



# DENVER

## THE MILE HIGH CITY

CITY AND COUNTY OF DENVER  
DEPARTMENT OF PUBLIC WORKS | ENGINEERING DIVISION

## Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications

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### 7.1 Tunneling, Jacking and Boring

#### 7.1.1 General

Where indicated on the Drawings, or where field conditions dictate that open trenching for the pipeline across railroad tracks, highways, or other obstructions is prohibited, the pipe shall be installed by jacking, tunneling, boring and casing methods, or micro tunneling.

Should the General Contractor, in the process of Project construction, elect to propose that a portion of the pipe be installed by jacking, tunneling, and/or boring rather than by trenching operations, the subject cost shall not total more than the aggregate sum of the removal and replacement costs that such an activity would replace.

#### 7.1.2 Submittals

##### 7.1.2.1 Installation and Receiving Pits

Detailed shop drawings will be required for all pipe jacking, tunneling and boring installations; and receiving pits. These drawings shall include the materials and specific excavation support system along with applicable dimensions. All shop drawings must be stamped by a Professional Engineer licensed within the State of Colorado

##### 7.1.2.2 Jacking Design

Calculations showing the maximum concentric jacking load and the maximum allowable angular change in alignment shall be submitted to the Project Construction Engineer and the pipe supplier. Design and details of jacking collar, reaction plates, external shield, reaction thrust block, jacking frame and jack capacity shall be submitted to the Project Construction Engineer prior to construction.

### **7.1.2.3 Jacking Layout**

Layout diagrams for jacking pits, receiving pits, intermediate stations (including dimensions) shall be submitted to the Project Construction Engineer prior to construction.

### **7.1.2.4 Jacking Methods**

Design and details of wall support systems, dewatering, excavation method at the bore face, jacking pressure monitoring and control methods, lubrication procedures, method of grade and alignment control, joint cushioning, and grouting procedures shall be submitted to the Project Construction Engineer prior to construction.

### **7.1.3 Protection of Roadbed**

No excavation for boring or jacking pits will be permitted within 25 feet of the center line of any railroad track, or within 15 feet of the paved shoulder of any highway, or 15 feet of the toe of the side slope, whichever is greater.

The sides of boring or jacking pits shall be structurally supported by sheet-piling placed in such manner as to prevent any movement or slippage of the earth during the excavation and tunneling, jacking and/or boring operations. The General Contractor shall work in close cooperation with the agency having jurisdiction or the landowner to ensure the protection of their life, infrastructure, property and environment while maintaining residential/business access as necessary.

### **7.1.4 Tolerances**

Excavation and jacking of the sewer pipe shall be controlled by the General Contractor to allow construction of the sewer to a true circular shape and to within 1.5 inches on line and 1 inch on grade. When excavation is off line and grade, the General Contractor shall inform the Project Construction Engineer immediately to determine how correction will be made. Variations from line and grade tolerances listed herein may be allowed at the discretion of the Project Construction Engineer, in writing.

If the General Contractor is unable to maintain these tolerances, he/she shall bear full responsibility and expense for correction (redesign, easement acquisition, etc.) If these tolerances are exceeded and redesign of structures is required, the General Contractor shall obtain the services of an independent professional engineer registered in the State of Colorado for the redesign. Plans showing the changes shall be submitted to the Project Construction Engineer for review and approval.

The General Contractor shall survey the sewer at 24-foot intervals or once per pipe jack, whichever is less, to ensure the alignment is within the tolerances specified. The survey shall be conducted immediately behind the excavation face to allow immediate correction of misalignment if necessary. Excavation shall not precede surveyed verification of the alignment by more than 24 feet, or more frequently, if line and grade tolerances have been exceeded. The guidance system may be used; however, the General Contractor shall select

times to measure and record this information after the air temperatures have stabilized throughout the pipe to ensure accurate readings.

### **7.1.5 Jacking**

#### **7.1.5.1 Jacking Pit**

The jacking pit shall be excavated on one side of the right-of-way, utility, or roadbed under which the pipe or casing is to be installed. The pit shall be only of sufficient length to provide room for the jacking head and the pipe, dependent upon the kind of pipe to be jacked. The pit should be of sufficient width to permit ample working space. The end of the pit nearest the roadbed shall present a vertical face into which the adit shall be excavated.

#### **7.1.5.2 Jacking Frame**

The jacking frame shall be constructed of guide rails, a backstop and a pushing or jacking head. Guide rails shall be constructed to the exact line and grade of the pipeline and shall be anchored in such a manner as to be capable of maintaining the alignment and gradient throughout the operations.

The backstop shall be constructed to provide a bearing area capable of supporting no less than 200% (two hundred percent) of the estimated maximum jacking pressure and shall be perpendicular to the center line of the pipe to be jacked. It shall be anchored and braced in a manner to assure that this position will be maintained throughout the jacking operation. Jacking against previously installed pipe will not be allowed.

The pushing or jacking head shall be constructed to fit the pipe to be jacked and to assure that the pressure developed by the jacks will be evenly distributed on the periphery of the pipe. An opening large enough to permit the entrance of men and materials shall be maintained in the jacking head.

#### **7.1.5.3 Jacking Procedure**

Depending on soil conditions, the excavating operation inside the pipe shall proceed approximately one foot ahead of the lead pipe. The excavation around the top and sides of the pipe (over-cut) shall be no more than one-inch larger than the periphery of the pipe. The bottom of the excavation shall be cut accurately to line and grade.

The jacking operation shall be continuous until the entire crossing is complete except for sufficient time to place additional pipe sections, position the frame and to prepare each pipe joint.

On pipe 36-inch and larger a 2-inch grout nipple terminating in a coupling capable of accepting a threaded pipe plug which will be flush with the inside face of the pipe, shall be provided. The pipe shall be oriented so that the nipple is in the crown.

Immediately following the completion of the section being jacked, a neat portland cement grout consisting of (by volume) 2 parts Portland Cement (ASTM C150), 1 part fly ash (ASTM 618 Class F) and not to exceed 6 parts of clean, dry sand, shall be pumped to refusal at 5 psi into each grout nipple. Only enough water shall be used to produce a flowable grout, when well mixed, having the consistency of thick cream. After all grouting is completed, the

holes shall be filled with dry packed cement mortar grout. Threaded plugs shall be installed flush with the inside face and the remaining void shall be filled with a non-shrink grout rated to 4000 psi.

**7.1.5.4 Material**

Pipe to be jacked shall be as specified in the Contract Documents and shall be specifically designed by the pipe manufacturer with sufficient reinforcing and wall thickness to resist, without buckling or crushing, the horizontal, vertical and longitudinal loads applied to it during the jacking procedures. The casing material, if required, shall be approved by the Project Construction Engineer, in writing prior to construction. Concrete pipe for jacking shall be as specified in Section 10.1 of these Detail and Technical Specifications, or as otherwise noted in the Contract Documents. Joints for concrete jacking pipe shall include steel joint rings in accordance with ASTM-C361

The joints of concrete jacking pipe shall be cushioned in a manner and with such material to prevent chipping or breaking of the pipe ends due to concentrated pressure caused by any slight irregularity of the pipe ends. The quantity and type of cushioning materials to be used shall be approved by the Project Construction Engineer, in writing.

**7.1.6 Boring**

**7.1.6.1 General**

Sewer installations involving boring and casing methods may be used at the General Contractor's option subject to written approval by the Project Construction Engineer.

**7.1.6.2 Casing Pipe**

The casing pipe shall be of welded steel pipe conforming to the requirements of ASTM A53 Grade B or AWWA C200, having a minimum yield strength of 35,000 psi of the size and wall thickness as shown below or as otherwise noted in the Contract Documents.

| Casing Diameter | Minimum Thickness |
|-----------------|-------------------|
| 36" and Smaller | 3/8 - inch        |
| 42" and Larger  | 5/8 - inch        |

Casing shall be kept on line and grade as required within this specification. Joints in the casing shall be field welded around the entire joint perimeter to produce a watertight seal. Welds shall be of a size to develop the full strength of the pipe materials.

**7.1.6.3 Carrier Pipe**

The carrier pipe shall be as specified in the Contract Documents carrier pipe shall be approved by the Project Construction Engineer and in accordance with the submittal requirements of these Detail and Technical Specifications. Pipe sizes, joints, structural class, etc., shall also be subject to written approval by the Project Construction Engineer. The pipe

joints of the carrier pipe shall be as specified within these Detail and Technical Specifications for the specific type of pipe approved for use.

#### **7.1.6.4 Casing Spacers**

Factory manufactured casing spacers shall be installed on all carrier pipes passing through a casing pipe. Wooden skids will not be allowed.

All casing spacers shall adhere and conform to the following:

1. All casing spacers shall be Model SSI8 or SSIM (field adjustable) for carrier pipes up to 24-inches in diameter and Model SSI12 for larger diameter carrier pipe sizes as designed and manufactured by Advance Products & Systems, Inc., Lafayette, LA., or an approved equal. The runners shall be at least 7-inches long for SSI8 and SSIM models or 11-inches long for SSI12 models and they shall be manufactured of high abrasion resistant, low coefficient of friction, glass filled polymer.
2. The casing spacers shall be center restrained to limit vertical movement of the carrier pipe in the casing.
3. Casing spacers shall be bolt-on-style with a shell made of at least two halves.
4. Spacing is approximately 3 per joint of pipe or 1 spacer per every 7 feet maximum.
5. The band material shall be manufactured of a minimum 14 gauge T-304 stainless steel and 10 gauge T-304 stainless steel risers when needed.
6. The casing spacers shall have a flexible PVC or EPDM liner having a minimum thickness of 0.090 inches with a hardness of Durometer "A" 85-90.
7. All welds are to be chemically cleaned and passivated.
8. All hardware shall be stainless steel.

#### **7.1.6.5 Casing End Seals**

After insertion of the carrier pipe into the casing, the ends of the casing shall be closed by installing 1/8" thick synthetic rubber end seals such as the Model "AC" pull-on end seal, as manufactured by Advance Products & Systems, Inc., Lafayette, LA, or an approved equal. Ends seals shall be attached using minimum 1/2" wide T-304 stainless steel bandings utilizing a worm gear mechanism.