

**CONSTRUCTION SPECIFICATION FOR
PIPELINE AND UTILITY INSTALLATION
BY MICROTUNNELLING**

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XX.01 SCOPE

This specification covers the requirements for the installation of pipes, conduits and culverts by microtunnelling. This construction method involves jacking a pipe behind a micro-tunnel boring machine (MTBM).

XX.01.01 Specification Significance and Use

This specification has been developed for use in provincial and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

XX.01.02 Appendices Significance and Use

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.
Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

XX.02 REFERENCES

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This Specification refers to the most recent edition of the following standards and publications:

Ontario Provincial Standard Specifications, General

OPSS 180	Management and Disposal of Excess Material
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Ontario Provincial Standard Specifications, Construction

OPSS 401	Construction Specification for Trenching, Backfilling, and Compacting
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OPSS 402	Construction Specification for Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers
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OPSS 403	Construction Specification for Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
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OPSS 404	Construction Specification for Support Systems
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OPSS 517 Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation

OPSS 539 Construction Specification for Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS.MUNI 1004 Material Specification for Aggregates - Miscellaneous

OPSS.MUNI 1350 Material Specification for Concrete - Materials and Production

OPSS 1440 Material Specification for Steel Reinforcement for Concrete

OPSS 1820 Material Specification for Circular and Elliptical Concrete Pipe

OPSS 1802 Material Specification for Smooth Walled Steel Pipe

American Society for Testing and Materials (ASTM) International Standards

ASTM A252 Standard Specification for Welded and Seamless Steel Pipe Piles

Canadian Standards Association Standards

CAN/CSA A3000 Portland Cement

American Society of Civil Engineers

ASCE 27 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction.

CI/ASCE 36 Standard Construction Guidelines for Microtunneling.

PipeJackingAssociation

Guide to Best Practice for the Installation of Pipe Jacks and Microtunnels

XX.03 DEFINITIONS

For the purpose of this Specification, the following definitions apply:

Casing: A pipe to support a bore. Usually not a product pipe.

Cased Bore: A bore in which a pipe, usually a steel sleeve, is inserted simultaneously with the boring operation.

Conditioning Agents: Bentonite, polymers, surfactants, foam and soda ash, or other additives used as an aid in performing the microtunnelling excavation.

Contact Grouting: Grouting of the overcut.

Contractor's Engineer: The engineer retained by the Contractor who produces the Contractor's design and Working Drawings. The contractor's engineer shall be a professional engineer licensed to practice in the Province of Ontario.

Contract Administrator: The Agency's Project Manager or its authorized representatives.

Earth Pressure Balance Shield: A shield on a microtunnel boring machine that uses the excavated soil to provide continuous face support that counteracts the soil and groundwater pressure at the tunnel face.

Excavation: Excavation shall include removal of natural soil, boulders, cobbles and fill regardless of means/methods necessary including break up of materials into a manageable size for removal.

Geotechnical Report: The Geotechnical Report provides information on the anticipated geotechnical subsurface conditions. May be a geotechnical data report or a geotechnical interpretive report. May or may not be a contract document.

Grouting: The process of filling voids or modifying/improving ground conditions. Grouting materials may be cementitious, chemical, or other mixtures. In microtunnelling, grouting may be used to fill voids around the pipe or shaft, or to improve ground conditions.

Intermediate Jacking Station: A fabricated steel cylinder fitted with hydraulic jacks that is incorporated into a pipeline between two pipe segments. Its function is to distribute the jacking load over the pipe string on long drives.

Jacking Pipes: Pipes designed to be installed using pipe jacking techniques. May be casing and/or product pipe.

Launch/Exit Seal: A mechanical seal, usually composed of a rubber flange that is mounted to the wall of the drive shaft. The flange seal is distended by the MTBM as it passes through, creating a seal to prevent water or lubrication inflow into the shaft during tunnelling operations.

Lubricant: a mixture of water and additives designed to reduce friction in the bore.

Microtunnelling: A trenchless construction method for installing pipelines that includes the following features: (1) Remote Controlled, (2) Guided, (3) Pipe Jacked, (4) Continuously Supported.

Microtunnel Boring Machine (MTBM): Mechanized excavating component of the microtunnelling system including cutter head, machine can, and any trailing cans.

Microtunnelling Methodology: A written description, together with supporting documentation that defines the Contractor's plans and procedures for microtunnelling operations.

Obstruction: Any object or feature that lies completely or partially within the cross-section of the microtunnel and prevents continued forward progress.

OHSA: Occupational Health and Safety Act of Ontario.

Overcut: The annular space between the excavated hole and the outside diameter of the jacking pipe.

Pipe Jacking: A system of directly installing pipes behind a shield machine by hydraulic jacking from a drive shaft such that the pipes form a continuous string in the ground.

Product Pipe: Pipe used for conveyance of water, gas, sewage, and other products and services.

Portal: Entrance (start) and exit (end) of the microtunnel drive. Also referred to as the tunnel eye.

Shaft: vertically sided excavation from which the microtunnelling operation is initiated or directed.

Slurry: A fluid, normally water, used in a closed loop system for the removal of spoil and for the balance of groundwater pressure during microtunnelling.

Slurry Separation: A process in which excavated material is separated from the circulation slurry.

Spoil: Earth, rock and other materials removed during installation.

Work: The total construction and related services required by the Contract Documents.

XX.04 DESIGN AND SUBMISSION REQUIREMENTS

XX.04.01 General

The Contractor's documentation, submission requirements and installation methods shall address the subsurface conditions as identified in the Geotechnical Report and/or Geotechnical Baseline Report.

XX.04.02 DESIGN AND SUBMISSION REQUIREMENTS

When any of the following information is not specified in the Contract Documents, it shall be submitted to the Contract Administrator for review a minimum of 14 calendar days prior to the commencement of tunnelling operations. Submittals must provide sufficient detail to allow the Contract Administrator to determine whether the proposed equipment, materials, and procedures will meet the Contract requirements.

XX.04.02.01 PROJECT SPECIFIC SHOP DRAWINGS

- 1) A Scaled Site and Equipment Layout Plan.
- 2) Project Utility/Site Servicing Details.
- 3) Traffic Management Plan, Including Emergency Access/Egress.
- 4) Environmental Erosion and Sediment Control Plan.

XX.04.02.02 CONSTRUCTION SHAFTS

- 1) Shop Drawings & Calculations for Work Shafts sealed by the Contractor's Engineer.
- 2) Shaft Construction Details including Access/Egress, Launch/Reception Seals and Thrust Wall.

XX.04.02.03 METHODOLOGY

- 1) Microtunnelling Method Statement, including Pre-Launch and MTBM Reception Procedures and a Site Specific Construction Program.
- 2) Estimated Jacking Force Calculations, including identifying the need for any intermediate jacking stations, sealed by the Contractor's Engineer.
- 3) Casing Pipe Details, including any intermediate jacking stations and pipe specials, sealed by the Contractor's Engineer. Casing Pipe Design must demonstrate that the pipe is capable of sustaining all anticipated loads including loads imposed during jacking. Also to include potential larger jacking forces required to advance the pipeline following stoppages.
- 4) Contingency Plans as specified in the contract documents.
- 5) Microtunnelling Guidance System Details.
- 6) Spoil Disposal Plan.
- 7) Casing Contact Grouting Plan.

XX.04.02.04 EQUIPMENT

- 1) MTBM and Jacking Frame Details.
- 2) Slurry Management and Separation System Details.
- 3) Lubrication System Details.
- 4) Ventilation System Details.
- 5) Atmosphere Monitoring Systems and Alert Protocols.
- 6) Communication System Plan.

XX.04.02.05 HEALTH AND SAFETY PLAN

- 1) Response Plan to Hazardous Atmosphere Detection.
- 2) Confined Space Entry Plan.
- 3) Emergency Microtunnel and Shaft Evacuation and Rescue Plans, to Encompass Injury, Fire, Flooding, and Security Breach.

XX.04.02.06 ENVIRONMENTAL CONTINGENCY PLANS

- 1) Environmental Spill Response Plan.
- 2) Adverse Weather Plan, if required.

XX.04.02.07 QUALITY CONTROL AND AS-BUILT RECORDS

- 1) Survey Control: Verification of Jacking Frame Alignment and Elevation
- 2) Monitoring data (settlement, vibration, noise, building, groundwater, etc.) as specified in the Contract Documents.
- 3) Calibration and Certification Records as Specified in the Contract Documents.
- 4) Details of MTBM Data Logging and Daily Record Sheets.
- 5) Vertical and horizontal alignment survey of jacked pipe and/or final product pipe.

XX.05 MATERIALS

XX.05.01 Casing

Casing shall be as specified in the contract documents.

XX.05.02 Lubricant

Lubricants shall be appropriately mixed for the anticipated in situ ground conditions. Only bentonite or additives shall be used as annular lubricants. All additives shall be chemically inert, biodegradable, and non-toxic. No petroleum-based or detergent additives shall be permitted.

XX.05.03 Grout

Grout shall be as specified in the contract documents.

XX.06 EQUIPMENT

XX.06.01 Microtunnelling Equipment

The Contractor shall be responsible for selecting microtunnelling equipment which, based on past experience, has proven to be satisfactory for excavation of the soils that will be encountered.

The Contractor shall employ microtunnelling equipment that will be capable of handling the various anticipated ground conditions indicated in the Geotechnical Report. The MTBM shall also be capable of controlling loss of soil ahead of and around the machine and shall provide continuous pressurized support of the excavated face.

- a) **Remote Control System** - Provide a MTBM that includes a remote control system with the following features:
- Allows for operation of the system without the need for personnel to enter the microtunnel. Has a display available to the operator, at a remote operation console, showing the position of the shield in relation to a design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force cutter head torque, rate of advance and installed length.
 - Integrates the system of excavation and removal of spoil and its simultaneous replacement by Product Pipe. As each pipe section is jacked forward, the control system shall synchronize all of the operational functions of the system.
 - The system shall be capable of adjusting the face pressure to maintain face stability for the particular soil condition encountered.
 - The system shall monitor and continuously balance the soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.
 - The pressure at the excavation face shall be managed by controlling the volume of spoil removal with respect to the advance rate.
 - The system shall include a separation process designed to provide adequate separation of the spoil from the slurry so that slurry with a sediment content within the limits required for successful microtunnelling, can be returned to the cutting face for reuse. Appropriately contain spoil at the site prior to disposal.

- The type of separation process shall be suited to the size of microtunnel being constructed, the soil type being excavated, and the work space available at each work area.
- The system shall allow the composition of the slurry to be monitored to maintain the slurry weight and viscosity limits required.

b) **Active Direction Control** - Provide an MTBM that includes an active direction control system with the following features:

- Controls line and grade by a guidance system that relates the actual position of the MTBM to a design reference Provides active steering information that shall be monitored and transmitted to the operating console and recorded.
- Provides positioning and operation information to the operator on the control console.

XX.06.02 Pipe Jacking Equipment

Provide a pipe jacking system with the following features:

- Has the main jacks mounted in a jacking frame located in the launch shaft.
- Has a jacking frame that successively pushes towards a receiving shaft, a string of Product Pipe that follows the microtunnelling excavation equipment.
- Has sufficient jacking capacity to push the microtunnelling excavation equipment and the string of pipe through the ground.
- The main jack station may be complemented with the use of intermediate jacking stations as required.
- Has a capacity at least 20 percent greater than the calculated maximum jacking load.
- Develops a uniform distribution of jacking forces on the end of the casing pipe.
- Provides and maintains a pipe lubrication system at all times to lower the friction developed on the surface of the pipe during jacking.
- Jack Thrust Blocking shall adequately support the jacking pressure developed by the main jacking system.
- Special care shall be taken when setting the pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability.

XX.06.03 Spoil Separation System

The Contractor shall determine the type of spoil separation equipment needed for each drive based on the geotechnical information available and other project constraints.

XX.06.04 Electrical Equipment, Fixtures and Systems

Electrical equipment shall be suitably insulated for noise reduction. Noise produced by electrical equipment must comply with local municipal noise by-laws.

Electrical systems shall conform to requirements of the Canadian Electrical Code – CSA C22.1.

XX.06.05 Air Quality

Provide equipment to maintain proper air quality in shafts and in any manned microtunnel intervention during construction in accordance with OSHA requirements.

XX.07 CONSTRUCTION

XX.07.01 General

The Contractor shall notify the Contract Administrator and any other authorities identified in the contract documents at least 72 hours in advance of starting work.

Construction shall be subject to the requirements presented in the following subsections.

XX.07.01.01 Layout, Alignment and Grade Control

The layout, alignment and grade of the microtunnel shall be established from the lines, elevations and tolerances specified in the Contract Documents. Deviations from location, alignment, grades and/or invert levels shall be corrected by the Contractor at no additional cost.

The following tolerances shall be as specified in the contract documents:

- Maximum Departure from Established Grade.
- Maximum Departure from Established Line.
- Return to line and grade (i.e.: maximum steering correction).
- Overcut diameter.

All reference points necessary to construct the pipe installation and appurtenances shall be confirmed and/or established by the contractor.

When required, the Contract Administrator shall be provided with access necessary to check the layout of the pipe installation and associated appurtenances.

All excavations shall be carried out in accordance with the OHSA.

XX.07.01.02 Shafts

Construction Shafts shall be provided at locations and constructed as specified in the Contract Documents or according to the Contractor's submission.

Shafts shall be maintained in a drained condition.

A secure fence as stipulated in the OHSA shall be installed around the perimeter of the construction shaft area with gates and truck entrances. The fence shall be removed on completion of the Work.

XX.07.01.03 Protection Systems

The construction and monitoring of all protection systems shall be according to OPSS 539.

XX.07.01.04 Settlement or Heave

Any settlement or heave at the ground surface as a result of the pipe installation, that exceeds the limits specified in the contract documents, shall be immediately corrected by the Contractor at no additional cost.

XX.07.01.05 Stability of Excavation

The construction methods, plant, procedures, and precautions employed shall ensure that excavations are stable, free from disturbance, and maintained in a drained condition.

The construction methods, plant, and materials employed shall prevent the migration of any material into the excavation from adjacent ground.

XX.07.01.06 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

XX.07.01.07 Transporting, Unloading, Storing and Handling Materials

Manufacturer's handling and storage recommendations shall be followed.

XX.07.01.08 Backfilling and Compacting

Backfilling and compacting for shafts or other locations along the pipe path shall be according to OPSS 401, OPSS 402, OPSS 403 or the contract documents as appropriate.

XX.07.01.09 Dewatering

Dewatering shall be according to OPSS 517.

XX.07.01.10 Obstructions

The Contractor shall address the removal of obstructions in the proposed method of construction. The Contractor shall immediately inform the Contract Administrator of any obstruction encountered.

XX.07.01.11 Record Keeping

Verification record requirements of the alignment and elevation of the installation shall be as specified in the Contract Documents. A copy of the verification records shall be given to the Contract Administrator at the completion of the installation.

The Contractor shall maintain shift logs of construction events and observations. The Contract Administrator shall have access to the Contractor's logs with regard to the following information:

- Location of MTBM by station and progress of microtunnel drive during shift.
- Hours worked per shift on microtunnelling operations.
- Completed field forms for checking line and grade of the microtunnelling operation, showing achieved tolerance relative to design alignment. Steering control logs will generally be acceptable.
- Maximum pipe jacking forces per drive.
- Location, elevation and brief soil descriptions of soil strata.
- Groundwater control operations and groundwater levels.
- Observation of any lost ground or other ground movement.
- Any unusual conditions or events.
- Reasons for operational shutdown in the event a drive is halted.
- Pressure at the face of the tunnel.

XX.07.01.12 Management and Disposal of Excess Material

Management and disposal of excess material shall be according to OPSS 180.

XX.07.01.13 Site Restoration

Site restoration shall be according to OPSS 492.

XX.07.01.14 Personnel

Documentation summarizing the qualifications of the project superintendent and machine operators shall be requested by the Contract Administrator and provided by the Contractor.

XX.07.02 Microtunnelling

XX.07.02.01 General

Excavation of soil, rock and fill shall be done in a manner to control and prevent groundwater inflow to the tunnel.

The MTBM shall be capable of fully supporting the face and shall accommodate the removal of boulders and other obstructions from the face. Continuous ground support shall be maintained during excavation.

The tunnel is to be kept well drained at all times to permit work to be performed in a safe and satisfactory manner.

The Contractor shall maintain clean working conditions at all times.

In the event that excavation threatens to endanger personnel, the Work, adjacent property, roadways, railways, waterways, or the public in any way, the Contractor shall cease excavation. The Contractor shall then evaluate the methods of construction and revise as necessary to ensure the safe continuation of the Work.

The Contractor shall maintain the tunnel excavation line and grade to provide for construction of the culvert within the specified tolerances.

XX.07.02.02 Method of Installation

The installation procedure to be used shall be subject to the following limitations:

- The jacking pipe shall be fully supported in the jacking pit at the specified line and grade.
- Selection of the excavation method and jacking equipment shall take into consideration the subsurface conditions within the tunnel alignment.
- Perform microtunnelling operations in a manner that will minimize the movement of the ground in front of and surrounding the tunnel in conformance with the limits listed in the Contract Documents.
- Prevent damage to structures and utilities above and in the vicinity of the microtunnelling operations.

- Excavated diameter should be the minimum size required to permit pipe installation by jacking.
- Whenever there is a condition encountered which could endanger the microtunnel excavation or adjacent structures if tunnelling operations cease, continue to operate without intermission including 24-hour working days, weekends and holidays, until the condition no longer exists.
- Maintain an envelope of lubricant around the exterior of the pipe during the jacking and excavation operation to reduce the exterior soil/pipe friction and possibility of the pipe seizing in place.
- In the event a section of pipe is damaged during the jacking operation or a joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, the Contractor shall submit for approval his methods for repair or replacement of the pipe.

XX.07.03 Casing Installation

Casing must withstand the jacking forces determined by the Contractor.

The space between the Casing and the wall of the excavation shall be kept filled with lubricant during the pipe jacking operation. Upon completion of pipe jacking, the space between the Casing and the wall of the excavation shall be filled with grout that is compatible with the Casing.

The Casing shall act as a support system to maintain the safety of personnel, minimize ground movement into the excavation, ensure stability and maintain strength of ground surrounding the Casing.

The Casing shall be designed to support all subsurface conditions and hydrostatic pressures and to withstand any additional loads caused by installation and grouting.

XX.07.04 Instrumentation Monitoring

The Work specified in this Section includes the supply and installation of all instruments for monitoring settlement and ground stability.

Ground stability and settlement shall be monitored by in-ground and surface monitoring points at the locations shown on the Contract Drawings. The equipment and procedures used for settlement monitoring during construction must be capable of surveying the settlement point elevations to within ± 1 mm of the actual elevation.

Settlement monitoring points shall be installed as shown on the Settlement Monitoring Drawings.

The Contractor shall install all surface settlement instruments and monitoring points a minimum of two (2) weeks prior to the start of work and complete baseline readings as specified in the Contract Documents.

The surface settlement instruments and monitoring points shall be clearly labelled for easy identification and protected during construction.

The Contractor shall submit to the Contract Administrator a site plan showing the locations of the monitoring points, a geodetic survey of the settlement monitoring points that includes coordinates (Northings and Eastings) and elevations recorded at the time intervals specified in the Contract Documents.

All readings shall be submitted daily in spreadsheet format to the Contract Administrator for information purposes and a report including the settlement readings in spreadsheet format shall be submitted to the Contract Administrator on a weekly basis. Each report shall include all survey data collected in tabular and graphical format as plots of time versus settlement in comparison to survey data collected prior to commencement of the Work.

XX.07.05 Criteria for Assessment of Settlement/Heave

The following represents trigger levels that define magnitude of movement and corresponding action:

- Review Level: If a maximum value of 10 mm relative to the baseline readings is reached, the Contractor shall review or modify the method, rate or sequence of construction or ground stabilization measures to mitigate against further ground movement.

If the Review Level is exceeded, the Contractor shall immediately notify the Contract Administrator and present response actions for discussion and implementation. The Contractor shall submit a plan of action to prevent Alert Levels from being reached. All construction work shall be continued such that the Alert Level is not reached.

- Alert Level: If a maximum value of 15 mm relative to the baseline readings is reached, the Contractor shall cease construction operations, inform the Contract Administrator and execute pre-planned measures to secure the site, to mitigate further movements and to assure safety of public while maintaining traffic flow.

No construction shall take place until all the following conditions are satisfied:

- The cause of the settlement/heave has been identified.
- The Contractor submits a corrective/preventive plan.
- Any corrective and/or preventive measures deemed necessary by the Contractor are implemented.
- The Contract Administrator deems it is safe to proceed.

The Contractor shall avoid damaging instrumentation during construction. Instrumentation that is damaged as a result of the Contractor's operation shall be repaired or replaced by the Contractor within one business day.

The costs for replacement/repair shall be borne by the Contractor.

At the completion of the job, the Contractor shall abandon all instruments installed during the course of the Work and restore the site in accordance with OPSS 492.

XX.08 MEASUREMENT FOR PAYMENT

Measurement of tunnel shall be by length in metres along the centreline of the tunnel to the ends of the tunnel as constructed.

XX.09 BASIS OF PAYMENT

Payment at the Contract price for the above tender items shall be full compensation for all labour, equipment, and material to do the Work.

Appendix 14-A, March 2015

FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS

Note: This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

Designer Action/Considerations

This specification was written to encompass the requirements for the construction of pipelines, drainage conduits, or other utility pipe installations by the microtunnelling method. It is not intended to be a specification for other tunnelling applications such as the transportation industry, mining, hydro-electric, petroleum exploration industry, etc.

Engineering design based on geotechnical pre-design information is essential prior to the use of this specification for microtunnelling projects.

The experience of the microtunnelling Contractor is of prime importance. The designer may recommend prequalification of bidders.

The designer should specify the following in the Contract Documents:

- Casing pipe requirements. Alternatively, the designer may elect that the Contractor is responsible for determining the casing pipe design details.
- The plan, lines, elevations, and tolerances required for the tunnelling project.
- Location of required construction shafts. Alternatively, the designer may elect to specify that the Contractor is responsible for determining shaft locations to suit the method of construction.
- The appropriate casing pipe systems type, class, dimensions, etc.

- The appropriate product pipe type, class, dimensions, etc.
- The lines, grades, and tolerances required for the jacking and boring project.
- The method of verifying the product installation. This may include reporting information from the microtunnelling machine, or as constructed location survey, GPS, or closed-circuit television (CCTV) inspection. The designer should also specify the applicable leakage, infiltration, exfiltration, or pressure test requirements for the installation. This may apply to either the casing or product pipe.

The designer should provide benchmark and reference points for laying out the project.

The designer should specify the frequency and reporting requirements for settlement/heave monitoring in the Contract Documents. Criteria may include the following:

- Three consecutive readings consisting of one reading per day for three days at least one week prior to commencement of the Work. The average of these three readings will be considered to be the Baseline Reading;
- Once per shift during microtunnelling operations period; and
- Weekly after completion of the Work for one month, or until such time at which all parties agree that further movement has stopped.

The designer should specify if the shafts are to remain in place or be removed upon completion of the project. If the shafts are to remain in place, further details should be provided as to how they should be filled, or covered or remain accessible for future use.

The designer may wish to specify a process and payment criteria to deal with obstructions that are encountered by the microtunnelling operations.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.