SECTION 332010

HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

A. The Contractor shall provide all necessary tools, materials and equipment to successfully complete the installation of horizontal directionally drilled piping as specified herein and shown on the drawings. The Contractor shall be responsible for the final constructed product, and for furnishing the qualified labor and supervision necessary for this method of construction.

B. It is the Contractor's responsibility to verify location and depth of all underground existing utilities and to contact Sunshine 811 prior to construction.

C. The Contractor shall furnish all items necessary to perform the horizontal directional drilling (HDD) operation and construct the pipe to the lines and grade shown on the drawings.

D. Boring must use techniques of creating or directing a borehole along a pre-determined path to a specified target location. This must involve use of mechanical and hydraulic deviation equipment to change the boring course and must use instrumentation to monitor the location and orientation of the boring head assembly along a pre-determined course, as further described in this specification.

E. Drilling must be accomplished with fluid-assisted mechanical cutting. Boring fluids shall be a mixture of bentonite and water or polymers and additives. Bentonite sealants and water will be used to lubricate and seal the borehole. It is mandatory that minimum allowable pressures and flow rates be used during drilling operation as not to fracture the sub-grade material around and or above the bore.

F. The mobile drilling system shall utilize small diameter fluid jets to fracture and mechanical cutters to cut and excavate the soil as the head advances forward.

G. Steering shall be accomplished by the installation of an offset section of

drill stem that causes the cutterhead to turn eccentrically about its centerline when it is rotating. When steering adjustments are required, the cutterhead offset section is rotated toward the desired direction of travel and the drill stem is advanced forward without rotation.

H. The mobile drilling system must be capable of being launched from the surface at an inclined angle and drilling a diameter pilot hole. The pilot hole will then be enlarged with reamers as required to achieve the completed directional drill bore hole diameter to permit pullback activities.

I. The path of the pilot hole shall be monitored during drilling by taking downhole survey readings at intervals not to exceed 20 feet. These readings shall be used to calculate the horizontal and vertical coordinates (x, y, and z axes) of the downhole assembly as it progresses along the pilot hole. Calculations shall be performed according to American Petroleum Institute (API) Bulletin D20. Recorded data and calculations from downhole surveys shall include, but not be limited to the following items:

1. Course length. The distance between two downhole surveys as measured along the drilled path.
2. Measured distance. The total distance of a downhole survey from the entry point as measured along the drilled path; also the summation of the course lengths.
3. Inclination. The angle at which the downhole probe is projecting from the vertical axis at a particular downhole survey point; vertically downward corresponds to zero degrees.
4. Azimuth. The angle at which the downhole probe is projecting in the horizontal plane at a particular downhole survey point; magnetic north corresponds to zero degrees.
5. Station. The horizontal position of a downhole survey measured from an established horizontal control system.
6. Elevation. The vertical position of a downhole survey measured from an established vertical control system.
7. Right. The distance of a downhole survey from the design path reference line; positive values indicate right of the reference line while negative values indicate left of the reference line.

J. In addition to a magnetic downhole survey system, a surface monitoring system, such as TruTracker (or equivalent) shall be used to determine the location of the downhole probe during pilot hole drilling. The TruTracker locates the downhole probe by inducing a magnetic field in a surface coil of known location. The probe senses its location relative to this magnetic field and communicates this information to the surface.

Prior to drilling, the coil shall be laid out on the ground surface and its corners accurately surveyed.

K. Regardless of the tolerance achieved, no pilot hole will be accepted if it will result in any of the pipeline being installed in violation of construction right-of-way or easement restrictions. Concern for adjacent utilities and/or structures takes precedence over the listed tolerances. Listing of tolerances does not relieve the HDD Contractor of responsibility for safe operations or damage to adjacent utilities and structures.

Notwithstanding the Directional Tolerance stated above, curves shall be drilled at a radius equal to or greater than that shown on the drawings.

L. At the completion of pilot hole drilling, the HDD Contractor shall provide a tabulation of coordinates, referenced to the drilled entry point, which accurately describe the location of the pilot hole.

M. A swivel shall be used to connect the pull section to the reaming assembly to minimize torsional stress imposed on the section. The pull section shall be supported on rollers as it proceeds during pullback so that it moves freely.

N. The composition of all drilling fluids proposed shall be submitted for approval. No fluid will be approved or utilized that does not comply with permit requirements and environmental regulations. The HDD Contractor shall be responsible for obtaining, transporting and storing any water required for drilling fluids.

O. The HDD Contractor shall maximize the recirculation of drilling fluid surface returns. The HDD Contractor shall provide solids control and fluid cleaning equipment of a configuration and capacity that can process surface returns and produce a drilling fluid suitable for reuse.

P. The HDD Contractor shall employ his best efforts to maintain full annular circulation of drilling fluids. Drilling fluid returns at locations other than the entry and exit points shall be minimized. In the event that annular circulation is lost, the HDD Contractor shall take steps to restore circulation. The HDD Contractor will develop a plan for how to contain an inadvertent release of drill mud. While it is important not to delay or encumber the ongoing HDD operations, the plan should include:

1. Methods for rapid detection (method and frequency of monitoring the HDD alignment).

2. Sustained inventory of containment materials (silt curtain, hay bales, sand bags, excavation tools, etc.).

3. Identify a length of time before clean-up begins.

4. List regulatory agencies which should be notified.

Q. Use techniques of creating or directing a borehole along a pre-determined path to a specified target location. Use mechanical and hydraulic deviation equipment to change the boring course and use instrumentation to monitor the location and orientation of the boring head assembly along a predetermined course.

1. Develop, provide, and operate a Drill Fluid Loss Monitoring Program as follows:

   a. Drill Fluid Loss Monitoring Program shall ensure the following:

      1) Site specific storm water control measures meet the requirements of the FDEP Best Management Practices guidelines. Storm water control measures shall include, as a minimum, on-site silt fence and sandbags or other mechanical means located between the construction operations and any adjacent water body (i.e., man-made creeks or canals). Storm water control measures shall provide positive containment of uncontrolled fluids on the site resulting from spills or overtopping of drill pits from heavy rainfall and prevent the fluids from reaching adjacent water body, or bodies.

      2) Positive containment of uncontrolled fluids on the site resulting from spills or overtopping of drill pits from heavy rainfall.

      3) Fluids are prevented from reaching the adjacent water bodies, per FDEP ERP permit requirements.

      4) Turbidity barriers or other appropriate methods of containing and clean-up shall be part of the stand-by equipment to minimize dispersion in the event that drilling fluids reach surface water.

   b. Drill Fluid Loss Monitoring Program shall include the following:

      1) Observations along the drill path during drilling and reaming operations;

      2) Equipment for spill control remediation including, but not necessarily limited to, vac trucks, sand bags, and pumps; emergency spill and leakage control materials and

equipment including diapers, absorbent material and other fuel and oil spill containment and cleanup materials;

3) Means methods to deal with frac-out within man-made canals/creeks within thirty minutes. Submit methods to address frac-out within the man-made canals/creeks within thirty minutes of frac-out.

4) Drill fluid loss monitoring and containment including downhole verification of annular drill fluid pressure with continual and immediate reading capability of the pressure monitor;

5) Drill rig instrumentation, including remote-monitoring electronic data recording features, to monitor drill fluid pressures and rates at pits, tanks, pumps, and drill rig operations;

6) Drill fluid properties measuring equipment; and

7) Trained field personnel to monitor and maintain the instrumentation.

c. Provide drill fluid Loss Circulation Materials (LCM's) on site ready for use if needed

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO)

B. Occupational Safety and Health Administration (OSHA)

C. American Petroleum Institute (API) Standards

1. API Specifications 13A. Specification for Drilling Fluid Materials, American Petroleum Institute.

2. API Recommended Practice 13B-1. Recommended Practice for Field Testing Water-Based Drilling Fluids, American Petroleum Institute.

3. API Recommended Practice 13B-2. Recommended Practice on the Rheology and Hydraulics of Oil-Well Drilling Fluids, American Petroleum Institute.

4. API Recommended Practice 13L, Second Edition, November 2017. Training and Qualification of Drilling Fluid T

D. ASTM Standards

1. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

2. ASTM F 1962 Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe of Conduit Under Obstacles, Including River Crossings

E. HDD Manuals and Guidelines

1. Horizontal Directional Drilling Good Practices Guidelines, Latest Edition, HDD Industry Consortium.

2. IADC Drilling Manual, 1992. Eleventh Edition, Houston, Texas, International Association of Drilling Contractors.

3. Installation of Pipelines Beneath Levees Using Horizontal Directional Drilling, US Army Corps of Engineers, Waterways Experiment Station, Final Report, CPAR-GL-98-1, April 1998.

4. Installation of Pipelines by Horizontal Directional Drilling, Pipeline Research Committee, American Gas Association, PR-227-9424, April 1995.

5. Pipeline Design for Installation by Horizontal Directional Drilling, ASCE Manuals and reports on Engineering Practice No. 108, 2005.

1.3 DEFINITIONS

A. Contractor's Construction Drawings. Shall be defined as drawings by which the Contractor proposes to construct, operate, build, etc., the referenced item. The submission of these drawings shall be required for the sole purpose of providing the sufficient details to verify that the Contractor's work in progress is in accordance with the intent of the design.

B. Annular Space: Space between the HDD final reamed bore diameter and

the product pipe or cable.

C. Bent Sub: A section of drill pipe behind the cutting tools that is inclined at an angle of one to three degrees from the axis of the bore in the desired direction of steering. The bent sub allows steering while rotating the cutting tools.

D. Break-Away Connection: A connection to the product pipe that will fail at a pull force less than the rated stresses that is acceptable for the product pipe.

E. Drilling Fluid/Mud: A mixture of water, bentonite, and/or polymers continuously pumped to the drilling tools to facilitate the removal of soil cuttings, and stabilization of the bore. These fluids also cool the cutting tools and lubricate the drill pipe and product pipe string.

F. Drill String: Total length of the drill pipe in the borehole.

F. Drilling Tool/Bit: A tool or system of tools which excavates at the face of a bore.

G. Entry Pit: Location where the pilot bore initially penetrates the ground surface and where the HDD rig is positioned.

H. Exit pit: Location where the pilot bore exits the ground surface.

I. Horizontal Directional Drilling: A surface-launched, guided, steerable drilling system used for the trenchless installation of pipes, conduits, and cables. A pilot bore path is excavated in a shallow arc from a surface-launched drill rig. Excavation takes place with fluid assisted cutting from a drilling tool on the drill string. The pilot bore is directed by the positioning of a bent sub. Tracking of the drill string is achieved by using a downhole wireline survey tool which shall be augmented by using an energized wire grid at the surface. The bore is filled with drilling fluid/mud for stabilization, to cool the cutting tools, and to mix the cuttings into a slurry, which is circulated to the entry point where solids are removed before the drilling fluids are returned to the bore. The bore path is enlarged with subsequent reaming passes until the desired diameter is achieved. The product pipe, conduit, or cable is then pulled into the fluid-stabilized bore hole.

J. HDD Work Plan: Written descriptions, together with sketches, profile drawings, schedules, and other documents defining Contractor’s plans and procedures for horizontal directional drilling.

K. Inadvertent Return: Uncontrolled flow of drilling fluid/mud to the surface at a location other than the entry pit or exit pit. In certain conditions, this

may also be known as hydro fracture or frac-out.

L. Obstruction: A hard object lying completely or partially within the design pathway of the bore and pipe that prevents further advancement of the drill pipe, pre-reamer, reamer, and/or pipe, after reasonable Contractor attempts to advance past the object or re-drill around the object have failed.

N. Pilot Bore: Action of creating the first guided pass of the HDD process which is then reamed in one or more passes to the size required to allow pullback of the pipe.

O. Pullback: Part of a horizontal directional drilling process in which the drill pipe, swivel, and product pipe or cable is pulled back through the bore to the entry.

P. Pullback Loads: Loads (forces) applied to a drill string and product pipe during the pullback process which also includes tensile pullback loads, bending, buckling and combination loads.

Q. Reamer: A cutting tool pushed or pulled through the borehole in order to enlarge the pilot bore hole to a diameter sufficient for the installation of the product pipe.

R. Tracer Wire: Wire used to track the drill string, achieved by using a downhole wireline survey tool.

1.4 COORDINATION

A. Coordinate Work of this Section with City of NPU.

B. Advance Notices and Inspections: Provide at least 72 hours advance written notice to the City and Engineer of the major drilling activities, including pilot bore launch, pre-reaming, reaming, and pipe pullback. Notify the City and Engineer immediately, in writing, when significant problems are encountered or if ground conditions are considered to be materially and significantly different than those represented with the geotechnical data.

C. Certified Work Zone Traffic Control Plan: Submit a control plan for proposed traffic lane or sidewalk diversions or closures per City of North Port’s requirements. Plans shall depict detailed sequences and requirements for traffic control devices required, dimensioned positions of devices, and pavement striping. Before construction in the public right-of-way, coordinate with City of North Port as applicable for traffic lane diversions or closures and obtain their permits or written approvals.

1.5 SUBMITTALS

A. The City and the Engineer will base the review of submitted details/bore plan and data on the requirements of the completed work, safety of the work in regard to the public, potential for damage to public or private utilities and other existing structures and facilities, and the potential for unnecessary delay in the execution of the work. Such review shall not be construed to relieve the Contractor in any way of their responsibilities under the contract. Contractor shall not commence work on any items requiring Contractor's Construction Drawings or other submittals until the drawings and submittals are reviewed and accepted by the City and Engineer.

The Contractor shall submit a minimum of 20 days before starting drilling for review and approval. The submittal shall include the following:

1. Combine Submittals/Shop Drawings at discretion but at a minimum the below items shall be submitted.

2. Submit for review complete construction drawings and complete written description identifying details of the proposed method of construction, a drill plan, and the sequence of operations to be performed during construction, as required by the method of HDD excavation approved. The drawings and descriptions/bore plan shall be sufficiently detailed to demonstrate to the City and the Engineer whether the proposed materials and procedures will meet the requirements of this specification. Contractor shall submit arrangement drawings and technical specifications of the machine and trailing equipment (including any modifications), three-year experience record with this type of machine and a copy of the manufacturer's operation manual for the machine.

3. Sunshine 811 utility locate requests and visual confirmation of crossing utilities and parallel utilities within the vicinity of the bore centerline.

4. Contractor's construction drawings/bore plan shall be submitted on the following items.

    a. Proposed contingency plans for critical phases and areas of directional drilling and remediation of potential problems. Address the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Potential problems that shall be addressed in this Plan include, but are not limited to, the following:

        i. Encountering loss of returns/loss of circulation during drilling through limestone formations including methods for addressing voids, vugs, etc. Include a contingency plan in the event the borehole

is not recoverable due to loss of returns/circulation and/or a borehole collapse.
ii. Encountering obstruction during pilot bore or reaming/pullback.
iii. Drill pipe or product pipe cannot be advanced.
iv. Deviations from design line and grade exceed allowable tolerances.
v. Drill pipe or product pipe broken off in borehole.
vi. Product pipe collapse or excessive deformation.
vii. Utility strike.
viii. Deviation from planned bore path.
ix. Hydrolock occurs or is suspected.
x. Excessive ground settlement or heave.

b. The work zone equipment configuration at each end of the drill; staging and storage areas; location of the drill fluid, high-density polyethylene (HDPE) pipe, water supply for drilling, cuttings, pit spoil handling areas; and storm water containment measures, devices and locations.

c. Submit manufacturer's data for the HDPE pipeline as outlined in Section 331050 for HDPE product pipe material.

d. Layout and fusing/welding/assembly of pipe.

e. Final reaming and pullback of pipe.

f. Drill Fluid Loss Monitoring/Frac-Out Plan: Submit materials list including bentonite and bentonite additives for the project along with respective MSDS for all materials used on the site.

g. Pipe Stress Calculations (if required by the City): Submit calculations for pipe stresses expected to result from the pullback, bending, buckling loads, earth loads, groundwater loads, and other installation and service loads expected to be exerted on the pipe. The calculations shall identify parameters and state assumptions made in the calculations including the radius of curvature, assumed drilling fluid weights, whether pipe is assumed to be filled or empty during pullback, and temperature. These calculations shall be signed and sealed by a licensed Professional Engineer registered licensed in the State of Florida, if required by the City for a particular project.

h. Maximum Allowable Drilling Fluid Pressure Calculations (if required by the City): Submit calculations identifying the critical downhole pressure that would cause hydrofracture or inadvertent return of drilling fluid. The calculations shall identify the critical points in the alignment and near the entry and exit points where the soil cover

above the bore is low. The calculations shall identify parameters used and state assumptions made in the calculations. The calculations shall be signed and sealed by a Professional Engineer licensed in the State of Florida, if required by the City for a particular project.

i. Method of controlling line and grade of excavation.

j. Details of cuttings & drilling fluid removal, including equipment type, number, and disposal location.

k. Note on plan or submittal that pressure testing of pipe will be conducted after installation.

l. Submit a work sequence and schedule. Provide a list of key personnel for the project including superintendent, driller, and tracking specialists.

m. Cleanup, surface restoration, and demobilization.

n. Construction Records: The following shall be submitted as construction progresses and at the completion of construction.
    i. Daily Logs and Records: Submit complete, legible, written daily logs and records and as directed by the Engineer, by noon of the following day to which the records correspond.
    ii. Pilot Bore As-Built Profile: Submit the updated pilot bore profile as drilling is underway on a daily basis and an as-built profile of the pilot bore within 24 hours of completion of the pilot bore.
    iii. Pressure Test Records: Submit pressure test records for both the pre-installation and post-installation tests. These shall be submitted within 24 hours of completion of such tests.
    iv. Variations in Plan and Profile: Document variations between the actual Drawings and profile of the bore path and the location shown on the Drawings. Notify in writing and by telephone the Engineer immediately upon discovery of deviations.

B. Quality Control Methods. At least twenty days prior to the start of directional drilling, Contractor shall submit a description of his quality control methods he proposes to use in his operations to the Engineer and City. The submittal shall describe:

1. Procedures for controlling and checking line and grade.

2. Field forms for establishing and checking line and grade.

C. Hazardous chemical list as well as all SDS and technical data sheets.

1.6 DESIGN CRITERIA

A. Compatibility of Methods.

1. The methods of excavation, lining, and groundwater control shall be compatible.

1.7 JOB CONDITIONS

A. Safety Requirements

1. Perform work in a manner to maximize safety and reduce exposure of workforce and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards.

2. Whenever there is an emergency or stoppage of work which is likely to endanger the excavation or adjacent structures, operate a full work force for 24 hours a day, including weekends and holidays, without intermission until the emergency or hazardous conditions no longer jeopardize the stability and safety of the work.

B. Air Quality

1. Conduct directional drilling operations by methods and with equipment, which will positively control dust, fumes, vapors, gases or other atmospheric impurities in accordance with applicable safety requirements.

1.8 QUALITY ASSURANCE

1. Contractor Qualifications and Experience: The Contractor or the subcontractor who will perform the HDD work shall meet the following minimum qualifications:

    i. Be licensed in the State of Florida as an underground utility Contractor for a minimum of five years.
    ii. Demonstrated at least five years of successful experience installing pipelines by the means of HDD.

2. Employ skilled, experienced superintendent(s), equipment operator(s) and personnel throughout the Project. The superintendent for this Project shall have at least ten years of

successful experience using the HDD process.

3. HDD equipment operator for this Project shall have at least five years of successful experience using the HDD process.
4. Daily Logs and Records: Daily logs and records shall be maintained and shall include the following:
    iii. Drilling lengths.
    iv. Location of drill head.
    v. Drilling fluid pressures and flow rates.
    vi. Drilling fluid losses.
    vii. Drilling fluid (drilling mud) test results.
    viii. Inadvertent returns.
    ix. Drilling times required for each pipe joint.
    x. Instances of retraction and re-drilling of the pilot bore or segments thereof.
    xi. Other relevant observations, including observed settlement, heave, frac-outs, or surface spills.
    xii. Downhole annular drilling fluid pressures shall be measured and recorded throughout the pilot hole drilling. These records shall be maintained and provided daily to the Engineer. The position of the drill head shall be continuously tracked and recorded. A plot of actual locations of the bore path shall be maintained and updated daily, or more frequently, as directed by the Engineer. Pason or approved equal system shall be used for on/off site monitoring. These records shall be maintained and provided daily to the Engineer.
5. Surveying equipment used for downhole surveying and tracking of the bore path and drill head shall be inspected and calibrated by the equipment manufacturer prior to use. Proof of this inspection and calibration shall be provided to the Engineer prior to commencement of drilling operations.

1.9 PERMITS

A. Obtain all other permits required for prosecution of the work.

1.10 CLOSEOUT SUBMITTAL

A. Section 017710 – Contract Closeout

B. Project Record Documents: Record actual locations of pipe including invert or centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

D. Record actual depth of pipe at 25-foot intervals.

E. Record actual horizontal location of installed pipe.

F. Show depth and location of abandoned bores.

G. Record depth and location of drill bits and drill stems not removed from bore.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Section 331050 High Density Polyethylene (HDPE) Pipe.

B. Contractor shall install a single (unspliced) length of #10 reinforced composite tracer wire with directional drilled HDPE pipe for location purposes. Tracer wire shall be HDPE covered hi-carbon-steel-core copper wire as manufactured by Copperhead Industries, LLC, Monticello, MN or Approved Alternative. Tracer wire shall be securely attached to each end of the directionally drilled pipe and intermittently as needed.

C. Drilling Fluid: Select drilling fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space between the bore and the pipe to control settlement. Be responsible for management and disposal of drilling fluid. Drilling fluids shall not be disposed of on-site or discharged to sanitary or storm sewers, the waterways or adjacent wetlands.

D. Drill Pipe: Provide high quality drill pipes that have been inspected and determined to be adequate for the Project requirements. Bent, cracked, or fatigued drill pipes shall not be used. Threads shall be in good condition. The length of each drill pipe shall be measured and recorded.

E. Carrier Pipe: Pipe thickness shall conform to the most conservative design with respect to design calculations for the critical combination of internal and external pressure, pullback and bending.

PART 3 – EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for his means and methods of horizontal directional drilling construction and shall ensure the safety of the work, the Contractor’s employees, the public, and adjacent property, whether public or private.

B. Contractor should anticipate that portions of the drilled excavation will be below the groundwater table and/or under waterways.

C. Comply with all local, state and federal laws, rules and regulations at all times to prevent pollution of the air, ground and water.

D. The depths of horizontal directional bores under driveways shall be evaluated by the City and Engineer if deviations from bore path shown on the Drawings are proposed by the Contractor.

E. Do not initiate HDD until submittals are received and reviewed by the Engineer, and all of the Engineer's comments have been addressed.

F. Drawings show existing buried utilities that are believed to be near the directional drill alignment. There is no guarantee that these utilities are located as shown or that other utilities are not present. Field locate nearby utilities or other potential subsurface obstructions that may interfere with the Work.

G. Notify Sunshine 811 system to request marking of utilities that subscribe to Sunshine 811 and shall individually notify other known or suspected utilities to request marking of these utilities. Confirm that requested locates are made prior to commencing drilling operations. Make diligent efforts to locate unmarked or abandoned utilities using available information, maps, and drawings. Visually confirm and stake existing lines, cables, or other underground facilities including exposing crossing utilities and utilities within 20 feet laterally of the centerline of designed drilled path.

H. Control drilling practices to prevent damage to existing utilities, structures, pavement and sidewalks.

3.2 EQUIPMENT

A. Diesel, electrical, or air-powered equipment will be acceptable, subject to applicable federal and state regulations.

B. Contractor shall employ equipment that will be capable of handling the various anticipated ground conditions. In addition, the equipment shall:

1. Be capable of minimizing loss of ground ahead of and around the machine and providing satisfactory support of the excavated face at all times.

2. Provide a system to indicate whether the amount of earth material removed is equivalent to that displaced by the advance of the machine

such that the advance rate may be controlled accordingly.

C. Provide adequate secondary containment for any and all portable storage tanks.

3.3 MOBILIZATION

A. Mobilize equipment, materials, and personnel necessary to construct the carrier pipeline using the HDD process at the locations shown in the Drawings.

B. Entry Area: Set up temporary workspace within the areas delineated on the Drawings. Appropriate precautions and measures shall be employed to prevent erosion, surface drainage, and spillage of drilling fluids or other materials that could adversely impact the environmental quality of the site. Use appropriate precautions and measures to minimize erosion and contain spillage or runoff. A vacuum truck or trailer unit will be on standby and capable of responding within one hour to spills or inadvertent return incidents.

C. Exit Area: The exit area shall have appropriate precautions and measures for containing drilling fluids and cuttings. Use appropriate methods to minimize erosion and runoff. Containment and cleanup equipment shall be available to contain and clean up surface spills and inadvertent returns.

D. Pipe Layout Area: Layout area shall be free of stones, wood, debris, and obstructions. Pipe rollers shall be provided during the assembly process to facilitate pipe joining and pullback. Pipe rollers and pipe handling shall be non-abrasive and cushioned using special devices and methods to prevent damage. Pipe rollers that are uncushioned, unsteady or pose a possibility of damaging or scratching the pipe shall not be used. The pipe lay out area may not allow the entire length to be joined in a single length before start of pull-in. Plan work accordingly. Maintain access to properties unless written permission has been granted by the individual property owners.

3.4 HORIZONTAL DIRECTIONAL DRILLING

A. Construction Control

1. The Contractor shall establish and be fully responsible for the accuracy of his own control for the construction of the entire project, including structures, drill line and grade.

2. The Contractor’s control points shall be established sufficiently far from the drilling operation not to be affected by construction operations.

3. The Contractor shall maintain daily records of alignment and grade and shall submit these records to the City and the Engineer. However, the Contractor remains fully responsible for the accuracy of his work and the correction of it, as required.

4. The Contractor shall check his control for the bore alignment against an above ground undisturbed reference at least once for each rod length of bore constructed, or more often as needed or directed by the Engineer or the City. Contractor shall furnish a "Directional Bore Log" for each bore completed.

B. Pilot Bore: The pilot bore shall follow the design path of the bore shown on the Drawings.

1. Horizontal and Vertical Tolerances: Horizontal and vertical deviations shall be less than plus or minus two feet from the design path centerline. Continuously monitor horizontal and vertical position and record the position at least once per drill pipe length, or every 20 feet, whichever is less.

2. Radius of Curvature: The radius of curvature shall not be less than that shown on the Drawings. The radius of curvature shall be calculated over the distance of three drill pipe sections.

3. Entry and Exit Tolerances: The location of the entry and exit points shall be in accordance with the accepted HDD Work Plan.

C. Pre-reaming and Reaming: The pilot bore shall be pre-reamed and reamed using equipment and methods submitted. Pre-ream completely the bore to the final diameter prior to pullback. Multiple reams may be required to achieve the desired borehole diameter.

D. Pipe Pullback:

1. A final swabbing of the bore path prior to pullback of the carrier pipe is required.

2. Pipe shall be installed by pulling it into the reamed bore path in a continuous operation, behind a final reaming tool to be selected. Consideration shall be given that the carrier pipe may not be able to be pulled into the bore path in a continuous operation and that pulling may need to be temporarily suspended during intermediate fusing of the carrier pipe.

3. Pipe shall be isolated from excessive torsional and axial stresses by a swivel device.

4. Measurements shall be made, recorded, and submitted on the daily logs during final reaming and pipe pullback.

5. Pulling Loads: The maximum pull (axial tension force) exerted on the carrier pipeline shall be measured continuously and limited to the maximum allowed by the pipe

Manufacturer so that the pipe or joints are not overstressed. A factor of safety over the Manufacturer's maximum allowable is not required.

6. Pipeline Support: The pipelines shall be adequately supported during installation so as to prevent overstressing or buckling. Provide adequate support/rollers along the stringing area to support the required length of the carrier pipe for each bore. Such support/rollers shall be spaced according to the pipe supplier, and the rollers be comprised of a non-abrasive cushioned material arranged in a manner to provide support to the bottom and bottom quarter points of the pipeline allowing for free movement of the pipeline during pullback. The pipe layout area shall be cleared of large stones, construction debris, or other foreign objects that could damage the piping during pullback.

7. Leading end of the pipe shall be closed during the pullback operation, in accordance with the pipe supplier's recommendations. A pulling head shall be used that is rated at the allowable pull force capability of the pipe section being installed, in accordance with the pipe supplier's recommendations.

8. Each length of pipe shall be inspected and cleaned as necessary to be free of debris immediately before joining.

9. Handle, at all times, the carrier pipe in a manner that does not overstress or otherwise damage the pipe. Vertical and horizontal curves shall be limited to manufacturer's recommended bend radius so that wall stresses do not exceed the allowable bending radius as recommended by the pipe supplier. If the pipe is buckled or otherwise damaged due to acts or omissions, the damaged section shall be removed and replaced at their expense. Take appropriate steps during pullback to ensure that the carrier pipe and tracer wires will be installed without damage.

10. Monitor and inspect pipe rollers and method for suspending pipe at entry during the pullback operation to avoid damage to the pipe.

11. Cease operations if the pipe is damaged, remove the pipe from the bore and repair the pipe using the Manufacturer's recommended procedure or replace the damaged pipe before resuming installation.

12. Be responsible for damage to the pipe resulting from installation, including costs for replacement and labor and materials at no cost to the City.

13. After the carrier pipe is completely pulled through the bore, a sufficient period as recommended by the pipe manufacturer shall be provided before the final pipe tie-in.

14. Upon completion of pullback, perform the following cleaning on the completed pipeline. After the installation of the carrier pipe, swab inside of pipe with a flexible polyurethane foam swab complete with rear polyurethane drive seal. In tandem, swab with a one to two pound per cubic foot pig for proving, sweeping and sealing and a five to seven pounds per cubic foot pig for wiping. The tandem swabs shall

make a minimum of two passes through the entire pipeline. Cleaning and flushing shall be accomplished by propelling the swab down the pipeline to the exit point with potable water. Flushing shall continue until the water is completely clear.

15. Final Hydrostatic Test: Conduct a final hydrostatic test of the installed pipeline. Final test shall be in accordance with Section 331050 as applicable. Repair defects discovered during the test and repeat until the pipe passes the test.

3.5 DISPOSAL OF EXCESS MATERIAL/CLEANING

A. Upon completion of drilling and pipe installation, remove drilling spoils, debris, and unacceptable material from approach trenches and pits. Clean up excess slurry from ground.

B. Restore approach trenches and pits to original condition.

C. Contractor shall remove all puddled bentonite (drillers mud) and dispose of off-site in a legal manner, at no additional cost to the City.

D. Remove temporary facilities for drilling operations

END OF SECTION