Omaha Regional Stormwater Design Manual

Introduction

Chapter 1

Revised June 2014

City of Omaha Environmental Quality Control Division
www.omahastormwater.org

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Chapter 1 Introduction

1.1 Purpose

Providing adequate drainage in urban areas has been proven as a necessary component in maintaining the overall health, welfare, and economic well being of a region. Drainage is a regional feature that affects multiple jurisdictions and all parcels of land. It is important to develop drainage policy that balances both public and private considerations (UDFCD, 1969).

Certain underlying principles should be applied when planning drainage facilities. These principles apply to both water quantity and water quality management. Policy statements and technical criteria serve as the implementation tools for the underlying drainage principles (UDFCD, 1969).

The purpose of this Stormwater Design Manual, in conjunction with the development of overall master planning of the major watersheds throughout the Omaha, Nebraska metropolitan area, is to provide drainage facilities in urban areas that minimize the disruption of the community while improving the overall health and welfare of the region in an economical way. Upon adoption by the Omaha City Council, this manual will be applicable to all areas within Omaha zoning jurisdiction. In order establish uniform and consistent design standards, the City of Omaha also authorizes and encourages other communities in the region to incorporate this manual by reference in their respective jurisdictional codes and regulations.

1.2 Contents

This Manual has been prepared for the City of Omaha, Nebraska and the Papio-Missouri River Natural Resources District (P-MRNRD) to provide guidance to design engineers, hydrologists, water quality specialists, and others involved in the management of stormwater runoff. The Stormwater Management Systems Design Procedure is outlined in Appendix 1-A, and a Glossary of Key Terms is included as Appendix 1-B.

The Manual is comprised of nine technical chapters that provide guidance on the major aspects of urban stormwater management and drainage facility design. The Manual is intended to be an effective and practical resource that provides users with proven engineering approaches along with illustrative examples. The Manual represents a compilation of a large amount of technical information in a single document, which should help minimize the need for multiple outside references.

It is assumed that the user has basic knowledge of hydraulics, hydrology, and stormwater management concepts. While some theory is presented in the Manual, the text is devoted more to the practical application of the theory, as it relates to drainage management and design.

1.3 Objectives

Drainage, flood control, and water quality protection in the greater Omaha metropolitan area are an integral part of the comprehensive planning process. Drainage represents only one component of a larger urban system. The objectives of the City of Omaha and other communities that adopt this manual with respect to drainage, flood control, and water quality protection are to:

- To protect the general health, safety, and welfare of the residents of the region.
- To minimize property damage from flooding, including minimization of localized neighborhood flooding.
- To ensure that new buildings and facilities are free of flood hazard from major and smaller storm runoff events.
- To minimize water quality degradation by limiting the amount of sediment generation and erosion of channels.
- To encourage the retention of open space, particularly along natural drainageways.
- To plan for large and small flooding events by providing both major and minor drainage systems.
- To implement reasonable, cost effective best management practices (BMPs) for sediment control and water quality enhancement.
- To manage stream and drainage channel corridors to maintain environmental diversity and to protect buildings and facilities from damage by channel erosion.
- To stabilize channels to, among other things, minimize the disruption of existing infrastructure such as bridges and utility lines.
- To comply with the applicable National Pollutant Discharge and Elimination System (NPDES) permit requirements.
- To develop equitable methods to adequately fund construction, operation and maintenance, and administration of an up-to-date stormwater management program.
- To minimize future operating and maintenance expenses.
- To educate the public on stormwater policies and administrative procedures.
- To build a regional stormwater program based on understanding and cooperation with builders and developers, providing for effective administrative authority for the cities, counties and P-MRNRD.

The strict application of this Manual in the overall planning of new development is practical and economical; however, there are many built-up areas within and around the City of Omaha which will not conform to the drainage standards proposed in this Manual. In fact, the problems associated with these areas provided some of the impetus for the development of this Manual. The up-grading of built-up areas to conform to the policy, criteria, and standards contained in this Manual may be difficult, and sometimes impractical. Therefore, in the planning of drainage improvements in built-up areas, it is recommended that the design approaches presented in this Manual be adjusted to optimize the benefit to cost ratio.

1.4 Planning Concepts

The following general principles apply when planning for and designing urban storm drainage systems (ASCE, 1992):

1.4.1 Drainage Requires a Regional Solution

Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between public and private properties. Therefore, a successful plan must integrate regional jurisdictional cooperation, where applicable, to accomplish established goals. The City of Omaha will seek the cooperation of P-MRNRD and the cities and counties in the greater metropolitan area to minimize the contribution of all storm drainage systems to flooding and in the preparation and implementation of regional master drainage plans.

1.4.2 Storm Drainage is a Sub-System of the Total Urban System

Drainage is a sub-system of all urbanization. The planning of drainage facilities must be included in the urbanization process. The first step is to include drainage planning with all regional and local urban master plans.

Stormwater management facilities, such as open channels and storm drains, serve both conveyance and storage functions. When a channel is planned as a conveyance feature, it requires an outlet as well as downstream space to safely convey and mitigate adverse impacts from the design flows. The space requirements for adequate drainage may become a competing use for space with other land uses. If adequate provision is not made in the land use plan for the drainage requirements, stormwater runoff will conflict with other land uses, will result in water damages, and will impair or even disrupt the functioning of other urban systems (Tulsa, 1993).

1.4.3 Urban Areas Have Two Drainage Systems

Urban areas are comprised of two drainage systems. The first is the minor or primary system, which is designed to provide public convenience and to accommodate relatively moderate frequent flows. The other is the major system, which carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system.

1.4.4 Runoff Routing is a Space Allocation Problem

Analysis and design of drainage systems generally should not be based on the premise that problems can be transferred from one location to another.

1.4.5 Stormwater Runoff as a Resource

Stormwater runoff and the facilities to accommodate the runoff can be an urban resource when properly included in the urban system. Drainageways can provide environments for various life forms such as aquatic life, mammals, birds, and vegetation. In many cases the drainage facilities can provide areas for active and passive recreation for citizens to enjoy. Although sometimes a liability to urbanization, stormwater runoff can be beneficial as an urban resource (Tulsa, 1993).

When stormwater runoff is treated as a resource, water quality aspects become important. As such, it is important to implement best management practices (both structural and nonstructural) for water quality and effective erosion and sediment control.

1.4.6 Utilize the Features and Functions of the Natural Drainage System

Every site contains natural features that may contribute to the management of stormwater under existing conditions. Each development plan should carefully map and identify the natural system. Natural engineering techniques can preserve and enhance the natural features and processes of a site and maximize post-development economic and environmental benefits. Good designs improve the effectiveness of natural systems, rather than negate, replace, or ignore them.

1.4.7 Post-Development Flow Rates

In new developments, post-development flow rates shall be controlled to achieve the goals and objectives of the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009.

1.4.8 Design the Stormwater Management System from the Point of Outflow

The downstream conveyance system should be evaluated to ensure that it has sufficient capacity to accept the major and minor storm design discharges without adverse backwater impacts on the proposed conveyance system. Adverse downstream impacts such as flooding, streambank erosion, and sediment deposition must also be prevented or mitigated. Guidance for design to avoid such problems is provided in Chapter 5.

1.4.9 Provide Regular Maintenance

Failure to provide proper maintenance reduces both the hydraulic capacity and pollutant removal efficiency of the system. Effective maintenance relies on clear assignment of tasks and a regular inspection schedule. Maintenance for local amenities (such as open drainageways, BMPs detention/retention facilities, etc.) will be provided consistent with the policies established in the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009, in compliance with the applicable local codes and regulations, and implemented through advance formal agreements between the entities with jurisdiction or responsibility.

1.4.10 Preventive and Corrective Actions

In existing urban settings, it may be necessary to develop a stormwater management strategy based upon both preventive and corrective measures. For example, structural corrective measures such as inlets, storm drains, interceptor lines, channelized stream sections and reservoirs affect and control storm runoff and floodwaters directly. Nonstructural corrective measures, such as floodproofing and land use adjustments, help limit activities in the path of neighborhood storm runoff or in river floodplains. Preventive actions available for reducing storm runoff and flood losses include: flood-prone land acquisition, floodplain regulations, and control of land uses within flood-prone areas.

1.5 Criteria Summary

1.5.1 Drainage Design and Technical Criteria

The design criteria presented in this Manual are based on national engineering state-of-the-practice for stormwater management, modified to suit the specific needs of Omaha metropolitan area. Extensive input from the City of Omaha, P-MRNRD and other stakeholder groups was used to develop and refine the criteria. The criteria are intended to establish guidelines, standards, and methods for effective planning and design. The criteria should be revised and updated as necessary to reflect advances in the field of urban drainage engineering and urban water resources management.

1.5.2 Minor and Major Drainage Systems

Every urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the *minor* system and the other is the *major* system. To provide for orderly urban growth, reduce costs to taxpayers, and avoid loss of life and property damage, both systems must be planned and properly engineered and maintained.

1.5.2.1 Minor Drainage System

The minor drainage system is typically thought of as storm drains and related appurtenances, such as inlets, curbs and gutters. For residential areas, downtown areas, and industrial/commercial areas in Omaha, the minor drainage system design will provide capacity and management for the 10-year return frequency storm runoff, under assumed ultimate upstream development conditions.

During design, the hydraulic grade line for all enclosed systems shall be determined to ensure that inlets act as inlets, not outlets. All easements for newly constructed storm drainpipe should be a minimum of 30 ft. wide. In situations where the engineer can clearly demonstrate that an easement less than 30 ft. is adequate, the City may consider such a request. Easements wider than 30 ft. may be necessary for storm drainpipe and surface water flowage where a drainageway must be designed and maintained to carry stormwater flow in excess of the storm drainpipe capacity.

1.5.2.2 Major Drainage System

The major drainage system is designed to convey runoff from, and to regulate encroachments for, large, infrequently occurring events. When development planning and design do not properly account for the major storm flow path, floodwaters will seek the path of least resistance, often through individual properties, thus causing damage. An assured route of passage for major storm floodwaters should always be provided such that public and private improvements are not damaged. For subdivisions in Omaha, this need is to be provided for both in watershed headwaters settings and along major drainageways.

The 100-year return frequency storm under assumed ultimate upstream development conditions shall be the major drainage system design storm for all new developments. Runoff from major storms should pass through a development without flooding buildings or homes. Overland flow routes can be provided using streets, swales, and open space.

Open channels for transportation of major storm runoff are desirable in urban areas and use of such channels is encouraged. Open channel planning and design objectives are best met by using natural, or natural-type channels, which characteristically have slow velocities, and a large width to depth ratio. Optimum benefits from open channels can best be obtained by incorporating parks and greenbelts with the channel layout.

To the extent practicable, open channels should follow the natural channels and should not be filled or straightened significantly. Effort must be made to reduce flood peaks and control erosion so that the natural channel regime is maintained. Channel improvement or stabilization projects are encouraged which minimize use of visible concrete, riprap, or other hard stabilization materials to maintain the riparian characteristics.

1.5.3 Storm Runoff Computation

The calculation of the storm runoff peaks and volumes is important to the proper planning and design of drainage facilities. The calculation of runoff magnitude shall be by either the rational method, the Soil Conservation Service (SCS, now known as the Natural Resource Conservation Service) TR-55 method, or using the SCS method in the U.S. Army Corps of Engineers (USACE) HEC-HMS software. Other potential methods for calculation of runoff shall require advance approval from the City Department of Public Works.

1.5.4 Detention

Detention facilities shall have release rates that do not increase the potential for downstream flooding and are consistent with the policies of the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009. Submittal of hydraulic design calculations is required to document that major and minor design storm peak flows are adequately attenuated.

1.5.5 Streets

The primary drainage functions of streets are to convey nuisance flows quickly and efficiently to the storm drain or open channel drainage with minimal interference to traffic movement and to provide an emergency passageway for the major flood flows with minimal damage to adjoining properties, while allowing for safe movement of emergency vehicles.

The allowable use of streets for new land development in metropolitan Omaha for minor and major storms runoff in terms of pavement encroachment is presented in Chapter 3.

1.5.6 Flood Corridor Management

In all watersheds where a FEMA Flood Insurance Study (FIS) floodway has not been delineated, development shall preserve a corridor with a minimum width consistent with the policy of the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009.

1.5.7 NPDES Construction Site

A NPDES notice of intent and a Stormwater Pollution Prevention Plan (SWPPP) shall be required before land disturbance or vegetation removal activities occur on any site 1.0 ac. or greater in size (see Chapter 9). Structural and non-structural best management practices (BMPs) may be required to address stormwater quality enhancement.

1.5.8 Water Quality

Both structural and nonstructural best management practices (BMPs) are recommended that address long-term stormwater quality enhancement. Effective, reasonable, and cost-effective BMPs should be selected for implementation on a site-specific basis and in a manner that is consistent with the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009.

The following is a list of voluntary structural BMPs that should be considered:

- Create temporary ponding areas on parking lots and in landscaped or turfed open areas of building sites
- Use porous or turf pavement for remote parking areas
- Reduce the amount of impervious area directly connected to the storm drain system
- Intentionally create longer vegetated drainage paths for minor storm events
- Encourage use of constructed wetlands
- Develop multipurpose extended detention facilities
- Use retention facilities (wet ponds) where feasible

The following is a list of voluntary non-structural BMPs that is encouraged:

- Use of appropriate vegetation to reduce the need for fertilizer and pesticides
- Preservation of environmentally sensitive areas to protect them from development or other disruption
- Set aside more open space
- Preserve or re-establish riparian vegetation
- Implement staged grading of developments to minimize the amount of land disturbed at one time

Additional structural and nonstructural BMPs are presented in Chapters 8 and 9 of this Manual.

1.6 Interrelationship Between Stormwater Quantity and Quality Management

With urbanization, the hydrology of a watershed changes in three important ways: (1) the total runoff volume is greater, (2) the runoff occurs more rapidly, and (3) the peak discharge is greater. The increase in runoff volume results from the decrease in infiltration and depression storage. The shortened time base results from the greater flow velocities in the drainage system. The increase in peak discharge is the inevitable consequence of a larger runoff volume occurring over a shorter time. This increase in peak discharge for any storm means a related high discharge occurs more frequently (ASCE, 1992).

Receiving water impacts are caused by a combination of physical and chemical effects. Impacts associated with stormwater discharges can be discussed in terms of three general classes:

- Short-term changes in water quality
- Long-term water quality impacts
- Physical impacts

Short-term changes in water quality occur during and shortly after storm events. Long-term impacts are caused by the cumulative effects associated with repeated stormwater discharges. Physical impacts include erosional effects of high stream velocities that occur after the natural hydraulic cycle has been altered. More frequent occurrences of high discharges may cause or intensify channel erosion problems, disrupting the riparian habitat both where the erosion occurs and where the additional sediment is deposited downstream (ASCE, 1992).

The City of Omaha has seen the consequences of rapid urbanization on the water quality of its receiving streams. Consequently, this Manual is part of an effort to more effectively manage both stormwater quantity and quality in accordance with the Papillion Creek Watershed Partnership, Watershed Master Plan, 2009 policies. By implementing well-planned and designed engineering approaches, the necessary measures can be taken to minimize the cumulative water quality and water quantity impacts that result from urbanization.

1.7 Limitations

The interpretation and application of the provisions in this Manual shall be the minimum requirements for promotion of the health, safety, convenience, order and general welfare of the community. The standards, however, should not be construed as rigid criteria. Rather, the criteria are intended to establish guidelines, standards and methods for sound planning and design. The City may set aside these criteria in the interest of the health, safety, convenience, order and general welfare of the community.

The Manual is not intended to interfere with, abrogate, or annul any other regulation, statute, or other provision of the law. Where any provision of this Manual imposes restrictions different from those imposed by any other provision of this Manual or any other regulation or provision of law, that provision which is more restrictive or imposes higher standards shall govern.

1.8 Updating

The criteria presented in this Manual may be amended as new technology is developed and/or experience is gained in the use of the criteria indicate a need for revision. Amendments and revisions to the Manual will be made by the City when necessary to accomplish the goal of reasonable public protection from surface water runoff.

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Appendix 1-A
Stormwater Management Systems
Design Procedure

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I. Project Startup Feasibility Analysis

A. Identify goals, objectives and issues
   1. Wetlands and wildlife
   2. Floodplains and other drainageways
   3. Erosion and sediment control and stream channel stability
   4. Stormwater management goals and objectives
   5. Adjoining stormwater systems
   6. Probable future development

B. Collect basic data
   1. Topographic information
   2 Survey and boundary data
   3 Soils and geologic data
   4 Utilities
   5 Hydrologic and hydraulic data
   6 Regulatory data
   7. Previous studies
   8. Evidence of historic flooding
   9. Projected land use
   10. Existing floodplain maps

II. Planning and Preliminary Engineering Design

A. Prepare or obtain development plan

B. Develop conceptual stormwater management plan alternatives

C. Prepare preliminary design
   1. Select runoff method based on area
   2. Determine design storm frequencies
      a. Major storm
      b. Minor storm
   3. Locate outfalls and assure adequate outfall capacity
   4. Obtain rainfall
   5. Evaluate run-on
      a. Master planned basins
      b. Non-master planned basins
   6. Identify natural drainageways
   7. Delineate subbasins
   8. Calculate runoff for pre-and post-development conditions
   9. Refine conceptual alternatives
   10. Perform drainage calculations
   11. Determine preliminary conduit and open channel size

12. Select storage facility type
    a. On channel
    b. Off channel
    c. Regional
    d. "Wet"
    e. "Dry"
13. Determine preliminary storage facility volume
14. Define preliminary design
    a. "Dry"Drainage pattern and flow rates
    b. Preliminary system layout
15. Check flood risk on upstream and downstream properties due to proposed development

III. Final Engineering Design

A. Review all preliminary work and evaluate goals, objectives and issues
B. Obtain final street grades and geometrics
C. Coordinate
   1. Water
   2. Sewer
   3. Paving
   4. Public utilities
D. Hydraulically design the storm drain systems
   1. Street and intersection design
      a. Determine street classification(s)
      b. Determine street capacity for minor and major storms
      c. Compare street conveyance capacity with grading plan
   2. System layout
      a. Location requirements
      b. Manhole spacing
      c. Grade and cover/Structural loading
   3. Hydraulic design of storm drain conduit (establish HGL)
      a. Closed conduits
      b. Pressurized conduits
      c. Structures
      d. Outfalls
   4. Storm drain inlets
      a. Location and spacing
      b. Types
         (1) Curb inlets
         (2) Grate inlets
         (3) Special purpose inlets
   5. Culverts and bridges
      a. Determine overtopping frequency
      b. Perform hydraulic analysis
      c. Energy dissipation/outlet treatment
      d. Analyze debris control
      e. Structural loading

6. Drainageways (open channels)
    a. Select channel type
    b. Hydraulic analysis
    c. Channel stability analysis and design

E. Stormwater storage facilities
1. Environmental and water quality considerations
2. Determine storage and outlet characteristics
    a. Storage requirements including sediment accumulation
    b. Basin configuration
    c. Embankment criteria
    d. Spillway sizing and performance during extreme events
    e. Outlet performance
    f. Operation and maintenance
    g. Trash Racks

F. Water quality enhancement
1. Develop water quality control strategy
2. Select site control measures
    a. Structural BMPs
    b. Non-structural BMPs
3. Implement water quality management measures

G. Develop erosion and sediment control (ESC) plan
1. Identify soil erosion factors
2. Develop ESC strategy
3. Select BMPs
4. Design BMPs
5. Prepare Stormwater Pollution Prevention Plan (SWPPP)
6. Submit SWPPP

H. Economic and safety considerations

IV. Submittals and Review

V. Construction Phase

A. Obtain approvals and permits
B. Site observations
C. Prepare record drawings

VI. Operation and Maintenance Phase

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Appendix 1-B

Glossary of Key Terms

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1-year Flood: The flood typically occurring or being exceeded in any given year.

2-Year Flood: The flood having a fifty percent chance of being equaled or exceeded in any given year.

5-Year Flood: The flood having a twenty percent chance of being equaled or exceeded in any given year.

10-Year Flood: The flood having a ten percent chance of being equaled or exceeded in any given year.

Base Flood or 100-Year Flood: The flood having a one percent chance of being equaled or exceeded in any given year.

Compensatory Storage: Replacement of storage volume that is hydrologically equivalent to lost storage when encroachment occurs in the floodplain or flood-prone area.

Conveyance structure: A pipe, open channel, or other facility that transports runoff from one location to another.

Drainage criteria: Specific guidance provided to the engineer/designer to carry out drainage policies. An example might be the specification of local design hydrology ("design storm").

FEMA: The Federal Emergency Management Agency.

Flood Fringe: That portion of the floodplain which is outside of the floodway

Flood Insurance Rate Map (FIRM): Flood Insurance Rate Map (FIRM) shall mean the Flood Insurance Rate Map, and any revisions thereto, on which FEMA has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

Floodplain: Those lands which are subject to a one percent or greater chance of flooding in any given year, as shown on the Flood Insurance Rate Map (FIRM) most recently issued by FEMA, or as revised in accordance with FEMA-recognized processes.

Floodplain planning/floodplain management: Technical and nontechnical studies, policies, management strategies, statutes and ordinances that collectively manage floodplains along rivers, streams, major drainageways, outfalls, or other conveyances. The federal government normally plays a major role in floodplain planning and management, whereas in urban stormwater management and design, local governments dominate the decision-making process.

Floodprone Area: Those lands which are subject to a one percent or greater chance of flooding in any given year, as determined by hydrologic and hydraulic studies completed by the City or other government agency, or other acceptable source as approved by the City where this is the best available information.

Floodway: The channel of a river or other watercourses and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

Major drainageway: A readily recognizable natural or improved channel that conveys runoff that exceeds the capacity of the minor drainage system, including emergency overflow facilities.

Major system: The portion of the total drainage system that collects, stores, and conveys runoff that exceeds the capacity of the minor system. The major system is usually less controlled than the minor system, and will function regardless of whether or not it has been deliberately designed and/or protected against encroachment, including when the minor system is blocked or otherwise inoperable. It may be collinear with, or separate from, the minor system. It should be noted that there are those who object to the use of the terms "major" and "minor" to describe portions of the drainage system, perhaps because these terms imply that the minor system is less important. Other terms (primary system, convenience or basic system, overflow system, major/primary drainage ways, subordinate system, etc.) have been suggested. Major/minor are used in this Manual because they seem to be the most widely used terms.

Master drainage plan: The plan that an engineer/designer formulates to manage urban stormwater runoff for a particular project or drainage area. It typically addresses such subjects as characterization of site development; grading plan; peak rates of runoff and volumes of various return frequencies; locations; criteria and sizes of detention ponds and conveyances; measures to enhance runoff quality; salient regulations and how the plan addresses them; and consistency with secondary objectives such as public recreation, aesthetics, protection of public safety, and groundwater recharge. It is usually submitted to regulatory officials for their review.

Minor or primary system: The portion of the total drainage system that collects, stores and conveys frequently-occurring runoff, and provides relief from nuisance and inconvenience. This system has traditionally been carefully planned and constructed, and normally represents the major portion of the urban drainage infrastructure investment. The degree of inconvenience the public is willing to accept, balanced against the price it is willing to pay, typically establishes the discharge capacity or design recurrence frequency of a minor system. Minor systems include roof gutters and on-site drainage swales, curbed or side-swaled streets, stormwater inlets, underground system sewers, open channels and street culverts.

Multiple-purpose facility: An urban stormwater facility that fulfills multiple functions such as enhancement of runoff quality, erosion control, wildlife habitat, or public recreation, in addition to its primary goal of conveying or controlling runoff.

Outfall facility: Any channel, storm drain, or other conveyance receiving water into which a storm drain or storm drainage system discharges.

"Risk-based" design: Design of urban stormwater management facilities not only on the basis of local standards, but also on the basis of the risk (cost) of the flow exceeding a selected design. Virtually all stormwater management projects have some component of risk which is inherent in selection of a design return frequency. Risk may also account for special upstream or downstream hazards that would be posed by adherence to some recommended standard. For example, the designer of culverts in a subdivision might choose to upsize particular storm drains from a 10-year to a 50-year basis to protect properties, or to make other provisions to secure emergency discharge capacity.

Special structures: Those components of urban drainage systems that can be thought of as "features" or "appurtenances" such as manholes, inlets, energy dissipaters, transitions, channel slope protection, detention ponds and dams, and outlet works.

"Standard-based" design: Design of urban stormwater management facilities based on some specified set of regulatory standards. An example is the stipulation in local drainage policies that culverts for a given subdivision all be designed to pass the 100-year flood before road overtopping.

Storm drain: Often buried pipe or conduit, typically referred to as storm sewer that conveys storm drainage, also includes, curb & gutter, grate & curb inlets, swales, open channels, and culverts.

Stormwater detention: The temporary storage of stormwater runoff in ponds, parking lots, depressed grassy areas, rooftops, buried underground tanks, etc., for future release. Used to delay and attenuate flow, normally drained between storms.

Stormwater retention: Similar to detention except the facility may have a permanent pool of water or wet land that does not drain between storms.

Stream Crossing Structures: Structures used to convey pedestrians, motor vehicles, and/or utilities across drainageways. Stream crossing structures are composed of the structure, abutments, guard rails, fill, and other structural appurtenances that are generally perpendicular to the conveyance of flow within the floodplain or floodprone area.

Urban area: Land associated with, or part of, a defined city or town. This Manual generally applies to urban or urbanizing, rather than rural, areas.

Watershed Master Plan: A plan generated by the City or by the City in cooperation with other agencies, which establishes the policy for the management of surface water quality and stormwater quantity in the Omaha metropolitan area.

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Appendix 1-C
References

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American Society of Civil Engineers, Manuals and Reports of Engineering Practice No. 77. Design and Construction of Urban Stormwater Management Systems. 1992

City of Lincoln, Nebraska Drainage Criteria Manual. February 2000, Revision – May 2004.

City of Tulsa, Oklahoma. Stormwater Management Criteria Manual. 1993

Papillion Creek Watershed Partnership, Watershed Master Plan, 2009

Urban Drainage and Flood Control District. Drainage Criteria Manual, Volume I. March 1969. Denver Regional Council of Governments.