Appendix D

STORM WATER MANAGEMENT

*The purpose of this section is to provide adequate measures for the retention, detention and distribution of storm water in a manner that minimizes the possibility of adverse impacts on both water quantity and water quality during development.***xx59** *Innovative runoff management practices designed to meet the provisions of the UDC, enhance the recharge of groundwater, and maintain the function of critical environmental features are encouraged.*
xx60 *The City recognizes that watercourses and their associated watersheds within the City of Poteet's jurisdiction represent significant and irreplaceable recreational and aesthetic resources and contribute to the economic and environmental health of the City. In addition, all of the watersheds within the City are vulnerable to concentrated surface water runoff, disturbance of wildlife habitat, nonpoint source pollution and sedimentation resulting from development activities and should be developed in a sensitive and innovative manner.*

This section implements the following policies:

- *Encourage retention of the 100-year floodplains as natural drainage ways without permanent construction, unnecessary straightening, bank clearing or channeling.*

- *Adopt strong storm water management practices throughout the drainage area which include site specific measures such as-*

on-site storm water retention and detention
reduction in impervious cover
natural bank contouring
floodplain preservation and buffering
preservation of riparian habitat
storm water harvesting sites for reuse purposes

(a) Applicability

The provisions of this section shall apply to any application for subdivision plat , or building permit approval except as otherwise provided by this chapter. A storm water management plan shall be provided as set forth in this Appendix.

(b) Storm Water Management Program

(1) Storm Water Management Program (SWMP).

A. To determine a significant adverse impact for the purposes of this section, the following criteria will be used to analyze the receiving storm water facility for 2000 linear feet downstream of the project ,. (The 2000 linear feet is based on an estimate that this length will approximate a 100-acre drainage area. The 100-acre drainage area represents the lower limit for a 100-year frequency storm water facility design.)

1. The design storm water surface elevation (DSE) in the receiving storm water facility may not be increased within the 2000 linear feet from the development unless the increased DSE is contained within an easement or right-of-way or the receiving facility has sufficient capacity to contain the increased DSE without increasing flooding to a habitable structure.

2. Where low water crossings exist within the study area, the DSE cannot be increased above the level of the 100-year ultimate development water surface at the low water crossing. The increase in flow at the low water crossing for the 5-year, 25-year and 100-year frequency design must not reclassify the low water crossing from a safe to a dangerous condition crossing based on Figure C-2. If the increased DSE exceeds this criterion, the development can improve the low water crossing to the standards of this chapter in lieu of providing for onsite controls.

3. Where a development is upstream of a flood control facility or other detention facility constructed prior to 2006, analyses will be provided to insure that capacity exists within the facility to accommodate the increased runoff from the proposed development.

4. The City of Poteet may require on-site detention for certain subdivisions. The City's decision will be based on the knowledge of significant adverse impacts that would be created within the watershed by the proposed development regardless of the distance from the development to the area impacted. The developer is recommended to meet with the City Engineer in person or by electronic message to discuss drainage options prior to commencing a project. This preliminary meeting in no way relieves the developer of his responsibility to prepare the necessary engineering documentation to support their drainage submittal.

(2) System Criteria.

A. All storm water management facilities, or combination of facilities, shall be designed for ultimate development. Facilities with drainage areas under 100 acres shall be designed for a 25-year storm. Facilities with drainage areas over 100 acres or areas within a designated floodplain shall be designed for a 100 year storm or a 25 year storm plus freeboard (based on Table 504-9) if that elevation is higher. .

B. Detention facilities and streets are exceptions to the frequency criteria cited above. Detention facility outflows will be designed for 5-year, 25-year and 100-year frequency storms. Refer to section (g) for specific drainage design criteria for streets.

C. Three development conditions shall be analyzed for each development.

1. **Existing Conditions.**

   This refers to current development conditions in the watershed and on site. Use as the baseline analysis for determining the impact of development.

2. **Proposed Conditions.**

   This refers to existing conditions with the proposed development added. Use to determine if the increased runoff from the proposed development results in an adverse impact to other properties.

3. **Ultimate Conditions.**

This refers to ultimate development conditions within the watershed used to design the drainage facilities. This condition may be used in lieu of subsection 2, above, to determine if the increased runoff from the ultimate watershed development results in an adverse impact to other properties.

(3) Responsibility to Accept Storm Water.

The owner or developer of property to be developed shall be responsible for the conveyance of all storm water flowing through the property. This responsibility includes the storm water flowing onto the property by any other developed property as well as the drainage naturally flowing through the property by reason of topography. Future upstream development shall be accounted for by assuming ultimate development when sizing drainage systems as specified in this section.

(4) Positive Overflow Pathways.

Storm water management facilities for local drainage systems will be designed to ensure that a positive overflow pathway is provided to the nearest 100-year conveyance facility. The overflow pathway must be delineated on a plan that shows all existing structures in the vicinity impacted by the overflow pathway.

(5) Maintenance.

A. Maintenance of publicly owned facilities will be the responsibility of the City. Maintenance of private facilities is the responsibility of the property owner or the community association and must be specified in the maintenance schedule submitted to the City. A maintenance schedule for both publicly owned and privately owned facilities must be approved by the City Administrator/ City Engineer prior to the approval of construction drawings.

B. Authorized personnel from the City of Poteet may conduct periodic inspections of these facilities and structures. Any required repairs will be consistent with current construction industry standards or as approved by the Director of Public Works or the City Engineer. Maintenance issues identified by the City or State during inspections shall be the responsibility of the current owner.

(6) New Development.

Peak storm water runoff rates from all new development shall be less than or equal to the peak runoff rates from the site's predevelopment conditions for the 5-year, 25-year and 100-year design storm events, except as provided in (b)(1), above.

(7) Redevelopment.

Peak storm water runoff rates from an area of redevelopment due to replatting shall be less than or equal to the peak runoff rates produced by existing development conditions for the 5-year, 25-year and 100-year design storm events, except as provided in (b)(1), above.

(c) Method of Computing Runoff

(1) Calculation Methods.

A. For drainage areas less than six hundred forty (640) acres, the basis for computing runoff shall be the rational formula or some other method provided it is acceptable to the Director of Public Works/City Engineer. Hydraulic calculations shall be by accepted engineering practice methods.

B. For drainage areas six hundred forty (640) acres or greater, the basis for computing runoff shall be a unit hydrograph method, preferably the Soil Conservation Service (SCS) Dimensionless Unitgraph method as contained in the U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-1 "Flood Hydrograph Package," which document shall be maintained on file with the Director of Public Works and is hereby incorporated by this reference. For the SCS method, antecedent moisture condition II shall be used in the runoff model. Design rainfall values listed in Table C-4 shall be used for hydrograph calculations.

C. Open channel hydraulic calculations shall be performed by using the U.S. Army Corps of Engineers HEC-2 "Water Surface Profiles" or HEC-RAS "River Analysis System" computer models, which documents shall be maintained on file with the Director of Public Works or City Engineer and is hereby incorporated by this reference.

D. Certain watersheds have hydrologic and hydraulic models that are available through and maintained by the City of Poteet or the City Engineer. Developments proposed within the limits of these watersheds must have the models updated by the consultant to reflect changes in flow, channel configuration (including alterations to vegetation) and channel structures. The consultants' models must use the same computer program that was used in the existing model. For example, HEC-RAS models will not be accepted where the original model used HEC-2. However, if the consultant first models the drain in the existing program, obtains approval, and then provides the model in an updated Corps of Engineers drainage program that is acceptable to the Director of Public Works or the City Engineer, the alternate program may be accepted into the City's master model. The updated models shall be submitted to the Director of Public Works/City Engineer for incorporation into the master models. The City of Poteet will periodically update the master models to reflect current watershed development conditions. The updated models will be made available for use and distribution as the latest existing condition models for the watershed.

(2) Time of Concentration.

A. Overland (sheet) flow, shallow concentrated flow and channel flows are components that need to be considered in the calculation of time of concentration. The following methods are recommended for time of concentration calculation.

B. Overland flow – flow over plane surfaces: Maximum allowable time is 20 minutes. Minimum is 5 minutes. The overland flow time chart from "Design" by Elwyn E. Seelye may be used to calculate overland flow times. Note that the minimum time has been reduced to 5 minutes. Alternate methods of calculating the overland flow component of the time of concentration must be approved by the Director of Public Works, City Administrator, or the City Engineer.

C. Shallow concentrated flow – overland flow usually becomes shallow concentrated flow after a maximum of 300 feet: Use Manning's equation to estimate travel time for defined swales, bar ditches and street sections, etc. Figure 3-1 from TR-55 "Urban Hydrology for Small Watersheds", SCS 1986, may be used where a geometric section has not been defined.

D. Channel flow: Use existing computer models where available or Manning's equation if data is not available. Non-floodplain channel velocities for ultimate watershed development should not be less than 6 fps when estimating time of concentration.

(3) Runoff Coefficients.

Runoff coefficients (C value) for use in the rational formula shall not be less than the values shown in Tables D-1A or D-1B, as appropriate.

Table D-1A
Runoff Coefficients (C) - Percentage

CHARACTER OF AREA	SLOPE			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Business or commercial areas (90% or more impervious), Existing Pavement / Buildings	95	96	97	97
Densely developed areas (80% to 90% impervious)	85	88	91	95
Closely built residential areas and school sites	75	77	80	84
Undeveloped areas * – Present land is undeveloped and ultimate land use is unknown. C values for use in ultimate development calculations.	68	70	72	75
Large lot residential area	55	57	62	64
Undeveloped areas * – Existing conditions. See Table D- 1(b)				
Average residential area	65	67	69	72

Table D-1B
Runoff Coefficients (C) - Percentage

CHARACTER OF AREA	SLOPE			
	Up to 1%	Over 1% up to 3%	Over 3% up to 5%	Flow over 5%
Cultivated or Range (Grass Cover < 50% of Area)	44	47	53	55
Range (Grass Cover 50-75% of Area)	37	41	49	53
Forest or Range (Grass Cover > 75% of Area)	35	39	47	52

* Areas included within parks, green belts or regulatory floodplains shall be considered to remain undeveloped per Table C-1B.

(4) Rainfall Intensity.

Use TxDOT "Rainfall Intensity Equation" to determine rainfall intensity.

Table D-2
Equation Coefficients

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e (in)	0.808	0.791	0.780	0.770	0.757	0.761
b	60	74	80	90	95	108
d (mins)	9.2	9.0	9.0	9.0	9.0	9.2
t_c	Time of Concentration (Minimum 10 minutes)					

(5) SCS Curve Numbers.

The SCS curve numbers adopted for use by the City of Poteet are shown in Table D-3. The hydrologic soil groups are listed in the latest version of the United States Natural Resources Conservation Service [formerly the Soil Conservation Service], "Urban Hydrology for Small Watersheds", Technical Release No. 55 (TR 55) which document is hereby incorporated by this reference. Soil types that relate to the hydrologic soil group may be found in the latest version of the United States Natural Resources Conservation Service "Soil Survey-Atascosa County, Texas" which document is hereby incorporated by this reference. Soil types may also be based on a Geotechnical Engineering Report.

Table D-3
SCS Curve Number by Soil Type

Hydrologic Soil Group	*Description*	*SCS Curve Number*
A	Soils having a low runoff potential due to high infiltration rates. These soils consist primarily of deep, well drained sand and gravels.	25
B	Soils having a moderately low runoff potential due to moderate infiltration rates. These soils consist primarily of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.	55
C	Soils having moderately high runoff potential due to slow infiltration rates. These soils consist primarily of soils in which a layer exists near the surface that impedes the downward movement of water or soils with moderately fine to fine texture.	70
D	Soils having a high runoff potential due to very slow infiltration rates. These soils consist primarily of clays with high swelling potential, soils with permanently high water tables, soils with a clay pan or clay layer at or near the surface, and shallow soils over nearly impervious parent material.	77

(6) **Percent Impervious Cover.**

The percent impervious cover for typical land use types in Poteet are presented in Table D-4.

Table D-4
Percent Impervious Cover by Land Use

Land Use Category		Average Percent Impervious Cover
Residential	1/8 acre Residential Lots, or Garden or townhouse apartments	65-85%
	¼ acre Residential Lots	38%
	1/3 acre Residential Lots	30%
	½ acre Residential Lots	25%
	1 acre Residential Lots	20%
Industrial		72-85%
Business or Commercial		85-95%
Densely developed (apartments)		65-85%
Streets, Roads, and Parking Areas		98%

(7) **Design Rainfall.**

A twenty-four-hour rainfall distribution shall be applied for runoff calculations. Rainfall intensities as adopted for the City of Poteet are given in Table D-5 and should be used for HEC-1 input. The lag value for a sub area shall be calculated as 0.6 times the time of concentration.

Table D-5
Design Rainfall Values (inches)

DURATION \ Frequency	5-year	10-year	25-year	50-year	100-year	500-year
5 minute	0.58	0.64	0.73	0.8	0.87	1.03
15 minute	1.26	1.39	1.59	1.75	1.91	2.25
60 minute	2.53	2.9	3.43	3.84	4.25	5.2
2 hour	3.08	3.66	4.42	4.99	5.57	6.95
3 hour	3.57	4.23	5.04	5.64	6.23	7.6
6 hour	4.26	4.99	5.89	6.52	7.13	8.47
12 hour	4.68	5.55	6.58	7.32	8.05	9.68
24 hour	5.45	6.55	7.78	8.78	9.91	12.75

(8) **Routing of Runoff.**

Routing of the runoff hydrograph through the channel from one sub area calculation point to the next in the HEC-1 shall be computed using one of the following methods:

A. Overbank/channel storage not significant: Use normal depth channel routing.

B. Overbank/channel storage is significant: use the Muskingum method where a hydraulic model is not available. Use Modified Plus Storage method where a hydraulic model is available to develop storage/out flow relationship.

C. Kinematic wave method for channel reaches where inflow from overbank runoff or multiple point sources (Example: storm sewer outfalls) is significant and where hydrograph attenuation is insignificant.

Channel routing methodologies currently being applied in the existing HEC-1 model of the watershed shall not be replaced with a different methodology without approval or direction from the Director of Public Works or City Engineer.

(9) **Manning's Roughness Coefficient.**

Manning's roughness coefficients ("n" values) for use in routing methods or in hydraulic calculations shall be consistent with the values listed in Table D-6

Table D-6
Manning's Roughness Coefficient

Channel Description	Manning's "n" Value
Concrete Lined Channel	0.015
Grass Lined Channel with regular maintenance	0.035
Grass Lined Channel without recent maintenance	0.050
Vegetated Channel with trees, little or no underbrush	0.055
Natural Channel with trees, moderate underbrush	0.075
Natural Channel with trees, dense underbrush	0.090
Natural Channel with dense trees and dense underbrush	0.100

Overbank Description	Manning's "n" Value
Pasture	0.035-0.055
Trees, little or no underbrush, scattered structures	0.060-0.075
Dense vegetation, multiple fences and structures	0.075-0.090

The N value to be used in Manning's Formula shall conform to the following for design purposes:

A. Earth channels--0.035
B. Concrete lined channels--0.015
C. Reinforced concrete pipe--0.013
D. Concrete box culverts--0.013
E. Corrugated metal pipe:
F. Unpaved 1/2" corrugated--0.024
G. Unpaved 1" corrugated--0.027

Any other N value shall be based on generally accepted engineering principles.

(d) Drainage easements / Rights-of-way

(1) Applicability.

Where a subdivision is traversed by a watercourse, drainage way, natural channel or stream, there shall be provided an easement or right-of-way conforming substantially to the limit of such watercourse, plus additional width as outlined below.

(2) Requirements.

Easement or right-of-way requirements are specified in the following subsections of this Section for particular storm water management facilities –

A. (d)(3) Natural Watercourses or Floodplains

B. (h)(7)(g) Concrete Lined Channels
C. (h)(8)(c) & (d) Vegetated Earth Channels
D. (i)(c) Storm Sewers

(3) Natural Watercourses or Floodplains.

Easements for natural watercourses shall be the 100-year floodplain or the 25-year plus freeboard (see Table C-9 of this Section) whichever is greater. In floodplain areas where ongoing maintenance is required or the floodplain will be reserved for use by the public, the drainage easements shall be maintained by a public entity and the property will be dedicated to the City as a multi-use drainage easement. A drivable access way shall be provided in floodplain easements for the length of the easement when regular maintenance of the floodplain is required. Diversion of storm water away from the natural watercourse will not be allowed except within the boundaries of the property controlled by the developer, provided that the diverted water is returned to the watercourse within which it would naturally have been flowing prior to leaving the developer's property. An analysis of the timing of the diverted hydrograph on watersheds greater than twenty (20) acres, as it reenters the receiving watercourse, must be performed to show that the peak flowrate in the receiving watercourse has not been increased as a result of the diversion.

(4) Maintenance Access Right-of-Way.

An unobstructed access right-of-way connecting the drainage easement with an alley or roadway parallel to or near the easement shall be provided at a minimum spacing of one access right-of-way at approximately one-thousand (1000) foot intervals. The access right-of-way shall be a minimum of fifteen (15) feet in width and shall be maintained clear of obstructions that would limit maintenance vehicular access. If the flow line of the designed channel incorporates grade control structures or vehicular bridges that would prevent maintenance equipment from accessing that portion of the channel, additional access points may be required. Channel design, earthen or concrete, shall have ramps in the side slopes near the access points that would allow maintenance equipment to descend to the floor level of the channel. The maximum allowable ramp slope for vehicular access is 7:1. Access points adjacent to roadways or alleys shall be provided with a post and cable feature with padlock to prevent unauthorized use.

(5) Lot and Property Line Crossings.

In those cases where drainage easements cross lot and property lines, a statement shall be added to the plat that no fencing or structures that will interfere with adequate drainage flow will be allowed on or across such lines. Fencing may be allowed across drainage easements only in accordance with the following restrictions:

A. Bottom of fence shall be a minimum of the flow depth, plus freeboard (see Table C-9 of this Section) above design flow line of channel or drain.

B. A hinged gate will be placed across the entire width of the drainage easement.

C. Fence posts located within the easement must be structurally designed to resist damage from the storm water flows and impact from debris.

D. A floodplain development permit will be required to construct a fence within an easement within the 100-year floodplain.

(6) Interceptor Easements.

Interceptor drainage easements and channels shall be provided where the drainage area to the back of platted lots exceeds the depth of two average residential lots. Interceptor drains shall be constructed prior to the issuing of building permits on any lot that would be affected by natural drainage being intercepted.

(7) Lower Elevation of Site.

All developments shall provide for adequate drainage outfall at the lower end of the site into an existing street, alley, drainage, easements or right-of-way, or to the centerline of an existing natural drain. Where proposed street, storm sewer, or open channel does not discharge into a natural low or into an existing, adequate drainage easement, then facilities and drainage easements of adequate width to contain the design discharge shall be constructed and dedicated to the centerline of an existing natural low within the same watershed. However, where the natural low lies within the developer's property, the developer will be required only to plat an easement to the centerline of the natural low, provided that the easement is adequate to accommodate the facilities that will be built in conjunction with the future development of that property.

(e) Site Design and Grading

(1) All land disturbing or land filling activities or soil storage shall be undertaken in a manner designed to minimize surface runoff, erosion and sedimentation, and to safeguard life, limb, property and the public welfare in accordance with the NPDES (TPDES) construction site regulations as amended, which is hereby incorporated by this reference.

(2) Erosion and sedimentation controls in accordance with the specifications established by the Director of Public Works and City Engineer in compliance with the National Pollution Discharge Elimination System permitting requirements for the City are required.

(3) Projects shall not be considered complete until restoration has been made in accordance with NPDES requirements.

(4) Where possible, multiple uses of drainage facilities and open space shall be incorporated by the owner or developer of a new subdivision. Alternative uses such as public recreation, horse/bike/hiking trails, walking paths, nature preserves, wildlife habitat areas, etc. are encouraged subject to the approval of the Director of Public Works and the City Administrator.

(5) A note must be placed on the plat for residential lots, which states that finished floor elevations must be a minimum of eight (8) inches above final adjacent grade. A grading plan shall be prepared and submitted to the City of Poteet, which indicates typical lot grading for all lots in the subdivision using typical FHA lot grading types (A, B & C). A more detailed grading plan is also acceptable. No more than two average residential lots may drain onto another lot unless a drainage easement is dedicated to contain the runoff.

(f) Storm Water Detention

Storm water detention shall be required for all new developments or redevelopment of individual parcels of property to mitigate peak flow rates to predevelopment or existing development conditions as stated in Subsections (b)(6) and (b)(7) of this Section. Mandatory detention is required in the areas of the City where the additional runoff from the new development will cause an adverse impact downstream. In areas of the City where there will be no adverse impact to downstream residents or low water crossings, the City may allow development without onsite detention. The Storm Water Management Report for the new development must provide the information that there is no adverse impact to downstream residents or low water crossings. The Director of Public Works or the City Engineer must approve the Storm Water Management Plan in order for the new development to be approved for construction without onsite detention. There are many commercially available storm water detention programs which calculate the outfall systems and volumes of the detention ponds. The acceptance of certain programs for the calculation of detention ponds is solely at the discretion of the Director of Public Works, and City Engineer. The City of Austin method for the calculation of detention ponds, using appropriate site specific parameters for conditions around Poteet is an acceptable method. The design engineer should meet with the City Engineer or the Director of Public Works prior to submittal of detention calculations to assure acceptance by the City of the method used to calculate a detention pond.

(1) Maximum Outflow Rate.

The maximum allowable outflow rate from the detention facility must be restricted to the flow rate from the undeveloped or existing development tract for the 5-year, 25-year and 100- year frequency. Best management practices shall be used in the design of detention facilities in accordance with this section. The timing of the hydrograph released from the detention facility must be checked against the timing of the flow rate in the first open watercourse to prevent any increase in the peak flow rate in the receiving watercourse. For detention basins constructed in-line on an existing watercourse, the creation of the basin shall not increase flood elevations in the channel upstream of the new development boundaries.

(2) On-Site Detention.

On-site detention facilities must be privately owned and shall be maintained by the community association or property owner. A maintenance schedule shall be submitted to the Public Works Department and approved by the Director of Public Works prior to approval of construction plans. The City of Poteet will have the right to do periodic inspections of privately owned and maintained detention facilities to ensure that the maintenance schedule is being implemented. Where a detention facility accepts flows from public facilities such as City right-of-ways, the detention facility will be considered a detention facility serving a public purpose and will be dedicated to the City upon completion and a drainage easement will be dedicated to provide for access to the facility. When a detention facility accepts flow from an area exceeding 300 acres, the facility shall be considered serving a public purpose and shall be dedicated to the City.

A. General locations and sizes of detention facilities may be identified in the master drainage plan for the major watersheds in the City's jurisdiction. The ownership of detention facilities may either be public or private. The creation of detention facilities designed to service one or several developments is encouraged, but not required. In watersheds where public regional detention facilities exist, mitigation of increased storm water runoff from new construction may utilize these facilities Temporary detention may be required for the development until sufficient capacity in the outfall channel is provided to accommodate increased flows. Maintenance of publicly owned facilities will be the responsibility of the City. Maintenance of private facilities is the responsibility of the property owner or the community association and must be specified in the maintenance schedule submitted to the City. A maintenance schedule for both publicly owned and privately owned facilities must be approved by the Director of Public Works prior to approval of construction drawings.

Drainage easements will be provided for all detention facilities. The easement will encompass the 100-year pool elevation plus all structural improvements (levees, dykes, berms, outfall structures etc.) necessary to contain the pool. The easement will extend, at a minimum, to the toe of the downstream embankment. Maintenance access (15' minimum) will be provided around the facility, outside the limits of the 100-year pool elevation. Ramps, as necessary, with a maximum slope of 7:1 will be provided for access to the flow line of the facility.

(4) Multi-Use Facilities.

Multi-use facilities are encouraged, but not required (multi-use facilities allows for water quality, satisfy NPDES requirements, enhance ground water recharge, provide open space, provide recreation or other amenities, and/or provide habitat) and may be utilized so long as the facility meets the standards set forth in Subsection (a) of this section and does not increase the rate or volume of erosion above that which would result from the use of a facility without multiple uses. The use of multi-use detention facilities to alleviate existing flooding problems, enhance and provide amenities for older neighborhoods, and support the revitalization of economically depressed areas is encouraged in public and private redevelopment initiatives.

(5) Permanent Wet Pool or Pumped Detention Systems.

Storm water retention with permanent wet pool or pumped detention systems will not be acceptable methods of storm water mitigation unless the facility will remain privately owned, operated, and maintained. The City will approve the use of a pumped facility for private use under the following conditions:

A. A gravity system is not feasible from an engineering and economic standpoint.

B. At least two (2) pumps are provided each of which is sized to pump the design flow rate;

C. The selected design outflow rate must not aggravate downstream flooding.

D. Controls and pumps shall be designed to prevent unauthorized operation and vandalism.

E. Adequate assurance is provided that the system will be operated and maintained on a continuous basis.

(6) Location of Detention Facilities and Surrounding Development.

Storm water detention facilities shall be located in topographically depressed areas where possible. When necessary, dams may be constructed to detain flows. All proposed dams shall conform to the following items:

A. All dams over six (6) feet above existing natural around shall be approved by the Dam Safety Team of the TCEQ for safety. All other new dams shall be designed in accordance with acceptable design criteria as approved by the Director of Public Works, City Engineer or their authorized representative.

B. All hydrology and hydraulic properties of a dam will be reviewed by the Department of Public Works or City Engineer with regard to spillway design, freeboard hydraulics, backwater curves and downstream effects due to the dam site.

C. The spillway section of any earthen dam with a height greater than six (6) feet shall be large enough to pass a PMP (probable maximum precipitation) flood, as defined by the NRCS, without overtopping the crest of the dam in accordance with TCEQ regulations.

D. A 100-year frequency flood shall be routed through the proposed dam and all land subject to flooding shall be dedicated as drainage easement or right-of-way. An unobstructed fifteen-foot access easement around the periphery of the flooded area shall be dedicated as drainage easement for facilities that require regular mowing or other ongoing maintenance, at the discretion of the Director of Public Works. An unobstructed fifteen (15) foot access right-of-way shall be established which connects the drainage easement adjacent to the dam structure to a road or alley.

E. Development below existing dams will take into account the original design conditions of the existing dam. Dam breach analysis checks will be required, dependent upon location of development with respect to dam site.

F. All spillway discharges shall be adequately routed to the centerline of the natural low below the dam site. The adequate routing of spillway discharges pertains to the hydraulic routing of the 100-year frequency flood for dedication of drainage easement limits. Probable Maximum Precipitation (PMP), flood routing or breaches will only be considered for safety considerations (that is, the placement of building and the setting of minimum floor slab elevations below the dams). Any proposed concrete dam structure need not have spillway capable of routing a PMP flood, however, it shall be shown to be structurally capable of withstanding any range of flood conditions with regard to possible failure due to sliding, overturning, and structural integrity, up to and including the PMP flood.

(g) Streets

(1) Generally.

A. Design of streets shall consider public safety and limit potential conflicts between storm water conveyance, traffic, parking, pedestrian access, ADA requirements, and bicycle traffic.

B. Streets draining a watershed greater than 100-acres must be designed for the 100-year frequency storm.

C. Streets may be used for storm water drainage only if the calculated storm water flow does not exceed the flows outlined in Table D-7 or the velocity does not exceed ten (10) feet per second.

D. Where streets are not capable of carrying storm water, as outlined above, inlets or curb openings discharging to drainage channels or storm sewers shall be provided. Partial flow past the inlet will be allowed when the capacity of all downstream street systems can accommodate the flow.

E. Street width shall not be widened beyond the width as determined by the street classification for drainage purposes.

F. Storm water conveyance on streets shall be designed to account for the cumulative impact of peak flows and runoff volumes on the system as the storm water progresses downgrade.

G. Curb cuts for driveways on all streets shall be designed for compatibility with the storm water conveyance function of streets.

H. Potential flooding problems or conflicts at the connection points where new or modified drainage systems (including streets, storm sewers, etc.) and the existing portions of the downstream street system and storm water conveyance system shall be identified and resolved either in the design of the new or modified drainage system or in modifications to the existing system.

I. Dwelling Units located on the downhill side of a T-intersection with a street or drainage channel discharging onto the intersection shall be sited so as to avoid obstruction of the drainage patterns.

(2) Major Through Fares and Collector streets.

A maximum flow depth to the top of curb on a major through fare and collector street sections will be allowed during a 25-year storm event. A collector street is a street with a width of thirty (30) feet or more. A major through fare is a street with a width of thirty-five (35) feet or more.

(3) Residential streets.

Local "A" streets shall be designed on a basis of a five (5) year frequency. A 25-year frequency storm must be contained within the street right-of-way.

(4) Alleys.

Alleys shall be designed for five (5) year frequency within the limits of the alley pavement / curbs and twenty-five (25) year frequency within the right-of-way/easement to carry storm water.

(5) All-Weather Crossings.

A. Where streets cross existing or proposed watercourses, all weather crossings shall be required. Culverts or bridges shall be adequate to allow passage of the design storm identified in Appendix D(b)(1)

B. All crossings, culverts and bridges shall be designed for an H-20-44 or HS-20 loading.

C. Dangerous conditions for existing crossings are defined by Figure D-2 (Dangerous Conditions on Crossing During Floods).

D. All design of major drainage ways shall be coordinated with the Texas Department of Transportation and the Atascosa County Flood Control, as required.

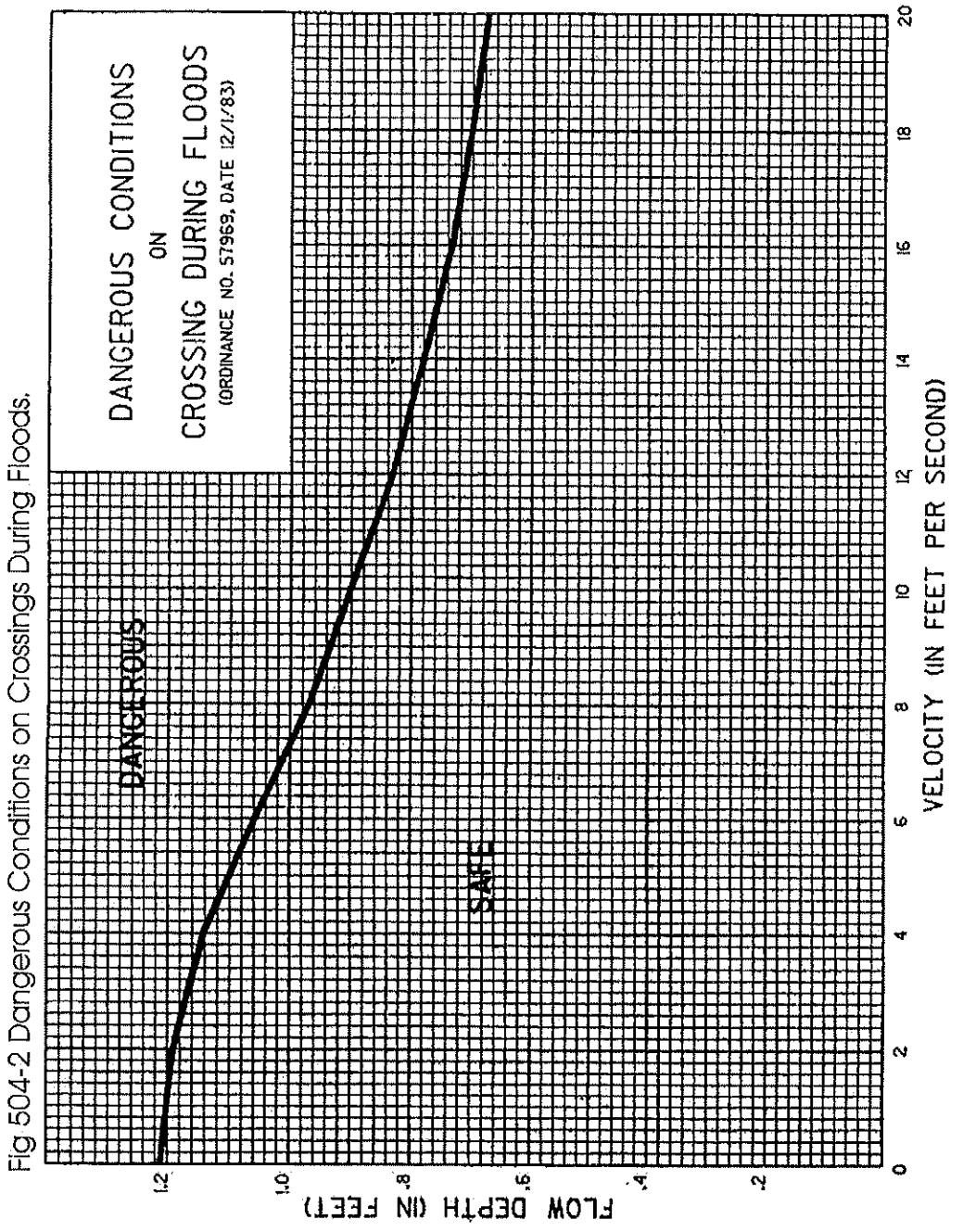
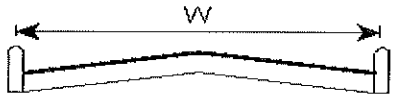


Fig 504-2 Dangerous Conditions on Crossings During Floods.

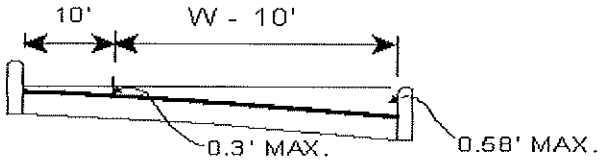
(Ord. No. 65513, § 2(I), 8-13-87)

Figure D-1

Table D - 7 Storm Drainage, street Velocities & Capacities, Manning's N=0.018



Local / Collector Street



Primary or Secondary Streets

STORM DRAINAGE
STREET VELOCITIES AND CAPACITIES
Manning's n=0.018

Slope %	LOCAL TYPE "A" W= 30'		LOCAL TYPE "B" W=40'		COLLECTOR W=44'		SECONDARY (W/MEDIAN) Maximum Water Depth = 7" W=24' Min. and 29' Max.		PRIMARY & Secondary (W/O MEDIAN) Maximum Water Depth = 7" W=24' Min. and 29' Max.	
	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s	Q cfs	V f/s
0.40	35.4	2.8	47.8	2.9	44.1	2.7	20.6	2.5	19.2	2.3
0.45	37.5	3.0	50.7	3.0	46.8	2.8	21.9	2.7	20.4	2.4
0.50	39.6	3.2	53.4	3.2	49.3	3.0	23.1	2.8	21.5	2.5
0.55	41.5	3.3	56.0	3.4	51.7	3.1	24.2	2.9	22.5	2.7
0.60	43.3	3.5	58.5	3.5	54.0	3.3	25.3	3.1	23.6	2.8
0.65	45.1	3.6	60.9	3.7	56.2	3.4	26.3	3.2	24.5	2.9
0.70	46.8	3.8	63.2	3.8	58.4	3.5	27.3	3.3	25.4	3.0
0.75	48.5	3.9	65.4	3.9	60.4	3.7	28.3	3.4	26.3	3.1
0.80	50.0	4.0	67.6	4.1	62.4	3.8	29.2	3.5	27.2	3.2
0.85	51.6	4.1	69.6	4.2	64.3	3.9	30.1	3.7	28.0	3.3
0.90	53.1	4.3	71.7	4.3	66.2	4.0	30.9	3.8	28.8	3.4
0.95	54.5	4.4	73.6	4.4	68.0	4.1	31.8	3.9	29.6	3.5
1.00	55.9	4.5	75.5	4.5	69.8	4.2	32.6	4.0	30.4	3.6
1.50	68.5	5.5	92.5	5.5	85.4	5.2	40.0	4.9	37.2	4.4
2.00	79.1	6.4	106.8	6.4	98.6	6.0	46.1	5.6	43.0	5.1
2.50	88.5	7.1	119.4	7.2	110.3	6.7	51.6	6.3	48.1	5.7
3.00	96.9	7.8	130.8	7.8	120.8	7.3	56.5	6.9	52.7	6.2
3.50	104.7	8.4	141.3	8.5	130.5	7.9	61.0	7.4	56.9	6.7
4.00	111.9	9.0	151.1	9.1	139.5	8.5	65.2	7.9	60.8	7.2
4.50	118.7	9.5	160.2	9.6	148.0	9.0	69.2	8.4	64.5	7.6
5.00	125.1	10.0	168.9	10.0	156.0	9.5	72.9	8.9	68.0	8.0
5.50	116.0	10.0	153.0	10.0	163.6	9.9	76.5	9.3	71.3	8.4
6.00	108.0	10.0	143.0	10.0	157.0	10.0	79.9	9.7	74.5	8.8
6.50	102.0	10.0	134.0	10.0	148.0	10.0	81.0	10.0	77.5	9.1
7.00	96.0	10.0	127.0	10.0	140.0	10.0	76.0	10.0	80.4	9.5
7.50	91.0	10.0	120.0	10.0	132.0	10.0				
8.00	87.0	10.0	115.0	10.0	126.0	10.0				
8.50	83.0	10.0	110.0	10.0	120.0	10.0				
9.00	79.0	10.0	105.0	10.0	115.0	10.0				
9.5	76.0	10.0	101.0	10.0	111.0	10.0				
10	73.0	10.0	97.0	10.0	106.0	10.0				

W = Width of ponded water.

(h) Drainage Channels and Watercourses.

This section addresses proposed improvements or modifications to drainage channels and watercourses required to convey storm water runoff from or through the proposed development. Refer to Appendix D (b)(1) for storm frequency design criteria.

(1) Watercourses to Remain Unobstructed.

Except as authorized by a development plan approved by the Director of Public Works, City Engineer, or their designee, no person shall place or cause to be placed any obstruction of any kind in any watercourse within the city and its ETJ. The owner of any property within the City, through which any watercourse may pass, shall keep the watercourse free from any obstruction not authorized by a development plan.

(2) Channel Modifications.

A. Modifications to existing watercourses or newly created open channels may be designed as earth channels, sod channels or as concrete lined channels. Liners other than sod or concrete which enhance the aesthetics or habitat value of the watercourse and which reduce future maintenance requirements are encouraged. Preliminary planning for the applicability of other channel liners shall be reviewed with the Director of Public Works, City Engineer, or their representative prior to the submittal of construction plans for approval.

B. Natural Unimproved Waterways. Runoff that results from upstream development and is discharged to an unimproved waterway can cause flood damage to properties adjacent to the waterway. Natural undeveloped waterways do not receive regular maintenance. Design of natural waterways shall take into consideration fluvial geomorphologic principals and practices. Consulting engineers and development review officials shall work to resolve potential downstream impact issues.

(3) Maintenance.

A. Design of new channels or alterations to existing channels shall consider future maintenance requirements. A maintenance schedule for any private channel shall be submitted to and approved by the Director of Public Works or City Engineer prior to approval of construction plans. Maintenance requirements of concrete channels consist of de-silting activities, prevention of vegetation establishment in construction joints, and repair of concrete as necessary. Maintenance of earthen channels includes regular observation and repair as necessary of erosion, scouring, and removal of silt deposits, as necessary to maintain design parameters. Developers shall be responsible for maintaining newly planted channels until coverage is established throughout 85 percent of the area. This area shall include slopes, floor, and any attendant maintenance easement. New earthen channels shall be planted with drought resistant, low growth, native species grasses, which will allow unobstructed passage of floodwaters. Johnson grass, giant ragweed and other invasive species shall not be allowed to promulgate in channels. Suggested species shall include, but not be limited to, common bermuda, coastal bermuda, buffalo grass, sideoats grama, seep muhly, little bluestem, and indian grass. Mowing frequencies vary with the

vegetation growth rates, but is required when the grass exceeds the design roughness coefficient of the channel.

B. Sedimentation Controls: Brush berms, hay bales, sedimentation basins and similar recognized techniques and materials shall be employed during construction to prevent point source sedimentation lading of downstream facilities. Such installation may be regularly inspected by the City Engineer for effectiveness. Additional measures may be required if, in the opinion of the City Engineer, they are warranted.

(4) **Multiple Uses.**

Planned multiple-use of a watercourse is allowed (for example:. bike paths or greenbelt). If multiple use of the watercourse is to be incorporated, the applicant shall form a property owners association that shall assume maintenance responsibility for private amenities. The appropriate government agency will be responsible for maintenance of public amenities. The applicant shall provide overlay easements for public or private use.

(5) Velocity Criteria.

Table D-8 shall be used to determine maximum permissible channel velocity.

Table D-8 Velocity Control

Velocity (fps)	Type of Facility Required	Hydraulic Radius (ft.)	Correction Factor	Maximum Permissible Velocity (fps)
1 to 6 (Maximum Average Velocity = 6 fps)	Vegetated Earthen Channel	0-1 1-3 3-5 5-8 8-10 Over 10	0.8 0.9 1.05 1.15 1.225 1.25	5 5.5 6.3 6.9 7.35 7.5
6 to 8	Concrete Retards	NA	NA	NA
> 8	Concrete Lining or Drop Structures	NA	NA	NA

A. Where velocities are in the supercritical range, allowance shall be made in the design for the proper handling of the water.

B. Ensure that the channel will contain the hydraulic jump (sequent depth) throughout the extent of the supercritical profile. An exception to this criteria is where concrete lined lateral channels discharge down the side slopes of channels. These channels may be designed for normal depth plus freeboard provided velocity controls are established at the main channel flow line.

C. Ensure that the energy grade of the channel will not result in upstream flooding at existing or proposed lateral facility connections.

(6) Retard Spacing.

Retard spacing shall be computed as follows when using the City standard retard section Figure C-3 and the following equations:

RETARD SPACING CRITERIA

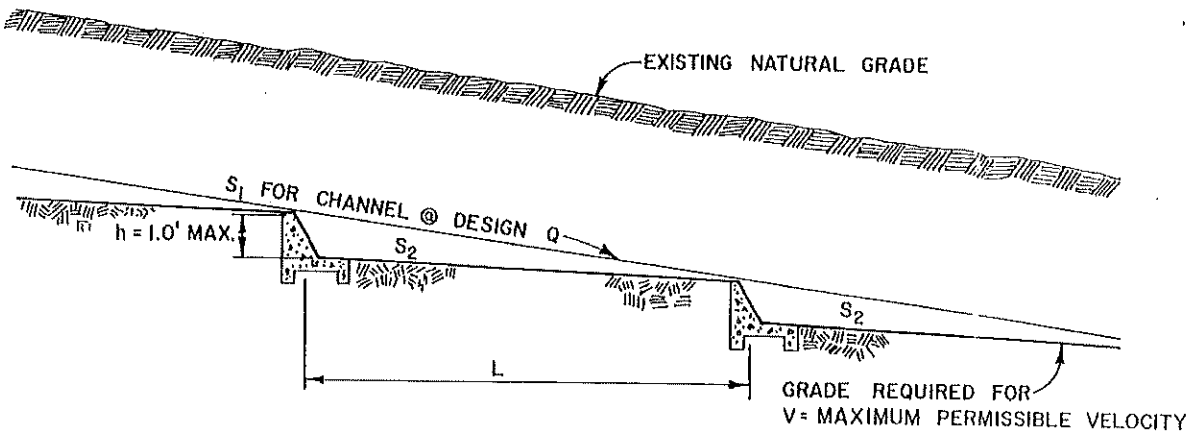


Figure D-2

$$L = 1.0' \div (S1 - S2)$$

Where: L = Distance required between retards in feet.
S1 = Actual slope of channel in ft./ft.
S2 = Slope of proposed channel for maximum permissible velocity established from Table 504-8, i.e.:

and

$$S2 = [(NV) \div (1.486R^{2/3})]^2$$

Where: V = maximum permissible velocity established from Table 504-8
N = .035
R = area/wetted perimeter

(7) **Concrete Lined Channels.**

The design of concrete lined channels shall comply with the following general requirements:

A. Freeboard consistent with Table C-9 will be applied to the 25-year design.

B. From the top of the concrete lining to the top of the ditch, a side slope not steeper than three (3) horizontal to one (1) vertical shall be required; nor shall the slope be less than twelve (12) to one (1).

C. For normal conditions, the concrete lining shall be a minimum of five (5) inches thick and reinforced with No. 3 round bars @ 12 inches on center each way. Where surcharge, nature of ground, height and steepness of slope, etc. become critical, design shall be in accordance with latest structural standards. All concrete lining shall develop a minimum compressive strength of not less than three thousand (3,000) pounds per square inch in twenty-eight (28) days. The depth of all toe downs shall be 36 inches upstream, 24 inches downstream, and 18 inches for side slopes. The City's Construction Inspector may permit an 18" toe down in rock subgrade in lieu of the above toe down requirements. The horizontal dimensions of toe downs shall not be less than six (6) inches.

D. Maximum concrete riprap side slopes shall be one and one-half horizontal to one vertical, unless soils tests made by a geotechnical engineer shows that a greater slope, or a special design, will be stable. Where vehicular traffic may travel within a horizontal distance equal to one-half the vertical rise of the slope, a two-foot surcharge load shall be included in the design.

E. Fencing will be required adjacent to the channel where channel vertical wall heights exceed 2 feet. Fencing will also be required adjacent to the channel where channel side slopes exceed 2:1 and the channel depth is greater than 2 feet. The fencing must not cause sight distance problems for motorists.

F. Vertical walls will not be permissible for depths greater than two (2) feet unless properly fenced or enclosed. Walls will have a minimum thickness of six (6) inches.

G. Easements or rights-of-way for concrete lined channels shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel. "Extreme limits" of the channel shall mean the side slope intercept with the natural ground or proposed finished ground elevation.

H. A minimum N value of roughness coefficient of 0.015 shall be used for a wood float type surface finish. This N value is as used in Manning's formula.

Table D-9
Drainage Freeboard for Concrete
Lined and Earth Channels for (25) year storm

Design Depth of Flow	Required Freeboard
0 to feet 5 feet	0.5 foot
5 to 10 feet	10% of design depth
10 feet and over	1.0 foot

(8) Vegetated Earth Channels.

A. Freeboard consistent with Table D-9 will be applied to the 25-year design.

B. The side slope shall not be steeper than three (3) horizontal to one (1) vertical.

C. Easements or rights-of-way for improved earth channels shall conform to the requirements stated in subsection (d) of this section and shall extend a minimum of two (2) feet on one side and fifteen (15) feet for an access road on the opposite side of the extreme limits of the channels when such channels do not parallel and adjoin an alley or roadway. When such channels do parallel and adjoin an alley or roadway, the easement or right-of-way shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel. Where utilities are installed in the access road of the drainage right-of-way, the right-of-way shall extend two (2) feet on one (1) side and seventeen (17) feet on the opposite side of the design limits of the channel. These seventeen (17) feet are to provide

an access way along the channel with a maximum cross slope of one (1) inch per foot toward the channel. Where designed channel bottoms exceed one hundred (100) feet in width, the fifteen-foot extra width shall be provided on both sides of the channel.

D. Interceptor drainage easements shall extend a minimum of two (2) feet on both sides of the extreme limits of the channel. Refer to Figure D-4.

E. Improved earthen channels will be vegetated by seeding or sodding. Eighty five percent of the channel surface area must have established vegetation before the City of Poteet will accept the channel for maintenance.

F. Open Sections

1. Definitions:

Major Stream – Drains 5 sq. miles or more

Major Collector – Drains 20 acres or more

Minor Collector – Drains less than 20 acres

G. Vegetated channels shall have sufficient grade to provide velocities that will allow self-cleaning but will not be so great as to create erosion. Side slopes shall not be steeper than three (3) to one (1) to allow for future growth and to promote slope stability. All slopes shall be hydro-mulched, sodded or seeded with approved grass, grass mixtures or ground cover suitable to the area and season in which they are applied; on sand, slope shall be concrete rip rap or not less that five (5) to one (1).

H. Sodding shall be St. Augustine or Bermuda with sufficient soil attached to sustain growth and must be alive at the time of application.

I. Hydromulch shall be applied as follows: Between April 15 and October 1, for each one-thousand (1,000) square feet, two (2) pounds of hulled Bermuda seed, and twenty (20) pounds of fertilizer (16-20-0 with magnesium and sulfur). On slopes, add forty (40) pounds of cellulose fiber mulch and one-half (1/2) pound of a soil binder.

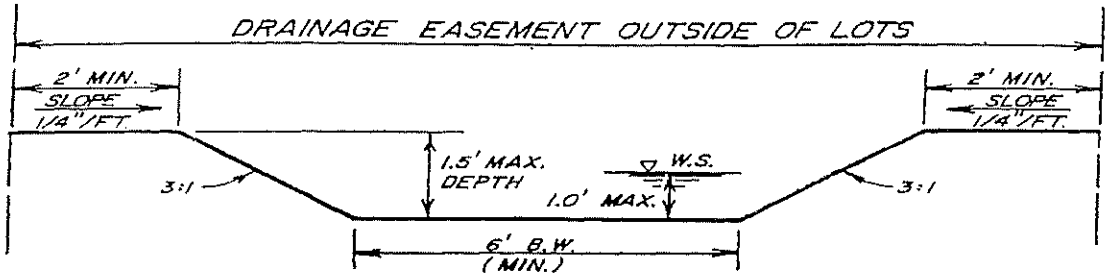
1. Between October 1 and April 15, for each one-thousand (1,000) square feet, six (6) pounds Rye grass seed, twenty (20) pounds of fertilizer (15-10-10 with magnesium and sulfur). On slopes add forty (40) pounds of cellulose fiber mulch and one-half (1/2) pound of a soil binder. As soon as practical after April 15, the April 15 to October 1 application described above must also be made, provided, however, surfaces must be reshaped to original configuration prior to the second application;

2. Hydromulch growth must be established over eighty-five percent (85%) of applied areas prior to acceptance of subdivision improvements by the City, with no exposed area exceeding ten (10) square feet. "Established growth" shall mean the vegetation has reached a height of one and one-half (1-1/2") inches and is of a density such that it can be reasonably expected to be selfsustaining.

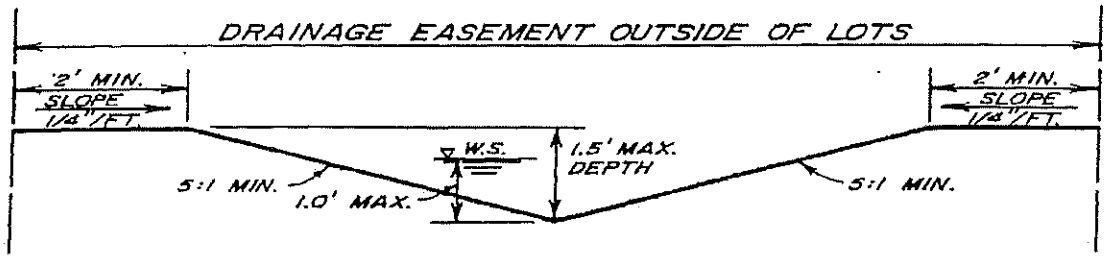
J. If, in the opinion of the City Engineer, either conditions such as drought, excess precipitation or extreme heat or cold are unsuitable for hydromulching or sodding, such applications shall be deferred by the developer. Under these circumstances, subdivision improvements may be accepted upon the provision of a letter of credit in a form acceptable to the City Attorney, in an amount of twice the City Engineer's estimated cost of the sod or hydromulch application and where appropriate, surface reshaping, maintenance and reapplication. If the developer is unable to meet the requirements of subparagraph 9.1.2.e.(3) above within nine (9) months of subdivision acceptance, the letter of credit will be drawn on and the proceeds used to obtain the required vegetation cover.

(9) **Channel Bends and Turns – Freeboard.**

Allowance for extra freeboard shall be made when the centerline radius of the channel is less than three (3) times the bottom width. Where sharp bends or



TRAPEZOIDAL CHANNEL



"V"-SHAPED CHANNEL

NO RETARDS
VEL. CONTROL

STANDARDS FOR
INTERCEPTOR DRAINS
FOR INTERCEPTING SHEET FLOW
(WITHOUT ACCESS EASEMENT REQ'D)

(Ord. No. 86711, § 22, 9-25-97)

Figure D-4

high velocities are involved, the applicant shall use the following formula for computing the extra freeboard:

$$d_2 - d_1 = V^2(T + B) \div 2gR$$

Where:
d_1 = depth of flow at the inside of the bend in feet.
d_2 = depth of flow at the outside of the bend in feet.
B = bottom width of the channel in feet.
V = the average approach velocity in the channel in feet per second.
T = width of flow at the water surface in feet.
g = 32.2 feet/second squared.
R = the center line radius of the turn or bend in feet.

A. The quantity d2-d1 divided by 2 shall be added to the normal depth of flow before adding the required freeboard in calculating required right-of-way widths.

B. Where sharp turns are used without curved sections, the depth required shall be large enough to provide for all head losses. Allowance shall be made for any backwater head that may result.

C. For normal design conditions no extra freeboard is required. An accepted rule of thumb to follow is this: Centerline radius of channel should be at least three (3) times the bottom width.

(i) Storm Sewers

(1) For all ordinary conditions, storm sewers shall be designed on the assumption that they will flow full under the design discharge; however, whenever the system is placed under a pressure head, or there are constrictions, turns, submerged or inadequate outfall, etc., the hydraulic and energy grade lines shall be computed and plotted in profile. In all cases adequate outfalls shall be provided and the system adequately designed.

(2) No storm sewers shall be less than twenty-four (24) inches in diameter.

(3) Minimum easement widths for storm sewers will be the greater of 15' or six-feet on both sides of the extreme limits of the storm sewer width (e.g. the easement width for a three barrel 10' wide box culvert with 6" walls would be (3 x 10')+(4 x 0.5')+(2 x 6') = 44').

(4) Junction boxes with manholes shall be provided at all inlets, at changes in grade or alignment, sewer intersections, and at a maximum of one-thousand (1000) feet.

(5) Pipe: Pipe for storm drains shall be concrete pipe in sizes as shown on the approved plans. Pipe eighteen (18") inches or larger in diameter shall be reinforced concrete pipe (RCP), ASTM C76, Class 3. Where, in the opinion of the city engineer, added strength of pipe is needed for traffic loads over minimum cover or for excessive height of backfill, concrete pipe shall be ASTM CI4, Extra Strength or ASTM C76, Class IV or Class V. Pipe shall have a minimum cover of not less than one (1 ') foot. Monolithic, reinforced concrete sewers may be used for storm sewers thirty-six (36") inches and larger.

(6) Minor collectors shall be constructed with underground storm sewers. If it can be established by certified engineering data to the satisfaction of the City Engineer that storm sewers are not physically feasible, open ditches may be used, provided that such ditches are lined with concrete or other permanent materials accepted by the City Engineer and approved by the City Administrator.

(j) Inlets and Openings

(1) Drop Curb Openings – Sidewalk Does Not Abut Opening.

Where drop curb openings are used to take storm water off the streets and into drains, the length of the curb opening can be calculated from the weir formula using the coefficient of 3.087 in the following formula:

$$L = Q \div Ch^{3/2}$$

Where:
- L = the length of drop curb opening required in feet.
- Q = amount of flow in CFS based on 25-year design frequency.
- C = 3.087.
- h = head of weir in feet.

Gutter line depressions will be permitted where such depressions will not hamper the flow of traffic. For amount of curb exposure, conform to City of Poteet inlet standards.

(2) Curb or Drop Inlets.

Where drop inlets are use, the City standard inlets with adequate reinforcing steel may be used. All other types or designs shall be subject to the approval of the City Engineer in consultation with the Director of Public Works. The following formulas for inlet capacity are based on drop inlets in sag points. Inlet capacities on grades will be considered less, the amount of which depends on street grades, deflections, cross slopes, depressions, etc.

(3) Grate Inlets.

The flow of water through grate openings may be treated as the flow of water through a rectangular orifice. The following formula may be used for determining grate capacity:

$$Q = CA\,(2gh)^{1/2}$$

Where:
- Q = discharge in cubic feet per second.
- C = orifice coefficient of discharge (taken as 0.70).
- g = acceleration due to gravity (32.2 ft./sec.^{2})
- h = head on the grate in feet.
- A = net area of the openings in the grate in square feet.

This formula gives the theoretical capacity of the grate inlet. Since grate inlets are subject to considerable clogging, capacity of the grate inlet will be taken as one-half on the value given by this formula.

(4) **Curb Opening Inlets.**

The capacity of curb opening inlets will depend on whether or not the opening is running partially full or submerged. If the depth of flow at the curb opening inlet is such as to cause a partially full opening, a weir effect will develop and the following formula will apply:

$$Q = C_w L(h)^{3/2}$$

Where: Q = the discharge of capacity in cubic feet per second.
C_w = the weir coefficient of discharge (3.087).
L = the length of curb opening in feet.
h = the head or depth of water at the opening in feet.

If the depth of flow at the curb opening is such as to fully submerge the opening, the orifice effect will develop and the formula used shall be identical to that given under grate inlets with the exception that the head, h, on the curb opening orifice shall be taken as the depth from the top of the water surface to the center of orifice or opening; one hundred (100) percent efficiency will be allowed for curb opening inlets.