall be scheduled and completed by Contractor. Contractor will collect the water samples and be responsible for completing the water sample analysis (lab testing). Contractor shall schedule bacteriological sample collection with City Inspector minimum 48 hours in advance of sample collection.

2. Temporary blow-offs shall be installed for the purpose of cleaning the water main. Blow-offs installed on water mains up to and including 16-inches shall be the next smaller size, in diameter, than the water main being tested. Temporary blow-off shall be removed and plugged after the main is cleared. The CITY Representative shall be present prior to and during the operation of blow-offs. The main shall be flushed prior to disinfection.
3. If feasible, the new water main shall be connected to an existing water main at one point only for flushing purposes (no looping). The new main MUST have a blow off on the end as required previously. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected. Any time the new line is reopened (to repair defective joints or pipe, defective fitting or valve) the complete disinfection process shall be repeated.
4. Pressure and Leakage Tests (FOR POTABLE AND WASTEWATER MAINS)
 - a. Perform tests in accordance with CITY's Water and Wastewater Approved Design Standards Manual.
 - b. Contractor furnish and install cement-lined ductile iron fittings for potable water applications (Protecto 401 or Tnemec Perma-Shield PL Series 431 ceramic epoxy-lined ductile iron fittings for wastewater applications), restraint glands, end caps, blow-off assemblies, service taps, tees, valves, fittings and all appurtenances required for pressure testing.
 - c. Contractor shall provide all tools, equipment, labor and incidentals necessary to complete the work.

M. LOCATE WIRE

1. Two strands of locate wire shall be provided on all installations. For HDD projects, locate wire shall be as specified within CITY's Water and Wastewater Standard Materials Manual and 10 AWG copper-clad carbon steel with 30 mils (min) insulation.

N. RECORD KEEPING AND AS-BUILTS

1. Contractor shall maintain a daily project log of drilling operations and a Magnetic Guidance System (MGS) log with a copy given to CITY's authorized project representative at the completion of the project.
2. The MGS data shall be recorded per accepted industry standard practice during the actual directional drilling operation. The Contractor shall furnish "as-built" plan and profile drawing based on these recordings showing the actual horizontal and vertical location of the new utility installation, and all existing utility facilities found during the installation. The MGS data shall be certified accurate by the Contractor to the capability of the MGS System.
3. "As-built"/Record drawings shall be completed and certified by the Contractor at Contractor's sole expense in a format acceptable to CITY's authorized project representative.

O. ROCK REMOVAL

1. Payment for installing piping under the rock removal unit price shall be on a linear foot basis on the actual number of linear feet of rock removed. The unit price shall cover the cost for all materials, labor, and equipment required to complete the bore through the rock. A minimum of three (3) continuous linear feet of rock is required before a rock removal adder may be requested by the Contractor. The Contractor is responsible for notifying CITY when at least three (3) continuous linear feet of rock is encountered and may resume work only when authorization from CITY is given to continue work under this provision.

S. DIRECTIONAL DRILLING OPERATION

1. Contractor shall provide all material, equipment, and facilities required for directional drilling. Proper alignment and elevation of the bore hole shall be consistently maintained throughout the directional drilling operation. The method used to complete the directional drill shall conform to the requirements of all applicable permits. Copies of all permits shall be supplied to the Contractor by the Owner.
2. The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo-magnetic variations or anomalies.
3. Contractor shall place silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection necessary by documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other close space measures. Contractor shall adhere to all applicable environmental regulations. Fuel may not be stored in bulk containers within 200 feet of any water body or wetland.
4. Readings shall be recorded after advancement of each successive drill pipe, (no more than 10') and the readings plotted on a scaled drawing of 1" = 2', both vertical and horizontal. Access to all recorded readings and plan and profile information shall be made available to CITY, or its representative, at all times. At no time shall the deflection radius of the drill pipe exceed the deflection limits of the carrier pipe as specified herein.
5. A complete list of all drilling fluid additives and mixtures to be used in the directional operation will be submitted to CITY along with their respective Material Safety Data Sheets. All drilling fluids and loose cuttings shall be contained in pits or holding tanks for recycling or disposal. No fluids shall be allowed to enter any unapproved areas or natural waterways. Upon completion of the directional drill close space project, the drilling mud and cuttings shall be disposed of by the Contractor at an approved dumpsite.
6. The pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100-feet. In the event that pilot does deviate from the bore path more than 5-feet of depth in 100-feet, Contractor will notify CITY and CITY may require Contractor to pull-back and re-drill from the location along bore path before the deviation. In the event that a drilling fluid fracture, inadvertent returns, or returns loss occurs during pilot hole drilling operations, Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and wait another 30 minutes. If mud fracture or returns loss continues, Contractor will discuss additional options with the CITY engineer and work will then proceed accordingly.
7. Upon completion of pilot hole phase of the operation, a complete set of "as-built" records shall be submitted in duplicate to the Owner. These records shall include copies of the plan and profile drawing, as well as directional survey reports as recorded during the drilling operation.
8. Upon approval of the pilot hole location the hole opening or enlarging phase of the installation shall begin. The bore hole diameter shall be increased to accommodate the pullback operation of the required size of Fusible PVC pipe. The type of hole opener or back reamer to be utilized in this phase shall be determined by the types of subsurface soil conditions that have been encountered during the pilot hole drilling operation. The reamer type shall be at

- the Contractor's discretion with the final hole opening being a maximum of 1.5 times larger than the outside diameter of the Fusible PVC pipe to be installed in the bore hole.
9. The open bore hole may be stabilized by means of bentonite drilling slurry pumped through the inside diameter of the drill rod and through openings in the reamer. The drilling slurry must be in a homogenous / flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the borehole. The volume of bentonite mud required for each pullback shall be calculated based on soil conditions, largest diameter of the pipe couplings, capacity of the bentonite mud pump, and the speed of pullback as recommended by the bentonite drilling fluid manufacture. The bentonite slurry is to be contained at the exit or entry side of the directional bore in pits or holding tanks. The slurry may be recycled at this time for reuse in the hole opening operation, or shall be hauled by the Contractor to an approved dumpsite for proper disposal.
 10. The Fusible PVC pipe shall be butt fused according to manufacturer's specifications. The pipe must be inspected and cleaned with a wet cloth prior to each joint assembly so they are free of any dirt or sand. The ends of pipe must be free of any chips, scratches, or scrapes before pipe is assembled. A pulling eye will be attached to the Fusible PVC pipe pulling head on the lead stick of pipe which in turn will be attached to a swivel on the end of the drill pipe. Tracer wire conforming to CITY standards shall be attached to the pulling eye and the crown of Fusible PVC pipe with duct tape @ 24" O.C. and a minimum of two full wraps around the pipe. This will allow for a straight, smooth pull of the product pipe as it enters and passes through the borehole toward the drill rig and original entrance hole of the directional bore. The product pipe will be elevated to the approximate angle of entry and supported by means of a side boom with roller arm, or similar equipment, to allow for the "free stress: situation as the pipe is pulled into the exit hole toward the drill rig. The product pullback phase of the directional operation shall be carried out in a continuous manner until the pipe reaches the original sentry side of the bore.

T. PIPE HANDLING

1. Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.
2. Ropes, fabrics or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe. Pipe or fittings shall not be dropped into rocky or unprepared ground.
3. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking of the pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.
4. The handling of the joint pipeline shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Slings for handling the pipeline shall not be positioned at pipe joints. Sections of the pipes with deep cuts and gouges shall be removed and the ends of the pipeline rejoined.

U. PIPE TESTING

1. Carrier pipe cleaning and flushing are to be performed by the Contractor at no additional cost to the owner.
2. Perform tests in accordance with CITY's Water and Wastewater Approved Design Standards Manual.
3. Carrier pipe shall be pressure tested by the Contractor after pullback. The average hydraulic test pressure shall be maintained at 150 psi (100 psi for wastewater force main) for two hours. The test pump and water supply shall be arranged to allow accurate measurements of the water required to maintain the test pressure. Any piping material showing seepage or the slightest leakage shall be replaced as directed by the Owner at no additional expense to the Owner.
4. The manufacturer's recommendations on pipe stretch allowances, bend radius and tensile strength, allowable make-up water, and duration of test pressure shall be observed.
5. All carrier pipe installed by the Contractor shall be pressure tested end to end.
6. All service lines installed by the Contractor on the new main shall also be tested in addition to the new main at no additional cost to CITY.

V. TEMPORARY WATER SUPPLY DURING CONSTRUCTION

1. Temporary water supply is water that is supplied for construction purposes prior to the installation of the permanent water supply system.
2. The contractor shall contact City of Lake City, Customer Service Department at (386) 719-5786 if there are any questions, to make application, and pay for temporary construction water meters.
3. The estimated lead times to obtain temporary water are based on existing conditions at the project site. Typical lead times are as follows:
 - a. If an existing fire hydrant is available, allow three (3) working days after payment is made for installation of fire hydrant meter.
 - b. If there is not an available fire hydrant but there is an available water main, allow ten (10) working days after payment is made (note: installation of backflow preventer will be required).
 - c. If the above two options are not feasible because of water main extension timing and on-site construction, then the contractor may have to arrange to transport water to the site by tanker truck. Filling of tanker truck to be coordinated with CITY.
4. The payment for temporary water supply includes a non-refundable meter installation charge and a deposit, which will be applied against the final bill, assuming the safe return of the meter. Water used through such a temporary meter shall be paid at the prevailing general water service rate. This type of temporary connection shall be allowed for a maximum time period of 60 days, but may be extended at the discretion of CITY Engineering.