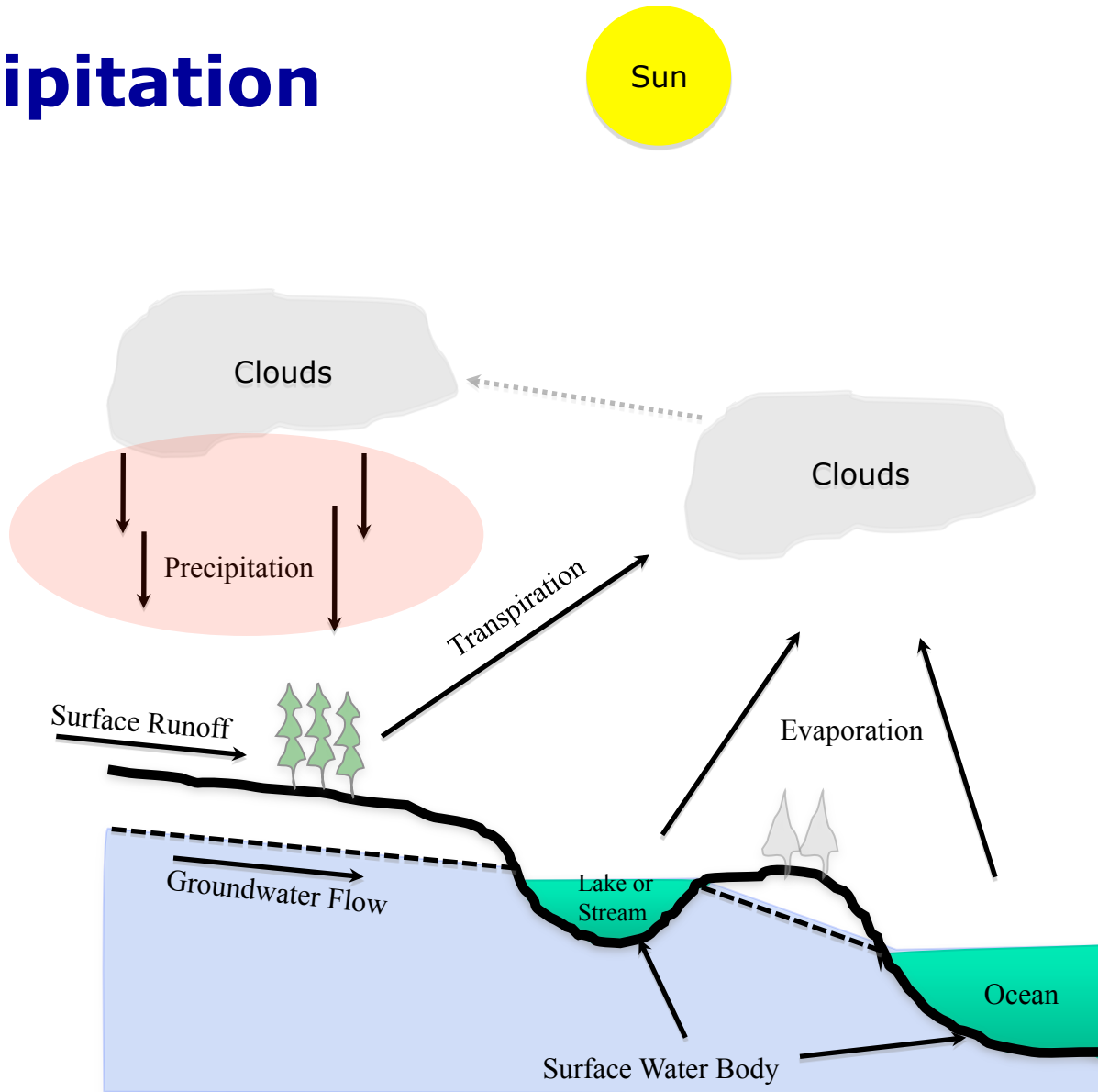


# **Basic Hydrology & Hydraulics: DES 601**

Module XX

Precipitation and Design Storms

# Precipitation



# Precipitation

There are four variables of engineering interest:

- Spatial: the average rainfall over the area
- Intensity: how hard it rains
- Duration: how long it rains at any given intensity
- Frequency: how often (probability) it rains at any given intensity and duration

# Precipitation

- Unlike flood frequency the rainfall probabilities are expressed as a combination of frequency (same idea as AEP), depth, and duration.
- The inclusion of depth and duration reflects that different “storms” can produce the same total depth, but deliver that depth over much different times

# Precipitation

- The statistical relationships are expressed in either:
  - Depth-Duration-Frequency (DDF curves)
  - Intensity-Duration-Frequency (IDF curves)

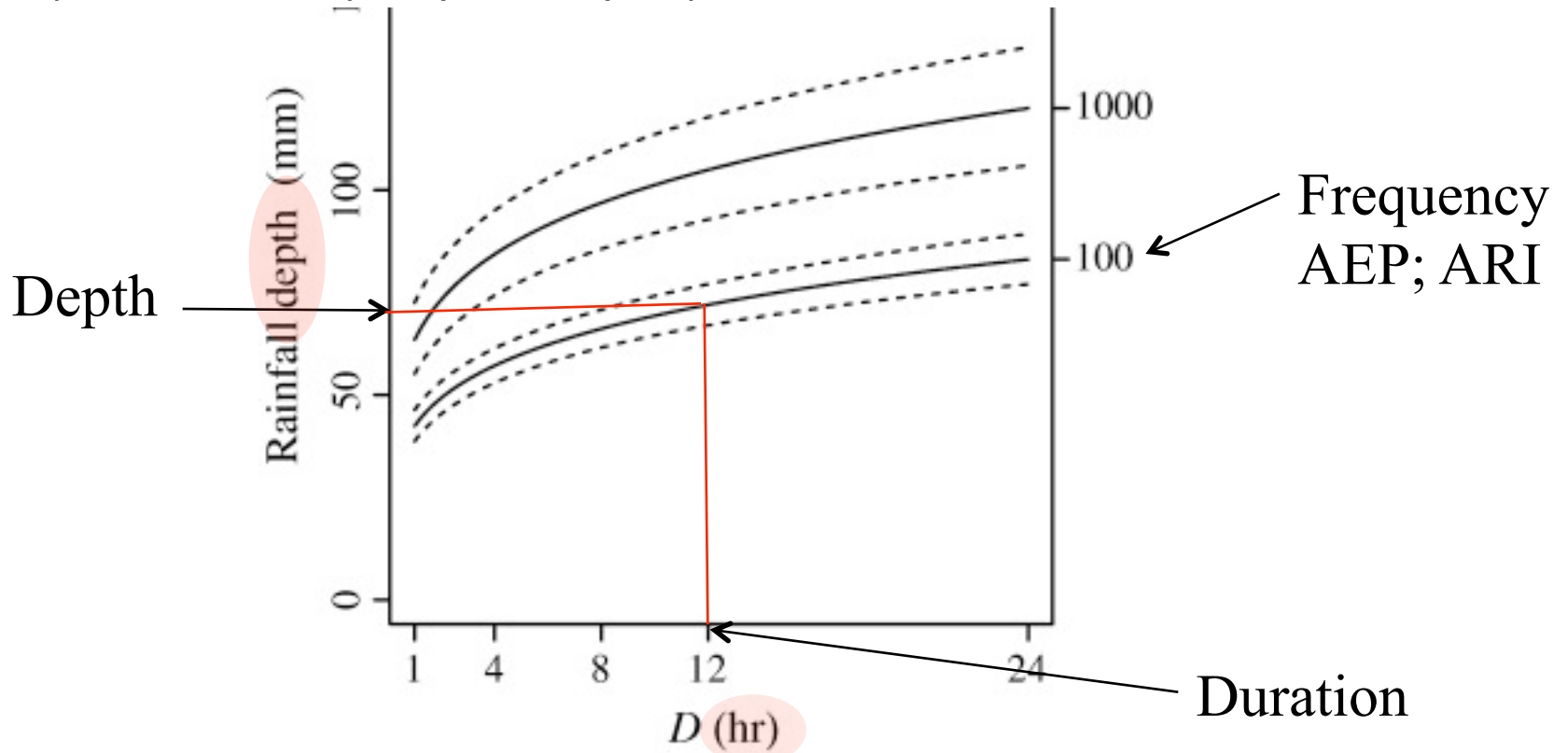
# Depth-Duration-Frequency

- Depth of rainfall is the accumulated depth (in a gage) over some time interval.
- Duration,  $T_c$ , is that time interval. ( )
- Frequency is the probability (like AEP) of observing the depth over the given duration.

# Depth-Duration-Frequency (DDF)

- DDF curve

e.g. 12 hour, 100-year (AEP=1%), depth is 70 millimeters



# Depth-Duration-Frequency Tools

- DDF estimates for a location can be constructed from maps of depth for a given duration and AEP.
- Such maps are available from:
  - NWS TP40 (online)
  - NWS HY35 (online)
  - Texas DDF Atlas (online)



In cooperation with the Texas Department of Transportation

**Atlas of Depth-Duration Frequency  
of Precipitation Annual  
Maxima for Texas**



Scientific Investigations Report 2004-5041  
(TxDOT Implementation Report 5-1301-01-1)

U.S. Department of the Interior  
U.S. Geological Survey



# DDF Data Sources

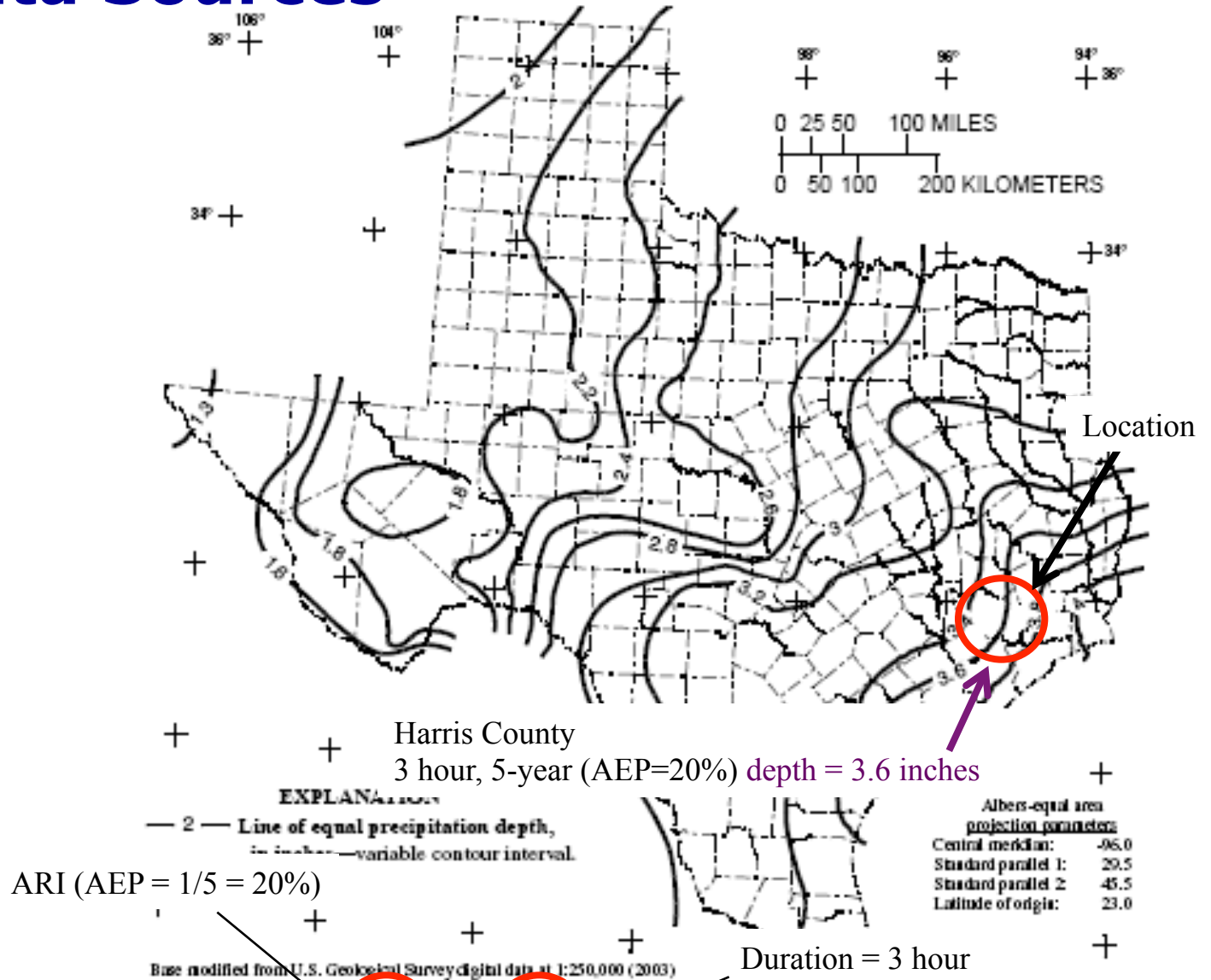


Figure 20. Depth of precipitation for 5-year storm for 3-hour duration in Texas.

# Intensity-Duration-Frequency

- An alternate form of DDF is to present the magnitude as an intensity (a rainfall rate).
- Intensity is the ratio of an accumulated depth to some averaging time, usually the duration.

$$i_{avg} = \frac{D}{T_C}$$

Intensity is NOT the instantaneous rainfall rate

# Depth, Intensity, and Duration

- Conversion from Depth-Duration to Intensity-Duration is obtained by the ratio of depth to duration.

$$i_{avg} = \frac{D}{T_C}$$

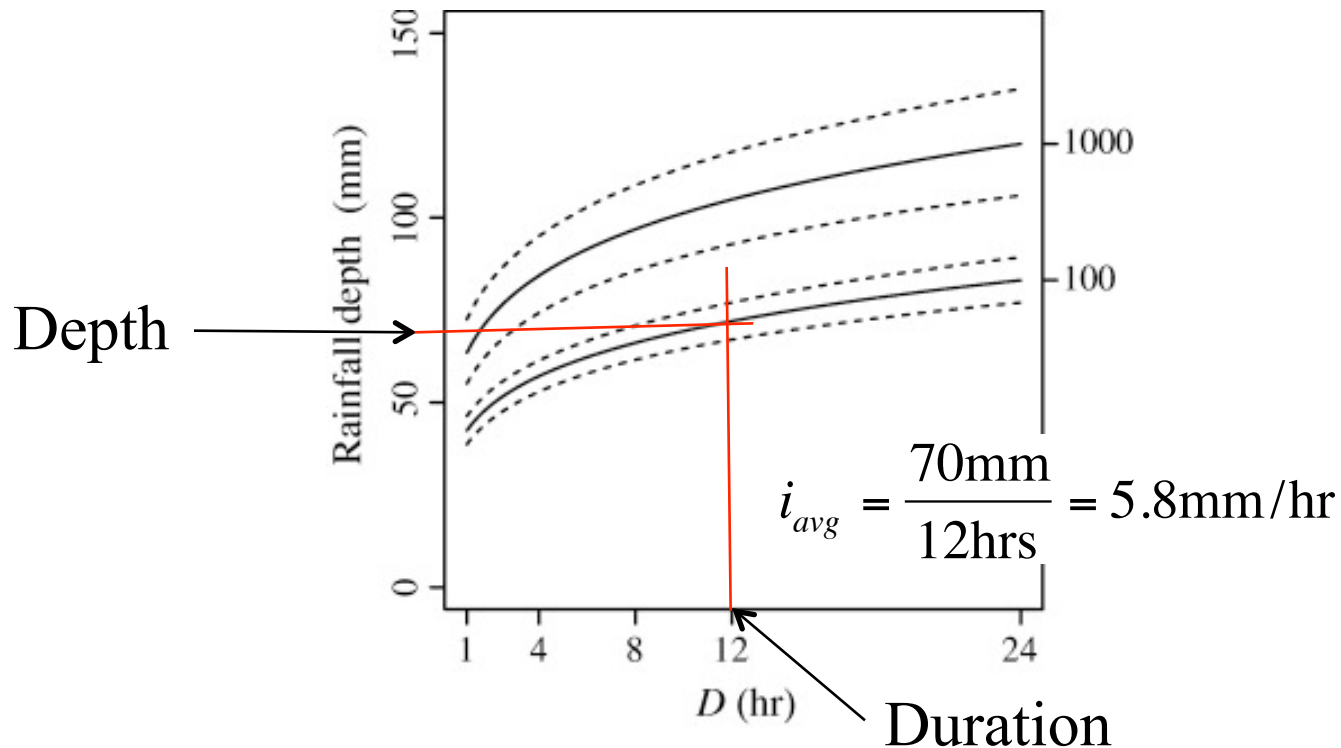
- Conversion from Intensity-Duration to Depth-Duration is obtained by multiplication.

$$D = i_{avg} * T_C$$

using same duration!

# Intensity-Depth Relationship

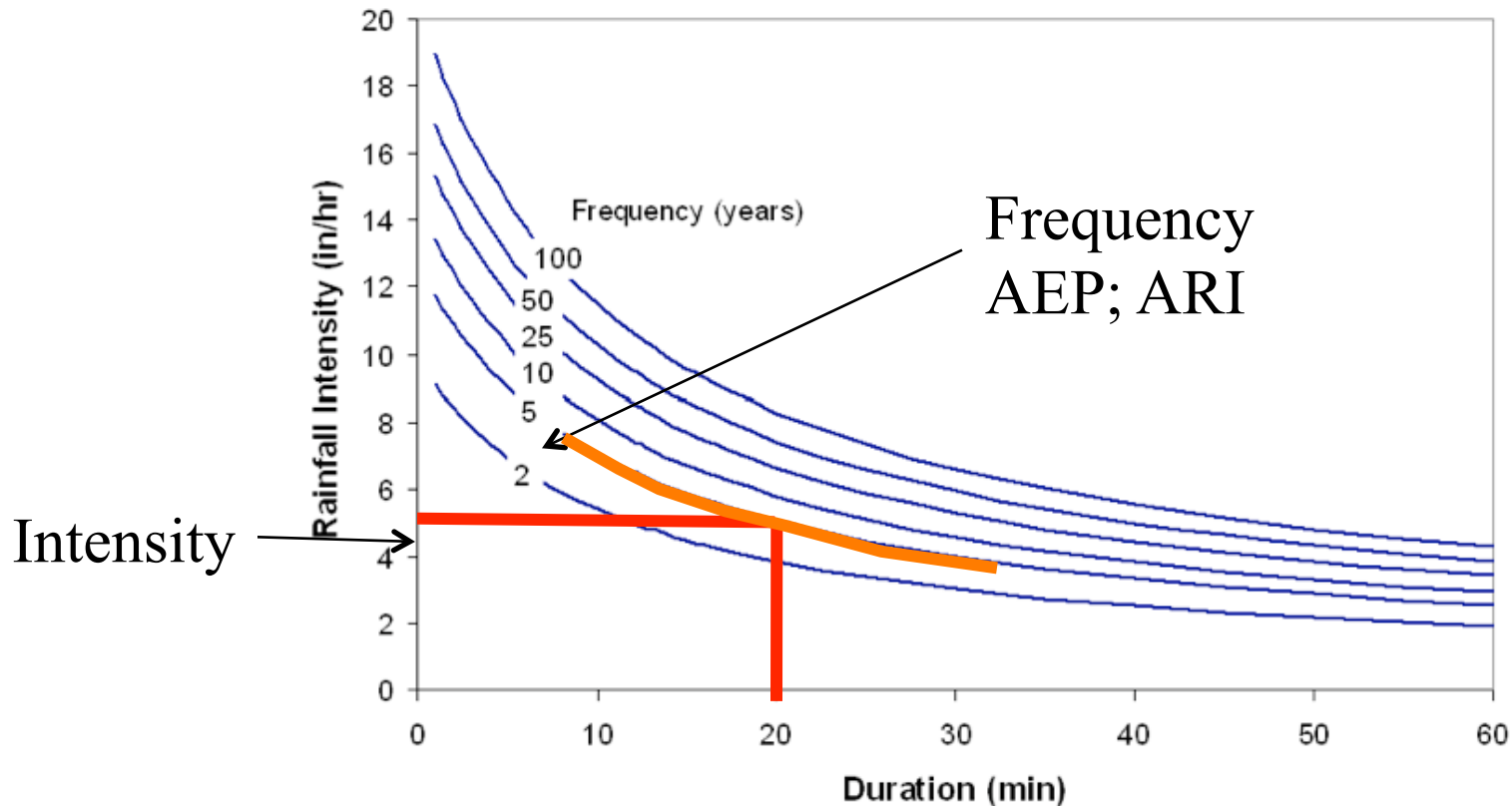
- Intensity (average rate) from depth  
e.g. 12 hour, 100-year (AEP=1%), depth is 70 mm  
average intensity is  $70\text{mm}/12\text{hr} = 5.8 \text{ mm/hr}$



# Intensity-Duration-Frequency

- IDF curves

e.g. 20 min, 5-year (AEP=20%), intensity is 5.5 in/hr



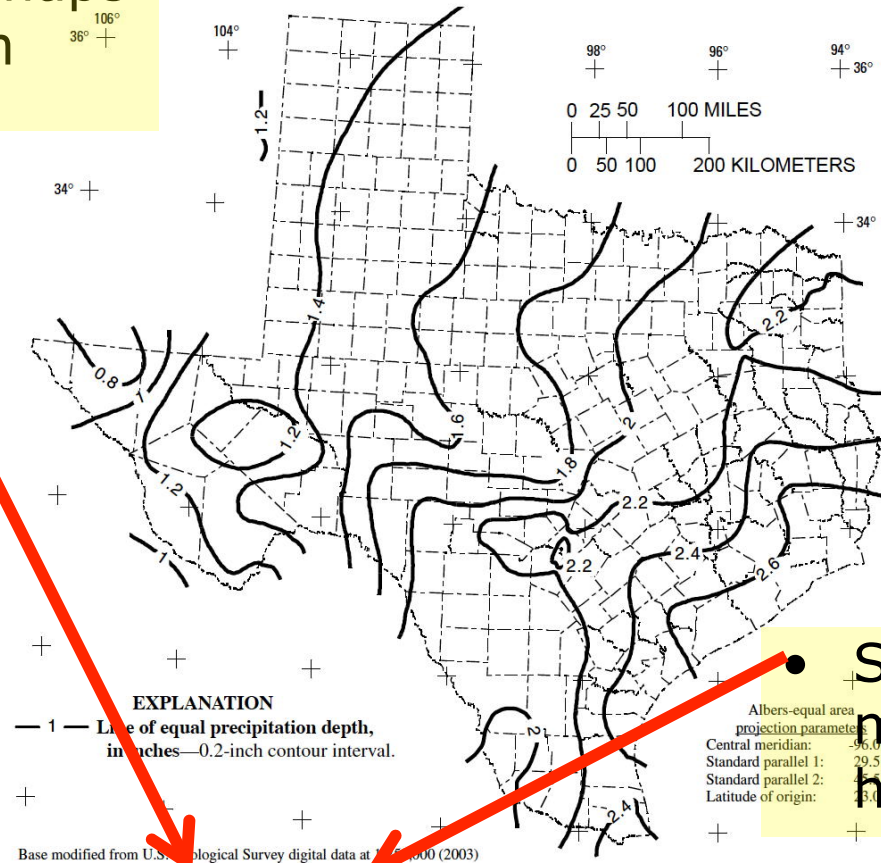
# Example: Intensity for Harris County

- Estimate the rainfall intensity for a 50%-chance, 2 hour storm for Harris County using the DDF Atlas
  - Step 1: Select the AEP (50% = 2yr storm)
  - Step 2: Locate maps for 2-year storm (Figures 4-15 in the DDF Atlas)
  - Step 3: Find the map that corresponds to a 2-hour storm.
  - Step 4: Locate Harris County, estimate the depth from the contour lines.
  - Step 5: Compute the intensity from  $i_{avg} = \frac{D}{T_C}$

# Example: Intensity for Harris County

14 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

- Step 2: Locate maps for 2-year storm



- Step 3: Find the map for the 2-hour storm.

Figure 7. Depth of precipitation for 2-year storm for 2-hour duration in Texas.

# Example: Intensity for Harris County

14 Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

- Step 4: Locate Harris County, estimate the depth from the contour lines.

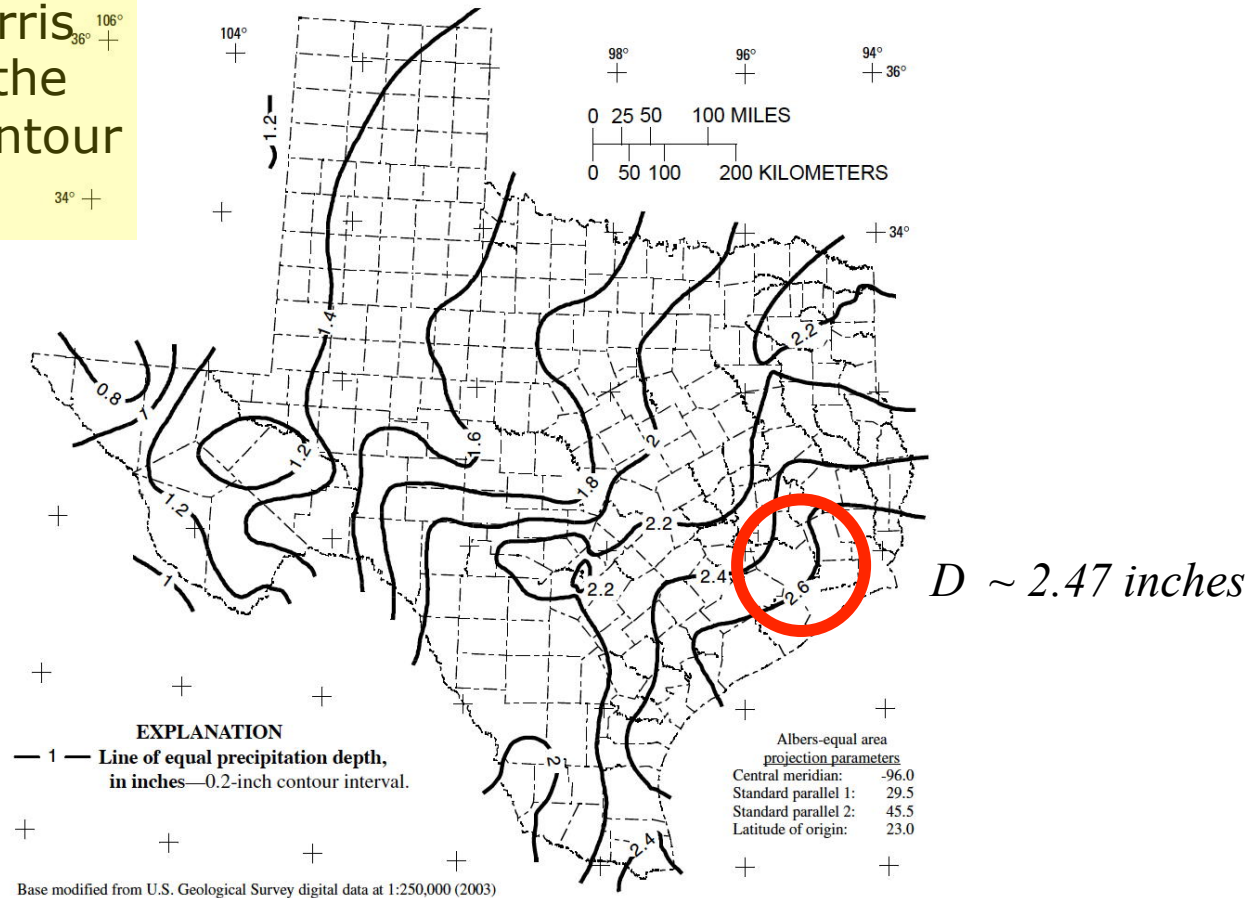


Figure 7. Depth of precipitation for 2-year storm for 2-hour duration in Texas.



# Example: Intensity for Harris County

- Step 5: Compute the intensity from

$$i_{avg} = \frac{D}{T_C} = \frac{2.47 \text{ in.}}{2 \text{ hrs.}} = 1.23 \text{ in/hr}$$

# Intensity-Duration-Frequency Tools

- EBDLKUP-NEW.xlsx is a spreadsheet tool that represents the rainfall IDF as the power law equation

$$I_{AEP;COUNTY} = \frac{B}{(T_c + D)^E}$$

- The coefficients  $E, B,$  and  $D$  are different for each county and each mapped AEP.
- The coefficients,  $E, B,$  and  $D,$  are based upon the information contained in the DDF Atlas (maps).

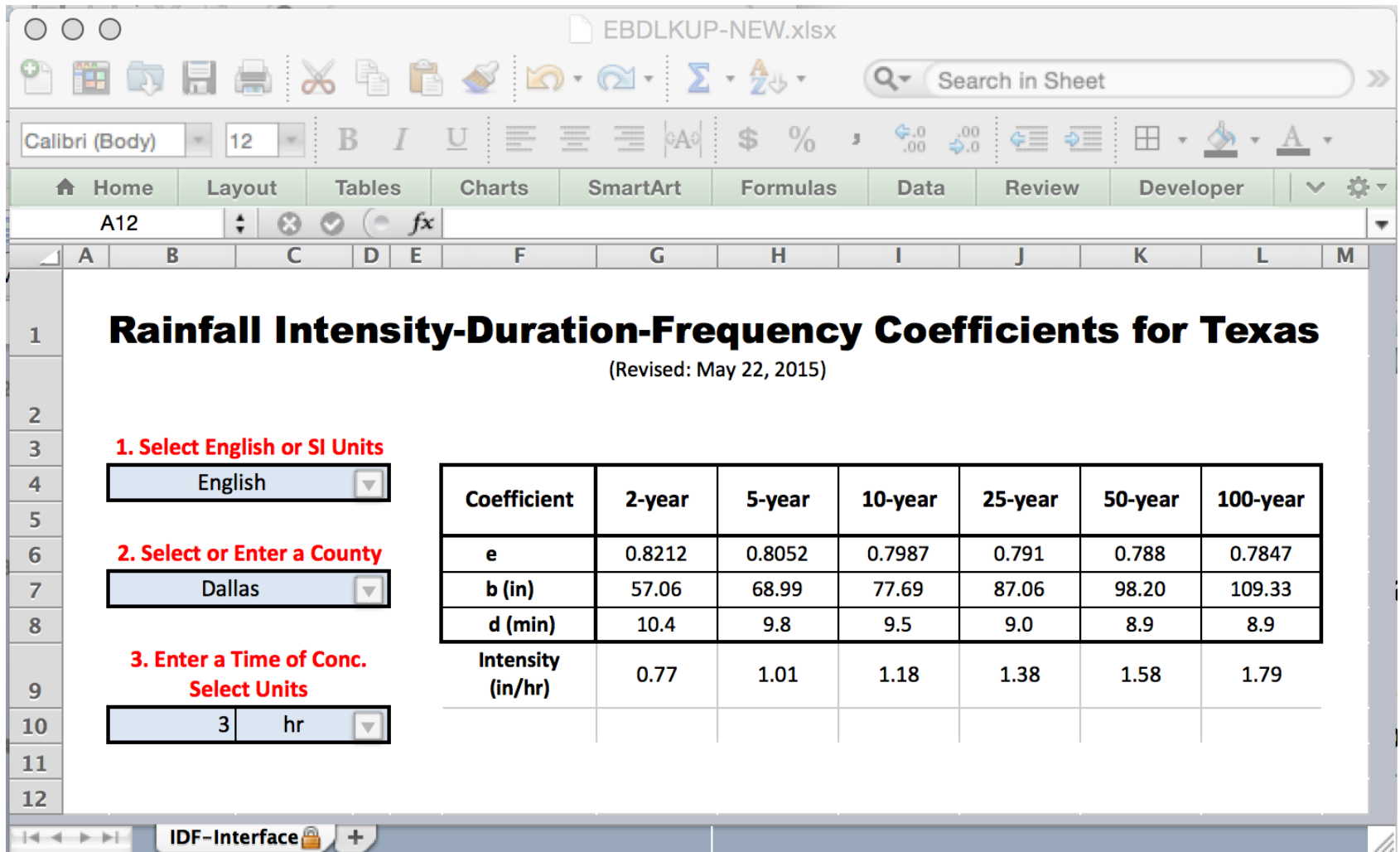
# Intensity-Duration-Frequency Tools

- The coefficient  $B$  has different numerical value in US customary and SI unit system.
  - The returned intensity is inches-per-hour in the US customary system
  - The returned intensity is millimeters-per-hour in the SI system
- The duration  $T_c$  does not need to correspond to a mapped value.

# EBDLKUP-NEW.xlsx

- The spreadsheet is distributed as a .ZIP archive
- The archive includes the spreadsheet, the research report, a tutorial video, and a tutorial document.
  - The video and tutorial document are hyperlinks within the spreadsheet – the links will not work if the spreadsheet is moved to a different directory from these files; however the spreadsheet itself will function fine without the files, but the user wont be able to access the video or tutorials.

# EBDLKUP-NEW.xlsx



**Rainfall Intensity-Duration-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

**1. Select English or SI Units**  
English

**2. Select or Enter a County**  
Dallas

**3. Enter a Time of Conc. Select Units**  
3 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.8212	0.8052	0.7987	0.791	0.788	0.7847
b (in)	57.06	68.99	77.69	87.06	98.20	109.33
d (min)	10.4	9.8	9.5	9.0	8.9	8.9
Intensity (in/hr)	0.77	1.01	1.18	1.38	1.58	1.79

# Example: Intensity for Harris County

- Estimate the rainfall intensity for a 50%-chance, 2 hour storm for Harris County using EBDLKUP-NEW.xlsx.
  - Step 1: Select the units (English)
  - Step 2: Select HARRIS county from the pull-down menu (or type HARRIS into the dialog box)
  - Step 3: Select the storm duration (2 hours) and the time units (hours)

# Example: Intensity for Harris County

- Step 1: Select the units (English)

**1. Select English or SI Units**

English

English

SI

Click

**3. Enter a Time of Conc. Select Units**

3 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.8212	0.8052	0.7987	0.791	0.788	0.7847
b (in)	57.06	68.99	77.69	87.06	98.20	109.33
d (min)	10.4	9.8	9.5	9.0	8.9	8.9
Intensity (in/hr)	0.77	1.01	1.18	1.38	1.58	1.79

# Example: Intensity for Harris County

- Step 2: Select HARRIS county from the pull-down menu

The screenshot shows an Excel spreadsheet with the following content:

**Rainfall Intensity**

1. Select English or SI Units  
English

2. Select or Enter a County  
Dallas

3. Enter a Time of Conc. Select Units  
3 hr

**Return-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

	2-year	5-year	10-year	25-year	50-year	100-year
	0.8212	0.8052	0.7987	0.791	0.788	0.7847
	57.06	68.99	77.69	87.06	98.20	109.33
	10.4	9.8	9.5	9.0	8.9	8.9
	0.77	1.01	1.18	1.38	1.58	1.79

County List: Erath, Falls, Fannin, Fayette, Fisher, Floyd, Foard, Fort Bend, Franklin, Freestone, Frio, Gaines, Galveston, Garza, Gillespie, Glasscock, Goliad, Gonzales, Gray, Grayson, Gregg, Grimes, Guadalupe, Hale, Hall, Hamilton, Hansford, Hardeman, Hardin, **Harris**



# Example: Intensity for Harris County

- Step 3: Enter the storm duration (2 hours) and select the time units (hours)

**Rainfall Intensity-Duration-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

1. Select English or SI Units  
English

2. Select or Enter a County  
Harris

3. Enter a Time of Conc.  
Select Units  
2 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.7939	0.7855	0.7829	0.7774	0.7727	0.772
b (in)	57.73	73.87	86.47	102.23	116.88	136.33
d (min)	9.5	10.5	11.3	12.3	13.0	14.1
Intensity (in/hr)	1.21	1.61	1.90	2.29	2.67	3.11

# Example: Intensity for Harris County

- Step 4: Find result for desired AEP (2-yr is 50% storm)

**Rainfall Intensity-Duration-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

1. Select English or SI Units  
English

2. Select or Enter a County  
Harris

3. Enter a Time of Conc.  
Select Units  
2 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.7939	0.7855	0.7829	0.7774	0.7727	0.772
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d (min)	2.5	10.5	11.3	12.3	13.0	14.1
Intensity (in/hr)	1.21	1.61	1.90	2.29	2.67	3.11

# Purpose of the Tools

- The EBDLKUP-NEW tool greatly reduces effort required to interpolate duration values that are not mapped.
- The  $E$ ,  $B$ , and  $D$  values can be entered into GeoPack Drainage (or WinStorm) for drainage design.

# Comparison of the Tools

- The results from the map and the spreadsheet tool are nearly the same.
- The results are not identical because:
  - The map requires the designer to estimate a depth based on nearby contour lines
  - The EBDLKUP-NEW uses the estimated depth at the county centroid
- The EBDLKUP-NEW tool reduces effort required to interpolate duration values that are not mapped
- The  $E$ ,  $B$ , and  $D$  values can be entered into GeoPack Drainage (or WinStorm) for drainage design.

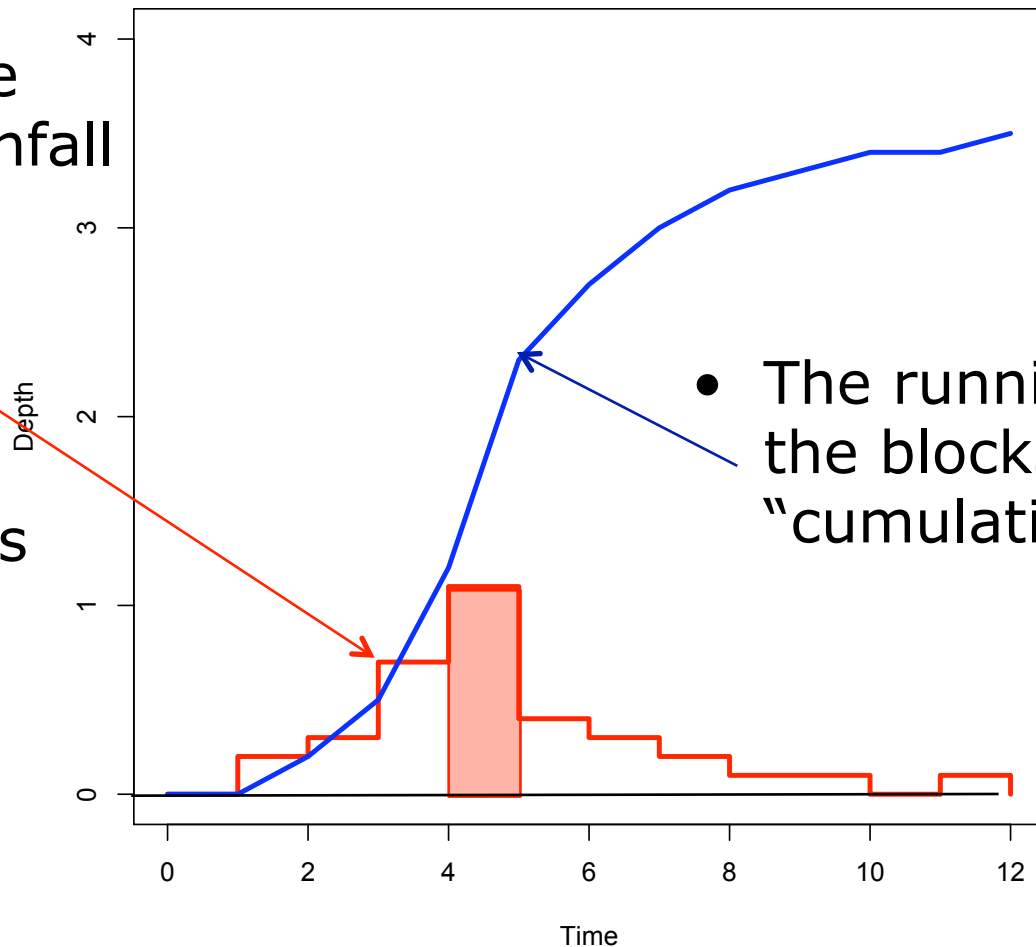
# Design Storms

- Design storms are rainfall distributions that represent temporal patterns of a storm.
- A rainfall distribution is also called a hyetograph.
  - Rainfall distributions are used when we need to estimate an entire hydrograph.

# Rainfall distributions

- Each “block” represents the amount of rainfall for the time interval

- The diagram is called “incremental” rainfall



- The running sum of the blocks is the “cumulative” rainfall

# Rainfall distributions

- Design storm (distributions) are created from historical storms and analyzed to generate statistical models of rainfall.
- Design storm distributions are typically dimensionless hyetographs
  - NRCS Type Storms
  - Empirical Texas Hyetographs

# Texas Empirical Hyetographs

- Alternative to SCS Type Curves is the Texas Empirical Hyetographs
  - Based on Texas data.
  - Reflects “front loading” observed in many real storms.
  - Rescales time and depth.



In cooperation with the Texas Department of Transportation

**Empirical, Dimensionless, Cumulative-Rainfall Hyetographs Developed From 1959–86 Storm Data for Selected Small Watersheds in Texas**

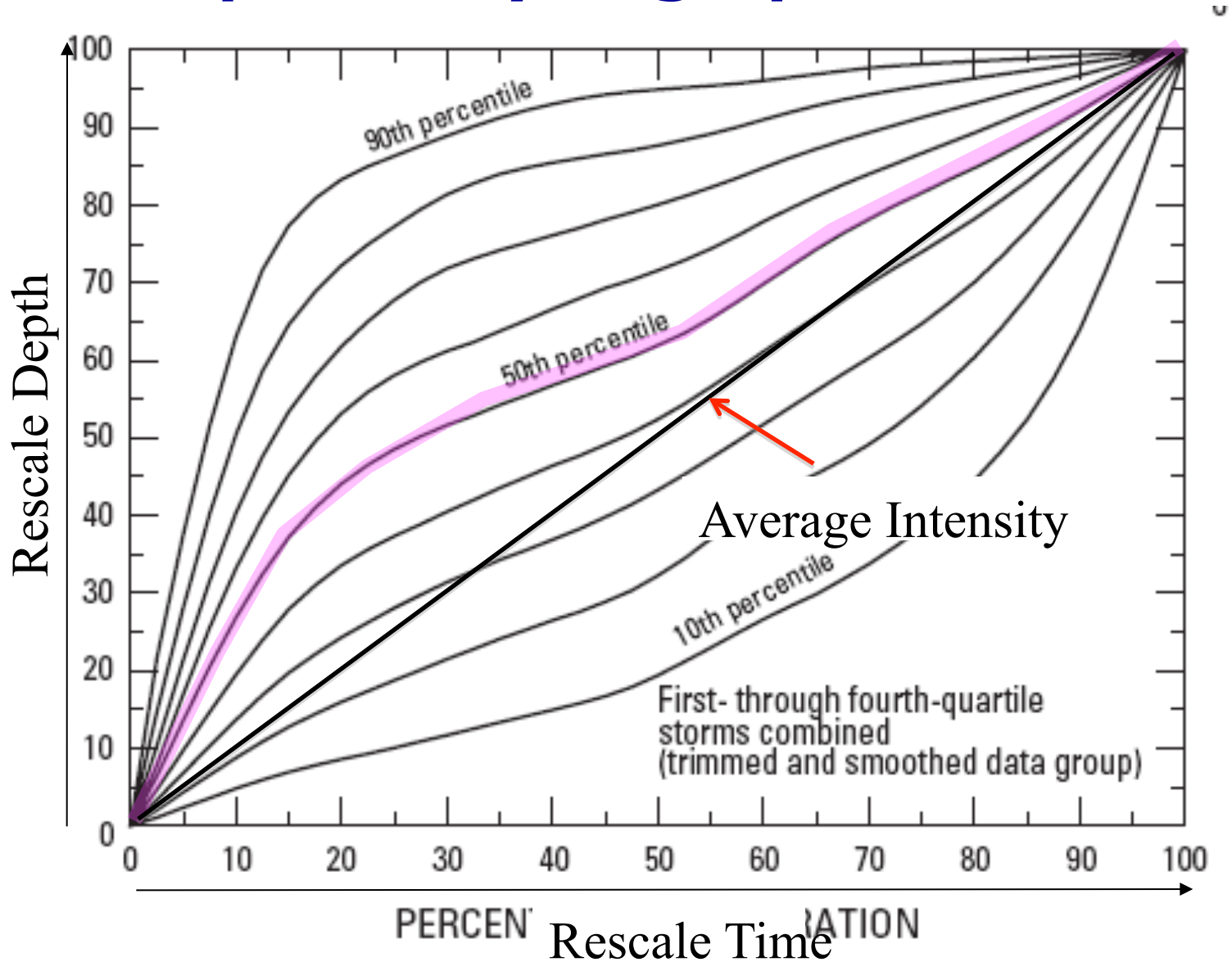


Scientific Investigations Report 2004–5075  
(TxDOT Research Report 0–4194–3)

U.S. Department of the Interior  
U.S. Geological Survey



# Texas Empirical Hyetographs



# Texas Empirical Hyetographs

- The 50<sup>th</sup> percentile curves represents the median behavior of observed storms in Texas that were known to produce runoff.
- To use the curves:
  1. Select a desired AEP.
  2. Select the desired storm duration.
  3. Use DDF Atlas or EBDLKUP-NEW to estimate the storm depth for the selected AEP and duration.
  4. Multiply the time axis by the storm duration.
  5. Multiply the depth axis by the storm depth.
- Result is a cumulative design storm distribution for given duration and AEP.

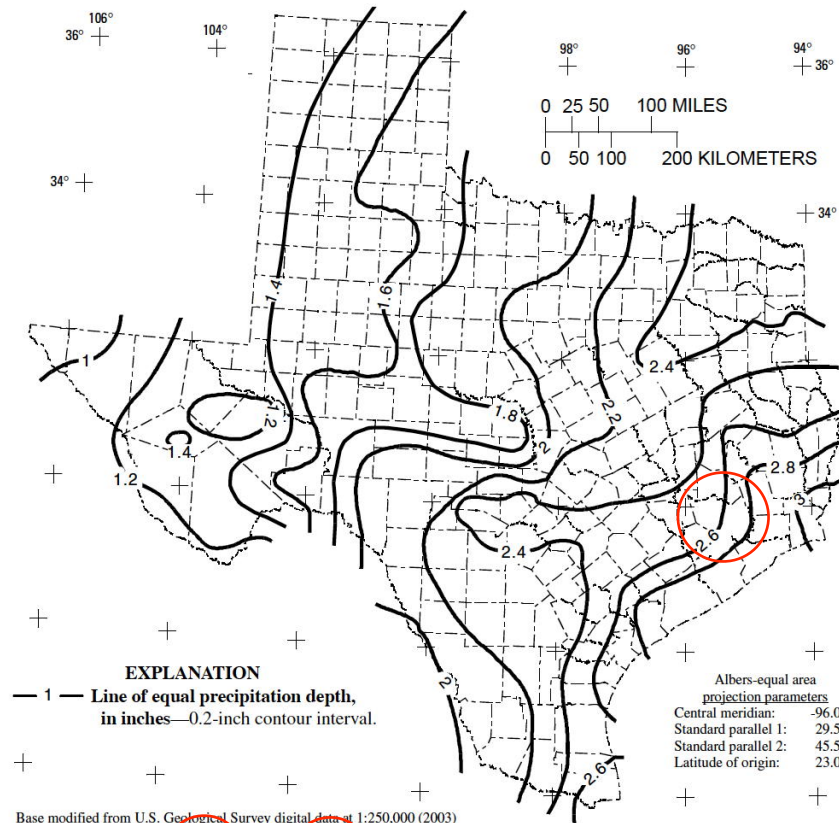
# Example: Texas Empirical Hyetographs

- Construct a design storm for the 3-hour, 2-year rainfall in Harris County using the Texas Empirical Hyetograph
  1. Obtain the depth from the DDF Atlas
  2. Rescale the depth and time using the Texas Empirical Hyetograph

# Example: Texas Empirical Hyetographs

1. Obtain the depth from the DDF Atlas

Figure 8 15

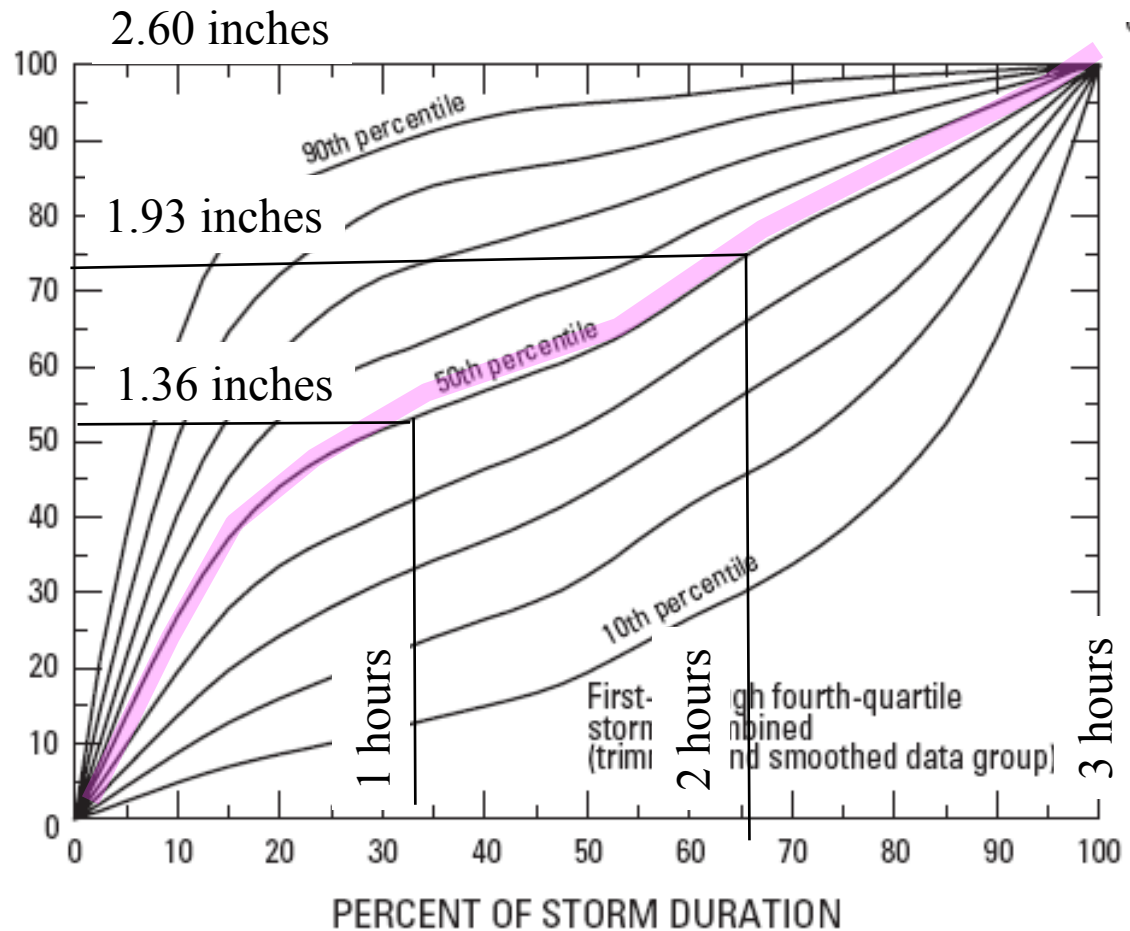


*D ~ 2.6 inches*

Figure 8. Depth of precipitation for 2-year storm for 3-hour duration in Texas.

# Example: Texas Empirical Hyetographs

## 2. Rescale depth and time using the Texas Hyetograph



# Texas Empirical Hyetographs Tools

- The empirical hyetograph is tedious to generate from the curves if short time intervals are desired (say every 10 minutes).
- TXHYETO.xlsx is a spreadsheet tool that approximated the 50<sup>th</sup> percentile curve and the 90<sup>th</sup> percentile curve using a distribution-mixture function model.

# Texas Empirical Hyetographs Tools

- The empirical hyetograph is tedious to generate from the curves if short time intervals are desired (say every 10 minutes).
- TXHYETO.xlsx is a spreadsheet tool that approximates the 50<sup>th</sup> percentile curve and the 90<sup>th</sup> percentile curve using a distribution-mixture function model.
- TXHYETO.xlsx can be used stand-alone, but it was built to be used in conjunction with EBDLKUP-NEW.xlsx

# TXHYETO.xlsx

- The spreadsheet is distributed as a .ZIP archive
- The archive includes the spreadsheet, the research report, a tutorial video, and a tutorial document.
  - The video and tutorial document are hyperlinks within the spreadsheet – the links will not work if the spreadsheet is moved to a different directory from these files; however the spreadsheet itself will function fine without the files, but the user won't be able to access the video or tutorials.



# TXHYETO.xlsx

TXHYETO-Function.xlsx

Search in Sheet

Arial 10 B I U ... \$ % ' .0 .00

Home Layout Tables Charts SmartArt Formulas

C27

Spreadsheet to Dimensionalize Texas Hyetographs																																													
(Revised: June 24, 2015)																																													
1																																													
2																																													
3																																													
4	<b>1. Enter a Storm Duration</b>				<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="background-color: #e0e0e0;">50TH PERCENTILE HYETOGRAPH</th> </tr> <tr> <th style="text-align: left;">Time (min)</th> <th style="text-align: left;">Time (hrs)</th> <th style="text-align: left;">Depth (in)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0.000</td> </tr> <tr> <td style="text-align: center;">60</td> <td style="text-align: center;">1.00</td> <td style="text-align: center;">1.000</td> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>					50TH PERCENTILE HYETOGRAPH			Time (min)	Time (hrs)	Depth (in)	0	0	0.000	60	1.00	1.000																								
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12	<b>3. Enter a desired Time Interval</b>																																												
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14	<input style="width: 50px;" type="text" value="60"/>	minutes																																											
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16																																													
17	<i>Mixture Model Parameters (50th)</i>																																												
18	w <sub>1</sub>	1.038977																																											
19	a	0.795463																																											
20	b	3.485892																																											
21	w <sub>2</sub>	0.248833																																											
22	m	0.471874																																											
23	s	0.283391																																											
24																																													

50th Percentile 90th Percentile +

# Example: Texas Empirical Hyetographs

- Construct a design storm in 10 minute increments for a 3-hour, 2-year rainfall in Harris County using the TXHYETO.xlsx and EBDLKUP-NEW.xlsx
  1. Obtain the intensity value from EBDLKUP-NEW.xlsx
  2. Multiply this value by the duration (3 hours) to obtain the storm depth.
  3. Enter the total duration into TXHYETO.xlsx
  4. Enter the total depth into TXHYETO.xlsx
  5. Enter time step size into TXHYETO.xlsx
- Result is a design storm for specified AEP, depth, and duration.

# Example: Texas Empirical Hyetographs

1. Obtain the intensity value from EBDLKUP-NEW.xlsx

**Rainfall Intensity-Duration-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

1. Select English or SI Units  
English

2. Select or Enter a County  
Harris

3. Enter a Time of Conc. Select Units  
3 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.7939	0.7855	0.7829	0.7774	0.7727	0.772
b (in)	57.73	73.87	86.47	102.23	116.88	136.33
d (min)	9.5	10.5	11.3	12.3	13.0	14.1
Intensity (in/hr)	0.90	1.20	1.41	1.71	2.00	2.33

# Example: Texas Empirical Hyetographs

2. Multiply this value by the duration (3 hours) to obtain the storm depth.

$$D = (0.9 \text{ in/hr})(3 \text{ hr}) = 2.7 \text{ inches}$$

# Example: Texas Empirical Hyetographs

- Enter the total duration into TXHYETO.xlsx

**Spreadsheet to Dimensionalize Texas Hyetographs**  
(Revised: June 24, 2015)

1. Enter a Storm Duration  
(from DDF Atlas, TP40, or equivalent)  
3 hours

2. Enter a Storm Depth  
(from DDF Atlas, TP40, or equivalent)  
1 inches

3. Enter a desired Time Interval  
(recommend intervals perfectly divisible by storm duration)  
60 minutes

Mixture Model Parameters (50th)

Parameter	Value
$w_1$	1.038977
$a$	0.795463
$b$	3.485892
$w_2$	0.248833
$m$	0.471874
$s$	0.283391

50TH PERCENTILE HYETOGRAPH		
Time (min)	Time (hrs)	Depth (in)
0	0	0.000
60	1.00	0.537
120	2.00	0.747
180	3.00	1.000

50th Percentile 90th Percentile +

# Example: Texas Empirical Hyetographs

4. Enter the total depth into TXHYETO.xlsx

The screenshot shows the 'TXHYETO-Function.xlsx' spreadsheet. The title is 'Spreadsheet to Dimensionalize Texas Hyetographs' (Revised: June 24, 2015). The spreadsheet is divided into three main sections:

- Input Section:** Three red instructions with corresponding input boxes:
  - 1. Enter a Storm Duration (from DDF Atlas, TP40, or equivalent):  hours
  - 2. Enter a Storm Depth (from DDF Atlas, TP40, or equivalent):  inches (highlighted with a red arrow)
  - 3. Enter a desired Time Interval (recommend intervals perfectly divisible by storm duration):  minutes
- 50TH PERCENTILE HYETOGRAPH Table:**

Time (min)	Time (hrs)	Depth (in)
0	0	0.000
60	1.00	1.449
120	2.00	2.016
180	3.00	2.700
- Mixture Model Parameters (50th):**

$w_1$	1.038977
$a$	0.795463
$b$	3.485892
$w_2$	0.248833
$m$	0.471874
$s$	0.283391

At the bottom, there are tabs for '50th Percentile' and '90th Percentile'.

# Example: Texas Empirical Hyetographs

5. Enter time step size into TXHYETO.xlsx
  - The spreadsheet automatically fills the depth column with the cumulative depths for each time increment

The screenshot shows the 'TXHYETO-Function.xlsx' spreadsheet. The title is 'Spreadsheet to Dimensionalize Texas Hyetographs' (Revised: June 24, 2015). The spreadsheet is divided into three main sections:

- 1. Enter a Storm Duration** (from DDF Atlas, TP40, or equivalent): A text box contains the value '3' hours.
- 2. Enter a Storm Depth** (from DDF Atlas, TP40, or equivalent): A text box contains the value '2.7' inches.
- 3. Enter a desired Time Interval** (recommend intervals perfectly divisible by storm duration): A text box contains the value '10' minutes. A red arrow points to this box from the left.

Below these inputs are the 'Mixture Model Parameters (50th)':

w <sub>1</sub>	1.038977
a	0.795463
b	3.485892
w <sub>2</sub>	0.248833
m	0.471874
s	0.283391

On the right side, there is a table titled '50TH PERCENTILE HYETOGRAPH' with columns for 'Time (min)', 'Time (hrs)', and 'Depth (in)'. A pink arrow points to the 'Depth (in)' column. The data in the table is as follows:

Time (min)	Time (hrs)	Depth (in)
0	0	0.000
10	0.17	0.430
20	0.33	0.805
30	0.50	1.061
40	0.67	1.237
50	0.83	1.359
60	1.00	1.449
70	1.17	1.525
80	1.33	1.600
90	1.50	1.684
100	1.67	1.782
110	1.83	1.894
120	2.00	2.016
130	2.17	2.143
140	2.33	2.267
150	2.50	2.382
160	2.67	2.484
170	2.83	2.570
180	3.00	2.700

A pink arrow points to the '180' row in the table. At the bottom, there are tabs for '50th Percentile' and '90th Percentile'. A pink arrow points to the '50th Percentile' tab.

# Texas Empirical Hyetographs

- The result is then ready to paste into HEC-HMS or similar tools that make use of a design storm.
- The next example illustrates using the two tools to input a design storm into HEC-HMS



# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

- The result is then ready to paste into HEC-HMS or similar tools that make use of a design storm.
- The next example illustrates using the two tools to input a design storm into HEC-HMS

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

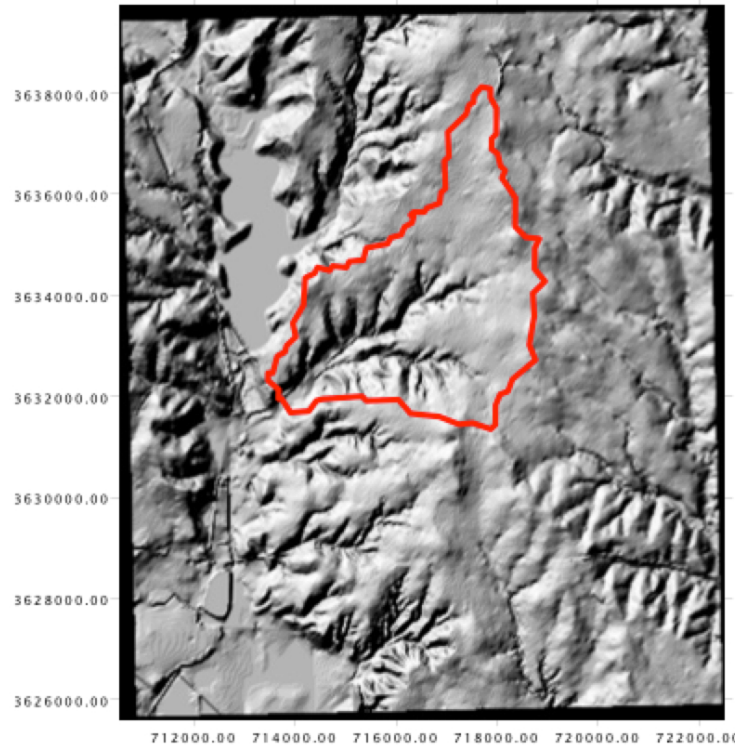
## Watershed Properties

AREA=6.92 mi<sup>2</sup>

MCL=5.416 mi

MCS=0.005595

CN=86



- Consider a watershed with the properties in the figure.
- The watershed is located in Dallas County, Texas
- Estimate the response of a 5-year, 3-hour storm using HEC-HMS

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

**Rainfall Intensity-Duration-Frequency Coefficients for Texas**  
(Revised: May 22, 2015)

1. Select English or SI Units  
English

2. Select or Enter a County  
Dallas

3. Enter a Time of Conc. Select Units  
3 hr

Coefficient	2-year	5-year	10-year	25-year	50-year	100-year
e	0.8212	0.8052	0.7987	0.791	0.788	0.7847
b (in)	57.06	68.99	77.69	87.06	98.20	109.33
d (min)	10.4	9.8	9.5	9.0	8.9	8.9
Intensity (in/hr)	0.77	1.01	1.18	1.38	1.58	1.79

- Estimate the response of a 5-year, 3-hour storm using HEC-HMS
- EBDLKUP-NEW estimates the intensity as 1.01 in/hr
- The product of that intensity and duration estimates the depth as 3.03 inches

$$1.01 \text{ in/hr} \times 3.0 \text{ hr} = 3.03 \text{ inches}$$

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

TXHYETO-Function.xlsx

Search in Sheet

Calibri 11

Home Layout Tables Charts SmartArt Formulas

B14 fx 10

**Spreadsheet to Dimensionalize Texas Hyetographs**  
(Revised: June 24, 2015)

**1. Enter a Storm Duration**  
(from DDF Atlas, TP40, or equivalent)

hours

**2. Enter a Storm Depth**  
(from DDF Atlas, TP40, or equivalent)

inches

**3. Enter a desired Time Interval**  
(recommend intervals perfectly divisible by storm duration)

minutes

Mixture Model Parameters (50th)

w <sub>1</sub>	1.038977
a	0.795463
b	3.485892
w <sub>2</sub>	0.248833
m	0.471874
s	0.283391

50TH PERCENTILE HYETOGRAPH		
Time (min)	Time (hrs)	Depth (in)
0	0	0.000
10	0.17	0.482
20	0.33	0.903
30	0.50	1.190
40	0.67	1.388
50	0.83	1.525
60	1.00	1.626
70	1.17	1.711
80	1.33	1.796
90	1.50	1.890
100	1.67	2.000
110	1.83	2.126
120	2.00	2.263
130	2.17	2.405
140	2.33	2.544
150	2.50	2.673
160	2.67	2.788
170	2.83	2.884
180	3.00	3.030

50th Percentile 90th Percentile +

- Enter the duration and depth into TXHYETO
- Enter the desired simulation time step (10 minutes this example)
- Result is a design storm that can be supplied to HEC-HMS

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

**Spreadsheet to Dimensionalize Texas Hyetographs**  
(Revised: June 24, 2015)

1. Enter a Storm Duration  
(from DDF Atlas, TP40, or equivalent)  
3 hours

2. Enter a Storm Depth  
(from DDF Atlas, TP40, or equivalent)  
3.03 inches

3. Enter a desired Time Interval  
(recommend intervals perfectly divisible by storm duration)  
10 minutes

50TH PERCENTILE HYETOGRAPH			
Time (min)	Time (hrs)	Depth (in)	
0	0	0	0.000
10	0.17	0	0.482
20	0.33	0	0.903
30	0.50	0	1.190
40	0.67	0	1.388
50	0.83	0	1.525
60	1.00	0	1.626
70	1.17	0	1.711
80	1.33	0	1.796
90	1.50	0	1.890
100	1.67	0	2.000
110	1.83	2	2.126
120	2.00	2	2.263
130	2.17	2	2.405
140	2.33	2	2.544
150	2.50	2	2.673
160	2.67	2	2.788
170	2.83	2	2.884
180	3.00	2	3.030

Mixture Model Parameters (50th)

$w_1$	1.038977
$a$	0.795463
$b$	3.485892
$w_2$	0.248833
$m$	0.471874
$s$	0.283391

HEC-HMS 4.0 [C:\...My Documents\Example\_TXHYETO\Example\_TXHYETO.hms]

Example-TXHYETO

- Basin Models
  - Example-TXHYETO
    - MySubBasin
- Meteorologic Models
  - Example-TXHYETO
    - Specified Hyetograph
- Control Specifications
  - Control 1
- Time-Series Data
  - Precipitation Gages
    - TXHYETO-DesignStorm
      - 01Jan2000, 00:00 - 01Jan2000, 23:00

Components: Compute Results

Time-Series Gage | Time Window | Table | Graph

Name: TXHYETO-DesignStorm

Description: [ ]

Data Source: Manual Entry

Units: Cumulative Inches

Time Interval: 10 Minutes

Latitude Degrees: [ ]

Latitude Minutes: [ ]

Latitude Seconds: [ ]

Longitude Degrees: [ ]

Longitude Minutes: [ ]

Longitude Seconds: [ ]

- HMS model ready to receive the hyetograph (How to build model is covered in DES-606)

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

The screenshot displays two windows side-by-side. The left window is an Excel spreadsheet titled 'TXHYETO-Function.xlsx' with the following content:

**Spreadsheet to Dimensionalize Texas Hyetographs**  
(Revised: June 24, 2015)

- Enter a Storm Duration (from DDF Atlas, TP40, or equivalent): 3 hours
- Enter a Storm Depth (from DDF Atlas, TP40, or equivalent): 3.03 inches
- Enter a desired Time Interval (recommended intervals perfectly divisible by storm duration): 10 minutes

**Mixture Model Parameters (50th)**

w <sub>1</sub>	1.038977
a	0.795463
b	3.485892
w <sub>2</sub>	0.248833
m	0.471874
s	0.283391

**50TH PERCENTILE HYETOGRAPH**

Time (min)	Time (hrs)	Depth (in)
0	0	0.000
10	0.17	0.482
20	0.33	0.903
30	0.50	1.190
40	0.67	1.388
50	0.83	1.525
60	1.00	1.626
70	1.17	1.711
80	1.33	1.796
90	1.50	1.890
100	1.67	2.000
110	1.83	2.126
120	2.00	2.263
130	2.17	2.405
140	2.33	2.544
150	2.50	2.673
160	2.67	2.788
170	2.83	2.884
180	3.00	3.030

The right window is HEC-HMS 4.0. The 'Basin Model [Example-TXHYETO]' window shows a 'MySubBasin' component. The 'Time-Series Gage' window shows a table of precipitation data for a design storm:

Time (ddMMYYYY, HH:mm)	Precipitation (IN)
01Jan2000, 10:00	
01Jan2000, 10:10	
01Jan2000, 10:20	
01Jan2000, 10:30	
01Jan2000, 10:40	
01Jan2000, 10:50	
01Jan2000, 11:00	
01Jan2000, 11:10	
01Jan2000, 11:20	
01Jan2000, 11:30	
01Jan2000, 11:40	
01Jan2000, 11:50	
01Jan2000, 12:00	
01Jan2000, 12:10	
01Jan2000, 12:20	
01Jan2000, 12:30	
01Jan2000, 12:40	
01Jan2000, 12:50	
01Jan2000, 13:00	
01Jan2000, 13:10	
01Jan2000, 13:20	
01Jan2000, 13:30	

- Select the design storm from TXHYETO

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

The screenshot displays two windows. On the left is a Microsoft Excel spreadsheet titled 'TXHYETO-Function.xlsx'. It contains a '50TH PERCENTILE HYETOGRAPH' table with columns for Time (min), Time (hrs), and Depth (in). The table data is as follows:

Time (min)	Time (hrs)	Depth (in)
0	0	0.000
10	0.17	0.482
20	0.33	0.903
30	0.50	1.190
40	0.67	1.388
50	0.83	1.525
60	1.00	1.626
70	1.17	1.711
80	1.33	1.796
90	1.50	1.890
100	1.67	2.000
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140	2.33	2.544
150	2.50	2.673
160	2.67	2.788
170	2.83	2.884
180	3.00	3.030

Input fields in the spreadsheet show: Storm Duration = 3 hours, Storm Depth = 3.03 inches, and Time Interval = 10 minutes. The HEC-HMS software window on the right shows a project tree with 'Example-TXHYETO' selected. A 'Time-Series Gage' table is open, showing a list of time entries from 01Jan2000, 10:10 to 01Jan2000, 13:30. A context menu is open over the '01Jan2000, 11:00' entry, with 'Paste' selected.

- Select destination (in time) for the storm in HMS

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

**Spreadsheet to Dimensionalize Texas Hyetographs**  
(Revised: June 24, 2015)

1. Enter a Storm Duration  
(from DDF Atlas, TP40, or equivalent)  
3 hours

2. Enter a Storm Depth  
(from DDF Atlas, TP40, or equivalent)  
3.03 inches

3. Enter a desired Time Interval  
(recommend intervals perfectly divisible by storm duration)  
10 minutes

Mixture Model Parameters (50th)

$w_1$	1.038977
$a$	0.795463
$b$	3.485892
$w_2$	0.248833
$m$	0.471874
$s$	0.283391

Time (min)	Time (hrs)	Depth (in)
0	0	0.000
10	0.17	0.482
20	0.33	0.903
30	0.50	1.190
40	0.67	1.388
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170	2.83	2.884
180	3.00	3.030

HEC-HMS 4.0 [C:\...My Documents\Example\_TXHYETO\Example\_TXHYETO.hms]

Basin Model [Example-TXHYETO]

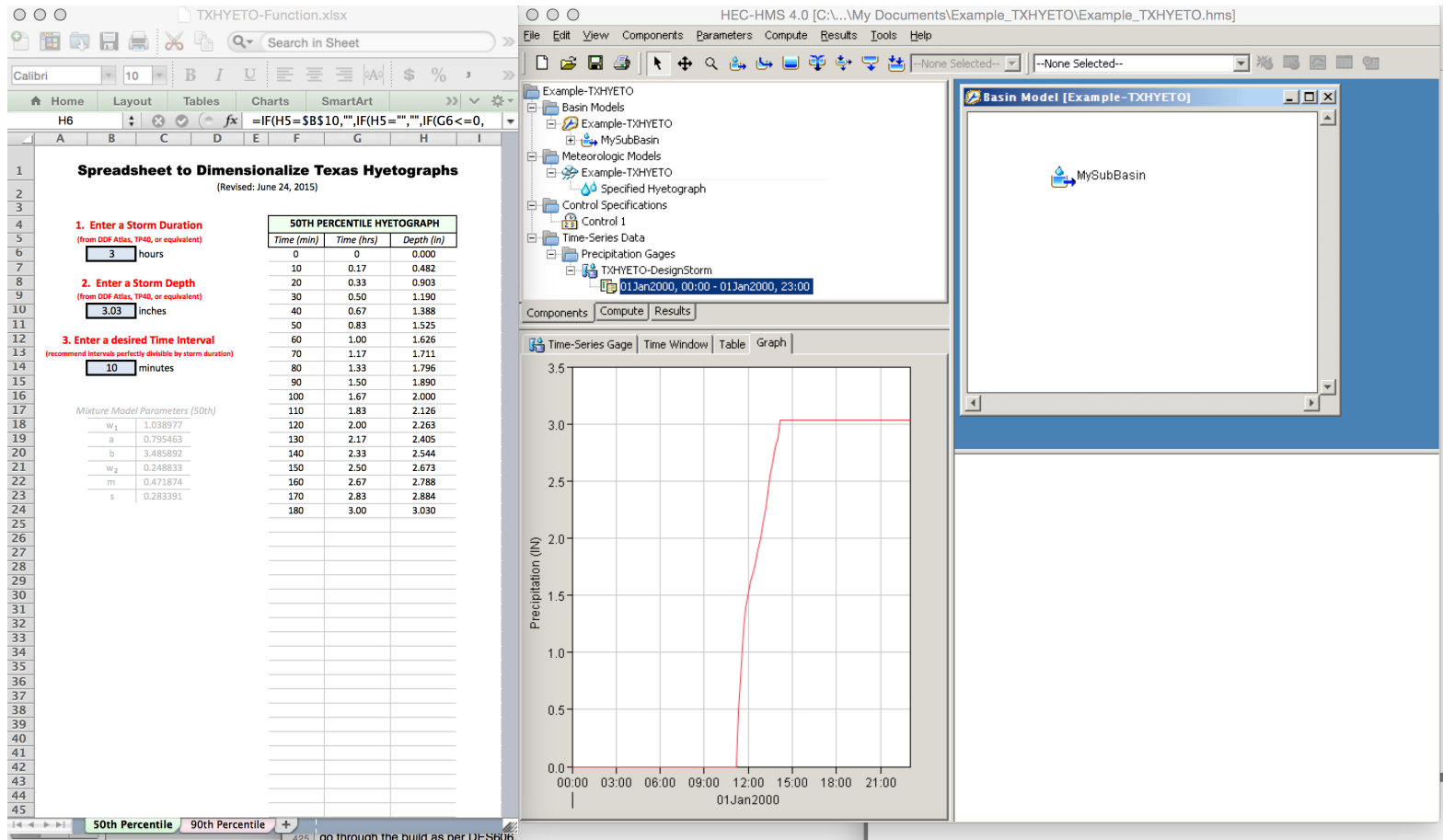
MySubBasin

Time (ddMMYYYY, HH:mm)	Precipitation (IN)
01Jan2000, 10:50	
01Jan2000, 11:00	
01Jan2000, 11:10	0.000
01Jan2000, 11:20	0.482
01Jan2000, 11:30	0.903
01Jan2000, 11:40	1.190
01Jan2000, 11:50	1.388
01Jan2000, 12:00	1.525
01Jan2000, 12:10	1.626
01Jan2000, 12:20	1.711
01Jan2000, 12:30	1.796
01Jan2000, 12:40	1.890
01Jan2000, 12:50	2.000
01Jan2000, 13:00	2.126
01Jan2000, 13:10	2.263
01Jan2000, 13:20	2.405
01Jan2000, 13:30	2.544
01Jan2000, 13:40	2.673
01Jan2000, 13:50	2.788
01Jan2000, 14:00	2.884
01Jan2000, 14:10	3.030
01Jan2000, 14:20	

- Paste the the design storm into HMS



# Integrated EBDLKUP, TXHYETO and HEC-HMS Example



- Fill missing values (see the report) and plot the storm to verify successful paste.

# Integrated EBDLKUP, TXHYETO and HEC-HMS Example

The screenshot displays the HEC-HMS 4.0 interface with three main components:

- Spreadsheet to Dimensionalize Texas Hyetographs:** A spreadsheet with input fields for storm duration (3 hours), storm depth (3.03 inches), and time interval (10 minutes). It includes a table for the 50th Percentile Hyetograph and Mixture Model Parameters (50th).
- Time-Series Gage:** A graph showing precipitation (in) over time (00:00 to 21:00 on 01Jan2000). The precipitation starts at 12:00, peaks at approximately 3.0 inches around 14:00, and ends at 15:00.
- Graph for Subbasin "MySubBasin":** Two stacked graphs showing results for Run "Run 1" on 01Jan2000. The top graph shows precipitation (in) with a peak of 3.03 inches at 14:00. The bottom graph shows flow (cfs) with a peak of approximately 2,000 cfs at 15:00. A legend identifies the series: Run:Run 1 Element:MySubBasin Result:Precipitation (blue), Run:Run 1 Element:MySubBasin Result:Precipitation Loss (orange), Run:Run 1 Element:MySubBasin Result:Outflow (blue), and Run:Run 1 Element:MySubBasin Result:Baseflow (red dashed).

- Run HEC-HMS to estimate the discharge hydrograph at the watershed outlet

# Summary

- Rainfall is described by DDF or IDF curves
- DDF values are obtained from NWS or similar sources – they are mapped to locations
- EBDLKUP-NEW can be used to estimate rainfall intensity (for use with the rational equation) directly.
- EBDLKUP-NEW can be used to estimate DDF values
  - The duration does not need to match a mapped time value.

# Summary

- Design storms are used to estimate temporal behavior during a storm – required when need to estimate an entire hydrograph
- Design storms based on the Texas Empirical Hyetographs can be built using TXHYETO
- The result from TXHYETO can be directly pasted into HEC-HMS (or SWMM)