ITEM 909 TUNNEL – JACKED LINER

909.01 Description. This work consists of furnishing and installing a tunnel liner of sufficient diameter to permit the installation of the sewer therein and encasing the sewer in the liner. This work includes all excavation, shoring and bracing, jacking pit and appurtenances (except for separate contract pay item), backstops, jacks, jacking shields, hoods, breasting attachments, grout holes and plugs, grout and other incidentals as needed for the installation. The Contractor may install the liner by jacking and hand mining, by spoil removal with a boring auger, or by tunnel boring machine.

909.02 Materials. Use the following materials:

1. Tunnel liner 909.06
2. Cement for grout 701
3. Sand for grout 703.03
4. Concrete, Class A/Class C..... 499, 905
5. Pipe sewer 901.02

909.03 General. Perform work in jacked tunnels in accordance with the requirements of Section 908.03. Jack in one direction only.

1. **Boring.** This method consists of pushing (jacking) the pipe into the earth with a boring auger rotating within the pipe to remove the spoil. This method is generally limited to 48 inch (1.2 m) and smaller lines.

2. **Jacking.** This method consists of pushing sections (strings) of pipe into position with a tunnel boring machine, or with jacks placed against a backstop and excavation performed by hand within the jacking shield or liner at the head of the pipe. This is generally used on tunnel liners greater than 30 inches (762 mm) in diameter.

909.04 Construction Layout and Alignment Holes. Perform work in conformance with Section 908.04.

909.05 Jacking Shield.

1. **Jacking Shield for Reinforced Concrete Pipe.** Provide a separate jacking shield, a tunnel boring machine or a shield fabricated as a special section of reinforced concrete pipe with steel cutting edge, hood, breasting attachments, and other necessary appurtenances cast into the pipe if required by the

Engineer. Design the wall thickness and reinforcing for the jacking stresses. Do not plan for the fabricated shield to remain as a part of the tunnel liner, unless specifically designed for that purpose and the design is approved by the Engineer.

2. **Jacking Shield for Smooth Steel Pipe Liner.** Provide a separate shield, or the leading section of conduit equipped with a securely anchored jacking head to prevent wobble and variation in alignment if required by the Engineer. The Contractor may use a modified section of standard pipe with the necessary breasting attachments and capability to completely bulkhead the face if approved by Engineer.

3. **Boring Head and Auger Assembly.** Submit details showing the equipment and the methods of operation the Contractor plans to use. The Engineer may require devices to prevent the cutting head from leading the pipe. Use a the cutting head designed to obstruct the flow of soft or poor soil through the face. Use a cutter head and auger assembly designed to allow the entire removal of the boring equipment from inside the liner. Limit the over cut to the minimum amount required for the installation and conduct operations to prevent unsupported excavation ahead of the liner pipe.

909.06 Tunnel Lining. Provide tunnel lining with strength commensurate with the tunnel diameter, depth of cover, and jacking thrust and with adequate buckling resistance, all in accordance with the design requirements of the authorizing entity. Submit to the Engineer design calculations prepared and stamped by a Professional Engineer registered in the State of Ohio demonstrating the capability of the materials proposed.

1. **Reinforced Concrete Pipe Liner.** Provide reinforced concrete pipe liner with tongue and groove joints conforming to ASTM C-76, Class V Wall C for railroad installation. For other installations, provide a pipe design for approval by the Engineer.

2. **Smooth Steel Pipe.** Provide smooth steel pipe having a minimum yield strength of 35,000 psi (241 MPa) with a maximum diameter of 72 inches (1.8 m) (nominal). Use tunneling procedures described under Item 908 for larger than 72 inch (1.8 m) smooth steel pipe sizes. Provide the following minimum wall thicknesses for the nominal sizes shown for railway installations with 5 foot 6 inches (1.7 m) of cover (minimum).

Nominal Diameter Inches (mm)	Nominal Thickness Inches (mm)
10 and under (254)	0.188 (4.8)
12 and 14 (305 and 355)	0.250 (6.3)
16 (406)	0.281 (7.1)
18 (457)	0.312 (7.9)
20 and 22 (508 and 558)	0.344 (8.7)
24 (609)	0.375 (9.6)
26 (660)	0.406 (10.3)
28 (711)	0.438 (11.1)
30 (762)	0.469 (11.9)
32 (812)	0.500 (12.7)
34 and 36 (863 and 914)	0.532 (13.5)
38 (927)	0.562 (14.3)
40 (1016)	0.594 (15.1)
42 (1067)	0.625 (15.9)
44 and 46 (1118 and 1168)	0.657 (16.7)
48 (1219)	0.688 (17.4)
50 (1270)	0.719 (18.2)
52 (1321	0.750 (19.0)
54 (1371)	0.781 (19.8)
56 and 58 (1422 and 1473)	0.812 (20.6)
60 (1524)	0.844 (21.4)
62 (1575)	0.875 (22.2)
64 (1625)	0.906 (23.0)
66 and 68 (1676 and 17257)	0.938 (23.8)
70 (1778)	0.969 (24.6)
72 (1829)	1.000 (25.4)

The Engineer will consider wall thicknesses for other conditions of loading if justified by the submitted engineering calculations.

Fully weld joints between sections of steel pipe around the circumference. Provide any stress transfer across the joint necessary to ensure capability to resist the jacking forces involved.

909.07 Excavation. Excavate all material of whatever nature encountered, including rock, necessary for the construction of the work. The City considers all excavated material as unclassified material. Do not excavate beyond the edge of the hood, shield or liner, except in rock.

909.08 Soil Stabilization. Perform soil stabilization in accordance with the requirements in Section 908.08.

909.09 Dewatering. Perform dewatering in accordance with the requirements in Section 908.09.

909.10 Grouting. The Contractor may place grout by grout pipes from the ground surface where conditions permit. On railroad and main highway installations, place the grout from within the jacked liner, or other approved method.

Locate grouting holes for smooth steel liners in accordance with Section 908.10. For railroads, provide tapped grout holes at least 1 1/2 inches (38 mm) diameter. For reinforced concrete pipe, provide grout holes cast into the liner at manufacture. Space the holes 4 feet (1.2 m) longitudinally and approximately 3 feet (0.9 m) circumferentially. For other installations, the Engineer will approve the grouting arrangement.

Use grout with a 1:3 (cement:sand) cement grout mixture. Start the grouting immediately after completing the jacking/boring operation. Provide a grouting machine, gauge, pressures, and cold weather instructions in accordance with Section 908.10.

909.11 Fill Material. Provide fill material in accordance with the requirements in Section 908.11.

909.12 Method of Measurement. The Engineer will measure and accept the length of jacked liner and appurtenances for payment by the actual number of linear feet (meters), as measured along the centerline of the sewer lines. If the tunnel liner unit price include the tunnel shaft-jacking pit , the Engineer will measure from the center of the jacking pit to the end of the tunnel liner.

909.13 Basis of Payment. The City will pay the accepted number of linear feet (meters) of tunnel-jacked liner of the sizes required at the contract unit prices per linear foot (meters) complete in place. The City will pay for the encased pipe under Item 901.

The City will pay under:

Item	Unit	Description
909	Linear Foot (Meter)	Tunnel - Jacked Liner for ____ Inch (mm) Diameter Pipe Including Jacking Pit
909	Linear Foot (Meter)	Tunnel - Jacked Liner for ____ Inch (mm) Diameter Pipe Excluding Jacking Pit