

CHAPTER 5

Storm Sewer

A. Introduction

All proposed developments shall have a properly designed and constructed storm water conveyance system. This chapter deals only with the conveyance system. Storm water retention/detention is discussed in Chapter 4 of this manual.

Each subdivision shall have a separate storm system with an adequate outlet or connection to an existing storm system. Storm systems shall be provided to accept and convey storm waters entering the subdivision according to the requirements of the City.

All designs shall coordinate with the City's Comprehensive Storm Water Master Plan and Storm Water Management Ordinance. Oversized mains, neighborhood ponds, and other coordinated facilities shall be discussed with the Public Works Director/City Engineer prior to commencing design.

B. Design Requirements

1. All storm drainage system construction plans, specifications, and drainage calculations shall be designed, prepared, stamped, and signed by a registered, professional engineer in the State of Wisconsin. Submittals for approval must include all design data and calculations.
2. All storm sewers and appurtenances shall be designed to conform to the standard specifications.
3. All storm sewer mains shall be installed in the public ROW or easements, and shall be dedicated to the City upon subdivision acceptance. Easements shall be a minimum of 20 feet wide for minor storm sewer mains and 30 feet wide for major storm sewer mains (> 36 inches or deeper than ten feet at the flow line).
4. Prior to storm sewer and drainage system acceptance, as-built drawings must be delivered to the City Engineer in the City's current Microstation digital format and hard copy format.
5. Any storm extension project shall include extending the storm sewer along the full length of the property if necessary to serve the adjacent property upon ultimate development.
6. Relief Swales

- a. Natural watercourses or ditches and sodded swales are classified as relief swales if they convey the 100-year storm.
- b. In areas where relief swales are not provided, the underground storm sewer system shall be designed with adequate capacity for 100-year storm conditions.
- c. Relief swale capacity shall be determined using the Manning equation.
- d. Roughness coefficients in the equation are as follows:

<u>Material</u>	<u>Manning's n</u>
Ordinary concrete or asphalt	0.013
Sodded channel	0.20
Natural channels in good cond.	0.25
Natural channels with stones	0.35
Earth	
Clean, recently completed	0.016 - 0.018
Clean, after weathering	0.018 - 0.020
With short grass, few weeds	0.022 - 0.027
Rock	
Design section	0.035
Actual section smooth & uniform	0.035 - 0.040
Actual section jagged & irregular	0.040 - 0.045
Channels Not Maintained	
Dense weeds, high as flow depth	0.08 - 0.12
Clean bottom brush on sides	0.05 - 0.08
Grass Channels & Swales	
Depth of flow up to 0.7 feet	
Mowed to 2"	0.07 - 0.045
Length 4" - 6"	0.09 - 0.05
Length about 12"	0.18 - 0.09
Length about 24"	0.30 - 0.15
Depth of flow 0.7 - 1.5 feet	
Mowed to 2"	0.05 - 0.035
Length 4" - 6"	0.06 - 0.04
Length 12"	0.12 - 0.07
Length 24"	0.20 - 0.10

- e. If the roughness is not uniform across the relief swale, an average value based on the above table shall be computed.

7. Mainline

- a. All storm sewers shall be designed to flow by gravity.
- b. Storm sewer pipe design calculations shall be submitted for review. Poor design calculations may be rejected. The City will not act as the Design Engineer for any Owner.
- c. Unless indicated by the City Engineer, all storm sewers shall be designed based on the rational method design. If pre-approved by the City Engineer, alternate computer based methods are acceptable.
- d. The design storm shall be 10-year return frequency and may be adjusted by the City Engineer in certain locations because of downstream capacity restraints, or if increased flows must be accommodated to prevent flooding conditions.
- e. The acreage used in the design formula shall be the watershed area tributary to the point under consideration, including tributary areas lying outside the development not provided with storm water holding facilities. It is the responsibility of the designer to include off site influences. The City will supply any public records necessary to aid the designer, for the prescribed public records fee.
- f. Duration time used in selecting a specific point on the curves shall be equal to the time of concentration. The time of concentration is defined as inlet time plus the flow time between the most distant inlet and the point under consideration. The minimum duration time shall be fifteen (15) minutes.
- g. Fifteen (15) minute initial inlet time shall be used.
- h. The intensity value (I) shall be based on the attached Table 5-A (see next page).
- i. Runoff Coefficient
 - 1) The runoff coefficient (C) is the ratio of runoff to rainfall.
 - 2) The runoff coefficient for impervious areas shall be 0.95. Gravel is considered impervious.
 - 3) The runoff coefficient for pervious areas shall be 0.25.
 - 4) The runoff coefficient shall be the weighted average for the tributary watershed based on the above percentages.
 - 5) The runoff coefficient shall be computed assuming ultimate development within the development.

- 6) Where ultimate development plans are not available, the City Engineer shall select a coefficient based on zoning classification and knowledge of the specific development.
- j. Maximum gutter flow shall be determined and calculated according to State Standards.
- k. The Design Engineer shall submit a drainage basin plan marked to indicate individual watersheds tributary to storm inlets, or manholes with contributory areas. Each storm structure shall be numbered and the watershed acreage shown on the plan.
- l. The minimum allowable pipe size is 12" in diameter, except for building service lines.
- m. The minimum pipe velocity shall be 2.0 fps, flowing full. The maximum pipe velocity shall be 15.0 fps, flowing full.
- n. Storm sewer pipes shall be designed using the Manning Formula.

$$V = \frac{1.486}{n} R^{2/3} S^{1/2}$$

where

n = 0.013, for concrete pipe, etc.

R = sewer cross section area divided by the wetted perimeter

S = slope of the hydraulic gradient

V = mean velocity

- o. Sewers shall be laid straight in both horizontal and vertical planes between manholes unless otherwise approved by the City Engineer.
- p. Where storm sewers of different diameter join, the invert elevations shall be adjusted to maintain a uniform energy gradient. (Top of pipe to match)
- q. When the City Engineer approves full-flowing sewers that produce velocities greater than 15' per second, special provisions shall be taken to prevent erosion or pipe displacement.
- r. Any outfall storm sewer that drains into an existing open ditch or natural watercourse shall have a reinforced concrete head wall or end wall section.
- s. Riprap or other energy-dissipating devices are required at all discharge points.
- t. Minimum cover for storm sewers in non-pavement areas shall be 2 feet.

- u. Minimum cover for storm sewers and laterals in paved areas shall be 1 foot, measured from the top of the pipe to the top of the subgrade.
- v. All storm sewers constructed within the ROW and/or designated as part of the public site improvements, shall be a minimum class III reinforced concrete pipe or better with rubber gasket-type joints, except driveway culverts, which may be corrugated metal pipe. PVC pipe schedule may also be accepted for mains and inlet laterals with more than three feet and less than ten feet of cover in permanently non-paved areas.
- w. The City Engineer may approve other types of pipe as listed below.
 - 1) Reinforced Concrete Culvert Storm Drain and Sewer Pipe, ASTM C76
 - 2) Concrete Sewer, ASTM C14
 - 3) Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe, ASTM C507
- x. Individual driveway culverts may be CMP and shall have a minimum size of 15". Culverts shall be sized to accommodate a 50-year storm event.
- y. A stronger class of pipe shall be used to provide protection against structural failure when subject to all future dead loads, live loads, and impact, as determined by the design engineer.
- z. Live load plus impact shall be assumed to be less than that resulting from a surcharge at the ground surface of 250 pounds per square foot. The field-supporting strength of the pipe shall be the three edge-bearing test strength to failure multiplied by the load factor for the particular type of bedding or cradling used.

8. Storm Laterals

- a. The location of the storm sewer lateral shall be in accordance with File #50 of the Standard Sewer Specifications and the lateral shall extend to two feet beyond the street Right-of-Way or to the property side of a utility easement.
- b. Storm sewer lateral lines shall be designed to receive the storm water runoff from roof drains, areaways, window wells, footing drains, and sump pumps.
- c. When the storm sewer lateral line connection or connections to the storm sewer system are intended to receive other than pumped flow, inlet time assumed in determining the time of concentration will be reduced to 5 minutes.

- d. Storm sewer lateral lines shall meet all the requirements of the storm sewer system as detailed in this chapter except for materials, and their minimum diameter shall be 6".
- e. The end of the Storm Laterals shall be marked with a wood 2"x4" or #4 rebar as shown in the Typical Storm Building Lateral drawing in Appendix A. The 2"x4" shall be painted green.

9. Sump Pumps, Down Spouts, and Roof Drains

- a. Sump pumps, down spouts, and roof drains shall be connected to a storm sewer system if one exists adjacent to the lot.
- b. If storm sewer is not provided or if a rural section exists, then sump pumps shall be installed to receive and discharge ground water or other storm water from footing drains so that they freely discharge to an open ditch located along the frontage of the property. They must be connected to the City system as soon as one becomes available as per City of Manitowoc ordinance.

10. Storm Inlets

- a. Storm Inlets shall have a maximum spacing of 300' and shall be located so that no surface water shall be carried across or around any street intersection.
- b. Side and rear lot inlets shall be placed so that no surface water will be carried for a distance greater than 300'.
- c. Computations shall be determined according to the WDOT, FDM, or the Neenah Design Charts for inlet capacities.
- d. A 10% maximum carryover flow may be permitted along pavement slopes in excess of 1%.
- e. Channelized storm runoff in excess of 0.5 cfs shall discharge into a catch basin or inlet before crossing a sidewalk or curb.
- f. The storm inlet rim elevations shall be located at least 1.5' above the hydraulic grade line.
- g. Rear and side lot inlet rim elevations must be at least 1' above the hydraulic grade line unless storage is provided at the inlet.
- h. No more than three inlets shall be daisy chained before the flow enters a storm main.

- i. Storm inlets shall be Type 3 pre-cast concrete with internal dimensions of 24" x 36", with a minimum depth of 3' (flange line to invert).
- j. Steps shall be provided for any storm inlet greater than 4' in depth, from flange to bottom.

11. Manholes and Junction Chambers

- a. Manholes or junction chambers shall be provided at the following locations:
 - 1) At the termination of all sewers which do not terminate at a storm inlet.
 - 2) At all changes in size when the downstream sewer is greater than 12" diameter.
 - 3) At all sewer main connections, except in the case of a lateral connection where the lateral is no greater than 10", in which case a direct connection may be made.
 - 4) At a spacing no greater than 400' (350' spacing is recommended).
- b. All manholes shall be pre-cast unless they are of special design and are specifically approved by the Engineer.
- c. Manholes shall be sized as follows:

Downstream Pipe Size	Minimum Manhole Internal Diameter
Less than or equal to 30"	4'- 0"
Greater than 30" to 36"	5'- 0"
Greater than 36" to 42"	6'- 0"
Greater than 42"	Special Design Required

- d. All manholes shall be pre-cast reinforced concrete, with offset cone tops (pre-cast corbel section.)
- e. Where field conditions prevent the manhole construction with an offset cone top, a reinforced pre-cast flattop (slab or deck) with an opening for the casting may be specified, with the City Engineer's approval.
- f. Sidewall thickness shall be governed by the Standard Specifications.

- g. Steps meeting the requirements of the Standard Specifications shall be installed in all manholes or inlets deeper than 4', from manhole or inlet floor to rim.
- h. All manholes in field or easement areas shall be marked with a steel channel post extending 4' (feet) above grade. The steel post shall also have a reflective marker attached to the top of the post.

12. Frames and Grates

- a. Standard vertical curb inlet frames and grates shall be Neenah R-3067-R, or equal as approved by the City Engineer.
- b. Mountable curb inlet frames and grates shall be Neenah R-3501-R, or equal as approved by the City Engineer. Mountable curbs are not recommended and can only be installed with specific written permission from the City Engineer.
- c. Manhole frames and grates in field inlet applications shall be Neenah R-2560-E, or equal as approved by the City Engineer.
- d. Manhole frames, lids, and grates in pavement applications shall be Neenah R-1550 Type "B" lid and R-1050 non-rocking type, or equal as approved by the City Engineer.

13. Frame Adjustments

- a. Metal adjusting rings shall be used to adjust manhole rim grades for resurfacing projects and for surface placement in new developments. These rings shall be Neenah R-1979, or equal as approved by the City Engineer.
- b. All other frame adjustments shall be made with pre-cast adjustment rings only.
- c. Maximum ultimate chimney height shall not exceed 12" from the top of the pre-cast section to the bottom of the casting.
- d. Minimum ultimate chimney height shall be 2" as specified above.
- e. The minimum thickness of individual pre-cast adjusting rings shall be 2". The maximum shall be 4".

14. Roadside Ditches

- a. Minimum distance from the ditch centerline to the shoulder edge shall be 7'.
- b. Under no circumstances shall the top of bank be closer than 3' to the pavement edge.

- c. Ditch depth shall be 24" minimum to 39" maximum as measured from the shoulder edge. Consideration shall be given to lateral cover when designing ditches.
- d. Ditch slopes shall be 1% minimum to 5% maximum.
- e. Ditch side slopes shall be 4:1 typical, however, no steeper than 3:1.
- f. Ditch restoration shall be according to the contract documents. However, grades greater than 3% shall be sodded and staked, or stabilized by other means approved by the City Engineer.
- g. Enclosing roadside ditches shall not be permitted.
- h. In unique cases, the City Engineer may approve enclosing roadside ditches for the following reasons:
 - 1) Authorized drive approaches, public walks, or courtesy walks.
 - 2) Protection of roots or trees in or near the ditch.
 - 3) When temporary ditches are to be abandoned, the minimum size culvert shall be 15" meeting a 50-year design frequency.
 - 4) When the ditch depth exceeds the maximum allowable as specified previously.

C. Construction Requirements

- 1. Existing field or drain tiles must be connected to a storm sewer or have positive outfall provided.
- 2. All materials and installations shall conform to the Standard Specifications.
- 3. All storm sewers shall be free from debris, sedimentation, or garbage prior to City acceptance. Televised reports will be required to verify the condition of the main.
- 4. All pre-cast barrel joints and chimney sections shall have mastic placed between them.
- 5. Excavation backfill shall be compacted in 12" lifts within the street ROW. The backfill material will be as specified in the contract documents or as specified in the Standard Specifications.

D. Testing and Inspection

1. Inspection
 - a. A full-time inspector shall be on the job site during the unloading of all materials and during construction of the storm sewer and laterals. The contractor is responsible for notifying the City Engineer 48 hours before the start of construction. Contractor shall supply material certification sheets prior to unloading of any material.
2. Tests
 - a. It shall be the intention of this section to secure a sewer system with a minimum amount of infiltration.
 - b. Subsequent to the construction of the storm sewer, the City Engineer will require television inspection and videotaping of all sections of the sewer. The videotapes and reports must include footage counters for reference purposes. This shall be performed at no cost to the City. No acceptance will be granted until the videotaping is completed.
 - c. All public improvements required by this manual and those that are to be accepted by the City for maintenance and ownership shall be inspected during the course of construction and at completion.
 - d. The contractor without delay shall take care of all defects and corrective work required as the result of television inspection. Upon completion, the sewer shall be retested and further inspection may be required.
 - e. PVC sewers must be deflection tested by visual examination via videotape and by use of a mandrel.