

ITEM 611E97400 – CONDUIT, MISC.: PILOT TUBE GUIDED AUGER BORING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work specified in this section includes the requirements for installation of 3 culverts approximately 300ft long passing beneath two rail tracks. The culverts will each consist of 72in steel casing proposed to be installed by Pilot tube guided auger boring. The 3 casing are installed parallel on a 5% grade with approximately 6ft spacing between each casing. The ground is as indicated on the geological bore hole information provided in the contract documents.

Guidance of the casing installation is required due to the minimal spacing between the 3 casings. Contractor must submit his means and methods with his proposal to install the casings within the alignment and settlement tolerances indicated in the contract documents. However, if the Contractor proposes to install casings using an alternate method suitable for the existing subsurface conditions capable of meeting the specified tolerances, a complete submittal of the methods and materials shall be made, subject to the approval of the Engineer prior to initiation of the work.

- B. The pilot tube guidance system if used shall be by electronic Theodolite with camera and electronic (LED) target that can continuously monitor Line and Grade to ensure accuracy is maintained within the tolerances specified by the equipment manufacturer. The head shall be designed to avoid the need for dewatering except as is required to control groundwater inflows at starting and receiving pits. Pipe insertion methods using pilot tube equipment shall be employed to directly install the casing pipe. For a large diameter casing as specified, Contractor will submit the means and methods to be used for the guidance including any intermediate casing to be installed to ensure guidance of the larger casing is maintained to the required tolerances.
- C. The work specified includes requirements for temporary and permanent works including excavation and support of excavations for starting and permanent receiving headwall portals. The Contractor shall design, furnish, install, and maintain a system of supports, including all bracing and associated items, to retain excavations in a safe manner and to control ground movements. Upon completion of the casing installation, the system of supports not required as permanent works, shall be removed and the starting and receiving pits construction staging areas restored as discussed herein.
- D. Contractor will hire a monitoring company to provide settlement monitoring of both rail tracks and the exit headwall. Monitoring of rail tracks will be as per the requirements of each rail track owner and will be submitted to them for approval.

- E. The contractor will provide and install steel casing pipe as specified in the contract documents, if required all internal and external surface coating to be initially completed offsite and a warranty certificate to be provided. Any welding areas or damage to the coatings will be repaired on site, external surface repairs to be completed before installation.
- F. The work shall include development of construction staging areas; fencing and signing; design and construction of shaft excavations and excavation support systems; material disposal; control and disposal of surface water, groundwater, and construction water; and site restoration.
- G. The Contractor shall have sole responsibility for sizing the pit excavations required for starting and receiving pits, within the work area limits delineated on the Drawings or shown otherwise. The size of the excavations shall provide adequate space for the Contractor's selected methods of construction.

1.2 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition available on the date of issue of Contract Documents shall be used.

1. Commercial Standards:

- a. ASTM A 36 - Specification for Structural Steel.
- b. ASTM A 53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- c. ASTM A 139 - Grade B Steel Pipe.
- d. ASTM A 283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- e. ASTM A 572 Specification for Electric-Fusion (Arc) - Welded Steel Pipe (NPS 4 and Over).
- f. ASTM A 1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- g. ANSI/AWS D1.1 Structural Welding Code

B. Codes:

1. Occupational Safety and Health Administration (OSHA) Regulations and Standards for Underground Construction 29 CFR Part 1926, Subpart S. 'US. Regulation.
2. FHWA/ FTA Manual

1.3 DEFINITIONS

- A. Auger Boring is a method of installing a steel casing pipe where the steel pipe is advanced by pipe jacking while simultaneously excavating the ground at the face and continuously transporting the material back to the starting shaft by a continuous flighted auger.
- B. Pipe Ramming is a method of installing steel casing where the steel pipe is advanced by a pneumatic hammer unit acting on the end of the pipe, as the pipe advances through the ground the material is ingested into the inside of the steel pipe to be removed later normally at the completion of the drive.
- C. Pilot Tube Guided Boring method (PTGBM) is a multi-stage method of accurately installing a pipe to line and grade by use of a guided pilot tube and followed by upsizing to install the product pipe. The system must use a guidance system as defined above to insure accuracy.
- D. Product Pipe / Carrier Pipe: Permanent pipeline.
- E. Casing: Typically, a steel pipe or RCP to support a bore that is inserted simultaneously with the excavation operation. A carrier or product pipe is frequently inserted inside a casing pipe.
- F. Starting Pit: A pit where the excavation equipment will be set up to start the boring or pipe installation from and where additional lengths of pipe will be added.
- G. Receiving Pit : A pit where the boring system drive exits and completes the drive

A. **DESIGN CRITERIA**

- B. THE METHOD AND EQUIPMENT SELECTED FOR THE PROJECT SHALL BE COMPATIBLE WITH THE GEOLOGIC CONDITIONS DESCRIBED IN THE GEOTECHNICAL DATA.
- C. PTGB equipment or suitable alternative is recommended to be used for all boring work where line and grade control are required .

- D. Design of the jacking pipe and determining acceptable pipe fabrication tolerances is the responsibility of the Contractor. Maximum compressive stresses applied to the pipe shall not exceed 40 percent of the maximum design compressive strength of the pipe material (2.5 Safety Factor) and shall not exceed the manufacture's recommended allowable stresses whichever is lower.
- E. The thrust block or track anchorage if required for the chosen method shall be perpendicular to the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure of the equipment, with a factor of safety of at least 1.25 without excessive deflection or displacement.
- F. Dewatering for groundwater control shall be utilized at the jacking and receiving pits only.
- G. General: Design a shaft support of excavation (SOE) for each jacking and receiving pit. Design support systems to withstand lateral earth pressures, unrelieved hydrostatic pressures, bottom heave, equipment loads, applicable traffic and construction loads, thrust block reactions, and other surcharge loads to allow safe construction of the pipeline without excessive movement or settlement of the ground, and to prevent damage to adjacent structures, streets, railroads, and utilities. Excavation support systems shall be compatible with the geologic conditions indicated by available borings. The Contractor shall be responsible for the control of groundwater, including the removal, handling, and disposal of groundwater as necessary to construct the shaft and maintain a stable shaft excavation. The Contractor shall:
1. Design each member or support element to support the maximum loads that can occur during construction with appropriate safety factors.
 2. Design the support system to limit horizontal and vertical movements to less than the threshold limits stated in Section 3.8.A of the ITEM 611E97300 – CONDUIT, MISC.: GEOTECHNICAL INSTRUMENTATION AND MONITORING specification, and to protect any adjacent improvements and utilities from damage. Design support system to maintain the stability of the excavation and provide a factor of safety of at least 1.5 against sliding or bottom heave.
 3. Design support system to provide groundwater control for each shaft.
 4. Employ walers, struts, beams and/or tie-backs for lateral support of shaft excavations. Provide struts with intermediate vertical and horizontal supports as required to prevent buckling.
 5. Design a sump system for shaft excavations to control groundwater inflows, prevent piping or loss of ground, and maintain stability of the excavation.
 6. Design a seal, if necessary due to soil type, at the entrance locations for pilot tubes, casings, and product pipes to prevent loss of ground into shafts.

7. Locate shafts for jacking and receiving pits as required for the trenchless installation of the pipeline between the stations indicated on the Drawings.
8. Provide temporary fencing and barricades around all shaft excavations in accordance with OSHA requirements.
9. Design shaft excavation support systems in accordance with all OSHA requirements.
10. All Temporary and permanent works will be stamped by a professional engineer licensed in the state of OHIO
11. Review of the Contractor's plans and methods of construction by the Engineer does not relieve the Contractor of the responsibility to provide an adequate support system achieving the specified requirements.

1.4 SUBMITTALS

- A. Submit the following. Provide sufficient detail to allow the Engineer to judge whether or not the proposed equipment, materials, procedures and qualifications will meet the Contract requirements.
- B. Shafts:
 1. Details of the methods to control groundwater inflows and loss of ground into the shafts when breaking out of starting pits and breaking into receiving pits.
 2. Layout of starting pits and receiving pits including details such as launching and exit seals, thrust block, jacking frame, and main jacks.
 3. Shop Drawings: Submit the following shop drawings for temporary and permanent works including pit excavations, headwalls, excavation support systems, and other related information as requested by the Engineer. The shop drawings shall be prepared and sealed by a Civil or Structural Engineer registered in the State of Ohio. The Contractor shall submit the following.
 - a. Name and qualifications of person responsible for excavation support system design.
 - b. A site plan for each pit excavation drawn to scale indicating the staging area limits, pit dimensions, site access provisions, site development details, traffic control details, fencing limits and gate locations, and the locations of the starting and receiving pits, cranes, trailers, support facilities, spoil handling and loading, and other plant and equipment.
 - c. Drawings and design calculations indicating arrangement of supports and construction sequence for proposed support system(s). Show the

elevation of struts or other supports as related to the depth of excavation at intermediate stages of construction. Indicate description, sizes, shapes, and material specifications for all support elements. Calculations shall include estimates of likely deflections or deformations of the support system and maximum tolerable values.

- d. Breakout plans indicating support installed to maintain pit excavation support and stability of the excavation when breaking out of starting pit and when breaking into receiving pits.
 - e. Provisions for protecting or relocating adjacent utilities. All utilities within 5 feet of shaft excavations shall be addressed.
 - f. Site drainage and groundwater control details. Show details of the measures to control, treat, handle and dispose of surface water runoff, groundwater, and construction water. Provide details of working slab, sub drains, and sump construction.
 - g. Details of groundwater control methods when launching machine from the starting pit and breaking into the receiving pit.
 - h. Quality control. Address materials testing requirements, and excavation monitoring provisions.
 - i. Details of materials handling, stockpiling, and disposal sites for excavated materials.
 - j. Plans indicating site restoration details.
4. Reports and Records: If available from PTGBM Submit excavation monitoring data of horizontal and vertical deflections of supports on each day that measurements are made.

C. Auger Boring

- 1. Qualifications: Submit the name of the Subcontractor or Contractor that will perform the work and written documentation summarizing the qualifications of the firm, description of similar reference projects including owner's name and telephone numbers, project superintendent, machine operators, and site safety representative. Provide evidence of OSHA certification for site safety representative.
- 2. Submit the following describing the equipment and construction methods to be employed.
 - a. A detailed description of the equipment and procedures to be employed. Provide manufacturer's literature describing in detail the system and if PTGBM is to be used full details of this equipment to be used including

machine type, spoil removal system, guidance system, and provisions for injecting pipe lubricants. Describe machine capabilities and procedures for minimizing loss of ground. Provide descriptions of projects on which this system has been successfully used including names, addresses, and telephone numbers of owner's representatives for these projects as well as length, diameter, and pipe material used. Include details of any intermediate temporary casing that will be used for the guidance of the auger bore.

- b. Schedule for the Boring work identifying all major construction activities as independent items. The schedule shall include as a minimum the following activities: mobilization; groundwater control if required at starting and receiving pits; pit excavation and Headwall construction, excavation support; equipment setup; If PTGBM is to be used schedule for the pilot tube and boring activities; site restoration; cleanup; and demobilization. The schedule shall also include the working hours for each activity, and a written description of the construction methods and equipment, to be employed in completing each of the work activities shown on the schedule. The schedule shall be reviewed with the Engineer and be updated and resubmitted by the Contractor every two weeks.
- c. If PTGBM is used a description of the alignment control and steering systems. Provide manufacturer's literature, drawings showing set up and support provisions, and other details for the guidance system. Submit a description of surveying methods to set reference points and a description of procedures to check the guidance system and reset or realign it during construction. Confirm that these systems can achieve the required pipeline line and grade within the specified tolerances.
- d. Arrangement and capacity, of thrust system. Provide details of thrust ring, jacking controls, and pressure gages. Provide an estimate of the maximum jacking force expected to be required to complete each drive.
- e. Thrust block if required and jacking frame design and details. Submit calculations demonstrating that the soils behind the thrust block will sustain the maximum planned forces developed by the main jacks.
- f. Details of pipe lubrication injection system for PTGBM and pipe lubricants to be used during Construction including manufacturer's literature.
- g. Spoil handling, transport, and disposal equipment and procedures spoil disposal sites. Provide written documentation from the disposal site(s) indicating that they will accept the spoil or slurry and are in compliance with prevailing (or applicable) regulations.

- h. Pre- and post-construction surveys including photographs, videotapes, and field notes and sketches.
 - i. A safety plan for the Boring operations including provisions for lighting, ventilation, and electrical system safeguards.
 - j. Details of the casing pipe to be used indicating pipe wall thickness, joint details, (welded or push fit eg Permalok) indicate any modifications to the required fabrication tolerances for the pipe.
- 3. Reports and Records: The Contractor shall submit the following on each day that measurements are made:
 - a. Survey notes, records, and shift reports indicating thrust force.
- 4. Calculations: Submit the following calculations:
 - a. Design calculations demonstrating that the specified pipe is capable of supporting the maximum stresses to be imposed on the pipe during jacking. Use the maximum allowable bearing stress criteria specified in this section.
 - b. Calculations showing the hydraulic pressure that is required to develop the maximum allowable jacking pressure. Provide a description of controls to ensure that this hydraulic pressure will not be exceeded during jacking operations.
 - c. Temporary shoring, dewatering and predicted settlement/deflection calculations.

1.5 QUALITY ASSURANCE

- A. All Boring/Ramming work shall be performed by an experienced Subcontractor or Contractor who has at least 3 years of experience in performing similar work. If PTGBM is used operator must have completed at least two Pilot Tube Guided Boring projects consisting of a total of 2000 feet combined. The project superintendent shall have at least 5 years of experience involving Auger boring construction. The machine operator(s) shall have technical training in the operation of the proposed equipment and shall have completed at least two similar projects involving at least 1,000 feet of steel casing installation.
- B. The site safety representative and personnel responsible for noise and air quality monitoring shall be certified by OSHA.
- C. Excavation support systems shall be designed by a Civil or Structural Engineer registered in the State of Ohio who has a minimum of five years of experience in the design of soil retaining structures.

- D. The surveyor shall be a licensed surveyor in the State of Ohio.
- E. Provide tolerances of casing elevation and tolerances of alignment within the right-of-way envelope and as required by the local authority having jurisdiction. As a minimum, allowable grade deviations in horizontal and vertical alignments shall be no greater than 6in in any direction over the length of the boring.

1.6 SAFETY

- A. Perform all work in accordance with the current applicable regulations and safety requirements of the federal, state and local agencies. Comply with all applicable provisions of and 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA. In the event of conflict, comply with the more stringent requirements.
- B. All shaft excavations and support systems for jacking and receiving pits shall conform to applicable OSHA provisions, and OSHA excavation, trenching, and shoring standards that are contained in the Code of Federal Regulations 29 C.F.R. 1926.650-1926.653. In the event of a conflict, comply with the more stringent requirements.

1.8 PROJECT/SITE CONDITIONS

- A. Existing Subsurface Conditions:
 - 1. Boring logs and laboratory test results, made in and adjacent to the work site, are made part of the contract documents.
 - 2. The locations of each boring are indicated on drawings.
 - 3. Subsurface investigations provide information regarding conditions encountered at particular location and time. Users of subsurface information are cautioned that some conditions, particularly groundwater conditions, may change between time of investigation and time of tunneling and jacking operations. Conditions at boring locations may not be reflective of that elsewhere.

1.9 PROTECTION OF EXISTING STRUCTURES

- A. Protect from damage and carefully support as necessary all existing pipes, poles, wires, fences, curbing, property line markers, and other structures, which the Engineer decides must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore them without compensation therefor, to at least as good condition as that in which they were found immediately before the work was begun.

1.10 SETTLEMENT REQUIREMENTS

- A. Settlement : Contractor shall monitor settlement at both the rail track crossings and if required utilities within 20ft of the bores. Contractor shall coordinate with the Railroad companies. Settlement monitoring will be by an approved company and an automated monitoring system will be used. Settlement at the rail tracks will have the following alarm criteria, or as required by the Railroad companies:

- (a) Less than 1/4in Green
- (b) >1/4in but <1/2 in Orange: Continue but with caution report to railway
- (c) >1/2in Red Stop excavation - report to Railway.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Pilot Tube Guided Boring Machine: The Pilot Tube Guided Boring machine if used for guidance of the auger bore shall be controlled as described above, manufactured by a company that specializes in the design and fabrication of this type of equipment and has at least five years of experience. The machine shall be compatible with the geologic conditions described in the Geotechnical Data and shall satisfy the following requirements:
- 1. A pilot tube lubrication injection system shall be provided to inject lubricants as required to minimize jacking forces.
 - 2. The maximum allowable overcut shall not be greater than 1/2 inch larger than the outside diameter of any casing pipe installed.

2.2 MATERIALS

- A. General: Casings used for jacking shall be round, have smooth, even outer surfaces and have either welded joints or push fit joints similar to Permalok. Casing ends shall be square and smooth so that jacking loads are evenly distributed around the entire pipe joint. Casing shall be capable of withstanding the jacking forces imposed during installation, and the final in place loading conditions. A minimum safety factor of 2.5 shall be maintained when comparing the ratio of the ultimate casing strength to the calculated maximum jacking load. The ends of the pipe shall be protected against damage. The casing material shall be installed according to the casing manufacturers' recommendations.

- B. Jacked pipe casings shall be uncoated steel unless otherwise indicated in the contract documents. Steel casings if welded shall be welded conforming to ASTM A 36, ASTM A 283 Grade D, or ASTM A 1011 Grade 33.
- C. The minimum size and wall thickness of jacked steel pipe casings shall be as indicated on the Drawings, unless otherwise required by the agency having jurisdiction over the road, utilities, or improvements. The Contractor may submit a greater steel thickness and diameter as appropriate for the method of work and loadings involved, as suitable for the site and as limited by possible interferences. Submit any deviations in the approved design to the Engineer fourteen (14) working days in advance of jacking operations, and do not proceed with any work until the Engineer has approved the alternate methods proposed.

2.3 ANNULUS LUBRICATION AND GROUT

FOR DIAMETERS OVER 48IN

- A. 2in or similar threaded grout / lubrication holes will be provided (one per pipe), each will be fitted with a threaded blanking disc but may be used for lubrication of the steel casing if required but after completion of the drive contact grouting to the outside of the casing will be carried out.
- B. Non-hazardous, environmentally compatible clay or polymer water-based lubricating fluids for reducing friction between pipe casings and ground may be used,
- C. Contact grout shall consist of a neat cement grout or clay filler suspension grout compatible with the lubricant and approved by the Engineer.
- D. Colloidal mixers, suitable grout pumps, lubricating pipework, and monitoring instruments shall be approved by the Engineer.

2.4 CASING ACCESSORIES

- A. Casings shall not be connected to conduit cathodic protection. Casings shall be equipped with test leads to test for electrical contact.
- B. Warning/Identification tape and pipeline marker materials shall be in accordance with ODOT CMS 625.

PART 3 - EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. Boring shall not begin until the following have been completed:

1. Required submittals have been made and the Engineer has reviewed and accepted all submittals.
 2. Monitoring Plan has been installed and understood by crew.
 3. Starting and Receiving Pit excavation and support has been completed in accordance with the requirements of this section.
 4. Groundwater control for breaking out of starting pits and into receiving pits has been established.
 5. Site safety representative has prepared a code of safe practices in accordance with OSHA requirements. . Hold safety meetings and provide safety instruction for new employees as required by OSHA.
 6. Pre-construction survey documents have been submitted to the Engineer.
- B. The pipe shall be installed using means and methods, between the limits indicated on the Drawings to the specified lines and grades, and utilizing methods that include due regard for safety of workers, adjacent structures and improvements, utilities, and the public. Starting and receiving pits shall be located as identified on the Drawings, unless approved otherwise by the Engineer.
- C. All work shall conform to the requirements of OSHA. Perform all work in accordance with the current applicable regulations of the federal, state, and local agencies. In the event of conflict, comply with the more restrictive applicable requirement. Gas testing if required shall be performed by a certified gas tester in accordance with OSHA requirements.
- D. Furnish all necessary equipment, power, water, and utilities for Equipment, pipe lubricant mixing and pumping, removal and disposal of spoil, grouting, and other associated work required for the Contractor's methods of construction.
- E. A thrust block or base slab are required to transfer jacking loads to the soil in the starting pit. The thrust support shall be properly designed and constructed and shall be perpendicular to the proposed pipe alignment. The attachment and support of the equipment shall be designed to support the maximum obtainable jacking pressure developed by the main jacks with a SF of 1.25.
- F. Provide launching seals if required to prevent loss of ground, groundwater inflows, and loss of lubricants at starting and receiving pits.
- G. No gasoline powered equipment shall be permitted in jacking and receiving pits. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations.

- H. Conduct all operations such that trucks and other vehicles do not create a dust or noise nuisance in the streets and adjacent properties. Promptly clean up, remove, and dispose of any spoil or slurry spillage.
- I. All work shall be done so as not to disturb roadways, adjacent structures, landscaped areas, or utilities. Any damage shall be immediately repaired to the satisfaction of the Engineer.
- J. Notify the Engineer at least 15 days before beginning any excavation.
- K. Begin site development of staging areas, and pit excavations only after shop drawings have been reviewed and accepted by the Engineer.
- L. Comply with all pit: support, traffic control, fencing, barricading, and signing regulations included in the encroachment permit provisions. In the event of conflict between this section and the encroachment permit provisions, comply with the more stringent requirements.
- M. Methods of construction shall be such as to ensure the safety of the work, Contractor's employees, the public and adjacent property and improvements.
- N. Size and locate pits and their work areas, so as to minimize interference with vehicular and pedestrian traffic.
- O. Provide pit excavations with a concrete and or gravel working slab equipped with a sump to pump out groundwater and construction water. Grade the site to prevent surface run-off from entering into the excavation.
- P. Before beginning construction at any location, adequately protect existing structures, utilities, railroads, trees, shrubs, and other existing facilities. Design excavation support systems to minimize deformations that could damage adjacent utilities. The repair of or compensation for damage to existing facilities shall be at no cost to the owner.
- Q. Perform pit excavations using conventional mechanical excavation techniques.
- R. All welding shall conform to the applicable provisions of ANSI/AWS D1.1.
- S. Construct fencing with locked gates, lights, and signs, as necessary around the staging areas to provide for public safety.
- T. On excavations over 10ft deep install excavation support SOE monitoring provisions as indicated on the shop drawings. Monitor performance of excavation support system for both horizontal and vertical deflections daily during excavation, and at intervals not to exceed seven days following the completion of excavation work. If monitoring data indicates that deflections may exceed estimated values increase frequency of monitoring as required by the Engineer. Submit all monitoring measurements to the Engineer on the same

day measurements are taken. If settlement or deflections of supports indicate that the support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the Engineer at no additional cost.

- U. Install excavation support systems SOE in accordance with shop drawings that have been reviewed and accepted by the Engineer.
 - 1. All supports shall be installed tight against the excavation to provide positive support and any voids between the support system and the excavation shall be filled promptly with flowable fill, sand or pea gravel to minimize ground movements.
- V. Conduct all pit and tunnel construction work, including excavation, shoring, temporary facilities, materials storage, and construction traffic within any construction easements established for the project. All work shall be in accordance with the applicable permits.
- W. Any permanent works such as exit headwalls etc shall be designed and stamped by a Professional engineer registered in the state of Ohio.

3.2 TEMPORARY VENTILATION FOR SHAFTS

- A. Furnish and operate when personnel are underground, a temporary ventilation system and air monitoring system conforming to the requirements of OSHA. Operate and maintain a ventilation system that provides a sufficient supply of fresh air and maintains an atmosphere free of toxic or flammable gasses in all underground work areas.

3.3 GROUNDWATER CONTROL

- A. Provide a sump and pump for each pit excavation to remove seepage that enters the excavation. Pumping from sumps shall not result in boils, softening of the ground, or loss of fines. Sumps, sub-drains, drain blankets, wells, and well points shall be installed with suitable filters or screens so that fines are not removed from the formation.
- B. If required provide positive groundwater control using dewatering wells, jet grouting, or other acceptable methods when launching or retrieving boring machines from starting and receiving pits to maintain excavation support and to prevent seepage and loss of ground.
- C. Review available utility drawings and locate conduits and underground utilities in all areas where dewatering wells are to be drilled and installed. Call Underground Service Alert (USA) prior to any drilling and place wells to avoid interference with the existing conduits and utilities (800-642-2444). Repair damage to existing utilities resulting from groundwater control installations at no additional cost.

- D. Maintain temporary drainage facilities of adequate size, with standby pumps and adequate back-up power for emergency use, to collect and dispose of water that enters the pit excavations.
- E. Dispose of all water removed from pit excavations in accordance with all applicable permits and regulatory requirements. Dispose of contaminated groundwater in accordance with all applicable permits and regulatory requirements.
- F. Maintain existing surface drainage conditions in all areas affected by pit excavations.

3.4 PILOT TUBE GUIDED AUGER BORING METHOD

- A. Pipe installation by Pilot Tube Guided Auger Boring shall be completed in accordance with the shop drawings, accepted submittals, and encroachment permit conditions. PTGBM machine shall meet the specified requirements of this section.
- B. Provide a suitable jacking frame and thrust block to carry out the work.
- C. Prior to starting Pilot Tube Guided Boring operations, survey the location and orientation of the pipe guide rails to ensure they are on the proper line and grade and check to see that they are properly supported. Special care shall be taken when setting the pipe guide rails in the starting pit to ensure correctness of the alignment, grade and stability.
- D. Intermediate sized casing pipe may need to be installed by the PTGBM so that the 72in casing pipe is installed on the required line and grade.
- E. Set the casing pipe to be bored in a properly braced and supported Framework.
- F. The axial forces from the thrust jacks shall be distributed to the pipe uniformly through a properly designed thrust ring and cushion material to prevent damage to the ends of the pipe. The jacking system shall be capable of continuously monitoring the jacking pressure.
- G. Pipes shall be jacked into position following the design line and grade of the pipeline without damaging the pipe. In the event a section of pipe is damaged during the jacking operation, the pipe shall be jacked through to the receiving pit and removed. Other methods of repairing the damaged pipe may be used, subject to approval by the pipe manufacturer and Engineer
- H. Provide a lubrication system, and inject pipe lubricants through injection ports at the rear of the Reaming head and ports in the pipe as necessary, to minimize pipe friction. Pipe lubricants shall be injected continuously as the pipe is advanced. The volume injected shall not be less than that required to fill the

annular void space outside the pipe. Inject greater volumes as required to minimize jacking forces.

- I. The Pilot Tube Guided Boring machine shall be operated so as to prevent both surface heave and loss of ground during PTGBM. Restrict the excavation of the materials to only those materials that are physically displaced by the pilot tube itself in order to prevent loss of ground and settlement or possible damage to overlying structures. In the 2nd phase control the advance rate and monitor the volume of material excavated and adjust advance rate, as required, to avoid loss of ground, over-excavation, and surface heave.
- J. The equipment will be operated to maintain line and grade within the tolerance specified. This shall be achieved by continuously monitoring line, grade.

3.5 BACKFILL STARTING AND RECEIVING PITS

- A. Backfill the starting and receiving pit with a flowable self-compacting thermal fill, Thermal Sand Backfill, Fluidized Thermal Backfill, as indicated on the Contract drawings.
- B. Place and compact backfill in accordance with

3.5.1 SPOIL TRANSPORT AND DISPOSAL

- A. Transport and dispose of all excavated materials properly away from the construction site. Solids shall be at acceptable facilities in accordance with current state regulations for disposal of these materials. Only use the disposal sites identified in the shop drawings for muck disposal.

3.6 CONTROL OF LINE AND GRADE

- A. The OWNER will establish the benchmarks indicated on the Drawings. The Contractor is responsible to verify these benchmarks at the beginning prior to start of construction and report any errors or discrepancies to the Engineer.
- B. When satisfied that all benchmarks are correct, use these benchmarks to furnish and maintain all reference lines and grades for PTGBM if used. The Contractor shall use these lines and grades to establish the location of the pipe using a guidance system. Submit to the Engineer copies of field notes used to establish all lines and grades and allow the Engineer to check laser set up prior to beginning PTGBM. The Contractor remains fully responsible for the accuracy of the Work and the correction of it, as required.
- C. Guidance system shall be mounted independently from the thrust block and jacking frame to maintain the alignment of the system. If alignment shifts or is moved off of design alignment and grade for any reason, stop Pilot tube operations and reset the Guidance system. Guidance system should only be reset by qualified surveying personnel in accordance with approved procedures.

- D. Monitor line and grade continuously during PTGBM operations. Control line and grade of the pipe to within the specified tolerances.
- E. If the pipe installation exceeds the specified tolerances, correct the installation, including, if necessary, redesign of the pipe or structures. All corrective work shall be performed as approved by the Engineer at no additional cost.

3.7 BACKFILL JACKING AND RECEIVING PITS

- A. Restoration shall follow construction as the work progresses and shall be completed as soon as possible. Restore and repair any damage resulting from surface settlement caused by shaft excavation, dewatering, Boring or PTGBM. Any property damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction. Restoration shall be completed no later than thirty (30) days after the pipe is in place along any tunnel segment. Final restoration that cannot be performed within the thirty day period due to adverse weather conditions, may, upon written request that includes a proposed procedure and time schedule, be performed as approved by the owner.

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