## SPECIAL CONDITIONS FOR HORIZONTAL AUGER BORING (HAB)

### 1 Description

This pipe installation method is called Horizontal Auger Boring (HAB). This method involves the forming of a bore from a drive pit, by means of a rotating cutting head, and installing a steel pipe that serves as a casing for carriers (pipe, cable, or wire line products). It is a multi-stage process consisting of constructing a temporary horizontal jacking platform and a starting alignment track in a drive pit at a desired elevation. The casing pipe is then jacked along the starting alignment track with simultaneous excavation of the soil being accomplished by a rotating cutting head in the leading edge of the casing pipe's annular space. The spoil is transported back to the entrance pit by a helically-wound auger rotating inside the casing pipe. HAB typically provides limited tracking and steering as well as limited support to the excavation face; unless a modified auger boring machine is used. This method may also be referred to as Jack and Bore.

### 2 Materials

### 2.1 Pipe

Pipe used in this method includes an external *casing pipe* (also called *jacking pipe*) and may include an interior *carrier* pipe.

### 2.2 Allowable forces

Considerable jacking forces may be required to install pipe using this method.

(a) Casing pipe shall be obtained from one manufacturer. Pipe shall be specifically designed and certified for Horizontal auger boring by the pipe manufacturer.

(b) The allowable jacking strength capacity of casing pipe shall be capable of withstanding the maximum jacking forces imposed by the operation. The specified allowable jacking capacity of the casing pipe shall be 3 times greater than the maximum jacking forces imposed by jacking operations as identified by theoretical calculations.

(c) Steel casing pipe shall have minimum yield strength of 35,000 psi.

### 2.3 Pipe dimensions

(a) The range in pipe diameters used in this method is indicated in table 1.

(b) Steel casing pipe shall have a minimum wall thickness of 6 mm or as per the owner's specifications, whichever is larger.

(c) Casing pipe shall be round. Steel casing pipe shall have a roundness tolerance, so that the difference between the major and minor outside diameters shall not exceed 1% of the specified nominal outside diameter, or 6 mm, whichever is less.

(d) Casing pipe shall have square and machine beveled ends. The pipe end maximum out-of-square tolerance shall be 1 mm, (measured across the diameter).

(e) Casing pipe shall be straight. The maximum allowable straightness deviation over any 3 m length of steel casing pipe is 3 mm.

(f) Pipe shall be without any significant dimensional or surface deformities. All pipes shall be free of visible cracks, holes, foreign material, foreign inclusions, blisters, or other deleterious or injurious faults or defects. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall not be used and shall be immediately removed from the site.

(g) Any of the following defects warrants pipe rejection:

- Concentrated ridges, discoloration, excessive spot roughness, and pitting
- Insufficient or variable wall thickness
- Pipe damage from bending, crushing, stretching or other stress
- Pipe damage that impacts the pipe strength, the intended use, the internal diameter of the pipe, and internal roughness characteristics
- Any other defect of manufacturing or handling

### 2.4 Casing Pipe

(a) Casing pipe shall be used within the entire roadbed influence area. The *roadbed influence area* is defined as the subsurface area located under the road and shoulder surface, between each shoulder point or back of curb; and continues transversely outward and downward from each shoulder point or back of curb on a 1 on 1 slope

(b) Casing pipe materials shall be steel.

(c) Only new casing pipe shall be used, unless otherwise approved by the owner's Engineer/Inspector.

(d) Casing pipe shall normally be constructed without any longitudinal seams. However, longitudinally-welded casing pipe is allowed for 1.2 m or larger diameter pipes when a certified welder performs all the welding.

(e) Casing pipe shall have smooth interior and exterior walls to reduce jacking force and prevent casing rotation.

(f) The inside diameter (ID) of the casing pipe shall be at least 150 mm larger than the largest outside diameter (OD) of the carrier pipe to allow the carrier pipe to be inserted or removed subsequently without disturbing the casing or the roadbed.

### 2.5 Carrier Pipe

Carrier pipe material may be constructed with any material. The carrier pipe diameter shall be small enough to insert into the casing pipe in conjunction with the casing spacers.

### 2.6 Casing Spacers

Casing spacers are required for all carrier pipes. Casing spacers shall be plastic, fiberglass, stainless steel, or carbon steel. Normally, one spacer is adequate to support a carrier pipe length that does not exceed three meter; otherwise, two spacers are required for longer carrier pipe lengths.

## 3 Construction

### 3.1 Minimum Allowable Depths

The minimum allowable depth of a HAB installed pipe under the road and shoulder surface is correlated to pipe diameter and the soil conditions. Table 1 summarizes the minimum depth:

**Table 1 – HAB *desirable* installation depth under different soil conditions**

| Pipe Diameter (mm) | Soil Condition | Minimum Depth (m) |
|---|---|---|
| 50 – 150 | Clayey | 1.2 |
| | Silty | 1.2 |
| | Sandy | 1.8 |
| | Gravely | 1.8 |
| 175 – 350 | Clayey | 1.2 |
| | Silty | 1.8 |
| | Sandy | 3.0 |
| | Gravely | 6.0 |
| 375 – 600 | Clayey | 1.8 |
| | Silty | 3.0 |
| | Sandy | 3.6 |
| | Gravely | 6.0 |
| 625 – 1200 | Clayey | 3.0 |
| | Silty | 4.2 |
| | Sandy | 6.0 |
| | Gravely | 7.5 |

In locations where the road surface is super elevated, the minimum depth of the bore shall be measured from the lowest side of the pavement surface.

### 3.2 Equipment

Equipment used for this method varies greatly. However, the basic operations of boring, removing tailings, and jacking pipe are essential. Please refer to the specific operator's manual for more information.

### 3.3 Method

A full-size auger section shall be used as the lead section of the casing.

### 3.4 Access Pits

(a) Location

A minimum distance of 6 m, from the edge of the paved shoulder or curb to the face of any access pit, equipment, and supplies, shall be maintained in areas posted at 50 kmph or less; otherwise, a minimum distance of 9 m shall be maintained.

(b) Sheeting and Bracing

Sheeting and bracing shall be required whenever any part of the access pit excavation is located within the roadbed influence area. Steel sheet piling shall be furnished and installed as indicated in the current owner's Specifications. An additional earth retention structure shall be required above and below the bore hole on the drilling face of all access pits to prevent loss of material during construction.

(c) Protection

- At the discretion of owner's Engineer/Inspector, and dependent on the pit distance from the road embankment, traffic barriers may be required to be installed adjacent to access pit locations according to the owner's plans. If instructed, temporary beam guardrail shall also be installed according to the current owner's specifications.
- Fencing barriers shall be installed adjacent to access pits, open excavations, equipment and supplies with suitable fencing and plastic drums to prohibit pedestrian access to the work site. Equipment shall not be used as fencing to protect access pits.
- The contractor shall construct and operate safe access pits according to all applicable regulatory requirements.

### 3.5 Overcut Allowance

Overcut is the annular space between the excavated hole and the outside diameter of the casing pipe. The allowable overcut diameter is 25 mm greater than the casing pipe radius.

### 3.6 Watertight Joints

Water tight pipe joints are required to ensure the integrity of the roadbed. Pipe shall be constructed to prevent water leakage or earth infiltration throughout its entire length.

A watertight specification for each type of pipe material can be obtained through each pipe material industry. Necessary reference must be made to the appropriate industry specifications for more detailed information.

### 3.7 Lubrication Fluids

(a) Lubrication fluids, consisting of a mixture of water and bentonite or bentonite/polymer, shall be used in the annular space between the casing being installed and the native soil. This is done primarily to reduce friction on the casing. Lubrication may also be used inside the casing pipe to facilitate spoil removal.

(b) Lubrication fluids are specifically recommended for this method regardless of the soil conditions.

(c) Grease is not allowed for use as lubrication for this purpose.

### 3.8 Pipe locating and tracking

One of the following tracking, locating, and guidance systems shall be used, unless an alternate is approved by the owner's Engineer/Inspector.

(a) *Waterline system.* Only the grade is monitored by this method. A water level sensing head is attached to the top of the leading edge of the casing, and an access pit mounted control and indicator board is located near the operator.

(b) *Mechanical control head.* The grade is monitored by using a waterline system, while the alignment is monitored by using a sonde transmitter and receiver on the ground surface. This system may only be used if the surface above the bore is safely accessible to take alignment readings.

(c) *Electronic (inertial) control head.* The line and grade of the steering head is monitored by using highly sensitive gyroscopes. This computer aided technology also allows the steering head to be controlled hydraulically and electronically. The minimum diameter of casing that can be tracked with this system is 900 mm.

(d) *Walkover system.* The grade is monitored by using a waterline system, while the alignment is monitored by using a walkover receiver; that includes a cable-ready remote display with a power supply and a sensitive pitch cable transmitter. The transmitter is connected with a wire through the length of the bore to a display located near the operator.

(e) *Laser guided tunnel attachment.* A laser beam is aimed at a target near the cutting head. Any deviation in the line or grade can be observed, so when the laser beam is off target, the head can be steered in the correct direction.

(f) Laser guided pilot rod. A laser is used to guide a pilot rod along the course of the pipe prior to installing the pipe.

### 3.9 Settlement/Heaving Monitoring

(a) This method shall be performed in a manner that will minimize the movement of the ground in front of, above, and surrounding the boring operation; and will minimize subsidence of the surface above and in the vicinity of the boring. The ground shall be supported in a manner to prevent loss of ground and keep the perimeter and face of the boring stable at all times, including during shutdown periods.

(b) Potential settlement shall be monitored at each edge of right of way, each shoulder point, each edge of pavement, the edge of each lane (or centerline for two lane roads), and otherwise at 15 m intervals along the pipe centerline.

(c) A survey shall be performed one day prior to initiating this operation at each required monitoring location. A similar survey shall then be performed at each location, on a daily basis, until the permitted activity has received a final inspection. This survey establishes the preexisting and post construction conditions, and the amount of settlement. All survey readings shall be recorded to the nearest one-hundredth (0.01) of a meter. Whenever possible, trenchless pipe installations shall <u>not</u> be installed directly under a pavement crack. Digital photographs of the pavement conditions shall also be taken prior and after the pipe installation.

(d) All operations shall stop immediately whenever monitored points indicate a vertical change in elevation of 12 mm or more, or any surface disruption is observed. The Contractor shall then immediately report the amount of settlement to the owner's Engineer/ Inspector.

## 3.10 Ground Water Control

(a) Dewatering shall be conducted whenever there is a high ground water table level to prevent flooding and facilitate the operation. The water table elevation shall be maintained at least 600 mm below the bottom of the casing at all times. When needed, dewatering *may* be initiated prior to any excavation.

(b) Minor water seepage or pockets of saturated soil may be effectively controlled through bailing or pumping. This control shall be accomplished without removing any adjacent soil that could weaken or undermine any access pit, its supports, or other nearby structure.

(c) Larger volumes of ground water shall be controlled with one or more well points or with staged deep wells. Well points and staged deep well pumping systems shall be installed and operated without damage to property or structures, and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractors. Any pumping methods used for de-watering and control of ground water and seepage shall have properly designated filters to ensure that the adjacent soil is not pumped along with the water. Well diameter, well spacing and the pump's pumping rate, shall provide adequate draw down of the water level. Wells shall be located to intercept ground water that otherwise would enter the access pit excavation and interfere with the work. Upon removal of a well, the hole shall be filled and grouted.

(d) Existing storm sewers shall only be used to discharge water from the dewatering operation in accordance with a permit obtained from the appropriate storm sewer owner. Filters or sediment control devices shall be required to ensure that the existing system is not adversely affected by construction debris or sediment.

(e) If grouting is used to prevent ground water from entering the area of the access pit, the grouting shall be installed without damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic, or the work of other contractors.

(f) Whenever a significant amount of unexpected groundwater enters an access pit, and a catastrophic pit failure is imminent, the pit shall be backfilled immediately, until the groundwater level is at least 600 mm below the bottom of the casing.

## 3.11 Boring Failure

(a) Should anything prevent completion of this operation, the remainder of the pipe shall be constructed by methods approved by the owner's Engineer/Inspector.

(b) Abandonment of any component of the installation shall only be allowed as approved by the owner's Engineer/Inspector.

(c) If an obstruction is encountered which prevents completion of the installation the pipe shall be remain in place, taken out of service, and immediately filled with flowable fill.

## 3.12 Contamination

When an area of contaminated ground is encountered, all operations shall stop immediately, and shall not proceed until approved by the owner's Engineer/Inspector. Any slurry shall be tested for contamination and disposed of in a manner, which meets Local, State and/or Federal requirements.

### 3.13 Bulkhead

Casing ends shall be enclosed or bulkheaded with a commercial grade concrete, or approved alternate to seal the ends to prevent water leakage or earth infiltration. The concrete shall extend longitudinally into the pipe end opening to create a minimum 300 mm thick bulkhead barrier, or as required by permit. Owner's Engineer/Inspector may allow rubber bulkheads in special situations.

### 3.14 Work Site Restoration

(a) Access pits and excavations shall be backfilled with suitable material, and in a method approved by the owner's Engineer/Inspector.

(b) The disturbed grass-surface area shall be topsoiled, seeded, fertilized, mulched, and anchored according the current owner's specifications. If a final site restoration is not completed within 5 days after completion of the operation, the installation of temporary soil erosion and sedimentation control measures shall be required.

(c) Upon completion of the work, the contractor shall remove and properly dispose of all excess materials and equipment from the work site.

(d) The permit, including the surety requirements, shall remain in effect for a minimum of one year after completing the work to monitor for settlements of the pavement and/or slope.