**SECTION 4.2**

**TECHNICAL Specifications FOR**

**HORIZONTAL DIRECTIONAL DRILLING OF WATER PIPE**

**PART 1: GENERAL**

* 1. **Scope of Work**

Furnish all labor, materials, tools, and equipment required to install a new water main using the directional drilling method to the sizes and limits as shown on the plans, and as specified by these technical specifications herein. Work includes, but not limited to, proper installation, testing, restoration of underground utilities and environmental protection and restoration.

The directional drilling method involves first drilling a pilot hole as shown on the approved pilot bore plan, and then enlarging the pilot hole no larger than 1.5 times the outer diameter of the pull-in pipe, pipe joint or coupling and pull back the pipe through the enlarged hole.

* 1. **Pipe Description**

Unless otherwise specified in the plans and/or specifications, one of the following pipes can be considered for horizontal directional drilling contingent upon approval by the Owner:

* Fusible Polyvinylchloride (PVC) Water Pipe as manufactured by Underground Solutions, Inc.
* Restrained Joint Polyvinylchloride (PVC) Water Pipe as manufactured by CertainTeed Corporation

The pipe to be used must be certified for use as a pressure-rated water delivery system and fire protection piping applications conforming to all standards and procedures, and meeting all testing and material properties as described in applicable pipe specifications.

* 1. **Related Works**
* Technical Specification for Fusible Polyvinylchloride (PVC) Water Pipe
* Technical Specification for Restrained Joint Polyvinylchloride (PVC) Water Pipe

**PART 2: QUALITY ASSURANCE**

* 1. **References**

### Unless otherwise stated, the latest editions of the following documents are applicable

for this specification:

* Public Works Construction Standards for North Central Texas by North Central Texas Council of Governments (NCTCOG), Edition as adopted by DWU
* City of Dallas Addendum to the NCTCOG Standards, Latest Edition
  1. **Qualification Requirements**

All directional drilling operations shall be performed by a qualified directional drilling company who has at least three (3) years experience involving work of a similar nature. The company must have installed a minimum of 25,000 linear feet of pipe (6-inch diameter or greater) using directional drilling operations or supply a list of project references, prior to job commencement.

* Schedule all work through the Owner. Notify the Owner a minimum of ten (10) working days in advance of the start of work.
* Perform all work in the presence of the Owner, or his representative.
* All applicable permits and applications must be in place prior to start of work.
  1. **Warranty**
     + - A one-year warranty for the pipe shall be included from the Contractor, and shall cover the cost of replacement pipe and freight to project site, should the pipe have any defects in material or workmanship.
       - In addition to the standard pipe warranty, the fusing contractor shall provide in writing a warranty for a period of one year for all the fusion joints, including formation, installation, and pressure testing, if applicable
       - Unless otherwise specified, the warranty periods shall begin after the Certificate of Acceptance is issued for the Contract.

* 1. **Submittals**
     1. Contractor’s Experience Record:

Furnish document(s) supporting the directional drilling Contractor's qualifications and experience.

* + 1. Material:

Submit all applicable pre and post-construction pipe submittals as per applicable technical specifications of the pipe to be used for this project.

* + 1. Work Plan:

Prior to beginning work, submit a work plan detailing the procedure and schedule to be used to execute the project. The Work plan is to include a description of all equipment to be used, down-hole tools, a list of personnel and their qualification and experience (including backup personnel in the event that an individual is unavailable), list of subcontractors, a schedule of work activity, a safety plan (including MSDS of any potentially hazardous substances to be used), an environmental protection plan, and contingency plans for possible problems. Work plan should be comprehensive, realistic and based on actual working conditions for this particular project. The plan should document the thoughtful planning required to successfully complete the project.

* + 1. Bore Plan:

Prior to beginning work, submit a signed and sealed, scaled drawing of the pilot bore plan for review and approval (Max. Vertical Scale 1" = 2' and Max. Horizontal Scale 1" = 20'). Show finished grade, deflection and radiuses of the pilot bore, all existing utilities with minimum vertical and horizontal clearances. Address the location of the drill rig setups and for multiple bores, the lengths of each bore based on soil condition, equipment used, topography, etc. The proposed vertical and horizontal clearances between the bored pipe and any existing/proposed conflicting pipes, conduits or obstructions cannot exceed the guidance system accuracy tolerance by a minimum of 100%.

* + 1. Equipment:

Submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project. Equipment list is to include but not be limited to: drilling rig, mud system, mud motors (if applicable), down-hole tools, guidance system, and rig safety systems. Include calibration records for guidance equipment. Submit any specifications for any drilling fluid additives that might be used.

# PART 3: PRODUCTS

* 1. **Pipe**

As specified in Section 1.2 of this specification.

**3.2 Directional Drilling Equipment**

3.2.1 General:

The directional drilling equipment is to consist of a directional drilling rig of sufficient capacity to perform the bore and pull back the pipe, a drilling, fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a Magnetic Guidance System (MGS) or "walkover" system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, and trained and competent personnel to operate the system. All equipment must be in good, safe condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

3.2.2 Drilling Rig:

The drilling shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. Anchor the machine to the ground sufficiently to withstand the pulling, pushing and rotating pressure required to complete the installation. The hydraulic power system must be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system must be free of leaks. The rig is to have a system to monitor and record maximum pull­back pressure during pull-back operations. A system to detect electrical current from the drill string must be in place with an audible alarm that automatically sounds when an electrical current is detected.

3.2.3 Drill Head:

The drill head shall be steerable by changing its rotation with the necessary cutting surfaces and drilling fluid jets.

3.2.4 Mud Motors (if required):

The mud motor shall have adequate power to turn the required drilling tools.

3.2.5 Drill Pipe:

The drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tools joints should be hardened to 32-36 RC.

**3.3 Guidance System**

* + 1. General:

Use an electronic "walkover" tracking system or a Magnetic Guidance System (MGS) probe or proven (non-experimental) gyroscopic probe and interface for a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance system must be capable of tracking at all depths up to fifty feet and in any soil condition, including hard rock. It should 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 has to be accurate and calibrated to manufacturer's specifications of the vertical depth of the borehole at sensing position at depths up to fifty feet and accurate to 2-feet horizontally.

3.3.2. Components:

Supply all components and materials to install, operate, and maintain the guidance system.

3.3.3 Operation:

Set up and operate the Magnetic Guidance System (MGS) with personnel trained and experienced with the system. Be aware of any geo-magnetic anomalies and consider such influences in the operation of the guidance system.

**3.4 Drilling Fluid (Mud) System**

3.4.1 Mixing System:

A self-contained, closed, drilling fluid mixing system of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water, and appropriate additives. The mixing system must be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank must be a minimum of 1,000 gallons. Agitate the drilling fluid during drilling operations.

* + 1. Drilling Fluids:

Use drilling fluid composed of potable water and bentonite clay. Supply water from an authorized source with a pH of 8.5-10. Treat any water of a lower pH or with excessive calcium with the appropriate amount of sodium carbonate or equal. No additional material may be used in drilling fluid without prior approval from the Owner. The bentonite mixture used must have the minimum viscosities as measured by a March funnel:

Rocky Clay 60 seconds

Hard Clay 40 seconds

Soft Clay 45 seconds

Sandy Clay 90 seconds

Stable Sand 80 seconds

Loose Sand 110 seconds

Wet Sand 110 seconds

These viscosities may be varied to best fit the soil conditions encountered, or as determined by the operator. No additional fluid shall be used without prior approval from the Owner.

* + 1. Delivery System:

Fluid pumping system with a minimum capacity of 35-500 GPM and capable of delivering drilling fluid at a constant minimum pressure of 1200 psi. Employ filters on the delivery system in-line to prevent solids from being pumped into drill pipe. Contain all used drilling fluid and drilling fluid spilled during operations convey to the drilling fluid recycling system or remove by vacuum trucks or other methods acceptable to the Owner. Maintain a berm, minimum of 12-inches high, around drill rigs drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Furnish pumping equipment and/or vacuum truck(s) of sufficient size to convey drilling fluid from containment areas, to storage and recycling facilities or disposal.

**3.5 Other Equipment**

3.5.1 Pipe Rollers:

Use pipe rollers for pipe assembly during final product pull back.

* + 1. Restrictions:

Do not use other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections unless approved by the Owner 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 by the Owner without undue delay and maintain line and grade within the tolerances prescribed by the particular conditions of the project.

# PART 4: EXECUTION

**4.1 General**

* Notify the Owner a minimum of ten (10) working days in advance of starting work. All necessary permits and approvals must be in place prior to commencement of work. Do not begin the directional drilling until the Owner is present at the job site and agrees that proper preparations for the operation have been made. The Owner's approval for beginning the installation does not in any way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract.
* All equipment used on the Owner's property and right-of-ways may be inspected by the Owner or his representatives and removed if considered unsatisfactory.

**4.2 Directional Drilling Operation**

* Provide all material, equipment, and facilities required for directional drilling. Maintain proper alignment and elevation of the borehole throughout the directional drilling operation. The method used to complete the directional drill must conform to the requirements of all applicable permits.
* Survey the entire drill path with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If using a magnetic guidance system, survey drill path for any surface geo-magnetic variations or anomalies. In addition, open cut, "pothole" or "daylight" areas along the proposed alignment at 200 foot intervals before and during the drilling operation to make sure proper alignment and grade are maintained. It may become necessary, if so determined by the Owner, to open excavate, "pothole" or "daylight" other areas to determine location of existing facilities and utilities. In this particular case payment will be made from Bid Item 20500 (Investigation). Costs of open cutting, "potholing" or "daylighting" for the purposes of determining proper alignment and grade are considered incidental to the base bid item (No Separate Pay Item).
* Place a silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection if required by documents, state, federal, and local regulations. Put in place any additional environmental protection necessary to contain any hydraulic or drilling fluid spills, including berms, liners, turbidity curtains, and other measures.
* Record readings after advancement of each successive drill pipe (no more than 10'), and plot on a scaled drawing of 1" = 2' vertical and 1" = 20' horizontal. Make all recorded readings and plan and profile information available at all times. At no time can the deflection radius of the drill pipe exceed the deflection limits of the carrier pipe as specified herein.
* Submit a complete list of all drilling fluid additives and mixtures to be used in the directional operation, along with their respective Material Safety Data Sheets. Contain all drilling fluids and loose cuttings in pits or holding tanks for recycling or disposal, no fluids should be allowed to enter any unapproved areas or natural waterways. Dispose of all the drilling mud and cuttings after job completion at an approved dumpsite.
* Drill the pilot hole on the bore path with no deviations greater than 5% of depth over the length of the bore unless previously agreed to by the Owner. In the event that pilot does deviate from the bore path more than 5% of depth over the length of the bore, the pilot must be pulled back and re-drilled from the location along bore path before the deviation. In the event of a drilling fluid fracture, inadvertent returns, or returns loss during pilot hole drilling operations, stop 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, notify the Owner.
* Upon completion of pilot hole phase of the operation, submit a complete set of "as-built" records. Include in these records copies of the pilot bore path plan and profile record drawing, as well as directional survey reports as recorded during the drilling operation.
* Upon approval of the pilot hole location, begin the hole opening or enlarging phase. Increase the bore hole diameter to accommodate the pullback operation of the required size of carrier pipe. The type of hole opener or back reamer to be utilized in this phase is to be determined by the types of subsurface soil conditions that have been encountered during the pilot hole drilling operation. Select the proper reamer type with the final hole opening being a maximum of 1.5 times the largest outside diameter pipe system component to be installed in the bore hole.
* Stabilize the open bore hole 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. Calculate the volume of bentonite mud required for each pullback based on soil conditions, largest diameter of the pipe system component, capacity of the bentonite mud pump, and the speed of pullback as recommended by the bentonite drilling fluid manufacturer. Contain the bentonite slurry 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 hauled off to an approved dumpsite for proper disposal.
* Fuse or join all pipe sections together according to manufacturer's specifications as applicable. The pipe must be free of any chips, scratches, or scrapes. All piping shall be installed with a continuous, insulated TW, THW, THWN, or HMWPE insulated copper, 8 gauge or thicker wire for pipeline location purposes by means of an electronic line tracer:

- The wires must be installed along the entire length of the pipe.

- The insulation color shall match the color of the pipe being installed.

- Sections of wire shall be spliced together using approved splice caps and waterproof seals. Twisting the wires together is not acceptable.

**4.3 Handling Pipe**

* Take care during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.
* Use ropes, fabrics or rubber protected slings and straps when handling pipes. Do not use chains, cables or hooks inserted into the pipe ends. Use two slings spread apart for lifting each length of pipe. Do not drop pipe or fittings into rocky or unprepared ground.
* Store pipe on level ground, preferably turf or sand, free of sharp objects that could damage the pipe. Limit the stacking of the pipes 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 store the pipe 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.
* Handle assembled pipe in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. Position slings for handling at pipe joints. Remove sections of the pipes with cuts and gouges or excessive deformation and replace.

**4.4 Personnel Requirements**

* All personnel must be fully trained in their respective duties as part of the directional drilling crew and in safety.
* Supply references of previous projects using this type of installation process that this directional drilling crew has been involved.
* A competent and experienced supervisor of the Contractor must be present at all times during the actual drilling operations. 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. Furnish a sufficient number of competent workers on the job at all times to insure the directional drilling is made in a timely and satisfactory manner.
* Remove any personnel who are unqualified, incompetent or otherwise not suitable for the performance of this project from the job site and replace with suitable personnel.

**4.5 Testing**

* Clean and flush all equipment and the surrounding site after completion. Use only potable water for flushing and pressure testing.
* Test directional drilling pipe after pullback. The average pressure should be maintained at 150 psi for two hours. Arrange the test pump and water supply to allow accurate measurements of the water required to maintain the test pressure. Replace any material showing seepage or the slightest leakage as directed by the Owner at no additional expense to the Contract.
* Observe and adhere to the pipe manufacturer's orOwner's, (whichever is more stringent) recommendations on pipe stretch allowances, bending radius, tensile strength, allowable test leakage allowance, and magnitude and duration of test pressure.

* Test pipeline end to end.
* Connect all new service lines and test along with the newly installed main.
* Pressure testing the drilled pipe is not necessary if the pipe is intended to be used as a casing for a finished product pipe.

**4.6 Site Restoration**

Following drilling operations de-mobilize equipment and restore the work site to the original conditions or better. Backfill and compact all excavations according to these specifications.

**4.7 Record Keeping**

* Maintain a daily project log of drilling operations and a guidance system log with a copy available to the Owner at the completion of project.
* Record the guidance system data during the actual crossing operation. Furnish "as-built" plan and profile drawings based on these recordings showing the actual location horizontally and vertically of the installation, and all utility facilities found during the installation. Certify the guidance data to the capability of the guidance System.

**PART 5: METHOD OF MEASUREMENT AND PAYMENT**

Method of Measurement and Payment for the work included in this section will be in accordance with the payment schedule in the Bid Proposal.

**\*\*END OF SECTION\*\***NOVEMBER 2000