CITY OF BIXBY, OK

Engineering Design Criteria Manual

City of Bixby Engineering Department

January 2011

SECTION A. GENERAL DRAWING PREPARATION

A.1. The size of all drawings shall be a multiple of 8.5 inches by 11 inches. with a maximum of 22 inches by 34 inches. All drawings shall be sealed by a registered professional engineer or a registered land surveyor of the State of Oklahoma.

A.2. Drawing *copies and* materials shall be prepared and submitted as specified in the current City of Bixby Engineering Design Checklist.

A.3. The scale shall not be less than 1 inch equals 100 feet on a plan sheet; and 1 inch equals 50 feet horizontal and 1 inch equals 5 feet vertical on plan and profile sheets. Profile sheets shall have *not more than* 10 graduations horizontal and vertical per inch.

A.4. Freehand lettering shall be a minimum height of 0.12 inches. Mechanical lettering shall also be a minimum height of 0.12 inches. Typing shall be a minimum of *0.12* inches.

A.5. All line work shall be of sufficient density to reproduce clearly. Any work that does not reproduce clearly and legibly shall be cause for rejection of the project drawings.

A.6. All project drawing packages shall include a cover sheet which shall serve to introduce the project. Information contained on the cover sheet shall include the project title; project location with location map, project owner's name, address, telephone number and contact person (if not the owner); project engineer's name, address, and telephone number; drawing index; and legend. The cover sheet shall not be used for a plan sheet.

A.7. On all drawings, a titleblock shall be shown which shall include the project title, owner's and engineer's name, drawing description, page number, and date.

A.8. The drawings shall show all obstructions, both existing and proposed, above and below ground, and located both vertically and horizontal.

A.9. All improvements shall be able to be located at the project site from dimensions shown on the drawings based on established physical objects. This includes section lines and section corners. No improvements shall need to be scaled off of the drawings to be located at the project site, or need for the designer to physically locate the improvement at the project site. The drawings shall be completely self explanatory.

A.10. The vertical control shall be based on USGS datum and bench marks shall be shown on each plan view drawing. *All horizontal control points shall be tied to the State Plane Coordinate System used by the City of Bixby.*

A.11. No improvements shall be installed without dedication of the right-of-way or appropriate easement and all such right-of-wav or easement shall be shown on the drawings.

A.12. *Upon project completion, Record Drawings and Final Plats shall be submitted for all projects. Drawings material shall be high quality vellum or stable base film, such as mylar. Record Drawings shall also be submitted electronically in the following file formats: .dwg, and either .pdf or .tif.*

SECTION B. DRAINAGE AND EARTH CHANGE

B.1. EARTH CHANGE PERMITS.

The application and development site plan shall contain the following information, unless the City Engineer determines that due to the scope and nature of the proposed development some of the information is unnecessary or that additional information is required to determine that the application meets the policies and standards governing the issuance of the requested permit(s). The site plan and design standards established by the application and approved by the City Engineer shall become conditions upon the issuance of the permit(s). No changes in an approved site plan or design standard shall be made without prior written approval of the City Engineer.

B.2. EARTH CHANGE APPLICATIONS.

Provide *five (5)* sets of scale drawings providing the following information:

B.2.1. Name and address of legal owner.

B.2.2. Vicinity sketch.

B.2.3. Legal description of property.

B.2.4. Boundary line survey.

B.2.5. Existing and proposed contours at 1 foot intervals.

B.2.6. Location of any structure or natural feature on site.

B.2.7. Location of any proposed additional structures or developments on site.

B.2.8. Location of any structure or natural feature on the land adjacent to the site and within 50 feet of the site boundary line.

B.2.9. Plans of all drainage provisions, retaining walls, cribbing, planting, erosion control measures, or other temporary or permanent soil erosion control measures to be constructed in connection with or as a part of the proposed work; together with a map showing the drainage area of lands tributary to the site and estimated runoff of the area served by any drains.

B.2.10. A time schedule indicating the anticipated completion date of the development, starting and completion dates of the development construction sequence, and the time of exposure of each area prior to the completion of the effective erosion and sediment control measures.

B.2.11. Owner's statement and signature certifying that the approved plans will be implemented under the direct engineering supervision of a registered professional engineer.

B.2.12. Hydraulic and hydrologic analysis for runoff and/or detention facility/facilities, if on-site detention is deemed necessary.

B.2.13. Floodplain boundaries and/or watercourse location.

B.2.14. Hydraulic and hydrologic analysis for any alterations within the flood hazard area, or for the alteration of any watercourse.

B.2.15. Estimate of the quantity of excavation and fill involved, with drawings indicating each separate excavation or fill.

B.2.16. Plans for control of on-site and off-site sedimentation for the purpose of preventing the deposit of sediment from the tract under application upon any other off-site public or private property or watercourse during all phases of project construction.

B.2.17. A summary statement concerning the effect the proposed development will have on the existing and future drainage system(s) of the area.

B.2.18. Earth Change Permits shall be issued only upon payment of the appropriate fee as established by ordinance by the City Council.

B.3. EXEMPTIONS TO EARTH CHANGE PERMITS.

The City Engineer may approve an exemption to the requirement for an earth change permit for those conditions meeting the exemption requirements listed in the City Code. The Applicant is required to submittal a letter requesting an exemption and provide the following information.

B.3.1. Address of the property and owner's mailing address, if different.

B.3.2. Purpose of the proposed earth change.

B.3.3. Acreage affected by the proposed action.

B.3.4. Amount of earth to be moved in truckloads or cubic yards.

B.3.5. Owner's statement that no drainage channels will be altered and that no adverse effects on other property will be caused by the earth change.

SECTION C. STREETS AND SIDEWALKS CRITERIA

C.1. PAVEMENT – *GENERAL.*

C.1.1. All pavements shall be constructed of either Portland cement concrete or asphaltic concrete, and base courses and thicknesses shall be in accordance with the following standards.

C.1.2. *Pavements shall be designed in accordance with current AASHTO standards. Pavements shall be designed to the minimum weighed structural number as follows:*

a. *Minor and high density minor = 3.9*
b. *Residential, commercial, and industrial collectors = 4.4*
c. *Arterials = 5.0*

C.1.3. *Acceptable coefficients for conversion of depth of various types of materials are as follows:*

Layer	***Coefficient Per Inch of Depth***
Sub-base	
Sandy Gravel	*0.11*
Sand, Sandy Clay	*0.05-0.10*
Lime-treated Soil	*0.11*
Lime-treated Clay, Gravel	*0.14-0.18*
Base	
Sand Gravel	*0.07*
Crushed Stone	*0.14*
Cement Treated Base (CTB)	*0.23*
>650 psi	*0.20*
400-650 psi	*0.15*
<400 psi	
Bituminous Treated Base (BTB)	
Coarse	*0.34*
Sand	*0.30*
Lime Treated Base	*0.15-0.30*
Soil Cement	*0.20*
Lime/Fly Ash Base	*0.25-0.30*
Surface Course	
Plant Mix	*0.40*
Road Mix	*0.20*
Sand Asphalt	*0.40*
Concrete	*0.50*

C.1.4. *All bases and pavements shall be specified, supplied, prepared, and installed in accordance with the appropriate ODOT Standard Specification.*

C.1.5. *Subgrade soils shall be bored and soil tests made to determine the subgrade soils stability and bearing capacity. The testing, conducted at appropriate intervals, shall be completed by a licensed engineer specializing in geotechnical investigations and an approved laboratory. The Geotechnical Engineer shall coordinate the soil borings and tests. The Geotechnical Engineer shall be approved for work in the City of Bixby. A copy of the geotechnical report shall be forwarded with the Preliminary Construction Plans for the subdivision streets. This report shall include recommendations for modifications to subgrade that are required to stabilize the subgrade and/or improve its bearing capacity. The application rate for lime, fly ash, cement, or screenings shall be determined by the Geotechnical Engineer, described in the geotechnical report and approved by the City Engineer. Subgrade preparation include, at minimum, the following:*

a. <u>*Material:*</u> *All subgrade material shall be free of organic matter, roots, brush, and vegetable matter. All soft and yielding or other unsuitable materials shall be removed and replace with suitable materials before construction proceeds. All material with a placticity index (PI) of ten (10) or more shall be treated with appropriate mater to reduce the PI to less than ten (10). All material that is nonplastic shall be treated with appropriate materials to provide a stable, proper strength subgrade.*

b. <u>*Preparation:*</u> *Subgrade shall be prepared to a minimum depth of eight (8) inches by discing, ripping, addition of require materials, and/or other forms of manipulation. The final subgrade shall be compacted to 95 percent of standard density at plus or minus two (2) percent of optimum moisture content.*

c. <u>*Special Condtions:*</u>

C.2.1. *When underground water sources are encountered, they shall be drained away from the subgrade with appropriate drains approved by the City.*

C.2.2. *Fill areas through old creek channels, ditches, ponds, and other drainage structures shall be excavated and backfilled with suitable material. Low areas through these areas shall be have underground drains approved by the City that will prevent saturation of the subgrade. In areas where soil strength is not sufficient to support the roadway, geotextile fabric may be used with approval of the City.*

C.2.3. *In areas where soil strength and or stability is not sufficient to support the roadway, rock or rock with geotextile may be used to improve the subgrade with approval by the City.*

C.1.6. All grading and drainage work shall be completed in accordance with plans and specifications as approved by the City Engineer before paving is commenced, and no paving shall be placed until the City Engineer has given his approval for work to proceed.

C.1.7. *Minimum* base courses and pavement thicknesses for various street types in the City of Bixby, Oklahoma, shall comply with the following standards:

Portland Cement Concrete				
	Assumed Load in Kips			
Street Type	*Tandem*	*Single*	*ADT*	*Thickness*
Minor	36	20	200	6"
High Density Minor	36	20	300-700	6"
Residential Collector	36	20	700-1500	6"
Commercial Collector	56	30	2000-6000	*8"*
Industrial Collector	65	40	2000-6000	*8"*
Arterial	65	40	----	8"

Asphaltic Concrete				
Street Type	*Total*	*Base*	*Thickness Surface*	*Subbase*
Minor	6 1/2"	5"	1 ½"	2"
High Density Minor	6 1/2"	5"	1 ½"	4"
Residential Collector	7"	5"	2"	4"
Commercial Collector	8 1/2"	6 1/2"'	2"	6"
Industrial Collector	8 1/2"	6 1 2"	2"	6"
Arterial	10"	8"	2"	8"

C.1.8. Proposed streets shall intersect with one another as nearly at right angles as topography and other limiting design factors permit. Four (4) way intersections involving minor and collector streets shall be avoided and three (3) way or "T" intersections shall be used for minor and collector streets wherever practical and not in conflict with other applicable design principles and standards.

C.1.9. Driveways shall be constructed of Portland cement concrete which meets the requirements for streets or as specified by the City Engineer. Driveways shall not be less than five (5) inches in thickness for residential, six (6) inches in thickness for commercial and light industrial, and seven (7) inches in thickness for heavy industrial and shall have a turn radius of not less than 10 feet.

C.1.10. Curbing is required on all street types, with the exception of residential streets where open drainage ditches under "RE" zoning are allowed by the City.

C.2. PORTLAND CEMENT CONCRETE STREETS.

C.2.1. Portland cement concrete shall have a twenty-eight (28) day compressive strength of not less than 3,500 pounds per square inch, a tensile strength greater than 500 pounds per square inch, a slump of not more than 4 inches, not less than 5 ½ sacks of Portland cement per cubic yard, and shall contain 6 per cent air, plus or minus 1 per cent.

C.2.2. Portland cement concrete streets shall have an integrally placed curb of the same mix design as for street paving. The curb shall be a minimum of 6 inches wide at the top and the curb face shall be a minimum of 6 inches in height exclusive of bottom fillet.

C.2.3. All Portland cement paving, curbs, and gutters shall be cured with white pigmented curing compound.

C.2.4. Joints in Portland cement paving, curbs, and gutters shall be placed in accordance with the City Engineer's recommendation.

C.2.5. *Curbs shall have handicapped access ramps at appropriate locations, in accordance with the Americans With Disabilities Act and its supporting standards.*

C.3. ASPHALTIC CONCRETE STREETS.

C.3.1. The base course for asphaltic concrete shall be of plant mix, hot mix/hot laid asphalt containing 4 ½ per cent to 6 per cent asphalt cement. *Unless otherwise approved, the base course shall be Type A asphalt concrete placed in 2 ½ inch maximum lifts.*

C.3.2. The surface course for asphaltic concrete shall be of plant mix, hot mix / hot laid asphalt containing 5 per cent to 7 per cent asphalt cement. *Unless otherwise approved, the base course shall be Type C asphalt concrete placed in 2 ½ inch maximum lifts.*

C.3.3. The mineral aggregates used in the asphaltic concrete mixture shall be approved by the City Engineer in accordance with the Bixby Standard Construction Specifications.

C.3.4. The asphaltic mixture shall be laid at a temperature of not less than 225 degrees Fahrenheit nor more than 300 decrees Fahrenheit.

C.3.5. Asphaltic concrete streets shall have a Portland cement concrete curb and gutter of the same mix design as required for Portland cement concrete streets. The curb shall not be less than 6 inches wide at the top with a 6 inch face in height exclusive of bottom fillet, and the gutter shall be a minimum of 18 inches in width.

C.4. STREET DESIGN STANDARDS.

C.4.1. MINOR STREETS AND SIDEWALK DESIGN STANDARDS.

Design Speed	*25 mph*
Right-of-way Widths	50 ft. min.
Pavement Width	26 ft. min.
Curb Height - Minimum	6 inch vertical
Sidewalk Width	4 ft.
Sidewalk Setback	6 ft. min. and 1 ft. inside P.L. as max.
Maximum Grade	8%
Minimum Grade	0.5%
Minimum Centerline Radius	100 ft.
Minimum Stopping Sight Distance	200 ft.
Minimum Traffic Lane Width	12 ft
Minimum Parking Lane	8 ft.

Driveway Width	10 ft. min. and 20 ft. max.
Driveway Radius	10 ft.
Note: Street width includes an 18 inch gutter both sides.	

C.4.2 COLLECTOR STREET AND SIDEWALK DESIGN STANDARDS.

Design Speed	*35 mph*
Right-of-way Widths	60 ft. min. Residential or Office 80 ft. min. Industrial or Commercial
Pavement Width	36 ft. min. Residential or Office 42 ft. min. Industrial or Commercial *(Note: Does not include on-street parking, add 8 feet per parking lane)*
Curb Height - Minimum	6 inch vertical
Sidewalk Width	4 ft.
Sidewalk Setback	10 ft. min. and 1 ft. inside P.L. as max.
Maximum Grade	7% Residential 5% Industrial and Commercial
Minimum Grade	0.5 %
Minimum Centerline Radius	*150 ft. Residential* 350 ft. Industrial, Commercial, or Office
Minimum Stopping Sight Distance	275 ft.
Minimum Traffic Lane Width	11 ft.
Minimum Parking Lane	12 ft.
Driveway Width	10 ft. min. and 35 ft. max.
Driveway Radius	10 to 15 ft.
Note: Street width includes an 18 inch gutter both sides	

C.4.3 ARTERIAL STREET AND SIDEWALK DESIGN STANDARDS.

Design Speed	40 – 60 mph
Right-of-way Widths	100 ft. for Secondary 120 ft for Primary
Pavement Width	*56* ft. min. Secondary 88 ft. max. Primary
Curb Height - Minimum	6 inch vertical
Sidewalk Width	4 ft.
Sidewalk Setback	10 ft. min. and 1 ft. inside R/W as max.
Maximum Grade	4% Primary

	5% Secondary
Minimum Grade	0.5 %
Minimum Centerline Radius	600 ft. Primary 400 ft. Secondary
Minimum Stopping Sight Distance	200 – 350 ft.
Minimum Traffic Lane Width	12 ft.
Minimum Parking Lane	10 ft.
Driveway Width	10 ft. min. and 35 ft. max.
Driveway Radius	10 to 15 ft.
Note: Street width includes an 18 inch on the outside pavement edges.	

C.4.4. In the event of an arterial requiring pavements wider than 52 feet. the owner shall discuss with city officials having jurisdiction the matter of partial funding at City expense so that pavement widths wider than 36 feet can be constructed simultaneously with development.

C.4.5. The minimum radius on returns at residential intersections shall be 25 feet. At intersections of a residential and arterial street, the minimum radius on returns shall be 30 feet. The minimum radius on the returns for industrial districts shall be 40 feet.

C.4.6. The maximum cross slope on all streets shall be 3/8" per foot.

C.4.7. Streets shall include earth work, treated subgrade, base course(s), wearing surface, concrete curb and gutters, proper backfill, and proper storm drains and inlets.

C.4.8. Plans shall include cross section plans and profiles of the streets, and all other construction drawings related to the improvements constructed or to be constructed in the subdivision.

C.4.9. Intersection details shall be drawn at a scale of 1 inch equals 20 feet showing drainage direction. spot elevations and inlet placements.

C.4.10. All underground utility crossings shall be shown and stationed on the paving plan and profiles.

C.5 CONSTRUCTION STANDARDS FOR SIDEWALKS.

C.5.4. REQUIREMENTS. All sidewalks shall be of Portland cement concrete which meets the requirements for PORTLAND CEMENT CONCRETE STREETS. Sidewalks shall include pedestrian bridges across creeks and streams where applicable.

C.5.5. BASE. Concrete shall be laid on a firm, smooth surface at an average depth below finish grade equal to the thickness of the sidewalk. All soft and yielding or other unsuitable materials shall be removed and replaced with suitable material before construction proceeds.

C.5.6. DIMENSIONS. The finished thickness of Portland cement concrete sidewalks shall not be less than 4 inches and the width shall be not less than 48 inches.

C.5.7. CURING. When curing compounds are used, sidewalks shall be cured with a white pigment compound.

C.5.8. DISTANCE FROM STREETS. In general, sidewalks shall be constructed within street rights-of-way at a distance no less than one foot from the abutting property lines; and except at

intersections or as approved by the city, shall be no less than three (3) feet from the outside curb line of the street pavements.

C.5.9. MAINTENANCE. After final acceptance of sidewalks by the city maintenance of sidewalks shall be the responsibility of property owners whose properties abut the right-of-way line along which the sidewalk has been constructed.

C.5.10. HANDICAPPED ACCESS. Sidewalks must provide reasonable access for the safe and convenient movement across curbs of physically handicapped persons, including those persons in wheelchairs. *Access ramps at appropriate locations, in accordance with the Americans With Disabilities Act and its supporting standard shall be included in the sidewalk construction.*

C.6 CONSTRUCTION STANDARDS FOR DRIVEWAYS AND PARKING AREAS.

C.6.1. REQUIREMENTS. All concrete driveways and parking areas shall be of Portland cement concrete which meets the requirements for PORTLAND CEMENT CONCRETE STREETS. Driveways shall be concrete on all new streets, on all industrial or commercial driveways, and on all driveways onto existing concrete streets. Asphalt driveways may be permitted on a case-by-case basis for residential access drives only onto existing asphalt streets and only if asphalt drives have been generally used for driveway construction in the area.

Parking areas may be either concrete or asphalt based on the recommendations to the property owner by a licensed professional engineer. The design recommendation shall be submitted to the City for review and approval prior to construction.

Driveway and parking materials other than asphalt or concrete will not be considered.

C.6.2. BASE. Concrete for drives shall be laid on a firm, smooth surface at an average depth below finish grade equal to the thickness of the drive. All soft and yielding or other unsuitable materials shall be removed and replaced with suitable material before construction proceeds. Parking areas construction shall proceed as per design engineer's specifications.

C.6.3. DIMENSIONS. Horizontal drive dimensions shall be as specified in C.4 above.

Concrete drives shall not be less than five (5) inches in thickness for residential, six (6) inches in thickness for commercial and light industrial, and seven (7) inches in thickness for heavy industrial and shall have a turn radius of not less than 10 feet.

Asphalt drives, where allowed, shall be a minimum of five and one-half (5 ½) inches in thickness.

C.6.4. MAINTENANCE. Driveways and parking areas shall be the sole responsibility of the property owner for which the drive provides street access and parking.

SECTION D. STORM WATER DRAINAGE CRITERIA

D.1 GENERAL REQUIREMENTS

D.1.1 Master Drainage Plans

If a Storm Water Master Drainage Plan is adopted for the area under consideration, proposed storm water drainage systems shall comply with the provisions of the plan.

D.1.2 Special Drainage Districts

D.1.2.1 ***Arkansas River Floodplain.*** *Projects requiring storm water detention that are located within or under the direct influence of Arkansas River Floodplain may utilize storm water detention facilities with outlet structures below the 100-year flood elevation However, the lowest discharge elevation of the outlet structure shall be constructed above the 50-year flood elevation.*

The storm water detention facility volume may not be counted in the computation of compensatory storage volumes need for floodplain construction.

D.1.2.2 ***Bixby Creek Drainage Basin.*** *Projects requiring storm water detention that are located within the Bixby Creek Drainage Basin may provide storm water mitigation through the use of total retention facilities. The facilities must entirely contain the 100-year runoff volume as determined by hydrology calculation for a storm duration of 24-hours No credit shall be taken for infiltration in establishing the minimum volume. Other design and construction criteria shall be as per detention facility requirements..*

A portion or all of the retention volume may be located below the 100-year flood elevation. Regardless of location, the retention facility volume may not be counted in the computation of compensatory storage volumes need for floodplain construction.

The discharge structure for a total retention facility must be still be designed and constructed to limit the discharge from the facility to pre-development flow rates or less. The outlet structure for the retention facility must also be equipped with a backflow prevention device such as a flap gate to prevent backwater from Bixby Creek or any of its tributaries from entering the retention area. The outlet structure must be designed to allow the entire retention volume to drain freely into Bixby Creek or one of its tributaries once downstream back pressures have subsided.

The retention facility shall be constructed with an overflow structure that allows for the emergency overflow of the 500-year storm event at elevations at least 1 foot below the finished floor elevations of the buildings served.

D.1.3 Storm Drainage System

D.1.3.1 All storm water runoff shall be reviewed and accepted by the City Council with regard to analysis, design and construction of drainage facilities. The appropriate public authority shall have the right to maintain or to cause to be maintained the drainage system for its intended purposes. Floodplain variances must be accepted by the City Council.

Review and acceptance of plans by the City Engineer does not release the

Consulting Engineer from his professional responsibility to meet the planning and design objectives of the project as required by good engineering practice and the City of Bixby.

D.1.3.2 Drainage facilities, both public and private, shall consist of all elements necessary to convey storm water runoff from its contact with the earth to its disposition in the Arkansas River.

The drainage system, both public and private, may consist of storm sewers (which are closed conduits); improved channels constructed in conformity with adopted City Standards; unimproved drainageways left in their natural condition; the areas covered by restricted drainage easements for the purpose of providing overland flow; and all appurtenances to the above including inlet, manholes, junction boxes, headwalls, dissipaters, culverts, etc. All portions of the drainage system that exist on dedicated drainage rights-of-way or restricted drainage easements shall be owned and maintained by the City, unless provided otherwise by agreement or covenant.

D.1.3.3 The storm water drainage system shall be designed to receive and pass the runoff from a 100-year frequency rainstorm within dedicated easements under full urbanization. Full urbanization is defined as the total development in an area that is anticipated. The entire flow shall be confined within the said storm water drainage system.

Subject to requirements for Earth Change Permits and of the City Drainage Standards, improvement of downstream conveyance may be required if such improvements comply with the policies of this chapter, or if current flooding problems exist, subject to the approval of the City Engineer.

D.1.3.4 The storm water collection system shall be designed for either of the following conditions:

A. Convey:

1. A minimum of the runoff from a 5-year frequency rainstorm in a pipe network with overland flow capacities so that the combination of any two will pass the runoff from a 100-year frequency rainstorm under fully urbanized conditions; or
2. The entire runoff from a 100-year frequency rainstorm may be contained in the pipe network. Should the entire runoff from a 100-year frequency rainstorm be conveyed in a pipe network, a bypass system shall be designed considering the pipe network to be 50% blocked. If it can be demonstrated that, in unique situations, property damage or flooding will not occur, a smaller by-pass system may be approved by the City Council.

B. Where sump collection systems are used, an overflow route shall be established in the event of complete blockage of the sump.

C. Runoff from areas greater that 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 flows into streets. This item does not apply to single-family residential lots on local streets.

D. Inlets shall be located at intersections to prevent 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.

E. Drainage areas, runoff from 5-year and 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.

D.1.4 Drainage Easements

D.1.4.1 Drainage easements will be required for all storm water management facilities, not in public rights of way; including storm sewers, channels, storage areas and other hydraulic structures. Drainage easements need not be exclusive, but other uses shall not restrict the drainage purposes within the easement.

D.1.4.2 The easement dedication should clearly identify that the purpose includes operation and maintenance of storm water management facilities. Widths and specific purposes (i.e.: storm sewer, maintenance access, channel, etc.) for drainage easements shall be shown on all plats.

D.1.4.3 For storm sewers, the widths of the easements are determined by the size of the sewer and equipment needed to remove, replace or repair the sewer. *For piped systems, the minimum easement width shall be 10', located entirely on one property.* For channels, storage areas and other structures, the width of the easement is generally determined by the size of the facility and the equipment needed for maintenance. Typically, the easement will cover the entire facility, plus 20 feet for maintenance access.

D.1.4.4 The overland flow portion of the collector system shall be confined to dedicated rights-of-way, or restricted drainage easements to assure that storm water 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. The storm water runoff from no more than 3 lots, or ½ acre whichever is less, shall be allowed onto another lot or between 2 lots. If more lots or area needs to be drained, then an underground storm sewer or *overland drainage channel located in a dedicated overland drainage easement* shall be required.

D.1.5 Maintenance

D.1.5.1 Owner's Maintenance Responsibility. It shall be the responsibility of all owners of property, whether undeveloped, developed, or undergoing development to:

A. Mow and provide minor maintenance of drainage channels and their slopes for that portion of the channel lying within their property line.

B. Keep clear all drainage channels within the boundaries of their properties in accordance with the requirements of this article.

C. Control all storm water runoff and drainage, erosion and sedimentation from points and surfaces on the property.

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

E. Not take any action which will alter or otherwise change designed and installed storm water management control systems and not take any action on existing property that shall adversely affect storm water runoff in any manner contrary to the provisions of this Section, whether temporary, permanent, or a combination thereof.

D.1.5.2 The City may require improvements, provision of drainage easements, and for provision of improvements, agreements, and/or easements beyond the boundaries of the subdivision, development, or property improvement to facilitate flow of storm water from or through the property, to avoid damage from changed runoff conditions, to provide continuous improvement of the overall storm drainage system, and to accommodate all drainage conditions or requirements. Where storm water runoff flows require the logical extension of any street or its associated drainage in order to prevent flooding, ponding, or uncontrolled runoff, the extension shall be provided by the developer.

D.1.5.3 During all construction activity and all other non-construction activity developers, property owners and contractors shall be required to keep streets, gutters, inlets, drainage pipes, swales, ditches, drainage channel, and all drainage devices and structures clean and free from debris, sedimentation, soil, and any materials. Any failure to meet this requirement shall, upon notice and failure to immediately correct the notified condition, constitute sufficient grounds for stopping all work until correction is completed.

D.1.5.4 Developers, property owners, or their legal agents, upon receipt of notice by the City of Bixby that repair or maintenance is required within a channel lying within their property, shall be responsible for effecting such repair or maintenance within the time specified, or the City shall have repair and maintenance performed at the expense of the property owner.

D.1.5.5 City's Maintenance Responsibility. It shall be the responsibility of the City to:

A. Repair and maintain drainage channels and their slopes when located within or upon rights-of-way dedicated to the City.

B. Develop and implement standards and specifications required to clearly and accurately interpret the physical requirements of this section.

C. Design and implement a Drainage Master Plan for urban drainage, storm water management, and flood control.

D. Make such necessary improvements of primary and secondary drainage channels that cannot or will not be improved through private development.

E. Improve and maintain floodway and flood fringe areas that are dedicated public areas, rights-of-way, parklands, or public-owned buildings or developments.

F. Improve and maintain all public-owned drainage channels or systems outside the flood fringe area.

D.1.6 Drainage Reports

D.1.6.1 Report Contents. The Drainage Report *shall contain the information listed below, in the format shown:*

A. Cover Sheet

1. *Project Name*
2. *Project Location*
3. *Engineer's Name, Address, and Telephone Number*
4. *Owner's Name, Address, and Telephone Number*
5. *Submittal Date*

B. Table of Contents

1. *Report Content list and pagination*
2. *Engineer's Certification (from D.1.6.2)*
3. *Registered Engineer's Seal, Signature, and Date*

C. Executive Summary

1. *Brief Project Summary*
   - *Watershed (Arkansas, Fry, Bixby, etc.)*
   - *Development type (residential, commercial, etc.)*
   - *Development area*
   - *Number of lots proposed*
   - *Major Drainage Elements proposed – detention facilities, drainage channels, etc.*
2. *Pre-development and Post-development Discharge Summary Table including Basin Names and Discharge Rates for all storm frequencies.*
3. *Detention Summary Table including for all storm frequencies: water surface elevations, detention volumes, and discharge rates.*
4. *Graph showing relationship between Pre and Post-development discharge rates vs. storm frequency for all Design Points.*
5. *Drainage Channel Summary Table including longitudinal stations, discharge rates, and water surface elevations for critical storm frequencies.*

D. Site Information

1. *Project Name(s)*
2. *Project Location*
3. *Watershed (i.e. Arkansas, Fry, Bixby, etc.)*
4. *Project Area*
5. *Number of Lots*
6. *Site Topography*
7. *Site Soils*
8. *Site Drainage Areas and discharge points*
9. *Off-Site Drainage and discharge points*
10. *Land Use – Pre and Post Project*
11. *Design Point(s)*
12. *Design Objectives/Assumptions*

E. Drainage Basin Summary

1. *Pre-development site map with Drainage Basins, contours, Design Points, and drainage paths used for Time of Concentration/Lag calculations shown. Boundaries shall be drawn for actual, physical basins.*
2. *Post-development site map with Drainage Basins, contours, Design Points, and drainage paths used for Time of Concentration/Lag calculations shown. Boundaries shall be drawn for actual, physical basins.*
3. *Curve Number Calculation Summary Tables for Pre and Post-development conditions including Basin Name, Basin Area, Basin Soil Hydrologic Group, Project Land Use Classification and Weighted CN calculations*
4. *Lag Time Calculation Summary Tables for Pre and Post-development conditions including Basin Names, any Routing Elements, and Lag Times.*

F. Hydrologic Data

1. *Rainfall Model including rainfall frequency, duration, and depth*
2. *HEC-HMS Model schematics for Pre and Post-development*
3. *Pre and Post-development Discharge Summary Tables including Names, Areas (in sq. miles), CN's, Lag Times, and discharge rates for all Basin and Routing Elements for all storm frequencies.*

G. Detention Design Information

1. *Detention Facility Site Plan*
2. *Stage-Storage Data for Proposed Detention and any existing, on-site detention areas (i.e. exist. pond or control structure such as a culvert).*
3. *Discharge Structure Details*
4. *Stage-Discharge for Outlet Structure*
5. *Elevation-Storage-Discharge Table for Proposed Detention and any existing, on-site detention area as described above.*

H. Channel Design Information

1. *Channel Site Plan with Pre and Post-development floodplain boundaries along with proposed drainage easements shown.*
2. *Typical Cross-sections*
3. *Bridge/Culvert Details*
4. *HEC-RAS Model Schematic*
5. *Summary Table Summary Table including longitudinal stations, discharge rates, floodway width, floodplain width and water surface elevations for critical storm frequencies.*
6. *HEC-RAS water surface profiles for critical storm frequencies.*

I. References

(List as applicable – SCS Soil Surveys, Hydrologic and Hydraulic Literature, Tulsa Stormwater Management Manual, etc.)

J. Appendices

1. *SCS Soils Map and Data Sheets*
2. *Detailed weighted CN Calculations and any Reference Tables used*
3. *Detailed Time of Concentration/Lag Time Calculations and any Reference Charts/Tables used*

4. *Detailed Detention Storage Volume Calculations – Elevation, Stage Area, Average End Areas, Incremental Storage Values, Cumulative Storage Values*
5. *Detailed Discharge Structure Calculations – List of weir and orifice equations with coefficients used along with elevation – discharge calculations. Any Reference Charts/Tables/Computer programs should be included.*
6. *Detailed HEC-RAS output Reports for Proposed Channels/Bridges*
7. *Culvert Design Data*
8. *Channel/Structure Discharge Velocity Calculations*
9. *Erosion Protection Measure Calculations based on discharge velocities (Rip rap, Energy Dissipator, etc.)*
10. *Inlet Design Summary Table with drainage inlet names, inlet design designation (i.e. Des 2, Des 2(D), etc.), basin areas, time of concentration calculations, rainfall intensity calculations (5, 50 and 100-year storms), runoff calculations (5, 50, and 100-year storms), street capacity, depth of flow, width of spread on street (5, 50 and 100-year storms), inlet type (sump or on-grade), clogging factors, inlet capacity, bypass flows, and identification bypass flow recipient.*
11. *Storm Sewer Pipe Design Table with pipe capacity and EGL/HGL calculation chart showing major/minor losses, and EGL/HGL elevations in relation to surface elevations at structures/junctions (i.e. grates, MH rims, etc.). (Note: Minor losses should be calculated as per the APWA Special Report No. 49, 1981 as shown in Table 1003 and Table 1004 of the Tulsa Stormwater Management Manual.)*

K. CD containing complete HEC-HMS and HEC-RAS files

L. The report shall contain a Certification sheet as follows:

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

(SEAL)_____
Signature

D.1.6.2 Additional types and descriptions of information *for use in Report preparation that may be specifically required in the Detention Report upon request by City staff include*:

General location and description

Location

1. Township, range, section, ¼ section
2. Local streets within and adjacent to the subdivision
3. Major drainageways and facilities
4. Names of surrounding developments

Description of Property

1. Area in acres
2. Ground cover (type of trees, shrubs, vegetation)
3. Major drainageways

Drainage basins and sub-basins

Major Basin Description

1. Reference to major drainageway-planning studies such as Master Drainage Plans, flood hazard delineation reports, and flood insurance rate maps.
2. Major basin drainage characteristics
3. Identification of all drainage system components within 50-feet of the property boundary.

Sub-Basin Description

1. Historic drainage patterns of the property in question
2. Off-site drainage flow patterns and impact of development

Drainage design criteria.

Regulations: Discussion of the optional criteria selected or the deviation from this criteria, if any.

Development Criteria Reference and Constraints

1. Previous drainage studies (i.e., Project master plans) for the site in questions that influence or are influenced by the drainage design and how the plan will affect drainage for the site.
2. Discussion of the drainage impact of site constraints such as streets, utilities, railways, existing structure, and development of site plan

Hydrological Criteria

1. Design rainfall
2. Runoff calculation method – *includes tables that provide all of the data used to calculate the time of concentration (length, slope – 85/10 or other weighted stream slope method, flow type, velocity), lag calculations, Curve Number calculation with HSG verification, all assumptions related to the proposed development including actual or estimated increase in impervious areas and resultant CN changes, revised times of concentration calculations and lag calculations.*
3. Detention discharge and storage calculation method. *Include tables of elevation-area-storage-outflow.*
4. Design storm recurrence intervals
5. Discussion and justification of any criteria or calculation methods used that are not presented in or referenced by this criteria.

Hydraulic Criteria

1. References for calculation of facility capacity
2. Detention outlet type. *Provide calculations for outflow including orifice and weir coefficient assumptions, tailwater effects, inlet vs. outlet control, conservation of existing storage, and compensatory storage calculations.*
3. Grade control structure criteria used. *Provide calculations for controlling velocities at the outlet structures, controlling stream degradation, baffle block placement and effects.*
4. Discussion of any drainage facility design criteria used that are not presented in this criteria.

Drainage facility design

General Discussion of

1. Proposed and typical drainage patterns
2. Compliance with off-site runoff considerations
3. The content of tables, charts, figures, plates, or drawings presented in the report.
4. Anticipated and proposed drainage patterns

Specific Discussion of

1. Drainage problems encountered and solutions at specific design points
2. Detention storage and outlet design
3. Maintenance access and aspects of the design
4. Actual maintenance agreement
5. Easements and/or RPW dedications required

Conclusions

Compliance with new Standards

1. Storm Water Criteria
2. Major Drainageway Planning Studies
3. 100-year floodplain after proposed project

Drainage Concept

1. Effectiveness of drainage design to control damage from storm runoff
2. Influence of proposed development on the Major Drainageway Planning Studies recommendation(s)

Computations

Hydrologic Computations

1. Land use assumptions regarding adjacent properties
2. Minor and major storm runoff at specific design points
3. Historic and fully developed runoff computations at specific design points
4. Hydrographs at critical design points

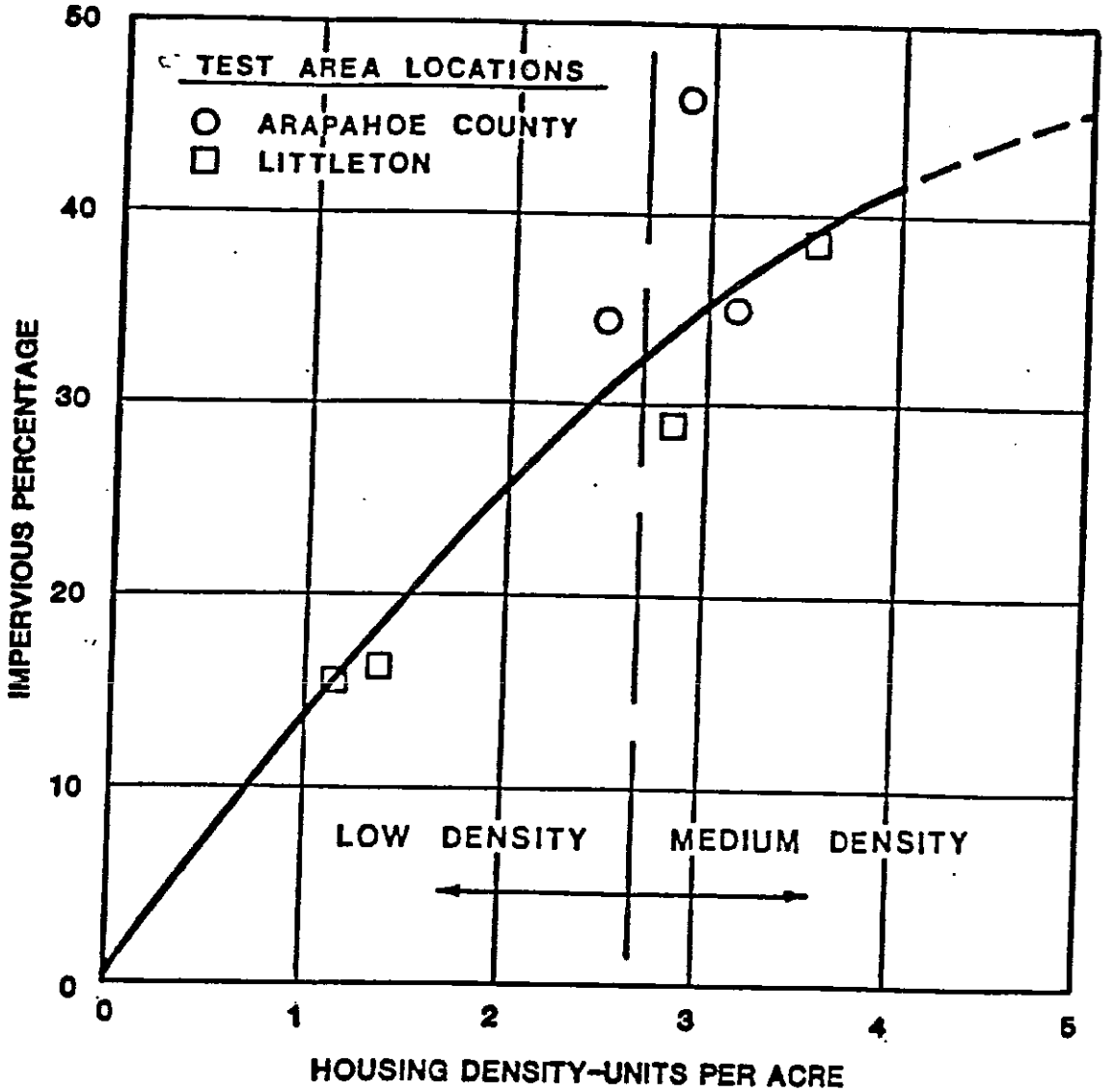
Hydraulic Computations

1. Culvert capacities
2. Storm sewer capacity
3. Street capacity
4. Storm inlet capacity including inlet control rating at connection to storm sewer
5. Open channel design
6. Check and/or channel drop design
7. Detention area/volume capacity and outlet capacity calculations

D.1.6.3 Drawing contents

Sheet-1 – General Location Map: 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" = 2000' 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 a multiple of 8½" x 11".

RESIDENTIAL HOUSING DENSITY VS IMPERVIOUS AREA



SOURCE: CITY OF TULSA STORMWATER CRITERIA MANUAL

D.2 RAINFALL / RUNOFF / FLOODPLAIN REQUIREMENTS

D.2.1 Storm Frequency Rainfall

Two publications were used to develop the design rainfall. The US Department of Commerce, US Weather Bureau "Technical Paper No. 40, Rainfall Frequency Atlas of the United States" (Reference 17) was used for cumulative rainfall data of storm durations greater than 1-hour. The National Oceanic and Atmospheric Administration (NOAA) "Technical Memorandum NWS HYDRO-35" (Reference 18) was used for cumulative rainfall data of storm durations from 5- to 60-minutes.

The cumulative point rainfall data for the 2-, 5- and 10-year storms from the US Department of Commerce requires conversion from a partial-duration series to an annual series. The partial-duration series is a series so selected that their magnitude is greater than a certain base value. If the base value is selected so that the number of values in the series is equal to the number of the record, the series is called an annual exceedance series. This conversion is calculated using the factors listed in Reference 17 and repeated below:

FACTORS FOR CONVERTING
PARTIAL DURATION SERIES TO ANNUAL SERIES

RETURN PERIOD	CONVERSION FACTOR
2-YEAR	0.88
5-YEAR	0.96
10-YEAR	0.99

The total rainfall depths for durations of five minutes to 24-hours and for return periods of 1-year to 500-years were developed and are presented in Table D.2.1. The data have been converted to an annual series.

TABLE D.2.1

	TOTAL RAINFALL DEPTHS (U.S. DEPARTMENT OF COMMERCE) Frequency (Return Period)							
Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year	500-year
5-minute	0.30	0.42	0.55	0.62	0.72	0.80	0.87	1.04
10-minute	0.65	0.77	0.94	1.07	1.24	1.36	1.49	1.70
15-minute	0.89	1.01	1.22	1.39	1.58	1.74	1.93	2.20
30-minute	1.15	1.32	1.73	2.00	2.28	2.58	2.85	3.40
1-hour	1.50	1.62	2.23	2.61	3.04	3.44	3.80	4.75
2-hour	1.76	1.94	2.75	3.25	3.80	4.40	4.75	6.00
3-hour	1.94	2.18	3.05	3.63	4.25	4.75	5.37	6.80
6-hour	2.25	2.44	3.70	4.36	5.20	5.78	6.40	8.25
12-hour	2.75	2.97	4.38	5.15	6.10	6.80	7.60	9.85
24-hour	3.18	3.43	4.98	6.04	7.00	7.78	8.75	11.50

D.2.2 RUNOFF

D.2.2.1 APPROVED METHODS

A. Table D.2.2 contains methods of runoff which analysis may be used for the design of components of the storm drainage system as applicable.

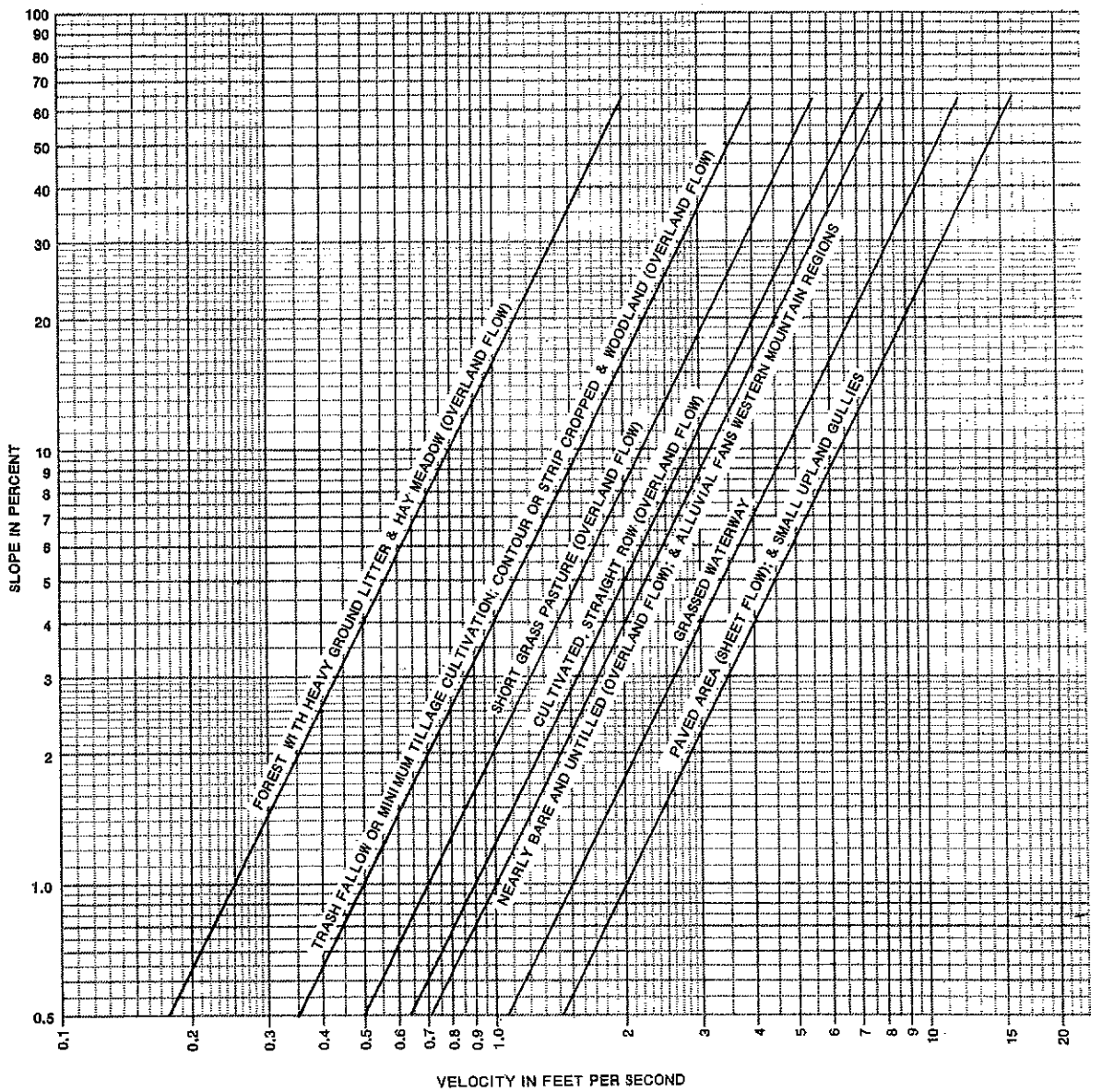


Figure 15.2.--Velocities for upland method of estimating T_c

TABLE D.2.3

RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUSNESS

Land Use or Surface Characteristics	Percent Imperviousness	Runoff Coefficients
BUSINESS:		
Commercial Areas	70 to 95	0.70 to 0.95
Neighborhood Areas	60 to 80	0.50 to 0.70
RESIDENTIAL:		
Single Family	35 to 60	0.30 to 0.65
Multi-unit (detached)	45 to 55	0.40 to 0.60
Multi-unit (attached)	65 to 75	0.60 to 0.75
1/2 acre lot or larger	30 to 45	0.25 to 0.40
Apartments	65 to 75	0.50 to 0.70
INDUSTRIAL		
Light uses	70 to 80	0.50 to 0.80
Heavy uses	80 to 90	0.60 to 0.90
PARKS, CEMETERIES	4 to 8	0.10 to 0.25
PLAYGROUNDS	40 to 60	0.50 to 0.60
RAILROAD YARDS	35 to 45	0.20 to 0.35
UNDEVELOPED AREAS		
Cultivated	30 to 70	0.35 to 0.60
Pasture	20 to 60	0.25 to 0.50
Woodland	5 to 40	0.10 to 0.40
Offsite flow analysis (land use not defined)	35 to 55	0.45 to 0.65
STREETS		
Paved	90 to 100	0.80 to 0.90
Gravel	50 to 70	0.55 to 0.65
DRIVES AND WALKS	90 to 100	0.80 to 0.90
ROOFS	85 to 95	0.80 to 0.90
LAWNS		
Sandy soils	5 to 10	0.10 to 0.20
Clayey soils	10 to 30	0.13 to 0.35

Source: Stormwater Management Criteria Manual, City of Tulsa

TABLE D.2.4
RAINFALL INTENSITY PARAMETERS

Design Storm	Parameter		
	d	e	f
2 Year	56.43	11.5	0.81
5 Year	72	15	0.80
10 Year	82	15	0.80
25 Year	95	15	0.80
50 Year	108	15	0.80
100 Year	120	15	0.80

Source: Drainage Design Manual, ODOT, February, 1988

D.2.3 UNIT HYDROGRAPH METHODS

D.2.3.1 Introduction: A hydrograph method must be used to determine peak runoff rates from watersheds larger than 200 acres, which is the upper limit of the Rational Method and for all detention pond analyses. A hydrograph method is required for all drainage areas larger than two acres. Table D.2.2 indicates methods applicable to various size watersheds. This section contains brief explanations of the various hydrograph methods; however, the design engineer is assumed to be familiar with the basic assumptions and limitations regarding the applicability of the method used.

D.2.3.2 Design Storm Precipitation:

A. The design storm shall have a duration a minimum of twice the time of concentration for peak flow calculations. For design of detention storage basins, a 24-hour storm shall be used.

B. A precipitation hyetograph shall be used as the input for all runoff calculations. The specified precipitation is assumed to be uniformly distributed over the watershed. The hyetograph represents average precipitation depths over a computation interval.

C. The unit duration incremented shall be in multiples of one, two or five minutes (e.g., 1-, 2-, 5-, 10-, or 15-minutes) with the maximum unit duration to be 15 minutes under most circumstances. An acceptable unit storm duration should not exceed one-fifth of the time to peak of the watershed, t_p. As an example, if the watershed has a t_p of 35 minutes, then an appropriate unit storm duration would be five minutes.

D.2.3.3 SCS Unit Hydrograph Method: The Soil Conservation Service (SCS) method is presented in detail in Section 4 of the U.S. Department of Agriculture Soil Conservation Service Engineering Handbook and Model Drainage Manual,

American Association of State Highway and Transportation Officials, 1991. *The U.S. Army Corps of Engineers computer program HEC-HMS shall be employed to utilize the SCS methodology.* The SCS publication TR55 may be used for areas up to 2,000 acres.

D.2.3.4 Snyder Unit Hydrograph Method: This unit hydrograph method is described in detail in Handbook of Applied Hydrology, V.T. Chow, McGraw-Hill Publishing Company, 1964. For this area, two regionalized equations for the lag time of the watershed in terms of time to peak, t_p and unit hydrograph, q_p, shall be used.

The equations are as follows:

The time to peak of the unit hydrograph from the midpoint of unit rainfall, t_p, is computed from the following formula:

$$t_p = 1.40\ (LxLca/S^{0.5})^{0.376}$$

where L = length along the stream from the study point to the upstream limit of the watershed, in miles;

L_{ca} = length along the stream to a point adjacent to the centroid of the watershed, in miles;

S = weighted average slope of the basin along the stream to the upstream limit of the watershed.

The time to peak, t_p, is further adjusted for the physical effects of urbanization based on the percentage of channel improvements within the basin. The following equation is used to make that adjustment:

$$adj.\ t_p = t_p\ x\ 10^{-(0.0034)x\%Ch}$$

where %Ch = percentage of channel improved.

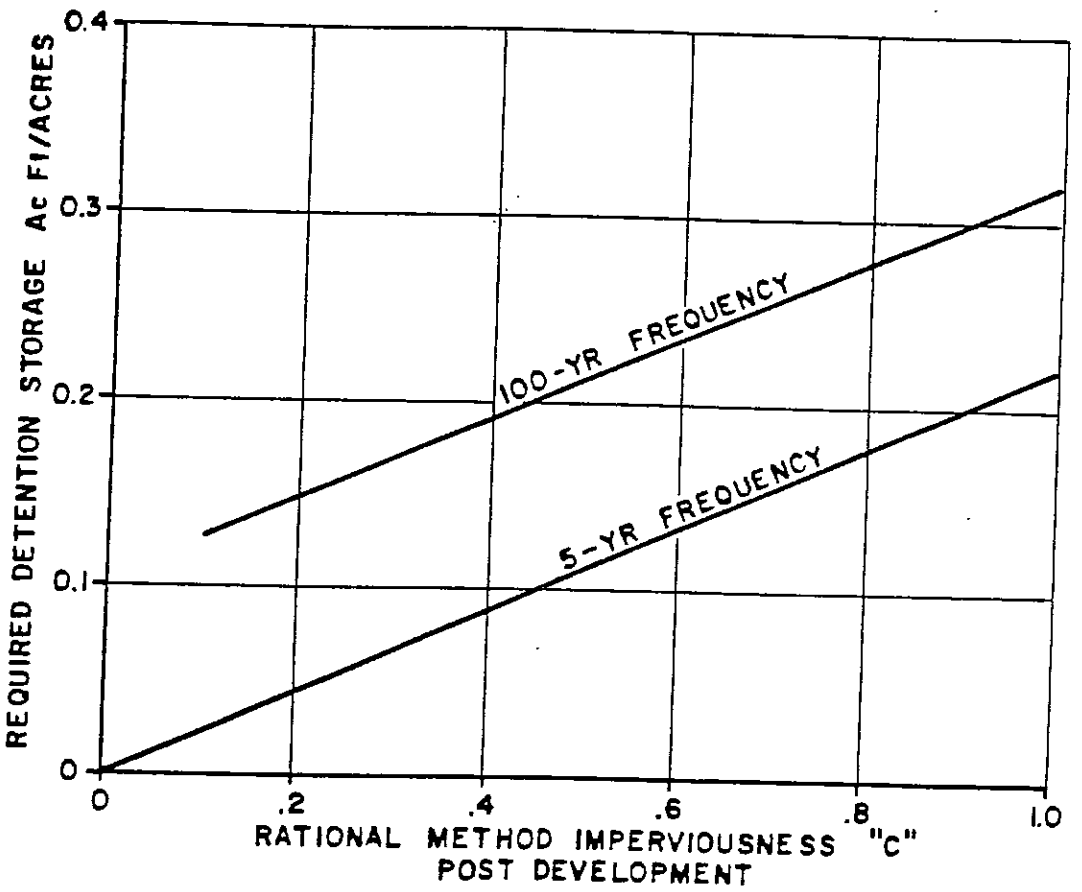
The peak of the unit hydrograph, q_p, is calculated as:

$$q_p = 375\ x\ (adj.\ t_p)^{-0.906}$$

Finally, the basin shape factor is computed from the following formula:

$$C_p = \frac{(adj.t_p\ x\ q_p)}{640}$$

UNIT VOLUME DETENTION CURVES



PRE-DEVELOPED 100-YEAR RATIONAL METHOD "C"	(OUTFLOW RATE FOR DRAINAGE CFS/AC) 5-YEAR	100-YEAR
.10	0.0	0.6
.20	0.1	1.3
.30	0.2	2.0
.40	0.6	2.9
.60	1.8	4.9
.80	3.6	7.5

SOURCE: CITY OF TULSA STORMWATER CRITERIA MANUAL

D.3 STREET DRAINAGE, INLETS, STORM SEWERS AND CULVERTS

D.3.1 STREET DRAINAGE

D.3.1.1 Depth in Streets: Use of streets for conveyance of storm water runoff shall be within the following limitations:

A. For the 50-year frequency rainstorm, two driving lanes of arterial streets and one driving lane for collector streets shall remain open. Depth of flow for arterial, collector and local streets shall not exceed 6". Where no curb exists storm water encroachment shall not extend past the street right-of-way.

B. The 100-year flow shall be contained within the right-of-way.

C. At sump locations, the water depth shall not exceed 12" above the top of the grate for the 100-year frequency rainstorm.

D. Where sump collection systems are used, an overflow route shall be established in the event of complete blockage of the sump in accordance with Section E.1.2.

D.3.1.2 Location of Storm Sewers: Storm sewer shall not be placed within the wheel path of any driving lane of the pavement. The preferred location of the storm sewer is according to the following order of priority listed.

A. Behind the Curb

B. Down the Center of the Traffic Lane

C. On Centerline

The traffic lane is defined as the normal width provided for each lane and delineated by pavement stripes.

D.3.1.3 Drainage Impact On Streets

A. Sheet Flow To minimize the effects of hydroplaning and splashing of sheet flow, streets shall be designed with a 2% (1/4" per foot) minimum cross slope. In addition, for arterial streets, the amount of flow permitted in the street is limited to the outside lane before a storm sewer inlet is required.

B. Cross Flow: The depth of cross flow permitted in non-arterial streets, where it cannot be avoided, is limited to the top of curb. Cross flow in arterial streets is not permitted and is strongly discouraged for collectors and residential streets. The cross flow limitations for freeways are determined by the Oklahoma Department of Transportation.

Sump areas will be drained by inlets and a storm sewer system. Omission of the crown to allow water to cross the street and drain into a side street at an intersection shall not be allowed.

C. Valley Gutters: Concrete valley gutters are required in asphalt streets when the longitudinal grade is 1% or less. The width of the valley gutter will be determined by the depth required. The maximum slope of the lateral grade shall be 5%. If a birdbath exists on an asphalt valley greater than 1%, then a concrete valley gutter shall be constructed.

D.3.1.4 Hydraulic Evaluation

A. Curb and Gutter Capacity:

1. The allowable storm capacity of each street section with curb and gutter shall be calculated using the modified Manning's formula:

$$Q = 0.56(Z/n)S^{1/2}Y_T^{8/3}$$

Where Q = discharge in cfs

Z = reciprocal of the street cross slope (S_x, ft/ft)

Y_T = depth of flow at the gutter (feet)

S = longitudinal grade of street (ft/ft)

n = Manning's roughness coefficient

2. Manning's roughness coefficient, n, shall be used according to the applicable construction condition from Table D.3.1.

3. When the street cross section has different cross slopes, capacity computation shall take into account the various cross slopes.

B. Roadside Ditch Capacity: The capacity of a roadside ditch shall be computed using Manning's equation. The allowable flow over the paved portion of the street is computed according to Section D.1.2. This capacity of the roadside ditch and street capacity are combined to determine the entire street section capacity. The paved street portion contributes to the total capacity only when the depth of flow in the roadside ditch is exceeded for the design storm. As in streets with curb and gutter, the maximum allowable depth at the pavement edge shall not exceed the limits set in Section D.1.2.

TABLE D.3.1
MANNING'S N-VALUES FOR
STREET GUTTERS

Construction Type	n
Concrete gutter troweled finish	0.012
Asphalt Pavement Smooth texture Rough Texture	0.013 0.016
Concrete gutter with asphalt pavement Smooth Rough	0.013 0.015
Concrete pavement Float finish Broom finish	0.014 0.016
Brick	0.016

Note: For gutters on flat grade where sediment may accumulate, increase all above values of Manning's "n" by 0.002.

Source: Drainage Design Manual, ODOT, February, 1988

D.3.2 STORM SEWER INLETS

D.3.2.1 Maximum Time of Concentration: A maximum time of concentration to the first inlet of 10 minutes shall be used for single and multifamily residential areas, and 5 minutes for commercial and industrial areas.

D.3.2.2 Allowable Inlet Types:

A. ODOT, CICI-1-X

B. Inlet types shall be in accordance with the City's standard drawings.

C. On arterial streets, offset type inlet, ODOT Standard SSCD-1-15, shall be used.

D.3.2.3 Location of Inlets:

A. Inlets shall be located at all low points in the gutter grade, on side streets at intersections where runoff would flow onto an arterial street or highway and upgrade of bridges to prevent runoff from flowing onto the bridge deck. Inlets are also required when the 5-year depth of flow in the gutter is exceeded.

B. Inlets at intersections shall be located in such a manner that no part of the inlet will encroach upon the curb return. Inlets on a continuous grade in the interior of a block should be placed upstream of a nearby driveway, if possible. The flowline and top of curb elevations shall be shown on all inlets.

D.3.2.4 Spacing Between Inlets: The spacing between inlets shall be such that depths of flow and widths of spread requirements are not violated. The distance between inlets and the distance to the first inlet shall not exceed 600 feet.

D.3.2.5 Interception and Bypass:

A. Some portion of the runoff is allowed to bypass an inlet and combine with the runoff at the next inlet. As many of the inlets as possible should be sump inlets.

B. The type of inlet to be used and the percent of flow to be intercepted at a particular location is left to the judgment of the designer. The objective is to minimize the cost of the storm sewer system while satisfying all of the design criteria. In general, an interception rate of 70 to 80 percent will result in an economical design.

D.3.2.6 Inlets in Sump Condition: When inlets are placed in a sump, emergency overflow shall be provided as described in Section E.1.2.4.A.2. An easement will be provided where overflow occurs outside of public rights of way.

If the overflow for the sump location will discharge directly into a storm water detention facility and if no other upstream inlets are connected to the sump inlet; then, in this case, the inlet and associated piping may be eliminated and the overflow used to convey the full 100-year discharge from the sump directly into the detention facility. The overflow, in this case where the pipe and inlet are omitted, shall be constructed as a concrete channel in a dedicated overland drainage easement and shall entirely contain the 100-year discharge inside the concrete channel.

D.3.2.7 HYDRAULIC DESIGN

A. Methodology: Curb and grate inlet capacities shall be in accordance with FHWA HEC-12 methods.

B. Grate Inlets:

1. Grated inlets without a curb opening are not permitted.
2. The bicycle safe grates (in combination with a curb opening) are the only grates approved within the street right-of-way. Refer to ODOT Standard CIG-1-X.
3. 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.
4. Grate interception capacities shall be determined for the specific grate to be used in the project. For example, if the grate inlet is manufactured by Neenah Foundry use Neenah's method of computing the capacity.

C. Curb Opening Inlets: Two types of curb opening inlets are approved. Cast in place concrete inlets, and manufactured metal inlets. Refer to ODOT Standards CICI-1-X or SSCD-1-15. The throats shall be open with no bar dividers.

D.3.3 STORM SEWER PIPE SYSTEM

D.3.3.1 Definitions. A "storm sewer system" refers to a system of inlets, pipes, manholes, junctions, outlets, and other appurtenant structures designed to collect and convey storm runoff to a defined drainageway. A "drainage system" also includes curbs and gutters, roadside ditches, swales, channels, and detention systems for the control of overland runoff. In general, a storm sewer system is required when other parts of the drainage system no longer have the capacity for additional runoff without exceeding the design criteria.

D.3.3.2 Design Criteria

A. Design Storm Frequency:

1. The storm sewer system, beginning at the upstream end with inlets, is required when the allowable street capacity (see Section D.1.2) or overflow capacity is exceeded for the design storm. The "design storm" has three connotations in the City: The design storm for the piped storm sewer system is the 5 year storm, the street and piped storm sewer system combined is the 50 year storm and the piped storm sewer system, street, and ROW combined is the 100 year storm. Minor system and the design storm for the major system, the 5-year and 50/100-year storm respectively. Thus, the storm sewer system should be designed for the larger of the following events:

a) The 5-year flow, less the allowable capacity of the gutter or roadside ditch; or

b) The flow equal to the difference between the 50-year and the allowable street capacity; or

c) The flow equal to the difference between the 100-year and the capacity within the ROW.

2. The intent is to intercept the 5-year flood and convey the flow in a storm sewer. However, it is impractical to intercept all the runoff in the street at the inlet and some "carry-over" flow will occur. The procedure simply puts a limit on the amount of carry-over flow that can occur in the street.

B. Construction Materials: Storm sewers may be constructed using reinforced concrete (RCP). *The use of any material other than RCP must be approved by a variance granted by City Council.* The materials, pipes, and appurtenances shall meet the requirements of ODOT.

C. Vertical Alignment:

1. The sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading on the pipe. The minimum cover depends upon the pipe size, type and class, and soil bedding condition, but shall not be less than one foot from the top of pipe to the finished grade at any point along the pipe. If the pipe encroaches into the street sub-grade, a variance must be granted of the City.

   Pipe joints shall be tight fitting. All joints shall have an approved gasket system to prevent infiltration of bedding material and minimize ex-filtration.

2. Manholes will be required whenever there is a change in size, alignment, elevation grade and slope, or where there is a junction of two or more sewers. For sewers equal to or larger than 60" diameter, pre-formed smooth transitions shall be approved by the City Engineer. Pipes entering or leaving a manhole shall have matching soffits unless a variance is granted by the City Engineer. The interior of manholes shall provide smooth grouted fillets and rounded exit openings. The maximum spacing between manholes for various pipe sizes shall be in accordance with Table D.3.3.

3. The minimum clearance between storm sewer and water main (for new construction), either above or below shall be 12". Ductile iron pipe (with proper bedding) or concrete encasement of the water line will be required for clearances of 12" or less when the clearance between existing water mains cannot be maintained.

4. The minimum clearance between storm sewer and sanitary sewer (for new construction), either above or below, shall be 12". In addition, when an existing sanitary sewer main lies above a storm sewer, or within 18" below, the sanitary sewer shall have impervious encasement or be constructed of ductile iron pipe for a minimum of 10' on each side of the storm sewer crossing.

5. Siphons or inverted siphons are not allowed in the storm sewer system.

6. Pumped systems may be considered after all other possibilities have been exhausted, subject to approval by the City Engineer. The pumping plants shall be designed in accordance with the same criteria as gravity systems. Where storage and/or bypass of higher flows are used in conjunction with pumping, a detailed analysis of stage verses discharge shall be submitted for review.

    A. Wet well – Provide a wet well large enough to provide ideal flow conditions for the pump intake.

    B. Trash removal – Provide a bar grating covered opening sufficient to accommodate 60% blockage and can be cleaned during operation.

    C. Power supply – 2 – independent sources or a back up generator.

    D. Capacity – Minimum 5-year capacity with redundant capacity. Controls shall allow for

    E. Sump drainage – Provide a sump capable of automatically maintaining a "dry" wet well.

    F. Controls – Electronic emitence or other similar level controls are acceptable.

    G. Pumps – Primary pumps shall be vertical lift single or multistage type. Pumps shall be placed so that they can be easily removed for repair. All pumps shall have intake screens adequate to protect the impeller from debris.

    H. Discharge pipes shall be steel or ductile iron. All outlets shall have flap gates.

Table D.3.3
STORM SEWER ALIGNMENT AND SIZE CRITERIA

MANHOLE SPACING:

Pipe Size	Maximum Spacing for Manholes	Minimum Manhole Size
15" to 24"	300'	4'
27" to 42"	400'	5'
48"	500'	6'
54" to 66"	500'	8'
>66"	500'	junction structure

MINIMUM RADIUS FOR RADIUS PIPE:

Short radius bends shall not be used on sewers 48" or less in diameter for public systems.

MINIMUM PIPE DIAMETER:

Type	Minimum Equivalent Pipe Diameter	Minimum Cross-Sectional Area
Main Trunk	15"	1.23 SF
Lateral from inlet	15"	1.23 SF

Source: Storm water Criteria Manual, City of Tulsa

D. Horizontal Alignment

1. Storm sewer alignment between manholes shall be straight except when accepted in writing by the City Engineer. Approved curvilinear storm sewers may be constructed using pipe bends or radius pipes.
2. A minimum horizontal clearance of ten feet is required between sanitary and water utilities and the storm sewer.
3. The permitted locations for storm sewer within a street right-of-way are: (a) behind the curb, (b) down the center of the driving lane, and (c) on centerline. Behind the curb is the preferred location.

E. Pipe Size: The minimum allowable pipe size for storm sewers is presented in Table D.3.3.

F. Storm Sewer Capacity and Velocity

1. Storm sewer shall be designed to convey the difference between the capacity of the street and the design storm (5-year) flood peaks without surcharging the storm sewer. The sewer may be surcharged during larger floods and under special conditions when approved by the City Engineer.

2. The capacity and velocity shall be based on the Manning's n-values presented in Table D.4.1. The maximum full flow velocity shall be less than 20 fps. Higher velocities may be accepted by the City Engineer if the design includes adequate provisions for uplift forces, dynamic impact forces and abrasion. The minimum velocity in a pipe based on full flow shall be 2.5 fps to avoid excessive accumulations of sediment.

3. The energy grade line (EGL) for the design flow shall be no more than one foot above the final grade at manholes, inlets, or other junctions. To insure that this objective is achieved, the hydraulic grade line (HGL) and the EGL shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses will include friction, expansion, contraction, bend, manhole, and junction losses.

G. Storm Sewer Inlets and Outlets

1. Before discharging the runoff from a parking lot of area larger than 0.5 acres, the runoff must first be collected in a storm sewer inlet and connected to the storm sewer within the street right-of-way, or roadway ditch or drainage conduit. Accordingly, the flow in the street shall be reduced by the amount intercepted by the inlet.

2. All storm sewer outlets into open channels shall be constructed with a headwall and wing walls, *concrete slope wall,* or a flared-end-section. When the outlet velocity exceeds six feet per second, erosion control measures shall be taken. If required to prevent erosion, energy dissipaters shall be provided.

D.3.4 Culverts:

D.3.4.1 **Definition:** A culvert is defined as a closed conduit for the passage of water under an embankment, such as a road, railroad, or driveway. The distinction between a culvert and a sewer is the means by which flow enters the conduit. Flow normally enters a culvert by an open channel, generally at a similar elevation and a culvert usually crosses a street.

D.3.4.2 **Construction Materials**: Culverts shall be constructed of reinforced concrete in accordance with Table D.5.2. Other materials may be used on a case-by-case basis on acceptance by the City Engineer.

D.3.4.3 **Hydraulic Design:** Culvert design shall follow the methodology presented in Hydraulic Design of Highway Culverts, Hydraulic Design Series HDS No. 5, FHWA, U.S. Department of Transportation and Drainage Manual, Oklahoma Department of Transportation, 1992.

D.3.4.4 **Design Frequency:** 100-year without overtopping, with one foot of freeboard below the minimum roadway overflow elevation, unless otherwise approved by the City Engineer.

D.3.4.5 **Minimum Size:**

a. Pipe Culverts - 15" equivalent

b. Box Culverts - no less than 3' in height

D.3.4.6 **Outlet Velocity**:

a. In design of culverts both the minimum and maximum velocities must be considered. A minimum velocity of 3- feet per second at the outlet is required to assure a self-cleaning condition of the culvert.

b. The outlet area shall include a headwall with wing walls or an end-section in addition to the riprap protection if required. Where outlet velocities exceed six feet per second, erosion control measures shall be taken. Energy dissipaters shall be provided as required.

D.3.4.7 **Structural Design:** Culverts shall be designed to withstand an HS-20 loading in accordance with the design procedures of AASHTO Standard Specifications for Highway Bridges and with the pipe manufacturer's recommendations. In addition, the AASHTO maximum heights of cover for corrugated metal structures shall also be followed. The minimum cover over top of the pipe shall be 12" unless otherwise accepted by the City Engineer.

D.3.4.8 **Driveway Crossings**: Driveway culverts shall be sized to pass the 10-year ditch flow capacity without overtopping the driveway. The minimum size culvert shall be a 15" round pipe , or equivalent, for all streets. Sloped headwalls required per the city's Standard Details, not smaller than upstream culvert.

D.3.4.9 **Pipe End:** Provide *concrete headwall with wingwalls, concrete slope wall,* prefabricated culvert end sections or other approved end treatment.

D.3.5 BRIDGES

D.3.5.1 **Bridge:** A bridge is constructed with abutments and superstructures, which are typically concrete, steel, or other materials. Since the superstructures are generally not an integral structural part of the abutments, and are therefore free to move, the hydraulic criteria for bridges is different than for culverts. Bridges are also usually constructed with earth or rock inverts, whereas culverts are typically the same material throughout the waterway opening.

D.3.5.2 **Hydraulic Design** The sizing criteria set forth in Section D.3.4.5 for culverts shall apply with the exception that freeboard for bridges is defined as the vertical clearance of the lowest structural member of the bridge superstructure above the water surface elevation of the design frequency flood. The minimum freeboard shall be 1 foot for the 100-year frequency flood, unless approved by the City.

No rise in water surface is allowed off-site due to the restrictions created by the construction of the bridge, unless approved by both the City Engineer and the affected landowner(s). Legal documentation of such approval is required in the form of an easement or other document as approved by the City Attorney.

D..3.5.3 **Velocity:** The velocity limitations through the bridge opening are controlled by the potential abutment scour and subsequent erosion protection provided. Using riprap for the channel lining and/or protection of the abutments and wing walls, the maximum channel velocity is limited to 15 fps.

D.3.5.4 **Hydraulic Analysis:** The hydraulic design of bridge crossings shall be in accordance with Drainage Manual, Oklahoma Department of Transportation, 1992.

D.3.5.5 **Inlet and Outlet Configuration:** The design of bridges shall include adequate wing walls of sufficient length to prevent abutment erosion and to provide slope stabilization from the embankment to the channel. Erosion protection on the inlet and outlet transition slopes shall be provided to protect from the erosive forces of eddy current.

D.3.5.6 **Structure Design:** Bridges shall be designed in accordance with AASHTO/ODOT criteria. Rails shall comply with ODOT TR-1 or TR-2 Standard Details.

D.4 OPEN CHANNELS

E.4.1 DESIGN

D.4.1.1 **Channel Geometry:** For trapezoidal channels, the minimum bottom width shall be 4' with side slopes of not steeper than 4 to 1 for sodded sections and a minimum bottom width of 3' with side slopes of not steeper than 1-1/2:1 for paved or rock-lined sections, unless approved by the City Engineer. Where the public may be exposed to hazards and nuisances of open channels, appropriate measures shall be taken to exclude the public from the perilous area.

D.4.1.2 **Manning's "n" - Value:** Manning's Equation in the calculations of hydraulic characteristics of channels will be acceptable. The "n" value used for channels shall be based on the individual channel characteristics, according to Table D.4.1. Designers should anticipate growth of trees as a natural maturation process of the channel. Values less than 0.05 shall be justified.

TABLE D.4.1

MANNING'S N-VALUE FOR OPEN CHANNELS

Channel Type	n-Value Range	Recommended Value
Grass lined - maintained	.029 to .100	
Grass lined - not maintained	.045 to .10	.035
Natural Streams	.025 to .100	Note (1)
Riprap Lined		
1. Ordinary riprap	.025 to .050	.035
2. Gabions	.025 to .050	.035
3. Grouted riprap	.023 to .030	.027
4. Stone mattress	.025 to .033	.028
Concrete Lined		
1. Float finished/wood forms	.013 to .016	Note (2)
2. Slip formed	.013 to .016	Note (2)
3. Gunite	.016 to .023	Note (2)

Notes:

1. Source: Chow, V.T., Open Channel Hydraulics, McGraw-Hill Book Company, 1959, and pictures
2. High value used for capacity determination and low value used for velocity consideration

D.4.1.3 **Minimum Slope:** Channels shall have minimum slopes of 0.15% for concrete-lined channels and 0.25% for grass-lined channels. The City Engineer's acceptance is required for channels with a flatter slope.

D.4.1.4 **Minimum Velocity:** Minimum velocity in a drainageway system shall be 2.5 fps to avoid sedimentation.

D.4.1.5 **Maximum Velocities:** Velocities shall not exceed 5 fps for sections grass sections depending on soil conditions. Velocities in concrete lined or paved sections shall not exceed 15 fps. The dissipation of energy shall be required at the confluence of improved channels with natural channels through the use of dissipaters, stilling basins and etc. which shall be designed in accordance with FHWA HEC #14 Hydraulic Design of Energy Dissipaters for Culverts and Channels Drainage Manual.

Velocities offsite shall not exceed those that existed prior to construction.

D.4.1.6 **Freeboard:** Where practical, the design water surface elevation shall be kept below the level of natural ground. A 1' freeboard above the energy grade line should be added to calculated flow depths to determine minimum channel depths for subcritcal flow. For super-critical channels, the freeboard requirement shall be:

$H_{FB} = 2.0 + 0.25V(d)^{1/3}$

H_{FB} = freeboard height (feet)

V = Velocity in fps

d = depth (feet)

D.4.1.7 **Trickle Channels:** All channels altered or improved from the natural state will require a paved trickle channel unless a variance is granted by the City Engineer. Sodding, or other methods of erosion control shall be required adjacent to the paved channel.

D.4.1.8 **Concrete Flumes:** Concrete flumes in lieu of enclosed pipe shall be required on a case-by-case basis by the City Engineer, as overflow protection for storm sewer systems, and to drain areas not exceeding five (5) acres in size. All concrete flumes shall extend to the rear of adjacent lots and shall discharge into a dedicated drainage facility or channel.

D.4.1.9 **Roadside Ditches:** Roadside ditches shall conform with requirements of this section.

D.4.1.10 Base Flood Elevation (BFE) or floodplain boundary changes shall be approved by FEMA.

D.5 HYDRAULIC STRUCTURES

5.1 DEFINITIONS

TABLE D.5.2

CULVERT MATERIALS

PIPE MATERIAL	STANDARD
Reinforced Concrete Pipe	
Round	ASTM C-76 or AASHTO M-170
Elliptical	ASTM C-507 or AASHTO M-207
Arch	ASTM C-506 or AASHTO M-206
Pre-Cast Concrete Manholes	ASTM C-478 or AASHTO M-199
Pre-Cast Concrete Box	ASTM C-789/C-850, AASHTO M-259/273 or ODOT
Concrete Cast-in-Place Box	ODOT Standard
Corrugated Aluminum Alloy:	
Alloy Pipe and Under-drains	AASHTO M-196
Structural Plate	AASHTO M-219
Aluminized Type II Coated	AASHTO M-274
Corrugated Steel	
Metallic coated for sewer/drains	AASHTO M-196
Bituminous Coated pipe/arches	AASHTO M-190
Polymer Pre-coated	AASHTO M-245
Structural Plate	AASHTO M-167
High Density Polyethylene (HDPE)	ASTM D2321-89

*No HDPE greater than 18-inch will be allowed. No HDPE will be allowed under any driving surfaces. No HDPE *or Corrugated Metal Pipe* will be allowed for any public facilities.

D.6 STORAGE

D.6.1 GENERAL

a. The detention storage shall accommodate the excess runoff from a 100-year frequency storm. The excess runoff is that runoff generated due to urbanization which is greater than the runoff historically generated under existing conditions, for a given frequency storm. Detention facilities shall be designed so that the peak rate of discharge does not exceed that of the pre-development conditions for all storm events up to and including 100-year.

b. Peak release rates from developments shall not exceed the existing runoff that occurred before development for all storm frequencies up to and including the 100-year frequency storm. Releases for 1, 2, 5, 10, 25, 50, 100, 500-year storms shall not exceed the existing rate. A variance may be allowed for the 500-year storm if dam safety is otherwise compromised, with the approval of the City Engineer.

c. Generally, urbanization results in more impervious area and a reduction in floodplain storage, both of which contribute to increased flow rates. If improvements are made to any natural channel downstream from an area of 40 acres or more, current floodplain storage must be maintained.

d. Where available, detention facilities shall be designed using the City's hydrologic and hydraulic models for the watershed to assure that there is no adverse impact from water surface elevation or flow velocity. Otherwise, a hydrologic and hydraulic model will be prepared by the owner's engineer for the analysis.

D.6.2 DESIGN CRITERIA

a. The design storm for detention shall be a 24-hour storm. Rainfall depths shall be in accordance with Section D.2.1.

b. The time increment used in developing the rainfall distribution and in reading off the ordinates of the unit hydrograph may be rounded off to the nearest whole time interval or to the nearest time increment.

c. Rainfall distributions shall be consistent with the modeling technique used.

d. All calculations for detention facilities shall be submitted for review by the City Engineer. The submittal shall include hydrographs for both existing and developed conditions, detention facility stage-area-volume relationships, outlet structure details, and a stage versus time analysis through the facility.

e. Floodplain areas and detention facility locations shall be identified at the preliminary plat stage to illustrate how these areas will be managed during and after construction.

f. If a tract of land under development has a floodplain area within its boundary, the information that must be furnished either with the preliminary plat or before the final plat is submitted, shall include:

   1. A backwater analysis on the existing drainage system.

   2. A backwater analysis on the proposed drainageway system

g. Detention facilities should be located in areas accepted by the City. Each

facility shall incorporate methods to minimize erosion and other maintenance reducing designs.

h. Additional detention storage, in excess of the required storage for a drainage area, can be provided to satisfy the detention requirements for a tract of land downstream of the detention facility, providing the detention facility is constructed prior to the development of the downstream tract, with the approval of the City Engineer.

i. A minimum number of detention facilities is encouraged for each development. Regional detention facilities are encouraged for phased or cooperative development in a drainage basin.

j. If runoff has a natural tendency to drain in several directions for a given development tract of land where detention is required, then detention storage shall be provided for the biggest drainage area. Additionally, a detention storage may be provided, at the same facility, to satisfy detention requirements for a separate drainage area on the same development, provided that:

   1. The whole developmental tract of land is in the same watershed.

   2. The smaller drainage area(s) that, has/have been compensated for does/do not, either singly or in combination, adversely impact the health, welfare and safety of the general public downstream. *The downstream impact from any compensated areas shall be specifically discussed in the Detention Report and include a discussion of Pre and Post-development flow rates as well as an analysis of downstream storm water conveyance facilities.*

k. If a tract of land being developed is located in more than one sub-watershed, of the same overall watershed, grading work to divert flows from one sub-watershed to another will be permitted if there is proper capacity in the receiving stream.

l. The detention area shall be identified as a separate platted area; as appropriate, it may consist of one or more platted lots, a separate block, or it may be identified as a reserve area.

m. Provision for the detention facility shall appear among the plat's restrictive covenants.

n. In the event the detention facility becomes unnecessary as a result of drainage improvements, the facility may be vacated, by action of the City Council, as provided for in the covenants or applicable law.

o. An access way at least 20 feet wide shall be provided to any required 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.

p. If the detention facility is approved by the City to serve areas outside the subdivision in which it is located, such additional areas shall be specifically identified in the provision for detention.

q. Any dam or berm shall be designed in accordance with the dam safety criteria of the Oklahoma Water Resources Board.

r. The maintenance responsibility for on site detention facilities shall remain with the private sector and appropriate covenants shall be obtained to secure such maintenance.

D.6.3 DESIGN DETAILS

a. Detention dams or dikes shall be constructed as earth filled and non-overflow type dams. Embankment slopes shall not be steeper than 4: 1. Spillways shall be constructed to pass the 500-year flood event with a minimum of one (1) foot of freeboard on the earth dam structure.

b. Side slopes on detention facilities shall not be steeper than 4:1.

c. Access road, with grade of 10% or less, shall be provided to the detention areas for maintenance purposes.

d. Detention facilities shall be provided with a low flow channel from the inlet to the outlet structure to transmit low flows, and with subsurface drainage as required to maintain a dry surface.

e. Storm sewer outlets in the slope of the detention pond shall be protected by a reinforced concrete slope wall.

f. All earth slopes and earth areas subject to erosion, such as, adjacent to low flow 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 facility site, shall have an established growth of Bermuda grass. All covered areas shall be fertilized, watered and in an established growing condition prior to completion and acceptance of the detention facility.

g. Storm water detention facilities shall be designed as "dry" facilities, with the outlet structure at the lowest elevation in the pond.

With the approval of the City Engineer, a "wet" facility may be allowed to maximize storage. Wet facilities shall have adequate flow through to maintain water levels. Mosquito control shall be incorporated into the maintenance plan.

D.7 SEDIMENTATION CONTROL AND WATER QUALITY

D.7.1 Regulation

A. This chapter includes standards and requirements for erosion and sedimentation control for construction areas less than 5-acres in size (City Earth Change Permit). For larger construction areas, discharges for storm water are authorized under the Oklahoma Department of Environmental Quality (ODEQ) , Water Quality Division, General Permit (GP-005) for Storm Water Discharges from Construction Activities within the State of Oklahoma.

The control of erosion and sedimentation from construction activities shall be in accordance with this Section and NPDES General Permits for Storm Water Discharges from Construction Sites in the September 9 and September 25, 1992, Federal Register.

B. The ODEQ adopted a General Permit for Storm Water Discharges from construction activities, which includes discharges from construction with areas greater than 5 acres in size. The objective of the General Permit is to improve water quality by reducing pollutants in storm water discharges. Authorization to discharge under the General Permit is obtained by submitting a Notice-of-Intent (NOI) along with supplemental information, which is briefly described in this Section and ODEQ General Permit for Storm Water Discharges from Construction Activities within the State of Oklahoma.

D.7.2 EXEMPTIONS

A. Exemptions from the erosion control submittal process are granted by the City for construction areas less than 5-acres or as stipulated in GP-005. A summary of these exemptions is presented below.

1. Bona fide agricultural and farming operations.
2. Customary and incidental routine grounds maintenance, landscaping, and home gardening.
3. Development or improvements on one and two family residential properties at residential single family or duplex density.
4. Emergency repairs of a temporary nature made on public or private property.
5. Temporary excavation for the purpose of repairing or maintaining any public street, public utility facility, or any service lines related thereto.
6. Routine maintenance of the storm water drainage system.
7. Other exemptions as may be granted by the City in writing.

D.7.3 SUBMITTALS

D.7.3.1 Permit Applications

1. All new development disturbing less than 5 acres shall have prepared and implemented an erosion and sedimentation control plan. The plan shall be prepared and will be reviewed in accordance with the criteria presented in this section.

2. New development disturbing an area greater than 5 acres must obtain authorization to discharge under the ODEQ General Permit for Storm Water Discharges from Construction Activities. Notices of Intent must be submitted to:

   Storm Water Notice of Intent
   Oklahoma Department of Environmental Quality
   Water Quality Division
   1000 NE Tenth Street
   Oklahoma City, OK 73117-1212

   Then the City strongly recommends that when a developer files an "NOI" for a development, it will remain in force for the duration of the development, including the development of smaller areas (for example: individual residential lots) that are a part of the larger common plan of the development.

3. Erosion Control Plans are an integral part of the Earth Change Permit. Erosion Control Plans are also related to drainage analysis and report requirements.

4. Erosion and Sedimentation Control Plan approval is required prior to issuance of an Earth Change permit. Since the drainage plan has considerable impact on site grading, erosion control planning and drainage planning should be a concurrent process. However, for some developments, site grading to an interim condition may be desired. To account for cases where site grading will precede final drainage planning, the erosion control plan may be submitted with a Preliminary Drainage Report. Subsequently, the plan will need to be modified to reflect grading changes necessitated by final drainage design.

D.7.3.1 Erosion and Sedimentation Control Report

Purpose: The purpose of the Erosion and Sedimentation Control Report is to identify and define conceptual solutions to the problems which may occur on site and off site as a result of the development. In addition, those problems anticipated on site and off site during development must be addressed in the report. All reports shall be typed on 8-1/2" x 11" paper and bound together. The drawings, figures, plates, tables, and site plan shall be bound with the report or included in a folder/pocket at the back of the report.

A. Report Contents: The narrative report shall contain the applicable information listed:

   1. Name, address, and telephone number of the applicant, landowner,

developer, and engineer.

2. Project description - Briefly describe the nature and purpose of the land disturbing activity, the amount of grading involved, and project location including section, range, and township.

3. Existing site conditions - A description of the existing topography, vegetation, and drainage.

4. Immediate adjacent areas - A description of neighboring areas such as streams, lakes, residential areas, roads, etc., which might be affected by the land disturbance.

5. Soils - A brief description of the soils on the site giving such information as soil names, mapping unit, erosion tendencies, permeability, hydrologic soil group, depth, texture, and soil structure. (This information may be obtained from the S.C.S. soil survey for Tulsa County.)

6. Erosion and sediment control measures - A description of the methods which will be used to control erosion and sedimentation on the site.

7. Permanent stabilization - A brief description, including specifications, of how the site will be stabilized after construction is completed. This information is optional for the initial report but may be required for the report addendum.

8. Storm water management considerations - Explain how storm water will be handled.

   Determine detention requirements. This information is optional for the initial report but may be required for the report addendum.

9. Maintenance - A schedule of regular inspections and repair of erosion and control structures should be set forth. This information is optional for the initial report but may be required for the report addendum.

B. Drawing Contents

1. General Location Map: A map shall be provided in sufficient detail to indicate the location of the project site. The map should be at a scale of 1" = 1000' to 1" = 2000' and should indicate the project site in relation to existing topographic, and transportation, features and land boundaries. The map shall show the drainage area of land tributary to the site. The drawing shall be a multiple of 8-1/2" x 11".

2. Sediment and Erosion Control Plan: Map(s) of the proposed development at a scale of 1" = 20' to 1" = 200' on 22" x 34" drawing sheets shall be included. The plan shall show the following:

   A boundary line survey of the site on which the work is to be performed.

   Existing topography at a maximum of two (2) foot contour intervals. The contours shall extend a minimum of 100-feet beyond the property line (if available).

   Proposed topography at a maximum of two (2) foot contour intervals.

Location of any existing structure or natural feature on the site.

Location of any structure or natural feature on the land adjacent to the site and within a minimum of 100 feet of the site boundary line. The map shall show the location of the storm sewer, channel, or creek receiving storm runoff from the site.

Location of any proposed additional structures or development on the site, if known.

Limits of clearing and grading - Areas which are to be cleared and graded.

Detailed Drawings: Detailed drawings and structural practices used that are not referenced in this Manual and other information or detail as may be reasonably required by the City. The size of drawings shall be a multiple of 8-1/2" x 11".

D.7.4 STRUCTURE PRACTICES

D.7.4.1 TEMPORARY STRUCTURAL PRACTICES

A. Dikes:

1. Types
   a. Diversion dike.
   b. Interceptor dike.
   c. Perimeter dike.
2. The design drainage area for dikes shall not exceed 5 acres.
3. The minimum dimensions shall be:
   a. Top Width - 2'
   b. Height - 1.5'
   c. Side Slopes - 2:1 or flatter

B. Swales:

1. Types:
   a. Interceptor swale.
   b. Perimeter swale.
2. The design drainage area for swales shall not exceed 5 acres.
3. The minimum dimensions shall be
   a. Bottom width - 4'
   b. Depth - 1' min,
   c. Grade - 1% min.
   d. Slopes - 2:1 or flatter

C. Straw Bale Dike: No straw bales will be allowed except in unusual circumstances when no other erosion control method would be effective. Use of

straw bales must be approved by the City Engineer on a case-by-case basis.

D. Silt Fence: Silt fences can be constructed near the perimeter of a disturbed area to intercept sediment while allowing water to percolate through. Silt fences may not be used where there is a concentration of water in a channel or other drainage. The following criteria are applicable:

1. Drainage area - 2 acre maximum
2. Height - 30" minimum
3. Material - burlap, polypropylene fabric or nylon reinforced polyester netting.
4. Support - Steel fence posts at 8' maximum spacing.

E. Entrances: A stabilized construction entrance shall be built to reduce or eliminate the tracking or flowing of sediment onto public rights of way.

F. Stone Outlets: A stone outlet structure shall be constructed in areas where the entire drainage area to the structure is not stabilized or where there is a need to dispose runoff at a protected outlet or where concentrated flow for the duration of the period of construction needs to be diffused.

G. Paved Chute: A grade stabilization structure in the form of a paved chute or flume shall be constructed to prevent erosion, where concentrated flow of surface runoff is to be conveyed down a slope. The maximum allowable drainage area upstream of such a structure shall not exceed 36 acres.

H. Pipe Slope Drain: A grade stabilization structure in the form of a pipe slope drain shall be constructed to prevent erosion, where concentrated flow of surface runoff is to be conveyed down a slope. The maximum allowable drainage area upstream of such a structure shall not exceed 5 acres.

I. Temporary Sedimentation Basin: Storm water detention facilities may be used temporarily as sediment basins.

1. A temporary outlet structure for the storm water detention facility to work as a sediment pond shall be constructed.
2. At the end of the construction activity, the developer shall make sure that the outlet structure shall meet the design requirements of a storm water detention facility.
3. Condition of the detention facility that is used as a sediment pond during construction, shall meet the following requirements at the time of acceptance.
   a. It shall be completely cleaned by the developer and be rid of any immediate maintenance.
   b. It shall meet all design standards.

J. Sediment Trap: A sediment trap, a small temporary basin usually installed in a drainageway at a storm drain inlet shall conform to the following criteria:

1. Drainage area - 5 acres maximum.
2. Trap size - at least 1800 cubic feet per acre of drainage.
3. Embankment:
   a. Height - 5' maximum
   b. Top width - 3' minimum

c. Slopes - 2:1 or flatter

D.7.4.2 PERMANENT STRUCTURAL PRACTICES

A. Depending on the project layout, a diversion shall be constructed across a slope less than 15% to:

1. Prevent runoff from higher areas having a potential for causing erosion and thereby interfere with the establishment of vegetation on lower areas.

2. Reduce the length of slopes to minimize soil loss.

B. Diversions need be constructed only below stabilized or protected areas.

C. Outlets from diversions shall be constructed to discharge in such a manner as not to cause erosion.

D. Outlets shall be constructed and stabilized prior to the operation of diversion.

E. Storm drain outlet protection shall be provided when converting pipe flow to channel flow. The reduction in velocity shall be consistent with the roughness coefficient of the receiving waterway. The reduction in velocity may be accomplished by:

1. Providing grouted riprap stabilization;

2. Providing energy dissipaters;

3. Providing permanent vegetation; depending on the site-specific needs.

D.7.5 VEGETATIVE PRACTICES

D.7.5.1 Temporary Vegetative Practices

1. Small grains like oats, rye and wheat, and sudans and sorghums are feasible temporary vegetation to control erosion. This practice is effective for areas where soil is left exposed for a period of 6 to 12 months. The time period may be shorter during periods of erosion rainfall.

a. Prior to seeding, needed erosion control practices such as diversions, grade stabilization structures, berms, dikes, etc. shall be installed.

b. Temporary vegetative practice is usually applied prior to the completion of final grading of the site.

c. If the area to be seeded has been recently loosened to the extent that an adequate seedbed exists, no additional treatment is required. However, if the area to be seeded is packed, crusted and hard, the top layer of soil shall be loosened by other suitable means.

d. Fertilizer shall be applied at a rate of 600 pounds per acre or 15 pounds per 1000 square foot using 10-20-10 or equivalent.

e. Soils known to be highly acidic shall be lime treated.

f. Seeding requirements shall be as specified in Table E.7.5.1.

g. Seeds shall be drilled or broadcast uniformly.

SECTION E. SANITARY SEWER CRITERIA

E.1. GENERAL

E.1.1. Design Period.

The minimum design criteria for all sanitary sewer collection and treatment facilities shall be the latest edition of *Title 252, Oklahoma Administrative Code, Chapter 655, Water Pollution Construction Standards.*

In general, sewer capacity should be designed for the estimated ultimate tributary population, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc.

In determining the required capacities of sanitary sewers the following factors should be considered:

a. maximum hourly domestic sewage flow;

b. additional maximum sewage or waste flow from industrial plants;

c. inflow and groundwater infiltration;

d. topography of area;

e. location of sewage treatment plant;

f. depth of excavation; and

g. pumping requirements.

The basis of design for all sewer projects shall accompany the plan documents. More detailed computations may be required by the City Engineer for critical projects.

E.1.2. Required Capacity.

a. The city will require all developers constructing sewerage systems within the city limits to construct the system with adequate capacity, as determined by the city, to serve city anticipated tributary population upstream from the point of consideration. The capacity shall include sewer lines, lift stations and force mains, where applicable. The minimum size of the sewer lines and lift stations shall be in accordance with the following tabulation:

Drainage Area	*Sewer Line Size*	*Pump Station Capacity*
Less than 154 acres	8"	*
155 to 238 acres	10"	0.76 MGD
230 to 540 acres	12"	1.08 MGD
541 to 807 acres	15"	1.62 MGD
808 to 1,174 acres	18"	2.35 MGD
1,175 to 1,617 acres	21"	3.24 MGD
1,618 to 2,065 acres	24"	4.13 MGD
2,066 to 2,828 acres	27"	5.65 MGD

2,829 to 3,745 acres	30"	7.49 MGD
3,746 to 6,090 acres	36"	12.18 MGD
6,091 to 9,189 acres	42"	18.38 MGD
9,190 to 13,118 acres	48"	26.24 MGD
13,119 to 17,962 acres	54"	35.92 MGD
17,963 to 23,790 acres	60"	47.58 MGD
23,791 to 30,675 acres	66"	61.35 MGD

* Capacity to be determined from actual area served.

b. No sewer line shall be less than 8 inches in diameter, except as approved by the city. This requirement does not apply to "house sewers" defined as lines from a single house or a single connection to lateral sewer.

c. The city will require any sewer so situated as to subsequently serve an entire tributary population to be constructed with a capacity and at such depths as to permit future extensions thereto throughout the entire natural contributing drainage area without subsequently exceeding the capacity available.

E.1.3. Materials.

Any generally accepted material for sewers will be given consideration, but the material selected shall be adapted to local conditions, special consideration being given to the character of the industrial wastes, possibilities of septicity, exceptionally heavy external loading, abrasion, the necessity of reducing the number of joints, soil characteristics, and similar problems. The sewer pipe to be used shall be identified in the project specifications with appropriate A.S.T.M., A.N.S.I., or A.W.W.A. specification numbers for both quality control (dimensions, tolerances, etc.) and installation. All pipe shall be stamped with the manufacturers logo and the specified quality control numbers. In no case shall bituminous fiberboard or paper pipe be acceptable for use anywhere in a sewerage system. PVC solid wall pipe shall have a minimum pipe stiffness of 46 psi.

E.1.4. Joints and Infiltration.

a. Joints.

The method of making joints and the materials used shall be included in the specifications. Materials used for sewer joints shall have satisfactory records for preventing excessive infiltration and the entrance of roots. Premixed cold joint material or cement mortar joints shall not be used. This prohibition does not prevent use of factory applied joints of demonstrated quality.

b. Leakage Tests.

Leakage tests shall be specified for all new construction *as per City Standard Construction Specifications*. This may include appropriate water or low pressure air testing. *The following shall be considered in leakage testing:*

- The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day for any section of the system.

- An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet.
- The air test if used shall, as a minimum, conform to the test procedure described in A.S.T.M. C-828, or latest revision.
- The testing methods selected should take into consideration the range in groundwater elevations projected and the situation during the test.
- With pressure pipe sewers the leakage allowance shall not exceed 200 gallons per inch diameter per mile per day under a test head of 1.5 times the maximum anticipated pressure.
- Certification of the test results must be submitted to the City Engineer before approval of the installation will be given.

Replacement of existing sewers may require the connection of house service lines as the sewer is installed. Under these circumstances, the City Engineer shall specify special construction and/or inspection techniques to insure the exclusion of infiltration to meet the above standards.

E.1.5. Water Supply Interconnections.

There must be no physical connection between a public or private potable water supply system and a sewer, sewage treatment plant, or appurtenance which would permit the passage of any sewage or polluted water into potable water supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

E.1.6. Relation to Water Works Structures.

It is the policy of the reviewing authority to approve sewers in the rear lot or alley easement with water lines located in the street easement. If local conditions require both sewer and water mains in the same easement or right-of-way, then mains should be located on opposite sides of the street.

E.1.7. Horizontal Separation.

Whenever possible, a sewer shall be located at least 10 feet horizontally from any existing or proposed water main and 50 feet horizontally from all other utilities such as storm sewers, oil and gas lines and buried electrical lines and conduits.

Sewers shall be located a minimum of 50 feet horizontally from all petroleum storage tanks. Should this separation be impossible to obtain, the sewer shall be constructed of cast of ductile iron pipe and be not closer than 10 feet.

The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, the City may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the water main is in a separate trench and the sewer is designed and constructed in accordance with the special conditions below. A sewer laid closer than 50 feet to a water well, existing or proposed shall be constructed in accordance with the special conditions. Under no condition shall a sewer line be constructed less than 10 feet from a water well.

E.1.8. Crossings *(Vertical Separation).*

Sewers crossing water mains shall be laid to provide a minimum vertical distance of 24 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. W here sewer and water main crossings occur, adequate structural support shall be provided to prevent damage to either piping system. Should this vertical separation be impossible to obtain, the special conditions below will be followed.

E.1.9. Street Crossings.

Street crossings shall be sleeved (conduit) for mains installed under

- *Arterial Streets*
- *Industrial or collector streets only if required by the City Engineer.*

The sleeve (conduit) shall extend beyond the curb, on both sides, for a distance of at least 5 feet. The trench shall be backfilled with limestone screenings to the top of paving subgrade and compacted to 95% standard proctor density.

Sleeves are not required for Residential Street Crossings. Instead, AWWA, C-900, DR 14 pipe will be required for all crossings. The pipe materials utilized for the crossings shall be used not only under the street but shall extend to the upstream and downstream manholes on either side of the street crossing.

Sanitary sewer service lines under streets do not require sleeves.

Any mains under asphalt and concrete parking areas shall also be sleeved. The sleeve shall extend feet beyond either side of the asphalt or concrete.

E.1.10. Special Conditions.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to the highest pressure obtainable under the most severe head conditions of the collection system. Construction involving crossing(s) shall be tested prior to backfilling the crossing area and shall show no detectable leakage in the area of the crossing. Allowable leakage for sewers constructed under requirements of this section shall be in accordance with the specified leakage tests.

Other methods of construction where proper separation cannot be obtained will be evaluated by the City Engineer on case-by-case basis.

E.1.11. Plans.

The plans shall show the sewer in both plan and profile view. Any manhole or lamphole that is buried out of sight shall be dimensioned to permanent objects in the vicinity.

E.2. TYPE OF SYSTEM

In general, and except for special reasons, the Oklahoma State Department of Environmental Quality will approve plans for new systems or extensions only when designed upon the separate plan, in which rain water from roofs, streets, or other areas, and groundwater from foundation drains is excluded.

E.3. DETAILS OF DESIGN AND CONSTRUCTION

E.3.1. Minimum Size.

No public gravity sewer shall be less than 8 inches in diameter except that the use of 6 inch diameter sewer may be permitted in situations where it cannot be extended and where not more than 300 feet will be installed in any one place.

E.3.2. Depth.

Sewers must be designed deep enough to drain wastes from houses on both sides of the sewer and to prevent frost damage. The sewer depth should be great enough to permit extension of the sewer where such extension is possible or practical.

A minimum cover of 30 inches shall be provided for all sewers of material other than cast/ductile iron. Where this depth cover is not available, protection shall be provided by earth fill, encasement in concrete, or construction with cast ductile iron. All sewers shall be designed to prevent cracking due to superimposed loads and weights of backfill material. Encasement of PVC pipe in concrete is not recommended due to the difference in coefficients of expansion for temperature change.

Small diameter systems with grit removal system or grinder pump may require less than 30 inches of cover for collection lines provided the lines are in an area protected against traffic loads.

E.3.3. Velocity of Flow.

All sewers shall be designed and constructed with hydraulic slopes sufficient to give mean velocities, when flowing full, of not less than 2.0 feet per second. The following are the minimum slopes which should be provided, especially where the depth of flow may be small, and are the minimum in all parts of the system:

Sewer Size (inches)	*Minimum Slope in Feet per 100 feet*
6	0.50
8	0.40
10	0.29
12	0.22
14	0.17
15	0.15
16	0.14
18	0.12
21	0.10
24	0.08

These slopes are based upon a Kutter's or Manning's formula "n" value of 0.013. Under special conditions, slopes slightly less than those required for the 2.0 feet per second velocity when full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, the design engineer must furnish a report of the computations of rates of flow at minimum, average, and peak rates of flow. It is recognized that such flatter grades may cause additional sewer maintenance expense and odor nuisance. The selection of the size of pipe shall be determined on the basis of the most desirable flow characteristics obtainable. The operating authority of the sewer system will give written assurance to the appropriate reviewing agency that any additional sewer maintenance required by reduced slopes will be provided.

E.3.4. Increasing Size.

When sewers are increased in size, or when a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevations.

E.3.5. Alignment.

Sewers should be laid in straight alignment and shall be laid with uniform grade between manholes.

E.3.6. High Velocity Protection.

In the case of sewers where the slope and volume are such that velocities exceeding 10 feet per second will be realized at average flow, special provisions shall be made to protect against erosion. This protections may be secured utilizing cast iron. ductile iron. steel pipe or equivalent.

a. Where velocities greater than 15 feet per second are attained, special provisions shall be made to protect against displacement by erosion and shock.

b. Sewers on 20 percent slopes or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

   1) Not over 36 feet center to center on grades 20 percent and up to 35 percent;

   2) Not over 24 feet center to center on grades 35 percent and up to 50 percent; and

   3) Not over 16 feet center to center on grades 50 percent and over.

E.3.7. Installation.

Installation specifications shall contain appropriate requirements based on the criteria, standards, and requirements established by industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

E.4. DESIGN FLOW

E.4.1. Per Capita Flow.

A rational procedure should be used based on the area or population served by the section in question. This procedure should vary the per capita flow from that required when wide variations and extreme maximum peaks occur, such as in laterals, to that required for the large trunk sewers where the flow is more uniform. A brief description of the procedure used for sewer design should be included with the summary of design data at the time plans are submitted for approval.

In lieu of the above, new sewage systems shall be designed on the basis of an average daily per capita flow of sewage of not less than 100 gallons per day.

The 100 g.p.d. figure is assumed to cover normal infiltration, but additional allowance should be made where conditions are especially unfavorable. This figure is considered sufficient to cover flow from floor cellar drains, but is not sufficient to provide any allowance for flow from foundation drains, roof leaders or unpolluted cooling water and which shall not be discharged into sanitary sewerage systems.

Flows for systems constructed under the federal grants program shall be determined in accordance with applicable federal regulations.

E.4.2. Peak Design Flow.

Sanitary sewers shall be designed on a peak design flow basis using one of the following methods:

a. Peak flow divided by average flow =

$(18 + \sqrt{p})$ divided by $(4 + \sqrt{p})$

where: p = population in thousands

$\sqrt{p}$ = square root of the population in thousands

b. Values established from an infiltration /inflow study acceptable to the approving agency.

Use of other values for peak design flow will be considered if justified on the basis of extensive documentation.

E.5. MANHOLES

E.5.1. Location.

Manholes should be installed at the end of each line, at all changes in grades, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18 to 30 inches. Greater spacing may be permitted in larger lines, those carrying a settled effluent or where adequate cleaning equipment for such spacing is provided. Lampholes may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterals greater than 250 feet in length.

E.5.2. Drop Manhole.

A drop manhole shall be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.

Drop manholes shall be constructed with an outside drop connection. Inside drop connections (*if approved by the City Engineer*) should be secured to the interior wall of the manhole and provide access for cleaning.

All drops shall be constructed in accordance with the City Standard Construction Details.

E.5.3. Diameter.

The minimum inside diameter of manholes shall be 4 feet. For manholes less than 4.5 feet deep, the full diameter shall extend from top to bottom of the manhole.

E.5.4. Flow Channels.

The flow channels through the manholes shall be made to conform in shape and slope to that of the sewers.

E.5.5. Inlet and Outlet Pipes.

Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or an watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

E.5.6. Steps, Rings and Lids.

a. Water-tight manhole covers shall be used wherever the manhole top may be flooded by street runoff or high water. including manholes within 100 year floodplain. Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.

b. Manhole steps, rings, and lids shall be made of gray cast iron conforming to ASTM A48 or shall be made of other corrosion resistant metals. Steps or ladders shall be provided whenever the manhole is deeper than 4 feet. Steps shall be spaced at intervals no greater than 16 inches. Wherre manhole steps are not utilized, in place or portable ladders shall be provided.

c. Manhole rings and lids utilized in traffic areas, i.e., streets, alley-ways, or parking lots, shall be cast iron construction and shall be capable of withstanding repeated traffic loads.

d. Solid manhole covers shall be utilized. Manhole covers with a pickhole area are acceptable. Manhole rings and lids of ABS Thermoplastic construction will not be allowed.

e. Manholes located in paved areas shall have their rims installed at grade. In addition, the manholes shall have 4 inches of grade adjustment rings installed immediately below the casting.

f. Manholes located in unpaved areas shall have their rims installed 4 inches above grade. This will minimize the stormwater inflow into the manholes.

E.5.7. Manhole Bases.

The base shall be poured of a minimum 3,000 psi concrete with a maximum slump of 4 inches, vibrated or tamped. The base should have a minimum diameter of 8 inches greater than the outside diameter of the manhole. The base shall have a minimum 8 inch thickness beneath the manhole wall. Joints between the manhole base and wall must be constructed to prohibit the infiltration or exfiltration of water.

E.5.8. Precast Reinforced Concrete Manholes.

Precast manholes shall conform to the current ASTM specifications C478.

E.5.9. Cast-In-Place Concrete Manholes.

Materials for concrete used for cast-in-place manholes shall conform, as a minimum, to the following current specifications:

Portland Cement	ASTM C 150
Aggregate for Mortar	ASTM C 144
Fine and Coarse Aggregate	ASTM C 33

The strength of the concrete material shall not be less than 3,000 psi.

E.5.10. Other Manhole Materials.

Manholes made of material not covered by these standards will be considered on a case-by-case basis.

E.6. INVERTED SIPHONS

Inverted siphons shall have not less than two barrels, with a minimum pipe size not less than 6 inches and shall be provided with necessary appurtenances for convenient flushing and maintenance, the manholes should have adequate clearances for rodding; and in general, sufficient head should be provided and pipe size selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details must be arranged so that the normal flow is diverted to one barrel, and so that either barrel may be out of service for cleaning. The vertical alignment shall permit cleaning and maintenance.

E.8. AERIAL CROSSINGS

Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning, and settlement.

Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above ground and below ground sewers.

For aerial stream crossings the impact of flood waters and debris shall be considered. The bottom of the pipe shall be placed no lower than the elevation of the 50 year flood.

E.9. PRESSURE SEWER SYSTEMS

The use of pressure sewers may be considered when justified by unusual terrain or geological formations, low population density, difficult construction, or other circumstances where a pressure system would offer an advantage over a gravity system. *Construction of a pressure sewer must be approved by the City Engineer and will only be considered if connection to City gravity lines is not possible or will create undue project hardship.*

E.9.1. Management. *Lift Stations to become part of the public sanitary sewer system and to be maintained and operated by the City shall be constructed to ODEQ and City requirements.*

E.9.2. Sewers. The engineer may be guided in his design of pressure sewers by the following considerations.

a. The number of units pumping at any one time.

b. Flow velocities in the range of 2 to 5 feet per second.

c. The installation of air relief valves.

d. The provisions of a means to flush all lines in the system.

e. The installation of cleanouts.

f. Development of procedures whereby portions of the pressure system may be rerouted with temporary lines in the event of leaks, construction, or repair.

g. *Wet well size and capacity to prevent excessive pump motor starts.*

E.9.3. Pumps. Pumping units and grinder pumps used in pressure sewer systems should be reliable, easily maintained, and *shall be from a manufacturer approved by the City.*

a. Pumps and grinder pump units shall be provided with backflow prevention devices.

b. Sufficient holding capacity shall be provided in the pumping compartment to allow for wastewater storage during power outages and equipment failures of short duration. *Emergency operation provisions in accordance with ODEQ regulations and City approval shall be provided.*

c. Pumping units *shall utilize only concrete wet wells.*

d. Alarms, warning lights, or other suitable indicators of unit malfunction shall be installed in the system. Telemetry devices compatible with the City's system shall also be installed.

e. Whenever any pumping unit handles waste from two or more residential housing units or from any public establishment, dual pump units shall be provided to assure continued service in the event of equipment malfunction.

E.10. CITY INSPECTION

E.10.1. Inspection. All phases of the construction must be inspected by the City, and approved prior to connection to the City's existing system. The contractor should contact the city prior to construction to obtain details of the City's inspection process.

E.10.2. Alignment Testing of Sewer Lines. All gravity sewer lines of rigid pipe connection must be inspected by lamping each line from manhole to manhole by placing a light in each manhole and visually inspecting the interior of the line. The sewer line must be true to line and grade and a full circle of light must be seen between each manhole. Mandrel tests for PVC pipe shall be conducted by the Contractor.

E.10.3. Flushing of Sewers - General.

a. After the test provided for in paragraph 2 above, a flushing test of all sanitary sewers will be made by the *Contractor. The City may lend assistance as available*. Any exfiltration of flushing water or any infiltration into the sewer shall not be acceptable and the contractor shall immediately correct the cause of any leak in a manner acceptable to the City Engineer.

b. All sewer lines shall be flushed by saturating the backfill with water injected from a fire hose at the approximate elevation of the top of pipe. The injection of the water shall be spaced at least 10 feet apart along the sewer center line and the water allowed to run until water appears at the surface of the ground. This saturation of the fill shall proceed from the lowest point of the sewer, while saturation of the fill is in progress, an observer shall be kept in the manhole to observe for leaks, and if any appear, they shall be reported immediately and the approximate location of the leak stake on the ground. The water injected into the backfill shall be applied at a pressure not to exceed ten (10) psi and this shall be controlled by a globe valve placed on the injection nozzle.

c. The City will accept the lines only if no leaks appear. Any leaks would indicate a broken line or a faulty joint.

d. The manhole, after saturating, shall also be checked for leaks, and if any appear, they will be marked for repair at a later time. After each portion of the sewer line has been checked for infiltration, and if no leaks appear, the sewer line shall be flushed with water placed in the manhole to determine the adequacy of the flow and grade.

E.10.4. Flushing and Inspection Fees. Each owner shall pay a sewer flushing fee, prior to the flushing test and inspection fees as established by ordinance by the City Council.

SECTION F. WATERWORKS SYSTEM CRITERIA

F.1. GENERAL

F.1.1. The minimum design criteria for all waterworks within the city shall be the latest edition of *Title 252, Oklahoma Administrative Code, Chapter 625, Public Water Supply Construction Standards*.

The distribution system of a waterworks includes the mains, valves, hydrants, storage tanks, consumer service pipes, and system and other appurtenances. The system shall be designed to provide an adequate supply of water to the consumers and for fire protection at all times.

The plans for a water distribution system shall show the valve locations and shall also include a table listing each "as-built" valve location and full description so that maintenance personnel can copy the table for reference.

The plans shall show the water distribution system in both plan and profile view. The profile view is to show depth constraints and to identify high points, low points, utility crossings and other underground obstructions.

F.1.2. **Standards.** Pipe selected shall have been manufactured in conformity with the latest standard specifications issued by the American Water Works Association, the American Standards Association, or the federal government. Whenever plastic pipe is approved and used, it shall bear the seal of the National Sanitation Foundation and *shall* be *AWWA C-900, DR 14, Class 200*. The average operating pressure in the system must not exceed two-thirds of the pressure rating of any pipe.

F.1.3. **Used Materials**. Used water mains that meet the American Water Works Association specifications and previously used for conveying potable water, may *only* be used again *after prior approval by the City Engineer* and the pipe has been cleaned thoroughly and restored practically to its original condition. The City must be consulted before plans are prepared.

F.1.4. **Joints and Fittings**. Packing and jointing materials used in the joints of pipe shall meet the standards of the AWWA and the *City Standard Construction Specifications*.

F.2. WATER MAIN DESIGN FOR MUNICIPAL SYSTEMS AND OTHERS PROVIDING PROTECTION

F.2.1. **General.** The distribution system shall be designed so that negative pressure will not occur under any conditions of draft on the system. The pressures in a system generally vary from 45 to 100 pounds per square inch.

A large system will consist of supply mains, arteries, and secondary feeders, spaced at intervals of 2,000 to 3,000 feet in the grid system, looped. The location of feeders will be determined by the distribution of consumers and high-value property; however, connecting pipes shall be laid on cross streets at intervals not exceeding 600 feet whether consumers are there or not.

F.2.2. **Pressure.** All water mains shall be sized after a hydraulic analysis based on flow demands and pressure requirements. The system shall be designed to maintain a minimum pressure of 25 psi at around level at all points in the distribution system under all conditions of flow.

F.2.3. **Diameter.** To comply with the American Insurance Association, a minimum main size of six inches in residential areas and eight inches in high-value districts is required where cross-connecting mains are not more than 600 feet apart. On principal streets, section line roads, and

for long lines cross-connected at intervals exceeding 600 feet, 12 inches or larger mains are required by the American Insurance Association. Size of new supply mains shall be determined by the Hardy Cross or other suitable analysis method, but shall not be less than 6 inches in diameter.

F.2.4. **Hydrants.** Water mains not designed to carry fire-flows shall not have fire hydrants connected to them.

F.2.5. **Dead Ends**. *Dead ends shall be minimized by looping of all mains unless otherwise approved by the City. Future plans eventually connecting dead ends to other mains to provide circulation of water is required.*

F.2.6. **Flushing.** Where dead-end mains occur they shall be provided with a fire hydrant if flow and pressure are sufficient, or with an approved flushing hydrant or blow-off for flushing purposes. No flushing devices shall be directly connected to any sewer.

F.2.7. **Valves.** Positive closing valves should be located so that a single break in the line will require no more than 500 feet of pipe to be disconnected from service in high-value areas, nor more than 1,320 feet in other section, nor shall require shutting down of an artery. Valves should be located at street intersections in position so that they can be readily operated in case of main failure. *Additional valves may be required based on recommendations by City Water Distribution System maintenance staff.* All small distribution lines branching from larger mains should be valved. *All valves greater than 4' deep shall be provided with a valve extension sufficient to allow operation with a standard valve wrench.*

Valves should be arranged so each block can be isolated in case of a main break. Each branch at large pipe intersections should be valved, with large supply lines at about one mile intervals.

Valves shall be located outside paving areas unless previously approved by the City Engineer.

F.2.8. **Hydrants.**

a. **General.** Hydrants shall conform to ANSI/AWWA C-502 standards for dry-barrel fire hydrants. *Only hydrants listed in the City Standard Construction Specifications may be installed.*

b. **Locating and Spacing.** Hydrants should be located at street intersections accessible from four directions. or spaced so that hose lines used do not exceed 500 to 600 feet in length. In high-value districts, hydrants may be spaced as close as 150 feet.

c. **Valves and Nozzles**. Fire hydrants should have a 4 ½ inch pumper outlet, not less than two 2 ½ inch hose outlets, and be connected to the main with pipe not smaller than six inches. The pumper should be able to connect to the hydrant with a single 10 foot length of suction hose, set so the center of the lowest outlet is not less than 18 inches above the surrounding grade. The hydrant operating nut should not be over four feet above the surrounding grade, and shall have a 4 foot 6 inch bury depth.

d. **Hydrant Leads.** The hydrant lead shall be a minimum of six inches in diameter. Auxiliary valves should be installed in all hydrant leads.

e. **Drainage.** Drains from hydrant barrels on distribution system shall not be connected to sanitary sewer or storm drains. *Unless otherwise approved*, hydrant barrels shall be drained to the ground surface, or to dry wells provided exclusively for that purpose.

F.2.9. **Air Relief Valves, Valve, Meter and Blow-off Chambers**. Air relief valves should be located at high points and blow-offs at low points in mains 8 inches or larger.

a. **Air Relief Valves.** At high points in water mains, where air can accumulate, provisions shall be made to remove the air by means of hydrants or air relief valves. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur.

b. **Air Relief Valve Piping**. The open end of an air relief pipe from automatic valves shall be extended to at least one foot above the grade and provided with a screened, downward facing elbow. The pipe from a manually operated valve should be extended to the top of the pit.

c. **Chamber Drainage.** Chambers, pits, or manholes containing valves, blow-offs, meters or other such appurtenances to a distribution system, shall not be connected directly to any storm or sanitary sewer, nor shall blow-offs or air relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface or the ground where they are not subject to flooding by surface water, or to absorption pits underground.

F.3. WATER MAIN DESIGN FOR RURAL WATER SYSTEMS PROVIDING DOMESTIC WATER ONLY: (This section shall apply to rural systems without full fire protection capabilities.)

a. **Pressure**. All water mains, including those not designed to provide fire protection, shall be sized after hydraulic analysis based on flow demand of not less than one gallon per minute per service connection and pressure requirements. The system shall be designed to maintain a minimum pressure of 25 psi at ground level at all points in the distribution system under all conditions of flow.

b. **Diameter.** The minimum size of water mains shall be *four* inches in diameter. Larger size mains will be required to satisfy peak demand while maintaining the minimum residual pressure.

c. **Hydrants**. Water mains not designed to carry fire flows shall not have fire hydrants connected to them.

d. **Dead Ends.** *Dead ends shall be minimized by looping of all mains unless otherwise approved by the City. Future plans eventually connecting dead ends to other mains to provide circulation of water is required.*

e. ***Flushing.*** *Where dead-end mains occur they shall be provided with an approved flushing hydrant or blow-off for flushing purposes. No flushing device shall be directly connected to any sewer.*

f. **Valves**. Sufficient valves shall be provided on water mains so that inconvenience and sanitary hazards will be minimized during repairs. Valves shall be located at not more than one mile intervals and at all branch lines from the main line.

g. ***Air Relief Valves, Valve, Meter and Blow-off Chambers****. The standards as outlined in Section F.2.9 shall apply to rural systems also.*

F.4. INSTALLATION OF MAINS (All Systems)

F.4.1. It is the policy of the city to approve sewers in the rear lot line easement with water lines located in the street easement. If local conditions require both sewer and water mains in the street, the mains will be located on opposite sides of the street.

Before excavation of the water supply trench is started, all intersecting sewer lines, house sewer lines, and sewer within 10 feet of the water line shall be located, mapped, and means taken to

prevent the discharge of waste into the trench. If any sewer is disturbed, it must be carefully restored immediately to a tight operating condition.

Pipe laying operations should be suspended during rains or whenever the trench cannot be kept dewatered. A tight plug shall be placed in the open end of a main at all times when work is not in progress.

All construction shall be inspected by the city before approval can be given for taps and connection to the City's existing system. The Contractor should contact the City Engineer prior to construction to obtain details of the city's inspection process.

F.4.2. **Standards.** The specifications shall incorporate the provisions of the AWWA standards and/or the manufacturer recommended installation procedures.

F.4.3. ***Bedding.*** *A continuous and uniform bedding shall be provided in the trench for all buried pipe. Backfill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Stones found in the trench shall be removed for a depth of at least six inches below the bottom of the pipe.*

F.4.4. **Cover**. All water mains shall be covered with at least 30 inches of earth or with sufficient insulation to prevent freezing.

F.4.5. **Blocking.** All tees, bends, plugs, and hydrants shall be provided with *mechanical restraints designed to prevent movement. In areas with soft or yielding soils and/or high system pressures, reaction blocking may also be required.*

F.4.6. ***Connections to Asbestos Cement Pipe.*** *Connections to existing asbestos cement (AC) pipe shall use only connection systems and materials approved by the City.*

F.4.7. **Pressure and Leakage Testing**. The installed pipe shall be pressure tested and leakage tested in accordance with AWWA Standard C600 *and City Standard Construction Specifications. At a minimum the following test procedure shall be observed*:

- The working pressure of the pipe should not exceed two-thirds of the rated pressure of the pipe. Leakage should not exceed ten gallons per inch of diameter of pipe per 24 hours at 150 psi testing pressure.
- The testing of water mains will be performed by the Contractor and will be witnessed by City personnel. A test pressure of 150 psi shall be applied for a period of thirty (30) minutes.
- If the lines pass the test without significant drop in pressure. a leakage test shall be made at the normal operating pressure under which the lines have to operate for a two (2) hour duration.

F.4.8. **Disinfection.** All new, cleaned or repaired potable water mains shall be disinfected in accordance with the *Department of Environmental Quality rules for Public Water Supply Operation. Oklahoma Administrative Code. Title 252. Chapter 630.*

Generally, water with 50 to 100 parts per million of chlorine shall be allowed to stand for 24 hours and develop a residual of at least 10 parts per million of chlorine. The spent solution should be drained and replaced with potable water. As an alternate, either of the methods listed in the latest American Water Works Association specifications may be used. Safe bacteriological samples shall be obtained on two consecutive days before that portion of the line may be used.

F.4.9. **Separation of Water Mains and Sewers.**

a. **Horizontal Separation**. Water mains shall be located at least 10 feet horizontally from any existing or proposed sewer lines, storm sewers, raw water lines, oil and gas lines, and buried electric lines. PVC water lines shall be located at least 50 feet horizontally from any gasoline storage tank. Wherever a 50 foot separation cannot be maintained for water lines, cast or *ductile* iron pipe must be used for the water line but in no case shall be closer than 10 feet to the storage tank.

The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, the *Department of Environmental Quality (DEQ)* may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the water line closer to a sewer line, provided that the water main is in a separate trench and the sewer is constructed and/or tested.

Water lines shall be located at least 15 feet from all parts of septic tanks and absorption fields, or other sewage treatment and disposal systems. In cases where the 15 foot separation cannot be maintained, *DEQ* may allow deviations on a case-by-case basis.

b. **Crossings.** Sewers crossing water mains shall be laid to provide a minimum vertical distance of 24 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main and no sewer line joint shall be less than *10* feet from water lines.

c. **Special Conditions**. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to water pipe, and shall be pressure tested to assure water tightness prior to backfilling. The sewer shall be designed and constructed in accordance with *DEQ* Bulletin No. 0587.

F.4.9. **Surface Water Crossings.** Surface water crossings, whether over or under water, present special problems. The City Engineer should be consulted before final plans are prepared.

a. **Above-water Crossing.** The pipe shall be adequately supported and anchored, protected from damage and freezing, and accessible for repair or replacement.

b. **Underwater Crossing.** A minimum cover of *four* feet shall be provided over the pipe. When crossing water courses which are greater than 15 feet in width, the following shall be provided:

1) the pipe shall be of special construction, having flexible watertight joints;
2) valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; the valves shall be easily accessible, and not subject to flooding; and the valve closest to the supply source shall be in a manhole;
3) permanent taps shall be made on each side of the valve within the manhole to allow insertion of a small meter for testing to determine leakage and for sampling purposes.

F.4.10. **Cross Connections and Interconnections.**

a. **Cross Connections.** Special consideration should be given to avoiding cross connections in the system.

1) No physical connection shall be permitted between a line carrying a public drinking water supply and a line carrying water of unknown or questionable quality. No water

connection shall be made from any public drinking water supply to any water using mechanical device or system unless it is of such design as will insure against backflow or siphonage of contaminated water into the drinking water supply. Where a connection is required that might possibly pose a threat to public health, a reduced pressure zone backflow presenter is required.

2) There shall be no cross-connection made between a public water system and any private water system or other source of possible contamination. In addition, any existing individual sewage disposal systems shall be approved by the Department of Environmental Quality prior to completing the service connection to the public water system. All individual sewage disposal systems constructed after the permitted water lines have been placed into service shall be constructed in accordance with *Oklahoma Administrative Code, Title 252, Chapter 635*, and be approved by the County and *Department of Environmental Quality* prior to completing the service connection to the public water system. It shall be the responsibility of the permitted to provide inspection of the plumbing installations.

b. **Cooling Water.** Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply.

c. **Interconnections.** The approval of the City shall be obtained for interconnections between potable water supplies.

d. ***Water Loading Stations.*** *Water dispensing units present special problems when the fill line may be used or filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of the public supply, the following criteria shall be met:*

1) A device shall be installed on the fill line to provide an air break and prevent a submerged discharge line.

2) The fill hose and cross connection control device must be constructed so that when hanging freely it will terminate at least two feet above the ground surface.

3) The discharge end of the fill line must be unthreaded and constructed to prevent the attachment of additional hose. piping or other appurtenances.

F.4.11. **Water Service and Plumbing.** Water service connections and plumbing shall conform to relevant local and state plumbing codes.

F.4.12. **Street Crossings**. All street crossings *of long service lines* shall be sleeved (conduit) under the street. *Water mains constructed of ductile iron pipe or AWWA C-900, DR 14 PVC pipe will not require a sleeve.* The sleeve shall extend beyond the curb, on both sides, for a distance of 2 feet. The trench shall be backfilled *as per the City Standard Construction Specifications* to the top of paving subgrade and compacted to 95% standard proctor density.

Street crossings shall be sleeved (conduit) for mains installed under

- *Arterial Streets*
- *Industrial or collector streets only if required by the City Engineer.*

The sleeve (conduit) shall extend beyond the curb, on both sides, for a distance of at least 5 feet. The trench shall be backfilled with limestone screenings to the top of paving subgrade and compacted to 95% standard proctor density.

Oxidation - reduction potential:	
Greater than +160 MV	0
+50 – +100 MV	3.5
0 – +50 MV	4
Negative	5
Sulfide:	
Positive	3.5
Trace	2
Negative	0
Moisture:	
Poor Drainage, continually wet	2
Fair drainage, generally moist	1
Good drainage, generally dry	0
Stray direct current:	
Positive	15
Negative	0

* If sulfides are present and the oxidation reduction potential is negative or 0 to +50 MV, 3 points shall be given in this range. If the points for the soil in question total less than 10, ductile iron pipe may be used without polywrap *if approved by the City Engineer*, unless the stray direct current test is positive. In the event that the stray direct current test is positive, only PVC pipe may be used.

APPENDIX A. ENGINEERING DESIGN CHECKLIST

City of Bixby
Engineering Design Checklist

This checklist has been prepared by the Engineering Department to minimize the number of Plan reviews by providing a list of information that must be provided for all submittals. The intent of this list is not to provide an exhaustive list of generally accepted practices, elements, or formats used for Construction Drawing production. The items included in the checklist identify and clarify key, recurring Plan elements; that if addressed from the outset; will reduce repetitive comments.

Review will not begin until the minimum Plan requirements listed below have been provided. To resolve questionable design issues prior to Construction Plan submittal, intermediate review meetings addressing specific issues are encouraged.

A completed copy of this checklist must be submitted with completed Construction Plans. Incomplete Plans and checklists will be returned to the Engineer without review.

Project: _____ **Submittal #:**

_____

Owner: _____

Engineer: _____ **Signature:** _____

Address: _____ **Date:** _____

_____

Phone: _____ **Fax:** _____

A. General Drawing Requirements

____ Five (5) sets of half-size Plans for Initial Submittal.

____ Six (6) sets of half-size & One (1) set of full size Plans for Final Submittal.

____ Cover sheet includes a vicinity map showing at least full mile section with proposed project area and adjacent properties and developments.

____ Plat drawing should be included in each Plan set.

____ North arrow and scale bars provided on all sheets.

____ Maximum Drawing Scales: 1" = 100' on Plan Sheets. 1" = 50' Horizontal and 1" = 5' Vertical on Plan & Profile Sheets.

____ Min. Lettering height = 0.12".

____ Titleblock on each sheet includes the project title, owner's and engineer's name, drawing description, page number, and date.

City of Bixby
Engineering Design Checklist

____ All improvements may be located at the project site from dimensions shown on the drawings based on established physical objects. No improvements shall need to be scaled off of the drawings to be located at the project site, or need for the designer to physically locate the improvement at the project site.

____ Vertical control is based on USGS datum (NAVD '88) and bench marks are shown on each plan view drawing. Horizontal control points are based on the State Plane Coordinate System (NAD 83 Feet Ok North) used by the City of Bixby. Control points are shown and labeled.

____ All easements and right-of-way required for improvement Construction have been identified, dedicated and shown on the Plans. Appropriate Book and Page listed for each instrument.

____ Call OKIE symbol included on Cover and Plan sheets.

____ Legend provided on all Plan sheets.

____ Benchmarks located and labeled on each Plan set.

____ Soil Borings shown on each Plan set.

____ 100-year floodplain boundaries and Wetland boundaries are shown on all Plan sheets.

____ All existing and proposed obstructions, above and below ground, are included in drawings.

____ Existing and proposed utilities shown in Plan drawings.

____ Existing contours are always shown with dashed, light line. Proposed contours are shown as continuous, heavy line.

B. Streets and Sidewalks

____ Soils Report with paving design recommendation submitted.

____ Typical street sections and paving details provided, dimensioned and labeled.

____ Maximum cross slope used = 3/8" per foot.

____ For Residential asphalt streets, base course is specified as Type A and surface course is specified as Type C.

____ ODOT Standards to be used are listed on Cover sheet.

____ Geometric design and sight triangles provided in accordance with Engineering Criteria Manual.

____ Complete geometric layout and curve data for horizontal layout provided.

____ Finish contours shown in Plan drawings.

____ Intersection details for each intersection are included in drawings. Spot elevations, exact horizontal location, and flow arrows are provided.

____ Wheelchair ramp locations labeled and ramp design specified.

____ Vertical curve data included for each curve: Tangent Grades, Curve Length, VPC Sta., VPI Sta., VPT Sta., High Point (crest), Low Point (Sag) , K, and Design Speed.

____ Fill areas shown, hatched, and labeled on Profiles.

____ Profiles show existing and proposed grades for roadway centerline and proposed grade for right-of-way lines on each side of roadway.

____ Storm water drainage inlet locations are labeled and stationed.

C. Storm Water Drainage

____ Storm Water Detention and Drainage Report meeting requirements of Section D submitted. Report contains detailed hydrologic and hydraulic calculations for storm water drainage system including storm sewers, culverts, bridges, erosion control measures (i.e. riprap), and an evaluation of downstream tailwater conditions that affect system hydraulic performance.

____ Floodplain development issues, where applicable, have been addressed. Floodplain areas have been placed within Reserve Areas. Compensatory storage calculations including cut/fill summary with supporting cross section information has been prepared and submitted. Required CLOMRs have been prepared and submitted to FEMA.

____ 404 Permit and Wetland issues, where applicable, have been pursued and addressed with the U.S. Army Corps of Engineers.

____ Detention facility and outlet structure construction details provided including geometric layout data and low flow concrete trickle channels.

____ Grading Plan showing existing and finish grade contours is included in the Plan set.

____ Finished Contours and Finished Floor elevations for each lot shown on Plan drawings. Spot elevations are used as required to show grading in and around individual building sites.

____ Overland drainage across more than two lots has been prevented by the use of storm water drainage structures or overland drainage easements containing vegetated swales or channels.

____ Storm water drainage maps for on-site and off-site drainage along with inlet & structure design and hydrology/hydraulic summary are included in drawings.

____ Off-site discharge or receipt of runoff addressed with adequate easements, drainage structures, and permanent erosion control measures.

____ Legend showing inlet and structure design designations provided.

City of Bixby
Engineering Design Checklist

____ Each structure labeled with unique identifier used in Drainage calculations, on Plan drawings and on Profiles.

____ Structures with Stations and Grate/Rim/Invert elevations shown on the profiles.

____ Max time of concentration to any inlet = 10 minutes for Residential and 5 minutes for Industrial/Commercial areas.

____ Pipe label, size, material, and length of run included on Plans and on Profiles. Culvert end treatments are also specified where applicable.

____ Cadi-Lok type wrap has been specified for RCP storm sewer joints in sandy soils.

____ Pipe grades, capacity, design flows, and flow velocities are labeled on Profiles (including culverts and tailwater conditions).

____ Existing and proposed grades shown on Profiles. Existing and proposed grades for culverts shall be extended a minimum of 50' upstream and downstream of the end of the pipe.

____ Street crossings shown and labeled on Profiles.

____ EGL and HGL grades are shown on Profiles (including culverts and tailwater conditions).

____ Typical sections for drainage swales and channels are provided. Design information including flow rate and velocity included with details.

____ Storm Water Pollution Plan in accordance with ODEQ regulations has been prepared and submitted.

____ Erosion Control Plan addressing temporary construction measures and long term permanent measures has been prepared and submitted.

____ Calculations for riprap sizing and/or other erosion control measures is included in Detention and Drainage Report.

____ Filter fabric provided for all riprap installations.

D. Sanitary Sewer

____ Sewer located 12.5' from property line within 17.5' perimeter easement.

____ Sewer located 7' from property line within 11' easement.

____ Offset dimensions of sewer line from property labeled on Plans.

____ Sewer adjacent to street right-of-way is placed on the side of the street opposite water line location.

____ Sewers terminating in manhole project a minimum of 15' into property served.

City of Bixby
Engineering Design Checklist

____ Manholes provided at all at the end of each line, at all changes in grades, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18 to 30 inches.

____ Manhole spacing at 500' in streets or parking areas pre-approved by City.

____ Manholes located outside of paved areas.

____ Manhole access should be provided within 20' of the back of curb(i.e. outside possible fenced areas) at street crossing for sanitary sewer lines installed through back and side yards.

____ Angle between inflow and outflow lines is greater than or equal to 90 degrees.

____ Each manhole labeled with unique identifier used on Plan drawings and on Profiles.

____ Minimum manhole depth = 4'.

____ Manhole diameters approved for pipe sizes.

____ Manholes with Stations and Rim/Invert elevations shown on the profiles.

____ Rim elevations elevated minimum 1' above 100-year flood level or bolt-down covers specified.

____ Drop manholes shown when the difference in manhole inverts is 2' or more.

____ Pipe label, size, material, and length of run included on Plans and on Profiles.

____ Flow direction arrows included on Plan Sheets.

____ Existing and proposed grades shown on Profiles.

____ Fill areas shown, hatched, and labeled on Profiles.

____ Street crossings shown and labeled on Profiles.

____ Pipe materials and grades included on Profiles.

____ Conduits/bores shown on Profiles.

____ Utility crossings (including water and storm sewer) and clearances shown and labeled on Profiles.

____ 10' horizontal and 2' vertical clearance provided between sanitary sewer lines and water mains.

____ At crossings of sanitary and storm sewer lines, the water line is to be installed over the sanitary and storm sewer lines except where otherwise pre-approved by the City Engineer. In areas of limited cover, conduit is used and/or construction of sanitary sewer lines with AWWA C900 pipe to keep the water line installation above that of the sanitary and storm sewer.

____ Sufficient slope provided to maintain minimum velocity of 2 ft/sec.

____ Main at sufficient depth and capacity to serve all upstream properties.

____ 3' minimum cover provided at creek or channel crossings. Either encased conduit with PVC line or encased DIP is shown for creek and channel crossings.

____ Service tees included on Profiles with station, size, and direction. Design depth based on service line stubout 1.5' below surface, 2% min. grade, and 1.5' drop into sewer.

____ Finished Contours and Finished Floor elevations for each lot shown on Plan drawings.

____ Finished Floor elevations for each service tee shall be labeled and shown on Profiles.

____ Pressure sewer system pre-approved by City.

____ Lift Stations and Force Mains designed and detailed in accordance with ODEQ regulations and City requirements for Lift Station layout and equipment.

E. Waterworks

____ Mains located and dimensioned at 8' from property line.

____ On all Plan sheets, structures that have (or will have) a finished floor elevation of 700 or less are specially designated to require installation of a pressure reducing valve.

____ Fire Hydrants spacing at 600' max for Residential areas and 300' max for Industrial and Commercial areas.

____ Plan sheet showing coverage radii for all hydrants provided in drawing set.

____ 4.5' bury Fire Hydrants labeled on Profiles.

____ Pipe label, size, material, and length of run included on Plans and on Profiles.

____ All fire hydrants, valves, and fittings use easily identifiable symbols and are labeled & stationed on Plan drawings and on Profiles. All hydrants, valves, and fittings mechanically restrained.

____ All valves located outside paved areas.

____ Connections to asbestos cement pipe are detailed and specified according to City requirements.

____ Water service connections, including long services shown and labeled. Long services cross roadways from property corner to property corner.

____ Minimum 3' cover shown and labeled on Profiles.

____ Existing and proposed grades shown on Profiles.

____ Fill areas shown, hatched, and labeled on Profiles.

____ Street crossings shown and labeled on Profiles.

____ Conduits/bores shown on Profiles.

____ Utility crossings (including sanitary and storm sewers) and clearances shown and labeled on Profiles.

____ 10' horizontal and 2' vertical clearance provided between sanitary sewer lines and water mains.

____ Stream and channel crossings comply with ODEQ regulations in OAC 252:626-19-2(9)(B).

F. Other Required Submittals

____ Traffic Control and Street Sign Plan prepared and submitted.

____ Street Lighting Plan prepared in conjunction with the appropriate power company prepared and submitted.

APPENDIX B. DEVELOPMENT FEE SCHEDULE

ORDINANCE NO. 599

AN ORDINANCE ADOPTING A FEE SCHEDULE FOR FILING AND PROCESSING ZONING; PLANNED UNIT DEVELOPMENTS; SUBDIVISION PLATS; LOT SPLITS; WAIVER OF PLAT; CHANGE OF ACCESS; EARTH CHANGE PERMIT; SUBDIVISION INSPECTION; BOARD OF ADJUSTMENT; REPEALING ALL ORDINANCES OR PARTS OF ORDINANCES IN CONFLICT HEREWITH; AND DECLARING AN EMERGENCY.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF BIXBY, OKLAHOMA:

Section 1. That zoning fees are hereby established as follows:

Zoning Categories (Zoning Classification)	Base Fee	Sliding Fee
A. Low Intensity (AG, RE, RS-1, RS-2, RS-3, RD)		
1. 5.0 acres or less	$ 50.00	
2. For each additional acre increment and/or fraction thereof		$ 2.00
3. Maximum	$ 200.00	
B. Medium Intensity (RMH, RM-1, RM-2, OL, OM)		
1. 5.0 acres or less	$ 75.00	
2. For each additional acre increment and/or fraction thereof		$ 5.00
3. Maximum	$ 300.00	
C. High Intensity (RM-3, CS, CG, CH, IR, IL, IM, IH)		
1. 5.0 acres or less	$ 100.00	
2. For each additional acre increment and/or fraction thereof		$10.00
3. Maximum	$ 400.00	
D. Multiple Zoning Classification*		
1. Highest base fees**	(A-1, B-1, C-1) (A-2, B-2, C-2)	
2. Plus per acre cost per category***		
3. Maximum	$ 400.00	
E. Planned Unit Development Review		
1. 10.0 acres or less	$ 200.00	
2. For each additional acre and/or fraction thereof over 10.0 acres		$5.00
3. Maximum	$ 600.00	
F. Abandonment of a Planned Unit Development	$ 35.00	
G. Minor Amendment to a Planned Unit Development		
1. Bulk & Area Variances (5% or less)	$ 25.00	
2. Bulk & Area Variances (10% to 5%)	$ 35.00	

* In addition to charging the highest base fee in a multiple zoning application the highest sliding fee shall be charged for the total area included in a multiple zoning classification request, unless the applicant calculates and records on the zoning application form the specific number of acres for each zoning classification requested.

** Only one base fee (A-1, B-1, C-1) shall be charged for multiple zoning classification requests and it shall be the highest of the base fees per type of zoning requested.

*** The applicant shall be charged, in addition to the highest of the base fees, a sliding fee (A-2, B-2, C-2) for each acre of category requested, except the first five (5) acres of the highest category which has already been charged in the base fee.

NOTE: The above fees do not include the cost of publication notice and posting of signs. Publication notice shall be billed to the applicant.

Section 2. That the following fees shall be established for the Board of Adjustment:

Appeal from Building Inspector	$ 25.00
Minor Variances	$ 50.00
Other Variances of Bulk and Area	$ 75.00
Special Exception	$100.00

NOTE. The above fees do not include the cost of publication notice which shall be billed to the applicant.

Section 3. That the following fees shall be established for subdivision plats, lot splits, waiver of plat and change of access:

1. For each preliminary plat submitted.....$100.00

2. For each final plat submitted the following fees shall apply:
   (a) Base Fee, all plats, regardless of size or number of lots.....$100.00
   (b) Plus additional processing fees computed as follows:
   1 to 100 lots inclusive.....$1.00 per lot
   101 or more lots.....$ .25 per lot

3. The total maximum final fees for processing a subdivision plat shall not exceed $400.00, excluding the basic filing fees.

4. For each "lot-split" submitted the following fees shall apply:
   (a) Lot-splits which meet all Subdivision Regulations and Zoning Code as submitted.....$15.00
   (b) Lot-splits which require only a waiver of Subdivision Regulations subject to action by the Board of Adjustment on a Minor Variance, in accordance with the adopted policies of the Board of Adjustment.....$25.00
   (c) Lot-splits which require a waiver of Subdivision Regulations other than a Minor Variance as in (b) above or a combination thereof.....$50.00

5. Request to waiver platting requirements under Section 260 of Zoning Code.
   (a) Processing and application fee (staff review only).....$25.00
   (b) Processing and application fee (T.A.C. review).....$50.00

6. Request change of access on recorded plat approved by the City Council.*
   (a) Processing and application fee.....$50.00

*When change of access is required with a platting waiver, only one $50.00 fee is applicable.

Section 4. That the Earth Change Permit fees shall be established as follows:

(a) 1.0 acres or less.....$ 25.00
(b) 1.01 acres to 10.0 acres.....$ 75.00
(c) 10.01 acres and more.....$150.00

+25.00 application fee

Section 5. That Subdivision Inspection Fees shall be established as follows:

Water lines, sewer lines, storm sewers, detention facilities, sidewalks, streets, and other items pertaining to a subdivision. The developer will estimate the number of days to complete the project and will place in escrow, $50.00 per day plus $500.00, with the City to cover inspection costs at $50.00 per day.

Section 6. That all ordinances or parts of ordinances found to be in conflict herewith, are hereby repealed.

Section 7. That an emergency exists for the preservation of the public health, peace and safety, and therefore this ordinance shall become effective from and after the time of its passage and approval.

PASSED BY A VOTE OF 5-0 BY THE BIXBY CITY COUNCIL AND THE EMERGENCY CLAUSE RULED UPON SEPARATELY THIS 28TH DAY OF NOVEMBER, 1988.

MAYOR

ATTEST:

CITY CLERK

APPROVED AS TO FORM:

CITY ATTORNEY

PFPI Review Fee Schedule

Ordinance	Item Description	Fees	Total Cost
828	Water Lines:	$50.00 ea pg	$
828	Sanitary Sewer:	$50.00 ea pg	
	Offsite (if applicable)		$
	Onsite		$
828	Storm Sewer, Grading, Paving	$50.00 ea pg	$
828	Storm Sewer Review Fee (Janet Meshek)		$
776	Fee-In-Lieu (if applicable)	$0.20 per sq. ft. *or*	$
		$1800 per Acre as per CC	$
Excess Capacity (fees are based on location of property)			
834	Sec. 25, T18, R13		
	Residential	$500.00 per acre	$
	Commercial	$1500.00 per acre	$
Res. 1999-11	Sec. 9,10,15,16,17,20,21,22,27,28,29,32 – T17 R13		
	Residential – inside City limit	$500.00 per acre	$
	Residential – outside City limit	$1500.00 per acre	$
	Commercial – inside City limit	$1500.00 per acre	$
	Commercial – outside City limit	$4500.00 per acre	$
	(Note: Multi-family = commercial)		
833	Sec. 2, T17 R13		
	Residential	$400.00 per acre	$
	Commercial	$1200.00 per acre	$
833	Sec. 35, T18 R13		
	Residential	$400.00 per acre	$
	Commercial	$1200.00 per acre	$
	(Note: Multi-family = commercial)		
618	Construction Inspection Escrow		$5,000.00
		Total	$

CITY OF BIXBY
Private Financed Public Improvements Log

Project Name: _____

Date: _____ **PFPI NO.** _____

Plat Recorded Y_____ N_____ **Book/Page** _____

Description of Requirements	All Together	Grading *	Storm Sewer SD	Sanitary Sewer SS	Water W	Streets S
ODEQ Permits						
Urban Engineering Agreement						
Professional liability Insurance						
PFPI Plan Review Fee						
Developer's Contract						
Approved NOI filed with EPA						
Written Pollution Prevention Plan						
Earth Change Permit & Fees						
Developer's Security						
Irrevocable Letter of Credit						
Escrow Account						
Performance / Payment Bond						
Contractor's Performance Bond						
Contractor's Maintenance Bond						
Contractor's Statutory Bond						
Contractor's Certificates of Insurance						
Letter from Contractor confirming surety						
Letter from financial institution						
Application for PFPI permit						
Inspection Fee ($ 5,000)						

* The Detention Facility and Outlet Structure shall be a part of the Grading.