

## **DIVISION 5 - DRAINAGE DESIGN REQUIREMENTS**

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### **5.1 General**

- 5.1.1 All drainage plans and construction shall meet or exceed the requirements of the City of Webster, Harris County Drainage District, and all other entities having jurisdiction (e.g., Harris County Engineering, Texas Department of Transportation).
- 5.1.2 All drainage systems that are to become a maintenance responsibility of the City of Webster shall be enclosed storm sewers, except as specifically approved by the City Engineer.
- 5.1.3 Public storm sewers are defined as sewers and appurtenances that provide drainage for a public right-of-way, or more than one private tract, and are located in public right-of-way or easement. Private storm sewers provide internal drainage for a reserve or other tract. Private storm sewer connections to public storm sewers shall occur at a manhole or at the back of an inlet as approved by the City Engineer. All private storm sewers within the public right-of-way shall be constructed in conformance with these Standards.
- 5.1.4 All construction shall conform with the City of Webster Construction Details.
- 5.1.5 All storm sewers and detention shall meet or exceed the requirements of the "Drainage Criteria Manual for City of Houston, Texas" and the requirements of the City of Webster.

### **5.2 Storm Sewer Materials**

- 5.2.1 Recommended pipe materials:
  - A. Storm sewer and culvert pipe shall be polypropylene dual wall pipe, unless specifically approved by the City Engineer. Twelve-inch to sixty-inch (12"-60") diameter polypropylene pipe is to be installed in all private and public storm sewer applications, including inside the city right-of-way and under roadways. Polypropylene pipe and fittings shall be manufactured in accordance with ASTM F2881 or ASSHTO M330: "Standard Specification for (12 in. to 60 in.) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications." Dual wall pipe should consist of a smooth inner wall and annular exterior corrugations. Pipe shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881 and ASHTO M330. Joint shall be watertight according to the requirements of ASTM D3212. Spigots shall have gaskets meeting the requirement of ASTM F477.

Installation shall be in accordance with ASTM D2321 and manufacturer's installation guidelines.

- B. With specific approval from the City Engineer, storm sewer and culvert pipe can be pre-cast reinforced concrete pipe. Concrete pipe shall be manufactured in conformance with the requirements of ASTM C76, "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe", current revision. Reinforced concrete pipe shall be Class III or stronger. The design engineer shall provide for increased pipe strength when conditions of the proposed installation exceed the allowable load for Class III pipe. All concrete pipe constructed in water bearing soil for forty-two inches (42") in diameter or larger, shall have rubber gasket joints meeting the requirements of ANSI/ASTM C443, "Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets", current revision. Concrete pipe with a diameter of less than forty-two inches (42") may be installed using pipe with tongue and groove type joints and Ram-nek, or approved equal, as a joint filler. When specifically approved by the City Engineer, reinforced concrete arch and elliptical pipe conforming to SEPTEMBER 2010 5-2 DRAINAGE ASTM C506 and C507, respectively, current revision, may be installed lieu of circular pipe. Reinforced concrete box culverts shall meet the minimum requirements of ASTM C850, "Pre-cast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers", current revision. Pipe joints for arch and elliptical pipe and box culverts shall be sealed using Ram-nek or approved equal.

5.2.2 Storm sewer outfalls into open channels shall be constructed using corrugated steel pipe. Corrugated steel pipe shall be manufactured in conformance with the requirements of AASHTO Designation M-36-82, current revision. Pipe material shall be Aluminized Steel Type 2, meeting the requirements of AASHTO Designation M-274-791, current revision, or Pre-coated Galvanized Steel, AASHTO M-246, 10-mil coating on both sides. All pipes shall have a full double coating, Type A, in accordance with AASHTO Designation M-190, current revision. Pipe joints and fitting shall meet the minimum requirements of these specifications and shall have an O-ring gasket seal meeting the requirements of AASHTO C-361, current revision. (See the City of Webster Construction Details.)

5.2.3 Storm sewer outfalls shall have slope protection to prevent erosion. Slope protection may be constructed of slope paving or riprap. Slope paving shall be four-inch (4") five (5) sack concrete with six-inch by six-inch (6"x6") welded wire mesh (W14 x W1.4) or three-eighths-inch (3/8") steel rebar on twenty-four-inch (24") centers, each way. Riprap shall be a minimum of six-inch (6") broken concrete rubble with no exposed steel or well-rounded stone and shall be a minimum of eighteen inches (18") thick. Slope protection texturing shall be required where public access likely. Refer to the City of Webster Construction Details for minimum dimensions.

5.2.4 Alternate materials may be used with specific approval of the City Engineer.

### **5.3 Location of Storm Sewer**

- 5.3.1 Public storm sewers shall be located within a public street right-of-way or a storm sewer easement, dedicated to the public and adjoining a public street right-of-way.
- 5.3.2 Recommended alignment within a public street right-of-way.
- A. Boulevard pavement section with median – along centerline of the right-of-way.
  - B. Undivided pavement section – five feet (5') inside the right-of-way.  
  
For all storm sewer located in a public street right-of-way, a minimum distance of two feet (2') shall be maintained inside the right-of-way line to the outside edge of the storm sewer unless otherwise accompanied by an adjacent easement.
  - C. Alternate locations for a storm sewer will be permitted by the City Engineer.
- 5.3.3 Recommended alignment within an exclusive storm sewer easement.
- A. Storm sewers placed in easements shall conform to the requirements of Section 2.4.5.
  - B. Storm sewers within easements shall be placed no closer than five feet (5') measured from the outside edge of the pipe to the edge of an easement, except when adjoining another easement or public right-of-way where the distance may be reduced to two feet (2'). The storm sewer shall be placed in the center of the easement. When the storm sewer easement adjoins a public right-of-way, the easement may be reduced to a minimum of ten feet (10') and the storm sewer may be aligned closer to the right-of-way line, as long as required clearances are met, with specific approval of the City Engineer.

### **5.4 Construction Plan Requirements**

- 5.4.1 A drainage map shall be included in the construction plans. The drainage area map shall include:
- A. Drainage areas, including areas draining from off-site onto or adjoining the project.
  - B. Design storm runoff.
  - C. 100-year storm runoff.
  - D. Route of overland flow including the overflow to a drainage way sized to accommodate the 100-year flow.
  - E. Elevations for the 25-year and 100-year storms in the outfall channel.

- F. Flow per inlet.
- G. Maximum 100-year ponding elevation.

5.4.2 Detailed drainage calculations shall be submitted with the construction plans.

5.4.3 The hydraulic gradient for the design storm shall be shown on the construction drawings. Calculations for the elevation of the hydraulic gradient shall be provided with the design storm drainage calculations.

**5.5 Design Requirements**

5.5.1 Minimum depth of a storm sewer (measured to the top of pipe) shall be twenty-four inches (24") below top of curb or finished grade, whichever is lower. Minimum size storm sewer for main and inlet lead shall be twenty-four inch (24")

5.5.2 Storm sewers shall be bedded using cement-stabilized sand (See specification in Section 4.2.3.) as shown in the City of Webster Construction Details.

5.5.3 Pipe Requirements

A. Reinforced concrete pipe, as described in Section 5.2.1 shall meet or exceed the following minimum requirements:

<u>Pipe Class</u>	<u>Maximum Cover (Ft.)</u>
III	15'
IV	30'

Reinforced concrete pipe installed at a depth greater than thirty feet (30') shall be designed by the engineer for the specific installation and approved by the City Engineer. Reinforced concrete pipe shall be designed in accordance with the American Concrete Pipe Association, "Concrete Pipe Design Manual". Maximum cover on the pipe shall be measured from the top of pipe to the ultimate finished grade or natural ground, whichever is greater.

B. Corrugated steel pipe shall have a minimum thickness as follows:

Pipe Size (Inches)	Corrugations	Minimum Thickness (Inches)
24	2-2/3" X 1/2"	0.052
30- 48	2-2/3" X 1/2"	0.064
54- 72	3" X 1" or 5" X 1"	0.064
78-102	3" X 1" or 5" X 1"	0.079

Bedding for corrugated steel pipe shall be cement stabilized sand (See specification in Section 4.2.3.) and shall have a minimum density of ninety-five percent (95%) Standard Proctor. Corrugated steel pipe less than or equal to fifty-four inches (54") in diameter and less than thirty feet (30') deep shall have the minimum thickness given above. Corrugated steel pipe larger than fifty-four inches (54") in diameter and greater than thirty feet (30') deep shall be designed by the engineer for the specific installation and approved by Community Development Department. Corrugated steel pipe shall be designed in accordance with the American Iron and Steel Institute, "Handbook of Steel Drainage and Highway Construction Products".

5.5.4 Storm sewers shall have a minimum clearance of six inches (6") from all other utilities. The clearance shall be measured from the outside wall of the pipe.

5.5.5 Design storm runoff shall be calculated in accordance with the "Drainage Criteria Manual for City of Houston, Texas".

5.5.6 Hydraulic Requirements

A. Storm sewers shall be designed to have a minimum velocity of three feet per second (3 fps), when flowing full. Manning's formula should be used to compute the size of the storm sewer. Manning's coefficient, n, is 0.013 for concrete pipe and 0.024 for corrugated metal pipe.

B. Minimum acceptable slopes in reinforced concrete pipe storm sewers shall be:

Size of Pipe (Inches)	Fall in Feet		
	Per 100 Feet of Sewer		
24			0.17
30			0.13
36			0.10
42			0.08
48			0.07
54			0.06
60			0.05
66			0.045
72			0.040
78			0.036

84			0.033	
90			0.030	
96			0.028	

- C. Inlet capacity for the design storm shall be computed using a maximum water surface elevation equal to the top of curb at the inlet. Design capacity for a Type B-B or H-2 inlet with a six-inch (6") standard curb shall be five (5) cubic feet per second. Design capacity for a Type B inlet shall not exceed two and one-half (2.5) cubic feet per second.
- D. Design storm flow in a street shall not exceed the capacity of the street, for the water surface equal to the top of curb and shall not exceed the inlet capacity. Design storm flow shall meet City of Houston criteria.
- E. For any public street, the top of curb elevation shall be at or above the 100-year flood plain elevation. For any public street, the maximum public street ponding and flow levels for the street for the extreme event analysis is the lowest of the following: (1) one foot above the natural ground or abutting lots; (2) one foot above top of the street curb; or (3) one foot below the lowest slab elevation of buildings on abutting lots. The City may approve an exception to the drainage requirements if the City approves development with reduced building setbacks and the imposition of the above drainage requirements would result in the streets, sidewalks, or public parking violating federal or state disabled accessibility requirements. In that case, if the underground storm drainage system is correspondingly increased in size to handle that maximum street ponding and flow levels, the City may allow: (1) maximum public street ponding and flow levels that are at least five inches below the lowest building slab elevations on abutting lots; and (2) regardless of any other provision of the Design Standards, building slab elevations on abutting lots that are at least one foot above the adjacent gutter.
- F. All bridges must be a minimum of eighteen inches (18") above the 100-year water surface elevation or in accordance with the Federal Emergency Management Agency (F.E.M.A.) regulations, latest revisions, whichever is greater.
- G. The internal storm drainage system for a regional mall retail development shall be sized for a conduit capacity capable of maintaining hydraulic design conditions below parking lot elevations during a twenty-five (25) year storm with a thirty (30) minute time of concentration.

5.5.7 Storm sewers less than forty-two inches (42") in diameter shall be constructed on a straight horizontal and vertical alignment between manholes. Storm sewers greater than or equal to forty-two inches (42") in diameter may be laid along a curve using manufactured bends of less than or equal to 11-1/4°. Camera inspection may be required on storm sewers constructed along a curve.

## 5.6 Appurtenances

### 5.6.1 Manholes

- A. Manholes shall be placed at all changes in alignment, grade and size of storm sewers; at the intersection of two or more storm sewers; at all inlet leads; and at the end of all storm sewers.
- B. Maximum spacing between manholes shall be six hundred feet (600').
- C. Manhole covers shall be cast iron, traffic bearing, type ring and cover with the words "**CITY OF WEBSTER - STORM SEWER**" cast into the cover.

### 5.6.2 Inlets

- A. Curb inlets shall be spaced and sized to intercept the calculated runoff for the design storm. The water surface elevation at the inlet shall be less than or equal to the top of curb for the design storm flow.
- B. Maximum travel distance of water in the street to a curb inlet shall be three hundred feet (300') on a major thoroughfare and in a commercial area. The maximum travel distance of water in the street permitted in a single-family residential area shall be six hundred feet (300').
- C. Curb inlets should be located on the intersecting side street at an intersection with major thoroughfare. Locations on the major thoroughfare at intersections shall be specifically approved by the Community Development Department.
- D. Grated inlets will not be permitted in an open ditch.
- E. Back slope swale interceptors shall be placed in accordance with the requirements of City of Houston.
- F. H-2 curb inlets are required on all streets that do not access residential lots (D-106). B-B curb inlets may be used on streets with access to residential lots. B-B type curb inlets must have grate inlet lids.
- G. Inlets must be backfilled with 1.5 sacks per cubic yard of cement-stabilized sand placed to the top of first stage inlet.

### 5.6.3 Safety End Treatments (SET)

Safety End Treatments (SET) must be placed on drainage culverts for commercial driveways, public streets, and residential driveways that cross open ditches located in the public right-of-way that are adjacent to and parallel to the public street. Safety End Treatments (SET) specifications shall meet Texas Department of Transportation requirements.