

**DIVISION II
CONSTRUCTION AND MATERIAL
SPECIFICATIONS SECTION 2600 STORM SEWERS**

**APPROVED AND ADOPTED THIS ____ DAY OF _____,
20__**

**THE CITY OF KANSAS CITY, MISSOURI
WATER SERVICES DEPARTMENT**

Revised April 19, 2019 (See underlined
paragraphs)

**KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS**

ASSOCIATION

As amended by KCMO

TABLE OF CONTENTS

| | |
|---|-----------|
| SECTION 2601 GENERAL | 2 |
| Scope | 2 |
| Referenced Standards | 2 |
| Cleanup | 5 |
| Maintenance Bond | 5 |
| SECTION 2602 PIPE SEWER CONSTRUCTION | 6 |
| Scope | 6 |
| Materials | 6 |
| Construction | 10 |
| SECTION 2603 BORING AND JACKING | 19 |
| Scope | 19 |
| Materials | 19 |
| Construction Details | 20 |
| SECTION 2604 STRUCTURES | 22 |
| Scope | 22 |
| Materials | 22 |
| Construction | 25 |
| SECTION 2605 OPEN CHANNELS | 27 |
| Scope | 27 |
| Materials | 27 |
| Construction | 29 |
| SECTION 2606 MEASUREMENT AND PAYMENT – DELETED | 30 |

CITY OF KANSAS CITY, MISSOURI

**STANDARD SPECIFICATIONS AND DESIGN CRITERIA
SECTION 2600**

This is the Kansas City, Missouri adopted version of Section 2600 revised from Section 2600 of the American Public Works Association, Standard Specifications and Design Criteria. The following pages are approved and adopted as replacement pages to the sections and paragraphs of the Kansas City Metropolitan Chapter's APWA, Standard Specifications and Design Criteria (Metro Chapter Standards) that were adopted by the Chapter on February 15th, 2017 and revised on April 19, 2019. The deletions and additions in the following replacement pages that partially revise and supplement the April 2019 Metro Chapter Standards, the _____, 20__ KCMO version become the Section 2600 for use within Kansas City, Missouri.

Any provisions of this document that conflict with the technical specifications issued by the City for a specific project shall be superseded by those specifications.

Any references to the American Public Works Association or APWA shall mean the KCMO adopted version.

Definition: KC Water shall mean the Director or designee of the City of Kansas City, Missouri Water Services Department.

SECTION 2601 GENERAL

2601.1 Scope

This section governs the furnishing all labor, materials, and equipment necessary for the complete installation of storm sewers and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. Unless otherwise noted within these specifications, the word "sewers" shall refer to pipe sewers, box culvert sewers, or open channels.

2601.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards exist, the more stringent standard shall apply.

APWA-KCMO

Section 2100 Grading and Site Preparation

Section 2150 Erosion and Sediment Control

Section 2200 Paving

Section 2300 Incidental Construction

Section 2400 Seeding and Sodding

ASTM

- A 48 Standard Specification for Gray Iron Castings
- A 139 Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
- A 153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- A 240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
- A 742 Standard Specification for Steel Sheet, Metallic Coated and Polymer Pre-coated for Corrugated Steel Pipe
- A 744 Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
- A 745 Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings
- A 760 Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
- A 761 Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
- A 788 Standard Specification for Steel Forgings, General Requirements
- A 929 Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
- A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- C 33 Standard Specification for Concrete Aggregates
- C 76 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- C 88 Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- C 361 Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
- C 443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- C 478 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
- C 506 Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
- C 507 Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
- C 923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
- C 990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- C 1628 Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets
- D 638 Test Method for Tensile Properties of Plastics.
- D 1683 Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
- D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

- D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D 2510 Resilient Rubber Connectors
- D 3034 Standard Specification for Type PSM Polyvinylchloride (PVC) Sewer Pipe and Fittings
- D 3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*
- D 3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
- D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- D 3681 Standard Test Method for Chemical Resistance of "Fiber glass" Pipe in a Deflected Condition
- D 3754 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
- D 3887 Standard Specification for Tolerances for Knitted Fabrics
- D 4161 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
- D 5034 Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
- F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- F 594 Standard Specification for Stainless Steel Nuts
- F 679 Standard Specifications for Polyvinylchloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings*
- F 894 Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe*
- F 949 Standard Specification for Type PSM Polyvinylchloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings*
- F 2512 Standard Specification for steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and sewerage*
- F 2764 - Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications*
- F 2881 Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications*
- F 2306 Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
- G 152 Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

AASHTO

- M 31 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- M 36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drain
- M 55 Standard Method of Test for Steel Welded Wire Reinforcement, Plain, for Concrete
- M 196 Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
- M 197 Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe
- M 245 Standard Specification for Corrugated Steel Pipe, Polymer-Pre-coated, for Sewers and Drains

M 246 Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Pre-coated, for Corrugated Steel Pipe
M 274 Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
M 294 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ANSI/AWWA

C 206 Field Welding of Steel Water Pipe

ACI 30 Specifications for Structural Concrete

Federal Standard 595B

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference.
However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation

Standard Specifications for State Road and Bridge Construction, Most Recent Version

Missouri Highways and Transportation Commission

Missouri Standard Specifications for Highway Construction, Most Recent Version

2601.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians. If streets are to remain open to traffic, cleaning shall be performed at a minimum of once per day at the end of the day's work or as directed by the Engineer or Owner.

Clean-up shall be considered subsidiary to other items in the Contract Documents.

Section 2601.4 Maintenance Bond

All new storm sewer installations completed by permit with the city shall include a two (2) year maintenance bond.

SECTION 2602 PIPE SEWER CONSTRUCTION

2602.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of pipe storm sewers and appurtenances at the location and to the lines and grades indicated on the Plans. The registered professional engineer shall evaluate the loads on the pipe to determine the appropriate wall thicknesses and class of pipe to be used and submit design calculations to the City for review and approval.

2602.2 Materials

A. Reinforced Concrete Pipe (RCP):

1. Pipe: Reinforced concrete pipe shall conform to the following ASTM Standards and be of the minimum strength designated herein or such higher strength as may be required by the Plans:
 - a. Round Pipe: ASTM C 76, Class III (minimum), Wall B (minimum).
 - b. Arch Culvert Pipe: ASTM C 506, Class A-III.
 - c. Elliptical Pipe: ASTM C 507, Class HE-III.
 - d. *In shallow installations less than 2 feet under pavement, Class V must be used.*

Except for fittings and closure pieces, each joint of pipe shall not be less than eight feet long for pipe diameters 48 inches or less and shall not be less than six feet long for pipe diameters larger than 48 inches.

2. Reinforcement: Circumferential reinforcement shall be full-circle type. Part-circle reinforcement will not be approved. All reinforcing shall be located and spaced as recommended by the pipe manufacturer.
3. Joints:
 - a. Rubber Gasket Joints: Rubber gasket joints shall conform to ASTM C 443 or ASTM C 1628-06 with the following additions and exceptions.
 - i. Replace ASTM C 1628-06 5.1.1 with: Circular Cross-Section or "O-Ring" Gaskets for standard use shall meet Class A requirements. Non-Circular Cross-Section or "Profile" Gaskets for standard use shall meet Class E requirements.
 - ii. Replace ASTM C 1628-06 9.4 with: The manufacturer shall conduct concurrently the hydrostatic test described in 9.2 and the structural test described in 9.3. If proven watertight under these combined conditions, hairline cracks that do not leak shall not be cause for rejection. A vacuum of the American Concrete Pipe Association, may be used in lieu of the hydrostatic test referenced above.

iii. Joint design details shall be submitted for approval together with design data and test results verifying the adequacy of the joint design.

b. Preformed Flexible Joint Sealant: This sealant shall be either rope form or flat tape form conforming to ASTM C 990. Primer, if recommended by the manufacturer, shall be applied within the manufacturers' time requirements on all bell and spigot joint surfaces. Joint shall be thoroughly sealed and watertight.

B. Corrugated Metal Pipe (CMP): Not approved for public infrastructure.

C. High Density Polyethylene (HDPE) Pipe:

1. Material: Pipe manufactured for this specification shall comply with and be certified to meet the requirements for test methods, dimensions and markings found in ASTM F 2306 and AASHTO M-294, current additions. Pipe and blow molded fittings shall be made from PE compounds which conform to the requirements of cell class 435400C in the latest version of ASTM D3350.

2. Pipe Sizes: Nominal sizes for this specification include 12-60 inch diameters designated in AASHTO M294 and ASTM F 2306 as full circular cross section with an outer corrugated pipe wall and essentially smooth inner wall (waterway). Pipe corrugations shall be annular.

3. Steel reinforced pipe meeting ASTM F 2112 or structural profile pipe meeting ASTM F 894 in large sizes up to 132".

4. Joints: Joints shall be water tight meeting ASTM D3212 and have a gasket and may be bell and spigot joints. The fittings shall be fabricated from the same material as the pipe conforming to AASHTO M294. Gaskets shall be furnished in accordance with the Plans and Special Provisions. *Alternate joint methods that meet the water tight conditions of ASTM D 3212 may be acceptable with approval of the Licensed Professional Engineer.*

5. Certification: All high-density polyethylene (HDPE) pipe used for culvert and storm sewer applications shall conform to the requirements of AASHTO M294 and ASTM F 2306, current edition. Pipe shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

6. Pipe Usage: High density polyethylene pipe (HDPE) may not be used for crossroad applications of collector roadways or higher unless approved by the Engineer. If approved by the engineer, HDPE in accordance with ASTM F2648, latest version, may be used in lieu of ASTM F2306 and AASHTO M294 in drainage applications that are

designated as private.

7. Perforated HDPE may be used with GSI (Green Solutions Infrastructure) or French drains.

D. Type PSM Polyvinyl Chloride (PVC) Pipe and Fittings (excluding end-sections):

1. Pipe and fittings shall conform to ASTM D3034 (3" – 15"), ASTM F 679 (18" – 60") or ASTM F 949 (4" – 36") except as otherwise specified herein.
2. General: Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.
3. Materials: The pipe shall be made of PVC plastic having a cell classification of 12454 or 12364 as defined in ASTM D1784.
4. Design: Pipe shall have an integral bell and spigot joint. *The pipe shall have a pipe stiffness of 46 psi or greater.* The maximum cover depth shall be determined by the maximum deflection limit of 5.0%. Heavy wall thickness shall conform to DR 26 (Pipe Stiffness of 115 psi).
5. Joints: Joint tightness shall be water tight and conform to ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F477. Natural rubber gaskets will not be used.

E. Dual Walled Polypropylene Pipe:

1. For 12-inch to 60-inch pipe, polypropylene pipe shall have a double wall with a smooth interior and annular exterior corrugations and conform to ASTM F2881 and AASHTO M330. The pipe shall not be perforated unless otherwise specified.
2. Pipe shall be joined with a gasket integral bell and spigot joint meeting the requirements of ASTM F2881.
3. Joints: Joint tightness shall be water tight and conform to ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Coupling bands shall cover at least two full corrugations on each section of pipe and shall prevent the infiltration of water or soil into the pipe.
4. Certification: All polypropylene (PP) pipe used for culvert and storm sewer applications shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

F. Triple Walled Polypropylene Pipe:

1. For larger than 30" pipe sizes, polypropylene pipe shall have a triple wall with smooth interior and exterior surfaces with inner corrugations and conform to ASTM F 2764 and AASHTO M330 Type D. The pipe shall not be perforated unless otherwise specified.
2. For 36-inch and larger pipe, pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2764. Coupling bands shall cover at least two full corrugations on each section of pipe and shall prevent the infiltration of water or soil into the pipe.
3. Joints: Joint tightness shall be water tight and conform to ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket.
4. Certification: All polypropylene (PP) pipe used for culvert and storm sewer applications shall be provided only by manufacturers that are certified through the National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

G. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe. (FRP):

1. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
2. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
3. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
4. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.
5. Elastomeric Gaskets: Gaskets shall meet ASTM F477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.
6. Joints: Joint tightness shall be water tight and conform to ASTM D3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket.

7. Manufacture and Construction:

- a. Pipes: Manufacture pipe by the centrifugal casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure. The interior surface of the pipes exposed to sewer flow shall provide crack resistance and abrasion resistance. The exterior surface of the pipes shall be comprised of a sand and resin layer which provides UV protection to the exterior. Pipes shall be Type 1, Liner 2, and Grade 3 per ASTM D3262. Compliance testing per ASTM D 3681.
- b. Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D 4161. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.
- c. Fittings: Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy-coated steel and stainless steel fittings may also be used. Fittings and accessories shall conform to ASTM D 3754.

8. Dimensions:

- a. Diameters: The actual outside diameter (18" to 48") of the pipes shall be in accordance with ASTM D 3262. For other diameters, outside diameter shall be per manufacturer's literature.
- b. Lengths: Pipe shall be supplied in nominal lengths of 20 feet. Actual laying length shall be nominal +1, -4 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.
- c. Wall Thickness: The minimum wall thickness shall be the stated design thickness.
- d. Square Pipe Ends: Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/8".

- H. Granular Bedding Material: Refer to Section 2100 Grading and Site Preparation.
- J. Flowable Backfill (CLSM): Refer to Section 2100 Grading and Site Preparation.
- K. RCP is not approved for use in the combined sewer system service area, unless fully separated.

2602.3 Construction

- A. Trench Excavation: Refer to Section 2100 Grading and Site Preparation.
1. Unclassified Excavation: Refer to Section 2100 Grading and Site Preparation.
 2. Rock Excavation: Refer to Section 2100 Grading and Site Preparation.
 3. Earth Excavation: Refer to Section 2100 Grading and Site Preparation.
 4. De-watering: Refer to Section 2100 Grading and Site Preparation.
 5. Cribbing and Sheet piling: Refer to Section 2100 Grading and Site Preparation.
 6. Unstable Foundation: Refer to Section 2100 Grading and Site Preparation.
 7. Protection of Property: The Contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether or not they are shown on the Plans; specifically, but not limited to, damage due to delay in utility relocation.
 8. *Groundwater Barrier: Interrupt continuity of groundwater through embedment material by placing low permeability Groundwater Barrier Material to impede passage of groundwater through the embedment. Groundwater Barrier Material shall be placed at intervals approved by KC Water not to exceed 250 feet and at a minimum of 10 feet outside of any structure.*
 - a. Materials:
 - i. Unpaved Areas: Suitable material classified as SC, CL, or ML-CL. Barriers shall be compacted to 95% maximum dry density in accordance with ASTM D698 with a moisture content range from 3% below optimum to 2% above optimum.
 - ii. Paved Areas: CLSM (Controlled low strength material) Barriers shall be constructed the full depth of the trench and shall include the foundation, bedding, haunching, initial backfill and final backfill zones of the trench. Barriers shall be the full width of the trench excavation and 3 to 5 feet in length measured along the pipe. Registered Professional engineer shall determine if this barrier should be waived or modified for specific installations supported by geotechnical analysis of soil permeability.

B. Laying and Jointing:

1. **Handling and Protection:** All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials.
2. **Grade Control:** Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.
3. **Laying:** The laying of pipe in finished trenches shall commence at the lowest point, and pipe shall be installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. Pipe laid shall be carefully centered to form a sewer with a uniform invert.
4. **Bedding:** Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.
5. **Jointing:** Preparatory to making filled, bonded, and watertight sealed pipe joints, all surfaces of the portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, and other substances that are used shall be compatible with the jointing material recommended or specified.

Other than for trimming sewer pipe to be flush with the inside walls of storm sewer structures, no pipes may be trimmed unless ordered by the Registered Professional Engineer.

Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing, and for as long a period as required to protect the pipe joints and concrete in structures.

As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

a. **Concrete Pipe:**

- i. **Plastic Joint Sealant:** Plastic joint sealant shall be applied to the tongue and spigot prior to its insertion into the bell or groove. A sufficient amount of sealant shall be used to fill the annular joint space with some excess. Wipe the outside surface of the joint with additional material to assure a complete seal.

- ii. Flexible Gaskets: Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in a groove on the pipe tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into position as the joint is assembled. Flat gaskets and O-ring gaskets shall be lubricated as recommended by the manufacturer.
 - a) Flat gasket: Flat flexible gaskets shall conform to ASTM C 443. If there is no recess provided for the gasket, the surface of the tongue shall be cleaned and rubber adhesive applied. Using quick-drying adhesive, gaskets may be applied ahead of the laying operation or in the plant.
 - b) O-ring gasket: O-ring or roll-on flexible gaskets shall conform to ASTM C 361, Section 4.10. The entire surface of the bell that comes in contact with the rubber gasket shall be well lubricated with a soap lubricant. The entire gasket shall be greased with soap. Only the soap lubricant supplied by the pipe manufacturer shall be used. Adhesive type cements shall not be used.
- b. *PVC Pipe: Polyvinyl Chloride (PVC) Pipe with a Smooth Interior: Pipe shall be assembled and installed in accordance with the manufacturer's instructions, ASTM D2321.*
- c. *PP Pipe: Polypropylene (PP): Installation shall be in accordance with ASTM D2321 and manufacturer's recommended installation guidelines. In single run applications, maximum fill heights depend on embedment material and compaction level and shall be in accordance with the manufacturer's guidelines. At a minimum, structural fill shall extend to the top of pipe under pavement and to the pipe spring line outside of pavement.*
- d. HDPE Pipe: HDPE pipe shall be assembled, installed, and backfilled in accordance with ASTM D2321. Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The fittings and couplings bands shall be fabricated from the same material as the pipe conforming to AASHTO M294. The coupling bands shall cover at least two full corrugations of each section of pipe and shall prevent infiltration of soil into the pipe. Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.
- e. *Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe. (FRP):*

- i. *Burial: The bedding and burial of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements.*
- ii. *Pipe Handling: Use textile slings, other suitable materials or a forklift. Use of chains or cables is not allowed.*
- iii. *Pipe Handling: Use textile slings, other suitable materials or a forklift. Use of chains or cables is not allowed.*
- iv. *Jointing: Clean ends of pipe and coupling components. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer. Use suitable equipment and end protection to push or pull the pipes together. Do not exceed forces recommended by the manufacturer for coupling pipe. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the manufacturer.*
- f. *During construction of the project in areas subjected to heavy construction equipment traffic, pipe sizes 12" - 42" shall have a minimum cover of 3 feet, and pipe sizes 48" - 120" shall have a minimum cover of 4 feet without special design by registered professional engineer.*
- g. **Structure Connections:** Pipes connected to structures shall be cut parallel with the inside face of the structure for structures having plane walls and parallel with the spring line of the pipe for structures having curved walls. Projection of the pipe beyond the inside face shall not exceed 1 inch (measured at the spring line for structures having curved walls).
- h. **Backfill of Trenches: General:** Refer to Section 2100 Grading and Site Preparation.

C. TESTING REQUIREMENTS FOR ALL STORM SEWERS:

1. GENERAL:

- a. *All storm sewers, regardless of material, shall be tested as specified herein except as noted. The City/Design Professional must witness the testing for it to be a valid test.*
- b. *There is zero allowable leakage. All storm sewers shall be watertight and free from leaks.*
- c. *All pipes shall maintain their roundness with a maximum deflection of 5%.*

- d. *All defects shall be corrected prior to acceptance by the City.*
- 2. *SAFETY: All work shall be performed in accordance with applicable Occupational Safety and Health Administration (OSHA) standards.*
- 3. *STORM SEWER ALIGNMENT, GRADE, DEFLECTION AND OVALITY TESTING:*
 - a. *The alignment, grade, ovality and deflection defects shall be checked as follows:*
 - i. *Prior to inspection, the Contractor shall clean and flush the storm sewer with clear water to remove dirt, debris etc.*
 - ii. *All storm sewers shall be Laser Profiled to determine the ovality, the presence of any misaligned, displaced or open joints, deflection or other defects. Flexible pipe storm sewers may use mandrel test as an alternative.*
 - iii. *All defects shall be corrected prior to conducting the pressure and leakage test.*
- 4. *PRESSURE AND LEAKAGE TEST FOR INFILTRATION/EXFILTRATION:*
 - a. *Storm Sewer pipe infiltration/exfiltration testing:*
 - i. *There shall be zero leakage on the infiltration/exfiltration test.*
 - ii. *The Contractor shall perform water or air pressure tests on all storm sewers before acceptance by the City. The Contractor shall provide all materials, labor and equipment required for testing including, but not limited to, the following: water, necessary piping connections, test equipment, water meter, pressure gauges, bulkheads, and fittings required for hydrostatic or air pressure testing.*
 - iii. *Pressure and leakage testing for Infiltration/Exfiltration shall be conducted on all storm sewers. Where evidence of infiltration/exfiltration is discovered by the Contractor or by the City/Design Professional, the Contractor shall repair or replace the defective reach of the storm sewer prior to acceptance by the City. Following repair of the pipeline, the Contractor shall retest and make additional repairs until zero infiltration/exfiltration is achieved.*
 - iv. *Pressure and leakage testing for Infiltration/Exfiltration shall be performed by the Contractor using the methods as specified herein. For storm sewers installed in a casing, the required testing shall be*

successfully performed on storm sewers prior to filling the void between the casing and the storm sewer with sand or the sealing of the ends of the casing.

a) *Air Testing:*

- (1) *After backfilling and compaction, each section of storm sewer between structures shall be tested as outlined below.*
- (2) *Contractor shall furnish all materials, labor and equipment required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulator to avoid over pressurization, and all miscellaneous items required.*
- (3) *The pipe plug for introducing air to the storm sewer line shall be equipped with two taps. One tap will be used to introduce air into the line being tested through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. Additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge valve may also be used to indicate loss of air pressure due to leaks in the sewer line.*
- (4) *The pressure test gauge shall meet the following minimum specifications:*

| |
|---|
| <i>Size (diameter): 4-1/2 inches</i> |
| <i>Pressure Range: 0-15 psi</i> |
| <i>Figure Intervals: 1 psi increments</i> |
| <i>Minor Subdivisions: 0.05 psi</i> |
| <i>Pressure Tube: Bourdon Tube or diaphragm.</i> |
| <i>Accuracy: +/-0.25% of maximum scale</i> |
| <i>Dial: White coated aluminum with black lettering, 270degree arc and mirror edge.</i> |
| <i>Pipe Connection: Male 1/2 inch N.P.T.</i> |

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the City/Design Professional whenever air tests are performed.

(5) Plug the ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak then bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 3.0 psig. If the time, in seconds, for the air pressure to decrease from 3.5 psig to 3.0 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Minimum Test Times

| <i>Pipe Diameter (in)</i> | <i>Minimum Time (min:sec)</i> | <i>Length for Minimum Time (ft.)</i> | <i>Time for Longer Length (sec)</i> |
|---------------------------|-------------------------------|--------------------------------------|-------------------------------------|
| 4 | 3:46 | 597 | .380 L |
| 6 | 5:40 | 398 | .854 L |
| 8 | 7:34 | 298 | 1.520 L |
| 10 | 9:26 | 239 | 2.374 L |
| 12 | 11:20 | 199 | 3.418 L |
| 15 | 14:10 | 159 | 5.342 L |
| 18 | 17:00 | 133 | 7.692 L |
| 21 | 19:50 | 114 | 10.470 L |
| 24 | 22:40 | 99 | 13.674 L |
| 27 | 25:30 | 88 | 17.306 L |
| 30 | 28:20 | 80 | 21.366 L |
| 33 | 31:10 | 72 | 25.852 L |
| 36 | 34:00 | 66 | 30.768 L |
| 42 | 39:48 | 57 | 41.883 L |
| 48 | 45:34 | 50 | 54.705 L |
| 54 | 51:02 | 44 | 69.236L |
| 60 | 56:40 | 40 | 85.476L |

L = Total Length

If the air test fails to meet the above requirements, repair or replace all defects and repeat testing as necessary to achieve requirements.

(6) If Polyvinyl Chloride (PVC) pipe is used it shall be air-tested in accordance with the requirements of ASTM F-1417.

b) Hydrostatic test:

(1) The Contractor shall provide all labor, materials and equipment required including water, necessary piping connections, test equipment, water meter, pressure gauges, bulkheads, and all miscellaneous items required for hydrostatic testing.

(2) Test a minimum of 10 lengths of pipe but do not exceed 300 linear feet. Perform before backfilling.

(3) Infiltration: Where storm sewers are laid within the ground water table, infiltration testing shall be conducted. Where evidence of infiltration is discovered by the City/Design Professional, the Contractor shall install weirs or other suitable flow rate measuring devices adequate to achieve zero leakage. The Contractor shall repair or replace the defective reach of storm sewer. Following the repair of the storm sewer, the Contractor shall re-measure the infiltration and make additional repairs until zero leakage is achieved.

(4) Exfiltration:

i. Test section shall be filled not less than twelve (12) hours prior to testing. Refill test section prior to performing test.

ii. Perform at depths of water as measured above center line of pipe of not less than 4 feet or more than 10 feet (consideration shall be given for water table above said centerline). Maintain test as necessary to locate all leaks but not less than two hours in order to achieve zero leakage.

iii. Protect structures by means of bulkheads to prevent pressures from being applied inside the structure.

5. **STORM SEWER PIPE OVALITY AND DEFLECTION TESTING:**

- a. *The deflection and ovality testing shall be conducted thirty (30) days after final trench backfill.*
- b. *The storm sewer shall be Laser Profiled or flexible pipe storm sewers may be mandrel tested. The mandrel device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe. Dimensions shall be per the appropriate standard. The "D" mandrel dimension shall carry a tolerance of + or - 0.01 inch. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the "D" dimension but shall be counted in as a part of the five (5) percent or lesser deflection allowance. Contact length (L) shall be measured between points of contact on the mandrel arm. The length shall not be less than twelve inches.*
- c. *The mandrel shall be hand-pulled by the Contractor through all storm sewers. Any sections of storm sewer not passing the mandrel test or Laser Profiling results shall be uncovered and the Contractor shall repair or replace the storm sewer to the satisfaction of the City. These repaired segments shall be retested by the Contractor.*

SECTION 2603 BORING AND JACKING

2603.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of steel casings, complete with bulkheads and sand fill, by boring and/or jacking at the locations and to the lines and grades indicated on the Plans, or where constructed at the Contractor's option, when approved, to bypass obstructions without open cutting.

2603.2 Materials

A. Steel Casing:

1. Steel casing for bored or jacked construction shall conform to ASTM A139.
2. Steel shall be grade B under railroads and grade A for all other uses.

3. Minimum wall thickness for steel casing shall be in accordance with the following table:

| <u>Diameter of Casing</u> | <u>Under Railroads</u> | <u>All Other</u> |
|---------------------------|------------------------|------------------|
| 24" | 0.406" | 0.281" |
| 26" | 0.438" | 0.281" |
| 28" | 0.469" | 0.312" |
| 32" | 0.500" | 0.312" |
| 34" | 0.500" | 0.312" |
| 36" | 0.500" | 0.344" |

4. Casing joints shall be welded by a certified welder in accordance with ANSI/AWWA C206.

- B.** End Seals: End seals shall be manufactured end seals, concrete plugs with allowances for water flow, or brick shall be in accordance with ASTM C 32, Grade SS or SM and mortar in accordance with ASTM C 270.
- C.** Sand Fill: Sand fill shall comply with ASTM C 33 or MCIB Section 4, Fine Aggregate. Moisture content of the sand shall not exceed 0.5%.

2603.3 Construction Details

A. Boring and Jacking:

1. Prior to starting work, complete details of the methods and the liner material to be used shall be submitted to the Engineer for approval.
2. The maximum allowable deviation from indicated alignment and grade shall be as follows except when altered by the Plans or Special Provisions:
 - a. Alignment..... 1.0%
 - b. Grade 1.0%

B. Casing Installation:

1. The steel casing shall be advanced in a continuous operation without interruption. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses including jacking stresses. The casing in its final position shall be within alignment and grade tolerances specified in Section 2603.3.A.2. There shall be no space between the earth and the outside of the casing. Any voids which do occur shall be filled by pressure grouting.
2. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Boring shall be performed in a manner to prevent disturbing the overlying and adjacent materials.

3. Jacking:
 - a. Jacking frame, guides, blocking, head, and reaction devices shall be arranged to apply uniform pressure about the casing circumference without damage to the casing material, and to maintain alignment within specified tolerances.
 - b. Jacking reaction device shall provide adequate resistance to withstand 200 percent of the maximum jacking pressure.
 - c. Provide jacks of adequate number and size for the required jacking pressure; but not less than two jacks.
 - d. Maintain jacking pit and pipe installation in such condition that drainage does not accumulate. Control and disposition of surface and subsurface water at the site of jacking operations shall be the Contractor's responsibility.
 - e. Excavation at the heading shall not be extended more than 1 inch outside the top and sides (upper 300-degree sector) of the casing and shall be true to grade at the invert (lower 60- degree sector).
 - f. Once jacking begins, it shall proceed without interruption until installation of the entire length of the jacked casing is complete.
4. Excavation in Jacked Casings: Perform excavation within jacked casings by hand or machine methods as necessary to remove the materials encountered without disturbing the overlying material. The jacked casing shall be advanced a sufficient distance ahead of the excavation face and/or shield used as necessary to protect the workman and the work, and to prevent the uncontrolled entry of unstable materials into the casing.
5. Unstable Materials: If materials are encountered during casing installation that cannot be excavated safely or without creating voids around the exterior of the casing, the Contractor shall discontinue casing installation and stabilize such materials by dewatering, chemical soil stabilization, grouting, or other methods, and/or modify equipment and procedures as necessary to complete the casing installation.

C. Sewer Pipe Installation:

1. Pipe shall be placed inside the casing to the indicated line and grade by the use of wood skids or other equivalent methods. The wood shall be pressure-treated with a preservative in accordance with ASTM D 1760. Cut surfaces shall be given 2 heavy brush coats of the same preservative. The wood skids shall be securely fastened to the sewer pipe with steel straps.
2. End seals shall be constructed after the sewer pipe is installed and approved.

3. The annular space between the casing and sewer pipe shall be filled with sand blown in so that all space is filled without disturbing the alignment and grade of the sewer pipe. Flowable Backfill (CLSM) meeting Section 2100, may be substituted in lieu of sand fill. Alternative methods may be submitted for approval by the Engineer.

SECTION 2604 STRUCTURES

2604.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of all work necessary for construction of cast-in-place and precast concrete structures for inlets, manholes, junction boxes, box culverts, headwalls, *thermo molded PVC inlet structures* and incidental structures.

Masonry or brick structures shall not be allowed under these Specifications.

2604.2 Materials

- A.** Concrete Mixes: Concrete shall be MCIB Mix Number A 558-1-2-0.421 or KCM MB 4K, unless otherwise specified.
- B.** Concrete Materials:
 1. For KCM MB mixes, concrete shall be an approved mix with admixtures that are approved for use in that mix design.
 2. For MCIB mixes:
 - a. Air-entraining admixtures shall provide an air content within the range of 4 1/2 to 7 1/2 percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
 - b. Portland cement: Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
 - c. Fine Aggregate: Fine aggregate shall be clean, natural sand meeting the requirements of ASTM C 33. Grading shall be within the limits as set forth by MCIB.
 - d. Coarse Aggregate: Coarse aggregate shall be limestone meeting the requirements of ASTM C 33. The sum total of all deleterious material shall not exceed the requirements of ASTM C 33.
 3. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.

- C.** Reinforcing Steel: Reinforcing bars shall conform to ASTM A615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.
- D.** Precast Concrete Structures:
1. Manholes: Precast manholes shall conform to ASTM C 478.
 2. End Sections for Concrete Pipe: Shall be flared end sections of the pipe manufacturer's standard design, and shall meet all applicable requirements of ASTM C 76 for Class II or higher classes of pipe.
 3. Rectangular Structures: Shall conform to the inside dimension indicated on the Plans and be designed for the following loads:
 - a. HS-25 live load for all structures in/or under pavement, shoulders, driveways, and other traffic areas.
 - b. 2,000-lb wheel live load for curb opening inlets and junction boxes in non-traffic areas.
 - c. 50 pcf equivalent fluid pressure for soil pressure on vertical walls.
 - d. 120 pcf for unit weight of soil cover on top slabs.
 4. Joints: Joints between concrete structures shall be filled with plastic joint compound or preformed plastic compound as stated herein.
 - a. Barrel Sections: Minimum cross sectional area of preformed compound between concrete barrel sections shall be 1 inch square or 1.25 inches diameter. Minimum cross-sectional area of the preformed compound between the concrete adjustment ring and cone barrel section shall be two beads of either 1 inch square or 1.25 inches in diameter.
 - b. Manhole Adjustment Rings: Rings shall conform to Section 2500.
 - c. Manhole Ring and Covers: Rings and covers shall conform to City Standard Drawings, MH-HL, MH-RC or MH-RC3.
 - d. Manhole Chimney Frame Seal: Mastic shall be place between adjustment rings, frame and cone per Section 2500.
 5. *Pipe connections shall be grouted for RDP and resilient rubber connectors per ASTM F 2510 for other pipe materials.*

E. Thermo-Molded PVC Inlet Structures (Allowed in limited space installations with approval of the City):

1. *General. The PVC Inlet Structure shall be custom manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the furnished configuration. PVC Curb Inlet Structures shall include a drainage pipe connection meeting watertight requirements as outlined in ASTM D3212. A customized weir and an external locking ductile iron casting shall be available upon request.*
2. *PVC Inlet Structures shall be 18" – 36" size with custom configurations as specified by engineer.*
3. *PVC Inlet Structures to be custom manufactured according to plan details. Excess height may be cut to proper elevation in field, with City/owner approval.*
4. *Drainage connection stub joint tightness shall confirm to ASTM D3212 for HDPE, Polypropylene (PP) & PVC or equal.*
5. *Adapters shall be mounted in various angles from 0 to 360 degrees in accordance with drawings, while allowing for minimum angle between adapters.*
6. *Castings shall be ductile iron per ASTM A536 Grade 70-50-05 for either grate inlets or curb inlets.*
7. *Concrete collars shall be installed in traffic loading situations according to manufacturer's installation recommendations as shown on City standard drawing details.*
8. *Weirs shall be custom built from gage 304 stainless steel specified as shown on drawings.*
9. *Diameters: The nominal diameters shall be in accordance with ASTM F679.*
10. *Heights: PVC Inlet body shall be manufactured and supplied in custom heights up to a total of 120 inches (10 ft.) Heights greater than 10' shall have analysis by Registered Professional Engineer.*
11. *Construction: The specified PVC inlet structure shall be installed using pipe backfill materials and procedures as specified in Section 02200. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The Catch basin body will 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. For H-25 load rated installations, a concrete ring will be poured under and around the grate and frame.

F. Manhole Castings:

1. Rings and Covers: All manhole rings and covers placed in paved areas shall be rated for H25 traffic. Cam lock covers or similar shall not be placed in roadway pavement or used unless shown on the Plans or directed by the Engineer. All covers shall have provisions for opening, such as concealed pick holes.
2. Steps: Steps shall not be installed.

G. Steel End Sections: If specified, steel end sections shall be fabricated from aluminized base metal as specified in Section 2602, and shall be flared end sections of the metal pipe manufacturer's standard design. End sections shall be furnished with a steel toe plate. Bituminous coating is not required.

H. Toe Walls: Flared end sections shall be set on a concrete toe wall centered on the end of the section *or formed with the flared end section*. Concrete toe walls shall be 8 inches thick by 24 inches deep by the width of the end section.

2604.3 Construction

A. Concrete Structures: Concrete construction shall conform to the current ACI 301 Specifications for Structural Concrete.

1. Precast Structures: The Contractor may, at his option, construct precast concrete inlets, junction boxes, and box culverts, in lieu of the cast-in-place structures indicated on the Plans; except that all concrete base slabs for pre-cast inlets, manholes, and junction boxes may be cast-in-place. Solid concrete brick or block shall be used to block inlets and similar structures to grade during placement of base slab concrete. Precast concrete box culvert sections shall be installed on a 4-inch leveling course of untreated compacted aggregate conforming to Section 2200 Paving. Leveling courses shall extend 1 foot past the line of the box section, and be finished to a true plane surface to provide uniform bearing for the precast section. Any adjustments required for precast structures to meet field conditions shall be at the cost of the Contractor.
2. Finishing: Exposed edges of all slabs, walls, and other concrete structures shall be beveled 3/4" or edged with a 1-1/4" radial tool.
 - a. Formed Surfaces: Immediately following removal of the forms, fins and irregular projections shall be removed. Form tie connections, holes, honeycomb spots, and other defects shall be chipped to ensure the voided

area is exposed, and shall be chipped back to solid material. These areas shall be thoroughly cleaned, saturated with water, and painted with a grout approved by the Engineer. The repaired surfaces shall be cured in accordance with these specifications.

- b. Exposed Slabs: Finish for exposed slabs shall be wood float texture. Exposed edges shall be beveled or edged with a radial tool.
3. Form Removal: Forms shall remain in place until the concrete has attained sufficient strength to support loads imposed by backfilling, construction, and traffic. Within 24 hours of form removal, small holes and pockmarks of exposed walls shall be filled with Portland cement grout and rubbed smooth. Concrete voids and honeycombs shall be chipped open with a light hammer to expose weak areas for inspection. At the direction of the Engineer, expansive repair grout shall be used for partial reconstruction of otherwise sound structures.
- a. Walls: Forms shall remain in place for a minimum of 5 days or until the concrete reaches a minimum strength of 2000 psi.
 - b. Slabs: Form shall remain in place for a minimum of 7 days or until the concrete reaches a minimum strength of 3000 psi.
4. Manhole Riser Adjustments: Manhole rings and covers shall be adjusted to match the slope and height, or grade, of pavements. In no case shall the surface pitch of the manhole ring and cover mismatch the pavement slope by more than 1/2 inch. The difference in height between the top of manhole cover and the top of precast cone shall not exceed 24 inches.

In lieu of replacing concrete adjustment rings that are properly seated and structurally sound but have a small fracture, an external rubber chimney may be fitted to secure a watertight seal between the casting (manhole ring and cover) and the concrete cone barrel section.

- B.** Invert Channels: Form concrete invert channels in manholes, inlets, and junction boxes to make changes in direction of flow with smooth curves of as large a radius as permitted by the inside dimension of the structure. Grade changes and transitions shall be smooth and uniform, and all parts of the invert channel and adjacent floor shall slope to drain. Channel bottom shall be finished smooth without roughness or irregularity. Invert channels for precast concrete structures may be cast integrally with the structure base slabs at the Contractor's option.
- C.** Excavation and Backfill: Refer to Section 2100 "Grading and Site Preparation".

SECTION 2605 OPEN CHANNELS

2605.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of open channel lining at the location, and to the lines, grades, and dimensions indicated on the Plans. Grading shall have been previously completed in accordance with Section 2100 Grading and Site Preparation.

2605.2 Materials

- A.** Concrete Materials: Concrete shall be in accordance with 2604.2.B, unless otherwise specified. Reinforcing steel shall conform to ASTM A615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.
- B.** Stone: Stone for riprap shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4: 1. Material shall be free from cracks, seams, or other defects. Shale and stone with shale seams are not acceptable.
1. The minimum unit weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity times 62.4 pounds per cubic foot.
 2. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5 cycles of the sodium sulfate soundness test in accordance with ASTM C 88.
 3. Riprap: Riprap shall have a minimum thickness of 15 inches, or 1.5 times as thick as the larger stones, whichever is greater.

The gradation for riprap (Light Stone) shall be as follows:

| Weight of Stone <u>In Lbs.</u> | Percent Passing <u>by Weight</u> |
|-----------------------------------|-------------------------------------|
| 250 | 100 (minimum) |
| 100 | 50 (maximum) |
| 75 | 70 (maximum) |
| 5 | 90 (maximum) |

The gradation for riprap (Heavy Stone) shall be as follows:

| Weight of Stone <u>In Lbs.</u> | Percent Passing <u>by Weight</u> |
|-----------------------------------|-------------------------------------|
| 1,000 | 100 (minimum) |
| 500 | 50 (maximum) |
| 75 | 90 (maximum) |

The Contractor shall provide certification that the material meets the specified gradations.

- C.** Filter Blanket: Filter blanket may be either of the following types at the Contractor's option:

1. Granular Filter: Granular filter material shall consist of sound, durable rock particles conforming to the following gradation:

Cumulative Percent

| <u>Sieve Size</u> | <u>Passing By</u> |
|-------------------|-------------------|
| 1" | 100 |
| 1/2" | 70 - 100 |
| No. 4 | 50 - 85 |
| No. 10 | 35 - 70 |
| No. 40 | 20 - 50 |
| No. 100 | 15 - 40 |

The Contractor shall provide certification that the material meets the specified gradations.

2. Filter Fabric: Filter fabric shall consist of woven or nonwoven fabric. The synthetic fiber of either the woven or nonwoven fabric shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 100. In addition, filter fabric shall meet the following physical requirements:
 - a. Tensile Strength: Minimum grab tensile strength, both warp wise and filling wise, shall be 200 pounds when tested in accordance with ASTM D 5034, using a 4-inch by 6-inch specimen and a jaw speed of 12 inches per minute.
 - b. Elongation: Grab elongation shall be not less than 15 percent nor more than 60 percent, both warp wise and filling wise, when tested in accordance with ASTM D 5034.
 - c. Tear Strength: Minimum trapezoid tear strength shall be 100 pounds, both warp wise and filling wise. Method of test for woven fabrics shall be in accordance with ASTM D 1117.
 - d. Bursting Strength: Minimum bursting strength shall be 400 psi when tested in accordance with ASTM D 3887.
 - e. Seam Strength: Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
 - f. Width: Filter fabric shall be furnished in widths of not less than 6 feet.

D. Gabion Baskets – Not approved for public infrastructure.

2605.3 Construction

- A.** Foundation Preparation: After completion of grading in accordance with Section 2100, the area to receive channel lining shall be trimmed and dressed to conform to the cross sections indicated on the Plans within a tolerance of plus or minus 1 inch from the theoretical slope lines and grades. All deleterious materials shall be removed from the foundation area.
- B.** Concrete Lining:
1. Preparation: Subgrade shall be moistened by sprinkling. Forms shall be securely staked, braced, and set to line and grade. Reinforcement and tie bars shall be held in position by bar chairs, concrete brick, or other approved devices.
 2. Placing and Finishing: Place, consolidate, and strike off concrete to the thickness indicated on the drawings. Concrete shall be tamped or vibrated to eliminate all voids and bring sufficient mortar to the top for finishing. Surface finish shall be a wood-float finish. Round all edges and joints with a 1/4 inch radius edging tool, except contraction joints may be sawed to a depth of 30 percent of the thickness of the concrete lining after concrete has hardened but before uncontrolled cracking occurs. Apply curing membrane as specified in Section 2000 "Paving".
- C.** Filter Blanket:
1. Granular Filter: Place granular filter to its full thickness in a single operation. Construction methods shall be such that the material is placed without segregation. Compaction of granular filter material is not required.
 2. Filter Fabric: Place filter fabric with its long dimension horizontal and lay free of tension, stress, folds, wrinkles, or creases.
 - a. Place to provide 18 inches minimum overlap at each joint and anchor to prevent dislocation during construction of overlaying material.
 - b. Fabric shall not be left exposed more than two weeks prior to placement of overlaying material. Tracked or wheeled equipment or vehicles shall not be operated on the fabric.
- D.** Riprap Placement: Riprap shall be placed on the prepared foundation in a manner which will provide a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses indicated. A filter blanket of filter fabric conforming to Section 2605.2.C.2 shall be constructed under all riprap **where specified**. Riprap shall be placed to full-course thickness in one operation and in such a manner as to avoid displacing the fabric. The Contractor shall place the riprap in such a way as to not tear, puncture, or shift the fabric. Riprap shall not be dropped more than 3 feet when being placed directly on the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

1. Placing: Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.
 2. Distributing: The larger stones shall be well distributed and the entire mass of stone shall conform to the specified gradation. All material shall be so placed and distributed that there will be no objectionable accumulations of either the larger or smaller sizes of stone.
 3. Hand Placing: It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the specified results.
- E.** Sod: Sod shall be installed as specified in Section 2400 Seeding, Sodding and over seeding, except all sod placed in drainage channels or ditches, including both the side slopes and bottom, shall be anchored in accordance with 2406.

SECTION 2606 MEASUREMENT AND PAYMENT – Deleted

END OF SECTION