ONTARIO
PROVINCIAL
STANDARD
SPECIFICATION

CONSTRUCTION SPECIFICATION FOR
PIPELINE AND UTILITY INSTALLATION IN SOIL
BY HORIZONTAL DIRECTIONAL DRILLING

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450.01 SCOPE

This specification covers requirements for installation of underground pipelines, conduits, cable, or ducts using the trenchless technology known as horizontal directional drilling.

450.01.01 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.
450.01.02 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.

450.02 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 following standards, specifications, or publications:

**Ontario Provincial Standard Specifications, Construction**

- OPSS 409  Closed-Circuit Television Inspection of Pipelines
- OPSS 504  Preservation, Protection, and Reconstruction of Existing Facilities
- OPSS 507  Site Restoration Following Installation of Pipelines, Utilities and Associated Structures
- OPSS 514  Trenching, Backfilling, and Compacting
- OPSS 517  Dewatering of Pipeline, Utility, and Associated Structure Excavation
- OPSS 538  Support Systems
- OPSS 539  Temporary Protection Systems

450.03 DEFINITIONS

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

**Backreamer** means a cutting head designed for the soil conditions and is attached to the leading end of a drill string to enlarge the pilot bore during a pullback operation to enable installation of the product.
**Bore Path** means a drilled path according to the grade and alignment tolerances specified in the Contract Documents.

**Drilling Fluid Fracture or Frac Out** means a condition where the drilling fluid’s pressure in the bore is sufficient to overcome the in situ vertical confining stress, thereby fracturing the soil and allowing the drilling fluids to migrate to the surface at an unplanned location.

**Drilling Fluids** mean a mixture of water and additives, such as bentonite, polymers, surfactants, and soda ash, designed to block the pore space on a bore wall, reduce friction in the bore, and to suspend and carry cuttings to the surface.

**Entry Point** means the location or excavation from which the bore is initiated for the installation of product.

**Exit Point** means the location or excavation to which the bore is directed for the installation of product.

**Guidance System** means an electronic system capable of indicating the position, depth, and orientation of the drill head during the drilling process.

**Horizontal Directional Drilling (HDD)** means directional boring or guided horizontal boring.

**Inadvertent Returns** mean the flow of unexpected fluids towards the drilling rig that typically originated from an artesian aquifer encountered during the drilling process.

**Loss of Circulation** means the discontinuation of the flow of slurry in the bore back to the entry or exit point or other planned recovery points.

**Multi Product Installation** means two or more products installed in the same bore path. The products may or may not have the same diameters.

**Pilot Bore** means the initial bore to set horizontal and vertical alignment between the connecting points.

**Product** means pipelines, conduits, cable, or ducts.

**Pullback** means that part of the HDD method in which the drill string is pulled back through the bore path to the entry point, usually installing the product at the same time.

**Reaming** means a process for pulling a tool attached to the end of the drill string through the bore path to enlarge the bore and mix the cuttings with the drilling fluid. This could include multiple passes.

**Rock** means natural beds or massive fragments of the hard, stable, cemented part of the earth's crust that are igneous, metamorphic, or sedimentary in origin, which may or may not be weathered and includes boulders having a volume of 0.5 m$^3$ or greater.

**Single Product Installation** means a single product installed into a bore path. The product may or may not have a tracer wire attached to it.

**Slurry** means a mixture of soil cuttings and drilling fluid.

**Soil** means all soils except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials.

**Strike Alert** means a system that is intended to alert and protect the operator in the case of inadvertent drilling into an electrical utility cable. The strike alert system consists of a sensor and an alarm connected to the drill rig and a grounding stake. The alarm is set off when the sensor contacts 42.5 volts or 0.5 amperes. The alarm may be audio or visual or both.
450.04  DESIGN AND SUBMISSION REQUIREMENTS

450.04.01  Submission Requirements

The following information shall be submitted to the Contract Administrator:

a) A work plan outlining the procedure and schedule to be used to execute the work.

b) A list of personnel, including backup personnel, and their qualifications and experience.

c) A traffic control plan.

d) A drilling fluid management plan including potential environmental impacts and emergency procedures and associated contingency plans.

e) A safety plan including the company safety manual and emergency procedures.

450.05  MATERIALS

450.05.01  Drilling Fluids

The drilling fluids shall be mixed according to the manufacturer's recommendations and be appropriate for the anticipated soil conditions. Only bentonite and manufacturer-approved polymers shall be permitted for use as drilling fluids. All additives used shall be chemically inert, biodegradable, and non-toxic. No petroleum-based or detergent additives shall be permitted.

450.05.02  Pipe Materials

Pipe type, class, and size shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the class and type of pipe with which they will be used.

450.06  EQUIPMENT

450.06.01  Directional Drilling Equipment

450.06.01.01  General

The directional drilling equipment shall consist of a directional drilling rig and a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the product installation without exceeding the maximum tensile strength of the product being installed.

450.06.01.02  Drilling Rig

The directional drilling rig shall:

a) consist of a leak-free hydraulically powered boring system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head.

b) contain a guidance system to accurately guide boring operations.

c) be anchored to the ground to withstand the rotating, pushing, and pulling forces required to complete the product installation.
d) be grounded during all operations or as specified by the drilling rig manufacturer.

450.06.01.03 Drill Head

The drill head shall be steerable by changing its rotation, be equipped with the necessary cutting surfaces and drilling fluid jets, and be of the type for the anticipated soil conditions.

450.06.01.04 Guidance System

The guidance system shall be setup, installed, and operated by trained and experienced personnel. The operator shall be aware of any magnetic or electromagnetic anomalies and shall consider such influences in the operation of the guidance system when a magnetic or electromagnetic system is used.

450.06.01.05 Drilling Fluid Mixing System

The drilling fluid mixing system shall be of sufficient size to thoroughly and uniformly mix the required drilling fluid.

450.06.01.06 Drilling Fluid Delivery System

The delivery system shall have sufficient flow capacity to ensure that all slurry volumes are adequate for the length and diameter of the final bore and the anticipated soil conditions. Connections between the delivery pump and drill pipe shall be leak-free.

450.07 CONSTRUCTION

450.07.01 General

The Contract Administrator shall be notified at least 48 hours in advance of starting work.

When strike alerts are provided on a drilling rig, they shall be activated during drilling and maintained at all times.

450.07.02 Site Preparation

The work site shall be graded or filled to provide a level working area for the drilling rig. No alterations beyond what is required for HDD operations are to be made. All activities shall be confined to designated work areas.

450.07.03 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 504.

Minimum horizontal and vertical clearances to existing facilities as specified in the Contract Documents shall be maintained. Clearances shall be measured from the nearest edge of the largest backreamer required to the nearest edge of the facility being paralleled or crossed.

Existing underground facilities shall be exposed to verify its horizontal and vertical locations when the bore path comes within 1.0 m horizontally or vertically of the existing facility. Existing facilities shall be exposed by non-destructive methods. The number of exposures required to monitor work progress shall be as specified in the Contract Documents.
450.07.04 Transporting, Unloading, Storing, and Handling Materials

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

450.07.05 Trenching, Backfilling, and Compacting

Trenching, backfilling, and compacting for entry and exit points or other locations along the bore shall be according to OPSS 514.

450.07.06 Support Systems

Support systems shall be according to OPSS 538.

450.07.07 Dewatering

Dewatering shall be according to OPSS 517.

450.07.08 Temporary Protection Systems

The construction of all temporary protection systems shall be according to OPSS 539. Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piles where necessary to prevent damage to such works or proposed works.

450.07.09 Drilling Fluid Management

The Contractor shall employ a containment, collection, and disposal method satisfactory to the Contract Administrator to prevent spillage of drilling fluids and inadvertent returns. The Contractor shall immediately clean up and dispose of any spillages of drilling fluids.

450.07.10 Pilot Bore

The pilot bore shall be drilled along the bore path in accordance with the grade, alignment, and tolerances specified in the Contract Documents. In the event the pilot bore does deviate, the Contract Administrator shall be notified. The Contract Administrator may require the Contractor to pullback and re-drill from the location along the bore path before the deviation. In the event that a drilling fluid fracture, inadvertent returns, or loss of circulation occurs during pilot bore drilling operations, the Contract Administrator shall be advised of the event and of the action taken.

If a drill hole beneath a road must be abandoned, the hole shall be backfilled with grout or bentonite to prevent future subsidence.

450.07.11 Reaming

When necessary, the bore shall be reamed using the appropriate tools to a diameter 50% greater than the outside diameter of the product to a maximum of 300 mm beyond the product diameter.

The drilling mud in the annular region should not be removed after installation, but permitted to solidify and provide support for the pipe and surrounding soil.
450.07.12 Product Installation

450.07.12.01 General

The product shall be jointed according to manufacturer’s recommendations. Where space and the Contract Documents permit, the length of the product to be pulled shall be jointed as one length before commencement of the pulling operation.

The product shall be protected from damage during the pullback operation.

The minimum allowable bending radius for the product shall not be exceeded at the entry point, exit point, or any other location along the bore path.

Product shall be allowed to recover before the connection to new or existing facility is made. Product recovery time shall be according to manufacturer's recommendations.

A tracer wire shall be supplied and installed along with the product.

450.07.12.02 Pullback

After successfully reaming the bore to the required diameter, the product shall be pulled through the bore path. Once the pullback operation has commenced, it shall continue without interruption until the product is completely pulled into bore.

A swivel shall be used between the reamer and the product being installed to prevent rotational forces from being transferred to the product. When specified in the Contract Documents, a weak link or breakaway connector shall be used to prevent excess pulling force from damaging the product.

The product shall be inspected for damage where visible at excavation pits and where it exits the bore. Any damage noted shall be rectified to the satisfaction of the Contract Administrator.

450.07.13 Product Testing

Where required, product testing shall be as specified in the Contract Documents.

450.07.14 Record Keeping

Verification record requirements of the alignment and depth of the installed product 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 HDD operations.

450.07.15 Closed-Circuit Television (CCTV) Inspection

CCTV inspection shall be according to OPSS 409.

450.07.16 Site Restoration

Site restoration shall be according to OPSS 507.

450.07.17 Management of Excess Material

Management of excess material shall be as specified in the Contract Documents.
450.09 MEASUREMENT FOR PAYMENT

450.09.01 Actual Measurement

450.09.01.01 Single Product Installation

Measurement for a single product installation shall be in metres along the horizontal centreline of the product between the connecting points.

450.09.01.02 Multi Product Installation

Measurement for a multi product installation shall be in metres along the horizontal centreline of the bore between the connecting points.

450.09.02 Plan Quantity Measurement

When Measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

450.10 BASIS OF PAYMENT

450.10.01 Single Product Installation by HDD, "diameter of product, product material, use of product," - Item
Multi Product Installation by HDD, "diameter of bore, product material, use of product" - Item

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 450-A, November 2007
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

The specification was written to encompass the majority of HDD drilling operations for small and medium sized projects with diameters generally up to 914 mm and drill lengths of less than 1,000 m. The basic design considerations should always include: minimum cover to prevent frac out; geology of the area, including future river "scour" or meander projections; site logistics; connection requirements; and site-specific issues (e.g., river crossings, wetlands, and archaeological sites).

Throughout the commentary, the designer is provided with guidance in the consideration of certain QC/QA techniques. However, it should be noted that evolving technology and techniques for improved QC/QA are currently in development and the designer should refer to trade publications to identify the latest available methods. In all cases, the designer should specify the quality assurance acceptance criteria to be used for each specific project.

Subject to the scope of operations, the designer may wish to specify in the Contract Documents a more detailed work plan prior to the commencement of work, particularly for multiple day projects, congested work areas, or environmentally sensitive sites. (450.04)

The designer should give careful consideration, in consultation with the pipe manufacturer, to minimum allowable product bending radii commensurate with the pipeline's strength. Pipe type, class, size, minimum bend radius, and maximum tensile load shall be clearly detailed in the Contract Documents. (450.05.02)

The designer should specify the maximum allowable pressure for the HDD operation so that it does not exceed that which can be supported by the overburden in relation to the depth of the bore, as this will mitigate the potential of heaving or hydraulic fracturing of the soil. (450.06.01.06)

The principal safety concern in HDD is ensuring that the drilling equipment does not accidentally contact existing underground infrastructure. The risk of contacting other Utilities can be mitigated by knowing the precise locations of all underground Utilities in close proximity to the HDD bore path. Detailed subsurface Utility locations and geotechnical information is a critical component of a directional drilling project and this information should be included in the Tender Documents to facilitate the Contractor's bid. Information in these documents may affect the Contractor's operations (i.e., drilling fluid mixtures, methods, or equipment). The designer may consider the use of Subsurface Utility Engineering to provide better mapping of underground utilities in congested areas. In addition, the designer may consider a detailed photographic or video documentation of the pre-construction conditions. (450.07.03)

The designer should specify the following elements in the Contract Documents: the minimum horizontal and vertical clearances to existing facilities; and the number of exposures required to monitor the work progress. (450.07.03)

The designer may consider special provisions for backfilling and compacting, including the consideration of unshrinkable backfill to ensure proper compaction in critical locations. (450.07.05)

The designer should provide the necessary grade, alignment, and tolerances for the product installation in the Contract Documents. (450.07.10)
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The designer may consider a lower reaming diameter than that specified if the soil conditions are suitable. The designer should also understand that multiple passes of the reaming operation can be expected and is included in the unit cost for the product installation. (450.07.11)

The designer should review product-jointing standards as provided by manufacturers. In smaller diameter gravity flow systems, the internal joint “bead” should be given consideration in order to prevent blockages. Experienced personnel with jointing accreditation may be added as a requirement of the Contract Documents depending on the nature of the installation. Where possible, the product should be completely jointed prior to the pull back operation to avoid delays during installation. (450.07.12.01)

For certain product installations, the designer may wish to consider the requirement of a weak link or breakaway connector to prevent excess pulling force from damaging the product. (450.07.12.02)

The designer may consider specifying physical product testing through the use of product coupons from the exit pit. In addition, in situ pressure or vacuum tests can be used to ensure the integrity of the product installation. (450.07.13)

The designer should specify the method of verifying the product installation location. The designer may consider the use of the reporting information available from the drill rig, daylighting, installation of tracer wire with the product, or the use of acoustic/magnetic locating equipment. (450.07.14)

The designer’s careful preparation of the project should greatly assist in the success of the installation. However, there may always be a risk of encountering unexpected problems that may require a fair resolution for payment. It is recommended that a process regarding payment for failed attempts be considered for inclusion in the Contract Documents.

The tender item description for product installation by HDD must include reference to one or more of the attributes shown (i.e., diameter of product, product material, use of product, to be complete). (450.10.01)

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

None