DIVISION II

MATERIAL SPECIFICATION APPROVED FITTINGS MANUFACTURERS

PART 201 – CONCRETE

201.1 CEMENT

201.1.1 All cement used in the work shall be a well-known brand of true Portland Cement and shall conform to the Standard Specifications for Portland Cement, ANSI/ASTM Designation C150. Unless otherwise permitted, the Contractor shall use only one brand of cement in the work and under no condition shall he use more than one brand of cement in the same structure. Cement, which for any reason has become partially set or contains lumps or cakes will be rejected and shall be removed from the site.

201.1.2 The acceptance or rejection of cement shall rest with the Engineer. All rejected cement shall be plainly marked for identification, shall be immediately removed from the work, and shall not be offered for inspection again. Cement kept in storage for several months may be subject to repeated tests, as directed by the Engineer.

201.1.3 The cement shall be delivered in strong cloth or paper bags. No cement shall be used or inspected unless delivered in the original package with the brand and name of the manufacturer plainly marked thereon. Each bag of cement shall contain approximately 94 pounds of cement, net weight, and four bags shall be the equivalent of one barrel. Packages received in broken or damaged condition will be rejected or accepted only as fractional packages.

201.1.4 The Contractor shall provide, at the site of the work, a suitable weather tight building, or buildings, having a tight floor properly blocked or raised from the ground, for the storage of cement. The building shall be large enough to permit keeping on hand a supply of cement in quantity sufficient to prevent delays or interruptions to the work, which might be due to the lack of cement. The cement shall be stored in such manner to permit easy access for the proper inspection and identification of each shipment. Cement in bags shall not be piled to a height in excess of 7'. Suitable accurate scales shall be provided by the Contractor for weighing the cement. After it has been delivered to the job, the Contractor will not be permitted to remove or dispose of the cement in any way without the consent of the Engineer.

201.1.5 At the beginning of operations and at all other times while cement is required, the Contractor shall have, at the site of the work, an ample supply of acceptable cement and shall carefully guard against possible shortage on account of rejection, irregular deliveries, or any other cause.

201.2 WATER

201.2.1 All water used in mixing mortar or concrete shall be free from acid, alkali, oil, salt, vegetable, or other matter in sufficient quantity to be injurious to the finished product and shall be from an approved source.

201.3 AGGREGATE

201.3.1 Fine aggregate for concrete shall be clean, hard, durable, uncoated grains of Arkansas River sand or other sand acceptable to the Engineer. It shall be free from injurious amounts of dust, clay balls, soft or flaky particles, shale, alkali, organic matter, loam, or other deleterious substances. It shall not contain more than 3%, by weight, of material, which can be removed by standard decantation tests. If the color of the supernatant liquid is darker than that of the reference standard color solution when subjected to the Standard Test For Organic Impurities in Sands for Concrete ANSI/ASTM C40, the fine aggregate shall be rejected unless it passes the Standard Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar ANSI/ASTM C87.

201.3.2 Fine aggregate shall be graded approximately within the limits shown in the following table. If there are not enough fines are available in the natural sands, limestone dust, or other approved fines shall be added:

Percent Passing Standard Square Mesh Screens

No. 4	No. 20	No. 50	No. 100
95 – 100	45 – 80	10 – 30	5 – 10

201.3.3 Coarse aggregate shall consist of the best available crushed limestone or other approved material. River gravel or other material with smooth surfaces shall not be used without specific written approval of the Engineer. Coarse aggregate shall be clean, tough, sound, durable rock and shall not contain harmful quantities of foreign materials and must be satisfactory to the Engineer.

201.3.4 Coarse aggregate shall be graded approximately within the limits shown in the following table:

Percent Passing Standard Square Mesh Screens

Aggregate								
Max Size	2-1/2”	2”	1-1/2”	1”	3/4"	1/2"	3/8”	No. 4
2”	100	95 – 100	60 – 95	50 – 83	40 – 70	20 – 40		0 – 5
1-1/2”		100	95 – 100		40 – 70		10 – 30	0 – 5
3/4"				100	95 – 100		40 – 75	0 – 5

201.3.5 Coarse aggregate shall conform to Standard Specifications for Concrete Aggregates, ANSI/ASTM C33, except as to graduation. The maximum size aggregate to be used in structures 6” thick and under shall be 3/4"; in structures from 6” to 10” thick, the maximum size of aggregate shall be 1-1/2”. If required, the Contractor shall furnish test certificates showing the aggregates meet the above requirements.

201.3.6 In case the concrete resulting from the mixture of the aggregates is not of a workable character or does not make the proper finished surface, the Engineer may require a different grading in order to secure the desired results, or they may allow the use of inert admixtures to correct deficiencies, upon proper showing that such use will not materially lower the strength or increase the permeability of the concrete.

201.4 STEEL REINFORCEMENT

201.4.1 All reinforcing steel shall be deformed bars and shall conform to the requirements of the Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement, ANSI/ASTM A615, for grade 40 or grade 60. All steel shall be manufactured in the United States.

201.4.2 The Engineer reserves the right to require a test of three specimens of each size of bar from each carload received. These tests shall be made by a laboratory or testing firm approved by the Engineer and the cost of such testing shall be included in the price bid for steel reinforcement.

201.5 STRENGTH AND PROPORTION

201.5.1 The concrete shall have a compressive strength of not less than 3500 psi, unless otherwise specified in the plans, as determined from test cylinders at 28 days, made, cured, and broken, as hereinafter specified.

201.5.2 The concrete shall be mixed in the approximate proportion of 1:2-1/2:4-1/4 and shall contain not less than six sacks of cement per cubic yard of finished concrete. With the approval of the Engineer, admixtures may be added in order to increase workability.

201.6 TESTING OF CONCRETE

201.6.1 During the progress of the work, a reasonable number of compression tests shall be made when and if required by the Engineer. Each test shall consist of not less than three test cylinders. At least one test shall be made for each 100 cubic yards of concrete placed. The test cylinders shall be made and stored in accordance with the Standard Method of Making and Curing Concrete Test Specimens in the Field, ANSI/ASTM C31, and shall be tested in accordance with the requirements relating to making compression tests on concrete test specimens as given in the Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ANSI/ASTM C39.

201.6.2 All test specimens shall be kept as near to the point of sampling as possible and yet receive the same protection from the elements as is given to the portions of the structure being built. Specimens shall be protected from injury. They shall be sent to a testing laboratory approved by the Engineer not more than seven days prior to the time of the test, and while in the laboratory shall be kept in the ordinary air at a temperature of approximately 70° F until tested.

201.6.3 The Contractor shall furnish the Engineer certified reports on these tests and shall pay all the expense of making the tests and of furnishing the concrete for preparing and testing the cylinders.

201.7 RESPONSIBILITY OF CONTRACTOR FOR STRENGTH

201.7.1 It is the intent of these specifications that the Contractor shall guarantee that concrete of the specified compressive strength is incorporated in the structures and that the responsibility for producing the required grades of concrete is assumed by the Contractor.

201.7.2 Should the average strengths shown by test cylinders fall below the strengths required, the Engineer will require any or all of the following changes: amount of cement, grading of aggregate, or ratio of the water to the cement used. If the tests disclose that the strength of the concrete is insufficient for the structure as built, the Engineer may condemn the part of any structure in which concrete of insufficient strength has been placed and the Contractor, at his cost, shall remove and replace such concrete with concrete meeting these specifications.

201.8 EXPERIMENTAL CONCRETE MIXES

201.8.1 The Contractor shall make experimental mixes prior to the placing of the concrete and at any time during the progress of the work when necessary to demonstrate that the concrete will meet these specifications. Materials for making experimental mixes shall be furnished by the Contractor and these materials shall be identical with those intended for use in the work. The cost of the materials, as well as the costs of crushing test specimens made from the experimental mix, shall be borne by the Contractor, and shall be included in the price bid for concrete.

201.9 MIXING

201.9.1 The concrete shall be mixed in an approved batch machine or mixer. The ingredients shall be accurately measured by weight, unless measurement by volume is permitted by the Engineer, before being placed in the mixer. Measuring boxes or other approved measuring apparatus shall be such that the proportions can be accurately determined. The quantity of water to be added, which will vary with the degree of dryness of the material and with the weather conditions, shall be accurately measured for each batch of concrete. Means shall be provided by which a measured quantity of water can be introduced at any stage of the process. The mixing shall be done in a thorough and satisfactory manner and shall continue until every particle of aggregate is completely covered with mortar. The mixing time for each batch shall not be less than one minute after the materials are in the mixer. The entire contents of the drum shall be discharged before recharging. Re-tempering of concrete, which has partly hardened, will not be permitted.

201.10 CONSISTENCY

201.10.1 All reinforced concrete which is required to be spaded or puddled in forms or around reinforcing steel shall be of such consistency that: all aggregate will float uniformly throughout the mass without settling or segregation; when dropped directly from the discharge chute of the mixer, it will flatten out at the center of the pile but will stand up at the edges, the pile spreading from internal expansion and not by flowing; it will flow sluggishly when tamped or spaded; it can be readily puddled into corners and angles of forms and around reinforcing steel, it can be readily spaded to the bottom of the pour or to a depth of several feet any time within thirty minutes after placing.

201.10.2 A desirable consistency is one which results in a very slight accumulation of water at the top of a layer several feet in thickness, but not with segregation or accumulation of laitance.

201.10.3 If, through accident, intention, or error in mixing, any concrete shall, in the opinion of the Engineer, vary materially from the consistency specified, such concrete shall not be incorporated in the work but shall be discharged as waste material at a location approved by the Engineer.

201.11 PLACING CONCRETE

201.11.1 Before beginning a run of concrete, surfaces of the forms, reinforcing steel, and concrete previously placed, shall be thoroughly cleaned of hardened concrete and foreign materials. Forms shall be thoroughly wetted or oiled.

201.11.2 Concrete shall be placed in the forms immediately after mixing. It shall be deposited so that the aggregates are not separated. Dropping the concrete any considerable distance, generally in excess of 5', depositing large quantities at any point and running or working it along the forms, or any other practice tending to cause segregation of the ingredients, will not be allowed. It shall be compacted by vibration or continuous tamping, spading, or slicing. Care shall be taken to fill every part of the forms, to work the coarser aggregate back from the face, and to force the concrete under and around the reinforcement without displacing it. All concrete shall be thoroughly vibrated, except where specifically excepted in the specifications. The concrete shall be deposited in continuous horizontal layers and, whenever practicable, concrete in structures shall be deposited continuously for each monolithic section of the work. Chutes and tremies used for conveying concrete shall be mortar tight.

201.11.3 Work shall be arranged in order that each part of the work shall be poured as a unit if this is possible. Where necessary to stop pouring concrete, the work shall be brought up in level courses and against a vertical stop board.

201.11.4 The placing of concrete under water, where permitted, must be done by special approved methods.

201.12 PLACING IN COLD WEATHER

201.12.1 No concrete shall be placed without the specific permission of the Engineer when the air temperature is at or below 35° F.

201.12.2 If concreting in freezing weather is permitted by the Engineer, care shall be taken to prevent the use of any frozen material. In addition to adequate provision for protecting the concrete against chilling or freezing, the Contractor shall be required to heat the water and aggregate in order that when deposited in the forms, the concrete will have a temperature of not less than 50° F, nor more than 90° F. The concrete shall be adequately protected in order to maintain this temperature for a minimum of 72 hours after it has been placed and a temperature above 32° F for a period of two additional days. The work shall be done entirely at the Contractor's risk.

201.12.3 No chemicals or other foreign matter shall be added to the concrete for the purpose of preventing freezing.

201.12.4 When early traffic placement on a repair is required, the following guidelines are provided as a minimum to assure required strength during cold weather. The Contractor is responsible for the protection and quality of concrete placed during all weather conditions. If circumstances occur which preclude following these guidelines, lower early strength may result in delays in opening areas to traffic as desired.

201.12.5 Ice, snow, and frost must be removed from the cut prior to placement of concrete. Concrete should not be place on frozen subgrade. Removal of frozen subgrade will be paid as unclassified excavation.

201.12.6 Fresh concrete temperatures shall be a minimum of 50° F and a maximum of 90° F at time of placement. Hot mix water and preheated aggregate may be necessary to accomplish the minimum temperature during extremely cold weather. The minimum ambient temperature at time of placement should be at least 30° F.

201.12.7 Insulated blankets should be placed immediately when average daily temperatures are below 50° F or when minimum ambient temperatures are anticipated below 40° F during the curing period and left in place until opening to traffic. Insulated blankets shall be MA KA closed cell insulated blankets or approved equal. The insulated blankets shall have a minimum R-value of two. Cost of insulated blankets shall be included in the price bid for the concrete where they are used.

201.12.8 Strict compliance with mix design slumps must be achieved to reach early strengths. "Drying out" of excessive slump mixes will not be allowed to reduce the slump.

201.12.9 All cold weather practices also apply to cementitious backfill material, except that blankets will not be required.

201.13 READY-MIXED CONCRETE

201.13.1 Ready-Mixed concrete may be used on the work, with the approval of the Engineer, when the Contractor can demonstrate that the concrete can be furnished in accordance with the specifications hereinabove and that delivery can be made at such rate as will ensure the continuity of any pour. Standard Specifications for Ready-Mix Concrete, ANSI/ASTM C94, when not in conflict with the specifications herein, shall control the furnishing of Ready-Mix concrete.

201.13.2 All mixer trucks shall be equipped with water meters. Additional water shall be added at the job site only with the specific approval of the Engineer.

201.14 CONSTRUCTION JOINTS

201.14.1 Construction joints shall be located as shown on the drawings and at other points as may be necessary during the construction, provided that the location and nature of additional joints shall be approved by the Engineer. In general, joints shall be located at points of minimum shear, shall be perpendicular to the principal lines of stress, and shall have suitable keys having areas of approximately 1/3 of the area of the joints.

201.14.2 In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft material, and shall be roughened. The surface shall then be thoroughly washed with clean water and covered with at least 1/2" of cement mortar, after which concreting may proceed. Mortar shall be placed in a manner in order not to splatter forms and reinforcing steel.

201.15 FINISH OF CONCRETE SURFACES

201.15.1 All surfaces exposed to view shall be free from conspicuous lines, affects, or other irregularities caused by defects in the forms. If for any reason this requirement is not met, or if there are any conspicuous honeycombs, the Engineer may require the correction of the defects by rubbing with carborundum bricks and water until a satisfactory finish is obtained or removal at Contractors expense.

201.15.2 Immediately after removing the forms, all wires or other exposed metal shall be cut back of the concrete surface, and the depressions thus made, and all honeycombs and other defects shall be pointed with mortar and then rubbed smooth. If the Engineer deems any honeycomb or other defect to require such treatment, the defective concrete shall be cut out to a depth sufficient to expose the reinforcement and to afford a key for the concrete replacing that cut out.

201.16 CURING CONCRETE

201.16.1 Exposed surfaces of concrete shall be protected by approved methods from premature drying for a period of at least seven days. Curing compounds, when

approved by the Engineer, shall be applied according to the manufacturer's recommendations. The Engineer may require the frequent wetting of the concrete and/or forms and the use of means to protect it from the direct rays of the sun.

201.17 PLACING REINFORCEMENT

201.17.1 All reinforcement, when placed, shall be free from mill scale, loose or thick rust, dirt, paint, oil, or grease, and shall present a clean surface. Bends and splices shall be accurately and neatly done and shall conform to American Concrete Institute Manual of Standard Practice for Detailing Reinforced Concrete Structures.

201.17.2 All reinforcing shall be placed in the exact position shown on the drawings and shall be held firmly in position by means of approved metal spacers and supports, by wiring to the forms, and by wiring the bars together at intersections with approved wire ties in order that the reinforcement will not be displaced during the depositing and compacting of the concrete. The placing and fastening of reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section. Care shall be taken not to disturb the reinforcement after the concrete has taken its initial set.

201.18 FORMS

201.18.1 Forms shall be so designed and constructed that they may be removed without injuring the concrete. The material to be used in the form for exposed surfaces shall be sized and dressed lumber or metal in which all bolt and rivet heads are countersunk. In either case, a plain, smooth surface of the desired contour must be obtained. Undressed lumber may be used for backing or other unexposed surfaces, except inside faces of conduit.

201.18.2 The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar-tight, and if necessary, to close cracks due to shrinkage, shall be thoroughly soaked in water or as shown in plans. Forms for re-entrant angles shall be filleted, and for corners shall be chamfered. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled with a non-staining mineral oil to insure the non-adhesion of mortar.

201.18.3 Form lumber, which is to be used a second time, shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete. Any bulging or warping shall be remedied, and all dirt, sawdust, shavings, or other debris within the forms shall be removed. No wood device of any kind used to separate forms will be permitted to remain in the finished work.

201.18.4 Temporary openings shall be placed at the bottom of the column and wall forms and at other points where necessary to facilitate cleaning and inspection immediately before depositing concrete.

201.19 REMOVAL OF FORMS

201.19.1 Forms shall be removed in such manner as to ensure the complete safety of the structure. No forms shall be removed except with the express approval of the Engineer. In general, this approval will be based on the following:

201.19.2 Forms on ornamental work, railings, parapets, and vertical surfaces which do not carry loads, and which will be exposed in the finished work shall be removed within 24 to 48 hours after placing, depending upon weather conditions.

201.19.3 Girder, beam, and joist sides only, column, pier, abutment, and wall forms may be removed within 24 to 48 hours after placing, depending upon weather conditions. No backfill shall be placed against walls, piers, or abutments, unless they are adequately supported or have reached the required strength.

201.19.4 Girder, beam, and joist soffit forms shall remain in place with adequate shoring underneath, and no construction load shall be supported upon, nor any shoring removed from any part of the structure under construction until that portion of the structure has attained sufficient strength to support safely its weight and the loads placed thereon.

PART 202 – QUICK-SETTING FLOWABLE FILL

202.1 MATERIALS

202.1.1 Quick-setting flowable fill shall be a sand-cement slurry consisting of the following materials in a 1 cubic yard mixture:

Type I Cement	100 pounds
Sand	2,925 pounds
Water	585 pounds
Master Builders Pozzutec 20	80 ounces
(ASTM C494, Type C and E)	

202.1.2 Note: Can change somewhat due to type of sand used.

202.1.3 The combination of materials above shall be mixed in a ready-mix truck to produce the sand-cement slurry mixture.

202.1.4 Submittals shall be delivered to the City of Tulsa at a date set by the Engineer. Submittals shall include the items outlined in ODOT Specification 701.03.

202.2 CONSTRUCTION METHODS

202.2.1 For each cubic yard of quick-setting flowable fill material required, the amount of the mix components in the MATERIALS section shall be used to produce the sand-cement slurry mixture. The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mix truck.

202.2.2 To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two minutes immediately prior to discharge of the sand-cement slurry mixture. Re-mixing of the flowable fill slurry shall be done under the direction of the Engineer.

202.3 TESTING

202.3.1 Special Provisions, “Flowable Fill Testing Procedures” identifies the Ohio Ready-Mixed Concrete Association (ORMCA) Standards FF1(94), and FF4(94) which shall be used in the performance of field testing.

202.3.2 The following are the testing requirements for the quick-setting flowable fill:

Flow	Minimum = 4-1/2 inches
Compressive Strength (28 days)	Minimum = 25 pounds per square inch (psi)
	Maximum = 60 pounds per square inch (psi)

202.4 GENERAL

202.4.1 The time required before placing pavement over the cured quick-setting flowable fill is a minimum of six hours and/or whenever a minimum penetration value of 400 pounds per square inch (psi) is achieved. Penetrometer readings shall be taken with a Soiltest Mortar Penetrometer, Model CT-421A, or approved equal. The upper 3” of the area of the cured flowable fill mixture to be tested shall be removed prior to taking the penetrometer readings. The test value of record shall be the average of three tests.

PART 203 – DUCTILE IRON PIPE, DUCTILE AND CAST IRON FITTINGS, AND VALVES

203.1 PIPE AND FITTINGS

203.1.1 Where ductile iron pipe (DIP) 3” in diameter and larger is specified or required, it shall conform to, and be tested in accordance with, the current American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids, ANSI/AWWA C151/A21.51.

203.1.2 Length of joints shall be either 18’ or 20’. The minimum standard thickness class of each size pipe shall be as follows:

Pipe Size	Thickness Class
4” thru 8”	51
10” and larger	50

203.1.3 For 16” and larger Water Ductile Iron Pipe, all bell and spigot joints shall be electrically bonded, using a #4 AWG bare copper wire of adequate length to braze, using a #15 cadweld cartridge, the copper wire to the bare metal at the bell and spigot. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.4 For 16” and larger Water Ductile Iron Pipe, junction box test stations shall be furnished and installed, EXCEPT, no magnesium anode banks shall be furnished or installed. Junction box test stations shall be installed in accordance with the stationing shown on the Schedule of Anode Spacing. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.5 Fittings for ductile iron pipe shall be cast or ductile iron. Cast iron and ductile iron fittings shall conform to the American National Standard for Ductile-Iron and Gray-Iron Fittings, 3” through 48”, ANSI/AWWA C110; or the American National Standard for Ductile-Iron Compact Fittings, 3” through 48”, ANSI/AWWA C153. The length of all solid sleeves (both AWWA C110 and C153) shall be the longest length listed in the AWWA C110 specification (12” length for 3” through 12” sleeves, 15” length for 14” through 24” sleeves, and 24” length for 30” through 48” sleeves).

203.1.6 DUCTILE IRON PIPE FOR GRAVITY SANITARY SEWER USE SHALL BE BY ENGINEERING DIRECTOR APPROVAL ONLY. Interior of all sanitary sewer ductile iron pipe shall be lined with 40 mils of ceramic epoxy (“Protecto 401”, or equal).

203.1.6.1 Condition of Ductile Iron Prior to Surface Preparation:

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance

prior to the application of the specified lining material and no coating shall have been applied to the first 6” of the exterior of the spigot ends.

203.1.6.2 Lining Material:

The Standard of Quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

A) A permeability rating of 0.00 when tested according to Method A of ASTM E 96-66, Procedure A with a test duration of 30 days.

B) The following test must be run on coupons from factory lined ductile iron pipe:

1) ASTM B117 Salt Spray (scribed panel) – Results to equal 9.0 undercutting after two years.

2) ASTM G95 Cathodic Disbondment 1.5 volts @ 77° F. Results to equal no more than 0.5 mm undercutting after 30 days.

3) Immersion Testing rated using ASTM D714-87.

a) 20% Sulfuric Acid – No effect after two years.

b) 140° F 25% Sodium Hydroxide – No effect after two years.

c) 160° F Distilled Water – No effect after two years.

d) 120° F Tap Water (scribed panel) 0.0 undercutting after two years with no effect.

C) An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

203.1.6.3 Application:

A) Applicator

The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

B) Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide maybe left on the surface. Any area where rust reappears before lining must be re-blasted.

C) Lining

After the surface preparation and within eight hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

D) Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6” back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

E) Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To prevent delamination between coats, no material shall be used for lining which is not indefinitely re-coatable with itself without roughening of the surface.**

F) Touch-Up and Repair

Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

203.1.6.4 Inspection and Certification:

A) Inspection

1) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.

2) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500-volt test. Any defect found shall be repaired prior to shipment.

3) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

B) Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was a specified.

203.1.6.5 Handling:

Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

203.2 JOINTS

203.2.1 Cast iron and ductile iron pipe and fittings shall be jointed with any of the end types as specified below unless a particular end type is specified. Fittings shall have mechanical joints, unless otherwise specified. Flanged ends shall be used only where specifically noted on the Drawings except that the valve connection end of all tapping sleeves shall be flanged.

203.2.2 Mechanical joints and push-on joints shall conform to, and be tested in accordance with, the American National Standard for Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings, ANSI/AWWA C111/A21.11.

203.2.3 Flange joints shall conform to the American National Standard for Cast Iron Pipe Flanges and Flanged Fittings, ANSI B16.1.

203.2.4 Where ductile or cast-iron pipe is to be tapped, a split case iron or a flexible stainless-steel tapping sleeve may be used.

203.2.5 Split case iron tapping sleeves shall be of 150 psi working pressure. Sleeve body shall be cast iron conforming to ANSI/AWWA C110. Sleeve shall have mechanical joints conforming to AWWA C111 on the run and a flange branch conforming to ANSI B16.1, Class 125. End gaskets shall be natural rubber or neoprene material conforming to ANSI/AWWA C111.

203.2.6 Flexible stainless-steel tapping sleeves shall be rated at 150 psi pressure, with flanges meeting AWWA C207. Assembly shall be NSF or UL rated. Bolts, nuts, and washers shall be stainless steel. Gaskets shall conform to ANSI/AWWA C111.

203.2.7 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material as specified under ANSI/AWWA C200. All bolts shall be carbon steel ANSI/ASTM A307, Grade A only, in accordance with ANSI/AWWA C207.

203.2.8 Where restrained joints are specified or required, they shall be of a mechanical type or push-on type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA rated. Set screw type retainer glands will not be permitted.

203.3 COATING, LINING, AND POLYETHYLENE WRAP

203.3.1 Cast iron and ductile iron pipe and fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with American National Standard for Cement Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water, ANSI/AWWA C104/A21.4.

203.3.2 All ductile iron and cast-iron pipe and fittings shall be encased with polyethylene tube in accordance with AWWA C105, American National Standard for Polyethylene Encasement for Ductile Iron Piping for water and other liquids referred hereafter as polywrap. Polywrap shall be manufactured from virgin polyethylene material conforming to the following:

203.3.2.1 Raw material requirements, per ASTM D4976:

A) Group: 2 (Linear).

B) Density: 0.910 to 0.935 g/cm^3.

C) Dielectric strength: Volume resistivity, 1015 ohm-cm, minimum.

203.3.2.2 Physical properties of finished film:

A) Tensile strength: 3,600 psi (24.8 MPa) for an 8 mil (200-µm) minimum thickness, or 28.8 lbf/in. width (50.4 N/cm width), minimum in machine and transverse direction (ASTM D882).

B) Elongation: 700%, minimum in machine and transverse direction (ASTM D882).

C) Dielectric strength: 800 V/mil (31.8 V/µm) thickness, minimum (ASTM D149).

D) Impact resistance: 600 g, minimum (ASTM D1709 Method B).

E) Propagation tear resistance: 2,550 gf (grams force), minimum in machine and transverse direction (ASTM D1922).

203.3.2.3 Thickness: Linear low-density polyethylene film shall have a minimum thickness of 0.008" (8 mil or 200 µm).

203.3.2.4 Color: Polywrap may be supplied in its natural color, white, black, or weather-resistant black containing not less than 2% carbon black with a particle diameter of 90 nm or less. A minimum 2% of a hindered amine ultraviolet inhibitor is required for all films other than the weather-resistant black film with carbon black. Where other colors are specified for purposes of identification, the pigmentation shall not contain any regulated substances.

203.3.2.5 Tape: The polywrap shall be secured as specified below with 2" wide pressure sensitive tape not less than 10 mils thick. This flexible tape shall consist of a polyethylene or polyvinyl chloride backing with a synthetic elastomeric adhesive film comprised of butyl rubber. Tape shall remain flexible over a wide range of temperatures, with tensile strength and elongation properties in conformance with ASTM D1000.

The minimum tube size for each pipe diameter shall be per Table 1.

Table 1 Polyethylene tube and sheet sizes for push-on joint pipe*

NOMINAL PIPE SIZES	PUSH-ON JOINT FLAT TUBE WIDTH	MECHANICAL JOINT FLAT TUBE WIDTH
3 in.	16 in.	16 in.
4 in.	16 in.	16 in.
6 in.	16 in.	20 in.
8 in.	20 in.	24 in.
10 in.	24 in.	27 in.
12 in.	27 in.	30 in.
14 in.	30 in.	34 in.
16 in.	34 in.	37 in.
18 in.	37 in.	41 in.
20 in.	54 in.	54 in.

24 in.	54 in.	54 in.
30 in.	67 in.	67 in.
36 in.	84 in.	84 in.
42 in.	84 in.	84 in.
48 in.	96 in.	96 in.
54 in.	108 in.	108 in.
60 in.	108 in.	108 in.
64 in.	121 in.	121 in.

*These wrap sizes should work with most push-on joint pipe and fitting bell sizes. Where bell or fitting circumferences are larger than the tube sizes shown, a larger tube to effectively cover these joints should be ordered.

203.4 GATE VALVES

203.4.1 Where gate valves are specified, they shall be resilient-wedged.

203.4.2 Resilient-wedged gate valves shall conform to and be tested in accordance with ANSI/AWWA C509. The valve shall be bubble tight from either direction at the rated design pressure of 200 psi. The valve shall have a single disc gate with synthetic rubber seat bonded or mechanically attached to the disc; non-rising stem with 2” AWWA operating nut; counterclockwise opening, “O” ring stem seals, and corrosion resistant interior coating acceptable for potable water use.

203.4.3 Where specified, flanges shall be ANSI B16.1, Class 125, cast iron. Mechanical Joint, push-on, and bell and spigot joints are allowed.

203.5 BALL VALVES

203.5.1 Ball valves shall conform to and be tested in accordance with the AWWA Standard for Ball Valves, ANSI/AWWA C507. Where ball valves are specified or required, they shall be double-seated with natural or synthetic rubber located in the valve body. Ball seating surfaces shall be stainless steel; designed for 150 psi working pressure; flanged end; "O" ring rotor bearing seals; constructed of high-tensile strength cast iron; counter-clockwise opening; equipped with totally enclosed manual operators, and torque limiting control device. Valves shall be tested by, and shall withstand without leak, a hydrostatic pressure of: one 250 psi on the valve body with rotor in the open position; and two 150 psi on the side of the valve with the opposite side open to atmosphere. Six copies of the test results and manufacturer's drawings shall be submitted for approval prior to delivery of the valve.

203.5.2 Valves shall be bubble tight at rated pressure with flow in either direction.

203.5.3 Where flanges are specified, they shall be ANSI B16.1, Class 125, cast iron flanges.

203.6 BUTTERFLY VALVES

203.6.1 Butterfly valves shall be of the tight-closing, rubber-seat type, shall have a rated pressure of 150 psig, and shall be bubble-tight at this pressure with flow in either direction. Valve opening shall be counterclockwise. The valves shall conform to and be tested in accordance with the AWWA Standard for Rubber-Seated Butterfly Valves, ANSI/AWWA C504, Class 150B. The valve body shall be of the short-body flange type, constructed of cast iron conforming to either ASTM A126, Class B, or ANSI/ASTM A48, Class 40 or ductile iron ANSI/ASTM A536, Grade 65-45-12. Flanges shall be ANSI B 16.1, Class 125, cast iron flanges. Valve Discs shall be constructed of alloy cast iron conforming to ANSI/ASTM A436, Type 1, or cast-iron conforming to ANSI/ASTM A48, Class 40, or ductile iron ANSI/ASTM A536, Grade 65-45-12. Valve shafts shall be constructed of 18-8, Type 304 or 316 stainless steel, ANSI/ASTM A296, Grade CF8, or monel. Valve seats shall be body mounted and shall be of natural or synthetic rubber compound with mating seat surfaces of 18-8, Type 304 or 316 stainless steel, or alloy cast iron conforming to ANSI/ASTM A436, Type 1, or bronze Grade A, D, or E. Valve bearings shall be corrosion resistant and self-lubricating.

203.6.2 Interior surfaces of the valve, except seating surfaces, shall be epoxy coated in accordance with AWWA Standard for Protective Interior Coatings for Valves and Hydrants, AWWA C550. Exterior surface of the valve shall be painted with two coats of asphalt varnish conforming to Federal Specifications TT-V-51C. For non-buried service, exterior surface shall be coated with two coats of epoxy, not zinc chromate.

203.6.3 Performance, hydrostatic and leakage tests shall be conducted in strict accordance with ANSI/AWWA C 504, except that the leakage tests as outlined in Section 5.3 are to be conducted on both faces of the disc.

203.6.4 Six certified copies of the manufacturers detail drawings shall be submitted for approval prior to delivery of the valve.

203.6.5 Six certified copies of the test results, signed by a registered professional engineer, are to be furnished to the Engineer.

203.7 MANUAL OPERATORS FOR BALL VALVES AND BUTTERFLY VALVES

203.7.1 Manual Operators for Ball and Butterfly valves shall be totally enclosed, permanently lubricated, counterclockwise opening, and designed for buried or submerged service. Manual Operators shall be equipped with a 2" square AWWA operating nut with a removable handwheel complete with spinner and an open-closed indicator, suitable for one-man operation at 150 psi unbalanced across the valve. Manual Operators shall be either worm gear or traveling-nut type, and shall conform to AWWA C507 for Ball Valves or AWWA C504 for Butterfly Valves.

203.7.2 Manual Operators for Ball and Butterfly Valves 16" and larger shall be equipped with a Torque Limiting Control Device. The device shall be mounted directly on the operating nut for valves in vaults and on top of the extension

shaft for buried valves. The device shall be secured to the operating nut with two setscrews. The device shall declutch at 200 lb/ft of input torque in either direction of rotation. The device shall be designed for permanent buried or submerged service. Declutch and reset shall be automatic. Repeatability shall be within 5% of original rating for a minimum of 1000 cycles. Certified proof-of-design test reports shall be furnished for the device.

203.8 AIR RELIEF VALVES

203.8.1 Where air relief valves for water applications are specified or required, the valve shall be heavy-duty combination air release and vacuum type for 150 psi working pressure. Body, cover, and baffle shall be cast iron, or nylon. All internal parts to be either highest quality stainless steel, nylon, or bronze. Interior and exterior surfaces of cast iron valve body and cover shall be coated with epoxy.

Air Relief Valve shall be guaranteed to operate under all surge conditions. Acceptable Manufacturers for water ARV's: APCO, Crispin, ValMatic, ARI.

203.8.2 Where air relief valves for sanitary sewer force mains, are specified or required, the valve shall be heavy-duty combination air and vacuum release type for 145 psi working pressure, tested to 230 psi, size shown on plans. Body, cover, and baffle shall be 316LC stainless steel or reinforced nylon. All internal parts shall be reinforced nylon, reinforced polypropylene, or stainless steel. Valves shall have float system designed to ensure separation of sewage and sealing mechanism. Valves to have back flushing attachments for routine cleaning maintenance.

203.9 CHECK VALVES

203.9.1 Where check valves are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Swing-Check Valves for Ordinary Water Works Service, AWWA C508. They shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss. Valves shall be of the non-slamming type designed for the future installation of outside lever and weight. Unless otherwise specified, all check valves installed in pump or lift stations shall be equipped with position indicator. Disk shall be coated rubber and body shall be epoxy coated. Ends shall fit the pipe or fitting to which attached (push-on, mechanical, bell and spigot, or flanged).

203.10 THREE-WAY FIRE HYDRANTS

203.10.1 Where fire hydrants are specified, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower breaking point than the rest of the unit; 5-1/4" compression main valve; 6" inlet connection; standard bell or mechanical joint hub; 3' 6" bury

length, or as specified on drawings; two 2-1/2” hose nozzles with National Standard threads; one 4” pumper nozzle with Tulsa Standard threads (refer to attached Standard Detail for Fire Hydrants); "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.10.2 Where fire hydrant extensions are specified or required, they shall be of proper design to accommodate the make of fire hydrant installed.

203.11 FOUR-WAY FIRE HYDRANT

203.11.1 Where four-way fire hydrants are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower breaking point than the rest of the unit; 8” inlet connection; bell, flange, or mechanical joint inlet; 4’ 6” bury length; two 2-1/2” hose nozzles with National Standard threads; two 4” pumper nozzles with Tulsa Standard threads; "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.11.2 Where fire hydrant extensions are specified or required, they shall be of the proper design to accommodate the make of fire hydrant installed.

203.12 BLOW-OFF HYDRANT

203.12.1 Where blow off hydrants are specified or required; they shall be constructed in accordance with Construction Standard Blow-off Hydrant.

PART 204 – STEEL PIPE AND FITTINGS

204.1 GENERAL

204.1.1 Where steel pipe is specified or required, it shall conform to the AWWA Standard for Steel Water Pipe, 6” and Larger, AWWA C200. No steel less than 35,000 psi specified minimum yield strength shall be permitted. All pipe shall be hydrostatically tested in accordance with AWWA C200. Mill Test Reports shall be furnished, and the hydrostatic test pressure shown on shop fabrication drawings. AWWA Designation C200 shall govern the testing. Pipe length shall be not less than 35’ per joint, except for specials, unless otherwise noted. There shall be no more than one longitudinal or girth seam per section. Nominal pipe diameter and steel thickness shall be as specified on the drawings. The diameter shown is the required inside diameter after cement-mortar lining. All pipe shall be manufactured by an established manufacturer who has had at least five years of experience in successfully building this type of pipe. Openings for air valves, main connections, and blow-off connections shall be provided with suitable reinforcements around the opening, welded to the body of the pipe in accordance with AWWA Manual M11. Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material listed above as specified under AWWA C200. All bolts shall be carbon steel ANSI/ASTM A307, Grade A only, in accordance with ANSI/AWWA C207. For corrosion monitoring of steel pipe, junction box test stations shall be furnished and installed. Magnesium anode banks shall be furnished and installed if specified in the plans. Junction box test stations and anode banks shall be installed in accordance with the stationing as shown on the Schedule of Anode Spacing in the plans.

204.1.2 All steel pipe shall be manufactured with ends of true circular shape, free from indentations, projections, or roll marks for a distance of 8" from the end of the pipe. This shall be done by hydraulic expansion or some other method satisfactory to the Engineer. The outside circumference shall not vary by more than ±1% or as required for jointing of pipe as described in AWWA C200.

204.1.3 Where steel fittings or specials are specified or required, they shall conform to all of the steel pipe specification requirements and to the AWWA Standard for Dimensions for Steel Water Pipe Fittings AWWA C208. Where fittings and specials are fabricated from mill pipe, they shall be fabricated from pipe hydrostatically tested in accordance with AWWA C200 with mitered joints dye checked for welding flaws. Changes in line and grade shall be made by steel specials or in the joints. Joint deflection shall not exceed that as recommended by the manufacturer. Inside diameter of steel specials and fittings shall be the required inside diameter of cement-mortar lining.

204.1.4 Where field cutting of steel pipe is permitted, pipe shall be cut by sawing. The inside lining shall be removed for a minimum of 6” each side of the cut and the

pipe surface shall be cleaned and brushed to bright metal. After welding, the inside lining shall be replaced in accordance with AWWA C602.

204.1.5 Steel Pipe shall be designed in accordance with AWWA M11 and AWWA C200 except as noted herein. Steel Pipe shall conform to ASTM A139 Grade B or C. The design criteria for steel pipe thickness shall be based on a minimum 150 psi working pressure plus a 100-psi allowance for water hammer except the minimum thickness of steel pipe shall be 0.25". The minimum thickness standard in inches for each following size pipe shall be as follows:

Minimum Thickness – Inches for Grade of Steel

Nominal Pipe Diameter	A-139 Gr. B	A-139 Gr. C
6" – 36"	0.250	0.250
42"	0.281	0.250
48"	0.313	0.281
54"	0.375	0.313
60"	0.406	0.344
66"	0.438	0.375
72"	0.500	0.406

Maximum depth of cover shall be 12'. Depth of cover in excess of 12' shall require special design.

204.1.6 Hangar and support systems shall be designed in accordance with AWWA M11.

204.2 JOINTS

204.2.1 Steel Pipe and fittings shall have one of the following type joints: slip joint ends for field lap welding, single beveled ends for field butt welding, double beveled ends for field butt welding, "O" ring bell and spigot joints, or plain ends for mechanically coupled field joints. Flange ends shall be used only when noted on the drawings.

204.2.2 Welded joints shall conform to, and be tested in accordance with, the AWWA Standard for Field Welding of Steel Water Pipe Joints, AWWA C206. Slip joints for field lap welding shall be sized to provide tolerances per C200.

204.2.3 Mechanically coupled joints shall consist of Dresser Couplings, Style 38, or equal, or as specified on the drawings. The harness lugs, tie bolts, and nuts shall conform to AWWA M11 Steel Pipe Design and Installation, Par. 19.8.

204.2.4 Bell and spigot joints with rubber gasket shall conform to the AWWA Standard for Steel Water Pipe 6" and Larger, AWWA C200 and the AWWA Steel Pipe Manual, M-11. The gasket shall be a continuous "O" ring design of natural rubber or neoprene and shall be of suitable cross-section and size to assure a watertight joint. Acceptable bell and spigot joints for all steel pipe diameters and thicknesses shall be the "O" Ring-Bar Type, or the "O" Ring-Carnegie Section, or rolled groove type joint. Bell and spigot ends shall be properly sized by forcing over a sizing die or by expanding to stretch the steel beyond

its elastic limit so that the difference in diameter between outside of spigot and inside of bell at normal engagement is not less than 0.03” and not more than 0.10" as measured on circumference with a diameter tape. Shop applied interior lining on the bell end of the pipe shall be held back a minimum distance of the spigot engagement +1-1/8" for the Bar and Carnegie Type Joints. Hold back for the rolled groove joint shall be the spigot engagement +1/2". Interior lining for the spigot shall be continuous to the end. Field replacement of the interior joint linings shall be in accordance with Section 201.4. of these specification for cement-mortar linings. All "O" Ring joints shall be electrically bonded using a #4 bare copper wire, 6" length #15 cadweld cartridge brazed to bare metal at the bell and spigot or equal. Shop applied exterior coatings shall be held back in accordance with manufacturer's specifications. Field replacement of exterior coatings at the joints shall be in accordance with the AWWA C216, Heat Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Specials, Connections and Fitting, AWWA C209, Cold-Applied Tape Coatings for Special Sections, Connections, and Fittings, for Steel Water Pipelines, or AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied.

204.2.5 Where steel pipe is to be tapped in the field, a split tapping saddle of 150 psi working pressure shall be used. The saddle body shall be heavy welded ANSI/ASTM A36, or ANSI/ASTM A285, Gr. C steel with flange conforming to ANSI/AWWA C207, Class D. The gasket shall be natural rubber or neoprene design in a continuous ring of suitable cross-section and sized to assure a watertight joint. The interior and exterior surfaces of the saddle body shall be shop coated with a fusion-bonded epoxy. The exterior coating or wrap on steel pipe shall be removed to bare metal beneath the entire area to be covered by the sleeve.

204.2.6 Flanged joints shall conform to the AWWA Standard for Steel Pipe flanges, AWWA C207, Class D.

204.3 EXTERIOR COATING

204.3.1 The exterior coating on steel pipe and fittings shall be in accordance with Tape Coating Systems for the Exterior of Water Pipelines, AWWA C214 or cement-mortar coatings in accordance with AWWA C205, Cement-Mortar Protective Lining and Coating For Steel Water Pipe, 4" and Larger, Shop Applied. Where tape coatings are used, the total thickness shall be no less than 80 mils. Where cement-mortar coating is used, the thickness shall be not less than 3/4" and reinforced with spiral-wire, wire-fabric, or ribbon mesh reinforcement in accordance with AWWA C205, Sec. 2.1. All above ground piping shall be cleaned, primed, and painted with enamel, as shown in the plans. The total dry film thickness shall be 6 mils.

204.3.2 If field welding is used, the pipe joints shall be furnished with the outside coating held back, in accordance with standard joint detailed drawings. The coating and any touch up work shall be done under the direction of the coating manufacturer, and as approved by the Engineer.

204.4 INTERIOR LINING

204.4.1 The interior lining shall be installed in the field in accordance with AWWA C602, Cement-Mortar Lining of Water Pipelines, 4” and Larger, In Place; or shop applied in accordance with AWWA C205, Cement Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied. The lining shall be 3/8" thick for diameters through 36", and 1/2" thick for 42" and larger, whether shop or in place lined. Tolerances shall be in accordance with the applicable AWWA standards. Coal-tar enamel and coal tar epoxy interior linings will not be permitted.

204.4.2 Where in place cement-mortar lining is used, the contractor shall furnish all materials, labor, and equipment, prepare the interior surface, and machine place the mortar lining in the pipe. The lining at valves, specials, and bends may be hand sprayed or troweled, or hand applied as required. The lining shall be maintained in a moist condition while curing. The contractor shall be responsible for any extended curing time until acceptance by the Engineer. No additional payment shall be made for any extended curing period.

204.4.3 Where in-place mortar lining is cracked or delaminated from steel cylinder pipe, contractor shall repair broken or delaminated areas with Hilti two-part epoxy or approved equal.

204.5 STRUTTING AND BRACING

204.5.1 Strutting and bracing shall be provided on all specials, fittings, and straight pipe, where shop lined or coated with cement mortar, so as to limit the maximum pipe deflection to 2% of inside diameter and to maintain roundness of ±1% during transportation, handling and joining the pipe. Coated pipe shall be handled with wide belt slings or padded forks. Chains, cables, or other equipment likely to cause damage to the pipe or coating shall not be used. The strutting shall remain in place until all compacting and backfilling has been completed.

PART 205 – REINFORCED CONCRETE PIPE AND FITTINGS

205.1 REINFORCED CONCRETE PIPE AND FITTINGS FOR WATER

205.1.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per AWWA C301, for water, they shall be designed, manufactured, and tested in accordance with the AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, AWWA C301, or Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and other Liquids, AWWA C303. All pipe shall be manufactured by an established manufacturer who has had at least three years of experience in successfully building this type of pipe. All specials and fittings shall be built to the details furnished by the manufacturer and approved by the Engineer. Each special and each length of straight pipe shall be plainly marked to indicate the head for which the pipe is designed and to indicate where the pipe will be used by reference to the layout drawings. All closure fittings shall be furnished with a 24" flanged access manway with a 24" steel blind flange. 6" screw type hand hole fittings will not be permitted.

205.1.2 All concrete or mortar substrates must be sweep-abrasive grit blasted to create adequate profile then made dust free. All surfaces to be lined must be free of any oil, grease, or other deleterious materials. The surface must be dry to the touch (no standing water) but can have some surface discoloration due to moisture.

205.1.3 RCP and fittings for water lines shall be designed for the following conditions (minimum): Normal operating pressure equal to 150 psi plus 50% for surge pressure plus earth load resulting from actual backfill depth, but not less than 8' plus external live load equal to AASHTO HS 20 loading. The thickness of the mortar coating shall provide a minimum cover of 1" over the reinforcing steel.

205.1.4 Reinforced concrete pipe and fittings for water lines shall be jointed according to AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids, ANSI/AWWA C301, or Reinforced Concrete Pressure Pipe, Steel Cylinder Type, Pretensioned, for Water and Other Liquids, AWWA C 303.

205.1.5 Where concrete pressure pipe ANSI/AWWA C301, Steel Cylinder Prestressed Concrete or Pretensioned Concrete Pressure Pipe, AWWA C303 is to be tapped, the tapping saddle shall be fabricated in accordance with the American Water Works Association Manual M-9, and as recommended by manufacturers of Concrete Pressure Pipe. Saddle shall provide grout gaskets and grout opening to enable filling the wall space between saddle and pipe wall with grout, to assure complete protection of the steel pipe wall. The saddle shall also provide gland assembly, including gasket and flange, to insure a tight seal.

205.1.6 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provisions are made for closing the openings. Blind flanges shall be fabricated from material as specified under AWWA C200. All bolts shall be carbon steel ASTM A307, Grade A only, in accordance with ANSI/AWWA C207.

205.2 REINFORCED CONCRETE PIPE AND FITTINGS FOR STORMWATER

205.2.1 Where reinforced concrete pipe (RCP) and fittings are specified or required per ASTM C76, for storm sewers, except as herein modified, they shall be designed, manufactured, and tested in accordance with ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe. Pipe shall be a minimum Class III. Pipe length shall be no less than 6' except for shorts and specials. Pipe sections connected to a manhole or structure shall be no more than 4' in length, as measured from the inside face of the structure to the point of flexure of the joint. Elliptical reinforcement is not allowed. At least three circumferential reinforcing bars shall be provided in each pipe bell equal in area to an equivalent length of outside cage in the pipe barrel. Concrete shall have a minimum 28-day compressive strength of 6,000 psi, and absorption not to exceed 6%. No lifting holes will be allowed on any reinforced concrete pipes or reinforced concrete boxes.

205.2.2 Testing shall be observed and reported by an independent testing laboratory approved by the Engineer. One Three-Edge Bearing Test in accordance with ASTM C497 shall be performed on a representative sample of each diameter and class of pipe to be furnished. One absorption test in accordance with ASTM C497 shall be performed for each 300 tons of pipe manufactured, not less than one test per day's production. Four concrete cylinders or core samples shall be tested for compressive strength from each day’s production, two at seven days and two at 28 days. An in-plant hydrostatic test in accordance with ASTM C361 shall be performed on each section of pipe and each pipe joint at an internal hydrostatic head of 25’. The joints shall be tested for a minimum period of one hour under constant pressure as specified. Each pipe unit that satisfactorily passes all hydrostatic testing shall bear the seal of the testing laboratory. This seal does not constitute acceptance of the pipe installation, which will be subjected to further testing and inspection in the field.

205.2.3 In lieu of the in-plant hydrostatic testing of each joint, the Contractor may substitute the following procedure: 1. Perform one in-plant hydrostatic test per days production, in accordance with the previously specified criteria; and 2. Perform an air test on each joint in the field after assembly, in accordance with the City of Tulsa Water and Sewer Department Standard Air Test Procedure. The Contractor shall furnish all air test equipment. Testing and test conclusions shall be verified by the Engineer. The Engineer reserves the right to require additional in-plant hydrostatic testing.

205.2.4 Reinforced concrete pipe and fittings for storm sewer shall be jointed in accordance with ASTM C361, Standard Specification for Reinforced Concrete

Low-Head Pressure Pipe. Joints shall be concrete bell and spigot, employing a rubber gasket and cement mortar formed by a diaper. Rubber gaskets shall be either a standard O-ring gasket or a Forsheda pre-lubricated gasket, or equal. For the O-ring gasket, the spigot end shall contain a groove to confine and compress the gasket on four surfaces when the joint is in final position. The Forsheda joint shall be designed and installed in accordance with the manufacturer's recommendations.

205.2.5 Reinforced concrete pipe and fittings are excluded for Sanitary Sewer.

PART 206 – VITRIFIED CLAY PIPE AND FITTINGS

206.1 PIPE AND FITTINGS

206.1.1 Where vitrified clay pipe (VCP), fittings and in-line tees are specified or required, they shall conform to the Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated ANSI/ASTM C700. Testing shall be in accordance with methods of Testing Clay Pipe, ANSI/ASTM C301.

206.1.2 Where vitrified clay pipe is being installed, in-line tees for future connections to the sanitary sewer shall be manufactured specifically for vitrified clay pipe.

206.2 JOINTS

206.2.1 Vitrified clay pipe shall be jointed with material conforming to the Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings, ANSI/ASTM C425. All jointing materials shall be used in accordance with the manufacturer's instructions and subject to the approval of the Engineer.

206.2.2 Where it is necessary to connect vitrified clay pipe to ductile iron pipe a rigid type adapter shall be used. Only the following adapters will be permitted: Dickey DPB-VC x DI, Dresser Style 39, and Rockwell Omni. Flexible couplings will not be permitted.

PART 207 – POLYVINYL CHLORIDE (PVC) PIPE, WATER SERVICE

207.1 Where polyvinyl chloride (PVC) pipe 4” in diameter through 12” in diameter is specified or required, it shall conform to and be tested in accordance with AWWA C900, "AWWA STANDARD for POLYVINYL CHLORIDE (PVC) PRESSURE PIPE, 4” THROUGH 12”, FOR WATER", as herein modified. PVC water pipe shall be approved by the Underwriters Laboratory Sanitation Foundation Testing Laboratory for potable water pipe. Polyvinyl chloride water pipe shall be restricted from use within arterial street right of way.

207.2 PVC pipe shall conform to pressure Class 200 (equivalent to Dimension Ratio 14) and shall have an outside diameter (OD) equal to the OD of equivalent size ductile iron pipe.

207.3 PVC pipe shall have integral wall-thickened bell ends and shall be jointed using one-piece elastomeric gaskets. Solvent cement jointing shall not be permitted.

207.4 Fittings for PVC pipe shall be polyethylene wrapped ductile or cast-iron conforming to Part 203 of these specifications. The use of PVC fittings shall not be permitted.

207.5 Contractor shall submit certifications from the manufacturer that PVC pipe has been manufactured in accordance with AWWA C900, and that it meets the approval of the "NSF".

207.6 Where restrained joints are required, they shall be of a mechanical type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA approved. Setscrew type retainer glands will not be permitted.

PART 207A – HIGH DENSITY POLYETHYLENE (HDPE) PIPE, WATER SERVICE

207A.1 Where high density polyethylene (HDPE) pipe 4” through 63” in diameter is specified or required, it shall conform to and be tested in accordance with AWWA C906 "POLYETHYLENE (PE) PRESSURE PIPE AND FITTINGS, 4” THROUGH 63”, FOR WATER DISTRIBUTION AND TRANSMISSION" as herein modified. HDPE water pipe shall be approved by the Underwriters Laboratory Sanitation Foundation Testing Laboratory for potable water pipe. HDPE water pipe shall be restricted from use within arterial street right of way.

207A.2 Polyethylene compounds utilized in the manufacture of products furnished under this specification shall be listed in PPI TR-4, have a grade of PE47 with a minimum cell classification of PE 445574C for PE4710 materials, as defined in ASTM D3350. In conformance with AWWA C906, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1600 psi (PE4710) at a temperature of 73.4° F (23° C). The materials shall meet the following nominal physical property requirements:

PROPERTY	TEST METHOD*	NOMINAL VALVE
Material Designation	PPI/ASTM	PE4710
Cell Classification	D3350	445574C
Density, Natural	D1505	0.947 gm/cc
Density, Black	D1505	0.956 gm/cc
Melt Index (190° C/2.16 kg)	D1238	<0.15 gm/10 min
Flow Rate (190° C/21.6 kg)	D1238	8.5 gm/10 min
Tensile Strength @ Ultimate	D638	5,000 psi
Tensile Strength @ Yield	D638	3,500 psi
Ultimate Elongation	D638	>800%
Flexural Modulus, 2% Secant	D790	110,000 – 160,000 psi
Environmental Stress Crack Resistance (ESCR)		
F_0, Condition C	D1693	>10,000 hrs.
PENT	F1473	>500 hrs.
Brittleness Temperature	D746	<-180° F
Hardness, Shore D	D2240	64
Vicat Softening Temperature	D1525	255° F
Izod Impact Strength, Notched	D256	7 ft-lb/in
Modulus of Elasticity (short term)	D638	130,000 psi
Modulus of Elasticity (long term)	D638	32,500 psi
Thermal Expansion Coefficient	D696	8.0 x 10^5 in/in/°F
Average Molecular Weight	GPC	330,000
PPI Hydrostatic Design Basis	D2837	1,600 psi @ 73.4° F
(As listed in PPI TR-4)		1,000 psi @ 140° F

*Test procedures are ASTM unless otherwise specified. (PPI = Plastics Pipe Institute, and GPC = Gel Permeation Chromatography.)

207A.3 HDPE pipe shall have a Diameter Ratio (DR) of 11, shall be Ductile Iron Pipe Size (DIPS) as indicated in the chart below, and shall be certified for conformance with NSF/ANSI Standard 61. A DR greater than 11 shall not be permitted.

DIP/PVC Size (in)	HDPE size (in)
6	8 DIPS
8	12 DIPS
10	12 DIPS
12	16 DIPS

207A.4 The Pressure Class of the PE pipe and PE fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to 1/2 of the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's

nominal pressure class may be ignored due to the fatigue endurance of the polyethylene materials. For PE 4710, the net pressure capability shall be the working pressure rating (WPR) @ 73° F as follows:

DR	WPR (psi)	WPR + Surge (psi)	Hydrotest (psi)	Nominal 60 sec. Burst (psi)
11.0	200	300	300	800

207A.5 Polyethylene fittings, including custom fabrication, shall have the same internal pressure rating as the mating pipe. The use of derated fittings shall not be permitted. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with AWWA C-906 for the same pipe size.

207A.6 All HDPE taps for water service line shall be made with a HDPE fusion tapping saddle Poly-Cam Series 415 or 575 (HDPE) or approved equal.

207A.7 Permanent identification of piping shall be provided by co-extruding multiple (minimum four) equally spaced blue color stripes into the pipe outside surface or by solid blue colored pipe shell. The identification material shall be the same material as the pipe material described herein, except for the blue color. Plain Black HDPE Pipe without color markings may not be used in the City of Tulsa Distribution System.

ASTM, AWWA, NSF and CSA standards require that markings on pipe and tubing be present at frequent intervals – generally not less than every 5’ – and that they include at least the following items of information:

A) The nominal pipe or tubing size (e.g., 1”).

B) The type of PE material from which the pipe is made (e.g., PE 4710).

C) The pipe or tubing dimension ratio or the pipe pressure rating or pressure class for 73° F water, or both.

D) The standard against which the pipe has been made and tested.

E) The manufacturer's name or trademark.

F) Production record coding the place and time of manufacture.

G) The seal or mark of the certification agency that has determined the suitability of the pipe for potable water service.

PART 208 – POLYVINYL CHLORIDE (PVC) PIPE, SEWER SERVICE

208.1 Where polyvinyl chloride (PVC) pipe 8” in diameter through 15” in diameter, fittings and inline tees are specified or required for sewer service, it shall conform to and be tested in accordance with ASTM D3034 "Type PSM Polyvinyl Chloride Sewer Pipe and Fittings" for standard dimensional ratio (SDR) of 26. Minimum pipe stiffness for all sizes shall be 115 psi.

208.2 Where polyvinyl chloride (PVC) pipe 18” in diameter through 48” in diameter is specified or required for sewer service it shall conform to and be tested in accordance with ASTM F679, Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings Minimum pipe stiffness shall be 115 psi.

208.3 The PVC sewer pipe shall be supplied in 12.5’ or 20’ laying lengths as specified.

208.4 Where it is necessary to connect PVC sewer pipe to ductile iron pipe and AWWA C110 long body solid sleeve shall be used with a special gasket for the PVC pipe. Flexible couplings will not be permitted.

208.5 Where PVC sewer pipe is being installed, the fittings for the service line and the in-line tees and risers for future service connections shall be of the same material as the mainline, and manufactured and specifically designed for connection to Schedule 40 PVC service lines.

208.6 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. Testing for flattening and the pipe stiffness shall be performed on one test specimen for each size and class of pipe produced for the project. Certifications shall be furnished that the material was manufactured, sampled, tested, and inspected in accordance with all applicable specifications. The certifications shall indicate the manufacturer's production code from which the plant location, machine, and date of manufacture can be identified.

PART 209 – CASTINGS

209.1 Gray iron castings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and applicable sections of Drainage Structure Castings, AASHTO M 306, current edition. All castings, including manhole steps, lamphole covers, water meter lids, manhole frames and lids, adjustment rings and valve boxes shall be Class 35B iron.

209.1.1 Iron class shall be determined using only those guidelines outlined in ASTM A48. Tensile specimens shall be obtained using AASHTO M306 Para 9.1.4, Acceptance on the Basis of Test Bars Cust from Portions of Units Supplied to Purchaser. Where samples are too thin and cannot be obtained under ASTM M306 Para 9.1.4, specimens shall be obtained under ASTM M306 Para 9.1.3 Acceptance on the Basis of Cast-on Test Bars. Elapsed time during tensile test shall follow ASTM A48 para 14. Tensile test specimens shall fit the holders of the testing machine in a way such that the load will be axial.

209.1.2 Additionally, castings that are rated for traffic loadings within dedicated public rights-of-way or other locations subject to vehicular traffic must pass an AASHTO proof load test that can maintain a 40,000 lb. proof load for one minute, applied on a 9” x 9” contact area in the center of the casting. The load shall be applied at a constant rate requiring a minimum of 30 seconds to reach the 40,000 lb. level. Following this test, the casting shall be visually inspected for cracks or permanent deformation which will be cause for rejection. Following this, the casting shall be loaded to failure.

209.1.3 Cost for tensile and proof load testing shall be borne by manufacturer, and testing shall be performed at a testing facility acceptable to the Engineer. All tests shall be witnessed by the Engineer.

209.2 Casting dimensions shall vary by not more than ±1/16 in/ft.

209.3 All bearings surfaces shall be machined to prevent rocking and rattling.

209.4 Where sealed manholes are specified, only McGard locking system with 5/8” – 11 thread which is keyed to City of Tulsa standard lock is allowed.

209.5 Only those castings which have been approved by the Department will be permitted. Approval for each casting shall consist of approved shop drawings, plus laboratory test reports of the tensile test and load test.

209.6 City of Tulsa Engineering Services Department, on an annual basis, reserves the right to randomly select any castings for tensile and proof load testing from the foundry’s local representative’s yard. Such testing shall be at manufacturer’s expense.

PART 210 – CONDUIT

210.1 Where conduit (also known as tunnel liner or pipe sleeve), 6” or larger, is specified or required, it shall be steel pipe, and be in accordance with AWWA C200, 3/8” wall thickness.

Conduit shall be sized according to the following:

Carrier Pipe		Conduit, ID
Water	**Sanitary Sewer**	
6”	6”	18”
8”	8”	20”
	10”	22”
12”		24”
	12”	26”
	15”	28”
16”		30”
	16”	32”
	18”	32”
24”	24”	42”
30”	30”	48”
36”	36”	54”
42”		60”
	42”	62”
	48”	68”

PART 211 – VAULT, PITS, AND MANHOLES

211.1.1 Concrete masonry units shall conform to, and be tested in accordance with the specifications for Concrete Masonry, Hollow Load Bearing Concrete Masonry Units, ANSI/ASTM C90, or Concrete Building Brick C55, Grade A.

211.1.2 Precast manholes shall conform to, and be tested in accordance with, the specifications for Precast Reinforced Concrete Manhole Sections, ANSI/ASTM C478, flat slab top type.

211.1.3 Manhole adjusting ring shall be solid cast iron that fits in the standard City of Tulsa Sanitary Sewer manhole frame and the standard manhole lid fits in the adjusting ring.

211.1.4 Adjusting rings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and Drainage Structure Castings, AASHTO Designation: M306-89. Castings shall be Class 35-B iron and unpainted.

211.1.5 The contact surface between manhole ring and manhole frame and the contact surface between manhole ring and manhole lid shall be machined smooth to prevent rocking and rattling.

211.1.6 The 2” manhole adjusting ring where specified shall have a minimum weight of 70 pounds and the 3” manhole adjusting ring where specified shall have a minimum weight of 100 pounds.

211.1.7 Markings on all gray iron castings shall conform to AASHTO Designation M306-89. (AASHTO M306-89 states: Each casting shall be identified by the foundry showing): Name of Foundry, Country of manufacturer, ASTM Designation Number, Class by a number followed by a letter indicating the minimum tensile strength and size of test bar. (i.e. Class 35-B), Heat Number and Date. No other wording or marking of any kind other than those stated above or shown on the plan will be permitted on castings.

211.1.8 All sanitary sewer manholes and structures 5’ I.D. or larger shall have an interior epoxy coating as described in City of Tulsa Specification Part 216.

PART 212 – SAND FOR CUSHION OR BACKFILL

212.1.1 Sand shall be graded from fine to coarse, free from objectionable material, and contain not more than 10% clay or loam by weight. One hundred percent shall pass a 3/4" screen, and 95% shall pass a number four screen.

PART 213 – CRUSHED STONE FOR SURFACING, BASE COURSE, AND STABILIZATION

213.1 Crushed stone shall consist of clean, tough, durable fragments, free from an excess of soft or disintegrated particles. Sampling shall be in accordance with the Standard Method of Sampling Aggregates, ANSI/ASTM D75. Sieve analysis shall be performed in accordance with the method of Sieve Analysis, ANSI/ASTM Cl36. Gradation to be used at each location will be specified by the Engineer. Crushed stone for aggregate base and surface course shall conform to the Oklahoma Department of Transportation Specifications for Highway Construction, and shall conform to the following gradations:

213.2 Percent Passing:

Sieve Size	Type A	Type B
3”	-	100
1-1/2”	100	40 – 100
3/4"	40 – 100	30 – 75
3/8”	30 – 75	25 – 60
No. 4	25 – 60	20 – 50
No. 10	20 – 43	15 – 35
No. 40	8 – 26	7 – 22

213.2.1 Crushed stone aggregate for stabilization and bedding shall conform to the following ASTM D448 and C33 gradations:

213.2.2 Percent Passing:

	Size # 1	Size #467	Size #57	Size #67	Size #7
Sieve Size	3 1/2” to 1-1/2”	1-1/2” to No. 4	1” to No. 4	3/4” to No. 4	1/2” to No. 4
4”	100	-	-	-	-
3-1/2”	50 – 100	-	-	-	-
2-1/2”	25 – 60	-	-	-	-
2”	-	10	-	-	-
1-1/2”	0 – 15	95 – 100	100	-	-
1”	-	-	95 – 100	100	-
3/4"	0 – 5	35 – 70	-	90 – 100	100
1/2"	-	-	25 – 60	-	90 – 100
3/8”	-	10 – 30	-	20 – 55	40 – 70
No. 4	-	0 – 5	0 – 10	0 – 10	0 – 15

PART 214 – RIPRAP

214.1 All riprap designs and installations shall comply with the more stringent requirements of the following:

A) The most current ODOT Standard Specifications which have also been adopted by the City of Tulsa.

B) The most current edition of the City of Tulsa Stormwater Management Criteria Manual.

214.2 ODOT Type IV Grouted Riprap is not allowed within the City of Tulsa unless specifically approved by the City Engineer.

PART 215 – CORRUGATED POLYPROPYLENE PIPE AND FITTINGS FOR STORMWATER

215.1 Where corrugated polypropylene (PP) pipe 15” in diameter through 60” in diameter are specified or required for storm sewer service, it shall conform to and be tested in accordance with ASTM F2881 "Standard Specification for 12” to 60” (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications" and AASHTO M330. Minimum cover shall be 2’. Pipe sizes of less than 15” are not allowed in closed public or private storm sewer systems.

215.1.1 If flowable fill is to be used for backfill in lieu of ODOT Type "A" Aggregate base, a pipe anchoring system must be utilized during installation. The anchoring system must be approved by the pipe manufacturer and the Engineer prior to use.

215.2 The PP sewer pipe shall be supplied in 13’ or 20’ laying lengths as specified.

215.3 PP pipes shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881, for the respective diameters. Joints shall be watertight according to the requirements of ASTM D3212 “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals". Spigots shall have gaskets meeting the requirements of ASTM F477 "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe". Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. Contractor shall use a joint lubricant, as recommended by the pipe manufacturer, on the gasket and bell during joint assembly.

215.3.1 Connections shall be watertight and conform to ASTM C923 “Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals” and

ASTM F2510/F2510M “Standard Specification for Resilient Connectors Between

Reinforced Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes”.

215.4 Fittings shall conform to ASTM F2881 for the respective diameters.

215.5 Field testing of joints as directed by the Engineer, shall be in accordance with ASTM F2487 “Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High-Density Polyethylene and Polypropylene Pipelines" or ASTM F1417 "Standard Practice for Installations Acceptance of Plastic Non-pressure Sewer Lines Using Low-pressure Air".

215.6 Installation shall be in accordance with ASTM D231 “Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-flow Applications” and City of Tulsa standards.

215.7 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. Certifications shall be furnished that the material was manufactured, sampled, tested, and inspected in accordance with all applicable specifications. The certifications shall indicate the manufacturer's production code, from which plant location, machine and date of manufacture can be identified.

216 PVC DRAINAGE STRUCTURES

216.1 Main body and pipe stubs of surface drainage structures shall conform to ASTM D1784 cell class 12454.

216.2 The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. The joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. For prefabricated PVC drainage structures, the pipe bell spigot shall be joined to the main body of the PVC drainage structures using a solvent weld connection.

216.2.1 Flexible elastomeric seals shall conform to ASTM F477.

216.2.2 PVC glue and primer used in the assembly of components shall conform to ASTM D2564 and ASTM F656 respectively.

216.3 Grates and frames for all surface drainage inlets shall be ductile iron for sizes 15", 18", 24", and 30" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05.

216.3.1 12" and 15" square grates shall be hinged to the frame using pins.

216.4 The specified PVC surface drainage structure shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be ODOT Aggregate Base Type A. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321.

216.5 PVC drainage structures shall be measured in linear feet from the bottom of the structure to the rim elevation. This overall height will take into account the minimum sump depths according to the manufacturer or specified deeper sumps when specified by the site plans. Castings furnished by the manufacturer are to be included in the cost of the PVC drainage structure, unless a replacement is needed.

216.6 The drain basin body may be cut at the time of the final grade. No brick, stone, or concrete block will be required to set the grate to the final grade height.

216.7 A concrete slab shall be poured under and around the grate and frame. The concrete slab must be designed taking into consideration the local soil

conditions, traffic loading, and other applicable design factors. Concrete shall be a minimum of 8" thick.

216.8 For other installation considerations such as migration of fines, ground water, and foundations, refer to ASTM D2321 guidelines.

216.9 Sumps shall be at inverts of outflow pipes to ensure all structures drain through the outlet pipe as intended.

216.10 Fittings for field connections to existing structures may be used with approval from the Engineer. submittal required.

PART 217 - CORROSION PROTECTION OF CONCRETE WASTEWATER STRUCTURES

217.1 GENERAL

217.1.1 SUMMARY

A. This specification covers all labor, materials, equipment, and services necessary to complete the installation of interior corrosion protection for new concrete wastewater structures and rehabilitation of existing concrete structures as herein specified. The entire interior surface exposed to hydrogen sulfide gas and wastewater flow shall be coated.

217.1.2 REFERENCES

A. ASTM 04258 - Surface Cleaning Concrete for Coating
B. ASTM 04259 - Abrading Concrete
C. ASTM 0638 - Tensile Properties of Plastics.
D. ASTM 0790 - Flexural Properties of Unreinforced and Reinforced Plastics.
E. ASTM 0695 - Compressive Properties of Rigid Plastics.
F. ASTM 07234 - Pull-off Adhesion Strength of Coatings on Concrete Using Portable Pull-off Adhesion Testers
G. ASTM 02584 - Volatile Matter Content.
H. ASTM 0543 - Resistance of Plastics to Chemical Reagents.
I. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
J. ACI506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete
K. Silica Chemical Resistant Mortars.
L. SSPC SP-13/NACE No. 6 - Surface Preparation of Concrete.
M. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
N. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
0 SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
P. Los Angeles County Sanitation District - Evaluation of Protective Coatings for Concrete.
Q. SSPWC 210-2.3.3 - Chemical resistance testing published in the Standard Specifications for Public Works Construction (otherwise known as "The Greenbook").

217.1.3 SUBMITTALS

A. Product Data:
   1. Technical data sheet on each product used.
   2. Safety Data Sheet (SOS) for each product used.
   3. Technical data sheet and project specific data for construction and repair materials to be topcoated with the coating product(s)

including compatibility with the specified coating product(s), application, cure time and surface preparation procedures.

B. Contractor Data:
   1. Current documentation from coating product manufacturer certifying Contractor's training and equipment complies with the Quality Assurance requirements specified herein.
   2. Five (5) recent references of Contractor indicating successful application of coating product(s) of the same material type as specified herein, applied by spray application within the municipal wastewater environment.
   3. Letter from the coating product manufacturer providing the name and qualification(s) of the Technical Representative to be on-site in accordance with this specification.
   4. All testing conditions and results.

C. Technical Representative Data:
   1. On Larger Projects (10,000 SF and above), the coating manufacturer's Technical Representative shall approve surfaces for application of coating at each stage.
      a. Letter providing the surface preparation method shall be submitted to the Engineer ten (10) days before work is to begin.
      b. Letter approving the completion of surface prep shall be submitted to the Engineer prior to concrete repair.
      c. Letter providing the concrete repair method recommended shall be submitted to the Engineer prior to the start of the repair (if applicable)
      d. Letter approving the completion of concrete repair shall be submitted to the Engineer prior to coating (if applicable).
   2. On projects below 10,000 SF, the manufacturer's representative must be available if requested within 24 hours.

217.1.4 QUALITY ASSURANCE

A. Coating product(s) shall be capable of being installed and curing properly within the specified environment(s). Coating product(s) shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems; and, capable of adhering to the substrates and repair product(s).
B. Repair product(s) shall be fully compatible with coating product(s) including ability to bond effectively to the host substrate and coating product(s) forming a composite system.
C. Contractor shall utilize equipment for the spray application of the coating product(s) which has been approved by the coating product manufacturer; and, Contractor shall have received training on the operation and maintenance of said equipment from the coating product manufacturer.
D. Contractor shall be trained by, or have their training approved and certified by, the coating product manufacturer for the handling, mixing, application and inspection of the coating product(s) to be used as specified herein.
E. On larger projects over 10,000 SF, the Contractor shall utilize the services of the coating product(s) manufacturer's technical representative to provide on site inspection at the following checkpoints during the project:
   1. Completion of Section 3.2 - Surface Preparation
   2. During Installation of Repair Product(s) - Section 3.3
   3. During Installation of Coatlng,Product(s) - Section 3.4
   4. During Holiday Detection inspection - Section 3.5 B

F. Each application supeNisor of foreman, spray rig operator, and spray technicians must have a valid training certificate verifying successful completion of training by the manufacturer.

G. Inspectors, Including Contractor and coating product(s) manufacturer personnel performing inspection, shall be trained in the use of testing or inspection instrumentation and knowledgeable of the proper use, preparation and installation of the coating product(s) to be used as specified herein.

H. Contractor shall Initiate and enforce quality control procedures consistent with the coating product(s) manufacturer recommendations and applicable NACE or SSPC standards as referenced herein.

I. Pre-construction meeting shall take place no less than two (2) weeks prior to Contractor mobilization. All parties to have physical presence on the project during construction shall be present. At this meeting responsibilities and authorities during construction shallbe discerned; comments and questions regarding materials and execution of these specifications shall be presented and addressed.

217.1.5 DELIVERY, STORAGE, AND HANDLING

A. Coating product(s) are to be kept dry, protected from weather and stored under cover.

B. Coating product(s) are to be stored between 50 deg F and 90 deg F. Do not store near flame, heat or strong oxidants.

C. Coating products(s) are to be handled according to their material safety data sheets.

217.1.6 SITE CONDITIONS

A. Contractor shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

B. Confined space entry, flow diversion and/or bypass plans shall be presented by Contractor to Authority as necessary to perform the specified work.

217.1.7 SPECIAL WARRANTY

A. Contractor shall warrant all work against defects in materials and workmanship for a period of one (1) year, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one (1) year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Authority.

217.2 PRODUCTS

217.2.1 EXISTING PRODUCTS

Materials, regardless of type or quantity, used to fill voids, anchor attachments or otherwise alter the surface material of concrete structures scheduled to receive coating product(s) shall be compatible with the specified coating product(s). Prior to use, technical data, material safety data sheets and proof of compatibility with the specified coating product(s) of all such materials shall be submitted to the Engineer for approval. Any materials used without prior written approval shall be removed and replaced with approved materials by Contractor without cost to Authority.

A. Standard Portland cement or new concrete (not quick setting high strength cement) shall be cured a minimum of 28 days prior to application of the coating product(s).

8. Remove existing coatings prior to application of the coating product(s) which

may affect the performance and adhesion of the coating product(s).

C. Thoroughly clean and prepare existing products to effect a seal with the coating product(s).

217.2.2 REPAIR PRODUCTS

A. Repair products shall be used to fill voids, bugholes, concrete surface anomalies, and/or smooth transitions between components prior to the installation of the coating product(s). Repair materials must be compatible with the specified coating product(s) and shall be used and applied in accordance with the manufacturer's recommendations.

217.2.3 COATING PRODUCTS

A. Manufacturers: Raven Lining Systems, Broken Arrow, Oklahoma 800- 324-2810, 918-615-0020 or FAX 918-615-0140; A.W. Chesterton, Pasadena, Texas, H&H Restoration, 817-572-2266 or FAX 817-563-5448; Citadel, Tulsa, Oklahoma, 918-584-2220 or FAX 918-584-2221;Belzona,Oklahoma City, Oklahoma 918-636-2942 or FAX 866-695-8559; Warren Epoxy Coating, Frisco,TX 214-548-0123.

B. Epoxy Coating System. Epoxy coating system shall be Raven 405, Shesterton S1HB, Citadel SLS-30, Belzona 5811 Immersion Grade, or Warren S-301-14.

C. Primer Product(s): Primer must be compatible with the specified coating product(s) and shall be used and applied in accordance with manufacturer's recommendations.

217.2.4 COATING APPLICATION EQUIPMENT

A. Manufacturer approved heated plural component spray equipment.

B. Hard to reach areas, primer application and touch-up may be performed using hand tools.

217.3 EXECUTION

217.3.1 EXAMINATION

A. Appropriate actions shall be taken by Contractor to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety during work.

B. All structures to be coated shall be readily accessible to Contractor.

C. New Portland cement concrete structures shall have cured a minimum of 28 days since manufacture prior to commencing coating installation.

D. Any active flows shall be dammed, plugged or diverted as required to ensure all liquids are maintained below or away from the surfaces to be coated.

E. Coating product(s) application shall not occur unless the temperature of the surface to be coated is between 40 and 120 deg F.

F. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat source.

G. Surface temperature logs shall be maintained by Contractor and used to Identify when temperatures vary greater than 5°F. Coating product(s) application shall be scheduled when the temperature is falling versus rising. (Coating Metal)

H. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Authority, in writing, of any noticeable disparity in the site, structure or surfaces which may Interfere with the work, use of materials or procedures as specified herein.

217.3.2 SURFACE PREPARATION

A. Concrete surfaces to receive coating shall be inspected prior to surface preparation to determine the condition of the surfaces specified to receive the coating product(s) and the appropriate method or combination of methods to be used for surface preparation to meet the requirements of the coating system(s) to be applied.

B. When required, the Manufacturer's Representative shall approve surfaces for application of coating at each stage. Any material that Is coated prior to the Authority's approval shall be stripped back and recoated.

C. Oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence,sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate shall be removed per ASTM D-4258.

D. Concrete fins, protrusions, burrs, sharp edges and concrete spatter shall be corrected by grinding or scraping.

E. Unless otherwise submitted and approved by the Engineer, surfaces to receive coating shall be abrasive blasted per ASTM D-4259 to remove laitance and weak concrete to expose subsurface voids, open honeycomb and air pockets. After blasting, surfaces shall be cleaned of all loose blast grit, dust and other debris by sweeping, vacuuming, air blasting and washing as necessary.

F. Surface preparation method(s) used shall be performed In a manner that provides a uniform, sound clean neutralized surface suitable for the specified coating product(s).

G. Infiltration shall be stopped by using a material which is compatible with the repair products and is suitable for topcoating with the coating product(s).

217.3.3 APPLICATION OF REPAIR PRODUCTS

A. Repair products shall be used to fill all voids, honeycombs, bug holes, spalls, cracks and other surface anomalies which may affect the performance or adhesion of the coating product(s) including their use to smooth or rebuild surfaces with rough profiles to provide a minimum profile of coarse (60) abrasive paper comparative to ICRI Replicas 4-6 (ICRI Guideline 03732) and suitable for the coating product(s) to be applied.

B. Repair products shall be handled, mixed, installed and cured in accordance with manufacturer guidelines.

C. All repaired surfaces shall be inspected for cleanliness and suitability to receive **the** coating product(s). Additional surface preparation may be required prior to coating application.

217.3.4 APPLICATION OF COATING PRODUCT(S)

A. Application procedures shall conform to the recommendationsof the coating product(s) manufacturer, including environmental controls, product handling, mixing, application equipment and methods.

B. Spray equipment shall be specifically designed to accurately ratio and apply the coating product(s) and shall be in proper working order.

C. Contractors qualified in accordance with Section 1.4 of these specifications shall perform all aspects of coating product(s) installation.

D. Prepared surfaces shall be primed by application of the waterborne epoxy primer described herein at an application rate of 200 square feet per gallon (8 mils wet film thickness). The primer shall be allowed to dry to a tack free state. The monolitic lining system shall be continuously bonded to all brick, mortar, and concrete inside the structure. Coating thicknesses shall be a minimum of 125 mils for new structures and 250 mils for rehabilitated structures.

E. No more than 12 hours shall be permitted to pass between each application of the waterborne epoxy, the solvent-free epoxy primer and the epoxy topcoat. Subsequent topcoating or additional coats of the coating product(s) shall occur within the product's recoat window as adjusted for temperature extremes. Additional surface preparation procedures will be required if this recoat window is exceeded.

F. Coating product(s) shall interface with adjoining construction materials throughout the structure to effectively seal and protect concrete substrates from infiltration and attack by corrosive elements. Procedures and materials necessary to effect this interface shall be as recommended by the coating product(s) manufacturer.

G. The coating shall be terminated at a saw cut key-in with minimum dimensions of¼" x¼". Surfaces not to receive the coating shall be masked or otherwise protected to prevent overspray or feathering of the coating termination. Termination points of the coating product(s) shall be made at joints and a minimum of 1" interfacing with each pipe penetration, and/or as shown within Project Drawings and Specifications.

H. The system shall effectively seal the interior surfaces of the structure and prevent any penetration or leakage of ground water (infiltration).

217.3.5 TESTING AND INSPECTION

A. During application a wet film thickness gauge, meeting ASTM 04414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used. Measurements shall be taken, documented and attested to by Contractor for submission to Authority.

B. After the coating product(s) have set in accordance with manufacturer instructions, all surfaces shall be inspected for holidays with high- voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays as indicated by the audible or visual signal of the test apparatus shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations.

Documentation on areas tested, results and repairs made shall be provided to Authority by Contractor.

C. A minimum of three (3) 20-mm test dollies shall be placed and pulled to evaluate adhesion/bond of the coating to the substrate for every one (1) out of five (5) manholes. Testing shall be conducted in accordance with ASTM 07234 as modified herein. Authority's representative shall select the location of at least one (1) test in each rehabilitated manhole. The adhesive used to attach the dollies to the coating shall be rapid setting with tensile strengths in excess of the coating product and permitted to cure in accordance with manufacturer recommendations. The coating and dollies shall be adequately prepared to receive the adhesive. Failure of the dolly adhesive shall be deemed a non-test and require retesting. Prior to performing the pull test, the coating shall be scored throughapproximately 90% of the coating thickness by mechanical means without disturbing the dolly or bond within the test area. Two (2) of the three (3) adhesion pulls shall exceed 300 psi or concrete failure, with more than 50% of the subsurface adhered to the coating. Should a structure fail to achieve two (2) successful pulls as described above, additional testing shall be performed at the discretion of the Authority or Engineer. Any areas detected to have inadequate bond strength shall be evaluated by the Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor.

D. Before final cleanup, a final Inspection of the project shall be made of the project for deviations in specifications. Deficient work should be corrected in accordance with repair procedures as approved by the Authority's Representative. The following is a list of qualities or properties that are defined and agreed upon prior to installation and should be inspected in the course of application and after completion:

Uniform color
Straightness and neatness of termination lines Depressions or humps which could affect liquid flow
Smooth transitions at cove radii, internal and external corners, intersections and terminations
Spatter of cured and uncured resinous materials on surfaces not being coated
Complete coverage

E. The municipal sewer system may be returned to full operational service as soon as final repairs have set dry to the touch and the final inspection has taken place.

SECTION END