

NOTICE OF MEETING OF THE  
STORM WATER MANAGEMENT ADVISORY COMMITTEE  
ARANSAS COUNTY, TEXAS

**WORKSHOP MEETING**

NOTICE IS HEREBY GIVEN THAT A MEETING OF THE ABOVE NAMED COMMITTEE *UTCA GOVERNMENT CODE, SECTION 551.001 (4)* WILL BE HELD ON THE 12<sup>th</sup> DAY OF FEBRUARY, 2010 AT 1:30 P.M. AT THE ARANSAS COUNTY SERVICE CENTER, 1931 FM 2165, ROCKPORT, TEXAS, AT WHICH TIME THE FOLLOWING SUBJECTS WILL BE DISCUSSED, TO-WIT:

1. OPEN MEETING & DECLARE QUORUM - McLallen
2. DISCUSS AND POSSIBLE ACTION REGARDING THE ARANSAS COUNTY HYDROLOGIC CONCEPT AND DESIGN CRITERIA - NEI
3. ADJOURN

**FILED**  
**AT 9:40A.M.**

FEB 05 2010

DATED THIS THE 5<sup>TH</sup> DAY OF FEBRUARY, 2010.

*posted  
@ 9:55a.m.*

By: \_\_\_\_\_

David J. Reid, P.E.

*Peggy L. Friebele*

PEGGY L. FRIEBELE

COUNTY CLERK, ARANSAS COUNTY, TEXAS

I, the undersigned, County Clerk, do hereby certify that the Notice of the above named Storm Water Management Advisory Committee, is a true and correct copy of said Notice, and that I posted a true and correct copy of said Notice on the bulletin board in the courthouse lobby of Aransas County, Texas on the \_\_\_\_ day of \_\_\_\_\_, 2010, and said Notice remained so posted continuously for at least seventy-two (72) hours preceding the scheduled time of said Meeting.

Dated this the \_\_\_\_ day of \_\_\_\_\_, 2010.

COUNTY CLERK, ARANSAS COUNTY, TEXAS

By: \_\_\_\_\_

## ARANSAS COUNTY HYDROLOGIC CONCEPTS AND ANALYSIS

The purpose of this report is to present the overarching hydrologic concepts and required analysis for development and drainage projects in the unincorporated areas of Aransas County.

### *The Hydrologic Cycle*

The hydrologic cycle is the movement of water through the hydrosphere, the region containing all the water in the atmosphere and on the surface of the earth. The cycle, while not simple, can be explained easily for our purposes when divided into four parts: precipitation, infiltration, runoff, and evaporation.

The cycle begins with **precipitation** which can (a) **Infiltrate**, which occurs when precipitation seeps into the ground - the more permeable the ground, the more precipitation infiltrates, (b) **runoff** as surface water to a depression, a watershed, and eventually to a bay, or (c) **evaporate** from ponds, lakes, or oceans.

### *Design Rainfall Events*

Precipitation, in Aransas County, normally occurs as rainfall in irregular patterns with respect to both time and location. However, for the purpose of analyzing hydrologic conditions, design storm events are typically used. These design storm events are developed through statistical analysis of recorded rainfall historical data and are defined by the *recurrence interval* and *storm duration*. For example, a 5-year storm event is a design storm which has a 20% (1/5) probability of occurring in any given year and a 100-year storm event has a 1% (1/100) probability of occurring in any given year. Also, the storm duration is described as period of time the storm event produces rainfall. For Example, in Aransas County, the depth of rainfall for the 24-hour, 5-year storm is approximately the same as a 3-hour, 100-year storm – about 6.5" (USGS/TxDOT). The following 2 tables provides a summary of the relationship between rainfall depth, duration, and recurrence interval for Aransas County.

USGS/TxDOT (2004) - Depth of Precipitation in Aransas County (inches)						
Duration	Recurrence Interval					
	2-year	5-year	10-year	25-year	50-year	100-year
15-minutes	1.1	1.4	1.6	1.8	2.0	2.3
30-minutes	1.6	2.0	2.3	2.7	3.0	3.4
1-hour	1.9	2.5	2.9	3.5	3.9	4.4
2-hour	2.5	3.3	3.8	4.5	5.1	5.8
3-hour	2.7	3.5	4.1	5.0	5.8	6.6
6-hour	3.2	4.4	5.2	6.5	8.0	9.2
12-hour	3.6	5.0	6.0	7.6	9.0	10.5
24-hour	4.5	6.5	7.8	9.8	11.5	13.2

USGS/TxDOT 2004– *Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas*

<b>TP-40 (1961) - Depth of Precipitation in Aransas County (inches)</b>						
<b>Duration</b>	<b>Recurrence Interval</b>					
	<i>2-year</i>	<i>5-year</i>	<i>10-year</i>	<i>25-year</i>	<i>50-year</i>	<i>100-year</i>
<i>30-minutes</i>	1.7	2.2	2.5	2.9	3.3	3.6
<i>1-hour</i>	2.2	2.8	3.2	3.7	4.2	4.6
<i>2-hour</i>	2.7	3.5	4.0	4.7	5.3	5.9
<i>3-hour</i>	2.9	3.8	4.5	5.2	5.8	6.5
<i>6-hour</i>	3.3	4.6	5.4	6.5	7.3	8.0
<i>12-hour</i>	3.8	5.4	6.5	7.7	8.7	10
<i>24-hour</i>	4.5	6.3	7.6	9.0	10.3	11.6

US Dept. of Commerce, 1961 – *TP-40 Rainfall Frequency Atlas for the U.S.*

### ***Infiltration & Runoff***

A portion of the rainfall that reaches the earth soaks into the ground via infiltration, while the balance of the rainfall is called runoff. Since infiltration increases with the permeability of the soil, infiltration for sandy soils is greater than clay soils. Infiltration is reduced as the moisture content of the soil is increased and ceases when the soil becomes saturated. As infiltration decreases, runoff increases and vice versa.

## **HYDROLOGY**

Hydrologic analyses shall be based upon ultimate land development anticipated in applicable Aransas County Development Plans, Development Master Plans, or other acceptable planning aids.

### **Rational Method**

For drainage areas up to 200 acres, the Peak Runoff Rate, Q (cfs) may be determined by the Rational Method using the following formula:

$$Q = C \cdot I \cdot A$$

Where: Q= the peak runoff rate (cubic feet per second)

C = runoff coefficient (see table below)

I = design rainfall intensity (inches per hour)

A = drainage area (acres)

### ***Establishing the Drainage Area***

Drainage areas for Rational Method analyses *should* be established using information contained in the *Aransas County Stormwater Management Plan* or approved *Site Layout, Drainage, and BMP Design Plan* as established in the *Interim Site Development and Construction Guidelines*. When establishing the drainage area, the contributing acreage upstream that runs onto a development shall be included. Topographic maps, storm sewer layouts, *LIDAR* data, and other available information shall be used as supplementary data for determining drainage areas.

### ***Determining Runoff Coefficients***

The runoff coefficient (C) is a function of land use, land cover, soil type, overland slope, and a host of other hydrologic abstractions and relates the estimated peak discharge to a theoretical maximum of

100% runoff. The hydrologic soil group is determined from the Soil Survey for Aransas County or the Soil Survey Geographic Database (SSURGO) for Aransas County. For drainage areas with multiple land uses, runoff coefficients and drainage areas associated with each land use should be determined and the composite runoff coefficient computed using the following equation.

$$C_w = \Sigma(C_i \cdot A_i) / A_t$$

Where:  $C_w$  = weighted runoff coefficient;

$C_i$  = runoff coefficients for various land uses;

$A_i$  = drainage areas corresponding to values of  $C_i$  (acres); and,

$A_t$  = total drainage area (acres).

#### Rational Method Runoff Coefficients, (C)

Land Use	Overland Slope		
	< 1%	1% - 3.5%	> 3.5%
<b>Pasture:</b>			
Sandy Soil	0.25	0.35	0.40
Clay Soil	0.30	0.40	0.50
<b>Cultivated:</b>			
Sandy Soil	0.30	0.55	0.70
Clay Soil	0.35	0.60	0.80
<b>Woodlands:</b>			
Sandy Soil	0.15	0.18	0.25
Clay Soil	0.18	0.20	0.30
<b>Residential:</b>			
<i>Lots greater than 1 acre</i>	0.20	0.25	0.30
<i>Lots 1/2 to 1 acre</i>	0.25	0.35	0.45
<i>Lots less than 1/2 acre</i>	0.30	0.40	0.50
<i>Townhomes / Trailer Park</i>	0.50	0.60	0.70
<i>Apartments / Condos</i>	0.55	0.70	0.85
<b>Commercial:</b>			
<i>Neighborhood Business</i>	0.50	0.60	0.70
<i>Primary Commercial (Downtown)</i>	0.85	0.85	0.85
<b>Industrial Districts:</b>			
<i>Light Industrial District</i>	0.50	0.65	0.80
<i>Heavy Industrial District</i>	0.65	0.75	0.85
<b>Parks, Greenbelts, Cemeteries:</b>	0.15	0.25	0.30
<b>Streets, Parking Lots and Paved areas:</b>			
<i>Asphalt</i>	0.80	0.85	0.90
<i>Concrete</i>	0.85	0.90	0.90
<b>Roofs</b>	0.85		

These runoff coefficients, to be used in the Rational Method, apply for storms with a frequency of 2-year to 10-year. Due to the decreasing effect of infiltration and other abstractions for less frequent storms, an adjustment factor should be used when calculating the runoff coefficient.

<b>Runoff Coefficient Adjustment Factor</b>	
<b>Recurrence Intervals</b>	<b>C<sub>f</sub></b>
25-year	1.1
50-year	1.2
100-year	1.25

**Establishing the Time of Concentration**

The time of concentration can be calculated as the sum of the travel times within the various consecutive flow segments (overland flow, concentrated flow, and channelized flow) from the most hydraulically remote location in the watershed to the outfall. Flow velocities for overland sheet flow and some concentrated flow conditions should be estimated using generally accepted methods. For storm sewers, creeks and channels, flow velocities may be estimated using Manning’s Equation or an appropriate computer model. The accepted minimum initial time of concentration is 30 minutes.

**Design Rainfall Intensity**

The rainfall intensity, I (inches per hour), used for the Rational Method shall be calculated based on the following formula, which was developed by TxDOT from TP-40 and HYDRO-35:

$$I = b / (T_c + d)^e$$

Where: T<sub>c</sub> = time of concentration (minutes)

b, d and e = empirical factors that characterize the IDF curves for Aransas County

The following table provides commonly used design rainfall intensities for Aransas County, based on the Rainfall Intensity formula.

<b>Time of Concentration, T<sub>c</sub></b>	<b>Design Rainfall Intensity, (I) (inches/hour) Aransas County, Texas</b>					
	<b>2-Year</b>	<b>5-Year</b>	<b>10-Year</b>	<b>25-Year</b>	<b>50-Year</b>	<b>100-Year</b>
	<i>b=73 d=9.2 e=0.821</i>	<i>b=77 d=8.5 e=0.787</i>	<i>b=79 d=8.5 e=0.753</i>	<i>b=88 d=8.5 e=0.745</i>	<i>b=95 d=8.5 e=0.739</i>	<i>b=98 d=9.2 e=0.725</i>
<b>15 Minutes</b>	5.3	6.4	7.3	8.4	9.2	9.7
<b>30 Minutes</b>	3.6	4.4	5.1	5.8	6.4	6.9
<b>1 Hour</b>	2.3	2.8	3.3	3.8	4.2	4.5
<b>2 Hours</b>	1.3	1.7	2.0	2.4	2.6	2.9
<b>4 Hours</b>	0.8	1.0	1.2	1.4	1.6	1.8
<b>8 Hour</b>	0.3	0.4	0.6	0.6	0.7	0.8

Assumptions inherent in the Rational Method formula are as follows:

- Peak flow occurs when the entire watershed is contributing to the flow.
- Rainfall intensity is the same over the entire drainage area.
- Rainfall intensity is uniform for a duration equal to the time of concentration.
- Frequency of the computed peak flow is the same as that of the rainfall intensity, i.e., the 10-year rainfall intensity is assumed to produce the 10-year peak flow.
- Coefficient of runoff is the same for all storms of all recurrence probabilities.

Because of these assumptions, the Rational formula should only be applied to drainage areas smaller than 200 acres. The following sections describe methods appropriate for areas larger than 200 acres.

### **USGS Regression Equations**

Regression equations are commonly used for estimating peak flows at ungauged sites or sites with limited data. The United States Geological Survey (USGS) has developed and compiled regional regression equations which are included in a computer program called the National Streamflow Statistics program (NSS). NSS allows quick and easy estimation of peak flows throughout the United States. Aransas County is within Region 9 as shown in the *Regional Equations for Estimation of Peak-Streamflow Frequency for Natural Basins in Texas* and the equations for Region 9 are as follows:

$$Q_2 = 278 \cdot A^{.526}$$

$$Q_5 = 329 \cdot A^{.645} \cdot SL^{.220} \cdot SH^{-.246}$$

$$Q_{10} = 350 \cdot A^{.691} \cdot SL^{.343} \cdot SH^{-.321}$$

$$Q_{25} = 329 \cdot A^{.743} \cdot SL^{.466} \cdot SH^{-.413}$$

$$Q_{100} = 350 \cdot A^{.811} \cdot SL^{.607} \cdot SH^{-.539}$$

Where:  $Q_d$  = The peak runoff for a specific recurrence interval (d)

A = contributing drainage area expressed in  $mi^2$

SL = Stream slope expressed in feet per mile

SH = Basin Shape factor which is the ration of the square of the stream length to the contributing drainage area.

### **Development of Design Hydrographs**

Several methods can be used to develop a design hydrograph. Hydrograph methods can be very complex and computationally involved so computer programs such as TR-55 and HEC-HMS (formerly HEC-1) are almost exclusively used to generate runoff hydrographs. Hydrographic analysis is performed when flow routing is important such as in the design of stormwater detention and can also be used to evaluate flow routing through large watersheds and storm drainage systems.

#### ***NRCS Peak Flow Method***

The NRCS (formerly SCS) peak flow method calculates peak flow as a function of drainage basin area, potential watershed storage, and the time of concentration. The graphical approach to this method can be found in TR-55. There is a computer model (Win TR-55) which is user-friendly with an accompanying

manual titled Small Watershed Hydrology: WinTR-55 User Guide, both of which are available on the USDA/NRCS website. Win TR-55 provides tables and equations to determine Time of Concentration of flow paths and typically accepted Curve Numbers used in the hydrograph calculations.

### ***HEC-HMS Analysis***

For drainage areas greater than 500, the Design Rainfall Depth presented earlier in this report from USGS/TxDOT (2004), shall be used for the US Army Corps of Engineers Hydrologic Modeling System (HEC-HMS).

## **DESIGN CRITERIA**

Flood analysis is based on 2 storm events: the design storm event for conveyance and the 100-year storm. The intent of the design criteria is to provide for public safety and minimize on-site and downstream flood impacts from the both storm events. Flood protection must be provided for on-site conveyance as well as downstream outfalls as described in the following sections.

### **Design Options**

There are three options by which Aransas County can address flood protection. At this time, only the ***third option*** is allowed under the existing policy for Aransas County without further approval from the County Engineer.

***Provide Adequate Downstream Conveyance Systems:*** When the downstream receiving system does not have adequate capacity, then the developer/engineer shall provide modifications to the off-site, downstream conveyance system. If this option is chosen (with approval by the County Engineer), the proposed modifications must be designed to adequately convey the ultimate stormwater peak discharge for the design storm event for conveyance to the point at which the discharge from the proposed development no longer has a significant impact on the receiving storm drainage system. The developer/engineer must provide supporting calculations and/or documentation that the upstream and downstream water surface elevation, based upon the 100-year storm event, is safely handled without endangering downstream properties, structures, bridges, roadways, or other facilities.

***Install Stormwater Controls to Maintain Existing Downstream Conditions:*** Again this option is only allowed with approval by the County Engineer. When the downstream receiving system does not have adequate capacity, the developer/engineer shall provide off-site regional controls such as detention. The developer must provide supporting calculations and/or documentation that the controls will be designed and constructed so that there is no increase in downstream peak discharges or water surface elevations due to development.

In lieu of a Downstream Assessment, ***Maintain Existing On-Site Runoff Conditions:*** This option, required in the *Interim Site Development and Construction Guidelines*, includes a provision for flood protection, requiring storm drainage facilities to limit the 2-, 5-, and 25-year storm event peak runoff to pre-development conditions. On-site controls shall be used to maintain the pre-development peak discharges from the site. The developer/engineer must provide supporting calculations and/or documentation that the on-site controls will be designed and constructed to maintain on-site existing conditions. It is important to note that this does not require a downstream assessment.

## LEVEL-OF-PROTECTION

Stormwater collection systems must be designed to provide adequate surface drainage while at the same time meeting other stormwater management goals such as water quality, habitat protection, and flood mitigation. Facilities shall be designed using the Minimum Level of Protection (Recurrence Interval) as shown below and in the following Table.

### *Design Frequency*

Fully developed conditions shall be used for all design storm events.

## Streets and Roadways

### *Rural Roads:*

- 2-Year (contained within adjacent roadside ditches maximum 4H;1V side slopes) – *additional attention should be noted when regional topography shows the area to be part of a large depression – only a 1' depth over the top of the roadway surface is allowed*
- 100-Year (1' below habitable living space)

### *Local Streets:*

- 5-Year (contained within conveyance system and inlet design)
- 100-Year (1' below habitable living space)

### *Collector Streets:*

- 10-Year (contained within conveyance system and inlet design)
- 100-Year (1' below habitable living space)

### *Arterial Streets:*

- 25-Year (contained within conveyance system and inlet design)
- 100-Year (1' below habitable living space)

### *Highway:*

- 50-Year (contained within conveyance system and inlet design)
- 100-Year (1' below habitable living space)

## Stormwater Conveyance Systems (<200 acres contributing area)

### *Underground Storm Sewers:*

- 5-Year (HGL at or below top of curb and manhole rims)
- 100-Year (1' below habitable living space)

### *Stormwater Conveyance Channels (4H:1V max side slopes):*

- 5-Year (1' of freeboard)
- 100-Year (1' below habitable living space)

### *Channel Crossings (Culverts):*

- 5-Year (Design Storm)

### *Channel Crossings (Bridges):*

- 5-Year (At least 1' freeboard below bottom of low chord)

## Stormwater Conveyance Systems (>200 acres contributing area)

### Underground Storm Sewers:

- 25-Year (HGL at or below top of curb and manhole rims)
- 100-Year (1' below habitable living space)

### Channels (4H:1V max side slopes):

- 25-Year (2' of freeboard)
- 100-Year (1' below habitable living space)

### Channel Crossings (Culverts):

- 25-Year (Design Storm)

### Channel Crossings (Bridges):

- 25-Year (At least 1' freeboard below bottom of low chord)

LEVEL OF PROTECTION SUMMARY FOR ARANSAS COUNTY						
COMPONENT CATEGORY	L.O.P. STANDARD					
	Design Storm Event Frequency (Years)					
	2	5	10	25	50	100
<b>STREETS AND ROADWAYS</b>						
<b>Rural Roads</b>						
Stormwater contained within conveyance system	•					
Stormwater below adjacent habitable living space						•
<b>Local Streets</b>						
Stormwater contained within conveyance system		•				
Stormwater below adjacent habitable living space						•
<b>Collector Streets</b>						
Stormwater contained within conveyance system			•			
Storm water below adjacent habitable living space						•
<b>Arterial Streets</b>						
Stormwater contained within conveyance system				•		
Storm water below adjacent habitable living space						•
<b>Highways and Freeways</b>						
Stormwater contained within conveyance system					•	
Stormwater below adjacent habitable living space						•
<b>STORMWATER CONVEYANCE SYSTEMS (&lt;200 acres contributing area)</b>						
Underground Storm Sewers (HGL at or below top-of-curb and manhole rims)		•				
Channels (1' freeboard above water surface)		•				
Channel Crossings – Culverts		•				
Channel Crossings – Bridges (1' freeboard below bottom of low chord)		•				
<b>STORMWATER CONVEYANCE SYSTEMS (&gt;200 acres contributing area)</b>						
Underground Storm Sewers (HGL at or below top-of-curb and manhole rims)				•		
Channels (2' freeboard above water surface)				•		
Channel Crossings – Culverts				•		
Channel Crossings – Bridges (1' freeboard below bottom of low chord)				•		