CITY OF PIEDMONT, OKLAHOMA

STORMWATER CRITERIA MANUAL

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PREPARED BY

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I. Policies

A. *Drainage policies.*

1. Stormwater drainage system design

The stormwater drainage system shall be designed to pass the peak stormwater run-off received from upstream and from the subject property for storms with durations up to twenty-four (24) hours and return periods of up to one hundred (100) years.

2. Development impact on flooding

All development, redevelopment, and earth changes shall be constructed such that it will not increase the frequency of flooding or the depth of inundation of structures during the 50% (2-year), 20% (5-year), 10% (10-year), 2% (50-year), and 1% (100-year) flood events. A commercial or multi-family development site under 5 acres shall be constructed such that it will not increase the frequency of flooding or the depth of inundation of structures during the 20% (5-year), 10% (10-year), 2% (50-year), and 1% (100-year) flood events.

3. Development impact on peak flow rates

Peak flows shall not be increased at any location, upstream or downstream of any development for the 50% (2-year), 20% (5-year), 10% (10-year), 2% (50-year), and 1% (100-year) flood events unless approved by the City Engineer and provisions of Sec 1.A.(4) are met. In order to compare the effects of the project, existing conditions shall be computed and compared to the "with proposed project" conditions at all points of discharge from the project and at points downstream as specified by the City Engineer to ensure that there is no increase in the discharges.

4. Offsite drainage requirements

The City may require improvements, provision of drainage easements, provision of improvements, agreements, and/or easements beyond the boundaries of the development. The required construction of offsite drainage improvements are:

a. to facilitate flow of storm water from or through the property,
b. to avoid damage from changed runoff conditions,
c. to provide continuous improvement of the overall storm drainage system, and
d. to accommodate other drainage conditions or requirements.

Where storm water runoff flows require the logical extension of any street and its associated drainage in order to prevent flooding, ponding, or uncontrolled runoff the extension shall be provided by the developer.

5. Stormwater management control

No action shall be taken in any land improvement by any developer, contractor, or lot owner that will alter or otherwise change existing designed and installed storm water management control, nor shall any action be taken on existing property that shall adversely affect storm water runoff in any manner contrary to the provisions of this Chapter. Whether temporary in nature to service only the construction phase of development, or whether a combination of temporary and permanent serving a dual purpose, the first techniques to be employed in the development of a site shall be the management of storm water and drainage in a manner consistent with the requirements of this Chapter.

6. Completion of stormwater facilities

Developers shall complete construction of stormwater facilities to control runoff and erosion prior to issuance of any building permits.

7. Use of Design Criteria

Regulation of peak flows to allowable levels, as determined by subparagraphs (2) and (3) herein, shall be achieved by on-site or off-site storage and/or other water management facilities as provided in these Drainage Criteria.

8. Downstream improvements and easements

Subject to requirements in the City Drainage Standards for a drainage plan or earth change permit, downstream conveyance may be improved or easements obtained for inundated areas to compensate for increased flow depths if such improvements comply with the policies of this chapter.

9. Concentration of flows

All development, redevelopment, and earth changes shall be constructed so that it will not cause harm to other properties as a result of concentrating flows.

10. Requirement for hydraulic analyses

If a tract of land under development has a drainage basin of 10 acres or larger within its boundary, then a hydraulic (backwater) analysis of the existing and proposed drainage system shall be provided to show any impact the proposed development has on the floodplain area and elevation.

11. Compensatory storage

Compensation shall be provided for filling or development which diminishes the flood storage capacity of the flood plain area from drainage basins of 10 acres or larger, by providing compensatory storage or other method as determined by the City Engineer.

12. Use of natural channels and streams

The design of any development shall provide for the maximum use of open channels and natural streams for drainage areas of 40 acres or more, and detention storage to control runoff rates. Natural drainage channels and techniques shall be given priority consideration in preparation of stormwater drainage system designs and shall be designed or improved as an integral part of the landscape of the area in accordance with the following guidelines:

a) Drainage channel improvements shall be developed and designed to preserve and protect trees and other worthy botanical and geological features to the maximum extent practicable. Vegetation shall be preserved when feasible. Riparian habitat shall be maintained when feasible, during improvements

b) Wherever channel improvements are required to accommodate storm runoff in a specified manner, the designs shall provide maximum practical utilization of turf, sodding, and natural ground surface protection techniques in order to protect the environment by reducing erosion potential.

c) Water quality control measures shall be incorporated into stormwater management designs, subject to approval of the City Engineer. Additionally, impacts on receiving water quality shall be assessed for all flood management projects.

d) The City Engineer may require open channels for other drainageways for just cause.

13. Open section roads and borrow ditches

Open section roads and bar ditches may be used in Zoning Districts A-1, RE, RE-1, I-2, I-3 or in developments where the road frontage for every lot is at least 145 feet. The conditions identified in Section V.C.7.

14. Storm sewer requirements

Storm sewers shall be used for all developments wherein the conditions given in this manual for use of open section roads are not met. Storm sewers may be used in any development at the developer's discretion and may be required by the City Engineer where there are no viable alternatives to fit the site or geographic conditions. Storm sewers may be used to alleviate existing drainage problems, subject to the approval of the City Engineer. Open ditches may be used at the discretion of the City Engineer in specific locations where green solutions are more desirable within the maintenance requirements of the City.

B. Erosion and sediment control policies.

1. Requirements for construction

All development, redevelopment, and earth changes shall be designed, constructed and completed in a manner which minimizes the exposure of bare earth to precipitation. Contractor shall file NOI, develop SWPPP and otherwise comply with applicable local, state, or federal regulations. Contractor shall provide a copy of the NOI and SWPPP to the city.

2. Minimize sediment-related pollution

All development, redevelopment, and earth changes shall be constructed in a manner that will minimize soil dispersal, sedimentation, erosion, or other similar forms of pollution:

a) From any surface of the site into drainage channel provided or created within the development;

b) From the site into drainage channels adjacent to and remote from the site.

3. Sedimentation facilities

All development, redevelopment, and earth changes shall be constructed only if appropriate sedimentation facilities are installed and maintained throughout the construction period.

4. Best Management Practices

All development, redevelopment, and earth changes shall be accompanied by Best Management Practices for controlling sediment and erosion so as to minimize the amount of sediment leaving the site.

II. General Requirements

A. Lot Drainage

1. Conveyance of surface drainage

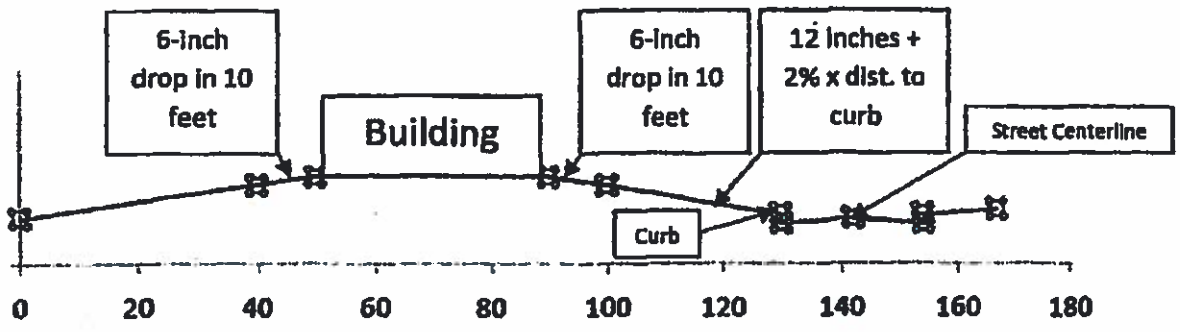
Surface drainage shall be diverted to a designated stormwater conveyance or other approved point of collection that does not create a hazard. No more than 2 lots or ½ acre shall be allowed to drain onto an adjacent lot unless it drains into a designated stormwater drainage system component.

2. Grading adjacent to foundations

Lots shall be graded to drain surface water away from foundation walls, as follows:

a) The grade shall fall a minimum of 6 inches within the first 10 feet.

b) The top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches plus 2 percent times the distance from the gutter to the building. The drawing below illustrates these requirements.



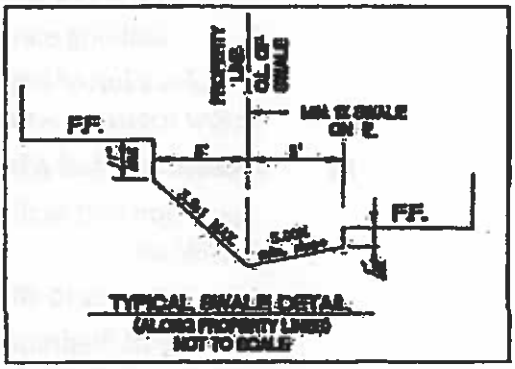
3. Grading adjacent to foundations under special circumstances

Where lot lines, walls, slopes or other physical barriers prohibit 6 inches of fall within 10 feet, the following applies:

a) Drains or swales shall be constructed to ensure drainage away from the structure.

b) Impervious surfaces within 10 feet of the building foundation shall be sloped a minimum of 2 percent away from the building.

c) Between buildings, the sketch to the right shows the minimum requirements for drainage.



4. Equipment or storage under crawlspaces

Crawlspaces shall not be used for mechanical and electrical equipment or storage purposes of any kind lower than the following:

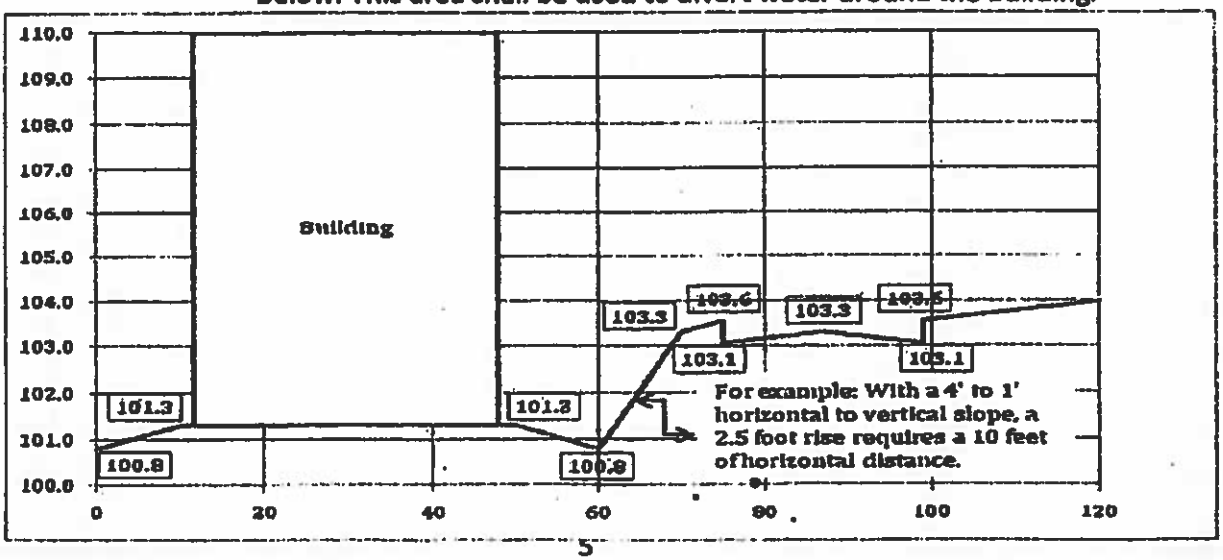
a) An elevation of one foot above the lowest curb (in a curb and gutter section) or street elevation (in an open paving section) adjacent to the lot; or

b) An elevation one foot above the lowest ground elevation adjacent to the lot.

5. Buildings located below street grade

In a curb and gutter roadway section where buildings are located below the grade of the street, the following applies:

a) There shall be a horizontal distance between the toe of the slope and the building equal to the vertical component of the slope, shown below. This area shall be used to divert water around the building.



b) If a wall is used to separate the curb elevation from the elevation in front of the building, the horizontal distance between the wall and the building shall be equal to or greater than the difference in elevation between the curb elevation and the building finished floor.

c) The drive shall be shaped so that the high point between the gutter and downhill portion of the driveway slope is at or above the highest adjacent curb elevation.

6. Building elevations along open paving sections

The elevation of the front of buildings adjacent to the street will not be allowed below roadway elevations in an open section.

B. Operation and Maintenance of Stormwater Detention Facilities

Operation and Maintenance of Stormwater Detention Facilities shall be provided as follows:

1. Access to stormwater facilities

The City of Piedmont requires that maintenance access be provided to all storm drainage facilities for operational and maintenance purposes through acceptance of the project by the City. After acceptance, private maintenance of the facilities shall be continued, with permanent access protected by a dedicated easement. The easement shall be shown on final plats or final development plans and shall clearly state that the purpose is for private stormwater management facilities maintenance.

2. Maintenance during construction

Drainage facilities provided by the developer shall be fully and properly maintained from construction through final acceptance of the development improvements by the City of Piedmont. Following acceptance, private maintenance of the facilities shall be governed by II.B.4.

3. Maintenance by property owners

It shall be the responsibility of all property owners to maintain drainage facilities as follows:

a) Mow and provide maintenance of drainage channels and their slopes for that portion of the channel lying within their property limits

b) Keep clear all drainage channels within the boundaries of their properties in accordance with the requirements of this MANUAL

c) Prevent any and all drainage interferences, obstructions, blockages, or other adverse effects upon drainage into, through, or out of the property

d) Control the erosion of the drainage channels and the deposition of materials into the drainage channels from the property.

e) Permanent access as described in B.1 shall be provided whether the stormwater facilities are public or private.

4. Maintenance of completed stormwater detention facilities

Stormwater detention facilities shall be maintained as follows:

a) Remedial activities to be provided include erosion control, sediment removal and minor reconstruction of side slopes, areas subject to turbulence, and detention pond outlet works.

b) Mowing shall be provided at least once a month during the 7-month growing season ***from March 15 to October 15.***

C. Easements:

1. Drainage and Detention Easements

a) Drainage easements shall be sized to carry, at minimum, a one percent (1%) storm. Such easements shall be continuous and contiguous from one property to the next.

b) A drainage easement shall be required:

(1) Where storm water runoff is designed to exit the public right-of-way and enter private property. Such easement shall be located at and extend from the point of entry onto private property to the point where the runoff enters another property, intersects another drainage easement, or enters a drainage facility or another public right-of-way.

(2) Where storm water runoff from a drainage basin of 1/2 acre or larger enters a property from an adjacent property. Such easement shall be located at and extend from the point of entry onto the site to the point where the runoff enters another property, intersects another drainage easement, or enters a drainage facility.

(3) Around the boundaries of drainage/retention facilities. Such easement shall be adequate in size to permit access to such

facility from a public right-of-way and around the perimeter of such facility.

c) Easements shall be required for all stormwater management facilities not in public rights of way; including:

(1) Storm sewers

(2) Channels

(3) Storage areas

(4) Other hydraulic structures

(5) All portions of the public stormwater drainage system with a drainage area of 1/2 acre or more.

d) Easements shall:

(1) Allow no restriction of the drainage purposes.

(2) Clearly identify that the purpose includes operation and maintenance of stormwater management facilities

(3) Be shown on all plats, including widths and specific purposes (i.e.: storm sewer, maintenance access, channel, etc.)

e) The widths of easements are determined by:

(1) The size of the storm sewer, its depth, and the equipment needed to remove, replace or repair the sewer.

(2) The width of the easement for channels, storage areas and other structures is generally determined by the size of the facility and the equipment needed for maintenance, typically covering the entire facility plus 20 feet for maintenance access.

f) Drainage easements

Drainage easements (see Table below) shall be shown on the Final Plats and Final Development Plan and shall state that the City has the right of access on the easements which shall be kept clear of obstructions to the flow and/or maintenance access.

REQUIRED OPERATIONS, MAINTENANCE EASEMENTS & OUTLOT AREAS (NOT WITHIN A PUBLIC RIGHT OF WAY)					
DRAINAGE FACILITY	MINIMUM EASEMENT/OUTLOT AREA WIDTH				
Pipe Diameter	Width of Easement for Trench Depth to Pipe Invert (Feet) of:				
Inches	5	10	15	20	
18"	15	15	20	30	
24"	15	15	25	35	
30"	15	15	25	35	
36"	-1	15	25	35	
42"	-1	15	25	35	
48"	-1	15	25	35	
54"	-1	15	25	35	
60"	-1	20	30	35	
>60" (2)	-1	30	30	30	
	(1) Area of minimum cover, depending on structural requirements and easement location.				
	(2) For pipe diameters greater than 60 inches, repairs can be made internally and the ROW width is not dependent of excavation for repairs.				
Storm Sewer Overflow, Where Required	As required to contain the top width of the surface overflow from a 1% storm in an overland drainage easement.				
Open Channel	Top width plus 20 feet; five feet on one side and 15 feet on the side with the maintenance access road.				
Post-development 1% (100-year) Regulatory Floodplain	Area sufficient to contain the regulatory 1% (100-year) post-development floodplain				
Open Space Detention Facilities	As required to access and contain storage volume and associated facilities plus 20 feet of maintenance access around the perimeter.				
Parking Lot and Underground Detention Facilities	As required to access and contain storage volume and associated facilities.				

g) The City Engineer may approve a reduction in the required easement area for open channels and open space detention facilities that will be contained within private drainage easements and be privately maintained.

h) Regulatory floodplain

Regardless of what is shown as floodplain boundary on the adopted floodplain maps, all areas within the development having an elevation lower than the 1% (100-year) water surface elevation shall be platted as common area or outlot.

D. Revisions to Floodplain Maps

1. CLOMR and LOMR requirements

Changes to the boundaries of a flood plain, floodway, flood insurance zone, flood elevation, flood depth and other information shown on the officially adopted floodplain maps must be approved by the Federal Emergency Management Agency (FEMA) through the Conditional Letter of Map Revision (CLOMR) and/or Letter of Map Revision (LOMR) process.

2. LOMR-F requirements

The Floodplain Administrator (FPA) will not approve a Letter of Map Revision based on Fill (LOMR-F) in the City of Piedmont without supporting documentation verifying compliance with City ORDINANCES. The placement of fill in the floodplain shall require hydraulic studies to determine the upstream and downstream effect.

3. CLOMR requirements

A CLOMR is required to be obtained from FEMA before a project can be built if the project includes any work within the designated floodway. If the project would require any change in the effective hydraulic model, the delineated 1% (100-year) flood floodplain, or the effective flood profiles, then duplicate effective, existing, and proposed conditions hydraulic models shall be submitted to the city for review. The City may request any other analysis or documentation deemed necessary to demonstrate that the project is in compliance with the City Flood Damage Reduction ordinance and requirements of the NFIP. The City may require a CLOMR for any project if needed to ensure compliance with the NFIP.

4. LOMR requirements

A LOMR is required as a follow-up to the CLOMR, or if any work has been completed within the designated floodway, or if the project requires any change in the effective hydraulic model, the delineated 1% (100-year) floodplain, or the effective flood profiles. No occupancy permits will be approved until the LOMR is approved by the City for submittal to FEMA.

5. Mapping requirements

The new floodplain boundaries must be submitted to the City in AutoCAD or GIS format in order to update the City's floodplain mapping. Submittal shall include

the 1% (100-year) and 0.2% (500-year) floodplain boundaries, cross sections used in the hydraulic model, and the stream centerline used in the hydraulic model.

E. Acceptance of Existing Stormwater Drainage Facilities

1. Guidelines for acceptance of stormwater drainage facilities

The City of Piedmont will consider acceptance of existing stormwater drainage facilities not constructed under these criteria for ownership and maintenance without modification to the system using the following guidelines:

a) The system must be capable of conveying the regulatory 1% (100-year) storm flow using the criteria presented in this MANUAL.

b) The system must be reasonably maintainable with legal access to all facilities using the standards for access presented in these criteria.

c) Facilities submitted as part of previously approved plats, but not building permits, will be considered for acceptance.

2. Guidelines for acceptance of channels

Channels must meet the minimum standards of:

a) The channel must have a concrete liner that is structurally sound and not subject to imminent failure.

b) The Froude number for the 1% (100-year) storm flow must be less than 0.85 or greater than 1.15.

c) The 1% (100-year) storm flow must be contained within the channel banks

3. Guidelines for acceptance of storm sewer systems

Storm sewer systems must meet the minimum standards of:

a) Manholes at changes in pipe sizes and vertical alignment.

b) Manholes at changes in horizontal alignment are required unless and exception is approved by the City Engineer.

c) Manholes or other appropriate maintenance access must not be spaced farther apart than 500 feet.

d) The sewer must be structurally sound and not subject to imminent failure.

III. Construction and approval of drainage facilities.

A. Scheduling of construction of stormwater facilities

All drainage facilities shown as part of an accepted drainage plan for any portion of a development shall be installed as a part of the first phase of construction or earth moving activity on that portion of the development. If only a portion of the drainage facilities are installed on any development due to phased construction of the development, these facilities shall be constructed to function in such a manner as to be consistent with the purpose of this chapter. The use of

temporary drainage facilities may be permitted so long as they function in such a manner as to be consistent with the purpose of this chapter and that they are replaced with permanent drainage facilities prior to occupancy or use of the development. Minor deviations from the requirement for installing the drainage facilities as a part of the first phase of construction or earth moving activity may be granted by the city engineer if deemed necessary for technical reasons related to the construction as long as the purpose of this chapter is met.

B. Maintenance of stormwater facilities during construction

Improvements provided by the developer shall be fully and properly maintained from initial approval of facilities through either final approval of the development improvements by the City Council or the point at which the maintenance is turned over to the Homeowners Association, whichever is later. The continuing maintenance of detention or retention facilities shall be assured by the developer in the manner described for other drainage facilities.

C. As-built drawings.

As-built drawings shall be prepared and sealed by a professional engineer registered in the State of Oklahoma and shall be submitted to the city engineer upon completion of the construction of the final drainage plan. As-built drawings shall clearly show any changes from the accepted final drainage plan. The as-built drawings shall be reviewed by the city engineer. This review is to determine if information required by the City for future use is included and is not intended to verify that dimensions and elevations are correct. If the submitted "as-built" drawings cannot be accepted, the certifying engineer and applicant shall be advised in writing of the reasons for their disapproval. "As-built" drawings must be accepted prior to the issuance of a certificate of occupancy and the use or occupancy of a site, development, or other improvement.

D. Maintenance bond.

Before approval by the City Council of any improvement for public or private maintenance, a maintenance bond for the total cost of the improvement and for a period of one year shall be filed with the city clerk to ensure the correction of any defect in materials or workmanship that may be found in the improvement.

IV. CONTENTS OF DRAINAGE PLANS AND STUDIES

A. General Requirements

1. Requirement for Professional Engineer licensure.

   All final drainage studies shall be formulated under the direct supervision of a registered professional engineer licensed by the State of Oklahoma. Studies submitted for final acceptance shall be accompanied by payment of a fee in accordance with the schedule approved by the City Council and bear the signature and seal of the submitting engineer and, additionally, the following statement shall immediately precede the signature and seal of the submitting engineer:

"I hereby certify that I am familiar with the adopted ordinances and regulations of the City of Piedmont governing drainage facilities; that this final drainage study has been prepared under my direct engineering supervision; and that the above and foregoing final drainage study complies with all governing ordinances and the adopted drainage standards of the City of Piedmont pertaining to drainage facilities to the best of my knowledge, information and belief."

2. Certification statement

All final drainage plans shall be formulated under the direct supervision of a registered professional engineer licensed by the State of Oklahoma. Plans submitted for final acceptance shall bear the signature and seal of the submitting engineer and, additionally, the following statement shall immediately precede the signature and seal of the submitting engineer:

"I hereby certify that I am familiar with the adopted ordinances and regulations of the City of Piedmont governing drainage facilities; that the final drainage plan has been prepared under my direct engineering supervision; and that the above and foregoing final drainage plan complies with all governing ordinances and the adopted drainage standards of the City of Piedmont pertaining to drainage facilities to the best of my knowledge, information and belief."

3. Owner's Statement

Following the signature and seal of the submitting engineer, the drainage plan shall bear the name, address, phone number, and signature of the owner which shall be subscribed below the following statement:

"I (We) hereby certify that the accepted drainage plan will be implemented as designed and "as-built" drawings prepared of the completed drainage facilities under the general supervision of a professional engineer licensed by the State of Oklahoma. I (We) further certify that I am (we are) aware of my (our) responsibilities as the owner(s) of record for this piece of property, and that I (we) may be held personally (corporately) liable for any violations on this property resulting from the failure to comply with the provisions of the adopted ordinances and regulations of the City of Piedmont governing drainage facilities. Said provisions include, but are not limited to, responsibilities for proper construction, construction procedures and maintenance of the drainage facilities upon completion."

4. Property owned by a corporation

In the case of property owned by a corporation, the statement shall use the parenthetical language and the owner's information shall also include the title of the authorized person signing the owner's certification and a notarized corporate seal.

B. *SUBMITTAL REQUIREMENTS*

The submittal requirements for drainage reports and plans are set forth in this section.

1. Summary Statement

The cover letter for the Drainage Reports shall include the following:

a) Goals and Policies

(1) Discuss how the proposed drainage plan meets the Stormwater Management goals and adheres to the floodplain policy(ies) of this Chapter.

(2) Discuss any deviation of the proposed drainage plan from the above goals and policies.

b) Drainage System Components

(1) Discuss the overall concept of the proposed system.

(2) Discuss the interaction of the major drainage and the proposed system.

c) Criteria

(1) Discuss any proposed deviation from the Chapter and methodology, as set forth in the standards, for consideration by the City for approval, if appropriate.

(2) Discuss the design criteria for the storm drainage design of the proposed system.

2. Drainage Report

a) Contents

The Drainage and Detention Report will identify and define solutions to the problems which may occur on site and off site as a result of the development. In addition, those problems that exist on site prior to development must be addressed during design. All reports shall be typed on 8 1/2" x 11" paper and bound together. The drawings, figures, plates, and tables shall be bound with the report or included in a folder/pocket at the back of the report. The report shall include a cover letter presenting the preliminary design for review and the report shall be prepared by or supervised by an engineer licensed in Oklahoma.

b) Certification:

The report shall contain a certification sheet as follows:

"I hereby certify that this report (plan) for the preliminary drainage design of (Name of Development) was prepared by me (or under my direct supervision) in accordance with the provisions of the City code of Piedmont for the owners thereof."

Licensed Professional Engineer
State of Oklahoma No._____
(Affix Seal)

3. Report Contents:

The Drainage Report shall be formatted in accordance with the following outline and contain all of the applicable information listed:

a) GENERAL LOCATION AND DESCRIPTION

(1) Location

(a) Name and address of Legal Owner

(b) Vicinity Sketch

(c) Legal description of property

(d) Boundary line survey

(e) Township, range, section, 1/4 section

(f) Local streets within and adjacent to the subdivision

(g) Major drainageways and facilities

(h) Names of surrounding developments

(2) Description of Property

(a) Area in acres

(b) Ground cover (type of trees, shrubs, vegetation)

(c) Major drainageways and floodplains.

(d) Soil Types and Hydrologic Soil Groups

b) DRAINAGE BASINS AND SUB-BASINS

(1) Major Basin Description

(a) Reference to major drainageway planning studies such as Stormwater Master Plan, flood damage prevention ordinance, and flood insurance rate maps

(b) Major basin drainage characteristics

(c) Identification of all drainage system components within 50-feet of the property boundary.

(d) Overall drainage area boundary and drainage sub-area boundaries.

(2) Sub-Basin Description

(a) Historic drainage patterns of the property in question

(b) Off-site drainage flow patterns and their impact on the proposed development

c) DRAINAGE DESIGN CRITERIA

(1) Regulations:

(a) Discussion of the optional criteria selected or the deviation from the Chapter, if any

(2) Development Criteria Reference and Constraints

(a) Previous drainage studies (i.e., project master plans) for the site in question that influence or are influenced by the drainage design and how the plan will affect drainage design for the site

(b) Discussion of the drainage impact of site constraints such as streets, utilities, railways, existing structures, and development of site plan

(3) Hydrological Criteria

(a) Design rainfall

(b) Hydrologic analysis for runoff and on-site or regional stormwater detention facilities as required.

(c) Hydrologic analysis for compensatory storage requirements for any alterations of the floodplain.

(d) Runoff calculation method

(e) Hydrologic analysis for runoff to ensure conveyance.

(f) Detention discharge and storage calculation method

(g) Design storm recurrence intervals

(4) Hydraulic Criteria

(a) Routing of off-site drainage flow through the development.

(b) Location of watercourse and the appropriate hydraulic analysis for any alteration of a watercourse.

(c) Hydraulic analysis for runoff to ensure conveyance.

(d) Hydraulic analysis for compensatory storage requirements for any alterations of the floodplain.

(e) References for calculation of facility capacity

(f) Detention outlet type

(g) Grade control structure criteria used

d) DRAINAGE FACILITY DESIGN

(1) General Discussion of:

(a) Proposed and typical drainage patterns

(b) Compliance with off-site runoff considerations

(c) The content of tables, charts, figures, plates, or drawings presented in the report

(d) Anticipated and proposed drainage patterns

(2) Specific Discussion of:

(a) Drainage problems encountered and solutions at specific design points

(b) Detention storage and outlet design

(c) Photographs of downstream channel condition

(d) Maintenance access and aspects of the design

(e) Proposed maintenance agreement

(f) Easements and/or ROW dedications required

e) IMPACT ON AREA OF SPECIAL FLOOD HAZARD

(1) Location of watercourse and the appropriate hydraulic analysis for any alteration of a watercourse

(2) Hydraulic and Hydrologic analysis for run-off to ensure conveyance

(3) Hydraulic and Hydrologic analysis for compensatory storage requirements for any alterations of the floodplain

(4) Hydraulic and Hydrologic analysis for run-off and on-site or regional stormwater detention facilities, if required

(5) Floodplain boundaries with elevations to 1988 NAVD

(6) Estimate of the quantity of excavation and fill with drawings indicating each separate excavation or fill (cross sections may be required)

(7) All appropriate FEMA (Federal Emergency Management Agency) submittal data to achieve a map revision (LOMR)

(8) No Rise certification for offsite properties.

f) CONCLUSIONS

(1) Compliance with the City code of Piedmont

(a) Stormwater Master Plan

(b) Best Management Practices Plan provided and implemented

(2) Drainage Concept

(a) Effectiveness of drainage design to control damage from storm runoff

(b) Influence of proposed development on the Stormwater Master Plan recommendation(s)

g) REFERENCES

(1) Reference all criteria and technical information used

h) APPENDICES

(1) Hydrologic Computations

(a) Land use assumptions regarding adjacent properties

(b) Path(s) chosen for computation of time-of-concentration.

(c) Stormwater runoff at specific design points onsite and offsite.

(d) Historic and fully developed runoff computations at specific design points

(e) Hydrographs at critical design points if applicable

(2) Hydraulic Computations

(a) Culvert capacities

(b) Storm sewer capacity – including profile plots showing flow line, size, material and grade. Profiles shall show the natural and proposed ground line at the center line of the storm sewer. The energy grade line and hydraulic grade line for the 10, 25, and 100-year events shall be shown.

(c) Street capacity

(d) Storm inlet capacity including inlet control rating at connection to storm sewer

(e) Open channel design

(f) Check and/or channel drop design

(g) Detention area/volume capacity and outlet capacity calculations

i) COMPLETED DRAINAGE AND DETENTION CHECK LIST ASSURING THAT ALL ITEMS HAVE BEEN ADDRESSED.

4. DRAWING CONTENTS

a) <u>Sheet-1 General Location Map:</u> A map shall be provided in sufficient detail to identify drainage flows entering and leaving the development and general drainage patterns. The map should be at a scale of 1" = 200' to 1" = 400' and show the path of all drainage from the upper end of any off-site basins to the defined major drainageways. The map shall identify any major construction (i.e., developments, irrigation ditches, existing detention facilities, culverts, main storm sewers), along

the entire path of drainage. The size of the drawings shall be 8 1/2" x 11", 11" x 17", or 22" x 34".

b) Sheet-2 Floodplain Information: A copy of the regulatory floodplain map showing the location of the subject property shall be included with the report.

c) Sheet-3 Drainage Plan: Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on a 22" x 34" drawing shall be included. The plan shall show the following:

d) Existing and proposed contours at 2 foot maximum intervals. In terrain where the slope is relatively flat, spot elevations and drainage arrows must be shown.

e) Property lines and easements with purposes noted: Name, address and telephone number of legal owner of property; vicinity sketch

f) Streets, roads and highways adjacent to the property

g) Existing drainage facilities and structures, natural or man-made, including, roadside ditches, drainageways, gutter flow directions, and culverts. All pertinent information such as material, size, shape, slope, and location shall also be included.

h) Overall drainage area boundary and drainage sub-area boundaries

i) Proposed type of street flow (i.e., vertical or combination curb and gutter), roadside ditch, gutter flow directions, and cross pans. Include street classifications.

j) Proposed storm sewers and open drainageways, including inlets, manholes, culverts, retaining walls, erosion control measures, and other appurtenances

k) Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties

l) Routing and accumulation of flows at various critical points for the minor storm runoff

m) Path(s) chosen for computation of time-of-concentration

n) Details of detention storage facilities and outlet works

o) Location and elevations of all defined floodplains affecting the property

p) Location and elevations of all existing and proposed utilities affected by or affecting the drainage design

q) Routing of off-site drainage flow through the development

V. Technical Requirements

A. *Technical Requirements – Rainfall*

1. Rainfall intensity – duration – frequency data for the City of Piedmont may be developed from the following sources. Where the cited reference has been superseded by a subsequent version, the most recent version shall be used.
    a. "Depth-Duration Frequency of Precipitation for Oklahoma," (USGS WRI Report 99-4232).
    b. The ODOT Zone II IDF curves or equations (Te Anh Ngo, 1988)
    c. The IDF equations developed for Oklahoma City, as follows:

$I = A/(B + T_c)^E$ where T_c is in minutes and I is in iph

Where: T_c = time of concentration (minutes)
I = rainfall intensity (inches per hour)

Storm Exceedance Probability	Recurrence Interval (years)	A	B	E
50%	2	104.332663	17.298017	0.934857
20%	5	79.655486	14.827708	0.825124
10%	10	87.535303	15.882422	0.811341
4%	25	101.481871	16.773612	0.805881
2%	50	98.924724	15.864806	0.775353
1%	100	102.769257	15.860016	0.760373

2. All computed hydrographs for stormwater detention shall use a storm duration of 24 hours and the NRCS Type II distribution.

B. *Technical Requirements - Runoff*

1. All stormwater runoff shall be subject to review and approval by the City Engineer with regard to analysis, design and construction of drainageway facilities. The appropriate public authority shall have the right of maintenance or to cause to be maintained the drainageway system for its intended purposes. If a stormwater master drainage plan is adopted for the area under consideration, then the provisions of the plan shall be adhered to.
2. Use of the Rational Method:

    a) The Rational Method may be used to determine the peak discharge from a single, homogeneous watershed with an area of 40 acres or less or a time of concentration of 15 minutes or less.

b) Additionally, the Wright-McLaughlin Method for adjustment of the larger storm frequencies is required, as described in the Oklahoma Department of Transportation Drainage Design Manual (February 1988 or as amended).

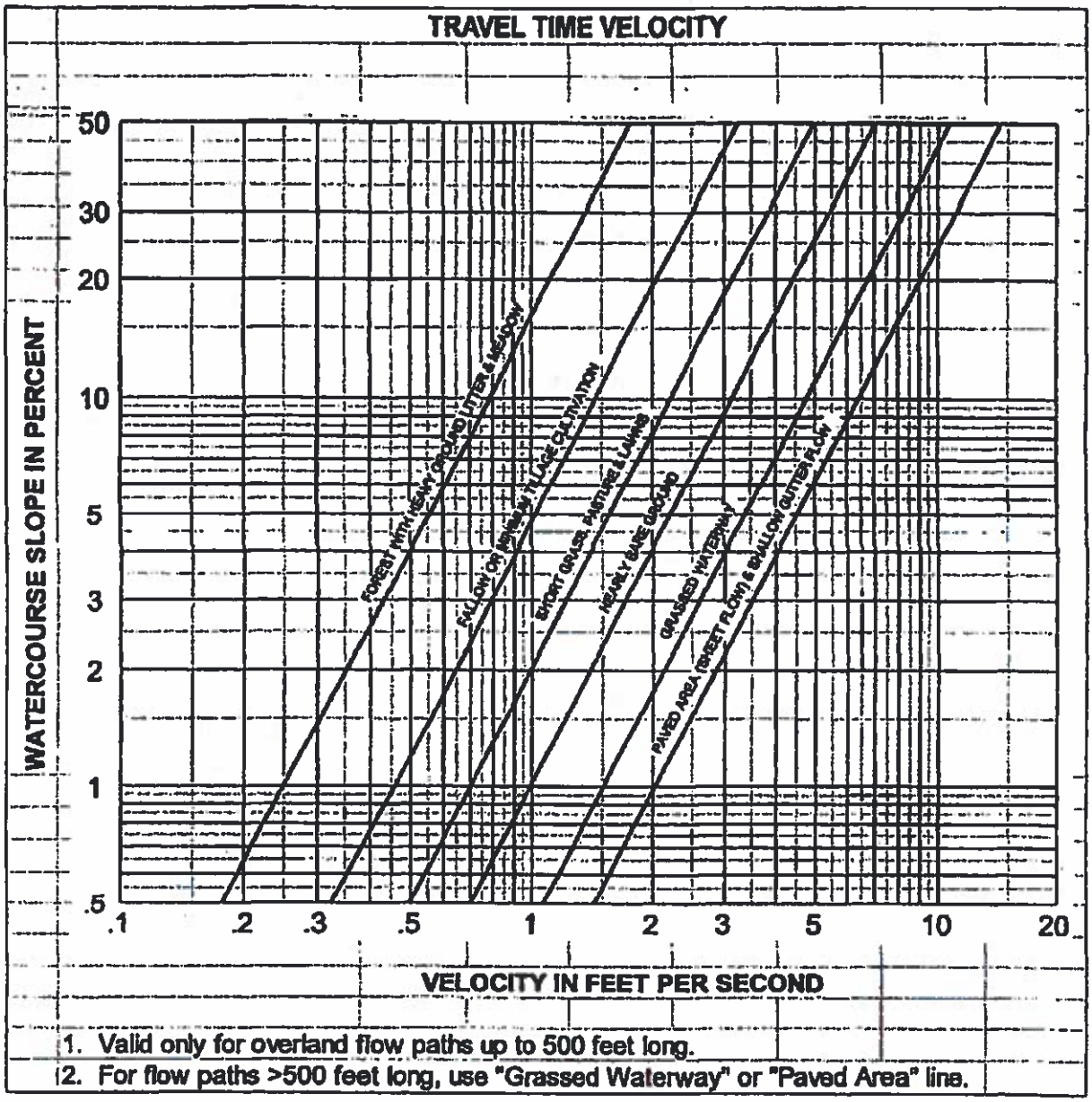
c) A brief description of the Rational Method is shown below:

(1) Values for "C", the runoff coefficient, shall be obtained from the Oklahoma Department of Transportation Drainage Design Manual (February 1988 or as amended). Values for I, the rainfall intensity, shall be obtained as described in Section VII-A-1-b or c.

(2) Times of concentration shall be calculated based on the velocities obtained from travel time velocity chart contained herein.

(3) For strictly overland flow, not channelized, of 1500 feet or less, the Overland Flow nomograph or equation in the Oklahoma Department of Transportation Drainage Design Manual (February 1988 or as amended) may be used.

3. All stormwater drainage facilities for which the contributing drainage area does not meet the criteria for use of the Rational Method or which receive runoff from multiple subwatersheds shall be designed using the SCS (NRCS) Method, using the rainfall pattern approved for this unit hydrograph method. The user is referred to Section 4, Hydrology, National Engineering Handbook, Soil Conservation Service, Washington, D.C., July 1966, for specific details on SCS Unit Hydrographs.
4. Floodplain storage must be taken into consideration for drainage basins of 40 acres or larger by storage routing of sub basin hydrographs.



1. Valid only for overland flow paths up to 500 feet long.
2. For flow paths >500 feet long, use "Grassed Waterway" or "Paved Area" line.

5. For all hydrologic studies submitted to the City of Piedmont which involve routing of sub basin hydrographs, the following routing methods shall be used as indicated:
    a. Kinematic Wave is approved where the flow is completely contained in the channel or in a storm sewer for the 1% (100-year) storm.

b) The Storage-Discharge (Modified Puls) method is approved for areas of overbank flow, for computing reach storage for hydrograph routing and for reservoir routing.

c) The Lag method is approved when the 1% (100-year) storm is completely contained in a storm sewer flowing full.

C. ***Technical Requirements - Hydraulics of Open channels***

1. Trapezoidal channels shall be designed with a hard lined low flow channel, such as concrete.

   a) The low flow channel shall branch off to pick up any storm sewers discharging into the channel.

   b) The top of the sides of the low flow channel shall be a minimum of 6 inches lower than the adjacent main channel bottom. This is to ensure that the drainage runs over and into the low flow channel and not erodes around it.

   c) The minimum cross slope on the bottom of the trapezoidal channel shall be 2 percent.

   d) The easement for the trapezoidal channel shall include 15 feet additional width along one side of the top of the bank for an access road and 5 feet on the other side of the channel.

2. Roughness coefficients for drainage design will be as listed in tables 5-5 and 5-6, figure 5-5, pages 109 through 123, of "Open Channel Hydraulics" by Ven Te Chow (published by McGraw-Hill Book Company, 1959, or latest edition).
3. The minimum velocity in any drainage system shall be 2.5 feet per second, for all events of 20% (5 year) frequency and greater. The maximum velocity in an unlined ditch shall be as specified in "Limiting Velocities and Tractive Forces for Open Channels," (Lane, 1955) or as specified in "Permissible Velocities for Vegetated Channels," (Ree, 1949). Velocity for all storm events up to and including the 1% (100-year) shall not exceed 6 feet per second.
4. The centerline radius of a curve on an improved open channel shall be a minimum of 3 times the top width at the design flow or 100 feet, whichever is greater.
5. All improved channels shall be provided with a minimum of one foot of freeboard above normal depth of the runoff from a 1% (100-year) frequency rainstorm.
6. At all bends in improved channels, the amount of freeboard shall be increased by the following conditions:

   a) The increased freeboard height shall be maintained a minimum of one channel width upstream and downstream of the bend.

7. Where borrow ditches are allowed (see Section I.A.13) the following requirements apply:

a) Borrow ditches may be used if the 4% (25-year) storm can be contained in a trapezoidal ditch (or equivalent) with a maximum bottom width of 4 feet; side slopes 3:1 or flatter; depth of flow no greater than 2.5 feet with 0.5 feet of freeboard between the water surface and top of bank as shown below.

D. *Technical Requirements - Hydraulics of Bridges*

New bridges shall be constructed with adequate capacity to pass the 1% (100-year) storm with one foot of freeboard from the water surface to the low chord. A backwater analysis shall be required to illustrate compliance with this requirement.

E. *Technical Requirements - Hydraulics of Culverts*

1. The following Oklahoma Department of Transportation Standards shall apply except as modified by this MANUAL.
   a) "ODOT, Office of Design, Section 6, Policies and Procedures".
   b) "Standard Specifications for Highway Construction", ODOT.
   c) FHWA publication: Hydraulic Design of Highway Culverts (HDS-5).
2. FEMA Requirements - All bridges that cross FEMA studied streams shall follow the FEMA and Floodplain Administrator's submission and review requirements.
3. Zero Rise - There shall be no adverse impact (zero rise in water surface elevation) for the design discharge and the existing conditions 100-year discharge upstream or downstream of the bridge.
4. Culvert Hydraulic Design Program - HEC-RAS is the preferred hydraulic design program for culverts. HY-8 may be used if the total opening width is 20 feet or less. Nomographs in HDS-5 may be used if an assessment documenting that the method is applicable is included.
5. Design Discharge - The design discharge for all roadway culverts with a drainage basin of 40 acres or larger, or for arterial and residential roadways, shall be the 1% (100-year) discharge.
6. Headwater - the maximum headwater to culvert diameter (or rise) ratio shall be 1.5 for the 1% (100-year) storm.
7. Backwater, or the rise in the 1% (100-year) flood water surface due to the restrictions created by the construction of the culvert, shall be 1 foot or less within the owner/developer's property. No increase in water surface elevation or increase in the extent of the floodplain boundaries is allowed outside of the boundary of the owner/developer's property.
8. Velocity
   a) The minimum velocity in the culvert shall be 3 feet per second for any studied flow rate to assure a self cleaning condition.
   b) The maximum velocity in the culvert shall be 20 feet per second.

c) The velocity at the outlet of the culvert will require channel protection or an energy dissipater according to the design guidelines applicable for the downstream channel type.

9. The hydraulic design calculations for all culverts must be prepared and certified by a licensed Oklahoma Professional Engineer using the hydraulic modeling program HEC-RAS or HEC-2 (or other program approved by the City Engineer). HY-8 may be used if the conditions in Section VII-D-?? are met.
10. The radius of curve for a long box structure shall be a minimum of 3 times the maximum width of the box structure, but not less than 50 feet.
11. Inlet and Outlet Configurations
    a) Culverts are to be designed with erosion protection at the inlet and outlet areas.
    b) The headwalls or end sections are to be located a sufficient distance from the edge of the shoulder or back of walk to allow for a maximum slope of 3H:1V to the back of the structure.
12. Construction Materials
    a) All roadway culverts within the CITY shall be constructed of reinforced concrete. Reinforced Concrete Box (RCB) culverts or Reinforced Concrete Pipe (RCP) culverts are acceptable. The City Engineer may accept alternative materials.
13. Driveway culverts shall be sized to pass the 10% (10-year) design flow. CMP may be used for driveway pipe as long as a concrete slope wall or other approved end treatment is provided. Minimum diameter for driveway pipes is 15". The City Engineer may accept alternative materials.
14. The minimum size roadway culvert shall be an 18" RCP (or equivalent).

F. Technical Requirements - Street and Overland Stormwater Drainage

1. The roadway and overland stormwater drainage systems shall be designed to receive and pass the runoff from a 1% (100-year) frequency rainstorm . The entire flow shall be confined within the said stormwater drainage system.
2. A storm sewer shall be required for all drainage basins wherein the requirements of this manual cannot be met through use of open channels. Open section streets are not allowed in residential development with average density greater than 1 home per 0.75 acres.
3. The street and storm sewer system shall be designed to pass the 1% (100-year) storm within the right of way. Inlets shall be designed to pass a minimum of the 4% (25-year) discharge.
4. The flow from a 4% (25-year) storm shall not exceed any of the following criteria:
    a) curb height,
    b) the crown of the street

c) the depth required to inundate the outside lane in a 4-lane or wider street.

5. Once the criteria listed in V.F.4 are exceeded, a storm sewer with a minimum capacity for the 10% (10-year) storm and sufficient additional capacity (if needed) to meet the requirements of V.F.3 and V.F.4 .
6. For non-residential streets, the first inlet shall be located no more than 400 feet from the high point in the street profile or at the point where the outside lane would be inundated, whichever is less.
7. Cross-over Flow:

   a) In the upstream sections of a drainage basin, above which the 25% storm flow is lower than the depth where the outside lane would be inundated, cross flow is allowed at intersections only.

   b) Otherwise, no cross-over flow is allowed. Inlets shall be located at intersections to collect the flow from crossing the intersection. Inlets at intersections shall be located so they do not encroach upon the curb return. No drainage structure shall be permitted at a wheelchair ramp.
8. Hydraulic design procedures may be obtained from the following sources:
9. The current state-of-the-practice for designing non-recessed storm inlets is presented in the FHWA publication Urban Drainage Design Manual Second Edition.

   a) Guidelines for design of recessed concrete inlets are presented the FHWA publication Hydraulic Characteristics of Recessed Curb Inlets and Bridge Drains.

   b) The guidelines for design of recessed metal curb openings without grates are based on the Kansas City Engineer of Transportation (KDOT) publication K-TRAN Research Project KU-98-3, Hydraulic Performance of Set-Back Curb Inlets.
10. Grated Inlets:

    a) Grated inlets without a curb opening are not permitted within City of Piedmont streets. Hydraulic information is provided for analysis of existing conditions.

       (1) The vane grate (in combination with a curb opening) is the only grate approved by the City of Piedmont within the street ROW.

    b) When a grate is used in conjunction with a curb opening directly behind the grate, only the hydraulic capacity of the grate shall be utilized to estimate the flow that is intercepted, since the curb opening portion is reserved to collect debris.
11. Paved ditches or flumes, commonly call beaver slides, shall not be allowed in lieu of inlets.

12. The overland flow portion of the collector system shall be confined to dedicated rights of way, or restricted drainage easements to assure that stormwater can pass through the development without inundating the lowest level of any building, dwelling, or structure. Restricted drainage easements shall be shown on the plat.
13. The overflow portion of the flow in a sump area shall be designed for 100% blockage of the sump area. This overflow route shall be identified as an overland drainage easement with language prohibiting blockage of flow.
14. Runoff from areas greater than one half (1/2) acre outside the roadway shall be collected before it reaches the roadway. Parking lots shall have internal drainage systems so as to reduce concentrated flow into streets. This item does not apply to single family residential lots.
15. Drainage areas, runoff from 25% (10-year) and 1% (100-year) frequency rainstorms, time of concentration, and inlet design for each inlet shall be summarized and tabulated on the plans. This summary table shall also be a part of the drainage calculations.
16. The flows and velocities for each pipe and open channel shall be summarized and tabulated as above on the plans as well as in the drainage calculations.
17. No pipe shall be installed downstream having a diameter smaller than the pipe from which it is receiving water.
18. All pipe shall meet one of the following requirements:

    a) Concrete pipe shall not be less than ASTM C-76 Class III. Corrugated metal pipes shall meet Oklahoma Department of Transportation gauge requirements for fill heights, and be bituminous coated and lined.

    b) Polyvinyl chloride (PVC) and smooth walled polyethylene (HDPE) pipe may be utilized, in sizes from 15-inches to 30 inches, in storm drainage systems. This material, however, may not be used under City streets or alley ways. Pipe must meet ODOT specifications.
19. Junctions between different pipe sizes shall be made with the top inside of the downstream pipe no higher than the top inside of the upstream pipe.
20. A manhole or junction box shall be required at all changes of grade, changes in alignment, and junctions between two or more different size pipe.
21. The horizontal distance between pipes being placed in the same trench shall be a minimum of two feet or one third the diameter of the larger pipe, whichever is greater. This would include multiple pipe crossings for culvert purposes.
22. The minimum storm sewer pipe size shall be 15 inches. Use of smaller pipes, such as for detention pond outlets, shall require prior approval by the City Engineer.

23. A minimum of 6 inches cover shall be provided over pipes and box culverts to the bottom of the subgrade in paved areas except when the box culverts are built with the top at grade.
24. All storm sewers shall be shown in profile, showing flow line, size, type and grade. Profiles shall show the natural and proposed ground line at the center line of the storm sewer. Stationing shall be continuous through manholes, along the main (longest) line, to the top of the system. Branch lines shall be stationed, starting from 0+00, from their connection with the main line. Lines shall be stationed in the profile drawing from left to right increasing upstream.
25. New box culverts and bridges with a drainage basin of 40 acres or larger shall have adequate capacity to pass 100 year fully urbanized flows with one foot of free board under the low chord. A backwater analysis shall be provided to illustrate compliance with this requirement.
26. Pipes discharging at a steep gradient into drainageways and detention facilities shall be provided with a headwall and energy dissipaters. A pipe with asteep gradient is defined as one having an energy grade line producing an outlet velocity is greater than six feet per second.
27. When storm sewers are constructed in fill areas, all materials in fill areas shall be compacted to a 95 percent standard proctor density prior to the trenching and laying of the pipe.
28. Maximum spacing between manholes or junction boxes shall not exceed 400 feet for pipes of 15 inches and 500 feet for pipes greater than 15 inches.
29. All junction boxes and manholes shall be built with one standard manhole ring and cover at grade.
30. A manhole or junction box shall be constructed at the P.C. or P.T. of all curves in large, long culverts.

G. Technical Requirements - Storage Requirements

1. For all stormwater detention facilities, the releases shall not exceed the pre-development runoff conditions for the 50% (2-year), 20% (5-year), 10% (10-year), 2% (50-year), and 1% (100-year), 24 hour storms, and must be conveyed to a public stormwater conveyance system with no negative impact downstream.
2. The provisions of the stormwater detention plan shall adhere to any stormwater master drainage plan that is adopted in the area under consideration.
3. The intent of the stormwater detention requirements shall be identified at the preliminary plat stage of the project review. The 1% (100-year) storm floodplain areas and stormwater detention site locations shall be shown on the preliminary plat to illustrate how these areas will be managed during and after construction.

4. All detention storage volume shall be located above the BFE in FEMA mapped areas, or above the 1% (100-year) floodplains as mapped by the City for regulatory floodplains.
5. Additional detention storage, in excess of the required storage for a drainage area, shall not be acceptable to satisfy the detention requirements for a tract of land downstream of the detention facility.
6. All stormwater detention facilities shall be located at the downstream end of the development to ensure that "flash" runoff from uncontrolled areas does not contribute to adverse conditions offsite.
7. If a tract of land being developed is located in more than one drainage area, then grading work to divert flows from one drainage area to another will not be permitted. Compensatory storage will not generally be permitted in one drainage area for that required in another. Exceptions may be granted by the City Engineer.
8. Detention facilities shall not be used for compensatory storage and shall not encroach into any floodplain area.
9. All dikes and spillways on detention facilities shall have a longitudinal profile of the outlet showing the 1% (100-year) water elevation in the pond and the tailwater elevation downstream.
10. All dikes and spillways on detention facilities shall have typical cross sections shown on the plans.
11. Side slopes on detention facilities shall not be steeper than 4:1 horizontal to vertical. Steeper side slopes may be allowed should the site conditions necessitate; however, methods for proper erosion control must be established and illustrated, and the procedures for maintaining these steeper side slopes must be established and shown on the plan.
12. Detention facilities shall be provided with a low flow channel from the inlet to the outlet structure to transmit low flows and the low flow channel shall be approved by the City, the low flow channel shall be concrete lined and of sufficient width and geometry to allow for proper maintenance. The maintenance procedure shall be shown on the plans.
13. The easements for the storm sewers and detention ponds shall appear on the plat.
14. An accessway at least 20 feet wide shall be provided to any detention area. Access may be provided by frontage on a dedicated public street or by an access easement from a dedicated public street to the detention area.

    If a detention area is larger than ¼ acre with a depth of 3 or more feet, the access road shall continue into the pond and shall have a maximum grade of 10 percent. The access road shall be paved, 12 feet wide, from the top of the bank to the bottom of the detention pond and in the bottom of the detention pond to locations of high maintenance.

15. An operations and maintenance guide shall be prepared to illustrate the proper use and care of the detention facility, and by whom, when and how. The guide shall include text and diagrams.
16. Any dam or berm constructed shall be designed and constructed under the supervision of a Registered Professional Engineer.
17. The pipe exiting the outlet structure through the dam shall be a 15" RCP or larger pipe. Alternative materials or an equivalent arch pipe section may be allowed on a case-by-case basis. If a smaller outlet is required, an upstream orifice plate shall be used to constrict the outflow.
18. Spillways on detention facility dams shall be constructed to pass the 500 year flood event with a minimum of one (1) foot of freeboard on the earth dam structure.
19. All detention facilities shall meet the Oklahoma Water Resources Board's requirements. The design of detention facilities that have a certain storage volume and/or dam height are subject to regulation by the Oklahoma Water Resources Board.
20. The classification criteria and design requirements are available for download at the OWRB website on the Rules and Regulations page: http://www.owrb.ok.gov/util/rules/rules.php.
21. Freeboard Requirements -all detention facilities shall be designed to meet OWRB requirements or the requirements set forth in this Manual, whichever is stricter. Freeboard requirements are shown in the table below:

Freeboard Requirements for Stormwater Detention Facilities			
Embankment or Excavated Pond	1% (100-year) water surface elevation depth	1% (100-year) water surface elevation	0.2% (500-year) water surface elevation
Embankment or Excavated	< 18-inches	Contained within a dedicated Stormwater detention easement.	
Embankment	18-inches to 6 feet	Contained within the detention facility with one foot of freeboard to the top of the embankment.*	

Freeboard Requirements for Stormwater Detention Facilities			
Embankment or Excavated Pond	**1% (100-year) water surface elevation depth**	**1% (100-year) water surface elevation**	**0.2% (500-year) water surface elevation**
Embankment	**> 6 feet**		**Contained within the detention facility with one foot of freeboard to the top of the embankment.***
Excavated	**>18-inches**	**Contained within the detention facility with one foot of freeboard to the top of the embankment.***	

*unless more stringent OWRB dam safety requirements control, as outlined in Title 785:25-3-3 of the Oklahoma Administrative Code, found at http://www.oar.state.ok.us/viewhtml/785_25-3-3.htm.

H. Design Standards – Stormwater Detention Facilities

1. General Design Criteria

All calculations and plans for detention facilities shall be presented to the CITY for review and approval. Information submitted shall include:

a) Inflow and outflow hydrographs.

b) A comparison of the pre-project and with-project peak discharges at the point(s) of discharge from the development and at points downstream as required by the City Engineer.

c) Elevation-Storage-Discharge relationships.

d) Discharge rating curves for each component of the outflow structure.

e) Tailwater rating curves at the outlet. Tailwater shall be considered when designing the outlet structure.

f) Erosion protection measures at the outlets and spillway.

g) Embankment design in accordance with OWRB guidelines, including slope protection in case of overtopping, slope stability, and maintenance access.

h) Multiple use plans (parks, playgrounds, sports fields, etc.).

i) Trash rack design.

2. On-Site Stormwater Detention

a) On-site detention facilities shall shown to be effective in controlling the peak discharges from the development immediately downstream of the development.

b) The volume of on-site detention required is calculated by comparing the total runoff volume, in acre-feet, of the existing condition 1% (100-year) flood with the volume of the proposed conditions 1% (100-year) flood. The comparison is made using the existing conditions and proposed conditions hydrographs, calculated as specified in Section V-B and subsections. . The Modified Rational Method may be used to determine detention volume required for a single, homogeneous watershed no larger than 40 acres or with a time of concentration of no more than 15 minutes. The detention must discharge directly off-site to a borrow ditch or other major storm drainage component. Hydrograph methods shall be used if the discharge from the detention is to be combined with discharge from another sub-watershed for purposes of routing through or off the site or sizing downstream structures.

c) On-site detention facilities shall be designed so that there is no increase in the peak discharge from any point of the development during the 50% (2-year), 20% (5-year), 10% (10-year), 2% (50-year), and 1% (100-year) flood events. This applies at the point(s) of discharge from the development as well as at points downstream, as required by the City Engineer.

d) The erosive effects of the increased runoff volume from the on-site detention facility shall be mitigated by armoring the stream bank downstream.

e) Mitigation for other water quality impacts of the urban runoff leaving the on-site detention facility shall be provided.

3. Design Standards for Open Space Detention

a) All earth slopes and areas subject to erosion, such as, adjacent to trickle channels, inlet structures, and outlet structures, shall be slab sodded with Bermuda sod or protected with other erosion control measures. All other earth surfaces, within the area designated for detention pond site, shall have an established growth of bermuda grass or other approved species. All grass covered areas shall be fertilized, to current recommendations, watered and in an established growing condition prior to completion and approval of the detention pond.

b) Detention facilities shall be environmentally sound and compatible with the area (neighborhood).Where feasible, multiple uses for the facilities should be established.

c) The city will accept dedication and maintenance responsibilities for drainage and detention facilities on a case-by-case basis under advisement of the City Attorney and Engineer. Otherwise, the maintenance responsibility shall belong to the private sector. A written agreement between the development and the City defining the maintenance requirements and responsible parties shall be made prior to the development's acceptance by the City.

4. Design Standards for Parking Lot Detention

a) Parking Lot detention may be used on properties that do not receive offsite water.

b) The maximum depth in the detention pond shall be 12 inches, occurring during the 1% (100-year) storm.

c) The total flooded area during the 100-year storm shall not exceed 25% of the parking areas and drives.

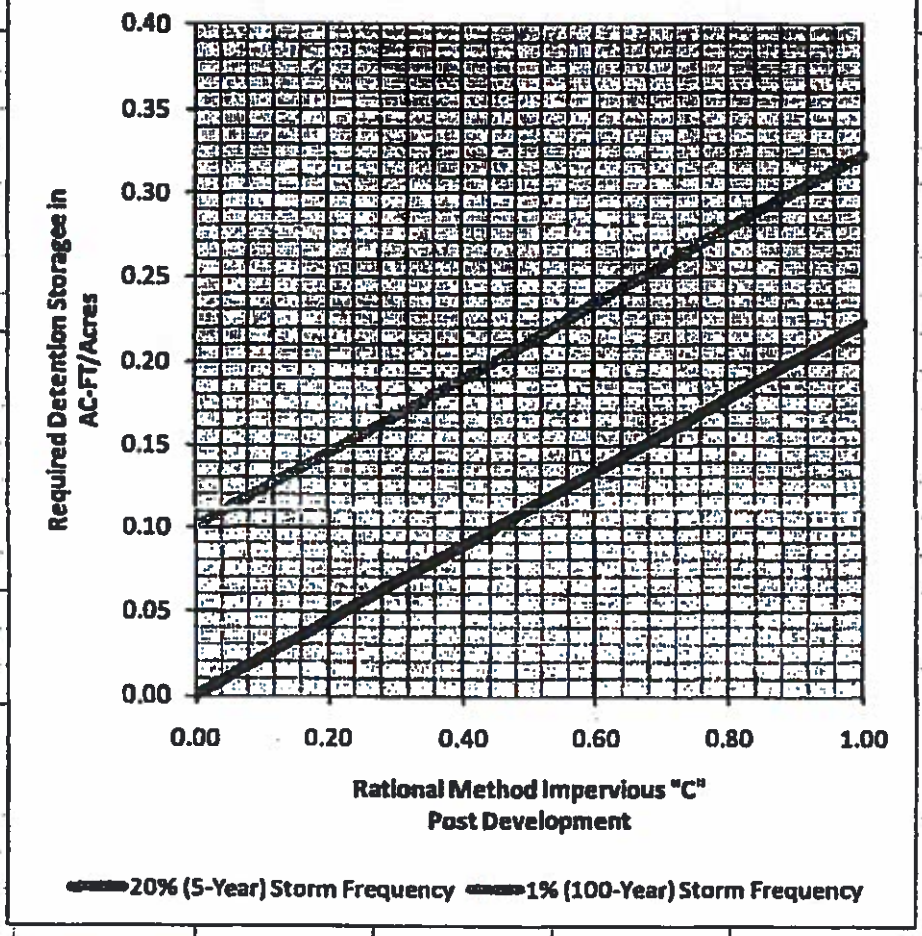
d) The unit volume curves included herein may be used to design the outlet if a two-stage weir is used.

e) The 20% (5-year) storm must completely fill the bottom 6 inches up to the first weir.

f) The 1% (100-year) volume must fill the entire 12-inch depth of water.

g) There must be a 6-inch drop off from the outlet elevation to the ground immediately downstream.

UNIT VOLUME DETENTION CURVES



Pre-Developed 1% (100-Year) Rational Method	Outflow Rate for Drainage CFS/AC	
"C"	20% (5-Year)	1% (100-Year)
0.1	0.0	0.6
0.2	0.1	1.3
0.3	0.2	2.0
0.4	0.6	2.9
0.5	1.8	4.9
0.6	3.6	7.5

Reference: City of Tulsa Stormwater Management Criteria Manual, Updated 1993

h) If a pipe and weir outlet is used, the same criteria apply, with the weir set at the 20% (5-year) elevation.

i) If a pipe outlet is used, a City-approved trash rack must be placed upstream.

VI. Green Development

A. The City encourages developers to incorporate stormwater management techniques that include water quality benefits, also known as "Green Infrastructure" or "Low Impact Development."

B. Specific structural requirements of this manual, such as requirements for concrete liners, may be waived by the City Engineer to accommodate use of low impact development techniques. In no case will any requirements dealing with off-site, upstream, or downstream impacts be waived.

C. Proposals for Green Development shall be presented to the City as an application for a Planned Unit Development (PUD). The PUD design statement shall include specific water quality goals and analysis demonstrating that they will be achieved through the methods proposed.