City of Fayetteville
North Carolina
ENGINEERING & INFRASTRUCTURE

Minimum Design Standards For Storm Drainage

July 2004

City of Fayetteville
Engineering Division
433 Hay Street
Fayetteville, NC 28301-5537

Fayetteville
North Carolina
ENGINEERING & MAINTENANCE

July 12, 2004

SUBJECT: MINIMUM DRAINAGE STANDARDS AND PLAN SUBMITTAL CHECKLIST

Please find the attached documents entitled Minimum Design Standards for Storm Drainage and Development Plan Submittal Checklist. Both documents have been prepared in cooperation with local engineers to assist in providing for a more uniform and efficient storm drainage system. At the direction of the City Manager and with the approval of the City Council, the Minimum Design Standards for Storm Drainage are to be met for all commercial and residential developments within the City limits.

The information included in, and required by the design standards and plan submittal checklist will assist engineers and developers to more clearly understand the expectations of the City Engineering Division with respect to stormwater runoff from new developments, as well as provide a list of submittal requirements that will help improve the plan review process by providing required information on plans and necessary calculations or documentation up front and at the time of submittal, not at the request of the reviewer.

- For residential development review, submit all necessary plans and documentation to the Engineering Division on the first floor of City Hall.
- For all commercial or industrial development, or developments that otherwise require building permits or review by zoning and inspections, submit all necessary plans and documentation to the Engineering Division either prior to, or the same time as submittal for the building permit.

City Engineering encourages and welcomes engineers and developers to submit preliminary plans for comments or schedule a meeting with staff to look at drainage issues in the preliminary stages of planning and design.

Sincerely,

Greg Caison
Engineering Manager

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1.1.0 Introduction

1.1 Purpose

This standard has been developed to assist in the design and evaluation of stormwater drainage systems within the City of Fayetteville, North Carolina. It provides engineering design guidance to:

- Engineers responsible for the design of stormwater drainage systems and management structures and,
- Developers involved in site planning and design.

Application of the standards should contribute to more uniform design and analysis of stormwater drainage systems throughout the City of Fayetteville. Application of the standards and adherence to the Plan Submittal Checklist should also create some uniformity in plan submittal, and therefore allow the City to provide better, more consistent Engineering review services.

Detailed design procedures and engineering data can be found in the City of Fayetteville Stormwater Design Manual. Engineering design methods other than those included in the manual can be used if approved by the City Engineer. Complete documentation of other methods may be required for approval.

1.2 Stormwater Design Manual Contents

The Minimum Design Standards for Drainage that are to be included in this document are separated to correspond with the chapter designation in the City of Fayetteville Stormwater Design Manual. The manual presents technical and engineering procedures and criteria that may be needed to comply with the City of Fayetteville Minimum Design Standards for Drainage. Copies of the manual will be available from the City of Fayetteville Engineering Department. Following are the chapters included in this design manual:

- Chapter 1 Introduction
- Chapter 2 Data Availability
- Chapter 3 Submittal Requirements
- Chapter 4 Hydrology
- Chapter 5 Storm Drainage Systems
- Chapter 6 Design of Culverts
- Chapter 7 Open Channel Hydraulics
- Chapter 8 Storage Facilities
- Chapter 9 Energy Dissipation
- Chapter 10 Water Quality BMPs

Contents (continued)

Each chapter contains equations, charts, and nomographs needed to design specific stormwater systems an/or management facilities. Example problems are used to illustrate the use of the procedures. Where appropriate, desktop procedures are developed for design application. Users are also encouraged to utilize applicable computer programs to support engineering analysis and design.

Shaded areas occurring throughout the manual represent design criteria that must be satisfied.

1.3 Planning Concepts

In addition to the engineering procedures and criteria necessary for stormwater management, there are many planning concepts which should be considered.

The planning involves the interaction of many elements within the planning process. Many advantages accrue to developers, residents, and local governmental units when drainage planning is undertaken at an early stage in the planning process. Advantages may include lower cost drainage systems, decreased flooding and maintenance problems, and facilities that provide more benefits.

Good drainage planning is a complex process. Land use planning and location of developments should be closely coordinated with drainage planning to prevent drainage problems. Early in the planning and development process, consideration should be given to major flood events, local drainage from small areas, and environmental consequences of proposed actions. As an example, when planning a new subdivision, various drainage configurations should be considered before decisions are made on block layout and street location. Sensitive environmental areas should be identified and integrated into the final plan. It is perhaps at this point in the development process where the greatest impact can be made on the cost of proposed drainage facilities. Also, the planning and design of drainage systems, facilities and associated land use planning should consider flood hazard areas at an early stage to avoid unnecessary complications.

There are also many secondary benefits received from good drainage planning:

- reduced street maintenance costs,
- reduced street construction costs,
- improved movement of traffic,
- improved public health,
- lower cost open space,
- lower cost park areas and more recreational opportunities,
- development of otherwise undevelopable land,
- opportunities for lower building costs,
- reduced city administrative costs, and
- reduced maintenance costs of drainage facilities.

Design engineers are encouraged to work with the City Engineering Department as early in the planning and development process as possible, when the maximum number of drainage alternatives are possible. Much time and expense can often be avoided with timely and productive cooperation between the engineer/developer and the reviewing engineering department.

The Minimum Design Standards for Stormwater are intended to establish the minimum uniform design practices; it neither replaces the need for sound engineering judgment nor precludes the use of information or methods not presented.

1.4 Erosion Control

For erosion and sediment control, see the North Carolina Erosion and Sediment Control Planning and Design Manual.

The North Carolina Sedimentation and Erosion Control Act is administered by the State in the City of Fayetteville. All subject projects must submit plans to the regional office of the North Carolina Division of Land Resources. Projects that are 1 acres or larger will also need to obtain a permit for the discharge of stormwater from construction sites. NPDES General Permit NCG010000 is available for this discharge. Form more information, contact:

Land Quality Supervisor
Department of Environment & Natural Resources
Division of Land Resources - Land Quality Section
Fayetteville Regional Office
Systel Building
Suite 714
Fayetteville, NC 28301
(910) 486-1541
http://www.dlr.enr.state.nc.us/dlr.htm

2.0 Stormwater Design Requirements

The following is a list of the minimum stormwater drainage system design requirements for residential subdivision and commercial development. For more details and design procedures refer to the corresponding chapter in the City of Fayetteville Stormwater Design Manual.

Chapter 4 -- HYDROLOGY

Summary of Design Frequencies

Description	Design Storm
Roadway Inlets	5-year
Storm drainage systems	10-year
Open channels	25-year
Culverts (subdivision streets)	25-year
Culverts (thoroughfare roads)	50-year
Permanent Storage Facilities	25-year
Emergency spillways	100-year
Energy Dissipaters	Same as Outlet System

Additional analysis may be required. See below for further clarification.

Chapter 5 -- STORM DRAINAGE SYSTEMS

- The following criteria shall be used for inlet design within either existing City of Fayetteville Rights-of-Way or proposed Rights-of-Way that are to be included in the City system.

Design Frequencies

	Facility Design Storm			
Roadway Type	Gutter Spread	Roadside Ditch	Storm Drain	Culverts Drainage
Thoroughfare[1]	5-yr	10-yr	10-yr	50-yr
All Other Streets	5-yr	10-yr	10-yr	25-yr

Spread Limits

- Maximum spread of 8 feet in a travel lane for all curb types.

Notes:
[1]Thoroughfares include all numbered routes and all roads with four or more travel lanes or otherwise designated "thoroughfare" by the City of Fayetteville.

- The maximum and minimum slopes for storm drains should conform to the following criteria:
  - The maximum pipe velocity shall not exceed 20 feet per second, but shall not cause scour or other erosion problems in the receiving channel.
  - Slopes required to maintain minimum velocity of three (3) feet per second at full flow are as follows:

	Minimum Slope	
Manning n:	0.013	0.024
Pipe Size (in.)	R.C. Pipe	C.S. Pipe
	(ft.)	(ft.)
15	0.00325	0.01107
18	0.00255	0.00868
24	0.00174	0.00592
30	0.00129	0.00439
36	0.00101	0.00345
42	0.00082	0.00281
48	0.00069	0.00235

- All structures flow shall allow for access to the storm drainage system with a grate, manhole ring and cover, or a lid capable of being removed. No "blind boxes" are permitted.
- Structures shall be required at changes in grade and/or alignment and at pipe junctions. The maximum spacing between two manholes, or inlet structures, in any instance shall be 400 feet.
- Headwall or flared end sections shall be required at the inlet and outlet of all pipe systems.
- Energy dissipaters shall be designed and constructed at the outlets of all pipe systems to prevent erosion in the receiving watercourse.
- The minimum size storm drainpipe diameter shall be 15 inches.
- All storm drainage pipe used within a City right-of-way shall be Reinforced Concrete Pipe (RCP). All RCP shall be Class III or higher.
- Minimum pipe cover, measured from invert to subgrade shall be as follows:

	Clearance Distance	
Pipe Size (in.)	R.C. Pipe	C.S. Pipe
	(ft.)	(ft.)
15	2.4	2.3
18	2.7	2.6
24	3.3	3.1
30	3.8	3.6
36	4.3	4.1
42	4.9	4.6
48	5.4	5.1

Chapter 6 – DESIGN OF CULVERTS

- Culverts shall be checked for overtopping for the following flood frequencies:
  - Cross-drainage culverts under thoroughfares[1] - 100-year frequency
  - Cross-drainage culverts under other streets - 50-year frequency
  - Other culverts - 25-year frequency

- Outlet protection shall be provided where discharge velocities will cause erosion problems.
- Culvert skews shall not exceed 45 degrees as measured from a line perpendicular to the roadway centerline without approval.
- The minimum culvert diameter shall be 18 inches for those culverts located within subdivision streets. The minimum culvert diameter shall be 24 inches for those culverts located on thoroughfare roads.[1]

Notes:
[1]Thoroughfares include all numbered routes and all roads with four or more travel lanes or otherwise designated "thoroughfare" by the City of Fayetteville.

Chapter 7 -- OPEN CHANNEL HYDRAULICS

- In general, the following criteria should be used for open channels:
  - Low flow sections shall be considered in the design of channels with large cross sections (Q>100cfs).
  - Channel sideslopes shall be stable throughout the entire length and side slope shall depend on the channel material. A maximum of 3:1 is allowed for vegetation and 2:1 for rip rap, unless otherwise justified by calculations.
  - Superelevation of the water surface at horizontal curves shall be accounted for with increased freeboard. See NC Erosion and Sediment Control Planning and Design Manual.
  - Trapezoidal or parabolic cross sections are preferred and triangular shapes should be avoided.
- The following criteria shall be considered at channel transitions:
  - Transition to channel sections shall be smooth and gradual.
  - Energy losses in transitions shall be accounted for as part of water surface profile calculations.
- Open channel drainage systems shall be sized to handle a 25-year design storm. If, for the specified design storm, the peak flow in the channel equals or exceeds fifty (50) cubic feet per second under ultimate build out conditions the 100-year design storm shall be routed through the channel system to determine if the 100-year flood elevation restrictions are exceeded, structures are flooded, or flood damages are increased. The post-development 100-year flood elevations and limits shall be shown on the recorded subdivision plat.[1]
- Additional analysis or measures may be required in areas that are documented as known drainage problems. For further information contact City Engineering.

DRAINAGE EASEMENTS

- Drainage easements will be required by the City for all open ditches, closed pipe systems, swales, or other systems dedicated to the City outside of public rights-of-way. Such rights-of-way or easements shall be centered over the culvert or watercourse with minimum widths based on the following:

  Easement Widths for Closed Pipe Systems
  Easement Width = the greater of 20 feet or;
  10' + (the diameter or total outside width for multiple pipes) + (2 x invert depth)
  Rounded to the nearest five (5) foot increment.

  Drainage easements associated with culverts may be offset as long as a minimum of 10 feet is provided on both sides.

  Easement Widths for Open Channels

Drainage Area, ac	Easement Width, ft
< 10 ac	10' on each side
10 - <25 ac	20' on each side
25 - <50 ac	30' on each side
50 - <100 ac	40' on each side
>100 ac	The greater of the floodway width or 50'

The above narrative is a summary of the Stormwater drainage system design requirements. It is not intended to be all-inclusive.