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8.0 DRAINAGE DESIGN CRITERIA FOR RURAL SUBDIVISIONS

8.1 PURPOSE

The Fort Bend County Drainage Criteria Manual ("DCM"), adopted in 1987, was intended to address design procedures for 100-year design channels and for storm sewer systems in response to the expanding urban development taking place in the county. However, this DCM did not specifically address certain drainage issued related to large lot subdivisions which typically are built in the rural areas of the county.

The purpose of this design criteria is to make available an alternative drainage procedure that can be used in the design of detention facilities for such rural-type subdivisions.

Typically, such developments consist of large-acre lots with minimal drainage improvements. Little change to the natural storm runoff occurs as a result of such rural subdivisions being developed. In recognition of this, this criteria has been developed such that the effect is to reduce the amount of on-site detention otherwise required by the DCM. However, this is minimal criteria for acceptance by the Fort Bend County Drainage District. Individual circumstances may warrant an enhanced drainage and/or detention system.

8.2 QUALIFICATIONS

The following qualifications are established and must be met in order to be considered a rural subdivision for purposes of utilizing this alternative design criterion:

1. Lot size of 1 acre or greater;

2. Maximum percent impervious cover based upon lot size (see Figure 8-1);

3. Roadside ditch drainage system (vs. curb and gutter); and

4. No major drainage improvements that would significantly alter the natural drainage patterns in the area for large flood events.

8.3 DESIGN CRITERIA

The following design criteria shall be utilized for rural subdivisions:

1. Minimum slab elevations – two (2) feet above natural ground, or 18" above the 100-year floodplain, or one (1) foot above the crown of any downgradient roadway, whichever is higher.

2. Roadways

    a. R.O.W. – Seventy (70) feet wide.

    b. Crown – Maximum of one (1) foot above natural ground.

    c. Roadside drainage system – Open ditch with 3:1 side slopes; equalizer pipes under roadway at least every 1,000 feet (minimum 24-inch diameter RCP) if roadway blocks natural drainage path.

3. Lot drainage – Swales may be constructed along lot lines to provide for minimal drainage of lots. Other than lot line swales and building pads, lots shall not be significantly graded.

4. Detention Requirements – See Figure 8-1 for amount of on-site detention required. Discharge pipe to be maximum 18-inch diameter RCP, or equivalent.

8.4 SUBMITTALS

1. Drainage area map showing existing drainage ways on or adjacent to property.

2. Map(s)/drawing(s) showing existing drainage patterns before development and proposed drainage patterns after development, for both small storm events and large storm events.

3. Preliminary (and eventually final) plat with the following plat notes:

a. The latest floodplain information, including Base Flood Elevation, and Flood Insurance Rate Map Panel Number and Date.

b. Land use within the subdivision is limited to an average imperviousness of no more than ____ percent. (Obtain maximum percent imperviousness from Figure 8-1 for the corresponding average lot size shown on the plat.) The drainage and/or detention system has been designed with the assumption that this average percent imperviousness will not be exceeded. If this percentage is to be exceeded a replat and/or redesign of the system may be necessary.

c. The minimum slab elevation shall be 18" above 100-year floodplain elevation, or at least 2 feet above natural ground, or 1ft above the crown of any down-gradient roadway, whichever is higher. Floodplain information note should be included.

d. This rural subdivision employs a natural drainage system which is intended to provide drainage for the subdivision that is similar to that which existed under pre-development conditions. Thus, during large storm events, ponding of water should be expected to occur in the subdivision to the extent it may have prior to development, but such ponding should not remain for an extended period of time. Street ponding information notes should be included.

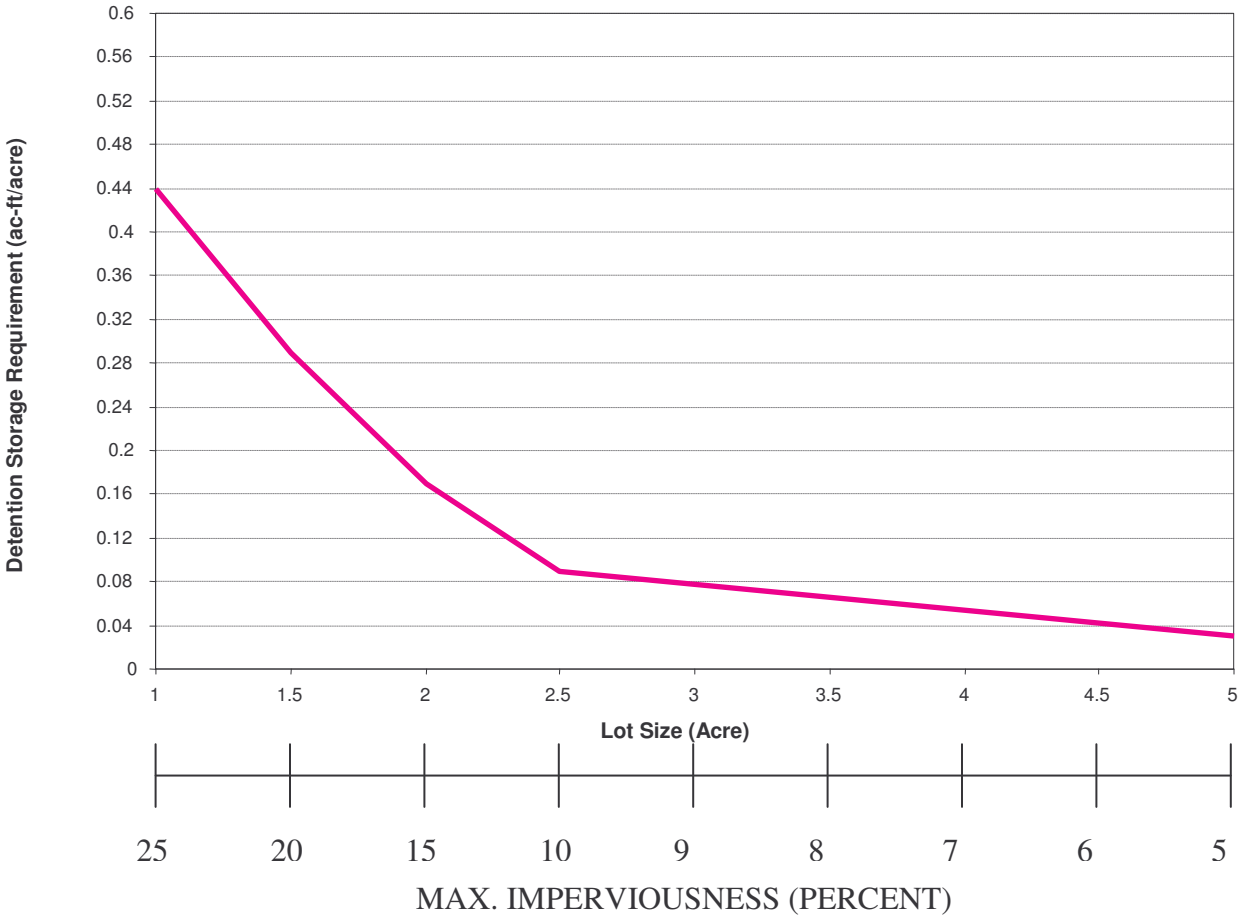

Figure 8-1 Detention Storage Requirements for Rural Subdivisions

8.5 TECHNICAL ANALYSIS OF DETENTION REQUIREMENTS FOR RURAL SUBDIVISIONS

The purpose for requiring detention for developing a subdivision is to minimize the adverse impact the development has on downstream flooding. This adverse impact is caused by a combination of additional runoff, due to the reduction of infiltration caused by the increase in imperviousness associated with development, and a higher rate of runoff, due to the reduced time of concentration cause by the more efficient drainage system associated with development. The detention requirement was developed so as to minimize these adverse impacts typically with urban development (involving less than 1-acre lots).

Rural subdivisions, however, generally involve lot sizes greater than 1 acre. These subdivisions also generally have less impervious cover per acre and a less effective drainage system than do urban developments. Therefore a technical analysis was performed in order to determine the appropriate detention storage that should be required for rural subdivisions in lieu of the standard detention storage that should be required for rural subdivisions in lieu of the standard detention required for urban development under the Fort Bend County Drainage Criteria Manual.

8.6 ANALYSIS OF RUNOFF VOLUME

As the percent of imperviousness associated with a development project increases, the availability of ground surface for infiltration is reduced; and therefore, the amount of rainfall that becomes runoff is increased. An evaluation was made as to how much of an increase in runoff volume (i.e. rainfall excess) occurs as the percent imperviousness increases.

The 100-year, 24-hour excess for various percentages of imperviousness is as follows:

% IMPERV	RAINFALL (INCHES)	RAINFALL EXCESS (INCHES)	INCREASE IN RAINFALL EXCESS	
			Inches	Ac-ft/Ac
0	12.5	7.34	--	--
5	12.5	7.59	0.25	0.02
10	12.5	7.85	0.51	0.04
15	12.5	8.11	0.77	0.06
20	12.5	8.37	1.03	0.09
25	12.5	8.63	1.29	0.11

The above increases in rainfall excess show the additional runoff volume attributable to the various increases in imperviousness, and presumably the amount of detention storage in acre-ft. per acre that would be needed to offset such additional runoff so as to minimize its adverse impact downstream.

8.7 ANALYSIS OF RUNOFF RATE

Usually as development occurs, the corresponding drainage system is improved, as compared to the undeveloped condition, so as to more effectively remove storm water runoff away from the property and reduce the amount and duration of standing and/or high water near residences or commercial buildings. Such an improved drainage system tends to reduce the time it takes storm water to be transported off-site, thereby causing an increase in the peak runoff rate associated with the development as compared to its undeveloped condition.

However, many rural subdivisions tend to provide minimal improvements to the natural drainage system, especially as to large storms events. Therefore, an analysis was made as to what effect rural subdivisions might have on the peak rate of runoff in order to determine an appropriate detention requirement to offset any adverse impact to downstream flooding.

The Rational Equation ($Q = ciA$) is the preferred method for computing the peak runoff for an area of less than 100 acres, which applies to most rural subdivisions. The runoff coefficient, c, represents the type of land used and its slope, as well as the soil type and its rate of infiltration. Values of c were obtained from Table 2-3 of the criteria manual.

The rainfall intensity, i, depends upon the storm frequency and the time of concentration for the area. The drainage area, A, is computed in acres.

An evaluation was made of three parameters used to compute the peak runoff for an undeveloped area as compared to the same area being developed with a rural subdivision. This comparison would assist in determining the amount of detention that might be needed to offset any increase in the peak runoff from an area when it is developed into a rural subdivision.

Assuming there is no significant change in the overall drainage pattern of an area during a large storm event as a result of developing a rural subdivision, the size of the drainage area, A, used to compute the peak runoff should not change between undeveloped conditions versus a rural development.

The runoff coefficient c, is an estimated value; for undeveloped pastureland and cultivated land with clay soil, it is 0.30 and 0.35 respectively, per Table 2-3 of the criteria manual.

For a residential subdivision with lot sizes greater than ½ acre, the *c* value is also 0.30. Thus, with a rural subdivision with lot sizes of 1 acre or larger, the runoff coefficient for the developed condition would be essentially equal to the undeveloped condition.

However, the remaining parameter in the Rational Equation is the rainfall intensity, *i*, which is a function of the time of concentration. The extent to which the time of concentration changes due to the development of a rural subdivision depends largely upon the improvement that is made to the natural drainage system, something that is highly site-specific. Yet it is reasonable to assume that as the lot sizes get smaller and the percent of imperviousness increases, there will be a tendency for the time of concentration to be reduced. This would result in an increase in the peak rate of runoff and require some amount of detention storage to offset this component of the adverse impact due to the development of a rural subdivision.

8.8 DETERMINATION OF REQUIRED DETENTION

Based on the above analysis, the runoff volume is increased as a result of development and imperviousness increasing. On-site detention is required to reduce the impact that this increased runoff volume might have on flooding downstream. The amount of on-site detention required is equal to the increase in rainfall excess. In addition, as the percent imperviousness increases, the time of concentration tends to decrease thereby raising the possibility that the peak runoff may increase, necessitating additional detention to be required.

The amount of detention required to offset this impact is difficult to quantify, since the possible increase in peak runoff is highly site-specific. However, it is assumed that this component of the adverse impact from development will be virtually non-existent for very large acre lots (i.e. low percent imperviousness), but will become more important as the lot sizes decrease.

Therefore, a comparison was made between the detention storage required under the Fort Bend County Criteria Manual and that required solely due to the increase in runoff volume associated with a rural subdivision, as show in Figure 8-2. The criteria manual curve was based upon the equation S/A = $\sqrt{I}$, referenced in the criteria manual, in which the percent imperviousness, I, that was used to develop this curve, was the maximum percent imperviousness allowable for each lot size. This curve presumably reflected the detention required to offset both the impact due to additional runoff volume and the impact due to the increase in the peak rate of

runoff generally attributable to the drainage systems associated with urban-type subdivisions. The Volume Only curve shown on Figure 8-2 was based solely upon the detention requirement to offset the increase in runoff volume determined in the Section above.

Based upon these two curves, the curve to be selected for this rural subdivision criteria should be expected to closely follow the runoff volume curve for the larger lot sizes and then diverge towards the criteria manual curve as the lot sizes decrease.

The resulting detention storage to be required for rural subdivisions to minimize any increase in flooding downstream as a result of such a development was selected to be as follows:

% Impervious	Detention Storage Required (Ac-ft/Ac)		
	Due to Vol. Increase	Assumed for Peak Q Inc	TOTAL
0	0	0	0
5	0.02	0.01	0.03
10	0.04	0.05	0.09
15	0.06	0.11	0.17
20	0.09	0.20	0.29
25	0.11	0.33	0.44

This tabulated information has been transferred onto Figure 8-2 on the following page, along with the incorporation of lot sizes associated with maximum percent imperviousness.

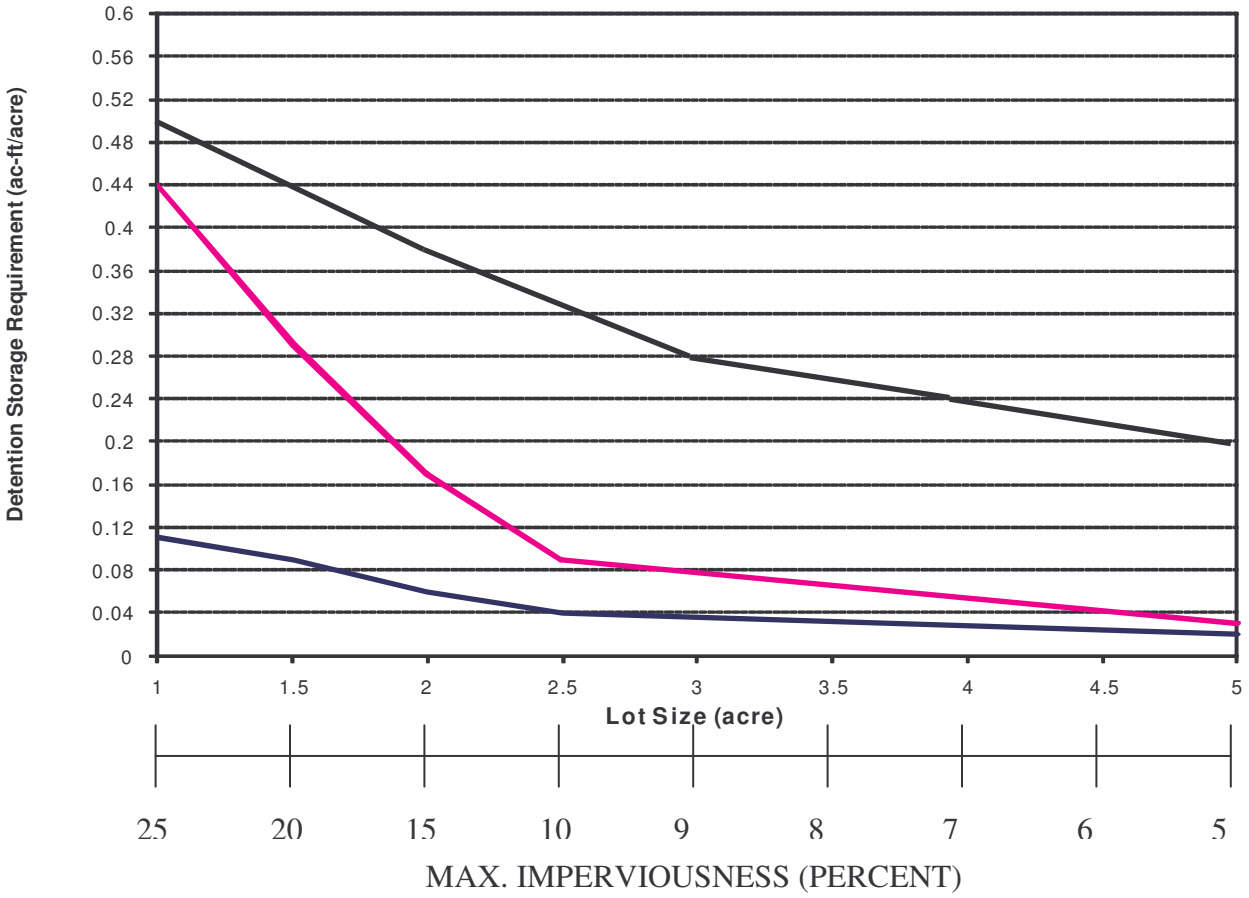

Figure 8-2 Comparison of Different Storage Requirements

Legend:

Black Line – Criteria Manual Curve S/A = $\sqrt{I}$
Magenta Line – New Detention Storage Requirement
Blue Line – Storage Due to Volume Increase Only