SECTION 02446

HDPE PIPE HORIZONTAL DIRECTIONAL DRILL

GENERAL

1.01 DESCRIPTION OF WORK

A. Scope of Work:

1. This specification covers the requirements for furnishing all labor, equipment and materials associated with the installation of a high-density polyethylene (HDPE) pipe by directional drilling method. This shall include, but not be limited to, steerable directional boring equipment, boring pits and equipment, sheeting, maintenance of traffic and coordination with other Contractors, miscellaneous appurtenances to complete the work as shown on the contract drawings, cleanup and disposal of spoils, and restoration. Directional drilling operations shall be performed within the right of way and/or easements shown on the drawings.

B. The work specified herein shall include:

1. Excavation of drilling and receiving pits.
2. Potholing or other similar practices as required to verify underground utilities along the entry and exit drill paths.
3. Drilling of a pilot hole at prescribed line and grade.
4. Reaming of the hole (as needed).
5. Pullback of the HDPE pipe through the hole.
6. Pressure testing of the HDPE pipe.
7. All incidental work such as horizontal and vertical control points, survey, grids, permits, slurry treatment and disposal, shoring and casing of the pits if required, and all else necessary for the complete installation of the pipe in accordance with these specifications and contract drawings.

C. The Water and Sewer Department is aware of the fact that a successful directional drill depends on the directional driller planning and adjusting to the conditions in the field. Therefore, the Department will require the Directional Drill Contractor to take responsibility for technical planning and having directional drill specialist that are capable of successfully performing the work of this project. 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.

D. The Contractor is responsible for the submittal of the final design and all directional drill calculations to confirm the design and pipe rating.

1.02 QUALITY ASSURANCE

A. 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 bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein,

or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

B. Standards:

1. Referenced ASTM Specifications:

a. AWWA 906 Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water ASTM D3035 Standard Spec for PE Pipe (DRPR) Based on Controlled Outside Diameter.
b. ASTM D3261 Butt Heat Fusion PE Fittings for PE Pipe & Tubing ASTM D3350 Standard Specification for PE Pipe & Fittings Materials.
c. ASTM D1238 Melt Flow Index ASTM D1505 Density of Plastics.
d. ASTM D2837 Hydrostatic Design Basis.
e. ASTM F714 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
f. NSF Std.#14 Plastic Piping Components & Related Materials.

2. Manufacturer’s Specifications.

C. Contractor’s Qualifications:

1. Directional drilling Contractor shall have actively engaged in the installation of pipe using on-grade boring for a minimum of three (3) years. Evidence of qualification shall be submitted with Bid.

2. Field supervisory personnel employed by the directional drilling contractor shall have at least three (3) years experience in the performance of the work. Qualifications shall be submitted with Bid.

3. The County reserves the right to require an on-site representative of the directional drilling equipment manufacturer and/or a representative of the drilling fluids manufacturer, knowledgeable in the use of the product(s), for a minimum of two (2) working hours per work day (10 days maximum). The cost for the on-site representative(s) will be paid by the Contractor.

1.03 SUBMITTALS

A. Design Plans: The Design-Builder shall submit Design Plans signed and sealed by a State of Florida Professional Engineer.

B. Directional Drill Calculations: The Design-Builder shall submit calculations that include pull back force, entry and exit angles, longitude, depth, pit sizes and any other relevant design information.

C. Work Plan: Prior to beginning work, the Contractor must submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the project. Plan should document the thoughtful planning required to successfully complete the project.

D. Equipment: Contractor will submit specifications on directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project.

E. Materials: Specifications on material to be used shall be submitted to Engineer. Material shall include the pipe, fittings and any other item which is to be an installed component of the project.

1.04 JOB CONDITIONS

A. Environmental Requirements:

1. Drilling operations must not interfere with or endanger surface and activity upon the surface. Areas outside designated work areas should not be disturbed. Examine work area and notify Engineer of conditions that may adversely affect work.

2. Contractor shall conduct operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians and to adjacent property owners.

B. Safety. The Contractor shall carry out the operations in strict accordance with all applicable OSHA regulations.

1.05 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall take precautions to protect the pipe while being handled. Chain, end hooks, or cables slings shall not be used to handle pipe. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe.

B. Care shall be taken to protect the pipe from scarring, gouging, or excessive abrasion. Pipe with gouges greater than 10% of the minimum wall thickness will be rejected.

C. If pipe is stacked, stacking height shall not exceed the manufacturer’s recommendations.

D. The Contractor shall comply with the Manufacturer’s storage and handling requirements.

1.06 QUALITY ASSURANCE

A. All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications.

B.

1. Qualified manufacturers shall be: JM Eagle, ISCO, PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., SCLAIRPIPE as manufactured by Dupont of Canada or Engineer-approved equivalent.
2. Design Life: 100 years

1.07 WARRANTY

A. The pipe Manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Department. The Manufacturer shall replace at no expense to the Department any defective pipe/fitting material including labor within the warranty period.

PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE, JOINTS AND FITTINGS

A. The pipe supplied under this specification shall be high performance, high molecular weight, high density polyethylene (HDPE) pipe, PE 4710 resin material. Minimum cell classification values of the pipe material shall be (345464E) as referenced in ASTM D 3350. The pipe rating shall be as identified on the Plans or Proposal. The fittings supplied under this specification shall be molded from a polyethylene compound having a cell classification equal to or exceeding the cell classification of the pipe supplied under this specification. Pipe shall meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on Outside Diameter or ASTM D3350.

B. Physical Properties of Pipe and Pipe Compound:

1. Density - The density shall be 0.941-0.957 gms/cm when, tested in accordance with ASTM D 1505.
2. Melt Flow - Melt Flow shall be no greater than 0.11 gms/l0 min. When tested in accordance with ASTM D 1238- Condition E.
3. Flex Modulus - Flex Modulus shall be greater than 110,000 psi when tested in accordance with ASTM D 790.
4. Tensile Strength at Yield - Tensile strength at yield shall be greater 3,200 psi when tested in accordance with ASTM D 638.
5. ECSR Environmental Stress Crack Resistance shall be in excess of 5,000 hours with zero failures when tested in accordance with ASTM D 1693 Condition C.
6. Hydrostatic Design Basic shall be 1,600 psi at 23° C when tested in accordance with ASTM D 2837.

C. Pipe shall be made of virgin materials. The pipe shall contain no recycled compound except that generated in the manufacturer’s own plant for resin of the same specification from the same raw material pipe.

D. Fittings:

1. All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

2. The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

3. All fittings shall be installed using buttfused fittings, thermofused fittings/couplings, or flanged adapters and must be approved by the Engineer. NO size on size wet taps shall be permitted.

4. All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. Unless otherwise directed by the Engineer, pipe of dissimilar materials shall be connected with stainless steel shielded sewer couplings. Gaskets shall meet ASTM C1173-91, 300 Series stainless steel shear ring with a minimum thickness of 0.012", 316 grade stainless steel nut and bolt tightening clamps, shear ring and clamps to meet all requirements of ASTM A167-70. Transitional sizes shall utilize a one piece gasket. Stainless steel sewer coupling shall be manufactured by Mission Rubber Company MR Series, Integrity Fusion Products, or Engineer-approved equivalent.

E. Pipe and Fittings Markings:

1. The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5 feet: name and/or trademark of the pipe manufacturer; nominal pipe size; dimension ratio; the letters PE followed by the polyethylene grade in accordance with ASTM D1248 followed by the hydrostatic design basis in 160's of psi (e.g., PE 3408); manufacturing standard reference (e.g., ASTM F714 or D3035); and a production code from which the date and place of manufacture can be determined.

2. Fittings shall be marked with the manufacturer's name (or trade mark), the designation ASTM D 3350 and ASTM F 714, and the manufacturer's code identifying the resin manufacturer, lot number and date of manufacture.

F. Pipe and Fittings shall be homogeneous throughout and free of: serious abrasion, cutting, or gouging of the outside surface extending to more than 10 percent of the minimum wall thickness in depth; cracks; kinking (generally due to excessive or abrupt bending); flattening; holes; blisters; and other injurious defects. They shall be uniform as commercially practical in color, opacity, density, and other physical properties. Any pipe and fittings not meeting these criteria shall be rejected.

G. The average outside diameter and wall thickness of pipe and fittings shall conform to either IPS or DIPS when measured in accordance with ASTM D2122.

H. Pipe and Fittings Color: Pipe and fittings shall conform to the following:

1. Inside: The inner wall shall be white or light gray. Yellow, black, and light purple are not acceptable.
2. Outside: The outer wall shall be black, white, or light gray. Yellow and light purple are not acceptable.
3. Both the inside and outside may be the same color.

I. Joints:

1. Pipe lengths shall be assembled in the field with butt-fused joints in accordance with ASTM D 2657 and the pipe manufacturer's written instructions shall apply. Joint strength shall be equal to or greater than the tensile strength of the pipe and shall indicate a ductile rather than brittle fracture when tested.

2. Joint with Fusion Equipment: The fusion machine shall have hydraulic pressure control for fusing two pipe ends together and shall be equipped with gauges to monitor fusion pressures. The machine shall be equipped with an electric or gasoline engine powered facing unit to square and trim the pipe ends smooth and provide full surface contact with the heating plate. The heating plate on the fusion machine shall be electrically heated and thermostatically controlled with a temperature gauge and be capable of maintaining 500°F with a tolerance of 10°F. Fusion temperature shall be as recommended by the pipe manufacturer. The heater plate shall be equipped with suitable means to measure the temperature of plate surfaces and to assure uniform heating such as thermometers or pyrometers.

3. Rejection: Polyethylene pipe and fittings may be rejected for failure to meet any of the requirements of this specification.

4. Pipe Dimension: Pipe supplied under this specification shall have an actual inside diameter not less than the diameters of pipe shown in the Contract Documents.

5. Connectional to DI or PVC C900 shall be restrained with mechanical joint restraints or as otherwise approved by the Engineer.

2.02 EQUIPMENT

A. General:

1. As a minimum, the directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the sewer pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the bore, a guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, personnel meeting the training requirements, and all other equipment required to complete the installation. The Contractor has the option of using a drilling fluid recycling system capable of removing solids from the drilling fluid so that the fluid can be re-used.

2. Prior to delivery to the site, all drilling equipment shall be serviced, inspected for damage and repaired as necessary. The equipment shall be in good, safe operating condition.

B. Drilling System:

1. Drilling Rig: The directional drilling machine shall consist of a hydraulically powered system to rotate, push, and pull hollow drive pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the bore. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. 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 Contractor shall record this information and provide a copy to the Engineer. 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.
2. Drill Head: The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

3. Mud or Mechanical Motors (if required): Mud or Mechanical motors shall be of adequate power to turn the required drilling tools.

4. Drill Pipe: Shall be constructed of high quality 4130 seamless tubing, grade D or better, with a threaded box and bins. Tool joints should be hardened to 32-36 RC. If the Contractor chooses another type of drill pipe, the Contractor shall supply to the Engineer the reason for change along with drilling rig manufacturers approval.

C. Guidance System

1. A Magnetic Guidance System (MGS), grade beacon 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 directional drilling guidance system shall have the capability of measuring vertical and horizontal positions and roll. The system shall obtain an accuracy range within one-inch of the actual position of the drilling head. It shall enable the driller to guide the drill head by providing immediate information on the toll face, azimuth (horizontal direction) and inclination (vertical direction).

2. The Contractor shall compute the position in the X, Y, and Z axis relative to the ground surface a minimum of every 1 foot. Ground surface elevation shall be based on surveyed field conditions.

3. The guidance system shall be of a proven type and shall be operated by personnel trained and experienced with the system.

4. The Contractor shall demonstrate a viable method to eliminate error. Contractor shall submit calibration results showing that the equipment is within tolerance. The Contractor shall follow the manufacturer’s recommended calibration sequence and calibration time schedule.

5. The guidance system shall be capable of generating a plot of the bore hole survey for the purpose of an as-built drawing.

6. Contractor shall use a locating and tracking system capable of ensuring that the proposed horizontal and vertical alignment is installed as intended.

7. Tolerances: Provide the tolerances necessary to maintain required distance from other utilities and structures. Real time location and tracking is required.

D. Drilling Fluid System:

1. 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 drilling operations.

2. Drilling Fluid: The Contractor shall use a drilling fluid suitable for the soil conditions as they exist for the project. The Contractor shall fully determine the soil conditions prior to fluid selection (be it from additional geotechnical investigation, exposing utilities, digging a slurry catch pit or other method). This decision shall include product concentrations and additives.

3. Delivery System: The drilling fluid pumping system shall have a capacity to provide an adequate flow rate and pressure to facilitate the HDD operation as defined in the construction documents. 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 leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system (if used). A berm, minimum of 12” high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits, and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and or vacuum trucks of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

4. Drilling Fluid Recycling System: If the Contractor chooses to use a drilling fluid recycling system, the system shall separate sand, dirt and other solids from the drilling fluid to render the drilling fluid re-usable. Spoils separated from the drilling fluid will be stored in a suitable location, as approved by the City, for later use or disposed.

2.03 OTHER EQUIPMENT

A. Pipe Rollers: Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydrotested and during pullback operations. Sufficient number of rollers shall used to prevent excess sagging of pipe. The HDPE pipe shall not be dragged across the surface.

B. Pullback: Contractor shall use breakaway swivel or mechanical “weak link” to prevent overstressing of the pipe.

C. Pipe Rammers: Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.

D. Restrictions: Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer 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 special conditions of the project.

EXECUTION

3.01 GENERAL

A. Directional Drill: Pressure test shall be at 100 psi for two hours in the presence of the Engineer. Zero leakage allowed on the HDPE pipe. Review the pipe manufactures recommendations for testing of HDPE and coordinate any factors that affect testing with the Engineer (temperature, pipe expansion, water temperature, etc.). **No payment for the directional drill aggregate sum shall be made until the installation is successfully pressure tested to the satisfaction of the Department. Labor and materials used in any unsuccessful directional drills shall not be paid.**

B. The Engineer must be notified 48 hours in advance of starting work. The Directional Bore shall not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer approval for beginning the installation shall in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract. It shall be the responsibility of Engineer to provide inspection personnel at such times as appropriate without causing undue hardship by reason of delay to the Contractor.

C. Installation Tolerance:

1. Tolerance requirements for the installed pipe (HDPE) are performance orientated. Tolerances specified herein are the minimum requirements. **It is the sole responsibility of the Contractor to select the appropriate types of equipment, work methods and procedures to meet the tolerance requirements.**

2. The County reserves the right to reject pipes installed not meeting the tolerance requirements specified herein. It will be the responsibility of the Contractor to replace rejected work with pipe meeting these requirements. No additional compensation shall be provided to the Contractor for replacement of pipe not meeting tolerance requirements.

D. It is the responsibility of the Contractor to implement means and procedures compatible with anticipated ground conditions. The Contractor shall have a representative who is thoroughly knowledgeable of the equipment and HDD procedures present at the job site during the entire installation and available to address immediate concerns and emergency operations.

E. The Engineer must be notified immediately if any condition is encountered that stops the forward progress of drilling operations. When it is determined that it is impossible to continue drilling operations, the Contractor shall determine the best course of action. The Contractor may be allowed to abandon the completed portion in place and start a new hole as directed by the Engineer at no additional cost to the County.

F. Contractor shall take responsibility for the restoration of any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid, or the directional drilling operation, at no cost to the County.

G. The installation of the sewer pipe into the bore hole shall be on the same day that the bore is completed to ensure the necessary support exists.

H. The required piping shall be assembled in a manner that minimizes the obstruction of adjacent roadways, driveways or public activities. The Contractor shall erect temporary fencing around entry and exit pipes staging areas as needed. The Contractor staging areas shall be as approved by the Engineer.

I. Permits: The Contractor is responsible for obtaining all necessary permits. Copies of each permit shall be available to the Engineer at the work site.

3.02 PERSONNEL REQUIREMENTS

A. All personnel shall be fully trained in their respective duties as part of the directional drilling crew and in safety.

3.03 DRILLING PROCEDURE

A. Site Preparation: Work site as indicated on drawings, within right-of-way, shall be graded or filled to provide a level working area. No alterations beyond what is required for operations are to be made. Contractor shall confine all activities to designated work areas.

B. Environmental Protection: Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract 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 measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any waterbody or wetland.

C. Safety: Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance and topic submitted to Engineer.

D. Pilot Hole:

1. The Contractor shall follow the pipeline alignment as shown on the Drawings, within the specified tolerances. If adjustments are required,

the Contractor shall notify the Engineer for approval prior to making the adjustments.

2. In the event of difficulties at any time during HDD operations requiring the complete withdrawal from the bore, the Contractor may be allowed to withdraw and abandon the bore and begin a second attempt at a location approved by the Engineer.

3. 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 then wait another 30 minutes. If mud fracture or returns loss continues, contractor will cease operations and notify Engineer. Engineer and contractor will discuss additional options and work will then proceed accordingly.

4. Establish an entry angle hole so that the curvature of the pilot hole does not exceed the allowable bending radius of the HDPE pipe.

5. At completion of the pilot hole drilling, provide Engineer tabulations of the horizontal and vertical alignment at minimum, intervals of 10 feet.

E. Pipe Installation:

1. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

2. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the contractor, at his own expense.

3. Ropes, fabric 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.

4. After the pilot hole is completed, the Contractor shall enlarge the hole by pre-reaming (as needed), and install a swivel to the reamer and commence pullback operations.

5. Contractor will ream bore hole to a minimum size necessary to safely and properly install the pipe. The annular space on the final bore hole shall not exceed 3-inches measured from the outside diameter of the host pipe.

6. The pipe being pulled into the bore shall be protected and supported by rollers so that it moves freely and is not damaged by debris on the ground during installation. The HDPE pipe may not be dragged across the ground surface.

7. Pullback forces shall not exceed the allowable pulling forces for the product pipe. The thickness of the pipe shall be increased by Contractor at their cost if pullback forces are anticipated to exceed the allowable pulling force on the specified pipe.

8. The Contractor shall allow sufficient lengths of pipe to extend past the termination point (4” minimum) to allow connections to adjacent pipe sections or manholes. Pulled pipe shall be allowed 12 hours of stabilization prior making tie-ins. The length of extra product pipe shall be at the Contractor's discretion.

F. Drilling Fluid:

1. Disposal of excess drilling fluid and spoils will be the responsibility of the Contractor who shall comply with all relevant regulations, right-of-way, work space, and permit agreements. Excess drilling fluid and spoils shall be disposed of properly. The Contractor is responsible for transporting all excess drilling fluid and spoils to the disposal site and paying any disposal costs. Excess drilling fluid and spoils shall be transported in a manner that prevents accidental spillage onto roadways. Excess drilling fluid and spoils shall not be discharged into sanitary or storm systems, ditches or waterways.

2. Drilling fluid returns (caused by fracturing of formations) at locations other than the entry and exit points shall be minimized. The Contractor shall immediately clean up any drilling fluid that inadvertently surfaces.

3. The Contractor shall be responsible for all fees and provisions for a clean water supply for mixing of drilling fluid.

G. Construction Practices:

1. Repair of Damaged Sections: Segments of pipe having cuts or gouges on the exterior of the pipe in excess of 10% of the minimum wall thickness of the pipe shall be cut out and removed or that section of pipe will be rejected. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method.

2. Pipe Joining: Sections of polyethylene pipe should be joined into continuous lengths on the job site above ground. The joining method shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedure shall be capable of meeting all conditions, alignment, and fusion pressure. Pipe lengths to be joined by thermal butt fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.

3. Handling of Fused Pipe: Fused segments of pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains

or cable type chokers should be avoided. Nylon slings are preferred. Care should be exercised to avoid cutting or gouging the pipe.

4. The pipe fusion machine shall have the following minimum design features:

   a. Guide rods shall be in a plane that passes through the centerline of the pipe thus canceling the bending forces in the machine caused by the fusion forces.

   b. The clamp shall be mechanically or hydraulically operated and have the strength to "round up" the pipe close to the fused joint and clamp each piece of pipe on continuing straight centerline. The jaws shall be designed for quick installation and removal of inserts for smaller pipe sizes.

   c. The heater-plate shall be electrically heated, and thermostatically temperature controlled. The surface shall be smooth with a high-quality Ryton coating. The machine shall be capable of maintaining the surface temperature set at the pipe manufacturer's recommended temperature range. The heater plate shall be equipped with an indicating thermometer but surface temperatures should be checked with a pyrometer occasionally. The heater surface shall be kept clean and free from plastic accumulation.

   d. The hydraulically operated machines shall have a pressure regulator to preset the correct pressure for the desired fusion force, and there shall be an auxiliary system to control "feed"' rate for the pipe face-off.

   e. Each machine shall be permanently equipped with a chart showing correct fusion pressure for each pipe size and wall thickness (DR).

3.04 FIELD TESTING

A. Prior to any pipe testing the pipe shall be cleaned and ready for testing.

B. Hydrostatic Pressure Testing:

1. Prior to pulling the pipe thru the bore a low pressure (5 psi min) hydrostatic pressure testing of the pipe may be done each time after fusing the HDPE pipe segments together on the surface. The testing is intended to verify proper fusion of the pipe segments prior to installation of the pipe. The test shall be conducted at a low pressure determined by the Contractor.
   a. Large diameter mains may utilize a low-pressure (5 psi min) air test where a hydrostatic test is not practical. This shall be subject to the approval of the Engineer and proper safety precautions.
   b. Intermediate welds during pulling that cannot be tested are the responsibility of the Contractor.

2. Once the pipe is installed, the directional drill installation is required to pass a pressure test of 100 psi for two hours with zero leakage.

3. Pipe not holding the specified pressure for the test duration shall be removed from the hole, repaired, and installed and tested again.

4. The cost of the hydrostatic test shall be included in the bid price for the appropriate sections of pipe.

3.05 CLEANING, SITE RESTORATION, AND INSPECTION

A. Following drilling operations, contractor will demobilize equipment and restore the worksite to original condition. All excavations will be backfilled and compacted to 95% of original density. Landscaping will be restored to original. All mud shall be disposed of by the Contractor.

B. The Contractor is required to maintain the work site in a neat and orderly condition throughout the period of work and after completing the work at each site, remove debris, surplus material and temporary structures erected by the Contractor. Upon completion of work, the site must be restored to its former condition.

3.06 RECORD KEEPING

A. As-Builts: Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to Engineer at completion of project. As-built drawings shall be certified as to accuracy.

END OF SECTION