

SECTION 02910

BORING AND/OR JACKING PIPE

02910.01 GENERAL

A. Description

Boring and/or jacking pipe shall include, but not necessarily be limited to, furnishing and installing carrier pipe without a casing pipe, or casing pipe beneath railways, roadways, or other locations indicated on the Plans and in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Structure excavation; Section 02220.
2. Trench excavation, backfill, and compaction; Section 02250.
3. Excavation support; Section 02400.
4. Dewatering; Section 02512.
5. Storm drain installation; Section 02520.
6. Water main installation; Section 02551.
7. Sanitary sewer installation; Section 02561.
8. Sanitary sewer force main installation; Section 02563.

C. Quality Assurance

1. Materials

a. General

The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When specific materials test are required by the referenced standards and specifications, the County Engineer will have the option of requiring that any or all of these test be performed for materials furnished for a specific project. When testing is required, it will be specified in the "Special Provisions."

b. Steel Pipe

Steel pipe shall be free from any visible defects or surface imperfections such as kinks, scars, or bends which may impair the performance or life of

the pipe. Defects shall be considered injurious when the depth of the defect is greater than 12.5% of the nominal wall thickness. The pipe shall be substantially round. The outside circumference of the pipe shall not vary more than $\pm 1\%$ from the nominal outside circumference based upon the diameter specified. The pipe shall not deviate by more than 1/8-inch from a 10-foot long straightedge held against the pipe. Defective or damaged coatings may be repaired in accordance with the coating manufacturer's written recommendations.

c. Reinforced Concrete Pipe

Reinforced concrete pipe shall be free from fractures or cracks that extend through the wall of the pipe; surface defects indicating honeycomb or open texture; defects that indicate imperfect proportioning, mixing, and molding; damaged or cracked ends where such damage would prevent making a satisfactory joint; or any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more.

Materials and finished product testing shall be in accordance with AASHTO M 170 as detailed in AASHTO T 33, and as specified herein. Acceptability of pipe through 54-inch diameter and classes produced in accordance with design tables found in AASHTO M 170, or the modified and special designs permitted therein, shall be determined by results of a three-edge bearing test for a load to produce a 0.01-inch crack. If the load exceeds the requirements before the 0.01-inch crack is reached, the load may be relieved and the pipe accepted for use. For pipe 60-inch diameter and larger, acceptance will be based on materials tests specified in AASHTO M 170.

2. Field Tests

a. General

No testing will be conducted on bored and/or jacked casing pipe, installed in accordance with this Section, however the work will be visually inspected after installation by the County Engineer prior to the installation of the carrier pipe.

b. Bored and/or Jacked Carrier and Casing Pipe

- 1) Bored or jacked carrier pipe shall be installed to the line and grade indicated on the Plans to within a tolerance of 2 inches.
- 2) Bored or jacked casing pipe shall be installed so as to provide a minimum concrete cradle thickness of 4 inches for the carrier pipe as indicated in the Contract Documents.

c. Carrier Pipe

Carrier pipe will be inspected and/or tested in accordance with the applicable section or sections under which the remainder of the pipeline was installed.

- 1) Storm drain pipe will be inspected as specified in Section 02520.01.
- 2) Water mains will be inspected and tested as specified in Section 02551.01.
- 3) Sanitary sewers will be inspected and tested as specified in Section 02561.01.
- 4) Sanitary sewer force main will be inspected and tested as specified in Section 02563.01.

D. Submittals

1. Shop Drawings

- a. Shop drawings shall be submitted as specified in the "General Provisions" for the various types of pipe specified in Section 02910.02. The shop drawings shall include: product information; material strength, type, or class; and joint details.
- b. The Contractors shall also submit detailed drawings including proposed method of boring and advancing casing or proposed method of preparing bored hole for installation of carrier pipe; size, capacity, and arrangement of equipment; method of dewatering; size and location of pit including configuration, backstop, pit base material, and type of cutter head; proposed method of monitoring and controlling line and grade; and proposed method of anchoring the carrier pipe within the casing to prevent flotation. Boring/jacking work shall not proceed until drawings have been reviewed and returned by the County Engineer.

2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for pipe and bituminous coatings specified in Section 02910.02. The certificate shall state that the item furnished has been manufactured in accordance with, and meets the requirements of the standard referenced.

02910.02 MATERIALS**A. Materials Furnished by the County**

The County will not furnish any materials for boring and/or jacking pipe.

B. Contractor's Options

None.

C. Detailed Material Requirements

1. Portland Cement Concrete

Portland cement concrete for inverts or cradles shall be Mix No. 2 as specified in

Section 03310.

2. Mortar for Grout

Mortar used for grouting voids outside the casing or carrier pipe shall conform to the requirements of Section 04100 except that it shall be composed of one part Portland cement and three parts sand.

3. Steel Casing Pipe

a. Steel casing pipe shall be smooth walled and have a minimum yield strength of 36,000 psi. Minimum wall thickness shall be as specified in the Contract Documents.

b. The pipe shall be fabricated and field connected in accordance with Section 02551. Joints shall be fully welded around the circumference of the pipe.

c. The exterior of the pipe including field connections shall be bituminous coated before installation. Bituminous coating shall meet the requirements of MIL P 23236 P, Class 2.

4. Reinforced Concrete Casing Pipe

Reinforced concrete casing pipe shall meet the requirements of AASHTO M 170 except the pipe shall be Class V, Wall B.

5. Carrier Pipe

Carrier pipe shall be as specified in the Contract Documents and meet the requirements specified in Sections 02520.02, 02551.02, 02561.02, or 02563.02 as appropriate.

02910.03 EXECUTION

A. Preparation

Preliminary work shall consist of excavating and sheeting a suitable shaft on the lower side of the crossing and installation of a backstop and guide timbers. The guide timbers shall be long enough to hold at least two lengths of pipe and shall be carefully checked for line and grade before any pipe is placed on them.

B. Boring and/or Jacking

1. When augers or similar devices are used for pipe emplacement, the front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe. The arrangement shall be removable from within the pipe in the event an obstruction is encountered. The excavation by the cutting head shall not exceed the outside diameter of the pipe by more than ½ inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft material.

2. The use of water or other liquids to facilitate casing emplacement and spoil removal is prohibited.
3. If an obstruction is encountered during installation that stops the forward action of the pipe, and it becomes evident that it is impossible to advance the pipe, operations shall cease and the pipe abandoned in place and filled completely with grout.
4. Bored or jacked installations shall have a bored hole essentially the same as the outside diameter of the pipe plus the thickness of the protective coating. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe (plus coating) by more than approximately 1-inch, grouting or other methods approved by the County Engineer shall be employed to fill such voids.
5. When water is known or expected to be encountered, pumps of sufficient capacity to handle the flow shall be maintained at the site. The pumps shall be in constantly attended operation on a 24 hour basis until, in the sole judgment of the County Engineer, their operation can be safely halted. When dewatering, close observation shall be maintained to detect any settlement or displacement of surface facilities. Should settlement or displacement be detected, the Contractor shall notify the County Engineer immediately and take such action as necessary to maintain safe conditions and prevent any further damage.
6. All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of traffic, or damage, destroy, or endanger the integrity of any surface facilities.
7. The procedure outlined above will also apply to installations where excavation with mechanical augers are used in smaller steel casings except there is no overcutting or grouting required under normal circumstances.
8. Bored and/or jacked casing pipe will be installed in accordance with the Standard Details.

C. Installation of Carrier Pipe

1. Carrier pipe shall be installed within the casing pipe as shown in the Contract Documents and as specified in Sections 02520.03, 02551.03, 02561.03, 02563.03 and in accordance with the Standard Details.
2. Where shown or specified in the Contract Documents, the annular space between the casing and carrier pipes shall be filled with Portland cement concrete or grout. Materials shall be as specified in Sections 03310 and 03600.

02910.04 METHOD OF MEASUREMENT**A. Casing Pipe**

RESERVED FOR FUTURE USE

B. Carrier Pipe

RESERVED FOR FUTURE USE

02910.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Casing Pipe

RESERVED FOR FUTURE USE

C. Carrier Pipe

RESERVED FOR FUTURE USE

SECTION 02920
EARTH TUNNELING

02920.01 GENERAL

A. Description

Earth tunneling shall include, but not necessarily be limited to, constructing earth tunnels and furnishing and installing tunnel liners to the limits shown on the Plans and in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Structure excavation; Section 02220.
2. Trench excavation, backfill, and compaction; Section 02250.
3. Excavation support; Section 02400.
4. Dewatering; Section 02512.
5. Storm drain installation; Section 02520.
6. Water main installation; Section 02551.
7. Sanitary sewer installation; Section 02561.
8. Sanitary sewer force main installation; Section 02563.

C. Quality Assurance

1. Materials
 - a. The County Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When specific materials tests are required by the referenced standards and specifications, the County Engineer will have the option of requiring that any or all of these tests be performed for materials furnished for a specific project. When testing is required, it will be specified in the "Special Provisions."
 - b. Tolerances
 - 1) Variation in thickness of liner plates shall be ± 0.01 inch maximum.
 - 2) Similar segments shall be fabricated with such accuracy and uniformity in dimensions that segments will be entirely

interchangeable not only in individual rings but with similar segments of other rings. Space holes accurately so that any two rings can be bolted up in any relative position with same size bolts in every bolt hole.

- 3) Grout holes shall be located to a tolerance of ± 0.50 inch. Bolt holes shall be provided with a diameter tolerance of ± 0.02 inches.
- 4) In making the taper offset, dimensions between the bolt pad and the flange face shall not increase by more than $9/16$ inch or decreased by more than $1/16$ inch from the dimensions indicated, provided bolt length is adjusted accordingly.
- 5) Any segment which does not comply with the tolerances indicated shall be replaced.

c. Fabricator Qualifications

Where fabricated segments for tunnel lining are to be used, the segments shall be fabricated by a qualified firm with a minimum of 5 years experience of similar type manufacturing and which has manufactured segments for at least three representative jobs of comparable type of service and size to the Project, which have been in satisfactory service for at least 3 years.

2. Field Tests

a. General

No testing will be conducted on tunnels installed in accordance with this Section, however the work will be visually inspected.

b. Tunnels

- 1) For segmented tunnel linings, inside dimensions of the ring measured along any diameter shall not vary by more than 3% of the lining diameter.
- 2) Tunnels shall be constructed to the line or grade indicated on the Plans so as to allow a minimum carrier pipe concrete cradle thickness of 4 inches.
- 3) Vertical deflection of the tunnel lining shall be limited to 3% of the diameter. If the vertical diameter of the tunnel is reduced by more than 3%, all further operations shall be carried out with a heavier liner section.

3. Detection of Movement

- a. The Contractor shall install, maintain, make observations, and maintain a permanent record of the Contractor's observations on a regular pattern of surface settlement markers as shown on the Plans or as directed by the County Engineer. Surface and subsurface control points shall be located

along the centerline of the crossing alignment. Settlement marker elevations shall be tied to bench marks sufficiently remote as not to be affected by the construction operations. The Contractor shall take readings and prepare a permanent record prior to start of excavation. The Contractor shall submit copies of the records to the County Engineer as the Project progresses.

b. Subsurface Indicators

- 1) Subsurface settlement indicators shall be installed at locations shown or directed by the County Engineer prior to start of dewatering or tunneling.
- 2) The tip of the indicator rod shall be installed to within 1 foot above the crown of the tunnel or as directed by the County Engineer.
- 3) The Contractor shall monitor the movements of the indicators to an accuracy of ± 0.01 foot in accordance with an approved schedule.
- 4) Whenever tunneling occurs within 50 feet of an indicator, the movements of the indicator shall be monitored before and after each advance of tunnel face within 50 feet of the indicator.

- c. Any settlement or horizontal movement shall immediately be reported to the County Engineer. The Contractor shall take immediate remedial action, at no cost to the County.

D. Submittals

1. Shop Drawings

- a. Shop drawings shall be submitted as specified in the "General Provisions" for all liner plate materials. The shop drawings shall include liner shapes, sizes, method of attachment and connection details, and details of grout holes.
- b. The Contractor shall also submit working drawings with pertinent descriptions, soils data, methods of dewatering, methods of excavation, support system, and the proposed tunnel access pit locations for approval. Include locations of surface and subsurface settlement markers if not indicated elsewhere.
- c. Tunneling Method
 - 1) Bids shall be based on tunneling using tunnel shields.
 - 2) Complete detail drawings shall be submitted of the shield and an adequate description of the proposed method of erecting, placing, and operating the shield.
 - 3) The Contractor may submit an alternate method for performing tunneling operations to the County Engineer for approval.

- 4) At the request of the County Engineer, complete details of alternate method and pertinent calculations shall be submitted. Should the County Engineer approve an alternate method, submit shop and working drawings as previously specified and directed by the County Engineer.
- d. Access Shaft Design
 - 1) When the Contract Documents do not include access shaft design, the Contractor shall be solely responsible for the preparation of access shaft design.
 - 2) When the Contract Documents include access shaft designs, the Contractor may submit alternate access shaft redesigns equal to or greater in size than those indicated. Shaft redesign and resultant additional construction costs shall be at no expense to the County.
2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for tunnel liner plates stating that the plates have been manufactured in accordance with, and meet the requirements specified in Section 02920.02.
 3. Certified Test Reports

The Contractor shall submit certified test reports before delivery of materials for the items listed below.

 - a. Gravel packing
 - b. Liner plate segments for tunnel lining
 - c. Tunnel liner plate connectors
 - d. Protective coatings

02920.02 MATERIALS**A. Materials Furnished By the County**

The County will not furnish any materials for earth tunneling.

B. Contractor's Options

None.

C. Detailed Material Requirements**1. Portland Cement Concrete**

Portland cement concrete for invert cradles shall be Mix No. 2 as specified in Section 03310.

2. Mortar for Grout

Mortar for grouting shall conform to the requirements of Section 04100 except as modified herein:

- a. For filling the annular spaces after the carrier pipe is installed, the grout shall consist of one part Portland cement and three parts sand.
- b. For filling voids outside the liner plate, the grout shall have a minimum compressive strength of 100 psi attained within 24 hours. The grout shall remain fluid long enough to be injected through the lining and to fill the voids and shall set promptly enough to avoid grout flowing into the new annular space after the next advance.

3. Liner Plate

- a. Steel liner plate shall conform to requirements of ASTM A 569. Liner plate steel shall have the minimum mechanical properties of flat plate before cold forming as follows:

Tensile strength	= 42000 psi
Yield strength	= 28000 psi
Elongation, 2 inches	= 30%

At least 10% of the number of liner plates shall be drilled, tapped, and fitted with a cast iron grout plug. The actual location and spacing of the plugs shall be determined by the County Engineer and Contractor according to field conditions.

- b. Bolts and nuts shall conform to requirements of ASTM A 307. The bolts shall have rolled threads.
- c. Coatings
 - 1) Liner plate shall be hot dipped galvanized to meet requirements of AREA Chapter 1, Part 4, Section 4.13 Specification for Corrugated Structure Steel Plate Pipe, Pipe Arches and Arches. Bolts and nuts shall be galvanized to meet requirements of ASTM A 153.
 - 2) Liner plate shall be bituminous coated to meet requirements of AREA Chapter 1, Part 4, Section 4.6.1 Specification for Bituminous Coated Galvanized Steel Pipe and Pipe Arches. Provide prime coat as required to assure compatibility with galvanized surface.
 - 3) Tunnels which are to be filled with concrete after carrier pipe is in place shall not be coated.

4. Gravel Packing

Gravel packing shall be rounded gravel, clean and free from objectionable material, and graded as follows:

Sieve Sizes U.S. Standard	Mass Percent Passing
3 inch	100
½ inch	85-100
3/8 inch	70-100
No. 4	0-55
No. 8	0-15
No. 16	0-8

5. Carrier Pipe

Carrier pipe shall be as specified in the Contract Documents and meet the requirements specified in Sections 02520.02, 02551.02, 02561.02, or 02563.02 as appropriate.

6. Surface Settlement Markers

- a. Surface settlement markers within pavement areas shall be P.K. nails.
- b. Surface settlement markers within non-paved areas shall be wooden hubs.

7. Subsurface Settlement Indicators

Subsurface settlement indicators shall be fabricated of 2 ½-inch diameter steel pipe casing, an inner 1-inch diameter extra strong steel pipe with a pipe cap, and 1/4-inch diameter round head stainless steel bolt as directed by the County Engineer.

02920.03 EXECUTION

A. Construction Criteria

1. Tunnel construction shall be performed in a manner that will minimize movement of the ground in front of and surrounding the tunnel, and prevent subsidence of the surface above and in the vicinity of the tunnel. During all stages of tunnel construction, the ground shall be continuously supported and controlled in a manner that will prevent loss of ground and keep the perimeters and face of the tunnel stable. The Contractor shall be responsible for all settlement resulting from tunnel operations and shall repair and restore damaged property to its original condition at no cost to the County.
2. The Contractor shall comply with applicable ordinances, codes, statutes, rules, and regulations of the State of Maryland, SHA, applicable County building codes, and/or affected Railroad Company and applicable regulations of the Federal Government (OSHA 29CFR 1926).

B. Job Conditions

1. Maintain the tunnel air in a condition suitable for the health of the workmen at all times.
2. Maintain an adequate supply of straight and tapered liner segments at the site at

all times.

3. Prevent damage to protective coatings during storage and delivery. Keep wire ropes, chains, or hooks from direct contact with the coated surfaces.
4. Dewatering if required, shall be performed in accordance with Section 02512.03.

C. Equipment

1. Tunneling equipment shall be of U.S. Bureau of Mines approved types.
2. Tunnel shields shall have uniform exterior surface from leading edge of head or poling plates to the rear edge of the tail. A horseshoe-shape shield may have a closed or open bottom: a circular shield shall have closed bottom.
3. A substantially proportioned hood shall be provided which projects not less than 2 feet beyond the shield bottom with sufficient rear overhang or tail to provide at least 12 inches of overlap beyond the last element erected when the shield has been shoved forward to the fullest extent possible. The annular space between the tail and the lining shall be as small as current practice indicates, but in no case shall it be greater than 1 ½ inches.
4. Provide each shield with suitably designed breast-jacks or breast-tables or both, and such other bracing as is necessary to support the face of the tunnel excavation without loss of ground.
5. Provide on each shield a propulsion system capable of moving the shield in a forward direction while maintaining line, grade, and direction. The propulsion system shall be designed to prevent the shield from moving backward despite a failure of any element of the propulsion system and shall not overstress or distort the lining.
6. Prevent grout from leaking into the tunnel space between the shield and lining by incorporating a seal in the tail of each shield.
7. The shield shall be equipped with an erector arm or system capable of handling the largest sizes of lining and of erecting the sections of the lining to the required tolerances without damage to the lining.

D. Power Supply

1. All power machinery and tools within the tunnel shall be operated by either electricity, compressed air, diesel with approved scrubber, or other approved power. All electrical tools and equipment shall be grounded in accordance with the latest requirements of the National Electrical Code.
2. Temporary electric lights shall be provided to properly and safely illuminate all parts of the tunnel construction area including special illumination at the working faces. Lighting circuits shall be thoroughly insulated and separated from power circuits; and all lights shall be enclosed in wire cages. The Contractor shall secure all electrical permits necessary for the installation and operation of this service.

E. Operations by Tunnel Shields and Machines

1. On initial set-up, the tunnel shields or tunneling machines shall be supported and properly set at lines and grades which will permit the correct installation of the tunnel lining. During forward movement of the shield provide sufficient support at the excavation face to prevent movement of any materials except such materials as are physically displaced by the elements of the shield itself.
2. The face shall be controlled using such support procedures as breasting, poling plates, face jacks, sliding tables, either singly or in combination, spaced as necessary.
3. Advance excavation for the tunnel liner in increments sufficient for the erection of one ring of liners and install liner plates immediately after each increment of excavation. Carry on excavation in such a manner that voids behind the liner plates are held to a minimum. Completely fill such voids with grout or gravel followed immediately by grout placed under pressure.
4. Whenever tunnel excavation is suspended or shut down, the tunnel invert is below the level of groundwater, and/or there is danger of water infiltration from any source, maintain on duty qualified personnel to observe conditions that might threaten the stability of the heading. Contractor may substitute acceptable observation devices such as closed circuit TV that enables continuous monitoring of conditions at the face by qualified observers from outside the tunnel.
5. During shut down periods, support the face of the excavation by positive means; no support shall rely solely on hydraulic pressure.

F. Installation of Tunnel Linings

1. Install the tunnel lining in a manner that will not damage the lining or coating.
2. Ensure that the edges are clean and free from material that could interfere with proper bearing.
3. Install bolts for liner plates in accordance with liner plate manufacturer's recommendations and retention or replace if necessary any bolt which does not meet the requirements.
4. Assemble liners to the lines and grades shown on the Plans or as directed by the County Engineer.

G. Gravel Packing and Grouting

1. Where approved, gravel packing may be used to fill voids between the excavation and support system. For voids to be filled with gravel pack, place gravel in the voids behind liner plate by compressed air (minimum pressure 80 psi) through a 1 ½ or 2-inch diameter hose.
2. Filling voids with gravel shall generally proceed from the bottom grout hole of each ring to the top hole.

3. Vent air through one of the upper holes.
4. Fill voids in the gravel pack between the tunnel excavation and the tunnel liner with grout mix.
5. The grout pump and injection system shall be of a type that will deliver the grout in a smooth even flow without surge. The grouting circuit shall contain a return line to allow return of the grout from the nozzle to the supply tanks. The grouting equipment shall be capable of developing a uniform pressure of 50 psi at the grout hole connection and equipped with hoses with a minimum inside diameter of 1 ½ inches. The grouting equipment shall have a minimum capacity of ½ cubic yards.
6. Grouting between the liner plates and excavation shall follow progressively with each adjacent set of holes provided in the liner plates.
7. In general, grouting shall proceed from the lowest grout hole of each ring and proceed progressively upward. When going from lower to higher grout holes, do not make connection to the higher holes until grout has completely filled the space below. Fill all voids completely at the close of each 8 hour work period.
8. Continue grouting until grout appears in the next set of grout pipes, which shall be kept open during grouting to permit escape of air and water.

H. Concrete Invert

Place cast-in-place concrete invert to the limits shown on the Plans in accordance with Section 03300.

I. Installation of Carrier Pipe

1. Install pipe inside tunnel where indicated on the Plans.
2. Pipe and joint requirements are specified elsewhere in the Contract Documents.
3. Provide bedding and anchorage in accordance with the Plans.
4. Provide wooden skids or other approved devices as required to eliminate damage to pipe.
5. Where so indicated, fill annular space between pipe and tunnel with grout, with concrete having a maximum aggregate size of 3/8 inch, or with sand. Positive means shall be provided to hold the pipe in place and to prevent flotation.

02920.04 METHOD OF MEASUREMENT**A. Tunneling**

RESERVED FOR FUTURE USE

B. Carrier Pipe

RESERVED FOR FUTURE USE

02920.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Earth Tunneling and Liners

RESERVED FOR FUTURE USE