

**Subsection 5.01
Storm Sewer Pipe**

I. Scope: This item includes the construction of storm sewer lines as shown on the plans and itemized in the project proposal. The minimum acceptable storm sewer pipe size shall be 18 inch diameter.

II. Materials

A. General: The Contractor will furnish any and all materials, including, but not confined to, pipe, jointing materials, and any and all other materials, labor, equipment, and supplies for the completion of this project in accordance with the plans and specifications.

B. Reinforced Concrete Pipe: All reinforced concrete storm sewer pipe shall be Class III unless otherwise specified. Supplier must be on TxDOT’s Material Producer List for reinforced concrete pipe and. All concrete pipe shall be with tongue and groove or bell and spigot joints manufactured in compliance with ASTM C 76, "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe." All pipe shall be machine made by a process which will provide for uniform placement of the concrete in the form and compaction by mechanical devices which will assure a dense concrete. Class III D-load equivalent is shown in Table 1.

**Table 1
Circular Pipe
ASTM C76 & ASTM C655**

Class	D-Load
III	1350

Steel areas may be interpolated between those shown for variations in diameter. Elliptical steel in circular pipe over 60 inches in diameter must be held in place by means of holding rods or chairs or other positive means throughout the entire length of the pipe and throughout the entire casting operation and remain in place until the concrete has taken its initial set.

1. Rubber Gasket Joint Storm Sewer Pipe

General: Pipe shall be reinforced concrete pipe with rubber gasket type joints and a corrosive resistant protective barrier. Recognized methods shall be used in the manufacture of the pipe to the end that a high quality product will be provided.

2. Quality Control Testing: To insure that an acceptable quality product is being produced, quality control testing will be accomplished by an independent testing laboratory and by the pipe manufacturer witnessed by an independent testing laboratory as specified herein. The testing laboratory shall be approved by the Engineer and paid by the Contractor.

The strength requirements shall be tested by performing three edge bearing tests or sand bearing tests on the pipe and by determining compressive strengths of cores taken from the pipe. The strength test requirements in pounds per lineal foot of pipe under the three edge bearing test shall be the D-load to the condition specified for the class and wall condition specified herein and in accordance with ASTM C 76. Test loads for sand bearing tests shall be one-half times those specified for the three edge bearing test. A joint of pipe shall be tested for every 300 pieces of pipe manufactured. The tests shall be performed by the pipe manufacturer and witnessed by an independent laboratory. At least two cores shall be taken from each piece of pipe tested by the three edge bearing test. These cores shall be used to determine steel placement, absorption and compressive strength. The cores shall be taken from the top of the pipe or at the spring line of the pipe. Steel placement shall be checked in both cores. Then one core shall be used to check the absorption of the concrete, in accordance with ASTM C 76 and the other core shall be broken to test the compressive strength of the concrete from the pipe. In addition to cores taken from three edge bearing test joints, cores to check steel placement will be taken from one joint out of each 100 joints of pipe manufactured. Any core taken from a joint of pipe in this manner shall also be checked for compressive strength. When the cores meet all requirements, the core-holes shall be plugged and sealed in accordance with ASTM C 76-90.

The performance of the rubber gasket joints shall be tested by means of hydrostatic pressure tests. The tests shall be performed, once for each 300 pieces of pipe manufactured, in accordance with ASTM C 443 in both the straight position and deflected position. The two sections of pipe shall be subjected to an internal hydrostatic pressure of 10 psi for 10 minutes and checked for leakage. If the joint passes the straight alignment test, it shall then be placed in the deflected position and tested again as before.

The pipe manufacturer shall furnish all equipment, material and personnel required for performing the 3 edge bearing test, for securing the pipe cores and for performing the hydrostatic pressure tests. The breaking of concrete cores, the checking of steel placement, the absorption tests, the selection of specimens to be tested and the witnessing of all tests shall be done by an independent testing laboratory at no cost to the City. The pipe manufacturer shall assist the laboratory in securing samples for all tests required.

Pipe shall be Reinforced Concrete Storm Sewer Pipe conforming to ASTM C 76. The aggregate used shall be sized, graded, proportioned and mixed in batch mixers with such proportions of cement and water as will produce a homogenous concrete mixture of such quality that the pipe will conform to the test and design requirements of these specifications. All pipe shall be manufactured with Type II Cement.

A wet-cast construction method may be used for pipe manufactured with liner plate. Pipe with liner plate may be Wall "C" if so requested by the pipe manufacturer. The pipe shall be cured by the Steam Curing Method or a combination of the Steam Curing Method and the Water Curing Method or a combination of the Steam Curing Method but in any case the pipe shall receive a minimum of 12 continuous hours of steam curing before water curing is used. Pipe shall be cured through the steam period with the end rings in place. Pipe shall be manufactured without lift holes.

The pipe joints may be either tongue and groove or bell and spigot. The bell shall be the improved bell type. Bell and spigot ends of the pipe shall be designed to receive the rubber gasket as specified. The tongue end of the pipe shall be notched or indented to receive the rubber gasket so that when the joint has been fully closed, concrete to concrete contact results in some point in the joint periphery. The deformation of the gasket adjacent to the point of contact shall not exceed 50% of the uncompressed stretched diameter of the gasket. At the diametrically opposite side, the gasket deformation shall not be less than 15% of the uncompressed stretched diameter of the gasket. All surfaces of the joint upon or against which the gasket may bear shall be smooth, free of spalls, cracks, or fractures, or imperfections that would adversely affect the performance of this joint.

Steel requirements shall be in accordance with ASTM C 76. Circular or elliptical steel may be used except that if elliptical steel is used, each end of the pipe shall contain circumferential reinforcement equal in area to that of a single line within the barrel of the pipe. In addition, if elliptical steel is used, care shall be taken to prevent the pipe from becoming "egg-shaped." Pipe manufactured with elliptical reinforcement shall be marked "Top" for proper laying.

The internal diameter of the pipe shall not vary more than $\pm 1\%$. The diameter of the interior surface of the bell or groove shall not vary more than $\pm 1/16$ inch; the exterior diameter of the spigot or tongue shall not vary more than $+ 1/16$ inch or $- 3/16$ inch. In no case shall the tolerances be more than that allowed by the rubber gasket furnished. The intent is to have a uniform compression of the rubber gasket around the periphery of the pipe to insure a water-tight joint. The taper on the conic surface on the inside of the bell or groove and the outer surface of the spigot or tongue shall not be more than 3.5 degrees measured from a longitudinal trace on the inside surface of the pipe.

The pipe manufacturer shall furnish and make available to the Engineer the necessary apparatus to check that the pipe manufactured is within the tolerances allowed by these specifications. This apparatus shall consist of the necessary gauges and truing rings, approved by the Engineer, required to check any dimension upon which an allowable tolerance is established.

The minimum laying length of each standard joint shall be 7 feet 6 inches except for bends, radius pipe or special joints at structures. The maximum laying length of the joint of pipe immediately before and after a manhole structure shall be 4 feet 0 inches.

Shop drawings of special pipe joints, such as bends or tapers for radius pipe shall be submitted to the Engineer for approval before the special is manufactured.

The Engineer may at any time refuse to accept pipe made when the plant is failing to follow the ASTM Designation C 76-90, or of these specifications in regard to workmanship, or failing to comply to such things as strength, position or reinforcing steel, curing, absorption, allowable tolerances, etc. The Engineer may reject the pipe if adequate means and methods are not proved to insure the manufacture of a product of uniform high quality.

All rubber-type gaskets shall be molded and cured in such a manner that any cross-section will be dense, homogeneous, and free of porosity, blisters, pitting and other imperfections. The rubber gasket shall be fabricated from a high-grade rubber-like compound and shall meet all the requirements of ASTM C 443. The rubber gasket shall be the sole element depended upon to make the joint flexible and water-tight.

The gasket shall be of the "O" ring type, circular in cross section, or approved equal. The gasket shall be designed to fit into a notch or indentation in the tongue or spigot of the pipe.

The rubber gasket shall be an integral part of the joint design and all dimensions and variations of both the rubber gasket and the concrete surfaces shall not exceed the tolerances specified in ASTM C 443 or herein when acting as a unit.

3. Preformed Plastic Gasket Joint Storm Sewer Pipe

All joints will be made with "Ram-Nek" jointing material or approved equal. Jointing material shall be continuous at joint and joint material should be visible when joints are compressed.

C. Reinforced Concrete D-Load Pipe: Precast reinforced concrete D-load storm sewer pipe shall be designed for a 0.01" crack and conform to ASTM C 76 and C 655.

The allowable trench width shall not be exceeded.

The pipe shall have minimum cover from pavement surface to outside edge of pipe in accordance with the details.

D. Galvanized Corrugated Metal Pipe: This specification applies to pipe and pipe-arch equivalents from 18 inch through 36 inch diameters in thicknesses 0.052 to 0.168 inch inclusive. Furnish corrugated metal pipe in accordance with Table 2.

**Table 2
Specifications for Corrugated Metal Pipe**

Pipe Type	AASHTO Specification
Galvanized Steel and Aluminum Steel	M 36
Aluminized Type 2	M 36
Polymer Coated	M 36 & M 245
Asphalt Coated	M 36
Aluminum	M 196

The pipe type and corresponding AASHTO designations are shown in Table 3.

**Table 3
Corrugated Metal Pipe Types**

Pipe Type	AASHTO Classification
Circular	Type I
Circular, smooth lined	Type IA
Circular, spiral rib	Type IR
Arch	Type II
Arch, Smooth lined	Type IIA
Arch, spiral rib	Type IIR

- 1. Sheets:** The pipe shall be made from zinc coated iron or steel sheets which shall conform to ASTM A 929 and/or AASHTO M 218.
- 2. Sheet Manufacturer's Guarantee:** The manufacturer of the sheets shall submit a guarantee providing that all metal furnished shall conform to the specification requirements, shall bear a suitable identification brand or mark, and shall be replaced without cost to the purchaser when not in conformity with the specified analysis, gauge, or spelter coating; and the guarantee shall be so worded as to remain in effect so long as the manufacturer continues to furnish material.
- 3. Rivets:** All rivets shall conform to ASTM A 31 Grade A and shall be zinc coated.
- 4. Bolts and Nuts**

 - a)** For bolted pipe seams, bolts shall conform to ASTM A 449 and nuts shall conform to ASTM A 563 Grade C.
 - b)** For connecting bands and miscellaneous fasteners, bolts and nuts shall conform to ASTM A 307 Grade A.
 - c)** Bolts and nuts shall be zinc coated.
- 5. Fabrication**

Corrugations: Pipe and pipe-arch shall be fabricated with annular corrugations in riveted, bolted or resistance spot welded lap construction or fabricated with helical corrugations and a continuous lock or welded seam.

 - a)** The corrugations shall form smooth continuous curves and tangents. The radius of curvature of any corrugation profile shall be at least one-half the depth of the corrugation. The corrugations shall be either annular or helical. The direction of the crests and valleys of the helical corrugations shall be not less than 50° from the longitudinal axis of the pipe.
 - b)** The average inside diameter of circular pipe and pipe-arch equivalents shall not vary more than 2% or 1 inch, whichever is greater, from the nominal diameter when measured on the inside crest of the corrugations. See Tables 4 and 5.

Table 4
Steel Pipe Arch
2-2/3 x 1/2 inch Corrugations

Design Size	Span Inches	Rise Inches	Minimum Cover Inches	Minimum Gauge Required	Coated Thickness Inches	Equivalent Circle Pipe Inches
2	21	15	12	16	0.064	18
2A	23	19	12	16	0.064	21
3	28	20	12	16	0.064	24
4	35	24	12	16	0.064	30
5	42	29	12	14	0.079	36
6	49	33	12	14	0.079	42
7	57	38	12	12	0.109	48
8	64	43	12	12	0.109	54
9	71	47	12	10	0.138	60

Table 5
Aluminum Pipe Arch
2-2/3 x 1/2 inch Corrugations

Design Size	Span Inches	Rise Inches	Minimum Cover Inches	Minimum Gauge Required	Coated Thickness Inches	Equivalent Circle Pipe Inches
2	21	15	12	16	0.060	18
2A	23	19	12	16	0.060	21
3	28	20	12	14	0.075	24
4	35	24	12	14	0.075	30
5	42	29	18	12	0.105	36
6	49	33	18	12	0.105	42
7	57	38	18	10	0.135	48
8	64	43	18	10	0.135	54
9	71	47	18	8	0.164	60

6. Lock or Continuous Welded Seams: Lock seams or continuous welded seams shall be so constructed as not to form an element of weakness.

7. Resistance Spot Welded Seams:

a) Resistance spot welds may be placed in valleys or crests or on tangents of corrugations. Longitudinal seams shall be welded with one spot in each corrugation except the longitudinal seams of all pipe 42 inches or more in diameter and all sizes of pipe having 1 inch deep corrugations which shall be welded with two spots in each corrugation. Circumferential shop welded seams shall have a maximum spot spacing of 6 inches except that 6 spots will be sufficient in 12 inch pipe.

b) The near edge of each spot weld shall be at least 1/16 inch from the edges of the metal sheets.

c) The welding shall be performed in such a manner that 1, the exterior surfaces of 90% or more of the spot welds on a length of pipe shall show no evidence of melting or burning of the base metal; and 2, base metal shall not be exposed when the area adjacent to the electrode contact surface area is wire brushed. Discoloration of the spot weld surfaces will not be cause for rejection.

d) Welding machines shall be qualified by a tension shear test for each combination of sheet thickness (gauge) or machine adjustment. Each test shall consist of two tension specimens.

e) Each specimen shall be prepared by lapping two 1-1/2 inch minimum wide x 5 inch long strips of corrugated culvert sheet representative of the material to be welded in production and joining them together with a single spot weld. The lap width and spot weld size shall be that which will be used in production. The longer axis of the specimen shall be parallel to the direction of rolling. Each specimen shall be welded after the resistance spot welding machine has been properly adjusted for the sheet thickness (gauge) and brand.

8. Couplers: Field joints of corrugated steel pipe and pipe arch shall preserve the pipe alignment and prevent infiltration of the backfill. Couplers shall be made of the same zinc coated base metal as the pipe. Unless otherwise specified they shall be of 0.064 inch thickness, but in no case shall they be less than 0.052 inches or more than 0.109 inches in thickness. Coupling band requirements shall meet manufacturer's recommendations.

9. Workmanship and Finish: The completed pipe shall show careful, finished workmanship. Pipe on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship, shall be rejected. The following defects are specified as constituting poor workmanship and the presence of any or all of them in any individual pipe shall constitute sufficient cause for rejection.

- a) Uneven laps
- b) Variation from shape
- c) Variation from a straight center line
- d) Ragged or diagonal sheared edges
- e) Loose, unevenly lined or spaced rivets, bolts, spot welds
- f) Poorly formed rivet heads or lock seams
- g) Illegible brand
- h) Bruised, scaled, or broken spelter coating
- i) Dents or bends

10. Repair of Damaged Spelter Coating: Units on which the spelter coating has been burned by flame cutting and gas or arc welding, or otherwise damaged in fabrication, shall be wire brushed and painted with 2 coats of a zinc dust zinc oxide paint conforming to Federal Specification TT-P-641.

11. Inspection: The pipe fabricator shall furnish a certificate stating compliance with this specification as required for each project, showing the quantities of fabricated material.

E. Cast-in-Place Non-Reinforced Concrete Pipe:

1. Concrete: The concrete shall be of such proportions of Portland cement, mineral aggregate, and water that the 28 day compressive strength of the concrete shall be 3,500 psi or greater. An air-entraining agent will be used to obtain 2% and 5% air, by volume, of the concrete. Other mineral admixtures such as fly ash, or blends may not be used. Proportioning shall be accurate batch weighing of cement, aggregate, and water. The slump, determined for each 25 cubic yards of concrete, or days pour and made in accordance with ASTM C 143, shall not exceed 3 inches for pipe sizes less than 48 inches and shall not exceed 2 inches for pipe sizes 48 inches and over. The concrete shall be furnished in accordance with the provisions of ready-mixed concrete ASTM C 94 except for the specific requirements of these specifications. The maximum aggregate size shall be not more than 1/3 of the minimum pipe wall thickness. The quality control will be performed by an independent laboratory at the Contractor's expense.

a) Cement: The cement used for concrete and mortar shall conform to ASTM C 150, C 175, or C 203.

b) Aggregates: The aggregates used for concrete or mortar shall be properly graded. The aggregate shall conform to ASTM C 33. The maximum aggregate size shall not be more than 1/3 of the minimum pipe wall thickness.

c) Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

d) Bonding Mortar: Bonding mortar shall consist of not less than 2 parts of cement to 3 parts of sand by volume.

2. Expansion Joint Material: Preformed fiber expansion joint material shall be of the dimensions shown on the plans. At the Contractor's option, the material shall be the types in the appropriate specification unless specifically noted otherwise on the plans.

F. High Density Polyethylene (HDPE) Corrugated and Smooth Lined Pipe & Fittings:

HDPE pipe shall be manufactured in accordance with requirements of ASTM F 2736 and AASHTO M330 for pipe sizes 18 inches through 30 inches. HDPS pipe sizes 36 inches through 60 inches shall be manufactured in accordance with F 2881 and AASHTO M330, latest edition. HDPE pipe shall be HP Storm Sewer Pipe or equivalent.

All HDPE Corrugated and Smooth Lined Pipe shall be certified through the AASHTO National Transportation Product Evaluation Program (NTPEP) 3rd Party Certification program.

III. EQUIPMENT

A. Pipe Making Equipment: The pipe shall be constructed with equipment specially designed for constructing cast-in-place concrete pipe. The equipment shall be acceptable to the Engineer and the Contractor shall be required to furnish evidence of successful operation in other work of the equipment he proposes to use.

B. The Contractor will supply sufficient equipment to excavate, lay and backfill the pipe in a safe and professional manner.

IV. CONSTRUCTION METHODS

A. Pipe Other Than Cast-in-Place Pipe

1. Excavation: Should rock be encountered during excavation, it shall be excavated to such a depth that no portion of the barrel of the pipe shall be closer than 3 inches to the rock. Blasting will not be permitted. The space made by the removal of the rock under the pipe shall be replaced by select earth except when under paving; then sand is to be used, and shall be thoroughly tamped in place to grade before the pipe is laid. The tamping shall be to the satisfaction of the Engineer.

2. Pipe Laying: The pipe shall be laid with groove or bell end facing the direction of laying and the tongue or spigot end as the discharge end. Laying shall commence at the discharge end of the line and precede upgrade. No pipe shall be laid in water or on soil that has been covered with water. If wet soil is encountered, the wet soil shall be removed and replaced with dry soil or sand thoroughly compacted to grade. The Contractor shall excavate trenches for the pipe and the pits for the manholes to proposed line and grade. Only excavation that is required for proper installation shall be done. Excavation which may be made below grade shall be brought up to grade with approved material and properly compacted. The Contractor shall keep the property owners and the general public from being inconvenienced. All street crossings, sidewalks, and entrances to public and private property shall be maintained. Should pipe excavation cross drainage paths, ditches and other conveyances so as to cause ponding in front of or along any property, the Contractor shall drain such locations immediately and prevent further ponding

Each pipe joint and each fitting shall have full bearing on the entire length of its barrel. The Contractor shall check each pipe joint and each fitting before placing. Any pipe or fitting found defective shall be removed from the site. Any faulty pipe shall be removed and replaced by the Contractor. The trench for precast concrete pipe shall be excavated to proper grade and alignment. Should the excavation be made below grade, all fills made to attain grade shall be in well compacted layers not over 4 inches.

3. Trench Widths: Trench width shall be in accordance with ASTM D2321 and shall be sufficient to ensure working room too properly and safely place and compact haunching and other backfill materials. Minimum trench width shall not be less than 1.25 times the pipe outside diameter plus 12 inches. On multiple pipe barrel runs the clear distance between pipes shall be 0.50 times the pipe diameter. The sides of the trenches shall be vertical and, should unstable soil be encountered, shall be braced for the safety. The floor of the trench will be excavated and graded so that the barrel of the pipe will have a continuous bearing throughout its length.

4. Pipe Bedding: The pipe shall be carefully placed on a granular foundation according to the following table. The maximum PI of material shall be 12. The bedding shall be shaped to the pipe's lower part to a depth of at least 1/6 of the pipe outside diameter. The remainder of the pipe shall be backfilled to at least 6 inches above its top by natural materials, placed and tamped to completely fill all spaces adjacent to the pipe. Bedding depth is shown in Table 6.

**Table 6
Bedding Depth**

Pipe Diameter	Bedding Depth
27" & smaller	3"
30" to 66"	4"
Over 66"	6"

5. Alignment and Grade: All pipe fittings shall be laid and maintained in proper alignment. Where necessary to deflect alignment from a straight line, the degree of deflection shall first be approved by the Project Representative. Y's or T's shall be placed as shown on the plans. They shall be placed in a concrete cradle as shown on the plans. Concrete cradles shall be included in the bid item for the respective T or Y. Maintain the clear distances between outer surfaces of adjacent pipes given in Table 7

**Table 7
Minimum Clear Distances Between Pipes**

Full Circle Pipe Inches	Arch Design Pipe	Metal Pipe	Arch Design Pipe	Concrete Pipe
18	2	1 foot 2 inches	1	9 inches
24	3	1 foot 3 inches	3	11 inches
30	4	1 foot 8 inches	4	1 foot 1 inch
36	5	1 foot 11 inches	5	1 foot 3 inches
42	6	2 foot 2 inches	6	1 foot 5 inches
48	7	2 foot 5 inches	7	1 foot 7 inches
54	8	2 foot 10 inches	8	1 foot 11 inches

6. Jointing of Pipes: All joints will be made with flexible jointing material or rubber gasket as specified.

Joints using cold applied preformed plastic gasket sealer shall be made as follows: A suitable primer recommended by the gasket joint sealer manufacturer shall be brush applied to the tongue and groove joint surfaces and the end surfaces and allowed to dry and harden. No primer shall be applied over mud, sand, dirt, or sharp cement protrusions. The surface to be primed must be cleaned and dry when primer is applied.

Before laying the pipe in the trench, attach the plastic gasket sealer inside the tapered bell. Remove the paper wrapper from the gasket and press it firmly to the clean, dry pipe joint surface.

When the spigot or tongue is correctly aligned with the flare of the bell or groove, pull or push the pipe home with sufficient force and power to cause the evidence of squeeze-out of the gasket material on the inside and outside around the complete pipe joint circumference. Remove any joint material that pushed out into the interior of the pipe that would tend to obstruct the flow. Pipe shall be pulled home in a straight line with all parts of the pipe on line and grade at all times. Backfilling of pipe laid with plastic gasket joints may proceed as soon as the joint has been approved by the Project Representative. Special precautions shall be taken in placing and compacting backfill to avoid damage to the joints.

When the atmospheric temperature is below 60°F., plastic gasket sealer shall either be stored in an area warmed to above 70°F., or artificially warmed to this temperature by placing in a metal container which, in turn, is placed in hot water. Gaskets shall then be applied to pipe joints immediately prior to placing pipe in trench, followed by connection to previously laid pipe.

Before the pipe is lowered into the ditch, each joint shall be free of all foreign matter. The ends of each joint shall be thoroughly cleaned before joint material is applied. After the first joint of pipe is laid in any section, the next joint shall not be laid until the lower half of the joint is in place.

Upon the completion of the jointing, all pipe must be in true alignment and must be smooth throughout its interior walls, at all points along the joints and invert.

Special care must be taken in the backfilling operation so that the joints are not disturbed. Any damage done shall be repaired immediately by the Contractor at his expense.

The connecting of one pipe run intersecting another pipe run shall be done in a workmanlike manner. The joint shall be buttered and completely filled with mortar, the interior surface of each pipe shall be smooth and free of any projection. The end of the pipe shall be temporarily plugged to keep rain, mud, animals, or foreign objects from entering the pipe during the cessation of pipe laying. If cement mortar is used, the mortar shall be a uniform mixture of 1 part of Portland cement to 2 parts of clean, sharp sand with sufficient water added for a putty consistency. The sand shall be approved by the Engineer before being mixed with the cement. Any sand which has been contaminated with dirt or mud will be discarded and removed from the site. No mortar that has attained an initial set shall be used.

HDPE joints shall be installed such that the connection of pipe sections will form a continuous line free from irregularities in the flow line. All installations within City of Amarillo right-of-way shall require watertight joints that meet a 74 kPa (10.8 psi) laboratory test per ASTM D3212 and utilize a bell and spigot design with a gasket meeting ASTM F477.

All joints in all sizes of pipe shall be made in place in the ditch.

B. Cast-in-Place Pipe:

1. Excavation and Subgrade Preparation: The trench shall be excavated to lines and grades as shown on the plans. The bottom of the trench shall be shaped to form the outside form for the pipe and shall be graded and prepared to provide full, firm, and uniform support by undisturbed earth or compacted fill over the bottom 180° of the pipe. If the trench is over-excavated, the excess area shall be filled with concrete. All soils to be in contact with the monolithic section shall contain sufficient moisture so that moisture is not drawn from the freshly poured concrete. Moisture shall be added to the soil as required. The trench at time of pour shall be completely free of water, mud, and debris.

Where rock is encountered in the trench excavation, the trench shall be over-excavated at least 8 inches and filled with concrete.

Where strata or lenses of loose sand, silt, or other noncohesive soils are encountered below the contact line of the concrete pipe and the trench wall, they shall be stabilized by asphaltic emulsions or cement mortar. When soils are soft and spongy, the soil shall be excavated to a depth of 8 inches below the bottom of the pipe. The space to be refilled with graded rock or gravel bedding stabilized by thorough compaction of layers not to exceed 6 inches in thickness. The gravel bedding shall be compacted to at least 90% density of Standard Proctor (ASTM D 698).

In locations where the pipe will be laid on unstable ground, 12 inch x 12 inch concrete grade beam shall be poured in the trench bottom for the pipe laying machine to ride on.

In lieu of specified construction, the Contractor may, at his option, and the Engineer's approval substitute reinforced concrete pipe and stabilized bedding.

Where the pipe is to be constructed through an embankment, such embankment section shall be stable in the trench zone.

2. Setting and Removing Forms: All forms shall be approved by the Engineer prior to the beginning of pour. Forms which, in the opinion of the Engineer, are defective in any way will not be used, and be removed from the project site.

Inside forms shall be removed from the pipe not sooner than 3 hours nor longer than 8 hours after concrete placement. Care shall be taken when removing forms to prevent damage to pipe. The inside of the pipe shall be carefully inspected for imperfections in placement and any required repairs shall be made immediately to provide a uniform interior surface. Visible cracks shall be brushed with cement paste or chipped out and pointed up with cement mortar. Any cracks that appear to go through the shell shall be grooved and filled with mortar. The methods for providing a water-tight pipeline shall be the Contractor's responsibility.

3. Concrete Placement

To leave the excavated trench open for adequate curing of the concrete, the concrete for cast-in-place non-reinforced concrete pipe shall be of such proportions as to provide for a 24 hour compressive strength of 2,500 psi or greater. No admixture, additive or other material may be used except high early strength cement to meet the 2,500 psi requirement.

The maximum aggregate size shall not exceed 1/3 the minimum pipe wall thickness with a maximum of 1- 1/2 inches. All junctions of pipe shall be provided for at the time the cast-in-place pipe is placed.

The Contractor shall have enough approved open ditch for the day's placing before pouring begins. The full circumference of the pipe shall be constructed in one placement. The interior form shall be of 360° construction, and shall support the entire 360° circumference of the pipe. The forms may be stripped within 3 hours after completion of pour or when the initial set has occurred. Stripping shall be performed in such a manner that no equipment or personnel shall enter the pipe or do damage to the concrete.

Grading, proportioning, moving and placement of the concrete shall produce a homogeneous concrete mixture conforming to this specification. The concrete shall be transported in such a manner as to insure delivery and placement in the forms without loss or segregation of ingredients and within 1 hour of the time of mixing. Intervals between loads of a continuous pouring shall not exceed 30 minutes or in any case not so great as to allow the concrete already in place to set up or become partially hardened. Continuous mixing shall occur during transit.

When placement stops, concrete shall be left at a 45° angle. When placement resumes, the concrete joint shall be cleaned and covered with cement slurry or appropriate concrete to concrete binder.

4. Grade and Alignment Tolerance: The trench shall be excavated to lines and grades as shown on the plans. Departure from grade shall not exceed 1 inch per 10 linear feet and a maximum departure shall be limited to 1-1/2 inches. Departure from alignment shall not exceed 2 inches per 10 linear feet and the maximum departure shall be limited to 4 inches.

5. Consolidation: The concrete shall be consolidated over the entire circumference and from within the pipe shell. Consolidation methods shall be capable of building up sufficient pressure to bond the concrete effectively to the surrounding earth and exclude loose sand, mud, and water from the pipe shell. Evidence of this pressure shall always be visible as the pipe is being extruded.

6. Jointing: When placement stops long enough that initial set takes place, a stoppage joint shall be formed. Such joints may be formed by either of the following methods:

On all such joints, after cleaning, wetting, freeing of all laitance, loose or defective concrete, coatings and foreign material, there shall be placed a layer of bonding mortar over the entire surface to a depth of approximately 1/2 inch immediately preceding additional placement.

After squaring off the end of the pipe, an excavation shall be performed along the sides and bottom of the joint of such sizes as to permit the placing of a concrete collar around the outside of the joint. This collar shall have a minimum thickness at the joint of 1.25 times the wall thickness of the pipe and shall lap the joint by at least 2 times the wall thickness. Preparation of the joint surfaces and application of bonding mortar shall conform to requirements specified above.

7. Temperature: The concrete temperature shall not exceed 90°F. Whenever the air temperature at the project site falls below 40°F. for more than 1/2 day, the concrete shall be maintained above 50°F. for at least six 6 days after it is placed. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. If concrete is placed when the concrete temperature would exceed 90°F. the Contractor shall employ effective means, such as precooling of aggregates and mixing water and placing at night, as necessary to maintain the temperature of the concrete, as it is placed below 90°F.

8. Finish: Except for the form offsets, the pipe interior surface shall be better than a wood float finish. All extraneous concrete shall be removed from the pipe interior surface as soon as possible after placing.

9. Repair: As soon as possible after placement and after the inside forms have been removed, rock pockets, honeycombs, cracks, or indentations shall be repaired. No mortar, concrete, or repair material shall be applied to the surface that has not been moistened and properly cleaned.

10. Pipe Dimensions and Tolerances

Diameter: The internal pipe diameter at any point shall be not less than 98% of the design internal diameter.

Thickness: The wall thickness at any point shall not be less than shown on the plans.

Offsets: Offsets at form laps and horizontal edges shall not exceed the thickness of the forms plus 10% of the minimum wall thickness.

11. Test Requirements

Thickness Tests: The thickness of the top and bottom shall be measured by probes, borings, or cores at least every 250 feet, with individual measurements staggered at approximately equal distances along the pipeline, except as otherwise requested by the Engineer.

The wall thickness, as determined by probes, borings, or cores through the concrete, shall be not less than the minimum wall thickness as specified in Table 8:

Table 8
Minimum Wall Thickness of Cast-In-Place
Non-Reinforced Concrete Storm Sewer Pipe

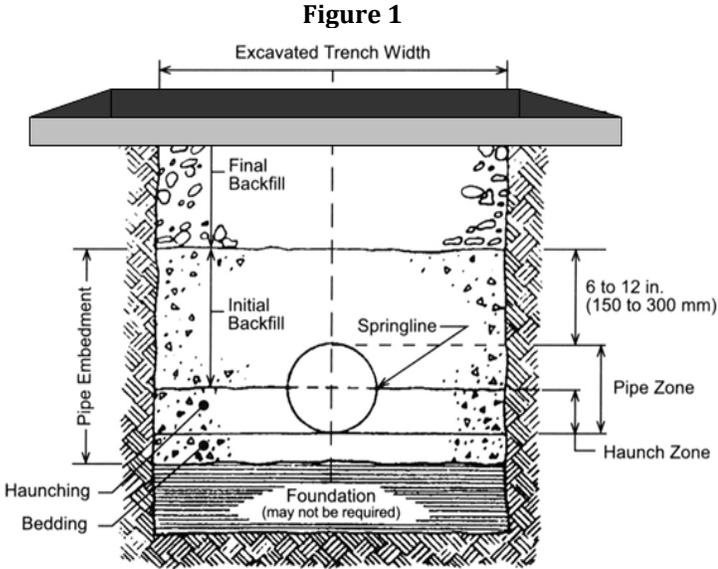
Nominal Internal Diameter Inches	Wall Thickness Minimum Inches
24	3
30	3
36	3½
42	4
48	5
54	5½
60	6
66	6½
72	7
78	7½
84	8
96	9
120	12

12. Load Bearing Tests: Load bearing tests shall be made in accordance with ASTM C 293. Failure of any test shall be cause for the ordering of additional tests.

13. Curing and Backfill: A 3 inch layer of moist initial backfill shall be placed on the top of the pipe as soon as possible after placement without damaging the concrete, and this thickness shall be increased to 6 inches after initial hardening of the concrete has taken place and before removal of inside forms. The initial backfill shall be kept moist until at least 12 inches more of backfill is placed. In lieu of the initial 3 inch layer of moist backfill, the freshly poured concrete may be covered with a sheet of vapor barrier with appropriate thickness. Final backfill shall be made as soon as possible after placement without damage to the pipe. All openings into the pipe shall be kept tightly closed at all times during construction, except when and where work is in progress, to keep air drafts from drying out the concrete and to maintain a humid atmosphere for a period of at least 7 days.

C. Backfilling of Storm Sewer Pipe

1. Backfill (Other Than Under Existing or Proposed Paving in Right-of-Way): As soon as practicable after the completion of the laying and jointing of the pipe, the backfilling of the trench shall begin and at no time shall the completely backfilled trench be more than 500 feet behind the pipe laying. Pipe shall be laid each day up to the ditching machine at quitting time. Backfill material shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench and to an elevation approximately 6 inches above the spring line of the pipe in accordance with Utility Trench Backfilling portion of Subsection 4.01 "Utility Construction in City of Amarillo Right-of-Way and Easements." Backfill material shall be compacted to 90% of Standard Proctor where applicable. Trench details, including foundation, bedding, haunching, initial backfill, final backfill, pipe zone, and trench width are shown in Figure 1.



The Contractor shall exercise extreme care in the backfilling of all trenches and especially those of greater depth. Any pipe that is damaged shall be removed and replaced immediately by the Contractor at his expense.

The backfill shall be compacted by pneumatic tamping in courses of not over 6 inches. If necessary for maximum compaction, water must be added at the Contractor's expense. The fill material must be thoroughly compacted. The Contractor shall maintain all surfaces until the project is finally accepted by the City of Amarillo. The fill material must be sufficiently moistened for maximum compaction, but care must be exercised that excess water is not placed in the ditch. Water jetting may be substituted for pneumatic tamping of the backfill with previous approval by the Engineer.

2. Backfill (Under Existing or Proposed Paving in Right-of Way): The trench excavation under all paving and proposed paving of any nature shall be backfilled to the bottom of the subbase or base, or within 1 foot of the present surface where subbase elevation is not supplied with backfill type shown on the plans of the type shown below.. The trench shall be considered under paving when any of the trench is in the subgrade, subbase, or other portions of the pavement.

Final backfill material shall meet the requirements of ASTM D2321 Class II or Class III material. All initial and final backfill material shall be placed in 6 inch lifts and compacted to a minimum 95% Standard Proctor Density. The contractor shall provide density reports and a Proctor on materials as requested by the City of Amarillo project representative. The descriptions for Class I, II and III material are as shown below:

- (1) Class I - Angular crushed stone or rock, dense or open graded with little or no fines (1/4 inch to 1 1/2 inches in size);
- (2) Class II - Clean, coarse-grained material, such as gravel, coarse sands and gravel/sand mixtures (1 1/2 inches maximum in size); and
- (3) Class III - Coarse grained material with fines including silty or clayey gravels or sands. Gravel or sand must comprise more than 50% of the Class III material (1 1/2 inches maximum size). Class III backfill can not be used for HDPE pipe.
- (4) Flowable backfill can be used for bedding material, as well as final backfill material meeting the requirements of Subsection 4.01 "Utility Construction in City of Amarillo Right-of-Way and Easements." Pipes shall be anchored when backfilling with flowable fill.

D. Minimum Cover for Pipe:

1. For the City of Amarillo and the ETJ areas, all pipe shall be placed a minimum of 24 inches below the bottom of stabilized subgrade in order to reduce the potential for conflicts with other utility systems. Variances from the minimum cover requirement must be submitted in writing to the City Engineer and approved by the City Engineer prior to commencing construction.

2. Extreme care should be taken when heavy construction equipment loads cross the pipe trench during construction. If the passage of construction equipment over an installed pipeline is necessary during construction, compacted fill in the form of a ramp shall be constructed to a minimum elevation of 3.0 feet over the top of the pipe. Any damaged pipe shall be replaced at the contractor's expense.

E. Installation Deflection: At the Engineer's discretion, all pipe exceeding 7.5% deflection (as per AASHTO Section 30) may require replacement or re-compaction at the contractor's expense when measured or inspected not less than 30 days following completion of installation. Deflection is defined per ASTM D 2321.

The Contractor shall provide Video Camera (CCTV) inspection on 100% of flexible pipelines installed. The test shall be conducted at least 30 days after the installation of the pipeline. Mandreling of the pipe may be accepted as a suitable alternative for pipeline inspection and deflection testing, in lieu of CCTV inspection.

F. Pavement Cuts: Repairing pavement cut will be in accordance with Subsection 4.01, "Utility Construction in City of Amarillo Right of Way and Easements."

1. **Protection of Public:** The Contractor shall furnish, place, erect, and maintain adequate barricades, construction signs, guards, and warning devices necessary for the protection of the public and private property. Whenever required, watchmen shall be provided at the Contractor's expense for this protection. When any thoroughfare will be closed to traffic, the Contractor shall notify all ambulance services, the Central Fire Station, and the Traffic Engineering Department of the City of Amarillo at least 24 hours prior to such closing as follows:

A traffic plan shall be submitted to the Traffic Engineer for his approval a minimum of 24 hours prior to the actual closing of the street. This plan shall include the proposed time and date of closure and the estimated time limits the street will be closed during the project. Work should be scheduled, if possible, so that peak-hour traffic, 7 a.m. to 8 a.m. and 5 p.m. to 6 p.m., can utilize the street or area under construction. The Contractor shall include on his plan and provide all necessary barricades, signs, flagmen, and other warning devices to accommodate traffic movements and detours.

Should it be necessary to detour traffic at any point, the Contractor shall erect proper barricades and post definite detour directions at all points to be travelled by those who must detour. If the Contractor uses a dirt street for a detour, he shall keep the dust settled on the detour so that it will not be obnoxious to those living adjacent to or near the detour. No extra remuneration will be paid for dust abatement.

2. Protection of Work: It is the responsibility of the Contractor to protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the product.

The Contractor shall maintain proper crossings, to protect and to repair damaged property, to keep the backfill completed to acceptable limits, and to clean up waste materials and surplus excavation. Failure to do any or all of these things shall be just claim for the City of Amarillo to withhold estimates until such faults shall have been corrected.

Should the Contractor remove or damage any curbs, sidewalks, driveways, shrubbery, plants, trees, fences, sod, or any other private or public property outside of the normal trench width, he shall replace same to condition equal to or better than that before the work began at his own expense, furnishing all labor, materials, supplies, equipment, and any and all things necessary. Replacements within the normal trench width will be paid at the unit prices bid. Repairs and replacement are to be made as soon as practicable, in the opinion of the Engineer.

3. Protection of Workers: The Contractor must comply with Occupational Safety and Health Standards - Excavations (29CFR Part 1926), U.S. Department of Labor and applicable Federal, State, and local rules, regulations, and ordinances. Trench protection shall be in accordance with Subsection 5.05, "Trench Protection." The Contractor shall bear the sole responsibility to provide a safe place to work for the worker.

4. Protection of Public or Private Property: The Contractor shall exercise precautions to protect all property. Contractor is responsible for any and all damage to property either private or public, due to his operations.

Should roots or tree branches be removed or damaged, the damage claims resulting from such work shall be settled by the Contractor satisfactorily to the property owner.

The Contractor shall uncover pipes, tees, elbows, and other conduits or utilities which are close to the proposed pipe.

5. Protection of Utilities: The Contractor shall familiarize himself with all utilities locations by consulting with the utility companies, private owners, and by visiting the site. All utility companies should cooperate in locating their properties. The Contractor shall protect utilities and repair all damage he may do at his expense and to the satisfaction of the affected utility company. Where sanitary sewers laterals or services, telephone, traffic or electrical conduits, poles, cables or poles, gas mains or services, water mains, or any other public utilities are encountered, proper protection shall be provided by means of blocks, supports or by some other means acceptable to the affected company or owner so that such property will remain intact and in service. All damage by the Contractor must be repaired in accordance with the affected utility company. Such repair must be done with the least inconvenience to the affected utility company.

6. Clean Up: The Contractor shall remove all surplus construction materials, equipment, scraps, broken pipe, debris, and rubbish from the site and leave the site in a workmanlike manner. At no time shall complete cleanup be more than 1000 feet behind the laying of the pipe. Dust is to be kept at an absolute minimum by sweeping and/or wetting of fill in the ditch.

V. MEASUREMENT

A. All types of pipes shall be measured in linear feet from the center of each inlet or junction box (when used). For multiple pipes, the measured length shall be the sum of the lengths of the barrels. The pipe shall be accepted by the test results, and by inspection. The pipe shall conform to these specifications as to design and freedom from defects. Any unacceptable portion of the pipe shall be replaced or repaired to meet the specifications at the expense of the Contractor.

VI. PAYMENT

The work performed and all materials furnished as prescribed by this Subsection and measured as provided under "Measurement" shall be paid for at the unit price bid for appropriate type of pipe in the proposal, which price shall be full compensation for excavating, trenching, plugging, placing all materials, backfilling and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION

All joints in all sizes of pipe shall be made in place in the ditch.

1. Cast-in-Place Pipe:

a) Excavation and Subgrade Preparation: The trench shall be excavated to lines and grades as shown on the plans. The bottom of the trench shall be shaped to form the outside form for the pipe and shall be graded and prepared to provide full, firm, and uniform support by undisturbed earth or compacted fill over the bottom 180° of the pipe. If the trench is over-excavated, the excess area shall be filled with concrete. All soils to be in contact with the monolithic section shall contain sufficient moisture so that moisture is not drawn from the freshly poured concrete. Moisture shall be added to the soil as required. The trench at time of pour shall be completely free of water, mud, and debris.

Where rock is encountered in the trench excavation, the trench shall be over-excavated at least 8 inches and filled with concrete.

Where strata or lenses of loose sand, silt, or other noncohesive soils are encountered below the contact line of the concrete pipe and the trench wall, they shall be stabilized by asphaltic emulsions or cement mortar. When soils are soft and spongy, the soil shall be excavated to a depth of 8 inches below the bottom of the pipe. The space to be refilled with graded rock or gravel bedding stabilized by thorough compaction of layers not to exceed 6 inches in thickness. The gravel bedding shall be compacted to at least 90% density of Standard Proctor (ASTM D 698).

In locations where the pipe will be laid on unstable ground, 12 inch x 12 inch concrete grade beam shall be poured in the trench bottom for the pipe laying machine to ride on.

In lieu of specified construction, the Contractor may, at his option, and the Engineer's approval substitute reinforced concrete pipe and stabilized bedding.

Where the pipe is to be constructed through an embankment, such embankment section shall be stable in the trench zone.

B. Setting and Removing Forms: All forms shall be approved by the Engineer prior to the beginning of pour. Forms which, in the opinion of the Engineer, are defective in any way will not be used, and be removed from the project site.

Inside forms shall be removed from the pipe not sooner than 3 hours nor longer than 8 hours after concrete placement. Care shall be taken when removing forms to prevent damage to pipe. The inside of the pipe shall be carefully inspected for imperfections in placement and any required repairs shall be made immediately to provide a uniform interior surface. Visible cracks shall be brushed with cement paste or chipped out and pointed up with cement mortar. Any cracks that appear to go through the shell shall be grooved and filled with mortar. The methods for providing a water-tight pipeline shall be the Contractor's responsibility.

C. Concrete Placement:

To leave the excavated trench open for adequate curing of the concrete, the concrete for cast-in-place non-reinforced concrete pipe shall be of such proportions as to provide for a 24 hour compressive strength of 2,500 psi or greater. No admixture, additive or other material may be used except high early strength cement to meet the 2,500 psi requirement.

The maximum aggregate size shall not exceed 1/3 the minimum pipe wall thickness with a maximum of 1- 1/2 inches. All junctions of pipe shall be provided for at the time the cast-in-place pipe is placed.

The Contractor shall have enough approved open ditch for the day's placing before pouring begins. The full circumference of the pipe shall be constructed in one placement. The interior form shall be of 360° construction, and shall support the entire 360° circumference of the pipe. The forms may be stripped within 3 hours after completion of pour or when the initial set has occurred. Stripping shall be performed in such a manner that no equipment or personnel shall enter the pipe or do damage to the concrete.

Grading, proportioning, moving and placement of the concrete shall produce a homogeneous concrete mixture conforming to this specification. The concrete shall be transported in such a manner as to insure delivery and placement in the forms without loss or segregation of ingredients and within 1 hour of the time of mixing. Intervals between loads of a continuous pouring shall not exceed 30 minutes or in any case not so great as to allow the concrete already in place to set up or become partially hardened. Continuous mixing shall occur during transit.

When placement stops, concrete shall be left at a 45° angle. When placement resumes, the concrete joint shall be cleaned and covered with cement slurry or appropriate concrete to concrete binder.

D. Grade and Alignment Tolerance: The trench shall be excavated to lines and grades as shown on the plans. Departure from grade shall not exceed 1 inch per 10 linear feet and a maximum departure shall be limited to 1-1/2 inches. Departure from alignment shall not exceed 2 inches per 10 linear feet and the maximum departure shall be limited to 4 inches.

E. Consolidation: The concrete shall be consolidated over the entire circumference and from within the pipe shell. Consolidation methods shall be capable of building up sufficient pressure to bond the concrete effectively to the surrounding earth and exclude loose sand, mud, and water from the pipe shell. Evidence of this pressure shall always be visible as the pipe is being extruded.

F. Jointing: When placement stops long enough that initial set takes place, a stoppage joint shall be formed. Such joints may be formed by either of the following methods:

On all such joints, after cleaning, wetting, freeing of all laitance, loose or defective concrete, coatings and foreign material, there shall be placed a layer of bonding mortar over the entire surface to a depth of approximately 1/2 inch immediately preceding additional placement.

After squaring off the end of the pipe, an excavation shall be performed along the sides and bottom of the joint of such sizes as to permit the placing of a concrete collar around the outside of the joint. This collar shall have a minimum thickness at the joint of 1.25 times the wall thickness of the pipe and shall lap the joint by at least 2 times the wall thickness. Preparation of the joint surfaces and application of bonding mortar shall conform to requirements specified above.

G. Temperature: The concrete temperature shall not exceed 90°F. Whenever the air temperature at the project site falls below 40°F. for more than 1/2 day, the concrete shall be maintained above 50°F. for at least six 6 days after it is placed. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. If concrete is placed when the concrete temperature would exceed 90°F. the Contractor shall employ effective means, such as precooling of aggregates and mixing water and placing at night, as necessary to maintain the temperature of the concrete, as it is placed below 90°F.

H. Finish: Except for the form offsets, the pipe interior surface shall be better than a wood float finish. All extraneous concrete shall be removed from the pipe interior surface as soon as possible after placing.

I. Repair: As soon as possible after placement and after the inside forms have been removed, rock pockets, honeycombs, cracks, or indentations shall be repaired. No mortar, concrete, or repair material shall be applied to the surface that has not been moistened and properly cleaned.

J. Protection of Public or Private Property: The Contractor shall exercise precautions to protect all property. Contractor is responsible for any and all damage to property either private or public, due to his operations.

Should roots or tree branches be removed or damaged, the damage claims resulting from such work shall be settled by the Contractor satisfactorily to the property owner.

The Contractor shall uncover pipes, tees, elbows, and other conduits or utilities which are close to the proposed pipe.

K. Protection of Utilities: The Contractor shall familiarize himself with all utilities locations by consulting with the utility companies, private owners, and by visiting the site. All utility companies should cooperate in locating their properties. The Contractor shall protect utilities and repair all damage he may do at his expense and to the satisfaction of the affected utility company. Where sanitary sewers laterals or services, telephone, traffic or electrical conduits, poles, cables or poles, gas mains or services, water mains, or any other public utilities are encountered, proper protection shall be provided by means of blocks, supports or by some other means acceptable to the affected company or owner so that such property will remain intact and in service. All damage by the Contractor must be repaired in accordance with the affected utility company. Such repair must be done with the least inconvenience to the affected utility company.

L. Pipe Dimensions and Tolerances

- 1. Diameter:** The internal pipe diameter at any point shall be not less than 98% of the design internal diameter.
- 2. Thickness:** The wall thickness at any point shall not be less than shown on the plans.
- 3. Offsets:** Offsets at form laps and horizontal edges shall not exceed the thickness of the forms plus 10% of the minimum wall thickness.

M. Test Requirements:

- 1. Thickness Tests:** The thickness of the top and bottom shall be measured by probes, borings, or cores at least every 250 feet, with individual measurements staggered at approximately equal distances along the pipeline, except as otherwise requested by the Engineer.

The wall thickness, as determined by probes, borings, or cores through the concrete, shall be not less than the minimum wall thickness as specified in Table 8:

Table 8
Minimum Wall Thickness of Cast-In-Place
Non-Reinforced Concrete Storm Sewer Pipe

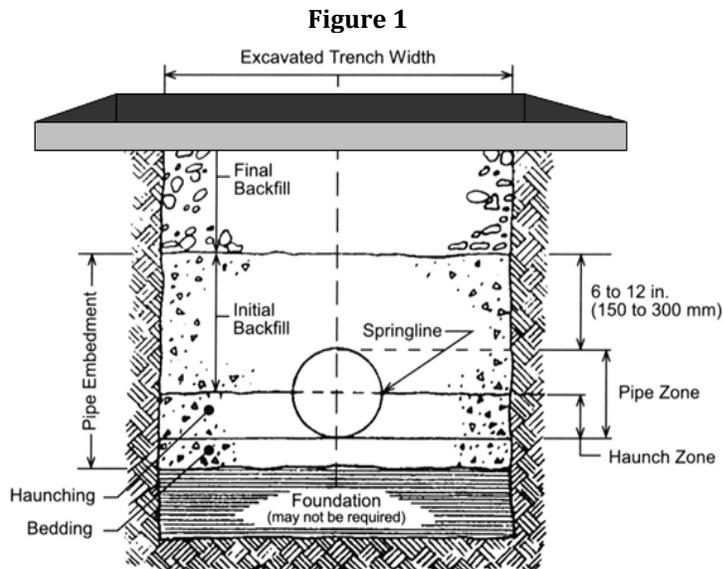
Nominal Internal Diameter Inches	Wall Thickness Minimum Inches
24	3
30	3
36	3½
42	4
48	5
54	5½
60	6
66	6½
72	7
78	7½
84	8
96	9
120	12

N. Load Bearing Tests: Load bearing tests shall be made in accordance with ASTM C 293. Failure of any test shall be cause for the ordering of additional tests.

O. Curing and Backfill: A 3 inch layer of moist initial backfill shall be placed on the top of the pipe as soon as possible after placement without damaging the concrete, and this thickness shall be increased to 6 inches after initial hardening of the concrete has taken place and before removal of inside forms. The initial backfill shall be kept moist until at least 12 inches more of backfill is placed. In lieu of the initial 3 inch layer of moist backfill, the freshly poured concrete may be covered with a sheet of vapor barrier with appropriate thickness. Final backfill shall be made as soon as possible after placement without damage to the pipe. All openings into the pipe shall be kept tightly closed at all times during construction, except when and where work is in progress, to keep air drafts from drying out the concrete and to maintain a humid atmosphere for a period of at least 7 days.

1. Backfilling and Restoration of Surface:

a) Backfill (Other Than Under Existing or Proposed Paving in Right-of-Way): As soon as practicable after the completion of the laying and jointing of the pipe, the backfilling of the trench shall begin and at no time shall the completely backfilled trench be more than 500 feet behind the pipe laying. Pipe shall be laid each day up to the ditching machine at quitting time. Backfill material shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench and to an elevation approximately 6 inches above the spring line of the pipe in accordance with Utility Trench Backfilling portion of Subsection 4.01 "Utility Construction in City of Amarillo Right-of-Way and Easements." Backfill material shall be compacted to 90% of Standard Proctor where applicable. Trench details, including foundation, bedding, haunching, initial backfill, final backfill, pipe zone, and trench width are shown in Figure 1.



The Contractor shall exercise extreme care in the backfilling of all trenches and especially those of greater depth. Any pipe that is damaged shall be removed and replaced immediately by the Contractor at his expense.

The backfill shall be compacted by pneumatic tamping in courses of not over 6 inches. If necessary for maximum compaction, water must be added at the Contractor's expense. The fill material must be thoroughly compacted. The Contractor shall maintain all surfaces until the project is finally accepted by the City of Amarillo. The fill material must be sufficiently moistened for maximum compaction, but care must be exercised that excess water is not placed in the ditch. Water jetting may be substituted for pneumatic tamping of the backfill with previous approval by the Engineer.

b) Backfill (Under Existing or Proposed Paving in Right-of Way):

The trench excavation under all paving and proposed paving of any nature shall be backfilled to the bottom of the subbase or base, or within 1 foot of the present surface where subbase elevation is not supplied with backfill type shown on the plans of the type shown below. The trench shall be considered under paving when any of the trench is in the subgrade, subbase, or other portions of the pavement.

Final backfill material shall meet the requirements of ASTM D2321 Class II or Class III material. All initial and final backfill material shall be placed in 6 inch lifts and compacted to a minimum 95% Standard Proctor Density. The contractor shall provide density reports and a Proctor on materials as requested by the City of Amarillo project representative. The descriptions for Class I, II and III material are as shown below:

- (1) Class I - Angular crushed stone or rock, dense or open graded with little or no fines (1/4 inch to 1 1/2 inches in size);
- (2) Class II - Clean, coarse-grained material, such as gravel, coarse sands and gravel/sand mixtures (1 1/2 inches maximum in size); and
- (3) Class III - Coarse grained material with fines including silty or clayey gravels or sands. Gravel or sand must comprise more than 50% of the Class III material (1 1/2 inches maximum size).
- (4) Flowable backfill can be used for bedding material, as well as final backfill material consisting of cement and sand that places without voids and attains a 28 day strength between 50 and 150 pounds per square inch when tested in accordance ASTM C 39.

P. Minimum Cover for HDPE Pipe:

1. The minimum cover is 18 inches below the bottom of stabilized Subgrade for HS-25 Live Loads (from 18 inch to 42 inch Pipe Diameters) and 24 inches below the bottom of stabilized Subgrade for larger diameter structures (from 48inch to 60 inch pipe diameters).
2. For the City of Amarillo and the ETJ areas, it is recommended that all pipe shall be placed a minimum of 24 inches below the bottom of stabilized subgrade in order to reduce the potential for conflicts with other utility systems. Variances from the minimum cover requirement must be submitted in writing to the City Engineer and approved by the City Engineer prior to commencing construction.
3. Extreme care should be taken when heavy construction equipment loads cross the pipe trench during construction. If the passage of construction equipment over an installed pipeline is necessary during construction, compacted fill in the form of a ramp shall be constructed to a minimum elevation of 3.0 feet over the top of the pipe. Any damaged pipe shall be replaced at the contractor's expense.

Q. Installation Deflection: At the Engineer's discretion, all pipe exceeding 7.5% deflection (as per AASHTO Section 30) may require replacement or re-compaction at the contractor's expense when measured or inspected not less than 30 days following completion of installation. Deflection is defined per ASTM D 2321.

The Contractor shall provide Video Camera (CCTV) inspection on 100% of the HDPE pipelines installed. The test shall be conducted at least 30 days after the installation of the pipeline. Mandreling of the pipe may be accepted as a suitable alternative for pipeline inspection and deflection testing, in lieu of CCTV inspection.

1. **Pavement Cuts:** Repairing pavement cut will be in accordance with Subsection 4.01, "Utility Construction in City of Amarillo Right of Way and Easements."
2. **Protection of Public:** The Contractor shall furnish, place, erect, and maintain adequate barricades, construction signs, guards, and warning devices necessary for the protection of the public and private property. Whenever required, watchmen shall be provided at the Contractor's expense for this protection. When any thoroughfare will be closed to traffic, the Contractor shall notify all ambulance services, the Central Fire Station, and the Traffic Engineering Department of the City of Amarillo at least 24 hours prior to such closing as follows:

A traffic plan shall be submitted to the Traffic Engineer for his approval a minimum of 24 hours prior to the actual closing of the street. This plan shall include the proposed time and date of closure and the estimated time limits the street will be closed during the project. Work should be scheduled, if possible, so that peak-hour traffic, 7 a.m. to 8 a.m. and 5 p.m. to 6 p.m., can utilize the street or area under construction. The Contractor shall include on his plan and provide all necessary barricades, signs, flagmen, and other warning devices to accommodate traffic movements and detours.

Should it be necessary to detour traffic at any point, the Contractor shall erect proper barricades and post definite detour directions at all points to be travelled by those who must detour. If the Contractor uses a dirt street for a detour, he shall keep the dust settled on the detour so that it will not be obnoxious to those living adjacent to or near the detour. No extra remuneration will be paid for dust abatement.

3. Protection of Work: It is the responsibility of the Contractor to protect his work against weather, vandals, and any and all things that may mar the finish, surface, or the appearance of the product.

The Contractor shall maintain proper crossings, to protect and to repair damaged property, to keep the backfill completed to acceptable limits, and to clean up waste materials and surplus excavation. Failure to do any or all of these things shall be just claim for the City of Amarillo to withhold estimates until such faults shall have been corrected.

Should the Contractor remove or damage any curbs, sidewalks, driveways, shrubbery, plants, trees, fences, sod, or any other private or public property outside of the normal trench width, he shall replace same to condition equal to or better than that before the work began at his own expense, furnishing all labor, materials, supplies, equipment, and any and all things necessary. Replacements within the normal trench width will be paid at the unit prices bid. Repairs and replacement are to be made as soon as practicable, in the opinion of the Engineer.

Protection of Workers: The Contractor must comply with Occupational Safety and Health Standards - Excavations (29CFR Part 1926), U.S. Department of Labor and applicable Federal, State, and local rules, regulations, and ordinances. Trench protection shall be in accordance with Subsection 5.05, "Trench Protection." The Contractor shall bear the sole responsibility to provide a safe place to work for the worker.

4. Clean Up: The Contractor shall remove all surplus construction materials, equipment, scraps, broken pipe, debris, and rubbish from the site and leave the site in a workmanlike manner. At no time shall complete cleanup be more than 1000 feet behind the laying of the pipe. Dust is to be kept at an absolute minimum by sweeping and/or wetting of fill in the ditch.

VII. MEASUREMENT

A. All types of pipes shall be measured in linear feet from the center of each inlet or junction box (when used). For multiple pipes, the measured length shall be the sum of the lengths of the barrels. The pipe shall be accepted by the test results, and by inspection. The pipe shall conform to these specifications as to design and freedom from defects. Any unacceptable portion of the pipe shall be replaced or repaired to meet the specifications at the expense of the Contractor.

VIII. PAYMENT

The work performed and all materials furnished as prescribed by this Subsection and measured as provided under "Measurement" shall be paid for at the unit price bid for appropriate type of pipe in the proposal, which price shall be full compensation for excavating, trenching, plugging, placing all materials, backfilling and for all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

LAST PAGE OF THIS SUBSECTION