

TABLE OF CONTENTS

CHAPTER 5  
STORM SEWER SYSTEM

	Page
<b>5.00.00 INTRODUCTION</b> .....	<b>5-1</b>
5.01.00 USE OF STORM SEWER.....	5-1
<b>5.10.00 DESIGN CRITERIA</b> .....	<b>5-1</b>
<b>5.20.00 CONSTRUCTION SPECIFICATIONS</b> .....	<b>5-1</b>
5.21.00 EXCAVATION AND TRENCHING .....	5-1
5.22.00 BEDDING.....	5-1
5.22.01 <i>Granular Bedding</i> .....	5-1
5.22.02 <i>General</i> .....	5-1
5.23.00 PIPELINE INSTALLATION .....	5-2
5.23.01 <i>General</i> .....	5-2
5.23.02 <i>Pipe</i> .....	5-2
5.24.00 MANHOLE CONSTRUCTION .....	5-3
5.24.01 <i>Cast-in-Place Base</i> .....	5-3
5.24.02 <i>Pre-Cast Base/Inverts</i> .....	5-3
5.24.03 <i>Pre-Cast Barrel</i> .....	5-3
5.24.04 <i>Inlets</i> .....	5-4
5.24.05 <i>Manhole/Inlet Grouting Treatment</i> .....	5-4
5.24.06 <i>Adjustment Rings</i> .....	5-4
5.24.07 <i>Underdrains and Other Connections</i> .....	5-4
5.25.00 CONNECTIONS TO EXISTING MANHOLES .....	5-4
<b>5.40.00 MATERIAL SPECIFICATIONS</b> .....	<b>5-5</b>
5.41.00 GENERAL .....	5-5
5.42.00 DEFECTS.....	5-5
5.43.00 CERTIFICATION.....	5-5
5.44.00 PIPE.....	5-6
5.44.01 <i>Reinforced Concrete Pipe (RCP)</i> .....	5-6
5.45.00 MANHOLES.....	5-7
5.45.01 <i>General</i> .....	5-7
5.45.02 <i>Manhole Rings and Covers</i> .....	5-7
5.45.03 <i>Manhole Base Slabs</i> .....	5-8
5.45.04 <i>Joint Material</i> .....	5-8
5.46.00 INLETS .....	5-8
5.46.01 <i>General</i> .....	5-8

**CHAPTER 5**  
**STORM SEWER SYSTEM**

**5.00.00**      **INTRODUCTION**

All storm sewer systems shall comply with the requirements of the “City of Westminster Storm Drainage and Technical Criteria Manual”, herein will be referred to as CRITERIA and these STANDARDS AND SPECIFICATIONS.

**5.01.00**      **USE OF STORM SEWER**

The stormwater sewer system includes, but not limited to pipes, culverts, inlets, manholes, underdrains, and stormwater treatment facilities. The use of storm sewers within the City of Westminster shall be in accordance with Title VIII, Chapter 8, of the CITY CODE.

**5.10.00**      **DESIGN CRITERIA**

CRITERIA shall be the design criteria for the analysis and design of storm drainage facilities within the City of Westminster. All subdivisions, resubdivisions, planned unit development, or any other proposed construction submitted for approval under the provisions of the CITY CODE shall include adequate storm drainage system analysis and appropriate drainage system plans in conformance with the requirements of the CRITERIA.

**5.20.00**      **CONSTRUCTION SPECIFICATIONS**

**5.21.00**      **EXCAVATION AND TRENCHING**

Excavation, trenching and backfilling shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

**5.22.00**      **BEDDING**

**5.22.01**      **Granular Bedding**

Granular Bedding is defined as that method of bedding in which the pipe is set on granular material meeting the requirements of Chapter 9 in these STANDARDS AND SPECIFICATIONS. Bedding shall be placed to a depth below the bottom of the pipe equal to one-fourth of the outside pipe diameter but not less than four inches. In the occurrence of rock excavation the CONTRACTOR shall submit means and methods to the CITY ENGINEER for approval. In rock excavation the minimum depth below the pipe shall be six inches. Granular material shall be placed around the sides of the pipe to a depth of 9 inches over the top of the pipe.

**5.22.02**      **General**

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of stabilization shall be as approved by the CITY. Pipe bedding shall be done in accordance with

Sections 5.22.02 or 5.22.03 of these STANDARDS AND SPECIFICATIONS and the detail drawing in the Appendix of this chapter.

## **5.23.00 PIPELINE INSTALLATION**

### **5.23.01 General**

The CITY shall be notified at least 48 hours in advance of any pipe installation. No pipes shall be backfilled until they have been inspected by the CITY INSPECTOR. Alignment and grade of the pipe and the location of fittings, manholes and inlets shall be staked under the supervision of a Professional Land Surveyor registered in the State of Colorado.

Proper implements, tools and facilities shall be provided and used by the contractor for the safe and convenient execution of the work. All pipe sections and pre-cast manholes shall be carefully lowered into the trench by suitable tools or equipment to prevent damage to storm sewer line material. Under no circumstances shall storm sewer line materials be dropped or dumped into the trench.

All pipe fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the CITY. All foreign matter or dirt shall be removed from the interior and ends of the pipe before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. For further requirements see 9.03.01 (B). During construction, the CONTRACTOR shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the WORK.

### **5.23.02 Pipe**

Pipe shall be laid from downstream to upstream with spigot ends pointing downstream. All pipe shall be placed true to line and grade and carefully centered and with a smooth invert at the joint. The joint shall be made in a workmanlike manner and shall be watertight. Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure, without jerky or jolting movements. The pipe shall then be properly set and brought to correct line and grade. All lifting holes shall be filled with cement mortar prior to backfilling only if they penetrate all the way through the pipe. The pipe shall be secured in place by installation of bedding material and backfill, in accordance with Chapter 9 and the detailed drawings in the Appendix of this Chapter.

Pipe deflections are not to exceed manufacturer's recommendations.

Cutting of pipe for inserting closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining, leaving a smooth end at right angles to the axis of the pipe.

No structure shall be installed upon a foundation in which frost has penetrated or at any time when the CITY INSPECTOR deems there is a danger of ice formation or frost penetrations at the

bottom of the excavation. No structure shall be installed unless backfilling can be completed before the formation of ice and frost.

## **5.24.00 MANHOLE CONSTRUCTION**

### **5.24.01 Cast-in-Place Base**

Cast-in-place bases may be allowed with approval of the CITY ENGINEER and shall be in conformance with this section.

Manhole bases shall be constructed with CDOT Class D concrete, placed on undisturbed ground and in conformance with the detail drawing in the Appendix of this Chapter. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. The floor of the manhole outside of the channel shall be finished to a brushed surface. Cast-in-place bases may be used for storm sewer connection to an existing pipe or as approved by the CITY.

Concrete bases shall extend at least eight inches below the invert of the pipe and shall be benched to at least two inches over the top of the pipe. The manhole floor between the storm sewer pipe and the outer portions of the bench shall be flush with the top edges at the pipe spring line and shall slope upward at least two inches per foot.

Where it is not practicable to use split pipe through manholes due to breaks in alignment, grade, or elevation of intersecting storm sewers, the storm sewer invert shall be made of concrete deposited between forms. The shape of the invert shall conform to the lower half of the pipe it connects. Side branches shall be constructed with as large a radius of curvature as possible. Inverts shall be plastered with cement mortar and left smooth and clean. Where called for on the plans, a pipe bell shall be stubbed out and plugged. The bell shall be placed as close to the manhole wall as possible, unless shown otherwise on the approved plans.

Bases shall be reinforced with a grid of #4 rebar on 12 inch centers and bars aligned perpendicular. Reinforcement shall be approved by the CITY INSPECTOR prior to installation.

### **5.24.02 Pre-Cast Base/Inverts**

The ground surface below the precast concrete base shall be excavated six inches below the elevation of the bottom of the base and backfilled with three quarter inch gravel meeting the requirements of Chapter 9 of these STANDARDS AND SPECIFICATIONS. The gravel shall be carefully leveled and smoothed to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole over the storm sewer main. The precast base shall also conform to the requirements of these STANDARDS AND SPECIFICATIONS.

### **5.24.03 Pre-Cast Barrel**

Precast manhole sections shall not be placed on the foundation until it has reached sufficient strength to provide support without damage. The joint between the manhole base and the barrel section shall be made with a flexible butyl resin joint sealing compound or as approved by CITY

ENGINEER. Each succeeding precast section shall be joined in a similar manner and smoothly finished, inside and out. The interior shall have a smooth grout finish. Exterior horizontal joints shall be wrapped with ConWrap joint wrap, or approved equal, and secured to the concrete to provide a watertight seal. Pre-cast barrel section height shall not exceed 48”.

#### **5.24.04 Inlets**

Inlets shall be constructed with CDOT Class D concrete, placed on undisturbed ground and in conformance with the detail drawings in the Appendix of this chapter. The top portion of inlets shall be constructed concurrently within 5 feet of either side of the adjacent curb and gutter to ensure proper alignment of grades unless otherwise permitted in writing by the CITY ENGINEER. Pre-cast inlets may be used as approved by CITY ENGINEER.

#### **5.24.05 Manhole/Inlet Grouting Treatment**

The horizontal joints between precast manhole sections shall be plastered and troweled smooth, inside and out, with non shrink grout. The mortar shall be not less than five eighths inch in thickness over the joint and shall extend at least four inches on either side of the joint. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar.

#### **5.24.06 Adjustment Rings**

Precast concrete adjustment rings shall be used on top of the cone to support and adjust the manhole frame to the required final grade. Refer to detail ST 2 for maximum depth of rings.

#### **5.24.07 Underdrains and Other Connections**

Underdrain connections to the storm sewer system shall be allowed if approved by the CITY ENGINEER and inspected during connection by the CITY INSPECTOR. Other connections not allowed.

### **5.25.00 CONNECTIONS TO EXISTING MANHOLES**

Storm sewer pipe connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work will conform as nearly as practicable to the requirements specified for new manhole construction. The CONTRACTOR shall break out as small an opening in the existing manhole as necessary to insert the new storm sewer pipe. The existing concrete foundation bench shall be shaped to the cross-section of the new pipe in order to form a smooth continuous invert similar to what would be formed in a new concrete base. The downstream invert shall be plugged during construction to prevent storm and non-sewage pollutants from entering the system. The CONTRACTOR shall pump out and clean the manhole before removing the plug. Non-shrink grout shall be used to smoothly finish the new invert and to seal the new line, both inside and outside, so the junction is watertight.

**5.40.00**      **MATERIAL SPECIFICATIONS**

**5.41.00**      **GENERAL**

Only those pipeline materials described in this section are approved for storm sewer installations. Any other material proposed as an equal shall be approved by the CITY ENGINEER prior to construction. All pipe materials to be incorporated in the construction of storm sewers shall conform to the requirements specified herein or as modified elsewhere in these STANDARDS AND SPECIFICATIONS. All materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on the approved drawings or not, and all installations shall be completed and fully operational. Acceptance of materials or the waiving of inspection thereof shall in no way relieve responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS.

All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality and fitness for the work.

**5.42.00**      **DEFECTS**

The presence of any of the following defects in an individual pipe, or in a shipment of pipe, may constitute sufficient cause for rejection of the pipe. Rejected materials shall be removed from the work site within 24 hours unless otherwise permitted by the CITY ENGINEER.

- Pipe length varying more than two inches from the specified length. Pipe shall not be ordered in random lengths.
- Pipe having a deviation from straight which exceeds the following:  
$$\frac{\text{Length of Pipe in Feet}}{32} = \text{Maximum Deviation in Inches}$$
- Porous areas on either the inside or the outside surface of a pipe having an area of more than five square inches and a depth of more than one-half inch.
- Pipe which has been patched or repaired -      Exposure of the reinforcement.
- Pipe damaged during shipment or construction.
- Any deficiencies noted in applicable ASTM Specifications.

**5.43.00**      **CERTIFICATION**

A manufacturer's certification that material was manufactured and tested in accordance with applicable ASTM designations, together with a report of all test results, may be required by the CITY INSPECTOR prior to final acceptance of the work.

**5.44.00 PIPE**

**5.44.01 Reinforced Concrete Pipe (RCP)**

All RCP used in the construction of a storm sewer system within the RIGHT-OF-WAY shall conform to the following specifications:

Pipe – ASTM C76 – Reinforced Concrete Culvert, Storm Drainage and Sewer Pipe for Class II, III, IV, and V.

TABLE 5.44.01

Maximum Fill Heights for Reinforced Concrete Pipe  
In Clay Soils with Granular Bedding

PIPE SIZE (INCHES)	CLASS II	MAXIMUM COVER (FEET)				CLASS V
		CLASS III	CLASS IV	CLASS V		
18	>	11	16	25+		
21	>	11	16	25+		
24	>	11	17	25+		
30	>	11	17	25+		
36	>	11	17	26+		
42	8	11	17	27+		
48	9	12	17	27+		
54	9	12	17	27+		
60	9	12	17	27+		
66	9	12	17	27+		
72	10	12	18	28+		
78	10	12	18	28+		
84	10	13	18	28+		
90	10	13	18	28+		
96	10	13	18	28+		
102	10	13	18	28+		
108	10	13	18	28+		
114	10	13	18	28+		
120	10	13	18	28+		
144	10	13	18	28+		

For Greater fill depths, consult Concrete Pipe Design Manual

**\*\*\* MINIMUM COVER FOR ALL CLASSES OF PIPE SHALL BE 12" BELOW TOP OF SUBGRADE**

Joints – ASTM C443 – Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.

## O-Ring/Profile Rubber Gaskets – AASHTO M198

All RCP shall be constructed with Type II modified cement. The absorption of the pipe shall not exceed 5.5 percent.

All concrete pipe fittings, wyes, tees, and bends shall be cast as an integral part of the pipe to which they are attached and shall be the same pipe classification.

The following shall be clearly marked on the exterior surface of all pipe with waterproof paint.

- ASTM Specification.
- Class and Size.
- Date of Manufacture.
- Name or Trademark of Manufacturer.

## **5.45.00 MANHOLES**

### **5.45.01 General**

Manholes, reducing sections, ladder rungs and traffic lids shall be precast and conform to ASTM C-478 and be no larger than 48” in height.. All traffic lids shall be designed for AASHTO HS-20 traffic loading. All ladder rungs or manhole steps shall be cast into the manhole barrel when the manhole barrel is poured unless approved otherwise, in writing, by the CITY. Concrete reducing sections shall not be used. Concrete extension collars shall be used to bring the manhole ring and cover up to approved street or ground surface elevation.

Concrete used in the manufacturing or construction of manholes shall be a minimum of Class D concrete in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

Precast manhole risers and cone sections shall be manufactured in conformity with ASTM Designation C-478.

Concentric cones are not allowed.

### **5.45.02 Manhole Rings and Covers**

All cast iron manhole rings and covers and other iron castings shall conform to the requirements of AASHTO M105/ASTM A48 Class 35B. Ductile Iron castings shall conform to the requirements of ASTM A536. All castings shall conform to Federal Specification RR-F-621E, for shape and dimension required. Castings shall be free from sand, blowholes, shrinkage, cracks, and other cold shuts and be well cleaned by shot blasting. Runners, risers, fins, and other cast-on pieces shall be removed from the castings and ground smooth. Bearing surfaces between manhole rings and covers shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact.



Manhole frame or ring dimensions shall be 24" diameter, 8" tall or as otherwise approved.

Cast iron ring and covers shall have a combined weight of not less than 365 pounds.

Fittings shall be hot dipped, factory applied, water base, asphalt paint to form a firm and tenacious coating.

Acceptable product is EJ #2405A, Product #240565 (storm vault only) or approved equal.

#### **5.45.03 Manhole Base Slabs**

Manhole base slabs may be poured in place or precast. The slab shall be designed to uniformly support AASHTO HS-20 traffic loading and any earth loading. The minimum cast in place slab thickness shall be eight inches. The minimum reinforcement in the base slab shall conform to the detail drawings of this Chapter.

#### **5.45.04 Joint Material**

Joint material used to set barrel sections shall be a flexible buytl resin joint sealing compound meeting Federal Specifications SS-S-00210-A and AASHTO M 198-B.

### **5.46.00 INLETS**

#### **5.46.01 General**

Concrete used in the manufacturing or construction of inlets shall be a minimum of Class D concrete in accordance with Chapter 7 of these STANDARDS AND SPECIFICATIONS.

Manhole ring and cover for Type R inlets shall conform to Section 5.45.02.