

**NORFOLK SOUTHERN CORPORATION**  
**GUIDELINES FOR UNDER TRACK CULVERTS**

- I. All culvert structures shall be designed for E-80 Live Load and based on a 100 year storm event unless otherwise approved by the Chief Engineer Bridges and Structures.
- A. Maximum headwater build up (for Q 100) for inlet control conditions shall be limited to an HW/D= 1.5 provided the roadbed fill is of sufficient height to maintain the high water elevation below the toe of ballast and the fill material is capable of resisting water infiltration for short durations. With the approval of the Engineer Structures, the HW/D limit may be adjusted for special field conditions.
- II. Culverts shall be sized based on the actual drainage basin. The minimum culvert size shall be 36 inches in diameter unless otherwise approved by the Engineer Structures. The "Rational Method" shall be used for drainage areas less than 500 Acres. For drainage areas greater than 500 Acres, one of the following methods should be considered and may provide more realistic runoff estimates provided data is available.
- A. Soil Conservation Service (Unit Hydrograph Theory Method) SCS
- B. Flood Frequency Regression Theory
- C. Seven Parameter Estimating Equation
- III. Corrugated metal with various coatings, corrugations, shape, and manufacturing processes, smooth wall steel pipes and concrete, both pre-cast and cast-in-place can be considered. Plastic coated pipe requires special care to avoid damage during handling and installation.
- A. Corrugated metal, galvanized and asphalt coated circular pipes will be our basic design with variations permitted with the approval of the Engineer Structures.

1. Aluminized Type 2 uncoated or Bituminous coated galvanized steel pipe - may be used for a PH range of 5-8. Suggested uses are runoff from non industrial rural areas.
  2. Fiber Bonded Bituminous coated pipe or Plastic coated pipe - may be used where soil and water conditions warrant such as Midwest farm fields (high concentrations of fertilizer runoff), coal fields (acidic runoff), salt water marsh areas, and in areas where high soil concentrations of heavy metals are present.
  3. Pipe Arch - may be considered for special cases where physical constraints and opening requirements warrant.
- B. Smooth Wall Casing pipe will be our basic design for culverts where jack and bore method is required due to traffic condition or fill height greater than 10 feet. Liner Plate installed by Tunneling method may be required when diameter, length, presence of rock or other unusual site conditions exist. Recommended wall thickness requirements and Liner Plate gage tables are attached.
- C. Concrete pipe culverts or pre-cast concrete culverts may not be used under company owned tracks due to the potential for differential settlement and joint separation, except with the approval of the Chief Engineer Bridges and Structures. Concrete pipe culverts or pre-cast concrete culverts may be used under industry tracks where "NS" has no maintenance responsibilities.
- D. Cast-in-place concrete structures may be used where appropriate.
- E. Structural Plate pipes and pipe arches are to be used where size and conditions dictate (generally considered culverts greater than 72 inch diameter). The coating to be either bituminous coated or fiber bonded depending on soil and runoff water condition (PH range).
- F. Tunnel Liner shall be used when the culvert diameter exceeds pipe sizes economically installed by the jack and bore method

(culverts generally larger than 60 inch diameter). All tunnel liner pipe shall be bituminous coated and have paved inverts. Grouting of voids between the pipe and adjacent soil at regular intervals, not to exceed once daily, is required.

**IV.** Paved inverts shall be used in corrugated metal pipes where water velocities are medium to high (above 10 f.p.s.) or the possibility of excessive wear from sand and gravel is likely.

A. Corrugated metal culverts shall have bituminous or asphalt paved inverts where needed due to high water velocities or the possibility of excessive wear from sand and gravel is likely.

B. Concrete or Asphalt paved inverts shall be used in structural plate, tunnel liner and pipe arches that are field assembled. If concrete is used, a minimum concrete compressive strength shall be 3000 p.s.i. after 28 days. The bottom 25% of culvert periphery shall be covered with concrete (or asphalt) to a depth of 1 inch above the crest of the corrugations for circular pipes and 40% of the periphery for pipe arches. The concrete pavement shall be reinforced with 6 x 6 (W2.9 x W2.9) welded wire fabric. This wire shall be attached to the pipe by either directly welding to the pipe or by mechanical attachment to the bolts.

**V.** Preformed bituminous coated end sections may be used in place of headwalls when erosion at the inlet is expected. Minimum end section gage shall be 12 gage. Headwalls and/or End Sections should be considered on both ends of all culverts greater than or equal to 60 inch diameter.

**SMOOTH WALL CASING PIPE**  
**RECOMMENDED WALL THICKNESS TABLE**  
 (REVISED 1/17/91)

<u>Nominal Size</u> (Inches)	<u>Recommended Wall Thickness</u> (Inches)
24	0.500
30	0.500
36	0.500
42	0.625
48	0.625
54	0.750
60	0.875
66	0.875
72	1.000

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**MINIMUM LINER PLATE GAGE TABLE**  
 (REVISED 7/10/91)

<u>Diameter</u> (Feet)	<u>2 Flange</u>		<u>4 Flange</u>	
	<u>Gage</u>	<u>Cover</u>	<u>Gage</u>	<u>Cover</u>
4'-----	12	4' TO 50'	12	4' TO 50'
5'-----	12	4' TO 50'	12	4' TO 50'
6'-----	12	4' TO 50'	10	4' TO 50'
7'-----	12 10	6' TO 50' 4' TO 50'	10	4' TO 50'
8'-----	10	4' TO 50'	8	6' TO 50'
9'-----	10	4' TO 50'	8	8' TO 50'
10'-----	8 7	4' TO 32' 34' TO 50'	5	8' TO 40'

**Note:** The above Minimum Liner Plate Gage Table was developed using 1989 AREMA Specifications Chapter 1, Part 4. The following factors of safety were used: Joint Strength = 3.0; Minimum Stiffness = ("3.0" for 2-Flange and "1.5" for 4-Flange); and Critical buckling = 2.0. The effects of high corrosive environments may be compensated for by adding one (1) gage to the above Liner Plate Gage Table values.

**SPECIFICATION FOR INSTALLATION OF UNDER TRACK CULVERTS  
BY OPEN CUT METHOD**

**I. SCOPE**

This specification covers the procedure for the installation of under track culverts by the "Open Cut Method". This method is limited to fills less than or equal to 10 feet as measured from the pipe flowline to the base of rail. For fills greater than 10 feet, the prior approval of the Chief Engineer Line Maintenance is required.

**II. GENERAL**

Except as otherwise specified hereafter, the current A.R.E.A. Chapter 1, part 4 and 5 apply to all work under this section. Minimum pipe size shall be 36 inches in diameter; gage and size selected by Engineer. Any size less than 36 inches or greater than 72 inches must be approved by Engineer.

**III. EXCAVATION**

In soil conditions other than sandy soils, the bottom of the proposed trench shall be excavated to a minimum of 6 inches below the proposed flowline elevation and the width of the trench shall be equal to 1 pipe diameter plus 24 inches (or as necessary to allow for compaction by mechanical tampers). In soft soil conditions the bottom of trench shall be excavated a minimum of 12 inches below the proposed flowline elevation, the poor foundation material removed and filled with approved base material. If rock is encountered during excavation a minimum of 12 inches of base material shall be required under the pipe. Shoring is required for excavations deeper than 5 feet or sides slopes shall be cut back a sufficient amount to prevent slides. Where there is any doubt about the safety of the excavation, the Chief Engineer Line Maintenance shall be contacted before excavation begins.

**IV. PIPE BEDDING**

"Crushed Stone Base" material shall extend the full length and width of the trench as follows:

- A. A uniform blanket of "Crushed Stone Base" material either clean sand or crusher run stone meeting the following gradation:

<u>Sieve</u>	<u>% Passing</u>
2 inch	100%
1 inch	95-100%
3/4 inch	30-70%
3/8 inch	10-30%
No. 4	0-5%

- B. Pipe bedding shall be compacted to 90-95 % maximum density obtained at optimum moisture content as determined by ASTM D-689.
- C. When vibratory equipment is used in conjunction with other methods of compaction, the compacted depth of a single layer shall not exceed six (6) inches (6-9 inches loose). When no vibratory equipment is used, the maximum compacted thickness of one layer shall not exceed 3 inches (3-6 inches loose). Each layer shall be thoroughly compacted by not less than six passes of compacting equipment suitable to the type of fill material used on the approval of the Engineer. Additional passes shall be made when the Engineer determines compaction is inadequate.
- D. Pipe backfill material shall be crusher run stone unless otherwise directed by the Engineer. Fill material under haunches and around the structure shall be placed alternately in 6 inch compacted layers (6-9 inches loose) on both sides of the pipe to permit thorough tamping. Fill shall be placed on alternate sides to keep it at the same elevation on both sides of the structure at all times (Plan No. 5-28 shows how the pipe structures should be backfilled). Complete the fill over the pipe using crusher run stone essentially the same as placed around pipe. Distribute and compact the fill evenly in 12 inch layers up to the original subgrade elevation.
- E. Cambering the center part of the foundation will compensate for unequal settlement under the weight of heavy fills. Generally enough camber can be obtained by installing the upstream half of the pipe on a flat grade, and then use a steeper grade on the downstream half. If camber is considered necessary it should be not less than 1/2 of 1% of the total length

of the structure. The amount of camber shall be determined by the Engineer.

V. **PIPE STRUTTING**

Corrugated metal pipes 48 inch and larger shall be shop strutted to produce 5% vertical elongation. Struts shall be horizontal when pipe is placed.

VI. **SPACING FOR MULTIPLE LINES OF PIPE**

<u>PIPE DIAMETER</u>	<u>MINIMUM CLEAR DISTANCE "C"</u>
UP TO 72" DIAMETER	1/2 DIAMETER
ABOVE 72" DIAMETER	36 INCHES

**FILLING OLD CULVERT**

The existing culvert shall be completely filled with a sand and cement grout mixture consisting of 4 parts sand to 1 part cement and enough clean water to facilitate pumping. Grouting of the existing culvert to be accomplished after the new culvert is placed in service.

**SPECIFICATIONS FOR INSTALLATION OF UNDER TRACK CULVERTS  
BY THE JACK AND BORE METHOD**

**I. SCOPE**

This specification covers the procedure for installation of undertrack culverts by the "Jack and Bore " Method.

**II. GENERAL**

Except as otherwise specified hereafter the current A.R.E.A. Chapter 1, part 4 and 5 apply to all work under this section. Minimum pipe size shall be 36 inches in diameter. The pipe size and gage shall be selected by the Engineer. The use of any size less than 36 inches or greater than 72 inches must be approved by the Engineer.

**III. APPROVED CULVERT TYPES**

Culvert installed by the Jack and Bore method shall be limited to either Corrugated Steel Pipe or Smooth Steel Pipe. Reinforced concrete pipe will not be allowed to be installed under main line track.

**IV. PIPE CONNECTIONS**

Corrugated metal pipes shall be connected with 24 inch wide bands. Connecting bands may be one gage lighter than culvert material. Smooth steel casing pipe shall be connected by welding using a full depth, single "V" groove butt weld.

**V. INSTALLATION**

The Contractor shall inspect the site where the culvert is to be installed and familiarize himself with the conditions under which the work will be performed and with all necessary details as to the orderly prosecution of the work. The omission of any details for the satisfactory installation of the work in its entirety, which may not appear herein, shall not relieve the Contractor of full responsibility.

Construction shall be carried on in such a manner that settlement of the ground surface above the pipe line shall be held to an absolute minimum. The installation of the pipe line shall follow the heading or boring excavation as soon as possible. Excavation shall be carried on in such a manner that voids behind the pipe will be held to a minimum. The Contractor shall pressure grout voids using an approved hydraulic pumping device, with grout mix in the proportions of one part Type I

cement to three parts sand and sufficient water to produce a free flowing grout.

If, in the opinion of the Engineer, the installation of the pipe is being conducted in an unsafe manner, the Contractor will be required to stop work and bulkhead the heading until suitable agreements are reached between the Contractor and the Company. The Company will not be responsible and shall be saved harmless in the event of delays to the Contractor's work resulting from any cause whatsoever.

**VI. FILLING OLD CULVERT**

The existing culvert shall be completely filled with a sand and cement grout mixture consisting of 4 parts sand to 1 part cement and enough clean water to facilitate pumping. Grouting of the existing culvert to be accomplished after the new culvert is placed in service.

**SPECIFICATIONS FOR INSTALLATION OF UNDER TRACK CULVERTS  
BY THE TUNNELING METHOD**

**I. SCOPE**

This specification covers the procedure for installation of undertrack culverts by the "Tunneling" method.

**II. GENERAL**

Except as otherwise specified hereafter the current A.R.E.A. Chapter 1, part 4 and 5 apply to all work under this section. Minimum pipe size shall be 48 inches in diameter. The pipe size and gage shall be selected by the Engineer.

**III. APPROVED CULVERT TYPES**

Culverts installed by the Tunneling method shall be limited to tunnel liner plate pipe. Reinforced concrete pipe will not be allowed to be installed under main line track or Company maintained tracks.

**IV. INSTALLATION**

The Contractor shall inspect where the tunnel is to be installed and familiarize himself with the conditions under which the work will be performed and with all necessary details as to the orderly prosecution of the work. The omission of any details for the satisfactory installation of the work in its entirety, which may not appear herein, shall not relieve the Contractor of full responsibility.

The tunnel shall be constructed by tunneling methods and completely lined on the inside with structural steel liner plates meeting all requirements herein specified.

The tunneling operation may commence from either end of the conduit. Construction of the tunnel shall be done in such a manner that settlement of the ground surface above the tunnel shall be held to an absolute minimum. When ground conditions are unstable, poling plates or breast boards shall be used to prevent caving of material above the tunnel before the liner plates can be installed.

The periphery of the tunnel shall be trimmed smooth to fit the outside of the liner plate as nearly as is practical. Excavated material may be disposed of on Company right-of-way subject to the direction and approval of the Engineer.

The liner plates shall be installed immediately after the excavated material has been removed, and the material shall not be removed more than 24" ahead of the installed liner plates.

Coated plates shall be handled in such a manner as to prevent bruising, scaling, or breaking of the coating. Any plates that are damaged during handling or placing, shall be replaced by the Contractor at his expense, except that small areas with minor damage may be repaired by the Contractor as directed by the Engineer.

Liner plates shall be assembled in accordance with the manufacturer's instructions.

The void between the steel liner plates and the tunnel excavation shall be pressure grouted using an approved hydraulic pumping device, with grout mixed in the proportions of one part Type I cement to three parts sand and sufficient water to produce a free flowing grout.

Inject pressure grout in lower holes first, moving up as the back space is filled. Threaded plugs should be installed in holes after filling at each one.

Concrete or asphalt paved inverts shall be used in all tunnel liner pipe pipes. If concrete is used, a minimum concrete compressive strength shall be 3000 p.s.i. after 28 days. The bottom 25% of culvert periphery shall be covered with concrete (or asphalt) to a depth of 1 inch above the crest of the corrugations for circular pipes and 40% of the periphery for pipe arches. The concrete pavement shall be reinforced with 6 x 6 (W2.9 x W2.9) welded wire fabric. This wire shall be attached to the pipe by either directly welding to the pipe or by mechanical attachment to the bolts.

The Contractor shall provide all necessary bracing, bulkheads, and/or shields to insure complete safety to all traffic at all times during the progress of the work; and he shall perform the work in such a manner as to not interfere with normal traffic over the work.

The Contractor shall construct temporary dikes or sheeting to divert or pump water through the culvert to allow construction "in the dry." Channel work necessary to direct the stream to and from the inlet and discharge ends of the completed culvert is considered part of the project.

All working operations of the Contractor, subcontractor, and/or their agents or employees must be subordinate to the free and unprotected use of the right-of-way for the passage of traffic without delay or danger to life, equipment, or property. The Contractor shall conduct his operations in such a manner that all work will be performed below road level and without obstructions on the roadbed.

If in the opinion of the Engineer, the installation of the tunnel is being conducted in an unsafe manner, the Contractor will be required to stop work and bulkhead the heading until suitable agreement is reached between the Contractor and the Engineer. The Company will not be responsible and shall be saved harmless in the event of delays to the Contractor's work resulting from any cause whatsoever. The Contractor must be fully equipped and experienced in the installation of large diameter structures by tunneling methods.

Blasting will not be permitted.

V. **FILLING OLD CULVERT**

The existing culvert shall be completely filled with a sand and cement grout mixture consisting of 4 parts sand to 1 part cement and enough clean water to facilitate pumping. Grouting of the existing culvert to be accomplished after the new culvert is placed in service.

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SECTION 4.01

(REVISED 1/17/91)

**CORRUGATED STEEL PIPE**  
**(Bituminous Coated Galvanized Steel)**

I. **SCOPE**

This work shall consist of installation of galvanized corrugated steel pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified herein, and/or as directed by the Engineer. This specification shall be governed by AREMA chapter 1, part 4, section 4.3.

**II. MATERIAL**

- A. Corrugated steel shall be fabricated in accordance with ASTM Specification A 760 and AASHTO Designation M 36. Pipe shall be formed from galvanized steel sheet conforming to ASTM A 525 and AASHTO Designation M 218.
- B. Corrugated steel pipe shall be annular riveted (with a profile of 2-2/3 x 1/2 inches unless otherwise directed) or helically corrugated welded seam. If helically corrugated welded seam pipe is used, re-rolled ends (four corrugation) will be required to mate with 24 inch wide annular corrugated bands.
- C. Corrugated steel pipe shall be fully galvanized.
- D. Corrugated steel pipe shall be fully bituminous shop coated inside and out according to AASHTO Designation M 190-Type A.
- E. Any damage to the bituminous coating will be repaired by patching before the surface is backfilled or grouted.
- F. Bituminous paved inverts, where specified on the plan or specifications, shall conform to AASHTO Designation M 190-Type C. They shall cover 25% of the bottom of culvert periphery for circular pipes and 40% of the bottom culvert periphery for pipe arches. Bituminous paved inverts shall be shop applied.

**III. COUPLING BANDS FOR CORRUGATED STEEL PIPE**

- A. Coupling bands shall be one or two piece annular corrugated, made from galvanized steel and fully bituminous coated, with a minimum width of 24 inches. Bands may be one gage lighter than the pipe gage. Bands shall be made of steel sheets conforming to ASTM Specification A 525 and AASHTO Designation M 218. Dimple band couplers shall not be used.

- B. Coupling bands shall be fastened using a minimum of three 1/2 inch diameter galvanized bolts. Culverts 48 inch diameter and larger to use 24 inch wide bands with a minimum of four 1/2 inch diameter rods and "silo" type lugs.

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SECTION 4.02

(REVISED 1/17/91)

**ALUMINIZED STEEL PIPE - TYPE 2**

**I. SCOPE**

This work shall consist of installation of aluminized corrugated steel pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified herein, and/or as directed by

the Engineer. This specification shall be governed by AREMA Chapter 1, part 4, section 4.3.

**II. MATERIAL**

- A. Aluminized steel pipe material shall be formed from aluminized sheets conforming to ASTM Specification A 819 and AASHTO Designation M 274 and manufactured according to AASHTO Designation M 36. No other coating is required.
- B. Corrugated steel pipe shall be annular riveted (with a profile of 2-2/3 x 1/2 inch unless otherwise directed) or helically corrugated welded seam. If helically corrugated welded seam pipe is used, re-rolled ends (four corrugations) will be required to mate with 24 inch wide annular corrugated bands.

**III. COUPLING BANDS FOR ALUMINIZED CORRUGATED STEEL PIPE**

- A. Coupling bands shall be one or two piece annular corrugated, made from aluminized steel, with a minimum width of 24 inches. Bands may be one gage lighter than the pipe gage. Bands shall be made of sheets conforming to ASTM Specification A 819 and AASHTO Designation M 274. Dimple bands couplers shall not be used.
- B. Coupling bands shall be fastened using a minimum of three 1/2 inch diameter galvanized bolts. Culverts 48 inch diameter and larger to use 24 inch wide bands with a minimum of four 1/2 inch diameter rods and "silo" type lugs.

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SECTION 4.03

(REVISED 1/17/91)

**CORRUGATED STEEL PIPE  
(Protected Polymeric Galvanized Steel)**

**I. SCOPE**

This work shall consist of installation of plastic coated galvanized steel pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified herein, and/or as directed by the Engineer. This specification shall be governed by AREMA Chapter 1, part 4, section 4.4.

**II. MATERIAL**

- A. Protected polymeric (plastic coated) corrugated galvanized steel pipe shall conform to AASHTO Designation M 246 Type C 10/10 (this indicates 10 mils of PVC plastic on the inside and 10 mils of PVC plastic on the outside of the pipe) and ASTM Specification A 742.
- B. The pipe shall be formed from galvanized steel sheet in compliance with ASTM Specifications A 525 and AASHTO Designation M 218.
- C. The pipe shall be manufactured in accordance with AASHTO Designation M 245 and ASTM Specification A 762. Corrugated plastic coated steel shall be annular riveted (with a profile of 2-2/3 x 1/2 inch unless otherwise directed).

**III. COUPLING BANDS FOR PLASTIC COATED CORRUGATED STEEL PIPE**

- A. Coupling bands shall be one or two piece annular corrugated, made from plastic coated steel, with a minimum width of 24 inches. Bands may be one gage lighter than the pipe gage. Bands shall be made of sheets conforming to AASHTO Designation M 246 Type C 10/10. Dimple bands couplers shall not be used.

- B. Coupling bands shall be fastened using a minimum of three 1/2 inch diameter galvanized bolts. Culverts 48 inch diameter and larger to use 24 inch wide bands with a minimum of four 1/2 inch diameter rods and "silo" type lugs.

**CORRUGATED STEEL PIPE**  
**(Fiber Bonded Galvanized Steel)**

**I. SCOPE**

This work shall consist of installation of Fiber Bonded galvanized corrugated steel pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified herein, and/or as directed by the Engineer. This specification shall be governed by AREMA Chapter 1, part 4, section 4.3.

**II. MATERIAL**

- A. Fiber Bonded galvanized corrugated steel pipe shall be fabricated in accordance with ASTM Specification A 760 and AASHTO Designation M 36. Pipe shall be formed from plate steel conforming to ASTM Specification A 525 and galvanized steel with Aramid fiber mats pressed into molten zinc coating conforming to ASTM Specification A 885.
- B. Corrugated steel pipe shall be annular riveted (with a profile of 2-2/3 x 1/2 inches unless otherwise directed) or helically corrugated welded seam. If helically corrugated welded seam pipe is used, re-rolled ends (four corrugation) will be required to mate with 24 inch wide annular corrugated bands.
- C. Corrugated steel pipe shall be fully galvanized.
- D. Corrugated steel pipe shall be fully bituminous shop coated inside and out according to AASHTO Designation M 190-Type A.
- E. Any damage to the bituminous coating will be repaired by patching before the surface is backfilled or grouted.
- F. Bituminous paved inverts, where specified on the plan or specifications, shall conform to AASHTO Designation M 190-Type C. They shall cover 25% of the bottom of culvert periphery for circular pipes and 40% of the bottom

culvert periphery for pipe arches. Bituminous paved inverts shall be shop applied.

**III. COUPLING BANDS FOR CORRUGATED STEEL PIPE**

- A. Coupling bands shall be one or two piece annular corrugated, fully bituminous coated, with a minimum width of 24 inches. Bands may be one gage lighter than the pipe gage. Bands shall be made of steel sheets conforming to ASTM Specification A 885. Dimple band couplers shall not be used.
- B. Coupling bands shall be fastened using a minimum of three 1/2 inch diameter galvanized bolts. Culverts 48 inch diameter and larger to use 24 inch wide bands with a minimum of four 1/2 inch diameter rods and "silo" type lugs.

SECTION 5.01

**SMOOTH STEEL PIPE**  
**(Uncoated)**  
**(REVISED 1/17/91)**

**I. SCOPE**

This work shall consist of installation of smooth steel pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified herein, and/or as directed by the Engineer. This specification shall be governed by AREMA chapter 1, part 5, section 5.2.

**II. MATERIAL**

Steel pipe shall conform to ASTM Specifications A 139 Grade B (No Hydro). The minimum yield strength of this pipe shall be 35,000 p.s.i.. The minimum wall thickness is as follows:

<u>Nominal Size</u> (Inches)	<u>Recommended Wall Thickness</u> (Inches)
24	0.500
30	0.500
36	0.500
42	0.625
48	0.625
54	0.750
60	0.875
66	0.875
72	1.000

**III. METHOD OF JOINING PIPES**

Sections of pipe shall be field welded with a full depth, Single "V" groove (Butt joint) weld.

SECTION 6.01

**STRUCTURAL PLATE PIPE**  
**(Bituminous Coated Galvanized Steel)**

**I. SCOPE**

This work shall consist of installation of structural plate pipe, de-watering, etc., required for the completion of the project in accordance with the drawings, as specified, and/or as directed by the Engineer. This specification shall be governed by AREMA Chapter 1, part 4, section 4.6.

**II. MATERIAL**

Structural Plate Pipe material (available only in galvanized steel) shall conform to ASTM Specifications A 761 and AASHTO Designation M 167. The galvanized pipe shall be bituminous coated according to AASHTO Designation M 190.

**III. HARDWARE**

Bolts and nuts shall be of the diameter and length as recommended by the manufacturer. Galvanized bolts and nuts are required with galvanized plate and they shall conform to ASTM Specification A 153 and AASHTO Designation M 232.

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SECTION 7.01

**TUNNEL LINER PLATE PIPE**

**I. SCOPE**

This work shall consist of excavation, de-watering, furnishing, and placing galvanized cold-formed steel tunnel liner plates to form a continuous steel support system. All plates shall be bituminous coated and paved in accordance with the drawings, as specified herein, and/or as directed by the Engineer. This specification shall be governed by AREMA Chapter 1, part 4, section 4.16.

**II. MATERIAL**

Liner plate shall be fabricated from structural quality, hot rolled, new carbon-steel sheets or plates conforming to ASTM Specification A 569. The maximum width of liner plate shall be 18 inches. The plate shall be hot-dip galvanized in accordance with ASTM Specification A 123 and AASHTO Designation M 167 but shall not be applied at a rate less than two (2) ounces of "Prime Western" zinc per square foot total of both sides.

Minimum uncoated thickness of the plate shall be shown on the drawing, or as directed by the Engineer.

All plates shall be punched for bolting on both longitudinal and circumferential seams and shall be so fabricated as to permit complete erection from the inside of the tunnel. Two inch diameter grout holes will be provided by using standard pipe half couplings welded into the center corrugation with threaded cast iron plugs. Holes shall be provided in every third ring of liner plate (a minimum of three grout holes per ring required unless otherwise directed by the Engineer) to permit grouting as the erection of tunnel liner plate progresses.

Bolts and nuts shall be 5/8 inch diameter and length as recommended by the manufacturer of the liner plate and be manufactured domestically. The bolts shall conform to ASTM Specification A 449 for plate thicknesses equal to or greater than 0.209 inches and A 307 for plate thicknesses less than 0.209 inches. All nuts and bolts shall be galvanized in accordance with ASTM Specification A 153.

**III. BITUMINOUS COATING**

The plates shall be bituminous coated and conform to AASHTO Designation M 190.

**IV. PAVED INVERTS**

Concrete or Asphalt paved inverts shall be used in all tunnel liner plate structures. If concrete is used, a minimum concrete compressive strength shall be 3000 p.s.i. after 28 days. The bottom 25% of culvert periphery shall be covered with concrete (or asphalt) to a depth of 1 inch above the crest of the flanges for circular pipes and 40% of the periphery for arches. The concrete pavement shall be reinforced with 6 x 6 (W2.9 x W2.9) welded wire fabric. This wire shall be attached to the pipe by either direct welding to the pipe or by mechanical attachment to the bolts.

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