City of Siloam Springs, Arkansas
STORMWATER MANAGEMENT AND DRAINAGE MANUAL

adopted by

Siloam Springs Board of Directors

Ordinance No. 15-03

March 3, 2015

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1.0 GENERAL PROVISIONS

1.1 SHORT TITLE

This manual, together with all future changes and amendments, shall be known as the *Stormwater Management and Drainage Manual for Siloam Springs, Arkansas* (hereafter called CRITERIA).

1.2 JURISDICTION

These CRITERIA shall apply to all land within the incorporated areas and planning areas of the City of Siloam Springs (The City), including any public lands. These CRITERIA shall apply to all facilities constructed on City right-of-ways (ROW), easements dedicated for public use, and to all privately owned and maintained drainage facilities, including, but not limited to, detention facilities, storm sewers, inlets, manholes, culverts, swales, and channels; or as otherwise approved.

1.3 PURPOSE AND EFFECT

The purpose of these CRITERIA is to provide requirements and guidance necessary for developers and consultants to select, design and maintain drainage and flood control facilities. The ultimate goal of these CRITERIA is to protect the public health, safety and welfare of this community.

Presented in these CRITERIA are the **minimum** design and technical criteria for the analysis and design of storm drainage facilities. All new development or redevelopment projects, construction or grading projects, demolition, or any disturbance of existing ground surface shall comply with these CRITERIA. Hereinafter, such projects are referred to as "development." All such projects submitted for approval under the provisions of the City of Siloam Springs Zoning Code shall provide adequate analysis and design of drainage systems in accordance with these CRITERIA. Implementing facilities that go beyond the minimum is encouraged.

The presentation of drainage calculation methods within this manual assumes basic engineering knowledge related to hydrology and hydraulics. Consult the referenced documentation for complete theory descriptions and discussions.

The applicant may suggest alternatives to the provisions of these CRITERIA. The applicant shall have the burden of showing that the alternatives are equal or better. Drainage facilities in place or under construction at the time of CRITERIA adoption shall be accepted without regard to the provisions of these CRITERIA.

1.4 ENACTMENT AUTHORITY

Arkansas State floodplain management legislation, Chapter 268 *Flood Loss Prevention*, authorizes the City of Siloam Springs to "*enact, adopt, and enforce ordinances, building or zoning codes, or other appropriate measures regulating, restricting, or controlling the*

management and use of land, structures, and other developments in flood-prone area. The measures may require drainage and such other action as is feasible to minimize flooding and assure the adequacy of sewerage and water systems that may be affected by flooding."

Chapter 42, Article III of the Revised Municipal Code adopts the City of Siloam Springs Stormwater Management and Drainage Manual in its entirety as being the source of City policy, guidelines, criteria, and submittal requirements for drainage issues during subdivision and development processes.

1.5 AMENDMENT AND REVISIONS

These policies and criteria may be amended as new technology is developed and/or if experience gained through the use of these CRITERIA indicates a need for revision. Amendments and revisions will be made by the City Administrator and may be accompanied by revision to the Municipal Code as appropriate. It is the applicant's responsibility to check the Engineering page of Siloam Springs's website for amendments and revisions to these CRITERIA.
(http://siloamsprings.com/departments/engineering/index.php)

1.6 ENFORCEMENT RESPONSIBILITY

It shall be the duty of the City Administrator to enforce the provisions of these CRITERIA, in coordination with the Planning Commission and City Attorney, as appropriate.

1.7 REVIEW AND APPROVAL

Siloam Springs Engineering Department will review all drainage submittals for general compliance with these CRITERIA. An approval by Siloam Springs staff does not relieve the owner, engineer, or designer from responsibility for ensuring that the calculations, plans, specifications, construction and record drawings are in compliance with the CRITERIA and will accomplish the necessary or desired drainage objectives.

Submittals that impact Federal Emergency Management Agency (FEMA)-designated floodplains shall be submitted to FEMA for review.

The City may refer submittals to other agencies that have an interest or responsibility for drainage and/or water quality issues. Other review agencies may include federal and state agencies responsible for floodplains, water quality, wetlands, and other stormwater related issues, as well as other impacted jurisdictions.

1.8 INTERPRETATION

In the interpretation and application of the provisions of the CRITERIA, the following shall govern:

- The CRITERIA shall be regarded as the **minimum** requirements for the protection of the public health, safety and welfare of the residents of Siloam Springs.
- If other laws, ordinances, or regulations cover the same subject as these CRITERIA, the stricter standard shall apply.

- These CRITERIA shall not abrogate or annul any permits or approved drainage reports, construction plans, easements, or covenants issued before the effective date of these CRITERIA.

The City Administrator shall have final authority to resolve any conflicting interpretation of these CRITERIA.

1.9 RELATIONSHIP TO OTHER STANDARDS, PERMITS AND PLANS

Permits from other regulatory agencies may be required for some of the work covered by these CRITERIA. The property owner has the responsibility to apply for all other required permits. If the State or Federal Government imposes stricter criteria, standards, or requirements, these shall apply in addition to these CRITERIA.

1.10 WAIVERS AND VARIANCES

The Planning Commission may, at their sole discretion, waive or grant variances from requirements contained in these CRITERIA upon a finding of undue hardship and no significant deleterious effects to public health, safety and welfare. Variances from these CRITERIA will be considered on a case-by-case basis. Variance requests must be submitted to the City Administrator in writing, and at a minimum, must contain the following information:

1. Identify criteria for which a waiver or variance is requested.
2. Explain why the criteria cannot be met.
3. Define alternative standard(s) to meet the intent of the criteria.
4. Provide supporting documentation, necessary calculations and other relevant information supporting the request.
5. Sign and stamp the variance request by a licensed engineer in the State of Arkansas.

1.11 USE OF MODELING SOFTWARE AND DESIGN SPREADSHEETS

Computer software programs, models and spreadsheets are referenced in these CRITERIA as design aids that may be useful in designing drainage improvements. Use of these design aids is in no way a substitute for sound engineering judgment, proper engineering qualifications and common sense.

Although the design aids recommended in these CRITERIA have been developed using a high standard of care, it is likely that some nonconformities, defects, bugs, and errors with the software programs may be discovered as they become more widely used. The City of Siloam Springs does not warrant that any version of these design aids will be error free or applicable to all conditions encountered by the designer, and the City of Siloam Springs shall not be held liable for their use.

1.12 GLOSSARY

Unless specifically defined below, words or phrases shall be interpreted so as to give them the meaning they have in common usage and consistent with the words and phrases used in the Subdivision Regulations and stormwater management programs (e.g., Federal Emergency Management Agency [FEMA], Arkansas Department of Environmental Quality, and Arkansas State Highways and Transportation Department [AHTD]) and to give this Drainage Criteria Manual its most effective application. Words used in the singular shall include the plural, and the plural the singular; words used in the present tense shall include the future tense. The word "shall" connotes mandatory and not discretionary; the word "may" is permissive.

ABRASION - Wear or scour by hydraulic traffic.

ABSORPTION - The assimilation or taking up of water by soil.

AGGRADATION - General and progressive raising of the streambed by deposition of sediment.

ALLUVIAL - Referring to deposits of silts, sands, gravels and similar detritus material, which have been transported by running water.

ANTECEDENT MOISTURE - The degree of wetness of the soil at the beginning of a runoff period; frequently expressed as an index determined by summation of weighted daily rainfalls for a period preceding the runoff in question.

BACKWATER - The rise in water surface measured at a specified location upstream from the constriction causing the increased height.

BASE FLOOD - The flood or tide having a 1 percent chance of being exceeded in any given year (commonly known as a 100-year flood).

BASE FLOODPLAIN - The area subject to flooding by the base flood.

BED LOAD - Sediment that moves by rolling, sliding, or skipping along the bed and is essentially in contact with the streambed.

BUOYANCY - The power of supporting a floating body, including the tendency to float an empty pipe (by exterior hydraulic pressure).

COMPOSITE HYDROGRAPH - A plot of mean daily discharges for a number of years of record on a single year time base for the purpose of showing the occurrence of high and low flows.

CONDUIT - A pipe of other opening, buried or above ground for conveying hydraulic traffic, pipelines, cables or other utilities.

CONFLUENCE - A junction of streams.

CONTRACTION - The reduction in cross sectional area of flow.

CONVEYANCE - A measure of the water carrying capacity of a stream or channel.

CRITICAL FLOW - That flow in open channels at which the energy content of the fluid is at a minimum. Also, that flow which has a Froude number of one.

CULVERT - A conduit for conveying water through an embankment.

DEGRADATION - General and progressive lowering of the longitudinal profile of a channel by erosion.

DESIGN FLOOD - The peak discharge, volume if appropriate, stage or wave crest elevation of the flood associated with the probability of exceedance selected for the design of a roadway encroachment. By definition, the roadway will not be inundated from the stage of the design flood.

DETENTION - The slowing, dampening, or attenuating of flows either entering the sewer system or surface drainage by temporarily holding the water on a surface area, in a storage basin, or within the sewer.

DETENTION BASIN POND - An open excavation or depression in the ground surface used for temporary storage of storm water prior to release downstream.

DEVELOPER – Any person or entity proposing building or land improvements.

DEVELOPMENT – Any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations.

DRAINAGE AREA – All land area that contributes runoff to the same discharge point.

DRAINAGE BASIN – All land area contributing to a given discharge point in terms of drainage.

ENCROACHMENT - Extending beyond the original, or customary limits, such as by occupancy of the river and/or floodplain by earth fill embankment. An action within the limits of the base floodplain.

ENERGY GRADE LINE - The line that represents the total energy gradient along the channel. It is established by adding together the potential energy expressed as the water surface elevation referenced to a datum and the kinetic energy (usually expressed as velocity head) at points along the flowing water.

ENERGY HEAD - The elevation of the hydraulic gradient at any section, plus the velocity head.

ENGINEER – A person who is a registered professional engineer in the State of Arkansas.

EQUALIZER - A culvert placed where there is no channel but where it is desirable to have standing water at equal elevations on both sides of a fill.

FLOOD FREQUENCY - Also referred to as exceedance interval, recurrence interval or return period; the average time interval between actual occurrences of a hydrological event of a given or greater magnitude; the percent chance of occurrence is the reciprocal of flood frequency, e.g., a 2 percent chance flood is the reciprocal statement of a 50-year flood.

FLOODPLAIN - Normally dry land areas subject to periodic temporary inundation by stream flow. Land formed by deposition of sediment by water; alluvial land.

FLOODPROOF - To design and construct individual buildings, facilities, and their sites to protect against structural failure, to keep water out or to reduce the effects of water entry.

FLOW, CRITICAL - That flow in open channels at which the energy content of the fluid is at a minimum. Also, that flow which has a Froude number of one.

FLOW, SUBCRITICAL - In this state, gravity forces are dominant, so that the flow has a low velocity and is often described as tranquil and streaming. Also, that flow which has a Froude number less than one.

FLOW, SUPERCRITICAL - In this state, inertia forces are dominant, so that flow has a high velocity and is usually described as rapid, shooting and torrential. Also, that flow which has a Froude number greater than one.

FLOW REGIME. The system or order characteristic of stream flow with respect to velocity, depth and specific energy.

FREEBOARD - The vertical clearance of the lowest structural member of the bridge superstructure above the water surface elevation of the overtopping flood; the vertical distance between the level of the water surface usually corresponding to the design flow and a point of interest such as a levee top or specific location on the roadway grade.

FREE OUTLET - (as pertaining to critical flow) - Exists when the backwater does not diminish the discharge of a conduit.

FRENCH DRAIN - An underground passageway for water through interstices among stones placed loosely in a trench.

FROUDE NUMBER - A dimensionless expression of the ratio of inertia forces to gravity forces, used as an index to characterize the type of flow in a hydraulic structure in which gravity is the force producing motion and inertia is the resisting force. It is equal to a characteristic flow velocity (mean, surface, or maximum) of the system divided by the square root of the product of a characteristic dimension (as diameter or depth) and the gravity constant (acceleration due to gravity) all expressed in consistent units. $F_r = V/(gy)^{0.5}$

GAGING STATION - A location on a stream where measurements of stage or discharge are customarily made. The location includes a reach of channel through which the flow is uniform, a control downstream from this reach and usually a small building to house the recording instruments.

GRADUALLY VARIED FLOW - In this type of flow, changes in depth and velocity take place slowly over large distances, resistance to flow dominates and acceleration forces are neglected.

GROUNDWATER - Subsurface water occupying the saturation zone, from which wells and springs are fed. In a strict sense the term applies only to water below the water table.

GROUNDWATER RECHARGE - Water descending to the zone of saturation from the atmosphere which gravitates to the zone of saturation under natural conditions or which is added to the zone of saturation by infiltration of storm water using subsurface disposal systems as defined herein.

GROUNDWATER TABLE - (or level) - Upper surface of the zone of saturation in permeable rock or soil. (When the upper surface is confined by impermeable rock, the water table is absent.)

HEAD - The energy, either kinetic or potential, possessed by each unit weight of a liquid expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed.

HYDRAULIC RADIUS - The cross-sectional area of a stream of water divided by the length of that part of its periphery in contact with its containing conduits; the ratio of area to wetted perimeter.

HYDROGRAPH - A graph of stage or discharge versus time.

HYETOGRAPH – A graph of rainfall versus time.

IMPERVIOUS - Not allowing, or allowing only with great difficulty, the movement of water; impermeable. Completely resisting entrance of fluids.

INFILTRATION - The passage of water through the soil surface into the ground. Normally used interchangeably with the word percolation.

INLET TIME - The time required for storm runoff to flow from the most remote point of a drainage area to the point where it enters a drain or culvert.

INVERT - That part of a pipe or sewer below the spring line - generally the lowest point of the internal cross section.

MEANDER - In connection with streams, a winding channel usually in an erodible, alluvial valley. A reverse of S-shaped curve or series of curves formed by erosion of the concave bank, especially at the downstream end, characterized by curved flow and alternating shoals and bank erosion. Meandering is a stage in the migratory movement of the channel as a whole down the valley.

NATIONAL GEODETIC VERTICAL DATUM of 1929 shall mean NGVD 29 for vertical control data (ground, structure, and flood elevations).

NATURAL AND BENEFICIAL FLOODPLAIN VALUES - Include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, and groundwater recharge.

NONUNIFORM FLOW - A flow in which the velocities vary from point to point along the stream or conduit, due to variations in cross section, slope, etc.

NORMAL WATER SURFACE (NATURAL WATER SURFACE) - The free surface associated with flow in natural streams.

NORTH AMERICAN VERTICAL DATUM of 1988 shall mean NAVD 88 for vertical control data based on the mass or density of the Earth instead of the varying values of the heights of the seas used to establish the NGVD.

OPEN CHANNEL - Any conveyance in which water flows with a free surface.

OUTFALL (or outlet) - In hydraulics, the discharge end of drains and sewers.

PERMEABILITY - The property of a material that permits appreciable movement of water through it when it is saturated and movement is actuated by hydrostatic pressure of the magnitude normally encountered in natural subsurface water.

PERVIOUS SOIL - Soil containing voids through which water will move under ordinary hydrostatic pressure.

PONDING - Refers to water backed up in a channel or ditch as the result of a culvert of inadequate capacity or design to permit the water to flow unrestricted.

PRACTICABLE - Capable of being done within reasonable natural, social, or economic constraints.

RAINFALL INTENSITY - Amount of rainfall occurring in a unit of time, converted to its equivalent in inches per hour at the same rate.

RAPIDLY VARIED FLOW - In this type of flow, changes in depth and velocity take place over short distances, acceleration forces dominate, and energy loss due to friction is minor.

REACH - A length of stream channel.

RECHARGE - Addition of water to the zone of saturation from precipitation or infiltration.

RECHARGE BASIN - A basin excavated in the earth to receive the discharge from streams or storm drains for the purpose of replenishing groundwater supply.

REGULATORY FLOODWAY - The floodplain area that is reserved in an open manner by Federal, State of local requirements, i.e., unconfined or unobstructed either horizontally or vertically, to provide for the discharge of the base flood so that the cumulative increase in water surface elevation is no more than a designated amount (not to exceed 1 foot as established by the Federal Emergency Management Agency (FEMA) for administering the National Flood Insurance Program).

RESTORE - To reestablish a setting or environment in which the functions of the natural and beneficial floodplain values adversely impacted by the development or improvements can again operate.

RETENTION - The prevention of runoff from entering the sewer system by storing it on a surface area or in a storage basin.

RETENTION BASIN POND - A man-made depression or impoundment or retain surface runoff waters.

RISK - The consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the street.

RISK ANALYSIS - An economic comparison of design alternatives using expected total costs (construction costs plus risk costs) to determine the alternative with the least total expected cost to

the public. It shall include probable flood-related costs during the service life of the facility for street operation, maintenance, and repair, for street-aggravated flood damage to other property, and for additional or interrupted street travel.

ROUGHNESS COEFFICIENT - A factor in the Kutter, Manning, and other flow formulas representing the effect of channel (or conduit) roughness upon energy losses in the flowing water.

RUNOFF - That part of the precipitation that runs off the surface of a drainage area and reaches a stream or other body of water or a drain or sewer.

SCOUR - The result of erosive action of running water, primarily in streams, excavating and carrying away material from the bed and banks.

SCOUR, GENERAL - The removal of material from the bed and banks across all or most of the width of a channel, as a result of a flow contraction that causes increased velocities and bed shear stress. Also known as CONTRACTION SCOUR.

SCOUR, LOCAL - Removal of material from the channel bed or banks which is restricted to a minor part of the width of a channel. This scour occurs around piers and embankments and is caused by the actions of vortex systems induced by the obstructions to the flow.

SCOUR, NATURAL - Removal of material from the channel bed or banks that occurs in streams with the migration of bed forms, shifting of the thalweg and at bends and natural contractions.

SEDIMENT - Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited by water.

SEDIMENTATION BASIN - A basin or tank in which storm water containing settleable solids is retained to remove by gravity a part of the suspended matter.

SIGNIFICANT ENCROACHMENT - A street encroachment and any direct support of likely base floodplain development that would involve one or more of the following construction - or flood-related impacts:

(1) a significant potential for interruption or termination of a transportation facility that is needed for emergency vehicles or provides a community's only evacuation route,

(2) a significant risk, or

(3) a significant adverse impact on natural and beneficial floodplain values.

SIPHON - (inverted) - A conduit or culvert with a U or V shaped grade line to permit it to pass under an intersecting roadway, stream or other obstruction.

SPECIFIC ENERGY - The energy contained in a stream of water, expressed in terms of head, referred to the bed of a stream. It is equal to the mean depth of water plus the velocity head of the mean velocity.

SPILLWAY - A low-level passage serving a dam or reservoir through which surplus water may be discharged; usually an open ditch around the end of a dam, or a gateway or a pipe in a dam. --An outlet pipe, flume or channel serving to discharge water from a ditch, ditch check, gutter or embankment protector.

STAGE - The elevation of a water surface above a datum of reference.

STEADYFLOW - A flow in which the flow rate or quantity of fluid passing a given point per unit of time remains constant.

STORAGE BASIN - A basin excavated in the earth for detention or retention of water for future flow.

SUBCRITICAL FLOW - Flow with a Froude number less than one. In this state the role played by gravity forces is more pronounced, so the flow has a low velocity and is often described as tranquil and streaming.

SUPERCRITICAL FLOW - Flow with a Froude number greater than one. In this state, the inertia forces become dominant, so the flow has a high velocity and is usually described as rapid, shooting and torrential.

SUPPORT BASE FLOODPLAIN DEVELOPMENT - To encourage, allow, serve, or otherwise facilitate additional base floodplain-development. Direct support results from an encroachment, while indirect support results from an action out of the base floodplain.

SURFACE STORAGE - Storm water that is contained in surface depressions or basins.

SURFACE WATER - Water appearing on the surface in a diffused state, with no permanent source of supply or regular course for a considerable time; as distinguished from water appearing in water courses, lakes, or ponds.

SWALE - A slight depression in the ground surface where water collects.

SYNTHETIC HYDROGRAPH - A graph developed for an ungaged drainage area, based on known physical characteristics of the watershed basin.

TIME OF CONCENTRATION - Time required for storm water runoff to arrive at the point of concentration (usually the inlet to the storm drain) from the most remote point of the drainage area.

TAILWATER - The water surface just downstream from a structure.

UNIFORM FLOW - Flow in which the velocities are the same in both magnitude and direction from point to point along the stream or conduit, all stream lines being parallel.

UNSTEADY FLOW - A flow in which the velocity changes with respect to both space and time.

UNIT HYDROGRAPH - A hydrograph of a direct runoff resulting from 1 inch of effective rainfall generated uniformly over the watershed area during a specified period of time or duration.

WATER COURSE - A natural or artificial channel in which a flow of water occurs, either continuously or intermittently. Natural watercourses may be either on the surface or underground.

WATERSHED - Region or area contributing to the supply of a stream or lake; drainage area, drainage basin, catchment area.

WETTED PERIMETER - The length of the wetted contact between the water and the containing conduit (measured along a plane at right angles to the conduit).

2.0 DRAINAGE SUBMITTAL REQUIREMENTS

2.1 INTRODUCTION

The requirements presented in this section shall be used to aid the design engineer or applicant in the preparation of drainage reports and construction drawings for drainage facilities. The requirements presented are the minimum necessary and will be used to determine the adequacy of all submittals to the City.

2.2 REVIEW PROCESS

All development and redevelopment projects in Siloam Springs's jurisdiction that are required to submit drainage reports, construction drawings, specifications and as-constructed information, shall do so in conformance with the requirements of these CRITERIA. Complete submittal requirements (Application, General Notes, Permit, etc.) can be found on the Engineering Department website.
(http://siloamsprings.com/departments/engineering/index.php).

2.2.1 SUBDIVISION PROCESS

The general requirements and conditions for the subdivision of land in Siloam Springs are set forth in Chapter 42 of the Revised Municipal Code. Reference the Subdivision Rules and Regulations for standards and procedures for the review and approval of subdivision plats.

A pre-preliminary Drainage Plan review conference is recommended prior to submittal for the purpose of overall general drainage concept review. The applicant may consult with City staff for general information regarding regulations, required procedures, possible drainage problems, and specific submittal requirements for projects.

A Preliminary Drainage Report and Drainage Plan shall be required at the time of the Preliminary Plat submittal and may be required for a replat, lot split, significant development, or building and/or development improvements. If needed, a review meeting will be scheduled by the City staff with representatives of the developer, including the Engineer, to review the overall concepts included in the Preliminary Drainage Plan. The purpose of this review shall be to jointly agree upon an overall drainage concept for the proposed development and to review criteria and design parameters that shall apply to the final design of permanent stormwater management practices of the project.

Either City Staff or the Planning Commission may request a more detailed drainage study prior to the Preliminary Plat approval.

The Final Drainage Plan shall be submitted at the time construction drawings are submitted for approval

Two sets of plans and specifications for the proposed improvements will be submitted in the following format during the platting process, where pertinent, and shall include:

(1) Title Sheet,
(2) General Layout Sheet,
(3) Right-of-Way Sheet,
(4) Plan and Profile Sheet(s),
(5) Standard and Special Detail Sheets, and
(6) Drainage Area Map.

If hydrologic and hydraulic studies reveal that the proposed development would cause increased frequency of flooding, increased depth of inundation of structures, or inundation of unprotected structures not previously subject to inundation, then the construction permit application shall be denied unless one or more of the following mitigation measures are approved by the City:

(1) onsite detention or retention storage,

(2) offsite detention storage, or

(3) improvements to the drainage system.

If it is determined that offsite drainage improvements are required, then cost sharing will be subject to City Board of Directors approval.

2.2.2 PERMIT PROCESS

Any structure or other development which requires a building permit under the Siloam Springs Building Code may also require a Grading/Paving Permit to be issued by the Engineering Department. No building permits or subdivision approvals shall be issued until and unless the Stormwater Management Drainage Plans have been approved by the City of Siloam Springs.

2.2.3 REVIEW BY REFERRAL AGENCIES

Review and approval of the Plan by the City is not intended to modify or replace the Developers/Owners/Contractors responsibility to submit and satisfy the Arkansas Department of Environmental Quality NPDES general permit requirements for stormwater discharges associated with construction activity. The review and approval by others, such as state or federal agencies, other local governments, affected jurisdictions, and other referral agencies may be required for some submittals. The applicant shall be required to address referral agency comments and obtain approvals when necessary.

2.2.4 STAND-ALONE DRAINAGE REPORT

The drainage report shall be a stand-alone document. When references are made or assumptions are based on previously approved submitted reports, the drainage

report must include the appropriate excerpts, pages, tables, and maps containing the referenced information.

Assumptions made in previous reports must be verified and substantiated. All submitted reports should be clearly and cleanly reproduced. Photocopies of charts, tables, nomographs, calculations, or any other referenced material must be legible.

2.2.6 SUBMITTAL ADEQUACY

The submittal checklist provided with application and the requirements specified in Sections 2.4 through 2.6 will be used by City staff to determine the adequacy of the submittal. Incomplete or absent information may result in the report being returned to the author without review. The City reserves the right to require additional information with any submittal.

2.3 ACCEPTANCE

Acceptance of a Final Drainage report, Drainage Plan and construction drawings must be obtained prior to construction of any drainage improvements within the City.

The approval of a Final Drainage Report based on submitted documents and information shall not prevent the Engineering Department from requiring the correction of errors.

2.4 PRELIMINARY DRAINAGE REPORT

A Preliminary Drainage Report will be required if it is determined during the development review process that the project is large, complex or unusual drainage conditions are present. The preliminary report may also be submitted at the developer's request. Two copies of the preliminary drainage report, prepared and signed by a professional engineer licensed in the State of Arkansas, shall be submitted to the Engineering Department for review.

2.4.1 PRELIMINARY DRAINAGE REPORT CONTENTS

The purpose of the Preliminary Drainage Report is to conceptually define the nature of the proposed development or project, describe all existing conditions and propose facilities needed to conform to the requirements of these CRITERIA.

The following is an outline of the minimum Preliminary Drainage Report requirements: (Note: The City reserves the right to require additional information with any submittal.)

1. General Location and Description
   - 1.1. Location
     - 1.1.1. City, county, state highway and local streets within and adjacent to the site or the area to be served by the drainage improvements.
     - 1.1.2. Township, range, section, ¼ section, subdivision, lot and block, address (if appropriate).
     - 1.1.3. Names of surrounding developments.

1.2. Description of Property
   1.2.1. General project description, including proposed land use
   1.2.2. Area in acres.
   1.2.3. Ground cover (type of trees, shrubs, vegetation, hydrologic soil group, topography and slope).
   1.2.4. Major drainageways and drainage facilities.
   1.2.5. History of flooding.
   1.2.6. Easements within and adjacent to the site.

2. Major Drainage Basins and Sub-basins
   2.1. Major Basin Description
      2.1.1. Reference to major drainageway planning studies such as flood hazard area delineation (FHAD) reports, major drainageway master planning reports and flood insurance rate maps (FIRMs); include a copy of current FIRM showing the location of subject property.
      2.1.2. Major basin drainage characteristics, existing and planned land uses within the basin, as defined by the Planning.

   2.2. Sub-basin Description
      2.2.1. Historic drainage patterns of the property in question.
      2.2.2. Onsite and offsite sub-basin characteristics.

3. Drainage Facility Design
   3.1. General Concept
      3.1.1. Drainage concept and typical drainage patterns.
      3.1.2. Compliance with offsite runoff considerations.
      3.1.3. Anticipated and proposed drainage patterns.
      3.1.4. Content of tables, charts, figures, or drawings presented in the report.

   3.2. Specific Details
      3.2.1. Flows, volumes and water quality capture volumes (WQCV).
      3.2.2. Existing stormwater conveyance and storage facilities.
      3.2.3. Proposed stormwater conveyances, storage facilities and outlet structures.
      3.2.4. Relationship to both upstream and downstream properties and impact of the development's drainage on these properties; include discussion of offsite drainage flow patterns and impact on development under existing and fully developed basin conditions as defined by the Engineering Department Division.
      3.2.5. Drainage problems encountered and solutions at specific design points.
      3.2.6. Maintenance (whose responsibility and frequency), public safety and access aspects of the drainage facilities.
      3.2.7. Compliance with other local, state and federal requirements.
      3.2.8. Structural and non-structural best management practices (BMPs) that will be part of drainage design.

3.2.9. When deemed necessary by the Review Engineer, electronic update to the Siloam Springs Drainage Master Plan in a format specified by the Review Engineer.

4. Conclusions
   4.1. Compliance with Standards
      4.1.1. CRITERIA.
      4.1.2. Major Drainageway Planning Studies.
      4.1.3. Water Quality Requirements.
      4.1.4. Justification for any requested waiver.

   4.2. Drainage Concept
      4.2.1. Effectiveness of drainage design to control damage from storm runoff.
      4.2.2. Influence of proposed development on master drainage plan recommendation(s).
      4.2.3. Drainage impacts of proposed development on upstream and downstream properties.

   4.3. Water Quality
      4.3.1. BMP Measures implemented for water quality.

5. References
   Reference all criteria, master plans, and technical information used in support of concept. The Preliminary Design Report must be a stand-alone document including portions of relevant documents referenced in the report. This supporting information may be included in an appendix.

6. Appendices
   Appendices should be provided, as needed, to provide supporting information for the report.

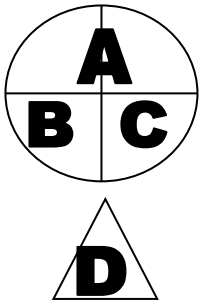
2.4.2 PRELIMINARY DRAINAGE PLAN CONTENTS

1. Overall Drainage Plan
   - 24” X 36” in size.
   - Title block, legend, P.E. stamp, North arrow, flow arrow, scale.
   - Basis of Bearing and Benchmark Datum (If Arkansas State Plain Coordinates are not used, survey data must be tied to 2 known City Benchmarks.)
   - Boundaries of entire development or project.
   - Limits of all major basins, including offsite basins.
   - General drainage patterns and flow paths, including those entering and leaving the site.
   - Any existing or proposed major drainage facilities, upstream, downstream or within the site.

2. Detailed Drainage Plan
   - 24” X 36” in size at a scale of 1” = 20’ to 1”= 100’.

- Include North arrow, scale, benchmark, and flow arrow.
- Legend to define map symbols. See Table 2.1 (at the end of this section).
- Project name, address, engineering firm and seal, and date in title block.
- Existing (dashed or screened) and proposed (solid) contours (use NAVD 88 Datum) with a 2-foot maximum interval. The contours must extend a minimum of 100 feet beyond property lines.
- All existing and proposed drainage facilities (e.g., detention facilities, storm sewers, swales, riprap, outlet structures, irrigation ditches, culverts, cross pans).
- Floodplain boundary based on the most current information (FHAD, master plan, FIRM, etc.).
- Major basin and sub-basin boundaries.
- Any offsite feature or basin influencing development.
- Runoff summary table. See Table 2.1 (at the end of this section).
- Detention basin summary table. See Table 2.2 (at the end of this section).
- Location and footprints of detention facilities.

Figure 2.1 - Runoff Summary Table



A = Basin ID

B = Basin Area (acres)

C = % Impervious

D = Design Point Designation

SUMMARY RUNOFF TABLE
(to be placed on Drainage Plan

Design Point	Contributing Basin ID's	Contributing Area (acres)	Minor Storm (10-yr) Flow (cfs)	Major Storm (100-yr) Flow (cfs)
x	xx / xx / xx	xx.xx	xx.x	xx.x

Figure 2.2 - Detention Summary Table

	Water Surface Elevation (ft)	Volume (cf or Ac-ft)	Controlled Release Rate (cfs)
Water Quality Capture Volume (WQCV)			
10-Yr			
100-Yr			

2.5 FINAL DRAINAGE REPORT

Following the preliminary Drainage Plan review, the final Drainage Plan shall be prepared for each phase of the proposed project as each phase is developed. The final plan shall constitute a refinement of the concepts approved in the preliminary Drainage and Drainage Report, with preparation and submittal of detailed design information as required in the Criteria. This plan shall be submitted at the time construction drawings are submitted for approval.

Reports shall be typed and bound on 8½" X 11" paper with all pages numbered. The report shall include a cover letter presenting the design for review.

2.5.1 CERTIFICATION STATEMENT

The report shall contain a certification page with the following statement:

"I, _____, Registered Professional Engineer No. _____ in the State of Arkansas, hereby certify that the drainage studies, reports, calculations, designs, and specifications contained in this report have been prepared in accordance with the requirements of the City of Siloam Springs, Arkansas, the Professional Engineers Registration Act of the State of Arkansas, and reflect the application of generally accepted standard of engineering practice. Further, I hereby acknowledge that the review of the drainage studies, reports, calculations, designs, and specifications by the City of Siloam Springs or its representatives cannot and does not relieve me from any professional responsibility or liability."

By: _____
Licensed Professional Engineer

Affix Seal

2.5.2 FINAL DRAINAGE REPORT CONTENTS

The report shall be in accordance with, but not limited to, the following outline and contain the applicable information listed below. The City reserves the right to require additional information with any submittal.

1. General Location and Description. See Section 2.4.1, #1
2. Major Drainage Basins and Sub-basins. See Section 2.4.1, #2

3. Drainage Design Criteria
   3.1. Regulations: Discuss optional provisions selected or deviation from the CRITERIA, if any, and their justification.

   3.2. Development Criteria References and Constraints.
      3.2.1. Previous drainage studies (e.g., project master plans, outfall system plans, Siloam Springs Drainage Master Plan) for the site that influence, or are influenced by, the proposed drainage

design and how the studies will affect drainage design for the site.

3.2.2. Relationship to and implications of adjacent drainage studies.

3.2.3. Drainage impact of site constraints such as streets, utilities, transit ways, existing structures, and development or site plans.

3.3. Hydrologic Criteria

3.3.1. Design rainfall.

3.3.2. Hydrologic soil group.

3.3.3. Runoff calculation method(s).

3.3.4. Detention discharge and storage calculation method.

3.3.5. Design storm recurrence intervals.

3.3.6. Justification for other criteria or calculation methods used that are not presented in or referenced by the CRITERIA.

3.4. Hydraulic Criteria

3.4.1. Various capacity methods.

3.4.2. Hydraulic grade line (HGL) calculation method and head loss coefficients.

3.4.3. Routing method used.

3.4.4. Other drainage facility design criteria used that are not presented in the CRITERIA.

3.5. Water Quality Requirements

3.5.1. Design procedures and WQCV for the site.

3.5.2. Permanent, post-construction best management practices (BMPs) for treatment of the WQCV.

3.5.3. Landscaping requirements.

3.5.4. Maintenance requirements for BMPs.

3.6. Waivers from Criteria

3.6.1. Provisions by section number for which a waiver is requested.

3.6.2. Justification for each waiver requested.

4. Drainage Facility Design

4.1. General Concept. See Section 2.4.1, #3 (A).

4.2. Specific Details. See Section 2.4.1, #3 (B) and in addition include:

4.2.1. Easements and tracts for drainage purposes, including the conditions and limitations for use.

4.2.2. All structural and non-structural BMPs, including tributary areas, sizing, treatment volumes, design features, etc.

5. Conclusions. See Section 2.4.1, #4.

6. References

Reference all criteria and technical information used. The final report must be a stand-alone document including portions of relevant documents referenced in the report. This supporting information may be included as an appendix.

7. Appendices
   7.1. Hydrologic Computations
      - Land use assumptions regarding adjacent properties.
      - Time of concentration and runoff coefficients for each basin.
      - Minor and major storm runoff at specific design points.
      - Connectivity diagram showing relationship/connectivity of basins, conveyance facilities, detention basins and design points.
      - Electronic copy and hard copy of input/output listings for computer models used.
   7.2. Hydraulic Computations
      - Street capacity as compared to allowable capacity.
      - Inlet capacity as compared to allowable capacity.
      - Storm sewer capacity, including HGL elevations and head loss coefficients.
      - Energy grade line (EGL) when the storm sewer is designed for events higher than the minor event or is requested by the Engineering Department Review Engineer.
      - Open channel design, low flow and trickle channel design, stabilization and grade control improvements.
      - Energy dissipation at pipe outlets.
      - Water surface profiles.
      - Culvert capacities.
      - Stage-Storage-Discharge determination for detention basins.
      - Downstream/outfall system capacity of the major drainageway.
      - Charts, figures and tables related to hydraulic computations.
      - Electronic and hard copy of input/output listings for computer models used.
   7.3. Water Quality Enhancement BMPs
      - Design and sizing.
      - Charts, figures, tables, and details related to design.
   7.4. Excerpts from supporting documents, if referenced in report.

2.5.3 FINAL DRAINAGE PLAN CONTENTS

1. Overall Drainage Plan. See Section 2.4.2, #1
2. Detailed Drainage Plan. See Section 2.4.2, #2 and in addition include:
   2.1. Property lines and easements with purposes noted.
   2.2. Adjacent developments or property ownerships.
   2.3. Street cross-section indicating ROW width, flow-line width, cross slope, sidewalk, and curb type.
   2.4. Street slope and flow direction and cross-pan.
   2.5. Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances, including riprap protection.
   2.6. Proposed outfalls or exit points for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.
   2.7. Finished floor elevation of proposed and existing structures.

2.8. Proposed detention basin grading and detention basin outlet schematic, include overflow directions and amounts and emergency spillway.
2.9. Water quality enhancement BMPs schematic.

2.6 CONSTRUCTION DRAWINGS

2.6.1 IMPROVEMENT REQUIREMENTS

Drainage improvements within the City are required to be designed, constructed and accepted in accordance with Siloam Springs' standards and criteria. Construction plans are required to be approved by the Engineering Department for all facilities within the City. The plans may also be subject to review by outside agencies such as Federal Emergency Management Agency (FEMA), U.S. Army Corps of Engineers, U.S. Environmental Protection Agency or others as required. The approval of construction plans based on submitted documents and information shall not prevent the City Engineer from requiring correction of errors.

Because all plans, specifications, and calculations are retained by the City for use as permanent records, neatness, clarity, and completeness are very important, and lack of these qualities will be considered sufficient basis for submittal rejection.

On combination roadway-drainage projects, it is not the intent that completely separate storm drainage plans be prepared. Where the required details of the proposed storm drainage system can adequately be shown on the roadway plans without sacrificing clarity, the roadway plans will be sufficient. If a combined project submittal is made for review of only roadway or only storm drainage aspects of the project, this fact shall be clearly indicated in large, bold lettering on the Title Sheet.

2.6.2 CERTIFICATION

Construction drawings and Specifications submitted for review and acceptance shall be prepared by a professional engineer licensed in the State of Arkansas.

2.6.3 CONSTRUCTION PLAN REQUIREMENTS

Plan sheet size will be 24" x 36" with all sheets in a given set of plans the same size. Larger sheets may be used with approval by the City on a case-by-case basis. Suggested sheet scales are provided below. Special cases may warrant use of larger or smaller scale drawings for increased clarity or conciseness of the plans and may be used with prior permission of the City Engineer.

Each sheet in a set of Plans shall contain a sheet number, the total number of sheets in the Plans, proper project identification, and the date. Revised sheets submitted must contain a revision block with identifying notations and dates for revisions.

It shall be understood that the requirements outlined in these standards are only minimum requirements and shall only be applied when conditions, design criteria, and materials conform to the City Specifications. When unusual subsoil or drainage conditions are suspected, an investigation should be made and a special design prepared in line with good engineering practice. The City reserves the right to require additional information with any submittal.

1. General Information Required for All Drainage Improvement Projects
   1.1. Cover sheet
      - Project Title, legal description, the name, city, county and state.
      - City assigned development project number.
      - Vicinity map.
      - Professional engineer certification.
      - Title block, sheet index.
      - The name, address, and telephone number of the owner of the project and the name, address, and telephone number of the engineer preparing the plans.
      - Basis of Bearing and Benchmark Datum - Arkansas State Plain coordinates
      - Unplatted tracts should have an accurate tie to at least one-quarter section corner.
      - "One-Call" number will be noted on plans
      - Siloam Springs standard notes
        (see City of Siloam Springs Engineering Department website (http://siloamsprings.com/departments/engineering/index.php) for the most current version).
   1.2. Overall utility plan showing water, sanitary and storm sewer facilities.
      - Name, location, and size of each utility within or adjacent to the project area.
   1.3. Grading plan (Use NAVD 88 Datum).
      - Plan drawings will be prepared with a max horizontal scale of 1" = 50'.
      - The water surface elevation (WSE) resulting from the 100-year storm for all overland flow, including flow in the streets, parking lots, swales and between lots shall be calculated and shown on the construction drawings and the final plat.
      - Minimum floor elevation shall be shown a minimum of 2-feet above the 100-year flood elevation on each lot when located in a designated FEMA floodplain and in areas where flooding is known to occur. Minimum floor elevations for other areas shall be a minimum of 1-foot above the calculated 100-year WSE of open channels, swales, or overland flow.

- Top of curb elevations will be noted at every inlet or drainage structure along the street. Top of inlet or structures elevations will be on all structures not adjacent to the curb.

1.4. Erosion and sedimentation control plan (refer to Chapter 15).

1.5. Basic information.

- Property and right-of-way lines, existing and proposed easements, tracts, structures, fences, and other land features.
- Relation of site to current floodplain boundaries.
- Maintenance access.
- Utilities adjacent to or crossing drainage facilities.
- Additional design details as required.

2. Specific Design Feature Information

2.1. Storm Sewers and Culverts

- Plan and profile of proposed pipe installations, inlets, manholes, junction boxes and outlet structures with pertinent elevations, dimensions, types, designs and pipe full flow rates and horizontal controls shown. Plan and profile shall be included on same sheet.
- Minor storm HGLs.
- Major storm HGLs – indicate inlet bypass flows.
- Pipe outlet protection on plan and profile views.
- Utilities adjacent to or crossing storm sewer or culvert alignment in plan and profile.
- Suggested horizontal scale of 1" = 20', with a maximum scale of 1" = 50' and a minimum vertical scale of 1" = 5'.
- Scale, minimum, grading details for all pipe and culvert inlets and outlets.

2.2. Detention/Storage Facilities

- Detention basin grading, trickle channel, inlet, outlet, and emergency overflow spillway locations.
- Detention facility summary, Table 2.2 (at the end of Section 2.4.2).
- Forebay, trickle channel and outlet construction details, including safety features, such as trash racks at openings.
- Finished floor of structures adjacent to detention basins.

2.3. Open Channels, Swales, Channel Stabilization

- Plan view showing horizontal locations of existing and proposed channels and swales, including locations of grade control structures and stabilization measures, such as check structures, drop structures, toe protection, bank stabilization, low-flow or trickle channels, with appropriate horizontal controls, safety features, etc.
- Profile along channel alignment with all invert elevations and top-of-channel bank elevations and design flow rates.
- Suggested horizontal scale of 1" = 20', with a maximum scale of 1" = 50' and a minimum vertical scale of 1" = 5'.
- Water surface limits in plan view.

- Water surface profiles for the minor and major storms.
- Side tributary channels and pipe outlets.

2.4. Water Quality Enhancement BMPs

- Plan and profile of improvements as required.
- Design details as required.

2.7 AS-BUILT DRAWINGS AND CERTIFICATIONS

As-Built drawings shall be submitted upon completion of construction. One bond copy, pdf plots and the AutoCAD files saved to a version no later than release 2013 are required for archiving with City records.

Certifications of the as-built drawings are required as follows:

- Licensed Professional Engineer: The responsible design engineer shall submit as-built drawings and all necessary approvals from all other required entities (e.g., FEMA approval for floodplain, etc.) will be required prior to the signing of a Certificate of Occupancy.

- Licensed Land Surveyor: A licensed land surveyor in the State of Arkansas may certify the as-built detention basin volumes and outlet structure sizes and elevations, storm sewer sizes and invert elevations at inlets, manholes and discharge locations, longitudinal slopes and representative cross sections of open channels and dimensions of drainage structures.

3.0 DRAINAGE POLICY

3.1 INTRODUCTION

Providing adequate drainage in urban areas is necessary to preserve and promote the general health, safety and welfare of the community. Underlying principles provide direction when planning for development drainage. These principles are made operational through policy statements.

The implementation of the policy is, in turn, facilitated by technical criteria and data as contained within these CRITERIA. A brief discussion of the key drainage principles these CRITERIA are based on is provided, followed by Siloam Springs' drainage design policies.

3.2 PRINCIPLES

The following principles of urban drainage are identified as the foundation of drainage design concepts within the City of Siloam Springs.

3.2.1 LEGAL

The natural flow of water follows the laws of nature irrespective of legal property lines and jurisdictional boundaries. Legal precedence and agreeable resolutions to conflicts related to property ownership rights should be respected related to stormwater runoff.

Excerpts from FHWA HEC-22

The Civil Law Rule of Natural Drainage *is based upon the perpetuation of natural drainage. "... every landowner must bear the burden of receiving upon his land the surface water naturally falling upon land above it and naturally flowing to it, and he has the corresponding right to have the surface water naturally falling upon his land or naturally coming upon it, flow freely upon the lower land adjoining, as it would flow under natural conditions. From these rights and burdens, the principle follows that he has a lawful right to complain of others, who, by interfering with natural conditions, cause such surface water to be discharged in greater quantity or in a different manner upon his land, than would occur under natural conditions....." (Heier v. Krull. 160 Cal 441 (1911))*

The Reasonable Use Rule *states that the possessor of land incurs liability only when his harmful interference with the flow of surface waters is unreasonable. Under this rule, a possessor of land is legally privileged to make a reasonable use of his land even though the flow of surface waters is altered thereby and causes some harm to others. The possessor of land incurs liability, however, when his harmful interference with the flow of surface waters is unreasonable.*

Excerpts from "Water Law in Arkansas"

When one landowner takes action to deal with diffused surface water, either to prevent it from coming onto lower lying land or to remove excess water from the land, neighboring property owners may complain of damage to their property. To determine the liability arising from such actions, Arkansas courts have applied a modified version of what is called the "common enemy" rule. In its pure, unmodified formulation this property rule suggests that diffused surface water may be treated as a common enemy and a property owner may take whatever steps necessary to protect against it.

A number of courts adopted the "common enemy" concept but also imposed liability if the landowner negligently protected his property and harm resulted to neighboring property. This modification permitted courts to evaluate the actions of the property owner to determine if he caused "unnecessary harm." Certainly, the collection and discharge of the water onto neighboring property through artificial means might be considered "negligent," and if it causes "unnecessary harm," liability would be imposed. Acceleration of flow by means of ditches or other artificial means would appear to violate the principle.

Levy v. Nash maintaining that the owner has a right to fill lower property, to elevate it, to construct ditches or otherwise protect it against surface water of an adjoining lot as a "necessary incident to the ownership of such property." To find to the contrary would, according to the court, "operates against the advancement and progress of cities and towns" and would be "against public policy." The court indicated that the upper proprietor had no right to concentrate the water and "throw it by ditches with greater force and volume than it otherwise would have gone."

Planning and design of stormwater drainage systems shall not be based on the premise that problems can be transferred from one location to another. The process of land development causes an increase in downstream peak flows by increasing runoff volumes and the speed of runoff conveyance. Drainage systems shall be designed and detention storage shall be provided so that downstream properties are not adversely impacted.

Drainage systems should be designed with full consideration of downstream effects and the effects of offsite flows entering the system. The drainage system shall be designed to provide for runoff from upstream sites conveyed through the development to discharge to existing flow paths. Flow calculations shall assume fully developed conditions for all offsite tributary basins. An evaluation of the downstream conveyance system shall be provided to ensure that it has sufficient capacity to accept design discharges without adverse backwater or downstream impacts such as

flooding, stream bank erosion, channel degradation, and sediment deposition.

3.2.2 REGULATION REQUIREMENTS

Governmental regulation of natural resources impacts local municipal requirements related to local stewardship of the drainage system. Both federal and state requirements are imposed upon design and planning of drainage systems.

Federal

Environmental Protection Agency (EPA) - In recognition of the need for improved control measures, in 1987 the U.S. Congress mandated the U.S. Environmental Protection Agency (EPA), under amendments to the Clean Water Act, to control certain stormwater discharges under the National Pollutant Discharge Elimination System (NPDES). In response to this federal legislation, a permitting program was put in place by EPA as the Phase I (1990) and Phase II (1999) stormwater regulations, which together set forth requirements for municipal separate storm sewer systems and industrial activities including construction.

The National Pollutant Discharge Elimination System (NPDES) Stormwater Program regulates stormwater discharges from three potential sources: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. NPDES permit coverage for small MS4s is required by the federal stormwater regulations contained in 40 CFR 122.26 and 40 CFR 122.30 through 122.37. Most stormwater discharges are considered point sources, and operators of these sources may be required to receive an NPDES permit before they can discharge. This permitting mechanism is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters.

Clean Water Act – Phase II includes smaller municipal storm sewer systems and smaller construction sites (down to one acre) [60 Fed. Reg. 40,230 (Aug. 7, 1995) (codified at 40 C.F.R. Parts 122, 124 (1995)]. If these covered sources fail to apply for a permit, they are in violation of the CWA. These MS4 permits require municipalities to implement programmatic control measures (the six minimum measures) in the areas of

(1) public education and outreach,
(2) public participation and involvement,
(3) illicit discharge detection and elimination,
(4) construction site runoff control,
(5) post-construction runoff control, and
(6) pollution prevention and good housekeeping

all to reduce the discharge of pollutants in stormwater to the *maximum extent practicable*. Efforts to meet the six minimum measures are documented in a stormwater management plan.

Federal Emergency Management Agency (FEMA) - In order for a community to participate in the FEMA National Flood Insurance Program, it must fulfill a number of requirements, including ensuring that projects will not increase flood heights, including flood levels adjacent to the project site [see, e.g., 44 C.F.R. § 60.3(d)].

Army Corps of Engineers (USACE) – The Corps' Regulatory Program is committed to protecting the Nation's aquatic resources, while allowing reasonable development through fair, flexible and balanced permit decisions. The Corps evaluates permit applications for essentially all construction activities that occur in the Nation's waters, including wetlands. USACE permits are required for work in streams, wetlands and other waters of the United States under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899.

State

Arkansas Department of Environmental Quality (ADEQ) - Under the terms of the Federal Clean Water Act and amendments as found in 40 CFR 122.26, operators of a wide range of construction and industrial activities must obtain NPDES permits for non-point source discharges of storm water. Conditions in the permit typically require the creation of a Storm Water Pollution Prevention Plan (SWPPP), designed to control and reduce pollutants in storm water from these sites. The State of Arkansas has been authorized by the U. S. EPA to administer the NPDES Program in Arkansas, including the issuance of general permits to categories of dischargers under the provisions of 40 CFR 122.28, as adopted by reference in the Arkansas Pollution Control & Ecology Commission's (APC&EC) Regulation No. 6. *Arkansas Water and Air Pollution Control Act, as amended (§§ 8-4-101— 8-4-106, 8-4-201 — 8-4-229, 8-4-301 — 8-4-314); Pollution Control and Ecology Commission Regulation 6 (May, 2010)*

A goal of at least 80% removal of total suspended solids from these flows which exceed predevelopment levels should be used in designing and installing stormwater management controls (where practicable) (*NPDES Permit No. ARR040000, p. 8*). The post-construction Storm Water Management Plan (SWMP) shall include pre-construction site plan review for compliance with local requirements for post-construction management of stormwater (*NPDES Permit No. ARR040000, p. 10*). Maintenance and Inspection provisions are required by NPDES permit to be incorporated into local stormwater programs and ordinances (*NPDES Permit No.: ARR040000,*

p. 9). Violation of any condition of a general permit constitutes a violation of the Arkansas Water and Air Pollution Control Act (*Act 472 of 1949, as amended*) and subjects the discharger to the penalties specified therein.

It is recognized that the City will eventually become an MS4 permittee and required to comply with these regulations. It is also evident that these practices and considerations are in the best interest of the City and shall be implemented.

3.2.3 MUNICIPAL INFRASTRUCTURE.

The drainage system is an integral part of The City's infrastructure. The primary purpose of the storm drainage system is to provide for public health, safety and general welfare. The following goals must be incorporated into planning and designs for stormwater management:

- Protect human life and health
- Protect property
- Eliminate adverse impacts of runoff
- Minimize interruptions to businesses and governmental services
- Minimize damage to public facilities and utilities
- Minimize expenditure of public funds

The City's drainage system is a subsystem of the total urban water resource system. Drainage system planning and design for all development must be compatible with regional comprehensive plans and should be coordinated with planning for land use, open space, and transportation corridors. Urban drainage must consider and address the interrelated issues of erosion and sedimentation control, flood control, site grading criteria, and regional water quality.

Design of the stormwater drainage system should consider the features, capacity, and function of the existing drainage system. Good drainage designs incorporate the effectiveness of natural systems rather than negate, replace or ignore them. Existing features such as natural drainageways, depressions, wetlands, floodplains, permeable soils, and vegetation provide for infiltration, help control the velocity of runoff, extend the time of concentration, filter sediment and other pollutants, and recycle nutrients.

3.2.4 MINOR AND MAJOR SYSTEM

Every urban area has a minor and major drainage system that must be properly planned and designed. The minor system is designed to provide public convenience and to accommodate moderate, frequently occurring flows.

The major system, which exists regardless of whether it is planned, carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system. To provide for orderly urban growth, reduce costs to future generations, and avoid loss of life and major property damage, both systems must be planned and properly engineered.

3.2.5 MAINTENANCE

The drainage system must receive regular maintenance to ensure long-term function and effectiveness. Drainage facilities shall be designed with ease of maintenance, long-term function, protection of public safety and accessibility as primary considerations. Operation and maintenance procedures and activities must be developed and documented with the facility design. Clear assignment of maintenance responsibilities must be identified and assigned to an established agency with the resources and understanding that are required to ensure proper maintenance. Access easements and agreements should be provided to allow The City to address maintenance issues in the event the responsible party does not provide the necessary actions.

3.3 POLICIES

In keeping with the above principles of drainage planning, the City has developed specific policies that must be followed. These policies are discussed in the following categories: planning, design, operation and maintenance, and water quality.

3.3.1 PLANNING

3.3.1.1 Storm drainage planning is required for all development projects in accordance with these CRITERIA. Requirements for drainage plan submittals must comply with Chapter 2 of these CRITERIA.

3.3.1.2 All drainage systems shall be designed on the total drainage basin assuming full development of the area in accordance with the land use plan designation at the time of development, except that the least intense zoning allowed for this purpose is R-1. Both runoff factors and time of concentration shall be calculated on a "fully developed" basis.

3.3.1.3 The City defines a major drainageway as any drainage flow path with a tributary area of 100 acres or more.

3.3.1.4 Major drainageways shall remain in open natural channels and shall not be piped.

3.3.1.5 Historic major drainage pathways shall be maintained, and inter-basin transfers of storm drainage shall be avoided to the

maximum extent practicable. Deviations from this policy may be granted on a case-by-case basis, only when the following criteria are met:

1. No other viable alternative exists.
2. No additional potential damage is created by the proposed transfer.
3. No other regulatory requirement is violated.

3.3.1.6 In areas with known drainage or water quality problems, additional analysis and/or definition of additional facilities to prevent compounding of these problems by development projects must be completed.

3.3.1.7 All development projects must design and construct drainage improvements that drain to an acceptable outfall in accordance with a City-approved Final Drainage Report for the minor system and any applicable master drainage plan for the major drainage system.

3.3.1.8 On-site detention of flood flows for all development projects is required in accordance with these CRITERIA for the purpose of reducing urban drainage problems and the costs of drainage facilities. Exemptions from flood control detention may be granted under these conditions:

1. Development of a total area of less than 1.0 acre .
2. Development or redevelopment of areas tributary to a publicly owned and maintained regional detention facility designed to accommodate flows from a fully developed basin, provided that adequate conveyance of 100-year developed flows from the development to the regional facility is provided.
3. Development or redevelopment of the property includes Low Impact Development (LID) techniques that maintain or return the land use hydrological characteristics to historic conditions.

All exemptions are subject to approval of the Planning Commission and may require additional analysis to demonstrate that no adverse effects to the overall drainage system will result from the exemption.

3.3.1.9 The City requires that flood detention and water quality facilities be safe and maintainable and strongly encourages aesthetically pleasing facilities that are viewed as community assets rather than liabilities.

3.3.1.10 Planning for water quality and flood detention shall be integrated within all development. In this context, site planning and design techniques shall reduce runoff volumes and velocities to the maximum extent practicable by implementing LID measures that minimize directly connected impervious area. Guidelines for implementation of this approach in The City are provided in Chapter 14 of these CRITERIA.

3.3.1.11 The City reserves the right to require improvements, provision of drainage easements, and for provision of agreements beyond the boundaries of the development to facilitate flow of water through the development. These drainage requirements will help avoid potential lawsuits based on damage from changed storm runoff, and provide for the continuous improvement of the overall storm drainage system. Developers shall be responsible at their expense for making off-site improvements necessary to correct drainage or flooding problems created by their development.

If it is determined that off-site drainage improvements are required, then cost sharing may be considered with approval by the City Board of Directors. If the City is unable to or unwilling to contribute its share of the offsite costs, the developer shall have the option of (a) building the offsite improvements at his or her own expense, (b) providing detention to match downstream capacities, or (c) delaying the project until the City is able to share in the offsite costs.

3.3.1.12 Floodplains shall be regulated and managed in accordance with The City's Floodplain Ordinance (Chapter 42, Revised Municipal Code, and as contained in Chapter 4 of these CRITERIA).

3.3.2 DESIGN

The design criteria presented herein represent The City's **minimum** requirements for stormwater management. These criteria will be revised and updated as necessary to reflect advances in the field of urban drainage engineering and water resources management.

3.3.2.1 All storm drainage facilities shall be planned and designed in accordance with these CRITERIA, of which may be revised or amended as new technology is developed and as additional experience is gained.

3.3.2.2 All subdivisions shall plan, design and implement the minor and major drainage systems.

3.3.2.3 The minor drainage system shall be designed to transport runoff from the 10-year storm with minimum disruption to the urban environment and to discharge to an acceptable outfall per these CRITERIA.

3.3.2.4 The capacity of the minor system of the downstream development must be equivalent to, or greater than, the capacity of the upstream system.

3.3.2.5 The major drainage system shall be designed to convey runoff from the 100-year recurrence interval flood to minimize health and life hazards, damage to structures, and interruption to traffic and services and shall be designed to discharge to an acceptable outfall per these CRITERIA.

3.3.2.6 The major drainage system shall be designed and sized without accounting for peak flow reductions from onsite or offsite detention unless otherwise approved by The City. In cases where permanently dedicated, publicly maintained detention facilities are in place, The City will provide credit for flow reduction.

3.3.2.7 Streets are an integral part of the urban drainage system and may be used for drainage in accordance with the limitations identified in Chapter 7 of these CRITERIA. Streets shall not be used for drainage in a manner that unduly restricts the primary purpose of streets, which is for traffic.

3.3.3 OPERATION AND MAINTENANCE OF DRAINAGE FACILITIES

3.3.3.1 Storm drainage facilities, including channels, flood detention and water quality facilities, storm sewers, and related appurtenances, require on-going maintenance and periodic repair to ensure proper functioning. Maintenance and access requirements shall be considered during the planning and design of these facilities. Maintenance requirements and access provisions shall be clearly defined in the drainage plan, storm sewer construction plan and site plan submittals. Easement widths should be based on maintenance access needs and overflow widths, if any.

3.3.3.2 The land owner is responsible for maintenance of drainage facilities located on their land. The City has the right to enter and maintain drainage facilities, in the event the land owner fails to maintain the facilities located on their property. The City has the right to charge the land owner with the cost of maintenance of drainage

facilities. Section 1-7 of the Municipal Code shall be used as a schedule of fines for violations associated with drainage facilities.

3.3.3.3 Maintenance access shall be provided for all storm drainage facilities. Easements for adequate maintenance shall be as defined in Table 3.2. Storm sewer pipes shall be provided an exclusive easement as defined in Table 3.2. Minimum horizontal separation between other buried utilities shall be 10-feet (centerline of pipe to centerline of utility).

3.3.3.4 Drainage easements shall be shown on the corrected plats, drainage plan, and storm sewer construction plan and state *"The City has the right of access on the easements, which shall be kept clear of obstructions restricting flow and/or maintenance access"*.

Table 3.2 - Required Maintenance Easements for Drainage Facilities

Facility Type	Easement Width	
Single Pipe	$W = B_c + 2H + 3$ Where: B_c = outside span of pipe in feet H = depth from top of pipe to final surface elevation in feet W = easement width, which shall be rounded to the next highest 5-foot increment with a minimum width of 20 feet.	
Multiple Pipe Installation	Width calculated on a case-by-case basis to include outside width of pipes + excavation width required for maintenance on each side.	
Open Channels and Swales	Q_{100} less than 20 cfs: Q_{100} less than 100 cfs: Q_{100} greater than 100 cfs:	20 ft 25 ft Top width of 100-yr flow + 10-ft along one side of channel
Detention Basin	Width as required to contain storage, freeboard and associated facilities plus no less than 20 feet for maintenance access around the perimeter. When multiple lots are involved, a dedicated tract of land is required.	

3.3.5 WATER QUALITY

3.3.5.1 All development shall comply with the terms and conditions of The City's MS4s Discharge Permit for the purpose of minimizing the discharge of pollutants to receiving waters to the maximum extent practicable.

3.3.5.2 All development located within The City shall provide specific measures to enhance the water quality of storm-generated runoff from the fully developed project site, as specified in Chapter 13 of these CRITERIA. Permanent water quality BMPs shall be implemented in accordance with the requirements of Chapter 13 of these CRITERIA.

3.3.5.3 All development located within The City are required to implement BMPs to control erosion, sedimentation, and pollutant laden stormwater discharges during construction activities in accordance with Chapter 14 of these CRITERIA.

3.3.5.4 The City reserves the right to require implementation of temporary and permanent BMPs on development sites less than one acre in size.

4.0 FLOODPLAIN REGULATIONS

4.1 INTRODUCTION

In accordance with Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP), "the community must adopt and submit floodplain management regulations that meet or exceed the minimum flood plain management requirements of the NFIP." The Legislature of the State of Arkansas has delegated the responsibility of local governmental units to adopt regulations to minimize flood losses (A.C.A. § 14-268-101 et seq).

The regulation of floodplains is necessary to preserve and promote the general health, welfare, and economic wellbeing of the region. The general purposes of floodplain regulations are summarized as follows:

1. To reduce the hazard of floods to life and property.
2. To protect and preserve hydraulic characteristics of water courses used for conveyance of flood waters.
3. To protect the public from extraordinary financial expenditures for flood control and relief.

Floodplains shall be regulated and managed in accordance with Siloam Springs's Floodplain Ordinance (Chapter 42, Section 42-31, Revised Municipal Code, *1978, § 11.72.01; Ord. No. 07-28, § I, 9-18-2007)*. It is the designer's responsibility to use the most current adopted floodplain maps and to ensure compliance with the current Siloam Springs ordinances and federal regulations. Floodplains shall be left in a natural state or used as open space recreational areas to the maximum extent practicable.

To summarize, the Flood Ordinance provides that:

1. Construction within the floodway is prohibited.
2. Flood protection elevation is 2.0 feet above the base flood elevation.
3. Residential construction within the floodplain must elevate the lowest floor (including basement) to or above the flood protection elevation.
4. Commercial or industrial development must elevate the lowest floor (including basement) or flood proof to or above the flood protection elevation.
5. Elevation certificates are required for all structures built within or adjacent to floodplain boundaries as defined by Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps.
6. Flood proofing must be approved by the Building Inspection Department.

In cases where the floodplain will be altered, it is the developer's responsibility to first obtain a Conditional Letter of Map Revision (CLOMR) early in the planning

process and obtain a final Letter of Map Revision (LOMR) when the project is complete. All analysis and associated costs are the responsibility of the developer.

The City encourages flood proofing of existing structures that are not in compliance with Siloam Springs's Floodplain Ordinance. Flood proofing shall be completed in accordance with the criteria specified in *FEMA Technical Bulletin 3-93* and *FEMA P-312*. Construction of critical facilities such as hospitals, nursing homes, schools and fire stations in the floodplain must be avoided.

The provisions of ***"Flood Damage Prevention Code for Siloam Springs, Arkansas,"*** dated September 28, 2007, shall be observed.

4.2 DEVELOPMENT PROCESS REQUIREMENTS

1) ***Flood zone certification.***
   Statement required on development plans, Preliminary Plats, Informal Plats, and As-Built Drawings.

2) ***Floodplain delineation of location and elevations***
   Shown on all development plans, preliminary plats, drainage plans, construction drawings and As-Built drawings.

3) ***Establish minimum Finish Floor Elevations***
   Designate FFE on grading plans and plats for lots within or immediately adjacent to an established FEMA floodplain.

4) ***Submit a floodplain determination application*** at the time of project submittal. If the project lies within a floodplain or will disturb a floodplain, a floodplain permit must be obtained.

5) ***Upon completion an Elevation Certificate*** is required for all structures located within or adjacent to a Special Flood Hazard Area prior to receiving a Certificate of Occupancy.

6) ***Submit a "No Rise Certificate"*** if any improvements are proposed within a regulatory floodway.

5.0 RAINFALL

5.1 INTRODUCTION

The design rainfall data to be used to complete hydrologic analyses described in the RUNOFF chapter of these CRITERIA are presented in this section. More specifically, this chapter provides:

1) Point precipitation values for Siloam Springs,
2) An intensity-duration-frequency table for use with the Rational Method,
3) Design information for use with the United States Department of Agriculture (USDA) Natural Resources Conservation Services (NCRS) *Technical Release TR-55*, and
4) Design information for use with the *United States Army Corps of Engineers (USACE) Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS)*.

All hydrological analyses within The City shall use the rainfall data presented herein for calculating storm runoff. There may be cases where the designer needs to consider events more extreme than the 100-year storm (e.g., for public safety).

The design storms and intensity-frequency-duration tables for Siloam Springs were developed using the rainfall data and procedures presented in National Oceanic and Atmospheric Administration (*NOAA) Technical Memorandum NWS HYDRO-35*.

5.2 RAINFALL DEPTH-DURATION-FREQUENCY VALUES

Values obtained from the isopluvial maps presented in the *Technical Paper No 40 Rainfall Frequency Atlas of the United States, May 1961* NOAA Atlas for Siloam Springs are presented in Table 5.1 below. The precipitation values for various return periods and duration storms were found to have slight variations across the city limits of Siloam Springs. The values selected are considered to be conservative to represent the entire city boundaries and maintain consistent standard rainfall values.

Table 5.1 - Point Rainfall Depths, NOAA TP No. 70

Point Rainfall (inches)

Return Period	One-hour	24-hour
1-Year	1.5	3.3
2-Year	1.8	4.1
5-Year	2.3	5.2
10-Year	2.7	6.1
25- Year	3.1	7.3
50-Year	3.5	8.0
100-Year	3.9	8.9

Source: Technical Paper No. 70, NOAA Rainfall Frequency Atlas.

Table 5.2 - Point Rainfall Depths, NOAA TM HYDRO-35

Point Rainfall (inches)

Return Period	5-minute	15-minute	60-minute
2-Year	0.47	0.98	1.75
100-Year	0.86	1.75	3.65

Source: NOAA Technical Memorandum NWS HYDRO-35, June 1977

The Intensity Duration Frequency (IDF) curves were developed in accordance with *FHWA Drainage of Highway Pavements HEC 12, Appendix A.* An IDF equation was developed for each frequency event for ease of spreadsheet Rational Method flow calculations.

The equation:

$$i = a / (b + t_c)^m \qquad \textit{(Equation 5.1)}$$

where;
i = intensity (inches per hour)
t_c = time of concentration (minutes)
a, b and m as shown in Table 5.3

Table 5.3 - IDF Equation Factors

Storm Event /Factor	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
a =	57.097	47.912	43.911	48	42.495	55.149
b =	12	10	9	9	7	9
m =	0.815	0.726	0.675	0.658	0.606	0.641

Table 5.4 provides the rainfall intensity-duration values for use with the Rational Method in accordance with **Chapter 6.**

The design engineer may manually enter the values from Table 5.4 or calculate directly for Equation 5.1 for Rational Method spreadsheet calculations.

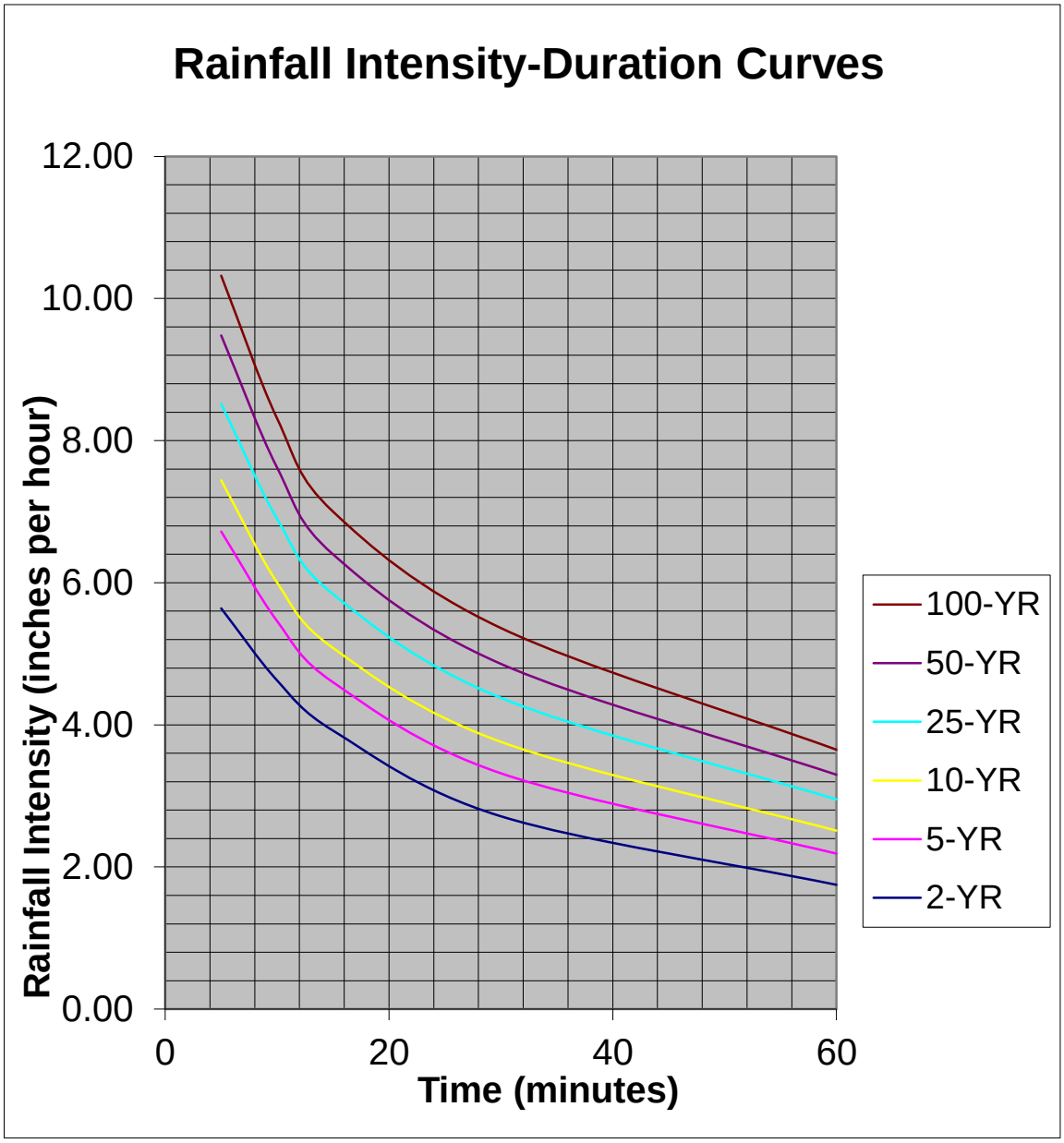
5.3 NCRS TR-55 MODELING

The design engineer will use the TR-55 rainfall data shown in Table 5.1 with the WINTR-55 modeling software. Siloam Springs falls within the boundaries of the Type III synthetic 24-hour rainfall distribution. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. The Type III storm unit hydrograph will be used for distribution of the 24-hour rainfall.

5.4 USACE HEC HMS Modeling

The User-defined Hypothetical Storm option will be used for modeling with the HEC HMS program. The user defined storm will be designated as the NCRS TR-55 hyetograph for a 24-hour storm.

Table 5.4 - Rainfall Intensity Duration Curves



6.0 RUNOFF

6.1 INTRODUCTION

Consistent runoff calculations are critical to planning and sizing of the storm drainage system. A standard runoff method provides an equivalent comparison methodology between site designs and master drainage plans. Invalid calculation methods may produce unnecessarily high runoff, resulting in more costly construction of facilities. On the other hand, mistakenly low runoff calculations may result in damage or loss of property, life or natural resources. This chapter identifies the standard methods to be used for determining the storm runoff design peaks and volumes for preparation of storm drainage studies, plans, and facility designs within The City.

6.2 GENERAL

Stormwater runoff shall be computed on the total drainage basin assuming full development of the area, in accordance with the Land Use Plan at the time of development. The least intense zoning allowed for undeveloped land is R-1. Both runoff factors and time of concentration shall be calculated on a "fully developed" basis.

6.3 CITY OF SILOAM SPRINGS DRAINAGE METHODS

The following methods of runoff calculation are specified in order to standardize the method of design for storm drainage and flood control systems within The City: The Rational Method, the NRCS Technical Release - 55 (TR-55) and the USACE HEC-HMS computer program. These three methods will be the basis of all drainage analysis in the City of Siloam Springs. The analysis method, design use and limitations are:

1.	Rational Method Site and Storm Sewer design	Less than 90 acres and T_c < 60 minutes
2.	NCRS TR-55 Large Development Design	Less than 2,000 acres and < 10 basins and reaches
3.	USACE HEC-HMS (For use in modeling major basin, master planning and stream flows.)	Greater than 60 acres

Criteria for the preceding three methods are specified in the following sections:

6.4 RATIONAL METHOD

The Rational Method shall be applied as outlined in FHWA ***HEC-22*** ***"Urban Drainage Design Manual"***, ***Section 3.22.***

6.4.1 SELECTION OF RUNOFF COEFFICIENTS

To standardize City Design Computations, **Table 6.1** represents standard runoff coefficient values by land use and composite analysis. A weighted average of different areas with each surface type shall be used for site design plans. If offsite basins are included in the analysis, the land use values may be used. Soils in the Siloam Springs area are predominantly type C and D classifications (clays). Use of A or B soil classifications are not expected and should be discussed with review staff prior to use.

Table 6.1 - Rational Runoff Coefficients

Slope /Category	Land Use	Type C and D Clay Soils (Impervious)
Flat (0 to 1%)	Cultivated	0.40
	Woodlands	0.15
	Pasture	0.40
	Residential	0.60
	Commercial/Industrial	0.90
	Paved	0.90
Rolling (1 to 3.5%)	Cultivated	0.70
	Woodlands	0.25
	Pasture	0.45
	Residential	0.60
	Commercial/Industrial	0.90
	Paved	0.90
Hilly (3.5 to 5.5%)	Cultivated	0.85
	Woodlands	0.30
	Pasture	0.55
	Residential	0.60
	Commercial/Industrial	0.90
	Paved	0.90
Mountainous (over 5.5%)	Woodlands	0.80
	Bare	0.90
Grassed ROW slopes		0.70
Generic Surfaces	Roof	0.90
	Pavement	0.90
	Gravel	0.65
	Lawn	0.20

Apply the T_r factor shown in **Table 6.2** to the ***C*** value to determine each storm frequency ***Coefficient*** value.

Table 6.2 - C Value Adjustment Factors (T_r)

Design Storm Frequency	<25-Yr	25-Yr	50-Yr	100-Yr
(***T_r***) Adjustment Factor	1.00	1.10	1.20	1.25

6.4.2 TIME OF CONCENTRATION (Tc)

The engineer shall use the Simplified Manning-kinematic solution as detailed by the *USDA SCS (NCRS) Chapter 15 Part 630 NEH, "Time of Concentration".*

The **initial time of concentration** is estimated by Equation 6.1.

$$T_i = 0.007\ (nL)^{0.8} / P_2^{0.5} \times s^{0.4} \qquad \textit{(Equation 6.1)}$$

Where:

T_i = Initial time of concentration overland flow travel time (min.)
n = friction factor (Manning's n) (from *Table 15-1 NEH*)
L = Length of shallow overland flow
P_2 = 24 hour 2-year precipitation (4.11-inches)
s = slope (ft/ft)

The maximum length of overland flow is restricted to 100-feet.

Shallow concentrated flow travel time occurring in small swales and curbs may be calculated using Manning's equation to determine average velocity and then applying the velocity to *Equation 6.2*. ***Figure 6.1*** may be used to determine the velocity as well.

$$T_t = L / 3{,}600v \qquad \textit{(Equation 6.2)}$$

Where:

T_t = Travel time (minutes)
L = Length of flow path (feet)
V = average velocity (feet per second (fps))

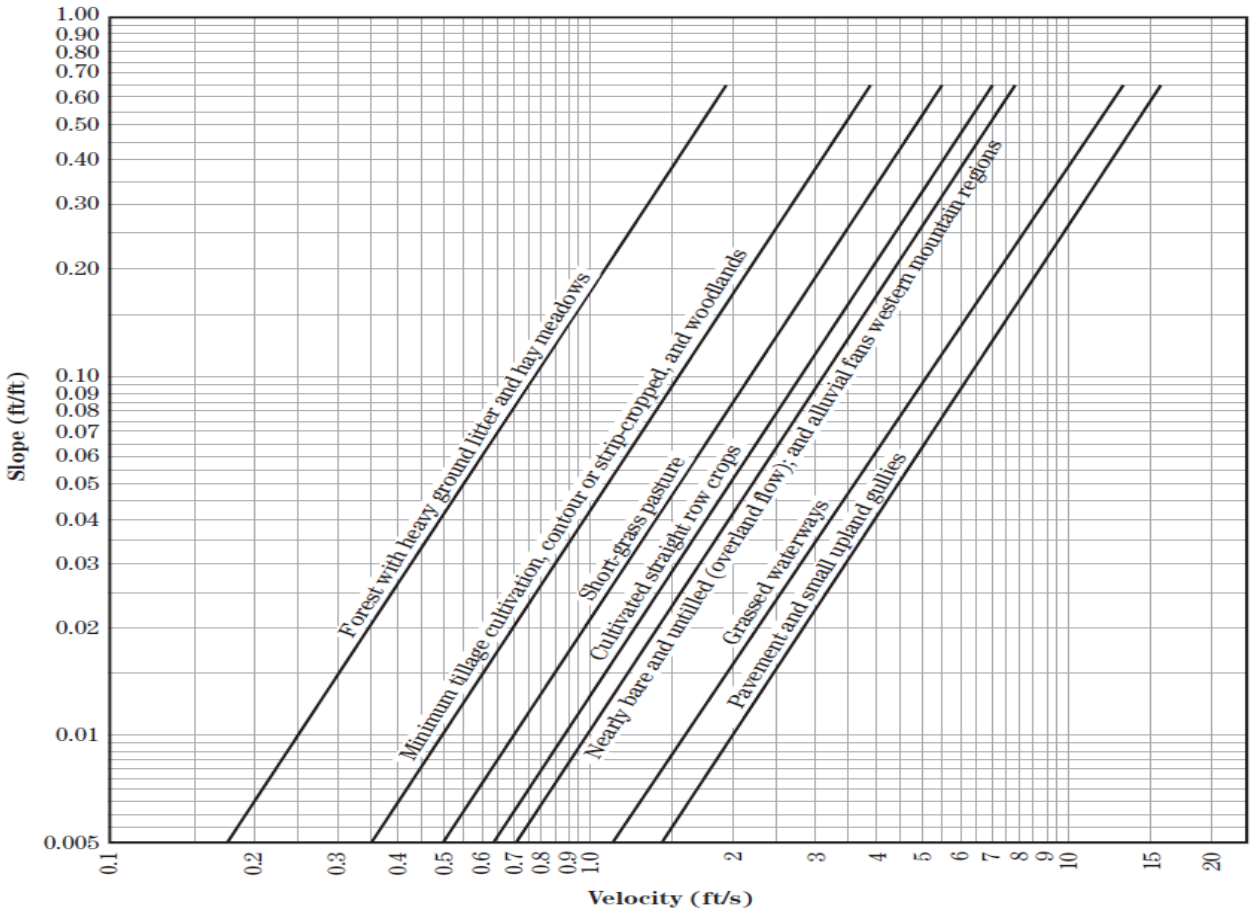
Additional channelized flow path segments for channel and pipe flow travel times shall be calculated by estimating the flow velocity using Manning's equation.

The total basin time of concentration (T_c) is the sum of travel times to the design point.

The minimum time of concentration shall be 5 minutes. The maximum recommended T_c for the first residential basin is 10 minutes and 5 minutes for the first industrial/commercial basin.

If a watershed or basin involves a design time of concentration in excess of 30 minutes then the applicability of the Rational Method must be evaluated.

Figure 6.1 - Velocity versus slope for shallow concentrated flow



Source: NRCS Part 630 National Engineering Handbook

6.4.4 Major Storm Analysis

When analyzing the major runoff occurring on an area that has a storm sewer system sized for the initial storm, care must be used when applying the Rational Method. Normal application of the Rational Method assumes that the storm sewer collects all of the runoff. For the initial storm design, the time of concentration is dependent upon the flow time in the sewer. However, during the major storm runoff, the sewers will probably be at capacity and would

not carry the additional runoff flowing to the inlets. This additional water would then flow overland past the inlets, generally at a lower velocity than the flow in the storm sewers.

The use of modeling software which provides a bypass capability to route excess inlet flows to the next inlet overland may be used to account for the differences in travel time.

6.5 NRCS METHOD, TABULAR TR-55

6.5.1 GENERAL

Reference USDA NCRS *Part 630 Hydrology National Engineering Handbook – Chapter 10* for details of tabular runoff methodology.

6.5.2 TABULAR METHOD USE

Determination Of Runoff Curve Number

The RCN determines the amount of runoff that will occur with the given rainfall. Soil types and land use are used to determine the runoff potential.

Soils in the Siloam Springs area are predominantly type C and D classifications (clays). Use of A or B soil classifications are not expected and should be discussed with review staff prior to use. An Antecedent Runoff Condition Class II shall be assumed for design purposes.

Table 6.3 lists RCNs for various land uses. A more complete table listing RCN values for specific soil types and land coverage can be found in the TR-55 Manual. Weighted RCN values should be rounded to the nearest whole number.

RAINFALL

Select the SCS Type III storm.

REPORTS

Include the following report print outs in the Drainage Report:

- Storm Data (idf files),
- Hydrograph Peak / Peak Time Table,
- Sub-Area Summary Table
- Design Point Hydrograph Plots

Table 6.3 - Runoff Curve Numbers For Urban Areas [a]

Cover Description		Curve Number for Hydrologic Soil Group	
Cover Type and Hydrologic Condition	**Average Percent Impervious Area** [b]	**C**	**D**
Fully developed Urban areas (vegetation established)			
Open space (lawns, parks, golf courses, cemeteries, etc.) [c]			
Poor condition (grass cover < 50%)		86	89
Fair Condition (grass cover 50% to 75%)		79	84
Good condition (grass cover >75%)		74	80
Impervious areas:			
Paved parking lots, roofs, driveways, etc.(excluding ROW)		98	98
Streets and roads:			
Paved; curbs and storm sewers (excluding ROW)		98	98
Paved; open ditches (including ROW)		92	93
Gravel (including ROW)		89	91
Dirt (including ROW)		87	89
Urban Districts:			
Commercial and business	85	94	95
Industrial	72	91	93
Residential districts by average lot size:			
1/8 acre or less (town houses)	65	90	92
1/4 acre	38	83	87
1/3 acre	30	81	86
½ acre	25	80	85
1 acre	20	79	84
2 acres	12	77	82
Developing urban area			
Newly graded areas (pervious areas only, no vegetation) [e]		91	94
Idle lands (CNs are determined using cover types similar to those in Table 6-4).			

[a] Average runoff condition, and Ia = 0.2S.

[b] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using Figure 2-3 or 2-4 (TR-55 Manual).

[c] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

[e] Composite CNs to use for the design of temporary measures during grading and construction should be computed using Figure 2-3 or 2-4 (TR-55 Manual), based on degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

Notes: CN = Curve number. ROW = Right-of-way

Source: USDA NCRS TR-55

Table 6.4 - Runoff Curve Numbers for Other Agricultural Lands[a]

Cover Description		Curve Number for Hydrologic Soil Group	
Cover Type	**Hydrologic Conditions[c]**	**C**	**D**
Pasture, grassland, or range – Continuous forage for grazing[b]	Poor	86	89
	Fair	79	84
	Good	74	80
Meadow – continuous grass, protected from grazing and generally mowed for hay		71	78
Brush – brush-weed-grass mixture with brush the major element[c]	Poor	77	83
	Fair	70	77
	Good	65	73
Woods – grass combination (orchard or tree farm)[d]	Poor	82	86
	Fair	76	82
	Good	72	79
Woods[e]	Poor	77	83
	Fair	73	79
	Good	70	77
Farmsteads – buildings, lanes, driveways, and surrounding lots		82	86

[a]Average runoff condition, and I_a – 0.2S.
[b]Poor = < 50% ground cover or heavily grazed with no mulch.
Fair = 50 to 75% ground cover and not heavily grazed.
Good = 75% ground cover and lightly or only occasionally grazed.
[c]Poor = < 50% ground cover.
Fair = 50 to 75% ground cover.
Good = 75% ground cover.
[d]CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.
[f] Poor = Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair = Woods are grazed but not burned, and some forest litter covers the soil.
Good = Woods are protected from grazing, and litter and brush adequately cover the soil.

Source: USDA NCRS TR-55

6.6 HEC-HMS COMPUTER MODEL

The HEC-HMS computer program is the successor program to the HEC-1, a hydrologic simulation model developed by the U.S. Army Corps of Engineers Hydrologic Engineering Center in Davis, California. The program has numerous options for determining and routing runoff hydrographs and is well documented. The user's manual and technical documentation should be referenced for specific program capabilities, limitations and data input.

Select the ***User Specified Hyetograph*** option to select the NCRS Hypothetical Storm. Select the SCS Type III storm.

6.7 STORMWATER RUNOFF ANALYSIS SOFTWARE

The City will allow the use of the following software or acceptable equal for estimating stormwater runoff.

6.7.1 RATIONAL METHOD

Common software packages (such as Haestad's StormCad and AutoDesk's HydroFlow) that include rational analysis may be used for calculations. It is preferred that the output reports be formatted to resemble the City Standard Form for inclusion in the Drainage Study.

The Siloam Springs IDF curve equations are to be used for rainfall data.

The design engineer is cautioned to ensure the flow routing in storm sewers does not reduce the flow between design points.

6.7.2 WINTR-55

WINTR-55 is ideal for modeling general hydrology and runoff from site development. In addition, if additional basins are required within the analysis, the WINTR-20 employs the same methods. Any modeling program that uses the TR-55 procedure engine may be used for runoff analysis. Reference USDA NCRS *WIN TR-55 User Guide* for program specifics.

6.7.3 HEC-HMS

HEC-HMS generates hydrographs from rainfall or snowmelt, adds or diverts them, then routes through reaches and reservoirs. HEC-HMS models multiple streams and reservoir networks, and has dam failure simulation capabilities.

6.8 CHECKLIST

1. Observe maximum initial time of concentration in Rational procedure. (10 minutes max to first inlet or design point)
2. Do not confuse C values (coefficient of imperviousness) with Cn (Curve number).
3. Observe maximum length of overland flow restrictions. (300' undeveloped / 100' developed basin)
4. Include data summary reports and output tables in drainage report appendices.
5. Include graphic results when available.

7.0 STREETS

7.1 INTRODUCTION

The criteria presented in this chapter shall be used in the evaluation of the allowable drainage encroachment within public streets.

7.2 FUNCTION OF STREETS IN THE DRAINAGE SYSTEM

The primary function of streets is for safe traffic movement. Stormwater drainage in streets is subservient to this function and must be properly designed to prevent interference with traffic, especially at intersections. When drainage in the street exceeds allowable limits, a storm sewer system (**Chapter 9**) or an open channel (**Chapter 10**) is required to convey the excess flows. Streets are also part of the major drainage system when they carry flows in excess of the minor storm.

7.3 ALLOWABLE USE OF STREETS FOR STORM FLOWS

The location of inlets and permissible flow of water in the streets should be related to the extent and frequency of interference to traffic and the likelihood of flood damage to surrounding property. Interference to traffic is regulated by design limits on the spread of water into traffic lanes, especially in regard to arterials. Flooding of surrounding property from streets is controlled by limiting depth of runoff in the street to the top of the curb for the design storm.

7.3.1 INTERFERENCE DUE TO FLOW IN STREETS

Water that flows in a street, whether from rainfall directly onto the pavement surface or overland flow entering from adjacent land areas, will flow in the gutters of the street until it reaches an overflow point or some other outlet, such as a storm sewer inlet. As the flow progresses downhill and additional areas contribute to the runoff, the width of flow will increase and progressively encroach into a traffic lane. On streets where parking is not permitted, as with many arterial streets, flow widths exceeding a few feet become a traffic hazard. Field observations show that vehicles will crowd adjacent lanes to avoid curb flow.

As the width of flow increases further, it becomes impossible for vehicles to operate without moving through water, and they must use the now-inundated lane. Splash from vehicles traveling in the inundated lane obscures the vision of drivers of vehicles moving at a high rate of speed in the open lane. Eventually, if width and depth of flow become great enough, the street loses its effectiveness as a traffic-carrier. During these periods, it is imperative that emergency vehicles such as fire trucks, ambulances, and police cars be able to traverse the streets by moving along the crown of the roadway.

7.3.2 INTERFERENCE DUE TO PONDING

Storm runoff, ponded on the street surface because of grade changes or the crown slope of intersecting streets, has a substantial effect on the street's traffic carrying capacity. Because of the localized nature of ponding, vehicles moving at a relatively high speed may enter a pond. The manner in which ponded water affects traffic is essentially the same as for curb flow, that is, the width of spread into the traffic lane is critical. Ponded water will often completely halt all traffic. Ponding in streets has the added hazard of surprise to drivers of moving vehicles, often producing erratic and dangerous responses.

7.3.3 INTERFERENCE DUE TO WATER FLOWING ACROSS TRAFFIC LANE

Whenever stormwater runoff, other than limited sheet flow, moves across the traffic lane, a serious and dangerous impediment to traffic flow occurs. The cross-flow may be caused by super-elevation of the curb, a street intersection, and overflow from the higher gutter on a street with cross fall, or simply poor street design. The problem associated with this type of flow is the same as for ponding in that it is localized in nature. Vehicles may be traveling at high speed when they reach the location. If vehicular movement is slow and the street is lightly traveled, as on residential streets, limited cross flows do not cause sufficient interference to be unacceptable.

The depth and velocity of cross flows shall be maintained within such limits that they do not have sufficient force to threaten moving traffic.

7.3.4 EFFECT ON PEDESTRIANS

In areas with heavily used sidewalks, splash due to vehicles moving through water adjacent to the curb is a serious problem.

Streets should be classified with respect to pedestrian traffic as well as vehicular traffic. As an example, streets that are classified as residential and located adjacent to a school are arterials for pedestrian traffic. The allowable width of gutter flow and extent of ponding should reflect this fact.

7.3.5 STREET CROSS FLOW

Whenever storm runoff, other than limited sheet flow, moves across a traffic lane, a serious and dangerous impediment to traffic flow occurs, therefore, cross flow is not allowed. In case of superelevation of a curve or overflow from the higher gutter on a street with cross fall, potential cross flow is to be collected by inlets prior to the superelevation transition.

7.3.6 ALLOWABLE FLOW OF WATER THROUGH INTERSECTIONS

As the stormwater flow approaches an arterial street or tee intersection, an inlet is required. Concrete swales may be used to convey water across residential streets at the intersection of a residential street and a larger capacity street. Swales are not allowed across larger capacity streets without the approval of the City.

7.4. PERMISSIBLE SPREAD OF WATER

A. The depth of flow in the street and the allowable spread of water in the gutter and street shall be limited as defined below:

7.4.1 ARTERIAL STREETS

Inlets shall be spaced at low points and such an interval to provide one clear traffic lane <u>in each direction</u> during the peak flows of the design storm.

Four and five lane streets shall be designed so that a minimum of one traffic lane is provided in each direction during the peak flows of the design storm.

Use of inlets with a gutter depression greater than the standard depression (4") is discouraged adjacent to the traffic lane. If depressed inlets are used, they shall be recessed back from the gutter line a minimum of one foot and a maximum of two feet. All recessed inlets are subject to approval of the City Staff. The design storm will have a 10-year return frequency.

Example:
Street width = 59' back-to-back; two 12' lanes to remain clear.

Therefore: Street flow spread in each gutter shall not exceed (59 - 24)/2 = 17.5'.

7.4.2 COLLECTOR STREETS

The flow of water in gutters of a collector street shall be limited so that <u>one standard lane</u> will remain clear during the peak runoff from the design storm. Inlets shall be located at low points or wherever the flow exceeds the one-standard-lane requirement.

Use of inlets with a gutter depression greater than the standard depression (4") is discouraged adjacent to the traffic lane. If depressed inlets are used, they shall be recessed back from the gutter line a minimum of one foot and a maximum of two feet. All recessed

inlets are subject to approval of the City Staff. The design storm will have a 10-year return frequency.

Example:
Street width = 37' back-to-back; one 12' traffic lane to remain clear.

Therefore: Street flow spread in each gutter shall not exceed (37' - 12')/2 = 12.5'

7.4.3 Local and Residential Streets

The flow of water in gutters of a residential street shall be limited to a depth of flow at the curb of 6" or wherever the street is just covered, whichever is the least depth. Inlets shall be located at low points or wherever the gutter flow exceeds the permissible spread of water.

Use of inlets with a gutter depression greater than the standard depression (4") is discouraged adjacent to the traffic lane. If depressed inlets are used, they shall be recessed back from the gutter line a minimum of one foot and a maximum of two feet. All recessed inlets are subject to approval of the City Staff. The design storm will have a 10-year return frequency.

B. The allowable spread of water for all street classifications as defined in (A) above applies to all configurations and layouts including the case of streets built on hillsides parallel to the contours. The maximum allowable spread of depth of water as defined in (A) above applies even if the downhill lane is theoretically clear.

C. For storm events in excess of the design storm for each street classification, the 100-year frequency storm shall be determined and the depth of flow resulting from the 100-year storm shall be determined and plotted on the construction drawings. The street, sidewalk, and driveway cuts shall be designed such that all storms greater than the 10-year storm does not convey through driveway cuts and across private property but remains generally within the street right-of-way and/or drainage easements.

7.5 BYPASS FLOW

Flow bypassing each inlet must be included in the total gutter flow to the next inlet downstream. A bypass of 10 to 20 percent per inlet will result in a more economical drainage system. Refer to **Chapter 8** for inlet design.

7.6 MINIMUM AND MAXIMUM VELOCITIES

To ensure cleaning velocities at very low flows, the gutter shall have a minimum slope of 0.01 feet per foot (1.0 percent). The maximum velocity of curb flow shall be 10 fps. Along sharp horizontal curves, peak flows tend to jump behind the curb line

at driveways and other curb breaks. Water running behind the curb line can result in considerable damage due to erosion and flooding. In a gutter where the slope is greater than 0.10 feet per foot (10 percent) and the radius is 400' or less, design depth of flow shall not exceed 4" at the curb.

7.7 DESIGN METHOD

The FHWA **HEC-22** ***"Urban Drainage Design Manual" Section 4.3 Flow in Gutters*** shall be used to evaluate the curb flow capacity.

Nomographs and summary tables may also be used. Include the exhibits in the Drainage Report Appendix of calculations if used. The designer is cautioned to use nomographs and tables that are representative of a triangular channel section. For a standard concrete gutter, a value of 0.016 for "n" is required.

7.8 CHECKLIST

1. Inlets must be provided at intersections when a storm sewer is available.
2. The maximum allowable street capacity for minor events is 10 cfs or gutter capacity, whichever is less.
3. Nuisance flows must be carried by gutters or pans to an inlet. Nuisance flows are not allowed to cross a driving lane.
4. Cross pans are not allowed on collector or arterial streets or where a storm sewer is available.
5. Include copies of all nomographs, tables or design aids used for calculations.

8.0 INLETS

8.1 INTRODUCTION

This chapter provides guidelines and criteria for use in designing and sizing of inlets within The City. The primary purpose of storm drain inlets is to intercept excess surface runoff and divert it into a drainage system, thereby reducing the possibility of surface flooding.

The location of inlets, storm sewers, and other drainage structures in and along streets shall be such that ponding, cross flows, and the flooding of adjacent properties are minimized or eliminated. In no case shall water be allowed to pond or spread in excess of the limits defined described in **Chapter 7-Streets**.

The most common location for inlets is in streets that collect and channelize surface flow, making it convenient to intercept. Because the primary purpose of streets is to carry vehicular traffic, inlets must be designed to avoid conflicting with that purpose.

The following guidelines shall be used in the design of inlets to be located in streets:

1. Minimum transition for depressed inlets shall be 3’ per 1” depression upstream and 1’ per 1” depression downstream. The use of inlets with a depression is discouraged on collector, industrial, and arterial streets unless the inlet depression is recessed a minimum of 1' behind the curb.
2. When recessed inlets are used, they shall not interfere with the intended use of the sidewalk.
3. The capacity of a recessed inlet on grade shall be calculated as 0.75 of the capacity of a similar unrecessed inlet.
4. Design and location of inlets shall take into consideration pedestrian and bicycle traffic.
5. Inlet design and location must be compatible with the criteria established in **Chapter 9.0 Storm Sewers** and **Chapter 10.0 Open Channels** of this manual.
6. Inlet extensions shall be in 4-foot increments as per AHTD.
7. Bicycle-safe grates shall be installed in area where pedestrian bicycle traffic and safety is of concern.
8. The City Staff’s review of the proposed Drainage Plan shall include examination of the supporting calculations.
9. Inlets are not allowed in radii of street intersections without approval of the City Staff.

10. Maintain grades of intersections and through cul-de-sacs to prevent ponding and deposition of solids.
11. Curb inlets shall be located on sections of straight tangents.

8.2 CLASSIFICATION

Inlets are classified into three major groups, mainly: inlets in sumps (Type A), inlets on grade without gutter depression (Type B), and inlets on grade with gutter depression (Type C). Each of the three major classes includes several varieties. The following are presented here and are likely to find reasonably wide use. (See ***Figure 4-4 HEC-22***)

Inlets in Sumps

1.	Curb opening	Type A-1
2.	Grate	Type A-2
3.	Combination (grate & curb opening)	Type A-3

Inlets on Grade Without Gutter Depression

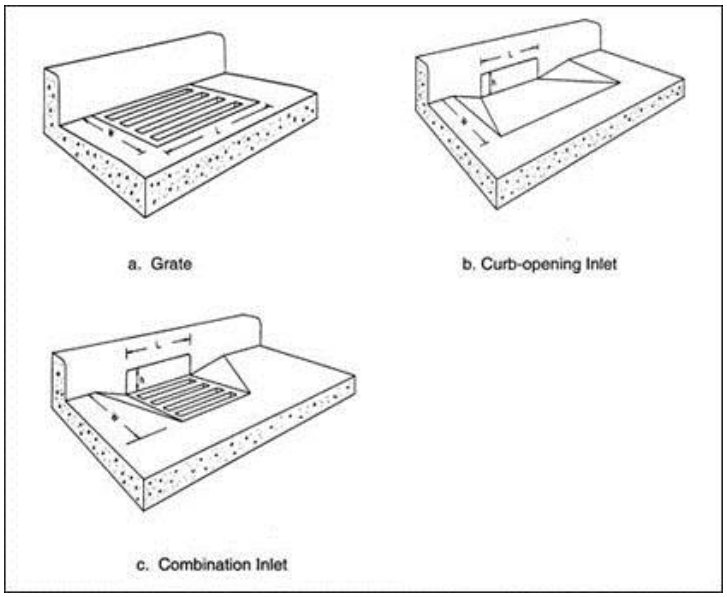
1.	Curb Opening	Type B-1
2.	Grate	Type B-2
3.	Combination (grate & curb opening)	Type B-3

Inlets on Grade With Gutter Depression

1.	Curb Opening	Type C-1
2.	Grate	Type C-2
3.	Combination (grate & curb opening)	Type C-3

Recessed inlets are identified by the suffix (R), (i.e.: A-1 (R)).

Figure 8.1 - HEC-22 - Figure 4-4 (modified). Classes of storm drain inlets.



8.3 INLET DESIGN

The FHWA **HEC-22** ***"Urban Drainage Design Manual"*** **Section 4.4** ***Drainage Inlet Design shall*** be used to evaluate the inlet flow capacity.

8.4 INLET CLOGGING

Curb opening inlets and grated inlets in sumps and on grade have a tendency to collect debris and clog, reducing the hydraulic efficiency of the inlet. Reduction factors shall be included in calculations for flow capacities as indicated in the inlet descriptions below.

8.5 INLETS IN SUMPS

Inlets in sumps are inlets placed in low points of surface drainage areas to relieve ponding. The capacity of inlets in sumps must be known in order to determine the depth and width of ponding for a given discharge.

8.5.1 GRATE INLETS (TYPE A-2)

Generally, a grate inlet, type A-2 in a sump, can be considered an orifice with the coefficient of discharge of 0.67.

Grate inlets in sumps have a tendency to clog when flows carry debris such as leaves and paper. For this reason, the calculated inlet capacity of a grate inlet shall be reduced by 50 percent to allow for clogging.

8.5.2 COMBINATION INLETS (TYPE A-3)

The capacity of a combined inlet type A-3 consisting of a grate and curb opening inlet in a sump shall be considered to be the sum of the capacities.

Combination inlets in sumps have a tendency to clog and collect debris at their entrance. For this reason, the calculated inlet capacity shall be reduced by 25 percent to allow for clogging.

8.6 Inlets on Grade Without Gutter Depression

8.6.1 CURB OPENING INLETS (TYPE B-1)

The capacity of the curb inlet, like any weir, depends upon the head and length of the opening. In the case of an undepressed curb opening inlet, the head at the upstream end of the opening is the depth of flow in the gutter. In streets where grades are greater than 1 percent, the velocities are high and the depths of flow are usually small, as there is little time to develop cross flow into the curb openings. Therefore, undepressed inlets are inefficient when used in streets of appreciable slope, but may be used satisfactorily where the grade is low and the crown slope high or the gutter channelized. Undepressed inlets do not interfere with traffic and usually are not susceptible to clogging. Inlets on grade should be designed and spaced so

that 20 to 40 percent of gutter flow reaching each inlet will carry over to the next inlet downstream, provided the water carry-over does not inconvenience pedestrian or vehicular traffic.

8.6.2 GRATE INLETS ON GRADE (TYPE B-2)

Undepressed grate inlets on grade have a greater hydraulic capacity than curb inlets of the same length so long as they remain unclogged. Undepressed inlets on grade are inefficient in comparison to grate inlets in sumps. For flow capacity through grate inlets, the Engineer should refer to FHWA publication HEC 22 or refer to appropriate vendor catalog. Grate inlets should be designed and spaced so that 20 to 40 percent of the gutter flow reaching each inlet will carry over to the next downstream inlet, provided the carry-over does not inconvenience pedestrian or vehicular traffic.

Grates shall be certified by the manufacturer as bicycle-safe. For flows on streets with grades less than 1 percent, little or no splashing occurs regardless of the direction of the bars.

Vane grate inlets are the recommended grates for best hydraulic capacity and should be the first grate type considered on any project. The calculated capacity for a grate inlet shall be reduced by 25 percent to allow for clogging.

8.6.3 COMBINATION INLETS ON GRADE (TYPE B-3)

The interception capacity of a combination inlet consisting of a curb opening and grate placed side-by-side is not appreciably greater than that of the grate alone. Capacity is computed by neglecting the curb opening. A combination inlet is sometimes used with the curb opening or a part of the curb opening placed upstream of the grate. The curb opening in such an installation intercepts debris that might otherwise clog the grate and has been termed a "sweeper" by some. A combination inlet with a curb opening upstream of the grate has an interception capacity equal to the sum of the two inlets, except that the frontal flow and thus the interception capacity of the grate is reduced by interception by the curb opening.

The capacity of a Type B-3 inlet without extensions shall be considered the same as the capacity of a Type B-2 inlet. The calculated capacity for a grate inlet shall be reduced by 25 percent to allow for clogging.

8.7 INLETS ON GRADE WITH GUTTER DEPRESSION

8.7.1 CURB OPENING INLETS ON GRADE (TYPE C-1)

The depression of the gutter at a curb opening inlet below the normal level of the gutter increases the cross-flow toward the opening, thereby increasing

the inlet capacity. Also, the downstream transition out of the depression causes backwater that further increases the amount of water captured. Depressed inlets should be used on continuous grades that exceed 1 percent, except that their use in traffic lanes shall conform to the requirements of Section VI of this manual.

The depression depth, width, length, and shape all have significant effects on the capacity of an inlet. Reference to Chapter 7 of this manual must be made for permissible gutter depressions.

8.7.2 GRATE INLETS ON GRADE (TYPE C-2)

The depression of the gutter at a grate inlet decreases the flow past the outside of a grate. The effect is the same as that when a curb inlet is depressed, mainly that the cross slope of the street directs the outer portion of flow towards the grate.

The bar arrangements for depressed grate inlets on streets with grades greater than 1 percent greatly affect the efficiency of the inlet. Grates with longitudinal bars eliminate splash that causes the water to jump and ride over the cross bar grates, and it is recommended that grates have a minimum of transverse cross bars for strength and spacing only.

For low flows or for streets with grades less than 1 percent, little or no splashing occurs regardless of the direction of the bars. However, as the flow or street grade increases, the grate with longitudinal bars becomes progressively superior to the cross bar grate. A few small rounded crossbars, installed at the bottom of the longitudinal bars as stiffeners or as a safety stop for bicycle wheels, do not materially affect the hydraulic capacity of the longitudinal bar grates. A bicycle-safe grate must be used.

Grate inlets and depressions have a tendency to clog gutter flow carries debris such as leaves and paper. For this reason, the calculated inlet capacity of a grate inlet shall be reduced by 25 percent to allow for clogging.

8.7.3 COMBINATION INLETS ON GRADE (TYPE C-3)

The interception capacity of a combination inlet consisting of a curb opening and grate placed side-by-side is not appreciably greater than that of the grate alone. Capacity is computed by neglecting the curb opening. A combination inlet is sometimes used with the curb opening or a part of the curb opening placed upstream of the grate. The curb opening in such an installation intercepts debris that might otherwise clog the grate and has been termed a "sweeper" by some. A combination inlet with a curb opening upstream of the grate has an interception capacity equal to the sum of the two inlets, except

that the frontal flow and thus the interception capacity of the grate is reduced by interception by the curb opening.

The capacity of a Type C-3 inlet without extensions shall be considered the same as the capacity of a Type C-2 inlet. For this reason, the calculated inlet capacity of a grate inlet shall be reduced by 25 percent to allow for clogging.

8.8 CALCULATION METHODS

Nomographs, charts and tables are available from Arkansas Highway and Transportation Department or the Federal Highway Administration and may be used for sizing inlets. Include the exhibits, nomographs, or tables in the Drainage Report Appendix of calculations. The designer is cautioned to use nomographs and tables that are representative of the type of inlet being designed. Verification of opening dimensions and grate type should be performed.

Several computer programs (FHWA Toolbox, HydraFlow, StormCAD) provide design solutions for inlet sizing and may be used by experienced engineers. The designer is cautioned to ensure the appropriate dimensional data is used for modeling purposes. Full summary report tabulations will be required for inclusion in the Drainage Report Appendix of calculations.

8.9 CHECKLIST

1. Inlets are required at sumps, median breaks with catch curbs, locations where allowable street capacity has been exceeded, and intersections.
2. Inlets should generally be located upstream rather than downstream of pedestrian curb ramps and driveways.
3. An emergency overflow route must be provided and indicated on plans for sump areas.
4. Include clogging factors for capacity reduction.
5. Verify inlet design dimensions are consistent with nomographs used.

9.0 STORM SEWERS

9.1 INTRODUCTION

A storm sewer is that portion of the drainage system that receives surface water through inlets then conveys the water through conduits to an outfall. Except as modified herein, the design of storm sewers shall be in accordance with the FHWA HEC-22 *"Urban Drainage Design Manual"*, ***Section 7.1 Hydraulics of Storm Drainage Systems***.

The location of inlets, storm sewers, and other drainage structures in and along streets shall be such that ponding, cross flows, and the flooding of adjacent properties are minimized or eliminated.

Where storm drainage crosses between lots to continue into other facilities, a swale shall be constructed to allow flows in excess of the design flows. When storm sewers are designed for the 50-year peak flow and are not within a public street, a drainage easement shall be provided that prohibits structures from blocking that flow. The easement shall be sized to pass the 50-year flow. The 100-year water surface elevation shall be plotted on the design drawings.

The design of the storm drainage system shall be governed by the following conditions:

1) The system must accommodate all surface runoff resulting from the selected design storm without serious damage to physical facilities or substantial interruptions of normal traffic.
2) Runoff resulting from storms exceeding the design storm must be anticipated and disposed of with minimum damage to physical facilities and minimum interruption of normal traffic.
3) The storm drainage system must have a maximum reliability of operation.
4) The construction cost of the system must be reasonable with relationship to the importance of the facilities it protects.
5) The storm drainage system must require minimum maintenance and must be accessible for maintenance operations.
6) The storm drainage system must be adaptable to future expansion with minimal additional costs.

9.2 DESIGN STORMS FOR SIZING STORM SEWERS

Two design storms shall be considered for sizing storm sewers, the minor (10-year) storm and the major (100-year) storm. In each case, storm sewers are to be sized to carry whatever portion of the runoff that cannot be conveyed on the surface, as dictated by the available capacity in streets and swales during these two events.

9.2.1 MINOR EVENT DESIGN STORM

At a minimum, storm sewers are to be sized to pick up any minor storm runoff that exceeds the minor event capacity of the street or roadside swales. Inlets are located at these points to intercept excess minor event flow and route it to the storm sewer. Storm sewers shall be designed to convey the minor storm flood peaks while flowing at 80 percent of the full pipe capacity.

9.2.2 MAJOR EVENT DESIGN STORM

There are conditions when the storm sewer system will be sized to convey flows greater than the minor storm runoff, including locations where:

1) The street capacity for the major storm is exceeded, especially where the grade slopes down behind the curb and the major storm capacity is limited to the height of the curb.
2) The major storm flows split off in an undesired direction (e.g., flow splits at intersections).
3) The storm sewer system is accepting flow from an upstream storm sewer system or branch that is designed for the major storm.
4) Regional storm sewers are designed for the major storm.
5) The storm sewers must convey undetained flows to a regional detention basin.

If a storm sewer is to be designed to carry major storm flows, the inlets to the storm sewer shall be designed accordingly. In pipes designed to convey up to the major storm, the hydraulic grade line (HGL) is allowed to rise above the top of the storm sewer, but shall be kept at least 1.0 foot below manhole lids, inlet grates and inlet curb openings.

9.3 CONSTRUCTION MATERIALS

Public storm sewers shall be:

- reinforced concrete box culverts for minimum HS-20 loadings
- R.C. pipe ASTM Class III with a minimum of 1 foot cover
- R.C. pipe ASTM Class IV when less than 1 foot of cover
- corrugated metal pipe of the required gage with a minimum of 2 feet of cover
- other as approved by the City Staff on a case-by-case basis.

9.4 PIPE SIZE

The minimum allowable pipe size for storm sewers is dependent upon a practical diameter from the standpoint of maintenance. The minimum diameter pipe allowed in public Right of Way shall be 18-inches.

9.5 HORIZONTAL AND VERTICAL ALIGNMENTS

In most cases, storm sewer alignment between drainage structures (inlets or manholes) shall be straight, using manholes to accommodate changes in alignment. Storm sewer horizontal alignment may be curvilinear for pipes with diameters of 48 inches or greater, but only when approved by the Review Engineer. The applicant must demonstrate the need for a curvilinear alignment. The radius limitations for pulled-joint pipe are dependent on the pipe length and diameter and amount of opening permitted in the joint. The maximum allowable joint pull shall be 3/4 inch. The minimum parameters for radius-type pipe shall be in accordance with the manufacturer's specifications.

In the design of a storm drainage system, the Engineer is frequently confronted with the problem of grade conflict between the proposed storm drain and existing utilities, such as water, gas, and sanitary sewer lines.

When conflicts arise between a proposed drainage system and utility system, the owner of the utility system shall be contacted and made aware of the conflict. Any adjustments necessary to the drainage system or the utility can then be determined. **Table 9.1** provides the minimum vertical alignment requirements between utility crossings with storm sewers.

Table 9.1 - Vertical Alignment Requirements for Storm Sewers

Vertical Alignment of Storm Sewer Relative to:	Minimum Vertical Clearance (above or below)	Comment
Cover	Minimum cover depends upon the pipe size, type and class, and the soil bedding Condition	The sewer grade shall be such that a minimum cover is maintained to withstand AASHTO HS-20 loading on the pipe.
Water Main	18-inches	Approval from Siloam Springs Water will be required for lesser clearances
Sanitary	12-inches	In addition, when a sanitary sewer main lies above a storm sewer, or within 18 inches below, the sanitary sewer shall have an impervious encasement or be constructed of approved sewer pipe with the nearest joint 9 feet from the centerline of the crossing.
Other	For vertical drops greater than 8-feet, special designs are required that address potential cavitation and energy dissipation.	These situations will require special review. See *Design and Construction of Urban Stormwater Management Systems* (ASCE and WEF 1992) for guidelines for drop shaft structures.

9.6 JUNCTIONS, INLETS, AND MANHOLES

Manholes shall be required whenever there is a change in size, direction, elevation, grade, or where there is a junction of two or more sewers. A manhole may be required at the beginning and/or at the end of the curved section of storm sewer. The maximum spacing between manholes shall be 400-feet.

The required manhole size shall be as follows denoted in **Table 9.2**.

Table 9.2 - Storm Sewer Manhole Size Requirements

MANHOLE SIZE	
Sewer Diameter	**Manhole Size**
18" to 24"	4'
27" to 42"	5'
48" to 54"	6'
60" and larger	To be approved by City

Larger manhole diameters or a junction structure may be required when sewer alignments are not straight through or more than one sewer line goes through the manhole.

9.7 HYDRAULIC DESIGN

The hydraulic grade line (HGL) and the EGL shall be calculated by accounting for pipe friction losses and pipe form losses. Total hydraulic losses shall be calculated accounting for friction, expansion, contraction, bend, and junction losses.

The final EGL shall be at or below the proposed ground surface for the design event. The HGL shall not exceed the crown of the pipe for the minor storm. In cases where the conduit is designed to convey up to the full 100-year flow, the allowable HGL must be 1 foot below inlet elevations, or 1 foot below ground where no inlets are present.

9.7.1 HYDRAULIC GRADE LINE

The HGL **shall be computed** for all storm sewer systems. A plotted hydraulic grade line shall be shown and labeled on the Plans. If STORM CAD

or other software is used, the printed summary results will be submitted with the drainage report.

9.7.2 STORM SEWER CAPACITY AND VELOCITY

The maximum full flow velocity shall be 20 fps. City Staff may approve higher velocities 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.

9.8 OUTLETS

Proper design of storm sewer outlets is necessary to minimize erosion at the outfall location and to protect public safety.

9.8.1 EROSION PROTECTION AT STORM SEWER OUTLETS

Adequate erosion protection shall be provided at all sewer outlets in the form of energy dissipaters as required in accordance with Section 12.4 of these Criteria. The outfall shall not discharge within a sloping embankment. All outlets will be designed to discharge with the invert located within the bottom of a channel outfall.

9.8.2 SAFETY

Headwalls and wingwalls associated with storm sewer outlets shall be provided with guardrails, handrails, or fencing in conformance with roadway design safety requirements. Handrails shall be required in all areas where the drop from the headwall or wingwall exceeds 30 inches. The height of the handrail shall be 42 inches for pedestrian walkways or open areas and 54 inches for bicycle traffic (AASHTO 2002).

9.9 CHECKLIST

1. Design the HGL not to exceed the pipe's crown for the minor storm event and not to exceed 1 foot below ground for the major event.
2. Account for all losses in the EGL and HGL calculations including outlet, form, bend, manhole, and junction losses.
3. Provide computer program design summary printout and graphic plots.
4. Minimum pipe size of 18-inches.
5. Provide adequate erosion protection at the outlet of all sewers.
6. Check for minimum pipe cover and clearance with utilities.
7. Provide emergency overflow path under sump conditions.
8. Erosion control measures must be provided at outfall structures.

10.0 OPEN CHANNELS

10.1 INTRODUCTION

This chapter provides the minimum technical criteria for the hydraulic evaluation and design of open channels in The City. In many instances, special design or evaluation techniques will be required.

10.2 GENERAL

Open channels for use in the major drainage system have significant advantages in regard to cost, capacity, multiple use for recreational and aesthetic purposes, and potential for detention storage. Disadvantages include right-of-way needs and maintenance costs. Careful planning and design are needed to minimize the disadvantages and increase the benefits.

Open channels may be used in lieu of storm sewers to convey storm runoff where:

(1) Sufficient right-of-way is available

(2) Sufficient cover for storm sewers is not available

(3) It is important to maintain compatibility with existing or proposed developments

(4) Economy of construction can be shown without long-term public maintenance expenditures

Intermittent alternating reaches of opened and closed systems should be avoided. Closed systems are preferred due to the inherent hazard of open channels in urban areas and the tendency for trash to collect in open channels.

The ideal channel is a natural one carved by nature over a long period of time. The benefits of such a channel are:

(1) Velocities are usually low, resulting in longer concentration times and lower downstream peak flows.

(2) Channel storage tends to decrease peak flows.

(3) Maintenance needs are usually low because the channel is somewhat stabilized.

(4) The channel provides a desirable green belt and recreational area, adding significant social benefits.

Generally speaking, the natural channel or the man-made channel that most nearly conforms to the character of the natural channel is the most efficient and desirable.

In many areas facing urbanization, the runoff has been so minimal that natural channels do not exist. However, a small trickle path nearly always exists that provides an excellent basis for location and construction of channels. Good land planning should reflect even these minimal trickle channels to reduce development

cost and minimize drainage problems. In most cases, the prudent utilization of natural water routes in the development of the major drainage system will reduce the requirements for an underground storm sewer system.

Channel stability is a well-recognized problem in urban hydrology because of the significant increases in low flows and peak storm runoff flows. A natural channel must be studied to determine the measures needed to avoid future bottom scour and bank cutting. Erosion control measures can be taken at a reasonable cost that will preserve the natural appearance without sacrificing hydrologic efficiency. This also helps reduce public cost and channel maintenance in the future.

Sufficient right-of-way or permanent easement should be provided adjacent to open channels to allow entry of City maintenance vehicles.

10.3 DESIGN CRITERIA

Open channels shall be designed to the following criteria:

(1) Open channels may be approved where needed to intercept runoff from an undeveloped area or from an area discharging sheet flow so that water does not wash across lots in an uncontrolled manner. Such channels shall be designed on a 50-year storm. In all cases for open channels, the Design Engineer shall calculate the 100-year flow and show the 100-year flow boundary and elevation on the plat.

(2) Major drainage channels or adjacent public drainage easement, floodway, etc., shall be capable of carrying the 100-year storm. Adjacent public drainage easements shall contain the width of flow of channel, floodway, floodplain, etc., plus an additional 10' on one side of the defined design top of bank or as approved by the City Staff.

10.3.1 CHANNEL DISCHARGE - MANNING'S EQUATION

The shear stress method of channel stability shall be used by the design engineer for all channels within the City. Theory and methodology may be found in FHWA, *Design of Roadside Channels with Flexible Lining, Hydraulic Engineering Circular Number 15, Third Edition*, *September 2005*.

A water surface profile must be computed for all channels and shown on all final drawings. Computation of the water surface profile should use standard backwater methods or acceptable computer routines, taking into consideration all losses due to the changes in velocity, drops, bridge openings, and other obstructions.

Channels should have sections of adequate cross-sectional areas to take care of uncertainties in runoff estimates, changes in channel coefficients, channel obstructions, and silt accumulations. Accurate determination of the "n" value is critical in the analysis of a channel's hydraulic characteristics. The "n" value of each channel reach should be based on experience and judgment with regard to the individual channel characteristics.

Where practical, unlined channels should have sufficient gradient, depending upon the type of soil, to provide velocities that will be self-cleaning but will not be so great as to create erosion. Lined channels, drop structures, check dams, or concrete spillways may be required to control erosion that results from the high velocities of large volumes of water. Unless approved otherwise by City Staff, channel velocities in man-made channels shall not exceed those specified in Table 10.1.

Table 10.1 - Permissible Velocities for Channels Lined with Grass

		Permissible Velocity (fps)	
Cover	**Slope Range (percent)**	**Erosion-Resistant Soils**	**Easily Eroded Soils**
Bermuda Grass	0-5	8	6
	5-10	7	5
	>10	6	4
Buffalo Grass, Kentucky bluegrass, smooth brome, blue grama	0-5	7	5
	5-10	6	4
	>10	5	3
Grass Mixture	0-5	5	4
	5-10	4	3
	Do not use on slopes steeper than 10%		
Lespedeza Sericea, weeping love grass, ischaemum (yellow bluestem), alfalfa, crabgrass	0-5	3.5	2.5
	Do not use on slopes steeper than 5%; except for side slopes in a combination channel		
Annuals – used on mild slopes or as temporary protection until permanent covers are established. Common lespedeza, Sudan grass	0-5	3.5	2.4
	Use on slopes steeper than 3% is not recommended		
Remarks: The values apply to average, uniform stands of each type of cover. Use velocities exceeding 5 fps only where good covers and proper maintenance can be obtained.			
Source: AHTD			

Where velocities exceed specified velocities, riprap, pavement, or other approved protective erosion protection shall be required. As minimum protection to reduce erosion, all open channel slopes shall be seeded or sodded as soon after grading as possible.

10.3.2 CHANNEL CROSS SECTIONS

The channel shape may be almost any type suitable to the location and to the environmental conditions. Often the shape can be chosen to suit open space and recreational needs and to create additional benefits.

(1) Side Slope
Except in horizontal curves, the flatter the side slope, the better. Normally, slopes shall be no steeper than 3:1, which is also the practical limit for mowing equipment. Rock or concrete-lined channels or those that for other reasons do not require slope maintenance may have slopes as steep as 1-1/2:1, or designed in rectangular form if walls are structurally designed.

(2) Depth
Deep channels are difficult to maintain and can be hazardous. Constructed channels should therefore be as shallow as practical. The maximum allowable normal flow depth is 5-feet.

(3) Bottom Width
Channels with narrow bottoms are difficult to maintain and are conducive to high velocities during high flows. It is desirable to design open channels so that the bottom width is at least twice the depth.

(4) Bend Radius
The minimum bend radius required for open channels is 25' or 10 times the bottom width whichever is larger.

(5) Freeboard
Freeboard height should be chosen to provide a suitable safety margin. The height of freeboard shall be the greater of:

1) 1' for velocities up to 8 fps,
2) 2' minimum for velocities over 8 fps, or
3) provide additional height as calculated by ***Equation 9.1***.

Freeboard (in feet) = $1.0 + 0.025\ V(D)^{1/3}$ *(Equation 9.1)*

Where,

V = Velocity of flow (fps)
D = Depth of flow (feet)

For the freeboard of a channel on a sharp curve, extra height must be added to the outside bank or wall in the amount:

$$H = V^2 \frac{(T + B)}{2gR}$$ *(Equation 9.2)*

Where,

H = Additional height on outside edge of channel (feet)
V = Velocity of flow in channel (fps)

T = Width of flow at water surface (feet)
B = Bottom width of channel (feet)
R = Centerline radius of turn (feet)
g = Acceleration of gravity (32.2 fps^2)

If R is equal to or greater than 3 x B, additional freeboard is not required.

(6) Connections
Connections at the junction of two or more open channels shall be smooth. Pipe and box culvert or sewers entering an open channel will not be permitted to project into the normal channel section, nor will they be permitted to enter an open channel at an angle that would direct flow from the culvert or sewer upstream in the channel.

10.4 CHANNEL LINING DESIGN

Open channels are generally the main facility for the major drainage system (except for the roadside ditch). If the historic or natural drainage path is selected for the open channel route, the construction costs for the system can be minimized and environmental opportunities optimized. The historic route along with minimum alteration of the existing channel is recommended for all drainage ways. In some instances, however, the land use of the property can be improved by relocating or straightening the natural drainage path, thereby improving the economic aspects of the project. The increased base flow from development may require additional design for channel flows.

10.4.1 UNLINED CHANNELS

Unlined channels shall not be permitted as the final design within the City. All channel designs shall incorporate a temporary lining if the final design lining is not fully functional upon construction.

10.4.2 TEMPORARY LININGS

Temporary linings are flexible coverings used to protect a channel until permanent vegetation can be established using seeding. For the most part, the materials used are biodegradable. Listed below are some of the temporary linings that can be used. Selected cover should **not** include a non-biodegradable material that will hinder mowing or maintenance operations (i.e. an erosion control blanket with a plastic string stitching that will wrap around a mower blade).

1. *Fiber glass roving
2. *Jute matting
3. *Wood fiber

* Refer to the Arkansas Highway and Transportation Department's Standard Specifications for material descriptions and construction methods.

10.4.3 GRASS LINING

AHTD seeding specifications shall be used.

10.4.4 ROCK RIPRAP (TO BE USED BY SPECIAL APPROVAL ONLY)

When rock riprap is used, the need for an underlying filter material must be evaluated. The filter material may be either a granular blanket or geotextile filter fabric.

10.4.6 CONCRETE

Concrete-lined channels provide high capacities, but also have high outlet velocities, so erosion problems become evident and must be dealt with. Concrete lined channels are the least preferred option for channel stabilization since concrete lining of channels precludes any beneficial biological processes. Concrete lining of channels will only be considered as a last resort.

10.5 HYDRAULIC STRUCTURES

Altering the channel alignment and shape may require the addition of grade control sections to control flow velocities. Grade control structures may also be required to control erosion from increased base flows due to urbanization. Hydraulic structures (e.g., riprap, channel grade control structures, bridges) help to control the energy associated with flowing water, thereby reducing erosion in the channel. Consideration of environmental, ecological, aesthetic and public safety objectives should be integrated with a thorough hydraulic engineering design.

The proper application of hydraulic structures can reduce initial and future maintenance costs by managing the character of the flow to fit the environmental and project needs. All hydraulic structures should be designed and constructed considering aesthetics and should fit in with their surroundings to the extent practicable. Structures must be designed with long-term maintainability as a key consideration.

10.5.1 APPLICATION OF HYDRAULIC STRUCTURES AND DESIGN GUIDANCE

The criteria to be used in the design of hydraulic structures shall be in accordance with Chapter 8 "*Hydraulic Structures*" and MAJOR DRAINAGE chapters of the Urban Drainage and Flood Control District's *Urban Storm Drainage Criteria Manual*, unless modified herein.

10.5.2 CHANNEL DROPS

The use of channel drops permits adjustment of channel gradients that are too steep for the design conditions. In urban drainage work, it is often desirable to use several low-head drops in lieu of a few higher drops.

The use of sloped drops will generally result in lower installation cost. Sloped drops can easily be designed to fit the channel topography.

Sloped drops shall have roughened faces and shall be no steeper than 2:1. They shall be adequately protected from scour and shall not cause an upstream water surface drop that will result in high velocities upstream. The design should offer protection against side cutting just downstream from the drop, which is a common problem.

10.5.3 BAFFLE CHUTES

Baffle chutes are used to dissipate the energy in the flow at a larger drop. They require no tail water to be effective. They are particularly useful where the water surface upstream is held at a higher elevation to provide head for filling a side storage pond during peak flows.

Baffle chutes are used in channels where water is to be lowered from one level to another. The baffle piers prevent undue acceleration of the flow as it passes down the chute. Since the flow velocities entering the downstream channel are low, no stilling basin is needed. The chute, on a 2:1 slope or flatter, may be designed to discharge up to 60 CFS per linear foot of width, and the drop may be as high as structurally feasible. The lower end of the chute is constructed to below streambed level and backfilled as necessary. Degradation of the streambed does not, therefore, adversely affect the performance of the structure. In urban drainage design, the lower end should be protected from the scouring action.

The baffled apron shall be designed for the full discharge design flow. Baffle chutes shall be designed using acceptable methods such as those presented by A.S. Peterka of the United States Bureau of Reclamation and Engineering Nomograph No.25.

10.5.4 STRUCTURAL AESTHETICS

The use of hydrologic structures in the urban environment requires an approach not encountered elsewhere in the design of such structures. The appearance of these structures is very important. The treatment of the exterior should not be considered of minor importance. Appearance must be an integral part of the design.

Parks. It must be remembered that structures are often the only above-ground indication of the underground works involved in an expensive

project. Furthermore, parks and green belts may later be developed in the area in which the structure will play a dominant environmental role.

Play Areas: An additional consideration is that the drainage structures offer excellent opportunities for neighborhood children to play. It is almost impossible to make drainage works inaccessible to children, and therefore, what is constructed should be made as safe as reasonably possible. Safety hazards should be minimized and vertical drops protected with decorative fencing or rails.

Concrete Surface Treatment: The use of textured concrete presents a pleasing appearance and removes form marks. Exposed aggregate concrete is also attractive but may require special control of aggregate used in the concrete and may result in unsafe slippery surface conditions.

Rails and Fences: The use of rails and fences along concrete walls provides a pleasing topping to an otherwise stark wall and also gives a degree of protection against someone inadvertently falling over the wall.

10.6 MAINTENANCE

Due to the difficulty and expense to the public with regard to hand cleaning, clearing, and other channel maintenance, the following channel requirements are specified to expedite small equipment cleaning and access to drainage easements and channels:

- Manholes are not allowed in drainage channels.
- Access easements shall be required every 600 feet.
- Utility crossings above the channel flowline shall not be allowed unless approved in writing by the City Staff.
- Utilities shall not be located beneath a concrete channel bottom except at crossings or be accepted and approved in writing by the City Staff.
- Utilities under earthen channels will have a minimum cover of 3 feet.

10.7 OPEN CHANNEL ANALYSIS SOFTWARE

To aid in the analysis and design of open channels, the City will allow the use of HEC-RAS or an acceptable equal approved by the City.

10.7.1 HEC-RAS

The U.S. Army Corps of Engineers' Hydrologic Engineering Center-River Analysis System (HECRAS)

For an in-depth discussion of the program's capabilities and limitations refer to the HEC-RAS River Analysis System, Reference Manual, January 2010, U.S. Army Corps of Engineers, Hydraulic Engineering Center, (916) 440-2105.

10.8 CHECKLIST

1. Check flow velocity with low retardance ("n") factor and capacity with high retardance factor.
2. Check shear stress for design flows.
3. Grass channel side slopes must be 3:1 or flatter.
4. Show EGL and water surface profile on design drawings.
5. Consider all backwater conditions (i.e., at culverts) when determining channel capacity.
6. Check velocity for conditions without backwater effects.
7. Provide adequate freeboard.
8. Provide adequate ROW for the channel and continuous maintenance access.

11.0 CULVERTS

11.1 INTRODUCTION

The function of a drainage culvert is to pass the design storm flow under a roadway or railroad without causing excessive backwater and without creating excessive downstream velocities. The designer shall keep energy losses and discharge velocities within reasonable limits when selecting a structure.

11.2 HEADWALLS AND END WALLS

The normal functions of properly designed headwalls and end walls are to anchor the culvert, to prevent movement due to the lateral pressures, to control erosion and scour resulting from excessive velocities and turbulence, and to prevent adjacent soil from sloughing into the waterway opening. Headwalls shall be constructed of reinforced concrete and may either be straight parallel headwalls, flared headwalls, or warped headwalls with or without aprons, as may be required by site conditions. Multi-barrel culvert crossings of roadways at an angle of 15° or greater shall be accompanied by adequate inlet and outlet control sections.

11.2.2 CONDITIONS AT ENTRANCE

It is important to recognize that the operational characteristics of a culvert may be completely changed by the shape or condition at the inlet or entrance. Design of culverts involves consideration of energy losses that occur at the entrance.

11.2.3 SELECTION OF HEADWALL OR ENDWALL

In general, the following guidelines should be used in the selection of the type of headwalls or end walls:

Straight/Parallel Headwall and End wall:

- Approach velocities are low (below 6 fps).
- Backwater pools may be permitted.
- Approach channel is undefined.
- Ample right-of-way or easement is available.
- Downstream channel protection is not required.

Parallel Headwall and End wall:

- Approach velocities are low [below six (6) feet per second].
- Backwater pools are permitted.

Flared Headwall and End wall:

- Channel is well defined.
- Approach velocities are between 6 and 10 fps.
- Medium amounts of debris exists

The wings of flared walls should be located with respect to the direction of the approaching flow instead of the culvert axis.

Warped Headwall and End wall:

- Channel is well defined and concrete lined.
- Approach velocities are between 8 and 20 fps.
- Medium amounts of debris exists

These headwalls are effective with drop down aprons to accelerate flow through the culvert and are effective for transitioning flow from closed conduit flow to open channel flow. This type of headwall should be used only where the drainage structure is large and right-of-way or easement is limited.

11.3 CULVERT DISCHARGE VELOCITIES

The velocity of discharge from culverts shall be limited as shown in **Table 11.2**. Consideration must be given to the effect of high velocities, eddies, or other turbulence on the natural channel, downstream property, and roadway embankment.

Table 11.2 - Culvert Discharge-Velocity Limitations

Downstream Condition	Maximum allowable Discharge Velocity (FPS)
Earth	6
Sodded Earth	8
Paved or Riprap Apron	15
Shale	10
Rock	15

Energy dissipators will be required at channel drops when the unit discharge exceeds 35 cfs and at culvert outlets when the discharge velocity exceeds those recommended in Table 11.2 for a given downstream channel condition.

The FHWA's Hydraulic Design of Energy Dissipators for Culverts and Channels, *Hydraulic Engineering Circular Number 14, Third Edition* shall be referenced for design methods.

11.3.1 ENERGY DISSIPATORS

Energy dissipators are used to dissipate excessive kinetic energy in flowing water that could promote erosion. An effective energy dissipator must be able to retard the flow of fast moving water without damage to the structure or to the channel below the structure.

Impact-type energy dissipaters direct the water into an obstruction that diverts the flow in many directions and in this manner dissipates the energy in the flow. Baffled outlets and baffled aprons are two impact-type energy dissipaters.

Other energy dissipaters use the hydraulic jump to dissipate energy. In this type of structure, water flowing at a higher than critical velocity is forced into a hydraulic jump, and energy is dissipated in the resulting turbulence. Stilling basins are an example of this type of dissipater, where energy is diffused as flow plunges into a pool of water.

Generally, the impact-type of energy dissipater is considered to be more efficient than the hydraulic jump-type. Also the impact-type energy dissipater results in smaller and more economical structures.

11.4 CULVERT TYPES AND SIZES

The only permissible types of culverts under all public roadways and streets are reinforced concrete box, round, or elliptical concrete pipe or pipe arch.

The minimum size of pipe for all culverts shall be 18" or the equivalent sized elliptical pipe or arch pipe. Box culverts may be constructed in sizes equal to or larger than 4' x 3' (width versus height), except as approved by the City Staff.

If material other than reinforced concrete pipe is to be used under roadways, it shall be approved by the City Staff on a case by case basis.

Flared, precast concrete and metal pipe aprons may be used in lieu of headwalls to improve the hydraulic capabilities of the culverts. Pipe sizes greater than 36-inches shall require headwalls.

The construction standards for culverts and bridges shall be in strict accordance with the latest published AHTD standards, or as amended by the City of Siloam Springs ordinances.

11.5 FILL HEIGHTS AND BEDDING

The minimum cover over any reinforced concrete culvert or box culvert shall be a minimum of 12" to the top of the subgrade. All other types of culverts shall have a minimum cover of 24” to the top of the subgrade. Minimum cover less than these values shall be fully justified in writing and approved by the City Staff prior to proceeding with final plans. Maximum fill heights shall be according to manufacturer’s specifications. Box culverts shall be structurally designed to accommodate earth and live load to be imposed upon the culvert. Refer to the Arkansas Highway and Transportation Departments Standard Plans for Typical Box

Culvert Designs. When installed within public right-of-ways or easements, all culverts shall be capable of withstanding minimum HS20 loading.

Where culverts under railroad facilities are necessary, the designer shall obtain permits from the affected railroad.

11.6 CULVERT DESIGN PROCEDURE

The design of culverts in the City shall be in accordance with FHWA's ***Hydraulic Design of Highway Culverts*, Hydraulic Design Series No. 5 (HDS-5).**

11.7 CULVERT ANALYSIS SOFTWARE

The City will allow the analysis of trapezoidal and circular channels, and pipe and box culvert using the FHWA Culvert Analysis (HY8) or acceptable equal software.

11.7.1 FHWA CULVERT ANALYSIS (HY8)

FHWA Culvert Analysis (HY8) software was developed by Pennsylvania State University in cooperation with the Bridge Division (HNG-31). The HY8 software is sponsored by the Rural Technical Assistance Program (RTAP) of the National Highway Institute under Project 18B administered by the Pennsylvania Department of Transportation.

The HY8 software automates the design methods described in HDS5, Hydraulic Design of Highway Culverts, FHWA-IP-85-15. HDS5 is available from the Government Printing Office, Washington, DC 20402.
http://www.fhwa.dot.gov/engineering/hydraulics/software/hy8/

11.8 CHECKLIST

1. No street overtopping for the 10-year storm.
2. Check minimum and maximum outlet velocity.
3. Minimum culvert size crossing the public ROW is 18-inch diameter or equivalent.
4. Headwalls and wingwalls are provided for all culverts with diameter larger than 36 inches.
5. Check maximum headwater for design conditions.
6. Check structural requirements and emergency overflow route.
7. Check public safety provisions.
8. Check backwater effects if culvert is part of a major drainageway

12.0 DETENTION (STORAGE)

12.1 INTRODUCTION

If hydrologic and hydraulic studies reveal that the proposed development would cause increased flood stages that would increase the flood damages to existing developments or property, or increase flood elevations beyond the vertical limits set for the floodplain districts, then the grading or construction permit applications shall be denied unless one or more of the following mitigations measures are used subject to Planning Commission approval: (1) Onsite storage, (2) offsite storage, or (3) improve the downstream drainage system.

Except as modified herein, the design of Stormwater Detention Facilities shall be in accordance with the FHWA HEC-22 *"Urban Drainage Design Manual"*, ***Section 8. Detention and Retention Facilities***.

Criteria for differential runoff and detention guidelines are set out in the following paragraphs, in an attempt to mitigate the possible effects of development on downstream properties due to increased runoff. Refer to **Chapter 13 – Water Quality** for an alternative to detention ponds using Low Impact Development techniques.

12.2 VOLUME OF DETENTION

Volumes of detention shall be evaluated according to the following methods:

A. Volume of detention for basins with total drainage areas of less than 100 acres may be evaluated by the "Modified Rational Hydrograph Method."

B. For basins with total drainage areas larger than 100 acres, the Owner's Engineer shall use the HEC-HMS flow routing method.

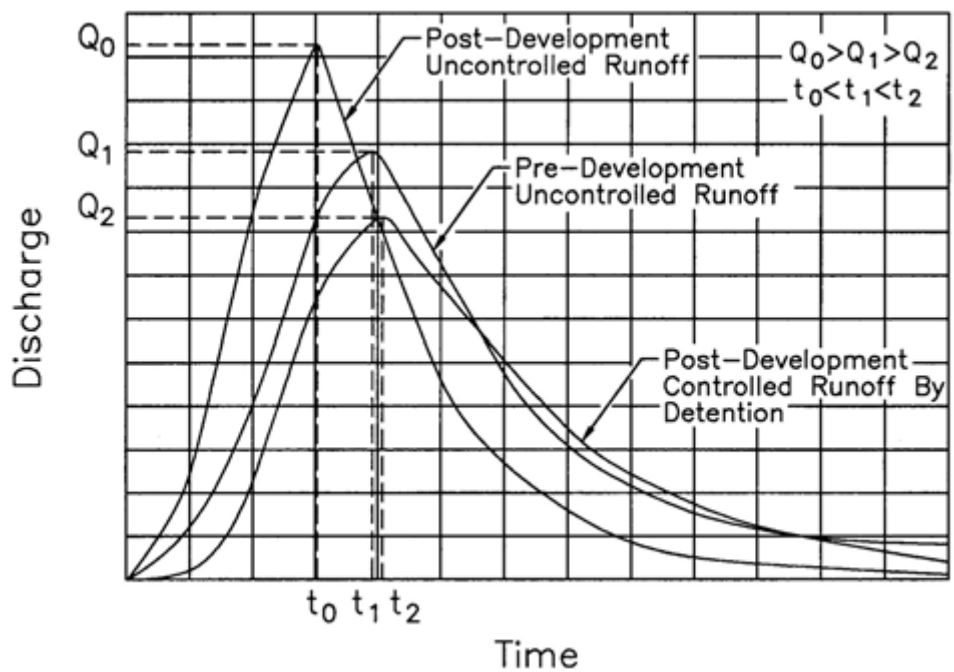
C. The computed hydraulic detention volume, described by a method presented in this section, will be increased by 25 percent to provide for sediment storage of undeveloped and channel erosion of upstream tributary areas. City Staff may reduce this requirement depending on the development characteristics and stream stability of upstream tributary areas.

12.3 DESIGN CRITERIA

Stormwater detention ponds shall be designed to limit the peak stormwater discharge rate provide for Excess Urban Runoff Volume (i.e., Full Spectrum Detention) in conjunction with the 100-year detention volume. Reference *"Full Spectrum Detention to Control Stormwater Runoff"* for description, theory and intent of the Excess Urban Runoff Volume.
http://www.udfcd.org/downloads/pdf/tech_papers/Full%20Spectrum%20Detention%202007.pdf

Figure 12.1 illustrates the concept of detention storage by comparing a runoff hydrograph to a detention facility outflow hydrograph.

Figure 12.1 – Detention Storage



Source: UFC 03-320-01/ FAA AC 150/5320-5C - Surface Drainage Design

A concrete trickle channel with a minimum width of 4 feet and a minimum slope of 0.40% shall be required for all detention ponds other than permanent lakes.

12.4 METHOD OF DETENTION

The following conditions and limitations shall be observed in selection and use of the method of detention:

12.4.1 GENERAL LOCATION

Detention facilities shall be located within the parcel limits of the project under consideration. No detention or ponding will be permitted within public road right-of-ways. Location of detention facilities immediately upstream or downstream of the project will be considered by special request if proper documentation is submitted with reference to practicality, feasibility, and proof of ownership or right-of-use of the area proposed. Conditions for general location of detention facilities are identified in the following sections.

12.4.2 DRY RESERVOIRS

Wet weather ponds or dry reservoirs shall be designed with proper safety, stability, and ease of maintenance facilities. Maximum side slopes for grass reservoirs shall not exceed 1' vertical for 3' horizontal (3:1) unless adequate measures are included to provide for the above-noted features. In no case shall the limits of maximum ponding elevation be closer than 20' horizontally from any building and less than 2' vertically below the lowest sill or floor elevation. The entire reservoir area shall be sodded as required prior to final plat approval or issuance of certificate of occupancy unless a bond is posted for completion of said work. Any area designed as overflow shall be sodded or paved depending upon the outflow velocity.

12.4.3 PERMANENT LAKES

Permanent lakes with fluctuating volume controls may be used as detention areas provided that the limits of maximum ponding elevations are no closer than 50' horizontal from any building and greater than 2' below the lowest sill or floor elevation of any building.

Maximum side slopes for the fluctuating area of permanent lakes shall be 1' vertical to 3' horizontal (3:1) unless provisions are included for safety, stability, and ease of maintenance.

Special consideration is suggested regarding safety and accessibility of small children in design of permanent lakes in residential areas. Allowances for silting during construction, for a period of no less than one year, are also recommended.

The entire fluctuating area of the permanent reservoir shall be sodded. Also, calculations must be provided to ensure adequate "live storage" is provided for the 100-year storm. Any area susceptible to or designed as overflow by higher design intensity rainfall (100-year frequency) shall be sodded or paved, depending on the design velocities. An analysis shall be furnished of any proposed earthen dam construction soil. The City Staff may request a boring of the foundation for the earthen dam. A Professional Engineer shall design earthen dam structures.

12.4.4 PARKING LOTS

Detention is permitted in parking lots to maximum depths of 6 inches. In no case should the maximum limits of ponding be designed closer than 10' from a building unless waterproofing of the building and pedestrian accessibility are properly documented and approved.

The minimum freeboard and the maximum ponding elevation to the lowest sill or floor elevation shall be 2'.

Performance - To assure that the detention facility performs as designed, maintenance access shall be provided in accordance with Section 3.3.3. The

outlet shall be designed to minimize unauthorized modifications, which affect function. Any repaving of the parking lot shall be evaluated for impact on volume and release rates and is subject to approval by the Department of Planning and Community Development. A sign shall be attached or posted in accordance with Section 13.4.7.

Flood Hazard Warning -All parking lot detention areas shall have multiple signs posted identifying the detention basin area. The signs shall have a minimum area of 1.5 square feet and containing the following message:

WARNING
This area is a detention basin and is subject
to periodic flooding to a depth of (provide design depth).

Any suitable materials and geometry of the sign are permissible, subject to approval by the Department of Planning and Community Development.

12.4.5 RETENTION PONDS

A retention facility (a pond with a zero release rate or a very slow release rate when a trickle outflow can be tolerated) is used when there is no available formal downstream drainageway, or one that is grossly inadequate. When designing a retention facility, the hydrologic basis of design is difficult to describe because of the stochastic nature of rainfall events. Thus, sizing for a given set of assumptions does not ensure that another scenario produced by nature (e.g., a series of small storms that add up to large volumes over a week or two) will not overwhelm the intended design. For this reason, retention ponds are strongly discouraged as a permanent solution for drainage problems. They have been used in some instances as temporary measures until a formal system is developed downstream.

12.4.5.1 Allowable Use

When a retention pond is proposed as a temporary solution to an evolving drainage problem, the pond shall be sized to capture, as a minimum, the runoff equal to 1.5 times the 24-hour, 100-year storm plus 1-foot freeboard. The facility also shall be situated and designed so that when it overtops, no human occupied or critical structures (e.g., electrical vaults) will be flooded, and no catastrophic failure at the facility (e.g., loss of dam embankment) will occur. Retention facilities shall be as shallow as feasible to encourage infiltration and other losses of the captured urban runoff. The maximum allowable depth of retained water is 4 feet. A minimum infiltration drawdown of the volume in 72 hours will be required for all retention ponds. If this volume cannot be infiltrated within this time frame, a secondary outlet must be designed to provide additional releases from the pond.

12.4.5.2 Calculation of Retention Volume

The standard methodology described below in Equation 12.1 shall be used for calculating the required volume for retention. The intent of this methodology is to provide a simple, reasonable calculation without compromising The City's policies for public safety and welfare.

$$Vr = 1.5 \times C\,[(R / 12) \times A] \qquad \textit{(Equation 12.1)}$$

where:

Vr = Volume of retention pond in acre-feet
C = 100-year Coefficient of Imperviousness
R = 100-year 24-hour NOAA Rainfall in inches = 8.80 inches
A = Area of development in acres

The proposed site development plan shall be used to determine the coefficient of imperviousness value for use in Equation 12.1.

12.4.5.3 Design Standards for Retention Ponds

Design standards for retention ponds must comply with specific site development; flood proofing, site investigation and physical design considerations, as described below.

1. Site Development: The total development site area must be accounted for when planning for the retention of stormwater runoff. Provide grading for the entire site development to drain to the retention pond. Any off-site basins that historically flow through the site must be provided flow routes around the site and returned to the natural drainageway. Off-site drainage cannot be excluded if there is no other discharge location to be used; therefore, in volume calculations, include all off-site drainage basin areas that cannot otherwise be rerouted around the development and returned to the natural drainage path.

2. Floodproofing: The construction of a retention pond is essentially creating an isolated floodplain on the property. Delineate the limits of the 100-year flood area on the design drawing. Provide 1-foot of freeboard from the 100-year maximum water surface elevation of retention pond volume. Provide a 100-year emergency release overflow route from the site, which returns the flow back to its natural drainage path. Ensure finished floor elevations are 1.5 feet above the water surface elevation when the emergency spillway is conveying the maximum design flow or emergency flow.

3. Site Investigation: Site selection for infiltration retention ponds is critical. Factors for evaluating site suitability include:

- Location of groundwater table
- Location of bedrock
- Seasonal fluctuation of water table
- Soil permeability and porosity
- Soil profile
- Environmental conditions (e.g., contaminated soils)
- Proximity to structures (e.g., basements)

The following factors would preclude the site's use as a retention infiltration pond:

- A seasonal high groundwater of less than 4 feet below the pond bottom
- Bedrock within 4 feet of the pond bottom
- Pond location over fill
- Surface and underlying soils classified as NRCS Hydrologic Group D
- Saturated infiltration rate less than 0.3 inch per hour

A thorough geotechnical and geohydrological investigation shall be performed to determine site suitability. The following shall be included in the investigation:

- Soil borings to a depth of 10 feet or to bedrock
- Percolation tests
- Soil classification

4. Physical Design Characteristics: The pond construction shall conform to the criteria as explained in Section 12.4 for above-ground detention basins.

12.4.6 OTHER METHODS

Other methods of detention such as seepage pits, French drains, etc., are discouraged. If other methods are proposed, proper documentation of soil data, percolation, geological features, etc., will be needed for review and consideration.

12.5 DISCHARGE SYSTEMS

In the case of detention basins, sizing of the system below the control structure shall be for the total improved peak runoff contribution to the structure, with no allowance for detention unless approved in writing by the City Staff.

12.6 OWNERSHIP OF STORMWATER DETENTION PONDS

Ownership of stormwater detention ponds in residential subdivisions accepted by the City shall be vested in the City of Siloam Springs within 30 days after filing the final plat. The Developer must warrant the operation of the drainage system for a 1-year period after the acceptance by the City by an acceptable Maintenance Bond or equal provided by the Developer's Contractor or the Developer. The bond shall be required to be extended until 1 year after all phases of the subdivision that substantially drain into the basin are completed. Ownership of stormwater detention ponds in commercial, industrial and non-residential areas **not** accepted by the City of Siloam Springs shall be vested in the property owner.

No alteration of the drainage system will be allowed without the approval of City Staff. If construction of the basin is not complete, a cash bond from an acceptable financial institution shall be posted in addition to the Performance/Payment Bond.

12.7 EASEMENTS

Easements shall be provided in Plans for detention facilities if the basin is not to be deeded to the City of Siloam Springs. A minimum 20'-wide drainage easement shall be provided around the 100-year flood pool, connecting the tributary pipes and the discharge system along the most passable routing of piping system.

12.8 MAINTENANCE

Detention facilities, when required, are to be built in conjunction with storm sewer installation and/or grading. Since these facilities are intended to control increased runoff, they must be partially or fully operational soon after the clearing of the vegetation. Silt and debris associated with early construction shall be removed periodically from the detention area and control structure to maintain the facility's storage capacity.

Maintenance of detention facilities is divided into two components. The first is long-term maintenance that involves removal of sediment from the basin and outlet control structure. Maintenance to an outlet structure is minimal due to the initial design of permanent concrete or pipe structures. Studies indicate that in developing areas, basin cleaning by front-end loader or grader is estimated to be needed once every 5 to 10 years. In residential subdivisions where the City has accepted the detention basin, the City is responsible for long-term maintenance. The residential developer and all non-residential property Owners are responsible for long-term maintenance in basins not accepted by the City.

Short-term maintenance or annual maintenance is the second component and is the responsibility of the Developer or association for 2 years after acceptance of the final plat or filing of the last subdivision phase that substantially adds stormwater to a detention basin. The items considered short-term maintenance are as follows:

1. Minor dirt and mud removal
2. Outlet cleaning
3. Mowing
4. Herbicide spraying (in strict conformance with state and federal law)
5. Litter control

The responsibility of maintenance of the detention facilities and single-lot development projects shall remain with the general contractor until final inspection of the development is performed and approved, and a legal occupancy permit is issued. After legal occupancy of the project, the maintenance of detention facilities shall be vested with the owner of the detention pond.

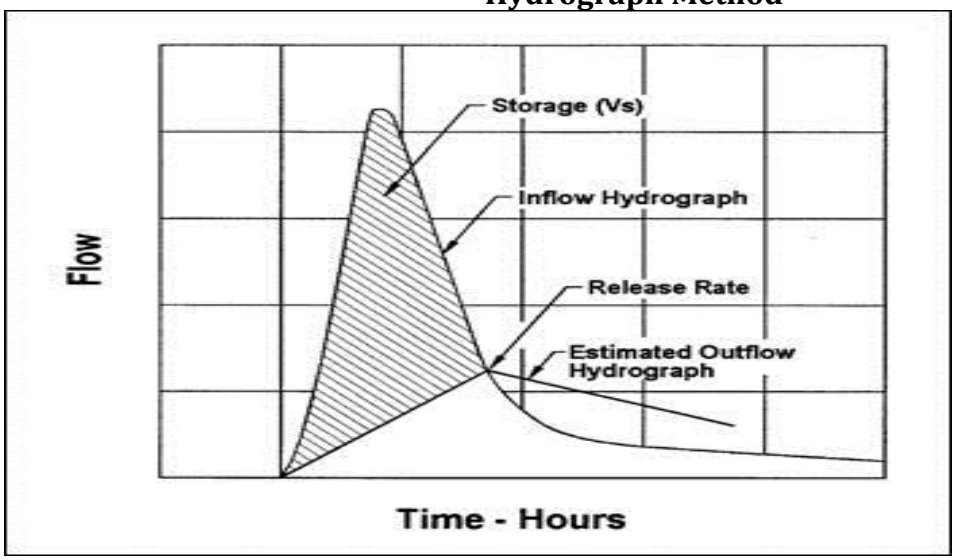
12.9 DETENTION BASIN DESIGN PROCEDURE

The design engineer will use the hydrograph method as described in ***FHWA HEC 22 Urban Drainage Design Manual*, *Chapter 8*** for calculating the required volume design (Reference **Figure 12.2**).

Outlet structure release design and stage/storage/discharge table design shall also be in accordance with Chapter 8 of HEC 22. Design examples are included.

Figure 12.2 - Estimating required storage

Hydrograph Method



Source: FHWA HEC 22

12.5 OUTLET WORKS

Detention facilities shall be provided with effective outlet works. Safety considerations shall be an integral part of the design of all outlet works. Plan view and sections of the structure with adequate details shall be included in Plans.

The outlet structure selected shall be designed to provide for Excess Urban Runoff Volume (i.e., Full Spectrum Detention) in conjunction with the 100-year detention volume. Slow release of the 10-year detention volume and controlled release of the 100-year volume to match the existing 100-year flow rate.

The overflow opening or spillway shall be designed to accept the total peak runoff of the improved tributary area.

Reference *Urban Drainage and Flood Control District Criteria Manual Chapter 10 Storage* for design details and equations for orifice, V-notch weir, rectangular weir, and EURV release outlet structures.
http://udfcd.org/downloads/pdf/critmanual/Volume%202%20PDFs/100%20Chapter%2010%20Storage%202011-12%20rev.pdf

All outlets shall be designed to minimize unauthorized modifications that affect proper function. A sign with a minimum area of 1.0 square foot shall be attached to the outlet or posted nearby (if unable to be posted to the outlet) with the following message:

WARNING
Keep screen and grate clean.
Unauthorized modification of this outlet
is a code violation.

12.11 VERIFICATION OF ADEQUACY

Upon completion of a project, the original design engineer shall provide As-Built plans and volume/release verification calculations to the City. The engineer shall certify that the project was constructed in accordance with the plans and specifications. The certification shall document that the constructed project is adequate and sufficient to accomplish the purpose of the project.

12.12 STORMWATER DETENTION ANALYSIS SOFTWARE

The City will allow the use of the following software or an acceptable equal approved by the City for the analysis of stormwater detention facilities.

12.12.1 POND-2

Pond-2 is a program for detention pond design. It estimates detention storage requirements, computes a volume-rating table for any pond configuration, routes hydrographs for different return frequencies through alternative ponds, and plots the resulting inflow and outflow hydrographs. Pond-2 automatically computes outflow-rating curves for single or multi-stage outlet structures, and computes the controlling flow rate for outlets operating in series. Pond-2 handles orifices, weirs, box culverts, circular

culverts, and more. Pond-2 is included in the **Pond Pack**, by Haested Methods, where it is integrated with Quick TR-55.

12.12.2 HEC-HMS

HEC-HMS generates hydrographs from rainfall or snowmelt, adds or diverts them, then routes through reaches and reservoirs. HEC-HMS models multiple streams and reservoir networks. It handles level-pool routing for reservoirs and detention ponds, and routes through stream reaches using Kinematic Wave, Modified Puls, and other methods. The NCRS dimensionless hydrograph option will be used with HEC-HMS to compute unit hydrographs.

12.13 CHECKLIST

1) Grade earth slopes 3:1 or flatter.
2) Provide minimum freeboard of 1 foot.
3) Provide trickle channels in above-ground detention areas.
4) Protect embankment from overtopping conditions.
5) Provide proper trash racks at all outlet structures.
6) Provide signs as required.
7) Provide maintenance access.
8) Provide emergency spillway and check emergency overflow path.
9) Check finished floor elevation of any structure near the detention basin.
10) Ensure that failure of underground detention is clearly evident from above ground.
11) Design the invert of the inflow pipe to the detention basin to be higher than the water quality level.
12) Include Stage/Storage/Discharge table on construction plans.

13.0 WATER QUALITY

13.1 INTRODUCTION

The City of Siloam Springs does not yet fall under the Arkansas Department of Environmental Quality (ADEQ) as a Municipal Separate Storm Sewer Systems (MS4) permittee. However, in anticipation of future requirements, The City intends to operate in compliance with the Federal National Pollution Discharge Elimination System (NPDES) Stormwater Program (40 CFR 122.34(b)(5)).

Through the implementation of policies and management practices embodied in the Stormwater Plan over time, Siloam Springs plans to improve urban stormwater quality and reduce negative impacts to local rivers and streams, and to develop and preserve the urban drainage infrastructure in a manner that meets the community's needs for years to come.

The City of Siloam Springs places a high priority on implementing new and innovative environmental friendly development techniques to protect sensitive public and private water supplies. The City's responsibility is to ensure that any development that occurs within the City Limits and within the city's planning area is in the best interest of its citizens, and that the City will continue to grow in a manner that provides the best quality of life for the citizens.

While the State and Federal regulatory programs place significant emphasis on improving water quality and the health of Arkansas's watersheds, Siloam Springs, as part of the Illinois River Watershed further emphasizes the need for local management of urban stormwater and waterways. It becomes even more important that management of these resources occur in a manner that minimizes destructive long-term impacts to drainage infrastructure and the natural features that help protect water quality and control flooding.

13.2 APPLICABILITY CRITERIA

Drainage systems shall be designed to reduce the discharge of pollutants from developed sites to the maximum extent practicable (MEP), to protect water quality, and to satisfy the appropriate water quality requirements of the Clean Water Act.

Developments and redevelopments within the city are required to comply with the following criteria:

1. All development and redevelopment projects greater than or equal to 1-acre in size will provide specific measures to enhance the water quality of storm-generated runoff from the fully developed project site.

2. All detention facilities for drainage and flood control purposes shall also provide water quality enhancement features.

13.3 MINIMUM STANDARDS

The City of Siloam Springs requires implementation of these measures to the maximum extent practicable:

1. Reduce post-development site runoff volume. This includes implementation of measures that minimize directly connected impervious area and promote infiltration of runoff.

2. Control the remaining (residual) runoff through Best Management Practices (BMP's) that treat the necessary water quality capture volume (WQCV), using reduced impervious values for steps taken to reduce runoff volume.

3. Channel stabilization techniques for drainageways on, or adjacent to, the site to minimize channel impacts from site runoff.

4. High pollutant potential sites (e.g., gas stations, loading facilities, industrial sites), will require additional treatment facilities, including covering of storage/handling areas, spill containment and control.

13.4 BMP SELECTION

From the ***Unified Facilities Criteria (UFC) Manual*** - Low Impact Development (LID) is a drainage strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory requirements. LID employs a variety of natural and built features that reduce the rate and volume of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and stabilize the flow rates of nearby streams.

The design engineer is directed to the following manuals for a complete description and analysis of Low Impact Development (LID) practices.

- ***LID Low Impact Development a Design Manual for Urban Areas,*** University of Arkansas Community Design Center, University of Arkansas Press, 2010

- ***Unified Facilities Criteria (UFC) Design: Low Impact Development Manual,*** United States Department of Defense, October 25, 2004

13.5 BASIC DESIGN PRINCIPLES

The design engineer shall be required to include cost effective measures to provide water quality enhancement to the project site. The city preferred BMPs do not require additional construction cost and will actually reduce construction costs of the overall drainage system when designed correctly. The following considerations are expected to be included in site design within The City.

1. Address drainage and stormwater quality needs early in the design process. Include conceptual drainage options early in the site design. Taking advantage of natural drainage patterns and features will prevent the need for expensive piping and massive grading solutions.

2. Reduction of runoff rates and volumes to match natural conditions. The site design becomes more economical by reducing the amount of runoff and delaying the time of concentration. Smaller pipes result when proper BMP's are employed in the design.

- minimize directly connected impervious areas,
- extend travel time by increasing the length of the flow path with low slopes,
- reduce the amount of impervious area (e.g., replace low-use or emergency access paved areas with porous pavement) and
- select treatment techniques that promote infiltration.

3. BMP's should enhance the site, the community, and the environment. Visual aesthetics are rarely considered during the engineering design process and should be provided more than a cursory thought. A well-engineered facility should not preclude blending into the natural environment. A well designed BMP should be indistinguishable from regular landscaping.

- Take advantage of small pocket areas of landscape
- Integrate BMP's into required detention facilities
- Several smaller BMP's are easy to hide versus one large pond on site.

4. Design BMP facilities that are easily maintained and safe. Maintenance access will be provided to the facility or the BMP should be located adjacent to a hard surface. The facility should not pose a danger while fully operational.

- Restrict depth of ponded water
- Minimize perimeter wall height
- Avoid vertical drops of 30" or more
- Provide basin edges with gradually sloping banks
- Avoid a walled in "bathtub" with limited means of egress

13.6 MINIMUM REQUIRED SITE BMP'S

Design guidelines and details are provided in the ***UD&FCD DISTRICT MANUAL, Volume III***.

Grass Buffers

Ensure pavement runoff at edge is sheet flow with a maximum depth of ½-inch for the minor storm event.

Grass Swales

Design slope for maximum velocity of 2.0 fps during the minor storm event.

Design swale depth to accommodate the 50-year storm event

Bioretention (Porous Landscape Detention or Rain Gardens)

Maximum depth of retention is 12-inches.

Must infiltrate or evaporate within 48-hours.

13.7 MAINTENANCE

To ensure the proper intended design performance standards are achieved with the City's water quality facilities, it is vital that they be properly maintained. Maintenance guidelines are provided in the ***UD&FCD DISTRICT MANUAL, Volume III, Chapter 6*** and are hereby incorporated by reference. For all drainage and water quality facilities, The City requires the following:

1. Facilities must be designed to be maintainable with clearly specified long-term maintenance requirements.
2. Provide and designate maintenance access.
3. Designate responsibility for maintenance of the BMP.
4. Maintenance access easement must be granted to The City.
5. Maintenance agreement established with The City

13.8 SMALL SITE LID WATER QUALITY PEAK FLOW ANALYSIS

13.8.1 INTRODUCTION:

This alternative detention design concept is applicable to project sites of approximately 5-acres in size. Larger development sites may be divided into tributary basins of 5-acres that discharge to a common outfall location to qualify for this methodology.

From the *Unified Facilities Criteria (UFC) Manual - Low Impact Development (LID) is a drainage strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory requirements. LID employs a variety of natural and built features that reduce the rate and volume of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve*

the quality of receiving surface waters and stabilize the flow rates of nearby streams.

LID Best Management Practices (BMPs) are well documented for the benefits achieved for pollutant removal. The benefits of LID designs also include increased infiltration, which reduces the amount of runoff from a site. The financial benefits for developers and the city include reduced pipe sizes downstream, a more stable stream bed that should not require armoring and a reduced flood plain area.

The premise of LID design practice is to replicate existing runoff characteristics of the land. Design techniques include increasing pervious surfaces, providing infiltration opportunities, removing directly connected impervious surfaces and slowing down site travel time to increase post development time of concentration. Existing water quality design procedures primarily focus on the volume to be treated by the BMP. This methodology is an attempt to quantify for design purposes the hydrological impacts of using LID BMP practices.

13.8.2 SILOAM SPRINGS DRAINAGE CRITERIA:

The Siloam Springs standard for runoff calculation is the United States Department of Agriculture (USDA) National Resource Conservation Service (NRCS) TR-55 methodology. Rainfall-runoff relationship is estimated based on Curve Numbers (CN) which are derived taking into account initial abstraction losses and actual retention based on surface types and hydrologic soil group. All calculations are to assume an Antecedent Runoff Condition (ARC) II.

Design parameters for the Siloam Springs area are expected to include type C and type D soils with little to no infiltration. The assigned Curve Number for landscape area in good condition with greater than 75% grass cover is 74 for a Type C soil and 80 for a type D soil. This is the same Curve Number for a pasture in good condition. Impervious surfaces are assigned a Curve Number of 98 for both soil types.

13.8.3 SITE DESIGN STRATEGIES

The following elements of the site design all contribute to maintaining a lower CN to reduce runoff from the project site.

13.8.3.1 INCREASE PERVIOUS SURFACES

Each zoning district has a maximum lot coverage requirement. Additionally, commercial zones have a buffer and minimum open space requirements. The minimal landscape requirement

is 10% of the site. Additional pervious area can be created within parking lots which provide opportunities for rain gardens and tree plantings.

13.8.3.2 PROVIDING INFILTRATION OPPORTUNITIES

All landscape buffers and other landscape areas can be designed for shallow sloped swales to convey site runoff to a common discharge point. Landscape islands provide opportunities to capture and retain site runoff.

13.8.3.3 LID DEVELOPMENT BMPS:

Required LID BMPs include rain gardens, bioswales, grass swales and bioretention areas. Each of these BMPs provides a retention volume that directly removes rainfall from runoff.

13.8.3.4 TREE CANOPY:

From the Watershed Resource Guide by the Center for Watershed Protection, Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In urban areas, the UTC provides an important stormwater management function by intercepting rainfall that would otherwise run off of paved surfaces and be transported into local waters though the storm drainage system, picking up various pollutants along the way. UTC also reduces the urban heat island effect, reduces heating/cooling costs, lowers air temperatures, reduces air pollution, increases property values, provides wildlife habitat, and provides aesthetic and community benefits such as improved quality of life.

A design standard has not been approached to quantify the amount of rainfall removal of a tree. A simplified design approach is needed to add value for developers to reduce the cost of drainage structures and increasing the city's potential tree canopy.

For purposes of design standardization, an assumed future canopy diameter of 12-feet will be used for newly planted trees. The actual canopy area of existing trees to be preserved may be used.

The rainfall capture of the tree canopy will be credited at 0.20 inches

13.8.4 NRCS TR-55 RAINFALL / RUNOFF:

A site composite Curve Number for a small developed site can be determined by the use of the following equation.

$$CN = \frac{1000}{10 + S} \qquad [10–12]$$

Where S = the potential maximum retention after runoff begins, in inches.

The amount of rainfall loss that does not become runoff can be determined for each runoff Curve Number by inverting the equation to

S(*inches*) = (1000/CN) - 10

Rainfall captured (S) from the types of surfaces are:

Impervious CN = 98 -> 0.20 inches
Landscape CN = 74 -> 3.51 inches (assuming amended soils to improve a D soil)
Preserved tree stands (woods) CN = 70 -> 4.29 inches

Rainfall captured by LID techniques for a small site is added as inches from the entire tributary site.

Rainfall captured within the tree canopy is added for the area of future canopy coverage (0.20 inches).

Multiply each S value by the area covered. Add up all SA's and divide by the tributary site area to obtain the modified Curve Number (CN_{mod}).

CN_{mod} = 1000 / (10 + SA/A)

Where

CN_{mod} = Modified Composite site Curve Number
SA = Sum of S x A
S = Potential retention
A = Total tributary Area

13.8.4.1 REMOVING DIRECTLY CONNECTED IMPERVIOUS SURFACES

An adjustment to the overall Curve Number is allowed if runoff from pervious surfaces is directed to impervious areas (Unconnected Impervious Areas - UIA). *If runoff from impervious areas occurs over a pervious area as sheet flow prior to entering the drainage system, the*

impervious area is unconnected. To determine CN when all or part of the impervious area is not directly connected to the drainage system:

- *use equation 9–2 or figure 9–4 if the total impervious area is less than 30 percent of the total area or*

$$CN_c = CN_p + \left(\frac{P_{imp}}{100}\right)\left(98 - CN_p\right)\left(1 - .05R\right) \quad [9–2]$$

where:

CN_c = composite runoff curve number
CN_p = pervious runoff curve number
P_{imp} = percent imperviousness
R = ratio of unconnected impervious area to total impervious area

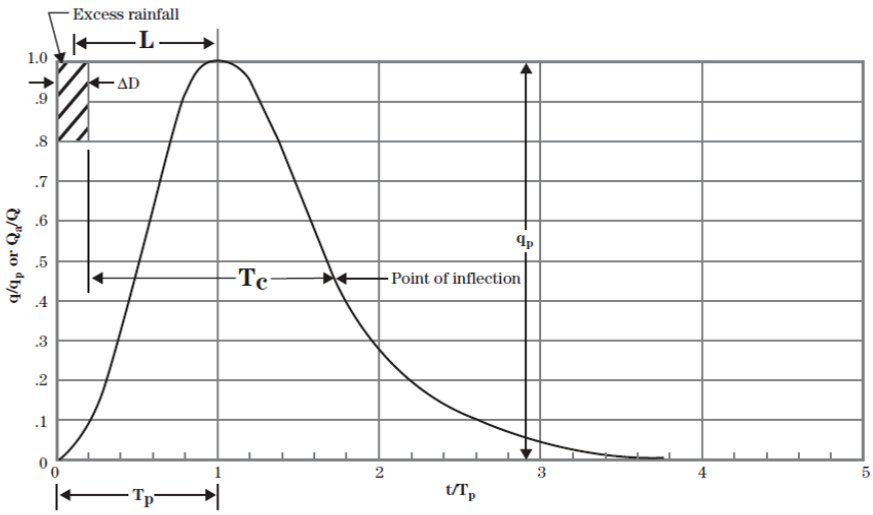
This adjustment would not immediately apply for commercial development and small lots. However, when accounting for increased retention from the LID facilities, the composite Curve Number may now mimic a 30% impervious site. The UCI adjustment would have a significant impact for residential applications. For a residential development that maintains less than 30% impervious surface, the Curve Number would be reduced from 81 to 77 assuming the entire pervious surface is unconnected. If only 50% of the pervious surface is unconnected the Curve Number goes down to 79.

13.8.4.2 SLOWING DOWN SITE TRAVEL TIME

The final factor to returning a developed site to an historical hydrological condition relates to the site's time of concentration. Runoff needs to be slowed down by means of maintaining overland flow as close to 100-feet as possible, decreased channel slopes, providing rougher surfaces to increase Manning's n value and increasing channel length.

Additional travel time may accumulate due to the dispersed LID features. Runoff accumulates and is retained within the furthest LID feature and is then surcharge to the next LID feature down gradient.

Figure 15–3 The relation of time of concentration (T_c) and lag (L) to the dimensionless unit hydrograph



where:
L = Lag, h
T_c = time of concentration, h
T_p = time to peak, h
ΔD = duration of excess rainfall, h
t/T_p = dimensionless ratio of any time to time to peak
q = discharge rate at time t, ft^3/s
q_p = peak discharge rate at time T_p, ft^3/s
Q_a = runoff volume up to t, in
Q = total runoff volume, in

COMPARISONS

SUB-BASIN DATA			INITIAL OVERLAND TIME				TRAVEL TIME					T_c CHECK		FINAL	
BASIN	AREA (Ac)	C Value	OVERLAND FLOW LENGTH (FT)	SLOPE (%)	n (Table 15-1)	t_i (MIN)	SHALLOW CONCENTRATED FLOW LENGTH	S_w (FT/FT)	V (FPS) (Figure 15-4)	t_t (MIN)	COMPUTED T_c	TOTAL LENGTH (FT)	L/180 + 10	t_c (MIN)	REMARKS
HIST	5.00	0.20	100	1.0	0.150	11.0	200	0.030	1.3	2.7	13.6	300	11.7	13.6	
								0.005	0.5	0.0					
Std	5.00	0.90	50	2.0	0.011	0.6	126	0.020	2.8	0.8	3.3	501	12.8	5.0	minTc
							325	0.020	2.8	2.0					
LID	5.00	0.70	100	1.5	0.011	1.2	55	0.005	0.5	1.8	13.7	475	12.6	13.7	
							320	0.005	0.5	10.7					

The low slope of 0.5% grade would only be used for grass swales. Pavement grades are typically 1.5 to 2 % to promote constructability and to provide adequate drainage.

13.8.5 DESIGN STANDARDS

Percolation tests at each site are required to determine infiltration potential for existing site soils.

Maximum recommended depth of retention in BMPs is 12-inches to permit evaporation in the event percolation/infiltration is inadequate. Most design guidelines recommend a maximum depth of 6-inches. The 6-inches maximum depth may make it more difficult to obtain the required retention volume. The city's primary concern is to minimize mosquito breeding habitat, so infiltration or evaporation should be achieved within 2 days' time. Adequate and appropriate plantings within the facility will also increase the take-up of retained rainfall through evapo-transpiration processes.

Amend soils to a depth of 2 to 3 feet deep for BMP facilities. The amended soil should specify a 60% sand, 20% or less clay and 20% silt/compost composition.

All roof gutter downspouts are to be discharged on the surface and directed to landscape LID features.

Landscape plans shall provide appropriate plant species and trees for BMPs.

Design for tree canopy at a nearly mature growth tree diameter of canopy. Assume a tree canopy diameter of 12-foot radius. Although it may be years before the total benefit of the tree canopy is achieved, this provides incentive for the developers to include trees in the site plans.

Target a post developed Curve Number equal to the historic land conditions. For redevelopment sites, a minimum goal to achieve is Curve Number 74 for pasture, grassland in good condition.

Match time of concentration of post developed to pre developed site.

If these requirements are met, no on-site detention is required.

The curve number runoff equation is:

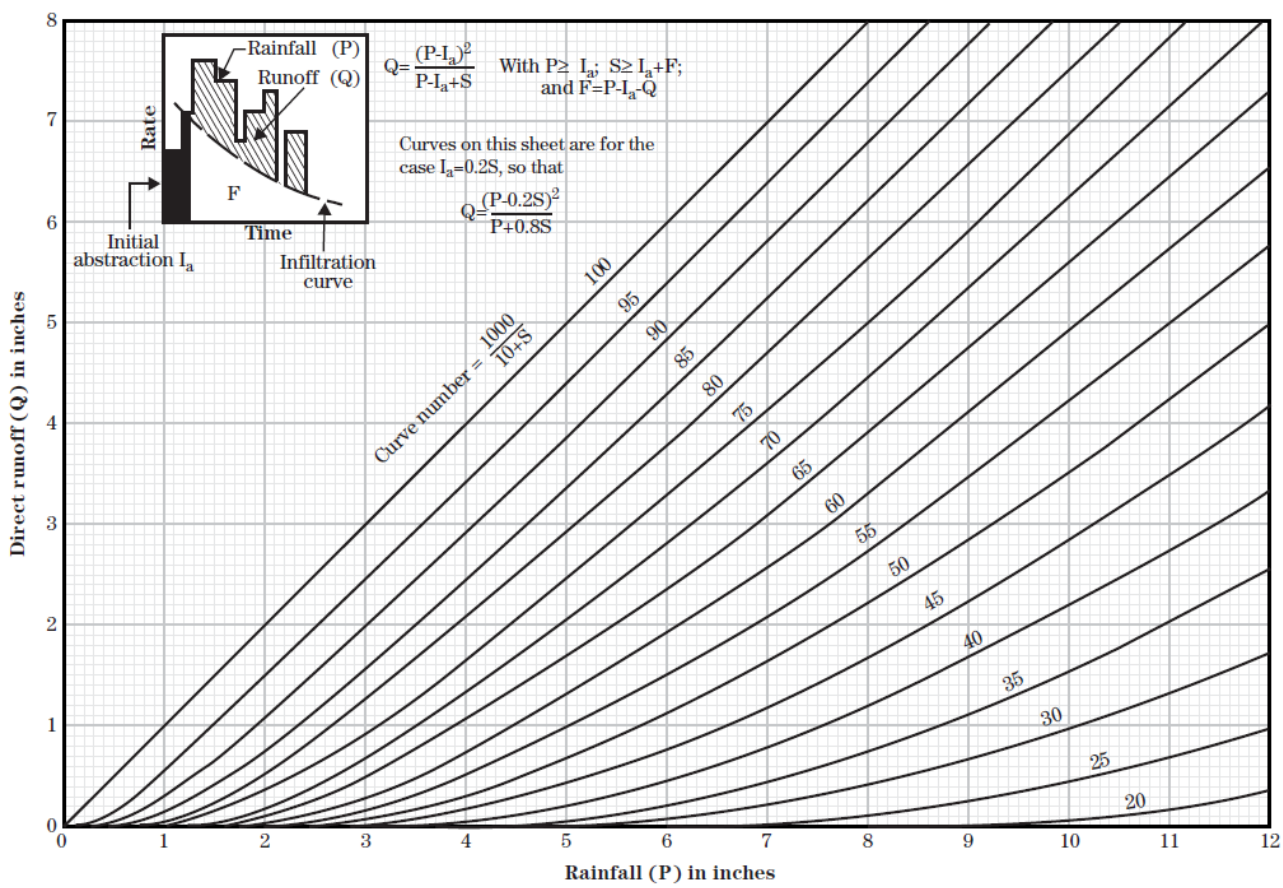
$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad P > I_a$$
$$Q = 0 \qquad P \le I_a \qquad [10\text{–}1]$$

where:

Q = depth of runoff, in inches
P = depth of rainfall, in inches
I_a = initial abstraction, in inches
S = maximum potential retention, in inches

Which results in the graphical solution below:

Figure 10–2 ES–1001 graphical solution of the equation $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$



13.10 Checklist

1. Provide calculation method reference for the WQCV.
2. Provide schematic details of selected structural BMPs.
3. Provide water quality outlet structure designs that minimize the number of perforation columns and keep the diameter of perforation below 2 inches.
4. Design over flow outlets and indicate flow path from WQ feature.
5. Select BMPs with ease of maintenance as a top priority.
6. Provide information on proper maintenance of the BMP(s), including frequency of required maintenance and responsible party.

14.0 STORMWATER MANAGEMENT AND EROSION CONTROL

14.1 General Provisions

14.1.1 Purpose

The purpose and objectives of this Article are as follows:

- To maintain and improve the quality of water impacted by the storm drainage system within the City of Siloam Springs.
- To prevent the discharge of contaminated stormwater runoff and illicit discharges from industrial, commercial, residential, and construction sites into the storm drainage system within the City of Siloam Springs.
- To promote public awareness of the hazards involved in the improper discharge of trash, yard waste, lawn chemicals, pet waste, wastewater, oil, petroleum products, cleaning products, paint products, hazardous waste, sediment and other pollutants into the storm drainage system.
- To encourage recycling of used motor oil and safe disposal of other hazardous consumer products.
- To facilitate compliance with state and federal standards and permits issued by ADEQ to responsible parties of construction sites within the City.
- To enable the City to comply with all federal and state laws and regulations applicable to the National Pollutant Discharge Elimination System (NPDES) permitting requirements for stormwater discharges.

14.1.2 Responsibility of Administration

The City Official shall administer, implement, and enforce the provisions of this Article. Any powers granted or duties imposed upon the City Official may be delegated in writing by the City Official to persons or entities acting in the beneficial interest of or in the employ of the City.

14.1.3 Definitions

The following words, terms and phrases, when used in this article, shall have the meanings ascribed to them in this section, except where the context clearly indicates a different meaning:

Best Management Practices (BMP's): a technique or series of techniques which, when used in an erosion control plan, is proven to be effective in controlling construction-related runoff, erosion and sedimentation.

City: the City of Siloam Springs, Arkansas

City Official: is the City Administrator of Siloam Springs, Arkansas, or duly authorized representatives designated by the City Administrator.

Clearing: the act of cutting, removing from the ground, burning, damaging or destroying trees, stumps, hedge, brush, roots, logs, or scalping existing vegetation.

Commercial: pertaining to any business, trade, industry, or other activity engaged in for profit.

Construction Site: any location where construction activity occurs.

Contaminated: containing harmful quantities of pollutants.

Contractor: any person or firm performing or managing construction work at a construction site, including any construction manager, general contractor or subcontractor. Also includes, but is not limited to, earthwork, paving, building, plumbing, mechanical, electrical or landscaping contractors, and material suppliers delivering materials to the site.

Discharge: any addition or release of any pollutant, stormwater or any other substance whatsoever into the storm drainage system.

Discharger: any person who causes, allows, permits, or is otherwise responsible for, a discharge, including, without limitation, any owner of a construction site or industrial facility.

Domestic Sewage: sewage origination primarily from kitchen, bathroom and laundry sources, including waste from food preparation, dishwashing, garbage grinding, toilets, baths, showers and sinks.

Earthwork: the disturbance of soils on a site associated with clearing, grading, or excavation activities.

Erosion: the wearing away of the ground surface as a result of the movement of wind, water and/or ice.

Excavation: to expose or uncover by digging, scooping, or removing soil.

Garbage: means decaying or rotting animal and vegetable waste materials from the handling, preparation, cooking, or consumption of food, including waste materials from markets, storage facilities, and the handling and sale of produce and other food products.

Grading: any land disturbance or land fill, or combination thereof.

Groundwater: any water residing below the surface of the ground or percolation into or out of the ground.

Harmful Quantity: the amount of any substance that the City Official determines will cause an adverse impact to storm drainage system or will contribute to the failure of the City to meet the water quality based requirements of the NPDES permit for discharges from the MS4.

Hazardous Substance: any substance identified or listed as a hazardous waste by the EPA pursuant to current regulations.

Household Hazardous Waste (HHW): any material generated in a household (including single and multiple residences) that would be classified as hazardous.

Illegal Discharge: see illicit discharge below.

Illicit Discharge: means any discharge to the storm drainage system that is prohibited under this Article.

Illicit Connection: any drain or conveyance, whether on the surface or subsurface, which allows an illicit discharge to enter the storm drainage system.

Industrial Waste: (or commercial waste) any wastes produced as a by-product of any industrial, institutional or commercial process or operation, other than domestic sewage.

Land Alteration: the process of grading, clearing, filling, excavation, quarrying, tunneling, trenching, construction or similar activities.

Mechanical Fluid: any fluid used in the operation and maintenance of machinery, vehicles and any other equipment, including lubricants, antifreeze, petroleum products, oil and fuel.

Mobile Commercial Cosmetic Cleaning (or mobile washing): power washing, steam cleaning, and any other method of mobile cosmetic cleaning, of vehicles and/or exterior surfaces, engaged in for commercial purposes or related to a commercial activity.

Municipal Separate Storm Sewer System (MS4): the system of conveyances, including roads, streets, curbs, gutters, ditches, inlets, drains, catch basins, pipes, tunnels, culverts, channels, detention basins and ponds owned and operated by the City and designed or used for collection or conveying stormwater, and not used for collecting or conveying sanitary sewage.

Non-stormwater discharges: septic systems, sanitary sewers and others; industrial NPDES discharges, urban return flows, water diversions, runoff from confined animal feeding lots.

NPDES Permit: a permit issued by EPA and or ADEQ that authorizes the discharge of pollutants to Waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.

Notice of Violation: a written notice detailing any violations of this Article and any action expected of the violators.

Oil: any kind of oil in any form, including, but not limited to: petroleum, fuel oil, crude oil, synthetic oil, motor oil, cooking oil, grease, sludge, oil refuse, and oil mixed with waste.

Owner: the person who owns a facility, part of a facility, or land.

Person: any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns, including all federal, state, and local governmental entities.

Permittee: the applicant in whose name a valid permit is duly issued pursuant to this article and his/her agents, employees and others acting under his/her supervision or control.

Pesticide: a substance or mixture of substances intended to prevent, destroy, repel or migrate any pest.

Pet Waste (or animal waste): excrement and other waste from domestic animals.

Petroleum Product: a product that is obtained from distilling and processing crude oil and that is capable of being used as a fuel or lubricant in a motor vehicle or aircraft, including motor oil, motor gasoline, gasohol, other alcohol blended fuels, aviation gasoline, kerosene, distillate fuel oil, and #1 and #2 diesel.

Pollutant: any substance attributable to water pollution, including but not limited to rubbish, garbage, solid waste, litter, debris, yard waste, pesticides, herbicides, fertilizers, pet waste, animal waste, domestic sewage, industrial waste, sanitary sewage, wastewater, septic tank waste, mechanical fluid, oil, motor oil, used oil, greases, petroleum products, antifreeze, surfactants, solvents, detergents, cleaning agents, paint, heavy metals, toxins, household hazardous waste, small quantity generator waste, hazardous substances, hazardous waste, soil and sediment.

Pollution: the alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water that renders the water harmful, detrimental, or injurious to humans, animal life, plant life, property, or public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Potable Water: water that has been treated to drinking water standards and is safe for human consumption.

Private Drainage System: all privately or publicly owned ground, surfaces, structures or systems, excluding the MS4, that contribute to or convey stormwater, including but not limited to, roofs, gutters, downspouts, lawns, driveways, pavement, roads, streets, curbs, gutters, ditches, inlets, drains, catch basins, pipes, tunnels, culverts, channels, detention basins, ponds, draws, swales, streams and any ground surface.

Public Improvement Plans: engineering drawings subject to approval by the City Official for the construction of public improvements.

Qualified Person: a person who possesses the required certification, license, or appropriate competence, skills, and ability as demonstrated by sufficient education, training, and/or experience to perform a specific activity in a timely and complete manner consistent with the regulatory requirements and generally accepted industry standards for such activity.

Release: to dump, spill, leak, pump, pour, emit, empty, inject, leach, dispose or otherwise introduce into the storm drainage system.

Rubbish: non-putrescible solid waste, excluding ashes, that consist of: (a) combustible waste materials, including paper, rags, cartons, wood, excelsior, furniture, rubber, plastics, yard trimmings, leaves, and similar materials; and (b) noncombustible waste materials, including glass, crockery, tin cans, aluminum cans, metal furniture, and similar materials that do not burn at ordinary incinerator temperatures (1600 to 1800 degrees Fahrenheit).

Sanitary Sewage: the domestic sewage and/or industrial waste that are discharged into the City sanitary sewer system and passes through the sanitary sewer system to the City sewage treatment plant for treatment.

Sanitary Sewer: the system of pipes, conduits, and other conveyances which carry industrial waste and domestic sewage from residential dwellings, commercial buildings, industrial and manufacturing facilities, and institutions, whether treated or untreated, to the City sewage treatment plant (and to which stormwater, surface water, and groundwater are not intentionally admitted).

Sediment: soil (or mud) that has been disturbed or eroded and transported naturally by water, wind or gravity, or mechanically by any person.

Septic Tank Waste: any domestic sewage from holding tanks such as vessels, chemical toilets, campers, trailers, septic tanks and aerated tanks.

Shall: means mandatory; May: discretionary.

Site: the land or water area where any facility or activity is physically located or conducted, including adjacent land used in connection with the facility or activity.

Solid Waste: any garbage, rubbish, refuse and other discarded material, including solid, liquid, semisolid, or contained gaseous material, resulting from industrial, municipal, commercial, construction, mining or agricultural operations, and residential, community and institutional activities.

State: the State of Arkansas.

Storm Drainage System: all surfaces, structures and systems that contribute to or convey stormwater, including private drainage systems, the MS4, surface water, groundwater, Waters of the State and Waters of the United States.

Stormwater: runoff resulting from precipitation.

Stormwater Pollution Prevention Plan (SWP3): a document that describes the Best Management Practices to be implemented at a site, to prevent or reduce the discharge of pollutants.

Subdivision Development: includes activities associated with the platting of any parcel of land into two or more lots and includes all construction activity taking place thereon.

Surface Water: water bodies and any water temporarily residing on the surface of the ground, including oceans, lakes, reservoirs, rivers, ponds, streams, puddles, channelized flow and runoff.

Uncontaminated: not containing harmful quantities of pollutants.

Used Oil (or Used Motor Oil): any oil that as a result of use, storage, or handling, has become unsuitable for its original purpose because of impurities or the loss of original properties.

Utility Agency: private utility companies, City departments or contractors working for private utility companies or City departments, engaged in the construction or maintenance of utility distribution lines and services, including water, sanitary sewer, storm sewer, electric, and gas, telephone, television and communication services.

Wastewater: any water or other liquid, other than uncontaminated stormwater, discharged from a facility.

Water of the State (or water): any groundwater, percolating or otherwise, lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, inside the territorial limits of the State, and all other bodies of surface water, natural or artificial, navigable or non-navigable, and including the beds and banks of all water courses and bodies of surface water, that are wholly or partially inside or bordering the State or inside the jurisdiction to the State.

Water Quality Standard: the designation of a body or segment of surface water in the State for desirable uses and the narrative and numerical criteria deemed by State or Federal regulatory standards to be necessary to protect those uses.

Waters of the United States: all waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and the flow of the tide; all interstate waters, including interstate wetlands; all other waters the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the United States under this definition; all tributaries of waters identified in this definition; all wetlands adjacent to water identified in this definition; and any waters within the federal definition of "waters of the United States" at 40 CFR Section 122.2; but not including any waste treatment systems, treatment ponds, or lagoons designed to meet the requirements of the Federal Clean Water Act.

Wetlands: an area that is regularly saturated by surface or groundwater and subsequently is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions. Examples include: swamps, bogs, fens, marshes, and estuaries.

Yard Waste: leaves, grass clippings, tree limbs, brush, soil, rocks or debris that result from landscaping, gardening, yard maintenance or land clearing operations.

14.1.5 Abbreviations.

The following abbreviations when used in this Article shall have the designated meanings:

ADEQ—Arkansas Department of Environmental Quality

BMP—Best Management Practices

CFR—Code of Federal Regulations

EPA—U. S. Environmental Protection Agency

HHW—Household Hazardous Waste

MS4—Municipal Separate Storm Sewer System

NOI—Notice of Intent

NOT—Notice of Termination

NPDES—National Pollutant Discharge Elimination System

SWP3—Stormwater Pollution Prevention Plan

14.2 Prohibitions and Requirements

14.2.1 Prohibitions

1. No person shall release or cause to be released into the storm drainage system any discharge that is not composed entirely of uncontaminated stormwater, except as allowed herein. Common stormwater contaminants include trash, yard waste, lawn chemicals, pet waste, and wastewater, and oil, petroleum products, cleaning products, paint products, hazardous waste and sediment.
2. Any discharge shall be prohibited by this Section if the discharge in question has been determined to be a source of pollutants to the storm drainage system.
3. The construction, use, maintenance or continued existence of illicit connections to the storm drain system is prohibited. This prohibition expressly includes, without limitation, illicit connections made in the past, regardless of whether the connection was permissible under law or practices applicable or prevailing at the time of connection.
4. No person shall connect a line conveying sanitary sewage, domestic sewage or industrial waste, to the storm drainage system, or allow such a connection to continue.
5. No person shall maliciously destroy or interfere with BMP's implemented pursuant to this Chapter.

14.2.2 Exemptions.

The following non-stormwater discharges are deemed acceptable and not a violation of this Section:

1. A discharge authorized by an NPDES permit other than the NPDES permit for discharges from the MS4;
2. Uncontaminated waterline flushing and other infrequent discharges from potable water sources;
3. Infrequent uncontaminated discharge from landscape irrigation or lawn watering;
4. Discharge from the occasional non-commercial washing of vehicles or the non-commercial washing of vehicles by charitable organizations.
5. Uncontaminated discharge from foundation, footing or crawl space drains, sump pumps and air conditioning condensation drains;
6. Uncontaminated groundwater, including rising groundwater, groundwater infiltration into storm drains, pumped groundwater and springs;
7. Diverted stream flows and natural riparian habitat or wetland flows;

8. A discharge or flow of fire protection water that does not contain oil or hazardous substances or materials.

14.2.3 Requirements Applicable to Certain Dischargers

1. Private Drainage System Maintenance.
The owner of any private drainage system shall maintain the system to prevent or reduce the discharge of pollutants. This maintenance shall include, but is not limited to, sediment removal, bank erosion repairs, maintenance of vegetative cover, and removal of debris from pipes and structures.

2. Minimization of Irrigation Runoff.
A discharge of irrigation water that is of sufficient quantity to cause a concentrated flow in the storm drainage system is prohibited. Irrigation systems shall be managed to reduce the discharge of water from a site.

3. Cleaning of Paved Surfaces Required.
The owner of any paved parking lot, street or drive shall clean the pavement as required to prevent the buildup and discharge of pollutants. The visible buildup of mechanical fluid, waste materials, sediment or debris is a violation of this ordinance. Paved surfaces shall be cleaned by dry sweeping, wet vacuum sweeping, collection and treatment of wash water or other methods in compliance with this Code.

4. Maintenance of Equipment.
Any leak or spill related to equipment maintenance in an outdoor, uncovered area shall be contained to prevent the potential release of pollutants. Vehicles, machinery and equipment must be maintained to reduce leaking fluids.

5. Materials Storage.
In addition to other requirements of this Code, materials shall be stored to prevent the potential release of pollutants. The uncovered, outdoor storage of unsealed containers of hazardous substances is prohibited.

6. Pesticides, Herbicides and Fertilizers.
Pesticides, herbicides and fertilizers shall be applied in accordance with manufacturer recommendations and applicable laws. Excessive application shall be avoided.

7. Prohibition on use of pesticides and fungicides banned from manufacture.
Use of any pesticide, herbicide or fungicide, the manufacture of which has been either voluntarily discontinued or prohibited by the Environmental Protection Agency, or any Federal, State or City regulation is prohibited.

8. Open Drainage Channel Maintenance.
Every person owning or occupying property through which an open drainage channel passes shall keep and maintain that part of the drainage channel within the property free of trash, debris, excessive vegetation, and other obstacles that would pollute, contaminate, or retard the flow of water through the drainage channel. In addition, the owner or occupant shall maintain existing privately owned structures adjacent to a drainage channel, so that such structures will not become a hazard to the use, function, or physical integrity of the drainage channel.

14.2.4 Release Reporting and Cleanup.

Any person responsible for a known or suspected release of materials which are resulting in or may result in illegal discharges to the storm drainage system shall take all necessary steps to ensure the discovery, containment, abatement and cleanup of such release. In the event of such a release of a hazardous material, said person shall comply with all state, federal, and local laws requiring reporting, cleanup, containment, and any other appropriate remedial action in response to the release. In the event of such a release of non-hazardous materials, said person shall notify the City Stormwater Control Inspector no later than 3:30 p.m. of the next business day.

14.2.5 Authorization to Adopt and Impose Best Management Practices.

The City may adopt and impose requirements identifying Best Management Practices for any activity, operation, or facility, which may cause a discharge of pollutants to the storm drainage system. Where specific BMP's are required, every person undertaking such activity or operation, or owning or operating such facility shall implement and maintain these BMP's at their own expense.

14.3 Stormwater Discharges From Construction Activities

14.3.1 Construction Sites Requiring an Approved NOI and NOT.

This section applies to all construction sites where construction on a site will disturb soil or remove vegetation on 5 (five) or more acres of land during the life of the construction project.

1. An approved NOI (Notice of Intent) received from ADEQ for the project shall be provided and posted on the job site. This should be posted at the entrance of the job site, available 24/7. This can be a photocopy of the original.

    a. An approved SWP3 shall be provided and posted at the same location as NOI.

b. A copy of engineer plans for erosion control shall be posted at the same location as NOI.

c. The inspection reports for the job site shall be posted at the same location as NOI.

d. Rain gauge.

2. An approved NOT (Notice of Termination) for the project shall be provided to the City Official after the said project has been completed to standards.

14.3.2 General Requirements for Construction Sites.

1. Responsibility. The owner/developer of a site of construction activity shall be responsible for compliance with the requirements of this ordinance, State and Federal regulations as well.

2. Waste Disposal. Solid waste, industrial waste, yard waste and any other pollutants or waste on any construction site shall be controlled through the use of Best Management Practices. Waste or recycling containers shall be provided and maintained by the owner or contractor on construction sites where there is the potential for release of waste. Uncontained waste that may blow, wash or otherwise be released from the site is prohibited.

3. Concrete. Ready-mixed concrete, or any materials resulting from the cleaning of vehicles or equipment containing or used in transporting or applying ready-mixed concrete, shall be contained on construction sites for proper disposal. Release of these materials is prohibited.

4. Erosion and Sediment Control. Best Management Practices shall be implemented to prevent the release of sediment from construction sites. Disturbed areas shall be minimized, disturbed soil shall be managed and construction site entrances shall be managed to prevent sediment tracking. Excessive sediment tracked onto public streets shall be removed immediately.

5. Completion. Upon completion of permitted construction activity on any site, the property owner and subsequent property owners will be responsible for continued compliance with the requirements of this ordinance, in the course of maintenance, reconstruction or any other construction activity on the site.

14.3.3 Construction Sites Requiring an Approved SWP3.

This section applies to all construction sites where construction on a site will disturb soil or remove vegetation on one (1) or more acres of land during the life of the construction project. An approved Stormwater Pollution Prevention Plan (SWP3) for the project must be provided and implemented by the construction site owner as follows:

1. The area disturbed shall be assumed to include the entire property area unless all applicable plans specifically exclude certain areas from disturbance.

2. For sites subject to plan review by any City Division or Department, the plan will not be released for construction until an approved SWP3 has been obtained.

3. A review of the SWP3 submitted for the site will be completed and notification will be given of either an approval of the SWP3 or a request for revisions will be made. Construction activity, including any soil disturbance or removal of vegetation, shall not commence on the site until the approval and implementation of the SWP3.

4. The owner/developer bears the responsibility for implementation of the SWP3 and notification of all contractors and utility agencies on the site.

14.3.4 Subdivision Developments Requiring an Approved SWP3.

Where construction of a subdivision development will disturb soil or remove vegetation on one (1) or more acres of land during the life of the development project, approved Stormwater Pollution Prevention Plans (SWP3's) for the project must be provided and implemented by the subdivision owner/developer as follows:

1. The area disturbed shall be assumed to include the entire platted area.

2. SWP3's must be provided by the subdivision owner/developer.

3. SWP3's must be provided for all phases of development, including sanitary sewer construction, storm drainage system construction, waterline, street and sidewalk construction, general grading and the construction of individual homes. The subdivision owner/developer will not be required to provide an SWP3 for the activities of utility agencies within the subdivision.

4. The subdivision owner/developer shall provide a copy of the approved SWP3's to all utility agencies prior to their working within the subdivision.

5. The subdivision owner/developer bears the responsibility for implementation of the approved SWP3's for all construction activity within the development, excluding construction managed by utility agencies.

6. The subsequent owner of an individual lot bears the responsibility for continued implementation of the approved SWP3's for all

construction activity within or related to the individual lot, excluding construction managed by utility agencies.

14.3.5 Stormwater Pollution Prevention Plans.

Preparation and implementation of Stormwater Pollution Prevention Plans for construction activity shall comply with the following:

1. SWPPP General Requirements. At a minimum the following shall be provided on the SWPPP.

a. Name and address of the owner of the property where construction activity is proposed; of the land developer; and of the applicant.

b. The existing and proposed topography of the site taken at a contour interval sufficiently detailed to define the topography over the entire site.

c. Contour intervals sufficient to show on and off-site drainage.

d. The site's property limits shown in true location with respect to the plan's topographic information.

e. The proposed grading and land disturbance including: surface area involved; limits of grading including limitation of mass clearing and grading wherever possible; and provisions to preserve topsoil and limit disturbance.

f. Appropriate and applicable information from the Federal Emergency Management Agency (FEMA) flood maps and federal and state protected wetland maps.

g. Specifications for a sequence of construction operations shall be contained on the SWPPP describing the relationship between the implementation and maintenance of sediment controls, including permanent and temporary stabilization and the various stages or phases of earth disturbance and construction. The specifications for the sequence of construction shall, at a minimum, include the following activities:

- Clearing and grubbing for those areas necessary for installation of perimeter controls.
- Installation of sediment basins and traps.
- Construction of perimeter controls.
- Remaining clearing and grubbing.
- Road grading.
- Grading for the remainder of the site.

- Utility installation and whether storm drains will be used or blocked until the completion of project.
- Final grading, landscaping, or stabilization.
- Operation and maintenance, inspection of practices.
- Removal of sediment controls.

h. Changes to the sequence of construction operations may be modified by the person conducting land disturbing activity or their representatives and do not constitute a violation unless measures to control stormwater runoff and sediments are not utilized.

i. If the SWPPP is designed by and carries the seal and/or signature of a "designated design professional" (Professional Engineer, Certified Landscape Architect, Certified Professional in Erosion and Sediment Control), it shall be given approval pending plan review. If the SWPPP is prepared by someone other than a "designated design professional" the City Official shall review the SWPPP, and after review notify the landowner/land developer of approval or denial within seven (7) days after receipt of the SWPPP. If the approval or denial has not been received within said such seven (7) day period by the landowner/land developer, then the SWPPP shall be deemed approved.

j. If the SWPPP carries the seal and/or signature of a "designated design professional" it shall include placement of the following statement.

> ***"The undersigned certifies this plan has been designated in accordance with federal NPDES guidelines and approved erosion, sediment and stormwater ordinances, programs, regulations, standards and criteria of the City of Siloam Springs."***

2. Preparation

a. The SWP3 shall be prepared under the direction of a qualified person.

b. The SWP3 shall provide a 24 hour contact name, address and phone number of the project owner for purposes of correspondence and enforcement.

c. The SWP3 shall identify existing natural resources such as streams, forest cover and other established vegetative cover.

d. The SWP3 shall specify and provide detail for all BMP's necessary to meet the requirements of this criteria, including any applicable BMP's that have been adopted and imposed by the City.

e. The SWP3 shall specify when each BMP will be installed, and for how long it will be maintained within the construction sequence. Multiple plans may be required for major phases of construction such as rough grading, building construction and final grading.

f. The SWP3 shall delineate all anticipated disturbed areas and specify the vegetative cover that must be established in those areas to achieve final stabilization.

3. Implementation

a. The SWP3 shall be posted at the entrance or accessible area that can be readily available on the project site 24/7.

b. BMP's shall be installed and maintained by qualified persons. The owner/developer or their representative shall be able to provide upon the City Official's request a copy of the SWP3 on site and shall be prepared to respond to unforeseen maintenance of specific BMP's.

c. The owner/developer or their representative shall inspect all BMP's every 14 days and within 24 hours after a rainfall of one half of an inch or more as measured at the site or generally reported in the Siloam Springs area.

d. Based on inspections performed by the owner/developer/or their representative or by authorized City Officials, modifications to the SWP3 will be necessary if at any time the specified BMP's do not meet the objectives of this ordinance. In this case, the owner/developer or authorized representative shall meet with authorized City Official to determine the appropriate modifications. All modifications shall be completed within seven (7) days of the referenced inspection, except in circumstances necessitating more timely attention, and shall be recorded on the owner's copy of the inspection report.

14.3.6 Requirements for Utility Construction.

1. Utility agencies shall be responsible for compliance with the requirements of this ordinance.

2. Utility agencies shall develop and implement Best Management Practices (BMP's) to prevent the discharge of pollutants on any site of utility construction within the City. In addition, the City may adopt and impose BMP's on utility construction activity.

3. Utility agencies shall implement BMP's to prevent the release of sediment from utility construction sites. Disturbed areas shall be

minimized, disturbed soil shall be managed and construction site entrances shall be managed to prevent sediment tracking. Excessive sediment tracked onto public streets shall be removed immediately.

4. Prior to entering a construction site or subdivision development, utility agencies shall have obtained from the owner a copy of any SWP3's for the project. Any disturbance to BMP's resulting from utility construction shall be repaired immediately by the utility company in compliance with the SWP3.

14.3.7 Grading Permit

1. Findings—The city has experienced development activity causing the displacement of large amounts of earth and the removal of tree cover. Significant problems resulting from such development include flooding, soil erosion and sedimentation, unstable slopes, and impaired quality of life. These problems are a concern because of their negative effects on the safety and general welfare of the community.

2. Purpose—The purposes of this chapter are to:

- Prohibit the indiscriminate clearing of property.
- Prevent excessive grading, clearing, filling, cutting, or similar activities.
- Substantially reduce flooding, erosion and sediment damage within the city.
- To safeguard the safety and welfare of citizens.
- Establish reasonable standards and procedures for development, which prevent potential flooding, erosion and sediment damage.
- Prevent the pollution of streams, ponds and other watercourses.
- Minimize the danger of flood loss and property loss due to unstable slopes.
- Preserve natural vegetation, which enhances the quality of life of the community.
- To conceal hillside scars.

3. General requirements

Persons engaged in land alteration activities regulated by this chapter shall take measures to protect neighboring public and private properties from damage by such activities. The requirements of this chapter, however, are not intended to prevent the reasonable use of properties.

a. Any person who engages in land alteration activities regulated by this chapter without obtaining a grading permit shall be required to restore the land, to the maximum extent practicable to its original condition immediately.

b. The permit applicant shall have on the project site at all times that work is occurring an agent who is a competent superintendent capable of reading and thoroughly understanding the plans, specifications and requirements for areas of tree protection for the type of work being performed. The superintendent shall have full authority to issue orders or direction to employees working on site, without delay and to promptly supply such materials, labor, equipment, tools, and incidentals as may be required to complete the work in a proper manner. If no superintendent is on site, the city official may issue the notice of violation and stop work order to the person conducting the violation.

4. Grading Permit Required.

a. Any person proposing to engage in clearing, filling, excavating, quarrying, construction or similar activities on any piece of disturbed land of 1 acre or larger shall apply to the City Engineer for a grading permit as specified in this chapter before construction or expanding a vehicular use area or when expanding or rehabilitation of a building and landscaping are required. The City Engineer may exempt the need for the permit on a limited case-by-case basis. No land shall be altered or cleared to the extent regulated in this chapter unless approved by a permit.

5. Conformance to Phase II Regulations.

Grading plans shall conform to the Phase II Stormwater Regulations as established by United States Environmental Protection Agency's regulations; Region VI published in the July 6, 1998 Federal Register or its latest revisions.

14.4 Enforcement Personnel Authorized

14.4.1 The City Engineer or their designee shall have the power to issue Notices of Violations, citations and implement other enforcement actions under this ordinance as provided by the City of Siloam Springs.

14.4.2 Right of Entry and Sampling

1. Whenever an authorized enforcement person has cause to believe that there exists, or potentially exists, in or upon any premises any condition which constitutes a violation of this ordinance, the enforcement person shall have the right to enter the premises at any reasonable time to determine if the discharger is complying with all requirements of this ordinance. In the event that the owner or

occupant refuses entry after a request to enter has been made, the City is hereby empowered to seek assistance from a court of competent jurisdiction in obtaining such entry.

2. The City Engineer or his or her assigns shall have the right to cause to be set up on the property of any discharger to the storm drainage system such devices that are necessary to conduct sampling of discharges.

14.4.3 Enforcement Procedures.

This policy establishes a formal enforcement procedure to be followed by the City of Siloam Springs when enforcement action is necessary on sites that do not comply with the City's Stormwater Pollution Prevention, Erosion Control Ordinance. Enforcement cases can be generated in any of three ways: (1) through the construction review process; (2) through complaints from individuals, groups, etc; and (3) through referrals from City/State agencies.

Procedures to be followed for each of these methods are outlined below.

1. Submissions from the General Public. Members of the General Public may submit information pertaining to this ordinance to the City of Siloam Springs, City Engineering Department. The Engineer will consider such submissions as they pertain to the implementation and enforcement of this ordinance and will provide written or verbal response to the person submitting the information.

2. Construction Review. Every effort is made to use the Construction Review process to correct deficiencies in site compliance whenever possible. Should that process fail to achieve expected results or the site reviewer feels that a violation is serious enough to warrant enforcement action, the following procedures shall be followed:

a. Issuance of Notice of Violation: If site deficiencies are noted, the Permittee or their on-site representative shall be given a notice of violation. The notice of violation shall be specific as to the noted violation, corrective measures to be taken, and time frame allowed completing the work.

b. Compliance Review: At the end of the time period specified above, a follow-up site inspection shall take place to determine whether compliance has been achieved.

Depending on that determination, the following actions may occur:

1. Site Violations Corrected: If all previous site violations have been corrected, the site reviewer shall issue an inspection report stating that fact and the site shall be returned to a normal Construction Review status.

2. Previous Violations Not Corrected: If previously noted violations have not been satisfactorily corrected, the further actions may be initiated as outlined in the following section.

3. Referrals from other agencies. Referrals from other agencies will be handled in the following manner:

a. Cases will be referred directly to the City Engineer. At this point the Engineer working with the referral agency will determine if enforcement actions are warranted and if proper documentation has been obtained. If a determination is made that action is required, the enforcement process will be set into motion.

b. Cases received by the Engineer will be handled on a first come first served basis. All enforcement actions will be initiated by a site inspection to verify site conditions that caused the case to be referred. If conditions have been corrected or do not exist as stated in the referral, the case will be returned to file for documentation and reporting purposes. If conditions exist as stated in the referral, enforcement actions will proceed.

4. Once site conditions have been verified and the site is determined to be in a state of non-compliance, two avenues of enforcement can be pursued, one for the infrequent offender and one for the frequent offender.

a. Infrequent Offender. If a Permittee is being reviewed for the first time or it has been at least 3 years since the last violation (36 months has elapsed since last violation), notice to comply will be issued to the Permittee informing them they are not in compliance with the City's Stormwater Pollution Prevention and Erosion Control Ordinance, the steps needed to be taken to get into compliance, and that they have an established time frame to complete the work. At the end of the period a re-inspection will be conducted to check for compliance. If all work has been satisfactorily completed the case will be returned to file for documentation and reporting purposes. If the work has not been satisfactorily completed within the established time frame a Stop Work Order will be issued to the Permittee.

b. Frequent Offender. If a Permittee has been cited for a violation three or more times in the preceding 36 months they will be considered repeat offenders. Repeat offenders will be issued a Stop Work Order upon verification of non-compliance with the City's Stormwater Pollution Prevention and Erosion Control Ordinance and the steps needed to be taken to get into

compliance will be outlined along with an established time frame to complete the work. At the end of the period a re-inspection will be conducted to check for compliance. If all work has been satisfactorily completed the case will be returned to file for documentation and reporting purposes. If the work has not been satisfactorily completed within the established time frame a citation shall be issued to the Permittee.

14.4.4 Enforcement Options for Failure to Comply Notice

1. City of Siloam Springs Transportation, Engineering Department or Community Development may issue a Stop Work Order to any persons violating any provision of the City's Stormwater Pollution Prevention and Erosion Control Ordinance by ordering that all site work stop except that necessary to comply with any administrative order.

a. The Engineering Department has primary responsibility for the administration and enforcement of this Stop Work Order.

b. Representatives of the Engineering Department, the City Engineer and Code Enforcement Officers may serve as the City's designee, with full authority to enforce all municipal infraction provisions of this Chapter.

c. In addition to all other means of enforcement provided for by law and in this Chapter, the Engineer, Stormwater Inspector, Code Enforcement officers, or police officers may issue a "stop work order" to any person who violates any provision of this Chapter. A stop work order also may be issued on the basis of information received setting forth the facts of the alleged violation.

d. Any person who receives such a stop work order shall immediately cease the activity that constitutes the violation. The person shall comply with all terms and conditions imposed by the person issuing the order before the activity may resume.

e. A person who receives a stop work order may appeal the issuance of the stop work order to the City Board within 10 days after the issuance of the stop work order.

f. If there has not been an appeal of the Stop Work Order made to the City Board within the designated 10 days of issuance of the stop work order and no reasonable attempt has been made to rectify the violation within 21 days of issuance of the stop work order, the City Engineer may at his/her discretion impose a fine in accordance with the schedule of fines found in paragraph 14.4.8.

2. City of Siloam Springs Engineering Department may initiate penalties as stipulated herein. Complete information concerning enforcement and penalties is described below.

3. Appeal Process for Stop Work Order.

a. Any violation notice issued pursuant to this chapter may be appealed in writing to the City Board within 10 days of the date of the violation notice.

b. Any party aggrieved by the decision of the City Engineer denying a waiver or a variance of the requirements of this chapter may appeal such decision to the City Board, in writing, within 10 days of the date of the written denial.

c. An appeal to the City Board pursuant to this section is a prerequisite to any court action by the aggrieved party.

14.4.5 Action without Prior Notice.

Any person who violated a prohibition or fails to meet a requirement of this Chapter will be subject, without prior notice, to one or more of the enforcement actions, when attempts to contact the person have failed and the enforcement actions are necessary to stop an actual or threatened discharge which presents or may present imminent danger to the environment, or to the health or welfare of persons, or to the storm drainage system.

14.4.6 Criminal Penalties.

The violation of any provision of this ordinance shall be deemed a municipal offense. Any person in violation of this ordinance shall, upon an adjudication of guilt or a plea of no contest, be fined according to the schedule of fines. Each separate day on which a violation is committed or continues shall constitute a separate offense.

14.4.7 Other Legal Action.

Notwithstanding any other remedies or procedures available to the City, if any person discharges into the storm drainage system in a manner that is contrary to the provisions of this ordinance, an Attorney acting on behalf of the City may commence an action for appropriate legal and equitable relief including damages and costs in any court of competent jurisdiction. The Attorney may seek a preliminary or permanent injunction or both which restrains or compels the activities on the part of the discharger.

14.4.8 Violations/Schedule of Fines.

A violation of any of the foregoing provisions shall be punished in accord with the schedule of fines found in Section 1-7 of the Municipal Code.

14.5 Termination

(A) Upon completion of construction activities a copy of the Notice of Termination filed with ADEQ shall be filed with the City Engineering Department indicating compliance with the provisions of this chapter.

14.6 Maintenance of Stormwater Facilities

14.6.1 Maintenance Responsibility.

Those stormwater management systems approved in compliance with this chapter that will function as an integral part of the system maintained by the city shall be dedicated to the city. All areas and/or structures to be dedicated to the city must be dedicated by plat or separate instrument and accepted by action of the City Board. All stormwater management systems accepted as dedications by the city shall be maintained by the city. Maintenance of all other stormwater management systems approved in compliance with this chapter shall be accomplished by the legal entity responsible for maintenance, which may include an approved entity as identified in the following:

1. Local government—a county, municipality, municipal service taxing unit, special district, or other appropriate governmental unit;

2. Special district—an active water control district, a drainage district, or a special assessment district;

3. State or federal agency—an appropriate state or federal agency;

4. Public entity—an officially franchised, licensed, or approved communication, water, sewer, electrical, stormwater, or other public utility;

5. Developer or property owner—a developer or property owner who provides a bond or other assurance of continued financial capability to operate and maintain stormwater management systems and who executes a legal maintenance agreement with the city; or

6. Property owner association—property owner associations able to comply with the following provisions:

a. The association provides a binding legal instrument through which it assumes full responsibility for stormwater management system operation and maintenance.

b. The association has sufficient powers to operate and maintain the system, establish rules, assess members, contract

for services, exist perpetually and, if dissolved, to provide alternative operation and maintenance services.

c. The association can provide a bond or other assurances of financial capability to operate and maintain services.

14.5 Checklist

1. Determination of whether the site requires a Construction Activities Stormwater Discharge Permit.
2. Complete application for a Grading Permit.
3. Complete Surface Water Pollution Prevention Plan and Erosion Control Plan drawing.
4. BMP details included in construction drawings.
5. Review fee
6. State or Federal permits applied for (if required) by developer.

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